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BSc Zoology Series

Volume IV

Ecology and Animal Behaviour



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BSc Zoology Series

Volume IV

Ecology and Animal Behaviour

B N Pandey

Professor and Head

Postgraduate Department of Zoology, Purnia College

(Affiliated to Bhupendra Narayan Mandal University, Madhepura)

Purnia, Bihar



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CONTENTS

ECOLOGY	1
Introduction 1, Ecology 2, Ecosystem 2, Ecological Pyramids or Eltonian Pyramids 4, Food Chain 4, Food Web 5, Energy Flow 5, Ecological Efficiencies 6, Ecological Succession 6, Biogeochemical Cycles 9, Biomes 9, Biodiversity and Conservation 10, Biogeographical Regions 12, Biogeographical Regions of India 12, Global Biodiversity 13, Biodiversity Conservation 15, Environmental Pollution 15	
ECOLOGY	32
(Long- and Short-Answer Questions) Structure and Functions of Ecosystem 32, Environmental Factors 38, Population Ecology 41, Biotic Interaction 44, Biodiversity 46, Biomes 48, Alien Species 51, Environmental Pollution 52	
STRUCTURE AND FUNCTIONS OF ECOSYSTEM	57
Multiple-Choice Questions 57, Answers to Multiple-Choice Questions 69, Fill in the Blanks 70, Answers to Fill in the Blanks 72, True or False 72, Answers to True or False 74, Give Reasons 74	
LIGHT, TEMPERATURE AND FIRE	77
Multiple-Choice Questions 77, Answers to Multiple-Choice Questions 83, Fill in the Blanks 84, Answers to Fill in the Blanks 85, True or False 85, Answers to True or False 86, Give Reasons 86	
SOIL ECOLOGY	88
Multiple-Choice Questions 88, Answers to Multiple-Choice Questions 94, Fill in the Blanks 95, Answers to Fill in the Blanks 96, True or False 96, Answers to True or False 97, Give Reasons 97	
POPULATION GROWTH AND REGULATION	99
Multiple-Choice Questions 99, Answers to Multiple-Choice Questions 106, Fill in the Blanks 106, Answers to Fill in the Blanks 107, True or False 108, Answers to True or False 109, Give Reasons 109	
SPECIES INTERACTION	111
Multiple-Choice Questions 111, Answers to Multiple-Choice Questions 116, Fill in the Blanks 116, Answers to Fill in the Blanks 117, True or False 118, Answers to True or False 119, Give Reasons 119	

NATURAL RESOURCES	120
Multiple-Choice Questions 120, Answers to Multiple-Choice Questions 127, Fill in the Blanks 127, Answers to Fill in the Blanks 128, True or False 129, Answers to True or False 130, Give Reasons 130	
BIODIVERSITY	132
Multiple-Choice Questions 132, Answers to Multiple-Choice Questions 141, Fill in the Blanks 141, Answers to Fill in the Blanks 143, True or False 143, Answers to True or False 144, Give Reasons 145	
BIOMES	146
Multiple-Choice Questions 146, Answers to Multiple-Choice Questions 156, Fill in the Blanks 156, Answers to Fill in the Blanks 158, True or False 158, Answers to True or False 159, Give Reasons 159	
ALIEN SPECIES	162
Multiple-Choice Questions 162, Answers to Multiple-Choice Questions 166, Fill in the Blanks 166, Answers to Fill in the Blanks 167, True or False 167, Answers to True or False 168, Give Reasons 168	
ECOTOXICOLOGY	169
Multiple-Choice Questions 169, Answers to Multiple-Choice Questions 174, Fill in the Blanks 174, Answers to Fill in the Blanks 175, True or False 175, Answers to True or False 176, Give Reasons 176	
POLLUTION	178
Multiple-Choice Questions 178, Answers to Multiple-Choice Questions 192, Fill in the Blanks 192, Answers to Fill in the Blanks 194, True or False 195, Answers to True or False 197, Give Reasons 197	
GLOBAL WARMING	200
Multiple-Choice Questions 200, Answers to Multiple-Choice Questions 205, Fill in the Blanks 205, Answers to Fill in the Blanks 206, True or False 206, Answers to True or False 207, Give Reasons 207	
ANIMAL BEHAVIOUR	209
Brief History 209, Innate Behaviour 209, Learned Behaviour 211, Habituation 211, Imprinting 212, Classical Conditioning 212, Operant Conditioning 212, Latent Learning 213, Communication in Animals 213, Territorial Behaviour 214, Courtship Behaviour 215, Parental Care 216, Migratory Behaviour 218, Pheromones and Behaviour 218, Types of Pheromones 219, Biological Clock 220, Social Behaviour 222	

INNATE AND LEARNED BEHAVIOUR (Long- and Short-Answer Questions) Biological Clock 228, Animal Communication 229, Pheromones and Behaviour 231, Social Behaviour 232, Parental Care 233	226
INNATE AND LEARNED BEHAVIOUR Multiple-Choice Questions 235, Answers to Multiple-Choice Questions 239, Fill in the Blanks 239, Answers to Fill in the Blanks 240, True or False 240, Answers to True or False 241, Give Reasons 241	235
BIOLOGICAL CLOCK Multiple-Choice Questions 242, Answers to Multiple-Choice Questions 247, Fill in the Blanks 247, Answers to Fill in the Blanks 248, True or False 248, Answers to True or False 249, Give Reasons 249	242
ANIMAL COMMUNICATION Multiple-Choice Questions 251, Answers to Multiple-Choice Questions 255, Fill in the Blanks 255, Answers to Fill in the Blanks 256, True or False 256, Answers to True or False 257, Give Reasons 257	251
PHEROMONES Multiple-Choice Questions 259, Answers to Multiple-Choice Questions 265, Fill in the Blanks 266, Answers to Fill in the Blanks 267, True or False 267, Answers to True or False 269, Give Reasons 269	259
SOCIAL BEHAVIOUR Multiple-Choice Questions 270, Answers to Multiple-Choice Questions 279, Fill in the Blanks 280, Answers to Fill in the Blanks 281, True or False 281, Answers to True or False 282, Give Reasons 283	270
MIGRATORY BEHAVIOUR Multiple-Choice Questions 284, Answers to Multiple-Choice Questions 289, Fill in the Blanks 289, Answers to Fill in the Blanks 290, True or False 291, Answers to True or False 292, Give Reasons 292	284
COURTSHIP AND PARENTAL CARE IN ANIMALS Multiple-Choice Questions 293, Answers to Multiple-Choice Questions 302, Fill in the Blanks 302, Answers to Fill in the Blanks 303, True or False 303, Answers to True or False 304, Give Reasons 305	293

PREFACE

This *BSc Zoology Series* of five volumes will be useful for all undergraduate students of life sciences. The series has been developed to follow a unique test-friendly approach to especially assist undergraduate-level students in exam preparation. Besides, the applicants of CSIR-NET, GATE, Civil Services and other competitive examinations will also find this series very helpful.

About The Series

The following five volumes collectively structure this series:

Volume 1: Animal Diversity

Volume 2: Cytology, Genetics and Molecular Genetics

Volume 3: Biochemistry, Physiology and Endocrinology

Volume 4: Ecology and Animal Behaviour

Volume 5: Evolution, Comparative Anatomy, Biometry, Economic Zoology and Animal Development

These volumes cover the latest syllabi, as per the UGC curricula, of BSc courses taught across different Indian universities. Each part of a volume in the series contains a synopsis which briefly introduces the theme and then details important features topic-wise. This is followed by a comprehensive section on objective-type questions which includes short-answer questions, long-answer questions, multiple-choice questions, fill in the blanks, true or false questions, and questions based on reasoning and diagrams.

This arrangement has been ideated to first get the students acquainted with a chapter by going through the synopsis and then attempt to answer different sets of questions based on that chapter. Such a flow seeks to encourage self-study and aids quick revision of the topics in a lesson. While the synopsis provides a clear framework and considerable depth to topic-wise study of the syllabi, the stupendous variety in exercises covers a broad spectrum of learning tools.

What Makes This Series Unique?

The changing pattern of syllabus of academic life-science courses has induced a change in the type of questions appearing in undergraduate-level examinations of major universities and noted competitive tests. A distinct alteration in the nature of objective questioning has been identified. Objective questions, now part of compulsory questions, include the variations mentioned above. It then becomes imperative that the students be made fully conversant with this new pattern.

However very few books, adequately containing the required pedagogical features, are available to facilitate such a pattern of study. Recognising the growing interest of students and a need for a comprehensive yet basic-level text, I have authored this *BSc Zoology Series* to aid test-ready academic study.

Besides students, this series will amply assist various faculty members in the design and preparation of periodical tests for internal evaluation, question papers for undergraduate-level university examinations as well as CSIR-NET, GATE and Civil Services examinations, etc.

Salient Features Of The Series

- Apposite theory to aid quick revision for examinations
- Wide range of chapter-end exercises designed as per undergraduate examinations
- Surplus artwork to help develop a holistic understanding of concepts

Volume IV : Ecology and Animal Behaviour

Introduction

Ecology deals with the study of living organisms and their interaction with the environment. Survival of any organism depends upon its surrounding environment. Knowledge of the environment is imperative for human beings to plan and use it sustainably.

Animal Behaviour is the way in which different animals act in their everyday lives. It is one of the fastest growing sub-disciplines in biology. The study of animal behaviour is known as Ethology. It helps us in understanding why animals behave differently.

Highlight

This volume elucidates all the important topics such as Classification, Structure and Functions of Ecosystem, Soil Ecology, Population Growth and Regulation, Biodiversity and Conservation, Global Warming, Innate and Learned Behaviours, Animal Communication, Pheromones, Biological Clock, Social Behaviour, etc.

Organisation of Volume IV

This volume has been classified in to two parts, viz., *Ecology* and *Animal Behaviour*. The first part, *Ecology* discusses topics such as **Division of Ecology**—autecology and synecology; **Classification of Ecosystem**—natural and artificial; **Structure and Functions of Ecosystem**; **Components of Ecosystem**—abiotic and biotic; **Levels of Consumers**; **Trophic Levels**; **Ecological Pyramids**; **Food Chain**; **Food Web**; **Energy Flow**; **Ecological Efficiencies**; **Ecological Succession**—characteristics and types; **Biogeochemical Cycles**; **Biomes**—grassland, desert, arctic, mountain and forest; **Biodiversity and Conservation**—levels and patterns; **Biogeographical Regions of India**; **Global Biodiversity**—patterns, importance, loss, causes of loss and conservation; **Environmental Pollution**—types of pollutants, types of pollution (water, air, soil, noise, radioactive, thermal and space), sources, effects and control of various types of pollution; **Alien Species**; **Ecotoxicology**; **Global Warming**; and **Population Growth and Regulation**.

The second part, *Animal Behaviour* discusses topics such as **Innate and Learned Behaviours**—kinesis, taxis, reflexes, instincts, habituation, imprinting, classical conditioning, operant conditioning, latent learning; **Communication in Animals**—visual, chemical, auditory, tactile, electrical; **Territorial Behaviour**, **Courtship Behaviour**; **Parental Care**; **Migratory Behaviour**; **Pheromones and Behaviour**—types of pheromones (territorial, trial, sex, aggregation, epideictic and alarm) **Biological Clock**; and **Social Behaviour**—social life in termites, honeybees, ants and wasps.

Online Learning Centre

For further interesting resources and supplements, please visit <http://mhhe.com/pandey/eab1/vol4>

Acknowledgements

Writing this series has been a tremendous yet fulfilling endeavour. All the volumes have taken a final shape after endless inputs of time and effort. Though many teachers and students assisted me in compiling this book, I must especially mention the effort made by my colleague, O P Ambasta who extended immense support in myriad ways for bringing out the series in its present form. I am also indebted to A K Jha for his many valuable contributions.

I am grateful to the following reviewers for their helpful suggestions for improving the contents of this series.

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I am thankful to the team at Tata McGraw Hill Education, most notably Smruti Snigdha for giving me the opportunity to author this series and Renu Upadhyay for helpful suggestions to improve the quality of the content and regular reminders for timely completion of the project. It has been a pleasure to work with Nimisha Kapoor and Yukti Sharma, who took great care during the copy-editing and production processes of all the volumes.

I welcome all feedback, criticisms and suggestions for improvements in all the volumes from teachers, students and all other readers of this series. You can write to me at b.n.pandey@hotmail.com.

B N Pandey

Publisher's Note

Do you have a feature request? A suggestion? We are always open to new ideas (the best ideas come from you!). You may send your comments to tmh.sciencemathsfeedback@gmail.com (Don't forget to mention the title and author's name in the subject line).

ECOLOGY

Introduction

- **Ethology** – Isidore Geoffroy, St Hilaire (1859) coined the term ‘ethology’ as ‘the study of relationship of an organism with the family and the society as a whole and in the community’.
- **Oikologie** – H Reiter (1868) first coined and used the term ‘oikologie’ (ecology) after combining the two Greek words *oikos* (meaning house or dwelling place) and *logos* (meaning the study of) to denote such relationships between organisms and their environment.
- **Ecology** – Ernst Haeckel (1869) coined the term ‘ecology’ (*oikos* meaning house; *logos* meaning to study).
- **Hexicology** – Mivart (1894) coined the term ‘hexicology’.
- Ecology is defined as follows by the following ecologists:
 1. **Haeckel (1869)** – ‘The science treating the reciprocal relationship of the organisms and the external world’.
 2. **Warming (1895, 1905)** – ‘The study of organisms in relation to their environment’.
 3. **Elton (1927)** – ‘The scientific natural history’.
 4. **R Misra (1967)** – ‘Interactions of form, functions and factors’.
 5. **Odum (1971)** – ‘Study of structure and function of nature’.
- Division of Ecology – Ecology is divided into two branches, viz., autecology and synecology.

1. Autecology

- (a) It is the study of a single individual of a species or its population with respect to its environmental complexity of its various aspects, i.e., life history, adaptations, population dynamics, etc. Autecology is also called ‘species ecology’ or ‘population ecology’.
- (b) **Population** is an interbreeding group of individuals of same species which exchange genes by sexual reproduction.
- (c) **Genecology** is the study of genetic basis of variability among the individuals of a population with respect to the environmental complexity.
- (d) **Ecotypes** are the ecological races of a population which are genetically different but interbreed among themselves and have the same taxonomic unit.
- (e) **Ecophenes or Ecads** are the ecological races of a population which have variations in the morphological characters but belong to the same genetic stock.
- (f) **Ecological Niche or Niche** is the specific complex of factors which characterises the environment of any given population.



2 Ecology and Animal Behaviour

- (g) **Ecocline** is a series of plant populations which show a gradual change in the genetically determined environmental adaption.
- (h) **Epharmony** is the ability of an organism to adapt into changed environmental conditions by acquiring morphological changes.

2. Synecology

- (a) Study of plant communities is called synecology.
- (b) **Community** is the population of two or more species, also called phytosociology.
- (c) **Ecotone** is the transition zone between two adjacent but different types of communities (biomes). It contains some organisms from the adjacent biomes and some characteristics are restricted to this zone only.
- (d) **Ecotope** is the collective action of all the climatic factors and edaphic factors acting on a community.

Ecology

It is the reciprocal relationship between organisms (biotic) and the environment (abiotic) factors.

Ecosystem

It is the system resulting from the integration of all the abiotic and biotic components or factors.

1. Abiotic Factors – Atmosphere, hydrosphere, lithosphere, sunlight and temperature.
2. Biotic Factors – Plants and animals.

Classification of Ecosystem

Natural ecosystem and artificial ecosystem.

1. Natural Ecosystem

- (a) Terrestrial Ecosystem – For example, ecosystem of forest, grassland and desert.
- (b) Aquatic Ecosystem – For example, freshwater ecosystem and marine ecosystem.
 - (i) Freshwater Ecosystem – Lotic or running water system (e.g., springs, streams, rivers and *lenti(c)*) or stagnant water system (e.g., lakes, ponds, pools, ditches and swamps).
 - (ii) Marine Ecosystem – For example, ecosystem of estuary, sea and ocean.

2. Artificial Ecosystem

Artificial Ecosystem (man-engineered ecosystem) – For example, ecosystem of croplands like wheat, maize, rice fields, kitchen gardens, aquariums and spaceships.

Structure and Functions of Ecosystem

Structure of Ecosystem – Composition of biological community (species, number, biomass, life history and distribution in space).

Functions of Ecosystem – Functions include (a) rate of biological energy flow, (b) rate of nutrient cycle and (c) ecological regulation, i.e., regulation of organism by the environment and regulation of environment by the organism.

Components of Ecosystem

1. **Abiotic Components** – Sunlight, temperature, air, water and soil.
2. **Biotic Components** – (i) Producers, (ii) consumers or phagotrophs and (iii) decomposers.
 - (i) Producers or Transducers or Photoautotrophs – Autotrophs or food synthesisers.
 - (ii) Consumers or Phagotrophs – Heterotrophs which feed on living organic matter.
 - (iii) Decomposers or Mineralisers – Heterotrophs-reducers or microconsumers which feed on dead organic remains.

Levels of Consumers

1. **Primary or First Order Consumers** – Herbivores, directly feed on producers. Also called 'key industry animals'.
2. **Secondary or Second Order Consumers or Primary Carnivores** – Feed on herbivores.
3. **Tertiary or Third Order Consumers or Secondary Carnivores** – Feed on primary carnivores.
4. **Top Carnivores** – Feed on all levels of consumers. They have no natural enemy in the ecosystem. Characterised by the slowest breeding rate in the ecosystem and after their death, no scavengers feed on their flesh.

Trophic Levels

Levels of organisms having a specific mode of obtaining food. Organisms are divided into the following trophic levels:

1. **First Trophic Level or T_1** – Producers which synthesise food from inorganic materials by photosynthesis. The source of energy is sunlight.
2. **Second Trophic Level or T_2** – Herbivores which feed on producers (green plants).

Producers → Herbivores → Primary Carnivores → Secondary Carnivores → Tertiary/Top Carnivores

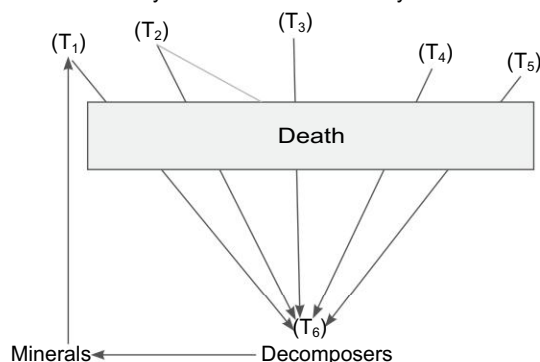


Fig. 1 Trophic level functions in an ecosystem

4 Ecology and Animal Behaviour

3. **Third Trophic Level or T_3** – Primary carnivores which feed on herbivores.
4. **Fourth Trophic Level or T_4** – Secondary carnivores which feed on primary carnivores.
5. **Fifth Trophic Level or T_5** – Tertiary or top carnivores which feed on secondary carnivores.
6. **Sixth Trophic Level or T_6** – In terrestrial ecosystems, it is occupied by decomposers. In aquatic ecosystems, decomposers generally belong to T_7 . Omnivorous organisms operate at several trophic levels.

ECOLOGICAL PYRAMIDS OR ELTONIAN PYRAMIDS

The concept of ecological pyramids was first given by Elton (1927). It is the graphical representation of various ecological parameters at successive trophic levels of the food chain. The producers are kept at the base, top carnivores at the apex and the remaining trophic levels are organised in ascending order. The three types of ecological pyramids are pyramid of numbers, pyramid of biomass and pyramid of energy.

- The pyramid of energy in all ecosystems is always upright (**Lindeman's 10 per cent law** – The energy difference from a trophic level to the next higher trophic level is only 10 per cent).
- The pyramid of biomass in pond ecosystem is always inverted.
- The other pyramids in forest, grassland and land ecosystems are upright.

FOOD CHAIN

- Transfer of food energy from one trophic level to another, i.e., from producers to herbivores to carnivores and to decomposers through the process of eaten and being eaten is known as food chain.
- Food chain starts with photosynthesis.
- A food chain may be simple or complex.
- In nature, food chains do not operate in isolation.
- Each food chain is distinct from other food chains.
- A food chain is always straight and proceeds in a progressing straight line.
- There is repeated eating in which each group eats a smaller one and is, in turn, eaten by a larger one. Thus, the food chain involves trophic interaction between the biotic components of an ecosystem.

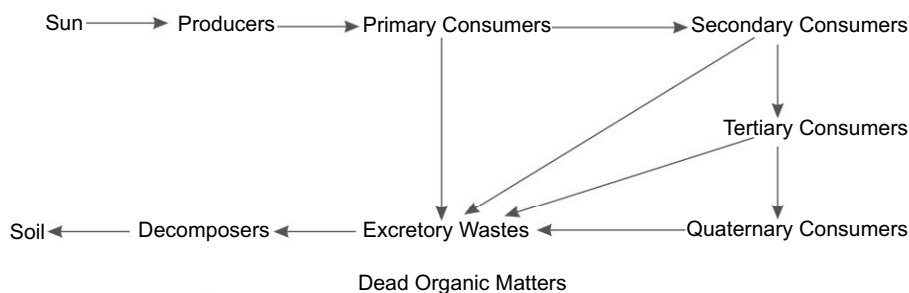


Fig. 2 Diagrammatic representation of a simplified food chain

- In a food chain, as we move from one trophic level to another, less food (energy) is available.
- In a food chain, about 80 per cent to 90 per cent energy is lost as heat at each transfer, as per the second law of thermodynamics.
- In a food chain, the transfer of energy is unidirectional.
- Generally, in a food chain there are four to five trophic levels.
- Shorter food chains provide more available energy.
- In a food chain, a change in size of one population will affect the other population.
- In a food chain, omnivores occupy more than one position.
- Some organisms like humans and bears occupy different positions in different food chains.
- Plants and animals depend successively on each other, which form the limbs of a food chain.
- According to Odum, food chains are of the following two basic types:
 1. **Grazing Food Chain** – It starts with green plants at the base and passes through grazing herbivores to carnivores.
 2. **Detritus Food Chain** – It starts with dead organic matter and passes through detritus feeders to carnivores.

FOOD WEB

- Interconnected food chains are called food web.
- A food web is a bundle of many interconnected food chains occurring within a community.
- Charles Elton (1927) gave the concept of food web. He called it food cycle.
- A food web shows that plants and animals are interconnected by different paths.
- In a food web, a given species may operate simultaneously at more than one trophic level.
- Decomposers are a critical component of a food web.
- In a food web, deficiency or excess of one type of organisms at one trophic level does not result in much change in the food web as alternative sources of food are present.
- In a food chain, there is competition between members of the same as well as members of other species.
- Food webs are never straight.
- In any food web, energy is lost each time one organism eats another.
- Food webs provide alternative pathway of food availability.
- Food webs help in checking overpopulation.
- Food webs provide stability to the ecosystem.

ENERGY FLOW

- All living organisms require energy for survival.
- Sun is the ultimate source of energy for every ecosystem.
- The flow of energy in nature is governed by two laws of thermodynamics.
- The flow of energy begins with the process of photosynthesis during which green plants capture radiant energy of the sun and transform it into organic compounds like glucose, i.e., radiant energy is converted into potential energy (First law of thermodynamics).

6 Ecology and Animal Behaviour

- Approximately 1 per cent to 2 per cent of the solar energy that falls on plants is converted into food or other organic material.
- Transfer of energy occurs from one trophic level to the next trophic level but each trophic level receives only a small percentage (10 per cent) of the total energy carried in the one being consumed, as majority of energy is lost as heat in the processes shown in the diagram (Second law of thermodynamics).
- The flow of energy in an ecosystem is unidirectional.
- The flow of energy occurs as follows:
Sun → Plants (Producers) → Animals (Consumers) → Decomposers
- There occurs progressive decrease in energy utilisation at each trophic level.

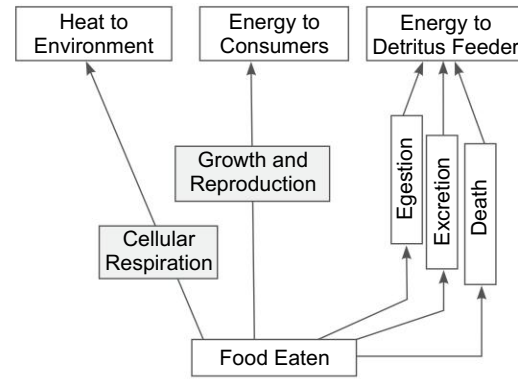


Fig. 3 Energy flow

ECOLOGICAL EFFICIENCIES

- Ecological efficiency refers to the ratio of the energy input (solar radiation) and the energy content of the produced biomass (by photosynthesis).
 1. **Photosynthetic Efficiency** – The percentage of incident solar radiation (PAR) utilised by the producers to synthesise food by photosynthesis.
 2. **Net production Efficiency** – The percentage of biomass energy stored by the producers to the biomass energy synthesised by photosynthesis.
 3. **Assimilation Efficiency** – The percentage of biomass energy assimilated by a consumer in relation to the biomass energy ingested by it.
The assimilation efficiency is extremely low (about 5 per cent) in herbivores and extremely high in detritivores (up to 90 per cent).
 4. **Ecological Efficiency (Trophic Level Efficiency)** – The percentage of energy stored in the biomass by a trophic level to the biomass present at its lower trophic level.
 5. **Exploitation Efficiency** – The percentage consumption of the biomass (of a species) in a trophic level.

ECOLOGICAL SUCCESSION

It is the gradual appearance and disappearance of a series of biotic communities in a habitat over a period of time, one after another, till the development of a stable community which is perfectly adapted to the climate of that region.

Physical, chemical and biological factors control ecological succession. Physical and chemical factors determine the rate, direction and optimum limit of the changes in the area, whereas biological communities control the succession by the actions, interactions and co-actions of organisms.

Ecological succession takes place in bare areas where common plants cannot grow due to the absence of soil and animals cannot survive due to the absence of food and shelter. Ecological succession begins with plants. The first plant species which grow in the bare areas are called the pioneer species, and they form the first biotic community called 'pioneer community'. The pioneer community is followed by a number of communities called 'transitional or intermediate communities' and finally the 'climax community'. The climax community is stable and continues to thrive till environmental changes are drastic. During the course of ecological succession, each community changes in the local environment in such a way that it becomes unsuitable for it after some time but suitable for the another following community. The entire sequence of stages taking place in ecological succession is called 'sere'. This can be classified as follows:

- Xerosere – Ecological succession stages in dry area
- Hydrosere – Ecological succession stages in water
- Lithosere – Ecological succession stages on bare rock
- Psammosere – Ecological succession stages on sand
- Halosere – Ecological succession stages in saline water or saline soil
- Xerarch – Ecological succession taking place over a dry area.
- Hydrarch – Ecological succession taking place in water bodies

Characteristics of Ecological Succession

1. Takes place from arid (dry) or aquatic environment and finally leads to mesic environment.
2. Pedogenesis (formation of soil) and soil differentiation takes place.
3. Humus content of the soil increases.
4. Size of the plants gradually increases which increases the biomass of the growing community.
5. The gradually appearing biotic communities have increasing biodiversity, therefore, they become more and more stable.
6. Increase in biodiversity leads gradually the simple food chain to complex food chain and food web formation.

Types of Ecological Succession

1. **Primary Succession or Prisere** – It is the succession which takes place in a soil-less habitat where there was no living matter (organisms) previously in any form. The pioneer community grows under extremely unfavourable conditions due to the absence of soil. Formation of soil (pedogenesis) occurs through hundreds and thousands of years. Therefore, primary succession completes in several hundreds to thousands of years.
2. **Secondary Succession or Subere** – It is the succession which takes place in a habitat with a lot of organic matter, where living matter (organisms) were present earlier in any form, but due to some external forces or climatic conditions, the existing biotic communities disappeared. The succession stages are fewer in number. In case of secondary succession, grasslands are formed in 50 to 100 years and forests in 100 to 200 or 250 years.

Types of Successive Communities

1. **Pioneer Community** – It is the first biotic community which develops on a bare area. The pioneer

8 Ecology and Animal Behaviour

community has very little biodiversity. Members of the pioneer community or species have a very high growth rate but a short lifespan; therefore, it produces a large amount of organic matter.

2. **Seral or Transitional Community** – It is a biotic community which develops in an area during ecological succession in between the pioneer community and the climax community. Seral communities are slow growing, long lived, slowly build soil, increase biodiversity and aid biogeochemical cycling of materials.
3. **Climax Community** – It is the highly stable and self-perpetuating biotic community which develops at the end of ecological succession. It has a complex food web, closed mineral cycling, maximum species diversity and maximum growth rate in the existing climatic condition of the area.

Factors Influencing Ecological Succession

- Factors/processes which play a key role in ecological succession are as follows:
 1. **Nudation** – It is the presence of bare area or without biotic community.
 2. **Migration** – It is the entry of organisms in the area of ecological succession. The first species entering the area is called 'pioneer' and thereafter every species is called 'invader'.
 3. **Colonisation** – It is the establishment of 'pioneer' and 'invaders' in the habitat.
 4. **Ecesis** – It is the germination, growth, establishment and reproduction of the colonisers.
 5. **Aggregation** – It is the increase in number of individuals or the size of a population.
 6. **Competition** – Struggle for food, space and reproduction among the members of same or different species.
 7. **Coaction** – Interaction among the members of the biotic community.
 8. **Reaction** – Refers to the changes in the environment, which take place due to an existing biotic community and become suitable for future development of another community in the same habitat.
 9. **Stabilisation** – The biotic community establishes it in the best way with the environment, having maximum biodiversity, complex food chain and food web and closed mineral cycling.

- **Hydrarch or Ecological Succession in Water**

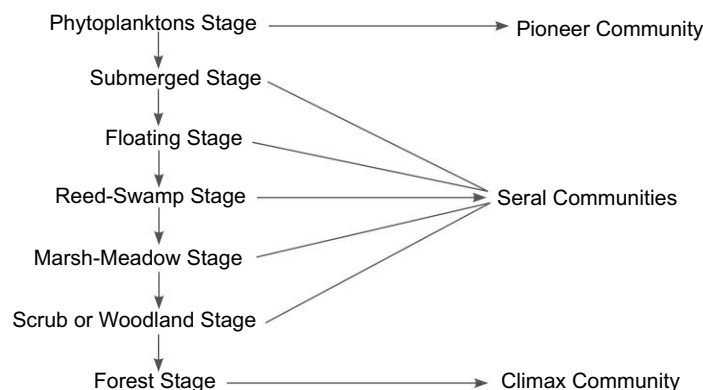


Fig. 4

• **Xerarch or Ecological Succession on Bare Rock**

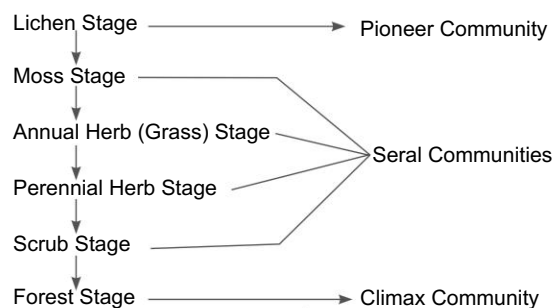


Fig. 5

BIOGEOCHEMICAL CYCLES

The cyclic pathway by which the essential chemical elements and compounds of protoplasm circulate in the biosphere from the environment to the organisms and back to the environment is called biogeochemical cycles (e.g., nitrogen cycle, carbon cycle, phosphorus cycle, hydrological cycle and sulphur cycle).

BIOMES

- The large biogeographic areas having distinct climate, vegetation and animals are called biomes.
- The various zoogeographic regions contain more than one biome.
- Biomes are of two types, viz., terrestrial biomes and aquatic biomes (Freshwater and oceanic biomes).
- The major terrestrial biomes are as follows:

I. Grassland Biome

- The vegetation is dominated by grasses.
- The environmental conditions vary in different grasslands.
- The hot dry climates are perfect for growing food.
- The rainfall in all grasslands is intermittent and erratic.
- In all grasslands, the primary consumers are the large grazing mammals.
- The principal grasslands are as follows:

Name	Distribution
(a) Prairies	North America
(b) Pampas	South America
(c) Steppes	Central Asia
(d) Puszta	Hungary
(e) Veldts	South Africa
(f) Tussocks	New Zealand

II. Desert Biome

- Nearly 5 per cent of the earth is covered in deserts.
- Deserts are found in every continent except Europe.
- Deserts have hot days and generally cold nights.
- Desert biome is characterised by less life as there is little or no rainfall.
- The deserts found in the Antarctic and Central Asia (the Gobi) are dry but very cold, while most other deserts such as Sahara in Africa and Atacama in South America are very hot.
- Camel is considered as the most famous desert animal.

III. Arctic Biome

- It is the coldest biome of the earth, receiving the least amount of sunlight.
- It lies in the north of the taiga.
- Polar bears, arctic foxes, walruses and seals are well adapted to the harsh condition of this biome.

IV. Mountain Biome

- Mountains are found in all continents and cover about one-fifth of the earth.
- The mountain biomes are that of Himalayas and others with slopes extending thousands of feet.
- The mountain biome is cold and windy but it supports life.
- Mountain goats, sheep, mountain lions and llamas are common animals.

V. Forest Biome

- The forest biome comprises many different types of forests and climates. Following are important forest biomes:
 - (a) **Rainforests** – Typically found in Asia, Africa, South and Central America as well as many Pacific islands. Plants and animals are abundant.
 - (b) **Coniferous forests** – Coniferous forests are found in the northern hemisphere. Cone-bearing trees such as fir and pine are abundant.
 - (c) **Deciduous forests** – They are found in the temperate mild zone in the northern hemisphere. The trees lose leaves during fall, resulting in very fertile soil.

BIODIVERSITY AND CONSERVATION

- The different types of genes, gene pools, species, populations, communities and ecosystems present in an area or different parts of the earth is called biodiversity or biological diversity.
- The term 'biodiversity' was coined by Walter Rosen (1986).
- Biodiversity is largely related with ecosystem productivity.

Levels of Biodiversity

- There are three levels of biodiversity:
 1. Genetic diversity

2. Species diversity
3. Community and ecosystem diversity

1. **Genetic Diversity**

- The genetic variations found amongst the members of the same population and geographically separated populations of the same species.
- The genetic information of all the organisms is present in the DNA in the form of genes.
- Each gene has one to several alleles, which express different characters as well as different functions in the organisms.
- The genes are fewer in the simplest forms of organisms and many in the complex and highly evolved forms (e.g., viruses 10 to 150 genes, *Mycoplasma* 450 to 700 genes, *E. coli* 4,000 genes, *Drosophila melanogaster* 13,000 genes, *Oryza sativa* 32,000 to 50,000 genes and *Homo sapiens sapiens* about 30,000 genes).

2. **Species Diversity**

- The whole range of organisms belonging to different species found on the earth.
- The total number of identified species worldwide is about 1.5 million. However, the total number of estimated species may be between 3 to 70 million.

3. **Community and Ecosystem Diversity** – The range and variety of biological communities and ecosystems in which communities operate.

Patterns of Biodiversity

- There are three patterns of biodiversities, viz., α , β and γ .

1. **α -or Point Diversity (Diversity within community)** – It is the total number of species present in a particular area or a community. Species diversity is an indicator of the geographical distribution of species. Species diversity increases with increase in latitude. α -diversity determines the stability of communities. Any increase in diversity is an indication of better adjustment and interrelationships among the member species with a higher degree of homeostasis in case of any disturbance or natural calamities. α -diversity is also useful in comparing different ecosystems.

2. **β -Diversity (Diversity between communities)** – The diversity which develops due to change in the habitat or community due to environmental factors like light (intensity, duration), temperature, humidity, altitude, latitude and topography. The greater differences or turnover of species between the habitats indicates higher β -diversity.

3. **γ -Diversity or Regional Diversity** – The number of species present in all the habitats of a region or landscape or geographical area.

- β -diversity is generally calculated by dividing γ -diversity with α -diversity.

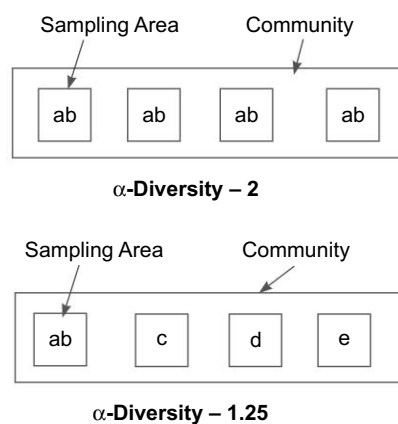


Fig. 6 Determination of α Diversity

Ecosystem Diversity

The different types of ecosystems operating in a geographical area having diversity in a number of niches, trophic levels, food chains, food webs, biotic interactions, keystone species, critical link species, biogeo-

12 Ecology and Animal Behaviour

chemical cycles, ecological processes sustaining energy flow, etc., is called ecological diversity.

Ecological diversity of India is very high due to the presence of rainforests, deciduous forests, temperate forests, alpine meadows, wetlands, estuaries, mangroves, coral reefs and deserts. Increase in ecosystem diversity increases its productivity and stability.

BIOGEOGRAPHICAL REGIONS

- The geographical distribution of plants (Phytogeography) and animals (Zoogeography) is called biogeography.
- Wallace (1876) divided the world into six biogeographical regions or realms, viz., Oriental, Palearctic, Nearctic, Neotropical, Ethiopian and Australian.
- India is situated in the Oriental region.

Biogeographical Regions of India

- The Wildlife Institute of India has divided the Indian landmass into the following 10 biogeographical regions:
 1. **Trans-Himalaya** – Cold deserts in parts of Jammu and Kashmir, Himachal Pradesh and Sikkim. Sparse vegetation with wild sheep, goats and snow leopards.
 2. **Himalayas** – Includes the western, central and eastern parts of the Himalayas. The vegetation is sub-tropical, temperate and alpine. Good forest cover is present below the timberline with rich animal population.
 3. **Desert** – Includes Rajasthan and parts of Gujarat. Sparse vegetation of ephemerals, succulents, hardy grasses, shrubs and small trees is found. Animals live in burrows or other sheltered areas during hot periods. They include lizards, snakes, jackals, foxes, wasps, ants, locusts and some birds.
 4. **Semi-arid Region** – Includes Punjab, Haryana, parts of Uttar Pradesh, Madhya Pradesh, Gujarat and Maharashtra. The vegetation is sclerophyllous and deciduous. Irrigated areas are fertile. Animal population depends on the vegetation density of the area.
 5. **Western Ghats** – The biodiversity is very rich. This region extends from the western coast of Maharashtra to Kerala. This region covers about 4 per cent of Indian landmass and has tropical rainforests. A large number of endemic amphibian populations are present.
 6. **Deccan Peninsula** – It is the largest region of India and covers about 42 per cent of the Indian landmass with uneven topography and tropical forests (semi-evergreen, deciduous, dry evergreen and thorn forests). It has abundant herbivore and carnivore animal populations.
 7. **Gangetic Plain** – Extends from Uttar Pradesh to Bihar and Bengal. The climate of the upper part is dry but the lower regions are more humid. Most forest covers are destroyed due to agricultural practices due to fertile soil area. Floods are frequent in the lower regions. The upper dry regions have dry deciduous, dry scrub and savanna vegetation and the humid regions have moist deciduous vegetation.
 8. **Coasts** – Includes areas of marshes and swamps, mostly with mangrove vegetation. Sunderbans in West Bengal is the largest mangrove forest of the world. Other mangroves are Ratnagiri and Pichavaram. Mangroves show a great variety of communities including estuaries, lagoons and deltas. It also has raised coral and rocky coastlines.

9. **Northeast Region** – This region includes the seven sister states of India (Arunachal Pradesh, Assam, Nagaland, Manipur, Meghalaya, Mizoram and Tripura). This region covers about 5.2 per cent of the total Indian landmass. This region is the place of origin of a large number of cultivated plants and their wild relatives are still found in this area.
10. **Islands** – Islands have species richness and endemism of plants and birds (not in mammals), the mammal fauna is poor. Some exotic mammals have naturalised (e.g., Andaman pig). The following two different groups of islands represent this region:
 - (a) The Andaman and Nicobar islands in the Bay of Bengal – Thinly populated with the tropical rainforests.
 - (b) Lakshadweep islands in the Arabian Sea – Have little remaining natural vegetation.

Important Characteristics of Biogeographical Regions of India

1. A wide range of habitats, biotic communities, ecosystems and biomes.
2. A large number of endemic plant and animal species. About 33 per cent angiosperms, 53 per cent freshwater fishes, 60 per cent amphibians, 36 per cent reptiles and 10 per cent mammals of the world population are endemic to India. The Western Ghats has the maximum endemic amphibian species.
3. Maximum endemism is found in the Northeast, Western Ghats, Andaman and Nicobar Islands and Northwest Himalayas.

GLOBAL BIODIVERSITY

Patterns of Biodiversity

- Biodiversity is not uniform in all parts of the world. Latitudes and longitudes are the major factors which govern biodiversity. Therefore, these are called master gradients. Besides, other factors like topographic, geographic and humidity or precipitation affect the intensity of biodiversity.
 1. Latitudinal Gradients
 2. Altitudinal Gradients
 3. Species–Area Relationship

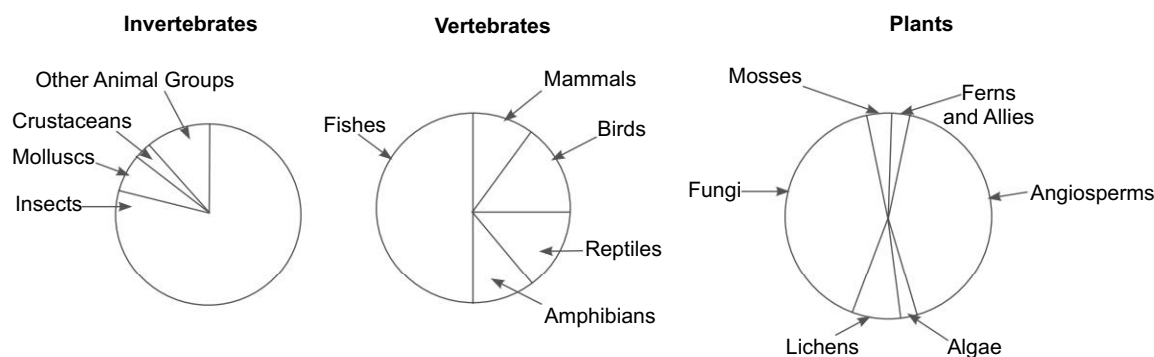


Fig. 7 Proportionate representation of major plant taxa, invertebrates and vertebrates

Importance of Biodiversity to the Ecosystem

- Biodiversity is important for the productivity, stability, resilience and healthy running of ecosystems.
- The effect of loss in biodiversity is explained by Paul Ehrlich by the 'Rivet Popper Hypothesis'. Loss of keystone species leads to the destruction of ecosystems.

Loss of Biodiversity

The disappearance, elimination or extinction of a species from the earth is called loss of biodiversity. The complete disappearance or extinction of a species is the complete loss of all its genetic information. Extinction takes place in three ways, viz., natural or background extinction, mass extinction and anthropogenic extinction.

Causes of Biodiversity Loss or Threats to Biodiversity

- Biodiversity loss is due to four major causes commonly called the 'evil quartet'. The 'evil quartet' are as follows:
 1. **Habitat Loss and Fragmentation** – Anthropogenic developmental activities which reduce the core area and increase the edge area. Biological species living in the core area are badly affected (e.g., forest patches with nearby croplands, orchards, plantations and urban settlements).
 2. **Overexploitation** – Excessive deforestation, over-grazing, uprooting of orchids and medicinal plants, hunting and poaching of animals.
 3. **Alien (Exotic) Species Invasion** – Every species is under biological control in its native place but when it is introduced in a new area, its biological control fails. It establishes in the new area and exterminates the native species from the habitat. The alien species have the maximum harmful impact on the island ecosystem because this ecosystem has very small biodiversity. Alien species invasion is the second most important factor after habitat destruction, (e.g., *Eichhornia crassipes*, *Lantana camera*, *Eupatorium odoratum*, *Parthenium hysterophorus* and the large predating fish Nile perch).
 4. **Co-extinction** – Some species of an ecosystem have an obligate association. The death of one species leads to the death of its obligate partner. When a host becomes extinct in an ecosystem, its specific parasites also become extinct. In case of co-evolved plant-pollinator mutualism, extinction of one partner leads to the extinction of the other.
 5. **Disturbance** – Natural or man-made modifications in a habitat, environment and a community of an area lead to loss of biodiversity. Natural disturbances are caused by natural calamities (e.g., drought, excessive rain, landslides, floods, diseases or epidemic, defoliation due to insect-pest attack and fire).
 6. **Pollution** – The ever-increasing pollution load on the environment due to rapid scientific and industrial development has become the greatest threat to biodiversity loss. The acid rain has destroyed about 50 per cent of natural forests and several freshwater lakes. Oil spills in the sea destroys planktons, algae, marine animals and smearing of sea birds results in their death. Eutrophication of the freshwater bodies leads to the decrease in the dissolved oxygen (DO) content. It causes death of animals, accumulation of organic matter and foul odour in water.
 7. **Intensive Agriculture** – Intensive and extensive agricultural practices to feed the ever-increasing human population is also playing a key role in biodiversity loss. This is due to increased wetlands, grasslands and forests into the agricultural fields.
 8. **Forestry** – In forestry, only a few economically important plants are grown in almost pure strands. Other economically less important plants are ignored which leads to the loss of biodiversity.

Biodiversity Conservation

- Protection of diminishing plant and animal species in reduced space against increased human activities is called biodiversity conservation.
- Biodiversity conservation is done in two ways, viz., in-situ (on-site) conservation and ex-situ (off-site) conservation.
 - I. In-situ (On-site) Conservation** – It is the protection, preservation and restoration of threatened species, communities and ecosystems in their natural habitats without any alien species. In-situ conservation is of two types, viz., hot spots and protected areas.
 - 1. Hot Spots** – The area of high endemism and very high levels of species richness.
 - 2. Protected Areas** – The biogeographical regions of land or sea where biodiversity with natural and cultural resources is protected and maintained against exploitation by legal and other effective measures. The protected areas are further subdivided as follows:
 - (a) National Parks** – Reserved areas for wildlife with all the natural resources and proper habitats. plantation, cultivation, tree cutting, grazing and habitat manipulation are not permitted.
 - (b) Sanctuaries** – Large areas of land with a lake or water body. The animals are protected from any type of exploitation and habitat destruction.
 - (c) Biosphere Reserves** – The large area of protected landmass to preserve the genetic diversity of local ecosystems by protecting wildlife and other fauna, flora as well as the traditional lifestyle of the tribals. A biosphere reserve has the following three parts:
 - (i) Core or Natural Zone** – The central, undisturbed and legally protected zone without any human activities or interference.
 - (ii) Buffer Zone** – Encircles the core zone with limited human activities to scientifically develop greater resources and strategies for conservation of the ecosystem and education.
 - (iii) Transition Zone** – The outermost zone where the biosphere reserve management develops a friendly bond with the local tribal population and allows temporary settlement, cropping, forestry and grazing activities. Restoration work in the degraded area is done to make the ecosystem healthy and stable.

ENVIRONMENTAL POLLUTION

- Any undesirable change in the physical, chemical or biological characteristics of the environment which adversely affects living organisms directly or indirectly is called environmental pollution.
- On the basis of origin, pollution is classified into the following two types:
 - 1. Natural Pollution** – It includes pollution caused by natural phenomena like dust, pollen grains, spores, volcanoes, marsh gases, soil erosion, landslides, forest fires and solar ultraviolet radiations.
 - 2. Anthropogenic Pollution** – Pollution caused by man or man-made activities like industries, automobiles, loudspeakers, fertilisers, pesticides, etc.
- Out of the total global pollution, natural pollution is 99.95 per cent and anthropogenic pollution is 0.05 per cent. However, man-made pollution is more severe due to its higher concentration in a small inhabited areas.
- **Pollutant** – A physical or chemical substance or factor that has direct or indirect harmful effects on human beings and other living organisms (e.g., dust, fly ash, ozone, oxides of sulphur, nitrogen, etc.).

Types of Pollutants

1. **Primary Pollutants** – Includes pollutants that remain in the same form as they were released in the environment (e.g., DDT, carbon monoxide, plastic, glass, etc.).
2. **Secondary Pollutants** – When two primary pollutants react and form a new chemical substance, which acts as a pollutant in the environment (e.g., a photochemical reaction between nitrogen oxide and hydrocarbons forms two secondary pollutants, viz., peroxyacyl nitrate and ozone), it is called a secondary pollutant. Secondary pollutants are more harmful and toxic than primary pollutants due to synergism.
3. **Biodegradable or Nonconservative Pollutants** – Refers to the pollutant which is broken down into simpler forms by natural or biological activities (e.g., heat by radiation and sewage and garbage and animal wastes by microbial decomposition).
4. **Nonbiodegradable or Conservative or Persistent Pollutants** – It includes pollutants which are not broken down into simpler forms by biological activities (e.g., DDT (Dichloro diphenyle tri-chloro-ethane), BHC, chlorinated hydrocarbon, polythene, plastic articles, broken glass, etc.).
5. **Qualitative Pollutants** – Refers to a pollutant which is not found in nature but it is formed due to man-made activities (e.g., pesticides, herbicides, insecticides, etc.).
6. **Quantitative Pollutants** – Refers to a physical or chemical factor present in nature that becomes a pollutant only when it is present in higher concentration due to man-made activities (e.g., oxides of sulphur and nitrogen, carbon monoxide are added due to the burning of fossil fuels).

Types of Environmental Pollution

- I. Water pollution
- II. Air pollution
- III. Soil pollution
- IV. Noise pollution
- V. Radioactive pollution
- VI. Thermal pollution
- VII. Space pollution

I. Water Pollution

Addition of inorganic, organic, biological and radiological substances in water which changes its physical, chemical and biological characteristics and makes it unfit for use.

Sources of Water Pollution

- (i) **Point Source** – Pollutants are added from regular channels (e.g., outlet of sewerage, industries, etc.).
- (ii) **Diffusion Source** – Pollutants scattered on the ground enter the water (e.g., fertilisers and pesticides from the agricultural crop fields).

Common Sources of Water Pollution

1. Domestic sewage or Municipal wastewater
2. Industrial effluents
3. Hot water wastes
4. Runoff water from crop fields

5. Groundwater
6. Oil spills
 1. **Domestic Sewage or Municipal Wastewater** – It contains wastes from household affairs, kitchens toilets slaughterhouses and small-scale industries situated in the municipal area. Of the total volume of municipal wastewater only 0.1 per cent is sewage or organic matter. The sewage contains grit, biodegradable organic matter, colloidal substances, pathogens, cysts, eggs, coli-forms and enterococci. Inorganic compounds like nitrates, phosphates from detergents, ammonia, sodium, calcium, toxic metal ions and many organic compounds are also present.

Effects

- (a) Potable water quality is lost and has foul odour due to the presence of decomposing organic wastes.
- (b) Microbial infection in the gastrointestinal tract causes jaundice, diarrhoea, dysentery, typhoid, etc.
- (c) Detergents and heavy metals cause acidity, ulcer and skin eruptions.
2. **Industrial Effluents** – Many small and large industries of chemicals, petrochemicals, sugar, pharmaceutical, paints and dyes, paper, tanneries, jute, fibres, metal extraction and processing discharge their wastes and wastewater directly in the water bodies without giving proper treatment to industrial effluents. These activities have caused severe pollution in almost all the rivers of India. Fish-processing units, prawn-culture units and other industries located in the coastal areas are also polluting the seas. Their industrial wastes contain organic wastes, hydrocarbons, toxic chemicals and heavy metals like cadmium, chromium, cobalt, mercury, nickel, etc.
3. **Hot Water Wastes** – Many industries like thermal power plants, oil refineries and other industries use water as a coolant. The water released from the cooling unit has a temperature about 10°C higher than the normal and it raises the temperature of the water bodies. Increase in water temperature reduces its dissolved oxygen (DO) content, which, in turn, reduces aerobic decomposition. The anaerobic decomposition rate increases by fermentation and putrefaction due to increased organic load. It produces many toxic chemicals, which make water fatal for fishes and other aquatic animals and plants. Some bacteria and cyanobacteria show luxuriant growth and lead to bloom formation.
4. **Runoff Water from Crop Fields** – The runoff water from the crop fields contains mainly three types of contents, viz., animal excreta in decomposed or undecomposed forms, fertilisers and pesticides.
5. **Groundwater** – During the course of water's movement from the earth's surface to the underground water table, water becomes polluted by the following sources:
 - (a) Underground septic tanks
 - (b) Underground sewage disposal pits and tanks
 - (c) Dumped industrial wastes
 - (d) Leaching of fertilisers and pesticides
6. **Oil Spills** – The accidental discharge of petroleum and its products in oceans, seas, estuaries and rivers is called oil spills. The common sources of oil spills are capsized oil tankers, loading and unloading of tankers, offshore exploration wells, extraction wells and oil refineries. Oil spills gradually spread over long stretches and reduce the oxygenation of water, which causes death of planktons, aquatic plants and animals. The sea birds become smeared and are unable to fly or feed, which leads to their death. Degradation of coral reef and loss of biodiversity also takes place.

Effects of Water Pollution

1. Deteriorates the colour, clarity, odour and taste of water.
2. Increases turbidity.

18 Ecology and Animal Behaviour

3. Colouration of water takes place due to anaerobic decomposition, addition of dyes, iron and chromium compounds.
4. Growth of algae, cyanobacteria, free chlorine, ammonia, hydrogen sulphide, phenols, etc., gives water a foul odour.
5. Addition of soaps, detergents and alkalies forms foam on the water's surface. It makes the water unfit for irrigation or other use by humans.
6. **BOD (Biological or Biochemical Oxygen Demand)** – It is the amount of oxygen required for the breakdown of organic compounds by microorganisms. Alternatively, BOD is the amount of oxygen in milligram required for complete oxidation of organic matter in one litre of water during a specific number of days at a given temperature. BOD of water increases due to organic pollutant load.
7. **COD (Chemical Oxygen Demand)** – It is the amount of oxygen in milligram required for the complete oxidation of organic compounds in one litre of water during a specific number of days at a given temperature.
8. **DO (Dissolved Oxygen)** – The amount of oxygen dissolved in the water is called dissolved oxygen (DO). Pure water at 0°C holds 14 ppm DO, whereas at 20°C it holds only 1 ppm (ppm = parts per million).
9. **Eutrophication** – Enrichment of nutrients in water bodies leads to the excessive growth of planktons, algae, cyanobacteria, bacteria and animals. Eutrophication is of two types, viz., natural eutrophication and cultural or accelerated eutrophication.
10. **Biomagnification or Bioconcentration** – An increase in concentration of persistent pollutants like DDT, toxic pollutants and heavy metals. Biomagnification takes place due to non-utilisation of the substance in metabolism, which thereafter accumulates in the fat and does not undergo decomposition.
11. **Minimata** – Signifies accumulation of soluble dimethyl mercury compounds in aquatic animal bodies to a fatal level. Minimata disease is caused due to mercury poisoning and was first reported in Japan in 1953 (fish poisoning at Minimata bay).
12. **Itai-itai or Ouch-ouch Disease** – Cadmium poisoning caused itai-itai disease due to its accumulation in the liver, kidney and thyroid.
13. **Plumbism** – Lead poisoning causes plumbism due to irreparable damage to the liver, kidney and brain.
14. **Methaemoglobinaemia** – Caused due to the presence of nitrate in drinking water. The nitrate is changed into nitrite in the alimentary canal. After absorption, it oxidises ferrous iron of haemoglobin into ferric form called methaemoglobin. Methaemoglobin loses the oxygen-carrying capacity and results in 'blue baby syndrome' or 'cyanosis' in infants and nausea, vomiting, drowsiness and breathlessness in adults.
15. **Fluorosis** – The excess of fluorine or fluoride in drinking water leads to mottling of teeth during enamel formation stage. In adults, bones undergo osteosclerosis and osteomalacia which results in hardening, stiffening and bending of bones. These conditions make the joints painful called 'skeletal fluorosis'.
16. **Black Foot Disease** – Presence of arsenic in drinking water causes 'black foot disease'. Arsenic enters the groundwater due to seepage or weathering of the bedrock. Arsenic pollution causes repeated diarrhoea, skin thickening or hyperkeratosis, peripheral neuritis, and cancer of lungs and skin. The peripheral vascular insufficiency and hyperpigmentation results in gangrenous condition called 'black foot disease'.

Natural De-pollution

In large rivers, lakes and other aquatic systems, pollutants are disposed off by natural phenomenon to some extent. Some solid organic pollutants settle down to the bottom, some are pushed ashore by the blowing air current and some undergo decomposition by microorganisms. Some microorganisms are killed in the

sunlight and this helps in disinfection of water. Heavy pollution of the water bodies decreases the amount of dissolved oxygen in them, which considerably slows down the 'natural de-pollution' process.

Treatment of Wastewater

- Sewage and the industrial wastes should be treated before discharging them into water bodies. Wastewater treatment is done in the following three steps:

1. Primary Treatment (Physical Treatment) – Removal of suspended wastes by physical processes like sedimentation, floatation, shredding (fragmentation), settling, screening and filtration. The larger organic molecules are collected as sludge.

2. Secondary Treatment (Biological Treatment) – Decomposition of organic matter is done with the help of microorganisms. After decomposition, the treated water is sterilised by chlorine treatment or chlorination. Secondary treatment is done by two methods, viz., decomposition of organic matter and chlorination.

(a) Decomposition of Organic Matter – It is carried out by any one of the three methods, viz., water hyacinth pond, trickling filter method and activated sludge method.

(i) *Water Hyacinth Pond* – Water Hyacinth or *Eichhornia* is grown in water containing organic matter. The organic matter is decomposed by microbes, and the minerals and heavy metals released after decomposition are absorbed by the *Eichhornia* for its own growth.

(ii) *Trickling Filter Method* – After primary treatment, the sewage is passed through a thick layer of gravel (small stones). The bacteria consume organic matter present in water and cleaner water trickles out through the bottom of the gravel bed.

(iii) *Activated Sludge Method* – After primary treatment, the sewage is pumped into the aeration tank. Here, the sewage mixes with the air and sludge containing algae and bacteria. The bacteria decompose organic matter and the algae produce oxygen for bacterial activities and growth. The clearer water is collected and chlorinated.

(b) Chlorination – After decomposition of organic matter present in the sewage, the water becomes clearer and is passed through some chambers for chlorination. Chlorination kills microorganisms, spores, cysts and pathogens present in the sewage. After chlorination, a large amount of inorganic compounds like nitrates, phosphates, sulphates and minerals are present in the wastewater. This wastewater is highly useful for irrigation purposes. The extra water is stored in pits for recharging groundwater (The wastewater is not discharged in the water bodies because it will cause eutrophication).

3. Tertiary Treatment – It is a physiochemical process for removing nutrients, metals and dissolved organic matter (nitrates, phosphates and sulphates) present in the treated wastewater. The tertiary treatment process is costly, therefore, it is not common. It is done only when the water is to be recycled.

Treatment of Industrial Effluents

Treatment of industrial effluents is done according to the stepwise method stated below:

1. Neutralisation of acid or alkali by testing its pH.
2. Precipitation by the known chemical reaction or electrostatically.
3. Adsorption is done for removing coloured impurities and highly toxic chemicals.
4. Photocatalysis is done to split chemical compounds and convert toxic chemicals into nontoxic ones.
5. Ion exchange and reverse osmosis is done to remove the remaining ions left after precipitation and photocatalysis.

II. Air Pollution

Air pollution is the addition of chemicals or materials into the atmosphere in a concentration which has harmful effects on human beings, plants, animals and other human assets and resources. The total amount of global air pollution per annum is estimated to be 1×10^{12} tons, out of which 99.55 per cent is natural by pollens from plants, smoke and dust from forest fires and gases and dust clouds from volcanic eruptions. Only 0.05 per cent (5×10^8 tons) air pollutants are added by anthropogenic activities, which includes gases, smoke, fly ash, soot, etc. Anthropogenic air pollution is done in a very minor magnitude, and even then it is very harmful because it remains restricted to the lower part of the atmosphere (300 to 600 m from the earth's surface). Anthropogenic air pollution is classified into the following two types on the basis of its source.

1. **Mobile source** – It includes air, water, road and rail transport systems and fireworks.
2. **Fixed source** – It includes all types of industries, thermal power plants, stone crushers, brick manufacturing units, kitchens, agricultural waste, burning, etc.

Air pollutants are of two types, viz., particulate and gaseous. Particulate pollutants are solid or liquid. The particulate pollutants are of the size more than $10 \mu\text{m}$ and settle down automatically in still air. These are also called settleable pollutants. The smaller particulate pollutants remain suspended in the atmosphere for a very long period; they are called suspended particulate matter or SPM. The SPM of size more than $1 \mu\text{m}$ is called dust in case of solid and mist in case of liquid. The SPM of size less than $1 \mu\text{m}$ is called aerosol.

Types of Air Pollutants

I. Primary Air Pollutants

Primary air pollutants include the following:

1. Particulate matters
2. Carbon monoxide
3. Nitrogen oxide
4. Hydrogen sulphide
5. Sulphur dioxide
6. Hydrogen fluoride
7. Hydrocarbons
8. Aerosols
9. Tobacco smoke (contains carbon monoxide, nitrogen oxide, seven types of polycyclic hydrocarbons and polonium-210, which is a radioactive chemical and also carcinogenic).

II. Secondary Air Pollutants

Secondary air pollutants include the following:

1. **Photochemical Oxidants** – Photochemical oxidants are formed by the reaction of nitrogen oxides with hydrocarbons of the air in the presence of sunlight. Photochemical oxidants are of five types, viz., ozone, PAN, aldehydes, phenols and smog.
2. **Acid Rain**
 1. **Photochemical Oxidants**
 - (a) **Ozone**
 1. Acts as a severe pollutant when formed in the troposphere.
 2. At low concentration it causes chest pain, coughing and irritation in the eyes, internal haemorrhage, headache, fatigue and loss of coordination. Its high concentration can kill both plants and animals.

3. It causes premature yellowing and falling of leaves.
 - **Chemical Weed** – Ozone is commonly called chemical weed because it is harmful when present in the troposphere and quite useful in the stratosphere.
 - **Good Ozone and Bad Ozone** – The ozone present in the stratosphere is called good ozone because it protects living organisms from harmful UV radiations. The ozone present in the troposphere is called bad ozone because it is extremely harmful for both the living and nonliving structures.

(b) PAN (Peroxyacyl nitrate)

1. It causes irritation in the eyes and respiratory distress.
2. It destroys spongy parenchyma of the young leaves, causing necrosis by damaging the chloroplasts.
3. Photosynthetic activity and growth is affected.
4. Electron transport system is inhibited.
5. Cellular metabolism is affected due to its interference with the enzyme system.

(c) Aldehydes – It causes irritation and damage to the gastrointestinal tract and the respiratory tract.

(d) Phenols – It causes injury to the spleen, lungs, liver and kidneys.

(e) Smog

1. It is opaque, dark fog formed by smoke, oxides of sulphur and nitrogen, H_2S and water vapour.
2. It causes allergy, asthma and bronchitis in human beings.
3. In plants, it causes silvering, glazing and necrosis.
4. Smog is of two types, viz., classical smog and photochemical smog.

(i) Classical Smog

1. It is produced at low temperatures in reducing environment.
2. It contains only primary pollutants, i.e., smoke or dust particles, H_2S , SO_2 and water vapour.
3. It is dark brown in colour, also called sulphurous smog or London smog.
4. The classical smog appeared in London in the year 1952 for a week, it killed about 4,000 persons, thousands of animals and destroyed a lot of vegetation.

(ii) Photochemical Smog

1. It is formed in the area of intense solar radiation.
2. It contains secondary air pollutants called photochemical oxidants.
3. It is formed by the interaction of hydrocarbons with nitrogen oxides; the products are ozone, PAN, aldehydes and phenols. Sulphur is absent and primary air pollutants are not present in appreciable amounts.
4. It is brown in colour, also called 'brown air'. In case of lesser solar radiations, the photochemical reaction is incomplete and 'grey air' is formed.
5. Photochemical smog was first observed over Los Angeles in 1946, therefore, it also called Los Angeles smog.
6. Photochemical smog is highly injurious to humans, human assets, plants and animals.

2. Acid Rain

1. Rainfall with pH less than 5 (generally 3 to 4.5) is called acid rain.

22 Ecology and Animal Behaviour

2. The minimum pH of acid rain recorded is 1.5 in West Virginia, USA.
 3. Acid rain is caused due excessive production of SO_2 , NO_2 , volatile organic carbons (VOCs) and ammonia due to the burning of fossil fuels and processing. Nitrogen oxides are also formed due to lightning and radiation.
 4. About 65 per cent of acid rain is due to SO_2 emissions, 30 per cent due to nitrogen oxides and the rest 5 per cent due to hydrogen chloride emitted by the chemical industries.
 5. Acid rain has destroyed more than 50 per cent of the forest area in Switzerland, Germany, Romania, Poland and USA. Acid rain causes chlorosis, necrosis and defoliation.
 6. Acid rain causes leaching of essential minerals and nutrients from the soil.
 7. Insoluble toxic minerals (e.g., nickel, lead and aluminium) become soluble at low pH and the plants get killed.
 8. *Killing of Lakes* – Destruction of flora and fauna of a lake is called killing of lakes. At acidic pH levels, heavy metals (aluminium, manganese, nickel, lead, zinc and mercury) present at the bottom of a lake get dissolved in water and kill both plants and animals. The dissolved aluminium clogs the gills of fishes which causes their death. The birds which feed on these fishes also get killed.
 9. Marble and limestone structures, metallic structures, textiles and paintings are damaged by acid rain.
 10. Acid rain forms blisters and rashes on human skin, damages cornea incase of direct contact and also causes hair loss.
- **Chlorofluorocarbons (CFC)**
 1. Chlorofluorocarbons are present in jet planes emissions and also used in refrigeration.
 2. They deplete the ozone layer in the higher atmosphere.
 3. Thinning of ozone layer or ozone hole is caused due to CFCs. The ozone hole permits more harmful solar ultraviolet radiations to reach the earth's surface. The ultraviolet rays cause sunburn, blindness, inactivation of proteins, RNA, DNA and plant pigments.
 4. CFCs have produced a hole in the ozone layer over Antarctica. The ozone hole has widened from 129 dobsons to 133 dobsons in just one year (1994).

Effects of Air Pollution

1. **On Human Health** – Polluted air increases the incidence of lung diseases especially in children. The incidence of lung diseases in urban populations is more than four times higher than rural populations. Irritation to the organ by the particulate matters results in various diseases and harmful effects of gaseous pollutants depends on its solubility.
 - (a) **Particulate Matters** – Particulate matters of size more than $2\text{ }\mu\text{m}$ are trapped in the nasal passage and respiratory tract. Their regular inhalation results in the respiratory trouble called 'lung fibrosis' or 'pneumoconiosis'. 'Lung fibrosis' is very common in flour mill workers and coal miners.
 - Asbestosis is caused due to the inhalation of asbestos fibres which may result in lung cancer.
 - Byssinosis is caused due to the inhalation of cotton fibres.
 - Silicosis is caused due to the inhalation of stone dust particles or sand.
 - Combustion of petroleum in automobiles, burning of coal and wastes and pesticide spray emit lead compounds (Petroleum contains tetra-ethyl lead and tetra-methyl lead. Lead affects the central nervous system and in chronic cases causes headache, loss of appetite, dizziness, insomnia, anaemia, weakness, miscarriage and distorts RBCs.
 - (b) **Pollen and Spores** – It causes allergy which results in bronchitis and asthma in many persons.
 - (c) **Carbon Monoxide** – It causes giddiness, headache, decreased vision and reduces the oxygen carrying capacity of the haemoglobin and in severe cases it causes death.

- (d) **Carbon Dioxide** – It causes nausea and headache.
 - (e) **Nitrogen Oxides** – These oxides impair smell, cause irritation in the eyes and the nasal passage, oedema of lungs, dilation of the arteries and damage the liver and kidneys. These are carcinogenic.
 - (f) **Sulphur Dioxide** – It causes irritation in the eyes and the nasal passage, bronchitis, asthma, emphysema and cancer.
 - (g) **Hydrogen Sulphide** – It causes nausea and irritation in the nose and the throat.
 - (h) **Hydrogen Fluoride** – It causes gastrointestinal and muscular disorders, weakening of bones and motling of teeth.
 - (i) **Hydrocarbons** – It causes injury to the eyes, the respiratory passage and the lungs, sometimes carcinogenic.
 - (j) **Ozone and PAN** – It causes irritation in the eyes and the respiratory passage, respiratory distress and haemorrhage.
 - (k) **Lead** – It causes loss of appetite, colic pain, headache and anaemia due to damage to RBCs. Also affects the nervous system and sometimes causes skin eruptions.
 - (l) **PCBs (Polychlorinated biphenyls)** – Burning of plastic and its products produces PCBs. PCBs cause vision impairment and damage the liver and the central nervous system. In acute cases, the skin undergoes deep pigmentation.
2. **On Animal Health** – Fluoride, lead, nickel and other mineral poisoning are common in animals because these pollutants are easily deposited on vegetation and forage crops in the form of dust particles. The affected animals show lameness, frequent diarrhoea, laziness, reduced appetite, loss of weight and weakening of bones.
3. **On Plant Health**
- (a) **Chlorosis and Necrosis** – Air pollution causes chlorosis and necrosis which finally leads to defoliation and premature death of the plants.
 - (b) **Clogging of Stomata** – Smoke, dust and other particulate matters settle down on leaves and block the stomatal passage meant for gaseous exchange and transpiration. Therefore, the rate of photosynthesis is reduced and it results in decrease in primary productivity.
 - (c) **Nitrogen Oxide** – It causes chlorosis, necrosis, abscission and dieback resulting in the loss of primary productivity.
 - (d) **Sulphur Dioxide** – It causes disintegration of the chlorophyll molecules, chlorosis, necrosis and water-soaked areas are formed.
 - (e) **Fluoride** – It causes chlorosis, necrosis and abscission of leaves.
 - (f) **Smog** – It causes silvering, glazing, death of mesophyll cells and abscission.
 - (g) **Hydrocarbons** – It causes premature abscission of leaves, floral buds and fruits, curling of leaves and discoloration of perianth leaves.
4. **Deterioration of Human Assets**
- (a) **SPM** – Its deposition causes discolouration and disfigurement of the physical structures.
 - (b) **Hydrogen Sulphide** – It degrades textiles and paper, discolouration of paints and fading of jewellery.
 - (c) **Ozone** – It oxidises paints, jewellery and rubber products. Rubber and rubber products crack due to contact with ozone.
 - (d) **Acid Rain** – The oxides of sulphur and nitrogen dissolve into the rainwater and form sulphuric acid and nitric acid. These acids convert CaCO_3 of marble and limestone into CaSO_4 and CaNO_3 . These converted regions peel off or wash off, resulting in pit formation and corrosion. This phenomenon is called 'stone leprosy'.

Control of Air Pollution

I. Industrial Pollution – Industrial pollution can be controlled by the following methods:

1. Suitable fuel selection.
2. Modification in process and equipments.
3. Very high chimneys and smoke stacks.
4. Removal of pollutants.
5. Modification and destruction of pollutants.
6. Increasing vegetation cover.

(a) For Gaseous Pollutants

1. Combustion
2. Absorption (Wet scrubbers)
3. Adsorption
4. Conversions

(b) For Particulate Matters

1. Gravity settling chambers or tanks
2. Trajectory separators
3. Porous filters
4. Cyclone collectors
5. Electrostatic precipitators (ESP)
6. Scrubbers

II. Automobile Pollution

1. Use of unleaded petrol.
2. Use of four-stroke engine in two-wheelers.
3. Use of catalytic converters.
4. Use of CNG in all commercial vehicles plying on the road because CNG is the least polluting among all fossil fuels.

Soil Pollution

Soil pollution refers to harmful changes in the physical, chemical and biological properties of soil due to addition or removal of substances leading to reduced productivity. Soil pollution is of the following four types:

1. Negative pollution
 2. Positive pollution
 3. Third pollution
 4. Third poison
1. **Negative pollution** – Decrease in productivity due to reduction in the quality or quantity of the top soil. It is caused due to overuse and erosion of soil.
 2. **Positive pollution** – Decrease in productivity and plant quality due to addition of pollutants from air, industrial effluents, faulty sanitation and excessive use of fertilisers and pesticides.
 3. **Third pollution** – Decrease in productivity and plant quality due to severe misuse of the land like dumping of garbage, industrial wastes, sludge, ash, etc.
 4. **Third poison** – Groundwater pollution due to leaching and seepage of sewage, toxic chemicals and extra minerals from the soil surface.

Soil Pollutants

Common soil pollutants include the following:

1. Agrochemical
 2. Manures
 3. Industrial effluents
1. **Agrochemicals** – Agrochemical soil pollutants change the chemical composition of the soil and also adversely affect soil microorganisms, surface water and groundwater qualities. They are of two types, viz., pesticides and fertilisers.
 - (a) **Pesticides** – Include chemicals used for killing pathogens, pests and unwanted weeds in agriculture, horticulture, forestry and aquatic systems. The broad spectrum pesticides kill most pathogenic microbes, so these are also called ‘biocides’. Many biocides are persistent in nature. Some persistent biocides adversely affect useful microbes, this phenomenon is called ‘ecological backlash’ or ‘ecological boomerang’. The commonly used pesticides are as follows:
 - (i) **Chlorinated hydrocarbons (Organochlorines)** – These are persistent insecticides which show biomagnifications (e.g., DDT, BHC, aldrin, endrin, dieldrin, etc.).
 - (ii) **Organic pesticides** – These are of two types, viz., organophosphates and carbamates.
 - (iii) **Inorganic pesticides** – These are compounds of sulphur, copper and arsenic. They are persistent in nature, therefore, their use is restricted.
 - (iv) **Weedicides or Herbicides** – They are selective metabolic inhibitors and have very long term effects on the plants (e.g., 2,4 –D, 2,4,5 –T).
 - (b) **Fertilisers** – These are concentrated chemical compounds which are added to the soil or sprayed on plants to fulfill the essential mineral needs of the plants. But their excessive or repeated use causes many harmful effects to the plant and reduces productivity.
 - (i) It harms the soil microflora and disturbs the biogeochemical cycle.
 - (ii) It causes harmful changes in the soil structure.
 - (iii) It increases the salt concentration in the soil which reduces soil fertility.
 - (iv) Leeching of minerals into groundwater.
 - (v) Causes eutrophication of water bodies.
 2. **Manure** – It is partially decomposed dead organic matter of plant and animal origin. It is generally prepared from garbage, sewage sludge and livestock excreta. Manure is contaminated with a lot pathogens which can cause infection in the crop plants and in turn the pathogens are transmitted to humans and domestic animals.
 3. **Industrial Effluents** – The liquid discharges from industries are often spread on open fields or poured in shallow ditches for natural sun and air drying. Industrial effluents contain many heavy metals like aluminium, cadmium, copper, zinc, chromium, nickel, etc. It also contains some toxic chemicals like cyanides, acids, alkalies, dyes, organic solvents, etc.

Noise Pollution

It includes a persistent, excessive and disturbing level of sound in the ambient atmosphere which affects human beings directly without affecting the life-supporting system (air, water and soil). In general, an unwanted sound of more than 80 dB (decibel) loudness is called noise.

Loudness in Decibel

1. Breathing sound – 10 dB

26 *Ecology and Animal Behaviour*

2. Whisper – 30 dB
 3. Moderate conversation – 60 dB
 4. Loud conversation – 70 dB
 5. Scooter – 80 dB
 6. Bus or truck – 90 dB
 7. Rolling mill – 100 dB
 8. Hooter horn – 120 dB
 9. Jet plane at take off – 150 dB
 10. Rocket launching – 180 dB
- Daytime noise in the Indian metro cities is 80 to 90 dB.
 - Noise becomes uncomfortable above 120 dB.

Sources of Noise Pollution

1. Industries printing press and engineering establishments.
2. Transport vehicles (e.g., scooters, motorcycles, car, trucks, bus, train, aeroplanes and jet planes).
3. Agricultural machines (e.g., tractors, harvesters and tubewells).
4. Defense equipments (e.g., tanks, artillery, rocket launchers, shooting practices and explosions).
5. Domestic gadgets (e.g., food processors, pressure cookers, washing machines, exhaust fans, coolers, air conditioners, vacuum cleaners, desert coolers, etc.).
6. Personal entertainment equipments (e.g., radio, transistors, televisions, etc.).
7. Social and religious functions (e.g., marriage parties, festivals, etc.).
8. Public address systems (e.g., loudspeakers).
9. Dynamite blasting.
10. Crackers fired during festivals, ceremonies and detonations carried out for blasting rocks during mining operations road and canal building.
11. Bulldozing, stone crushing and construction works.

Effects of Noise Pollution on Human Health

The unwanted sound of low intensity (40 to 60 dB) causes discomfort or unpleasant feelings. The noise above 80 dB is pollutant which affects psychological, psycho-physiological and physiological functions of the human body.

1. Initially hearing loss, whereas prolonged exposure leads to permanent hearing loss.
2. Sudden loud noise like explosion damages the tympanic membrane (eardrum).
3. It causes anxiety and stress and in extreme cases may lead to fright.
4. It causes headache by dilating blood vessels of the brain, dilates pupils and causes eye strain, digestive spasms are formed due to anxiety and high blood pressure (hypertension) by increasing cholesterol level in the blood.
5. It causes increase in the rate of heartbeat, constriction of blood vessels, decreased heart pumping or output and defective night and colour vision.
6. Sudden exposure to noise affects psychomotor functions.
7. It causes emotional disturbances.
8. It disturbs normal sleep (insomnia) and mind concentration.

9. Prolonged exposure to the developing foetus in urban mothers may lead to impairment in the development of the nervous system and it leads to abnormal behaviour in later life.
10. Defective foetal development has also been reported.
11. Prolonged exposure may lead to liver, brain and heart damage in humans and animals too.

Effects of Noise Pollution on Animal Health

1. The ability to assess the movement of the enemy is lost.
2. Normal functioning of the endocrine glands is disturbed.
3. The reproductive cycle of many insects is disturbed.
4. Egg laying in birds decreases and thinning of the eggshell has been observed in fowls and many other birds.
5. Defective development of the embryo and congenital defects have also been reported.
6. Hatching of birds is disturbed.

Effects of Noise Pollution on Plant Health

1. Chlorophyll synthesis rate decreases.
2. Fertilisation is delayed.
3. Differentiation of leaves is delayed.
4. The size and the number of the seed set-up decreases.

Control of Noise Pollution

1. City areas should be divided into the following different acoustic zones:
 - (a) Silence zone
 - (b) Residential area zone
 - (c) Commercial area zone
 - (d) Industrial area zone
2. Silence zone is also called horn-free zone. Hospitals, educational institutions and important offices are situated in this zone. Heavy vehicles are not permitted to ply in this zone.
3. Industrial area zone is built away from the silence zone and residential zone.
4. Railways and highways should be located away from the silence zone and residential zone.
5. Decibel meters should be installed at different places to monitor the noise pollution level.
6. Strict enforcement of noise pollution control laws to monitor ambient noise level.
7. The National Pollution Control Board has recommended the following permissible noise levels in different zones in Indian cities:

Table 1

<i>S. No.</i>	<i>Zone</i>	<i>Day hours</i>	<i>Night hours</i>
1.	Silence zone	40 dB	30 dB
2.	Residential zone	50 dB	40 dB
3.	Commercial zone	60 dB	50 dB
4.	Industrial zone	70 dB	65 dB

28 Ecology and Animal Behaviour

8. The least noise-producing engine and machines should be designed and installed and their proper maintenance should be carried out periodically.
9. Noisy machines should be installed in soundproof chambers.
10. Traffic police and industrial workers should be provided earplugs and earmuffs. **Earplugs** are devices, which fit into ear canals for blocking or attenuating sound waves. **Earmuffs** are hard shells, which are attached to the head and cover the external ears completely to block the entry of sound waves.
11. Green Muffler or Green Belt Vegetation – These are rows of trees and shrubs grown and maintained to act as noise absorbers. They also reduce air pollution by absorbing gaseous pollutants and cause settling of suspended particulate matter.
12. As per an international agreement, only those aircrafts should be allowed to fly which produce noise within permissible limits. Aerodromes should be built far away from residential areas. Night flights should be minimised.

Radioactive Pollution

The effect of radiation on humans was first studied and reported in 1909 when Uranium miners were found to suffer from skin burns and cancer.

Radioactive Pollution – It is the physical pollution of air, water and soil with radioactive materials.

Radioactivity – The property of certain elements (radium, thorium, uranium, etc.) to spontaneously emit protons (α particles), electrons (β particles) and gamma rays (electromagnetic waves of very short wavelength) by the disintegration of their atomic nuclei. The elements which give off radiation are called radioactive elements.

Types of Radioactive Pollution

Radioactive pollution is of two types, viz., natural (background) radiation and man-made radiation.

1. **Natural (Background) Radiation** – This type of radiation includes:
 - (a) **Cosmic rays** reaching the earth from the outer space.
 - (b) **Terrestrial radiation** from nuclides of radioactive elements present in rock, soil and water. These radioactive elements are Radium-224, Uranium-235, Uranium-238, Thorium-232, Radon-222, Potassium-40, and Carbon-14. The natural radiation is not a health hazard because of its low concentration. Human beings have been exposed to it since its appearance without any appreciable effect.
2. **Man-made Radiation** – Man-made sources of radioactive pollution are mining and refining of plutonium and thorium, production and explosions of nuclear weapons (nuclear fallout), atomic reactors and nuclear power plants, nuclear fuels and preparation of radioactive isotopes.
 - (a) **Atomic Explosion** – The first atom bomb was exploded in Hiroshima (Japan) on 6th August 1945, and the second atom bomb in Nagasaki (Japan) on 9th August 1945. This caused large-scale destruction of human, animal and plant life. Even after this great tragedy, super powers are still in the race for nuclear weapons. Their present stockpile of such nuclear weapons is enough to destroy the earth completely.
Atomic weapons use Uranium-235 and Plutonium-239 for fission and hydrogen or lithium as fusion material. The tests (explosion) of nuclear arms produce large amount of radioactive elements in the environment, which are thrown high up into the air as huge clouds. These particles are carried long distances by wind and gradually settle over the earth as fallout or are brought down by rain. This phenomenon is called 'nuclear fallout'. These include Strontium-90, Cesium-137,

Iodine-131 and some others. The plants take up these radioactive materials and these materials enter the body of animals and human beings through the food chain. Iodine-131 damages WBCs, bone marrow, spleen, lymph nodes and may cause lung tumours, skin cancer, sterility and defective eyesight. Strontium-90 accumulates in the bones and may cause bone cancer. From land, the radioactive materials move to the water bodies where aquatic organisms absorb them and again these materials reach the human body through the food chain.

- (b) **Atomic Reactors and Nuclear Fuels** – Radioactive isotope Uranium-235 is used as a fuel to bring about disintegration of other atoms. This process releases a large amount of heat energy, which is used to produce steam for turning large turbines to generate electricity. Wastes from atomic reactors contain radioactive materials, which need to be disposed properly; otherwise, they tend to damage the living system.
- (c) **Radioactive Isotopes** – Many radioactive isotopes (e.g., ^{14}C , ^{125}I , ^{32}P and their compounds) are used in scientific research fields. From the laboratory, these radioactive materials enter into the environment and produce harmful effects on living organisms including human beings.
- (d) **X-ray and Radiation Therapy** – Human beings receive voluntarily radiations, X-rays for the diagnosis of skeletal disorders, and radium and isotope therapy for cancer.
- (e) **Workers Exposed to Radiations** – Workers of atomic power plants, nuclear reactors and nuclear fuel processors or people in nearby settlements are vulnerable to radiation exposure from the plant.

Harmful Effects of Radioactive Pollution

The effects of radioactive pollutants depend on the following:

- (a) Strength of radiation
 - (b) Rate of diffusion and deposition of pollutants
 - (c) Duration for which tissue is exposed to radiation
 - (d) Half life of radioactive pollutants
 - Based on the mode of action on the cells, radiation is of two types, viz., non-ionising radiation and ionising radiation.
 1. **Non-ionising Radiations** – These radiations have low penetrability and affect cells and molecules which absorb them (e.g., ultraviolet rays from solar radiations produces toxic photoproducts in the cells, which causes sunburns, snow blindness and inactivation of DNA, RNA and other biochemicals).
 2. **Ionising Radiations** – These radiations have high penetrability and damage the cells mainly by physically breaking the macromolecules. The molecular damage produces short-range and long-range effects on living systems.
 - (a) **Short-range Effects** – These effects appear within days or weeks after exposure. It includes burns, loss of hair, subcutaneous bleedings, change in the number and proportion of blood cell types, impaired metabolism and death of the tissue or the individual.
 - (b) **Long-range Effects** – These effects appear months or years after the exposure or even in successive generation. These are mutations, increased incidence of tumours and cancer, short lifespan and developmental changes. Gene mutations adversely affect the progeny.
- Effects on Other Organisms** – Radioactive pollutants affect most plants and animals through entering the food chain. Milk and milk products become highly contaminated by radioactive pollutants. Some animals preferentially accumulate specific radioactive materials (e.g., oysters accumulate ^{65}Zn , fishes accumulate ^{55}Fe and marine animals ^{90}Sr).

Control of Radioactive Pollution

The following preventive steps should be taken to control radioactive pollution:

1. Leakage of radioactive materials from nuclear reactors, industries and laboratories using them should be totally stopped.
2. Safe disposal of radioactive wastes – They should be changed into harmless form or stored in safe places. Radioactive wastes with very low radiation level should be discharged into sewage.
3. Preventive measures are taken so that the natural radiation level should not increase above the permissible limits.
4. Strict safety measures should be taken in nuclear power plants to avoid accidents.
5. Workers in nuclear power plants and other institutions using radioactive substances should wear protective garments.
6. The level of radiation in risk areas should be regularly checked.
7. International moratorium on manufacture and testing of nuclear arms and 'Complete International Disarmament Slogan' should be adopted without any further delay to save our existence on the earth.

Thermal Pollution

An increase in the temperature of water and air to a harmful level due to addition of hot effluents from thermal power plants, nuclear reactors, industries and automobile sector is called thermal pollution.

Effects of Thermal Pollution

1. The thermal pollution in water bodies causes an increase in water temperature.
2. Higher temperature decreases the dissolved oxygen content of water (e.g., 14 ppm at 0°C and 6.5 ppm at 14°C). The BOD (biochemical oxygen demand) of the water body increases. Aerobic decomposition of the organic matters stops and is taken over by anaerobic decomposition. It increases organic load in the water body, which results in offensive odour, scum and sludge.
3. Many fishes are killed. Trout eggs fail to hatch and salmon does not spawn at a temperature of 30°C and above.
4. The green algae are replaced by less desirable Cyanobacteria.

Alien Species

- Species of plants and animals which are not native (natural) to an area, and become established in the ecosystem and threaten the natural biological diversity are known as alien species.
- Alien species are also called non-native, non-indigenous or exotic species.
- Growth of alien species may result in a serious and sometimes irreversible and socioeconomic damage on the native ecosystem.
- For alien species to become invasive, they must arrive, survive and thrive.
- Alien species are found in all groups including animals, plants, fungi and microorganisms.
- Invasive alien species can affect all types of ecosystems.
- Islands are especially vulnerable to invasive alien species as they are naturally isolated from efficient competitors and predators.

- Invasive alien species are the second-biggest threat to biological diversity after habitat destruction due to anthropogenic activities.
- Recently researchers have reported that alien plants are invading the big cat habitats of the Tadoba–Andheri Tiger Reserve in Maharashtra (India), endangering the native flora which could alter the food web of the predators.
- African giant snails are among the worst invasive species anywhere in the world.
- Common characteristics of alien invasive species are as follows:
 - (a) Rapid reproduction and growth rate
 - (b) Short generation time
 - (c) Ability to adapt physiologically in new environmental conditions
 - (d) Ability to survive on various types of food
 - (e) Ability to produce enormous amount of seeds that disperse easily
- Increased mobility, trade and tourism have resulted in increased impact of alien species globally.
- Invasive alien species have a wide range effects on the environment and humans. Some of these are as follows:
 - (a) They threaten many species with extinction.
 - (b) They change the way of function by interfering with the species that form the ecosystem.
 - (c) They carry diseases and may harm humans directly.
 - (d) They may harm crops and farm animals.
 - (e) Some invasive alien species may harm buildings, bridges and other structures.
 - (f) They cause negative impact on resources on which humans rely for survival, viz., food, water, shelter, etc.
- Invasive species are likely to have relatively small amounts of DNA in their cell nuclei. As a result, the cells in these plants are able to divide and multiply more rapidly and the entire plant can grow more rapidly in comparison to species having higher amounts of DNA.

ECOLOGY

STRUCTURE AND FUNCTIONS OF ECOSYSTEM

Short-Answer Questions

1. What is environment?
Answer: The surroundings in which organisms live is known as environment.
2. What is an ecosystem?
Answer: The system resulting from all abiotic and biotic components or factors is termed as ecosystem.
3. Who coined the term 'ecosystem'?
Answer: Arthur Tansley (1935)
4. What are the components of an ecosystem?
Answer: An ecosystem has the following two components:
 - (a) Abiotic components – Sunlight, temperature, light, soil, etc.
 - (b) Biotic components – Producers, consumers and decomposers
5. Distinguish between abiotic and biotic factors?
Answer: Abiotic factors are nonliving components of an ecosystem that constitute the environment such as light, temperature, water, atmospheric pressure, while biotic factors are living beings (such as plants, animals and microorganisms) which are part of the given environment.
6. Which type of autotrophic groups provides most of the molecular oxygen to the earth?
Answer: Cyanobacteria and algae
7. Can an ecosystem exist without producers?
Answer: No
8. What are key industry animals?
Answer: Primary consumers or herbivores are termed as key industry animals.
9. Which is the most stable ecosystem?
Answer: Ocean
10. Define complete and incomplete ecosystems.
Answer: An ecosystem having all the four components is known as a complete ecosystem (e.g., grass-land ecosystem and forest ecosystem).
An ecosystem that lacks one or more components is termed as an incomplete ecosystem (e.g., rainwater pond (without consumers), sea bottom (without producers), etc.)
11. Give two examples of an artificial ecosystem.
Answer: (a) Cropland ecosystem (like maize or rice field)
(b) Kitchen garden

12. Give the name of microorganisms that bring about breakdown of organic matter.
Answer: Decomposers
13. Decomposers are essential. Why?
Answer: Because they recycle the nutrient which is used by producers.
14. What is detritus?
Answer: Detritus is the dead part of plants and animals.
15. What is food chain?
Answer: Transfer of food energy from one trophic level to another, i.e., from producer to herbivores to carnivores and to decomposers through the process of eaten and being eaten is known as food chain.
16. Write three features of a food chain.
Answer: (a) As we go further along a food chain, less food (and hence energy) remain available.
(b) Most food chains have four or five trophic levels.
(c) A change in the size of population in a food chain will affect the other population.
17. What is the beginning of a food chain?
Answer: Photosynthesis
18. Which food chain, shorter or longer, provides more energy?
Answer: Shorter food chain provides more energy
19. In a food chain what is the position of omnivores?
Answer: In a food chain, omnivores occupy more than one position.
20. What is food web?
Answer: Interconnected food chains are termed as food web.
21. There are more herbivores than carnivores?
Answer: In a food chain, transfer of energy occurs from one trophic level to another. When a herbivore eats, only a fraction of energy (that it gets from plant food) becomes new body mass and rest of the energy is used up by the herbivore for various life processes such as locomotion, digestion, reproduction, etc. So, when a carnivore happens to eat a herbivore, it gets only a small amount of energy from the herbivore. Of this energy, some is used up by the carnivore. Therefore, the carnivore has to eat many herbivores to get enough energy to grow and for this reason the number of herbivores is more than the number of carnivores.
22. Name the critical component of the food web.
Answer: Decomposers
23. What is ecological pyramid?
Answer: Ecological pyramid is the graphical representation of various ecological parameters at successive trophic levels of a food chain.
24. Who gave the concept of ecological pyramid?
Answer: Elton (1927)
25. Name three types of ecological pyramids.
Answer: (a) Pyramid of number (b) Pyramid of biomass (c) Pyramid of energy
26. Which pyramid is always upright?
Answer: Pyramid of energy
27. What is represented by pyramid of number?
Answer: Pyramid of number represents number of individuals in each trophic level in a food chain.
28. In a numerical pyramid, what does a base represents?

34 Ecology and Animal Behaviour

Answer: In a numerical pyramid, the base always represents producers.

29. Give an example where the base of number of pyramid is smaller than other trophic levels.

Answer: A single tree can provide food for millions of insects.

30. Distinguish between grazing food chain and detritus food chain.

Answer:

Grazing food chain	Detritus food chain
(a) First trophic level organisms are producers.	First level organisms are decomposers and detritivores.
(b) Energy is derived from the sun.	Energy is derived from the detritus.
(c) It provides organic matter to detritus food chain.	It provides inorganic matter to grazing food chain.

31. Give examples of a wetland ecosystem.

Answer: Mangroves, swamps and marshes

32. What is bottom-up control and top-down control?

Answer: Bottom-up control is the control of an ecosystem by nutrient influx as well as conditions of the physical environment, while the control of ecosystem through trophic interaction is called top-down control.

33. Who gave the concept of trophic level?

Answer: Lindeman (1942)

34. What is the shape of pyramid of biomass in terrestrial habitats and aquatic habitats?

Answer: The shape of pyramid of biomass is upright in terrestrial habitats and inverted or spindle shaped in aquatic habitats.

35. What affects the functioning of an ecosystem?

Answer: The numerical strength and biomass of organisms affect the functioning of an ecosystem.

36. What causes an ecosystem to become endangered?

Answer: An ecosystem consists of abiotic and biotic factors. Any change in these abiotic (such as change in intensity of light, temperature, pH) and biotic factors (such as change in population density) results in an endangered ecosystem.

37. Name one most biologically diverse and most fragile ecosystem of the world.

Answer: Coral reefs ecosystem

38. What is the prime cause for endangered ecosystems?

Answer: Increased human population

39. Producers (green plants) are also known as transducers. Why?

Answer: Because they convert radiant energy of the sun into chemical energy.

40. What is 10 per cent law?

Answer: 10 per cent law of energy transfer states that in a food chain only 10 per cent energy is transferred from one trophic level to another.

41. What determines the amount of energy available to higher trophic levels?

Answer: Primary production determines the amount of energy available to higher trophic levels.

42. What is flux?

Answer: Flux is the amount of energy received per unit area per unit time.

43. What is ecological efficiency?
Answer: Ecological efficiency is the ratio of energy intake and energy of the produced biomass
44. What is gross primary production?
Answer: The conversion of light energy to chemical energy is termed as gross primary productivity
45. Name the most:
(a) Most productive marine ecosystem (b) Most stable ecosystem
(c) Most unstable ecosystem
Answer: (a) Coral reef ecosystem (b) Ocean ecosystem (c) Agro ecosystem
46. State that the earth is an open or a closed system with respect to:
(a) Energy (b) Elements (nutrients)
Answer: The earth is an open system with respect to energy, while it is a closed system with respect to elements.
47. What name is given to vehicles of transfer of energy from one level to another?
Answer: Food chains
48. What is trophic level?
Answer: A trophic level represents the position of organisms in the food chain.
49. What forms the first trophic level?
Answer: Producers always form the first level.
50. How can the trophic structure of an ecosystem be described?
Answer: The trophic structure of an ecosystem can be described in terms of total amounts of nutrients or living materials.
51. What is standing state and standing crop?
Answer: The amount of nutrients in the soil at a given time is termed as standing state, while the amount of living material is termed as standing crop.
52. What is the energy source in most ecosystems?
Answer: The sun is the source of energy in most ecosystems.
53. Name the organisms that remove last energy from the remains of organisms.
Answer: Decomposers
54. What is biogeochemical cycle?
Answer: The cyclic pathway by which the essential chemical elements and compounds of protoplasm circulate in the biosphere from the environment to the organisms and back to the environment is known as biogeochemical cycle.
55. How many types of biogeochemical cycles are found in nature?
Answer: Biogeochemical cycles are of the following two types:
 - (a) Gaseous type, in which the main reservoir of chemicals is the atmosphere (e.g., carbon cycle, nitrogen cycle, oxygen cycle, etc.).
 - (b) Sedimentary cycle, in which the main reservoir is the sedimentary rock and soil (e.g., phosphorus cycle and sulfur cycle).
56. What is difference between energy flow and biogeochemical cycle?
Answer: Energy flow is unidirectional and noncyclic, whereas biogeochemical cycle is cyclic.
57. What is nitrogen cycle and why it is called perfect cycle?
Answer: The movement of nitrogen between abiotic and biotic factors of the ecosystem is termed as nitrogen cycle. It is called perfect cycle because it maintains the overall amount of nitrogen constant in the atmosphere, soil and water.

36 Ecology and Animal Behaviour

58. Give the role played by the following bacteria in the nitrogen cycle:

- | | | |
|---------------------------|-------------------------|---------------------------|
| (a) <i>Rhizobium</i> | (b) Nitrifying bacteria | (c) Denitrifying bacteria |
| (d) Nitrosomonas bacteria | (e) Putrefying bacteria | (f) Nitrobacter bacteria |

Answer: (a) *Rhizobium* – Nitrogen fixation
 (b) Nitrifying bacteria – Nitrification
 (c) Denitrifying bacteria – Denirification
 (d) Nitrosomonas bacteria – Convert ammonia into nitrites
 (e) Putrefying bacteria – Ammonification
 (f) Nitrobacter bacteria – Convert nitrites into nitrates

59. What is the name given to the cycle that converts different elements in forms that can be utilised by autotrophs?

Answer: Biogeochemical cycle

60. Biogeochemical cycle is so named?

Answer: Because it involves biological, geological and chemical processes for the transfer of matter

61. What are the different steps of nitrogen cycle?

Answer: (a) Fixation (b) Uptake (c) Mineralisation
 (d) Nitrification (e) Denirification

62. Name the only organism that can fix nitrogen through metabolic processes.

Answer: Bacteria of the genus *Rhizobium* and cyanobacteria

63. What are the different means of nitrogen fixation?

Answer: Nitrogen fixation takes place by bacteria of the genus *Rhizobium* and high-energy natural events such as lightning, forest fires, etc. Besides, fixation of nitrogen also occurs by hot lava flow.

64. What are the biological components of the carbon cycle derived by living organisms?

Answer: Photosynthesis and respiration

65. Define ecological succession.

Answer: The gradual appearance and disappearance of a series of biotic communities in a habitat over a period of time, one after another, till the development of a stable community which is perfectly adapted to the climate of that region is known as ecological succession.

66. What is pioneer species and pioneer community?

Answer: The first plant species that grows in a bare area is known as pioneer species and it forms the first biotic community called pioneer community.

67. What are the chief characteristics of ecological succession?

Answer: (a) Ecological succession takes place from arid (dry) or aquatic environment and finally leads to the mesic environment.
 (b) Pedogenesis (formation of soil) and soil differentiation takes place.
 (c) Humus content of the soil increases.
 (d) Size of the plants gradually increases which increases the biomass of the growing community.
 (e) The gradually appearing biotic communities have increasing biodiversity, therefore, they become more and more stable.
 (f) Increase in biodiversity leads gradually the simple food chains to complex food chains and food web formation.

68. Distinguish between primary and secondary succession.

Answer: Primary succession – When succession takes place in a bare area (such as newly exposed rock

or sand surface or newly formed lava or glacial tills), it is known as primary succession.

Secondary succession – When succession takes place in a habitat with a lot of organic matter, i.e., replacement of one community by the other, it is called secondary succession.

69. Why does ecological succession occur?

Answer: Ecological succession occurs due to:

- (a) Change in the relationships between organisms in a community
- (b) Change in the physical state of the community

70. Give an example of primary succession.

Answer: Colonisation of bare rock

71. Give one word for the following:

- (a) Community in water
- (b) Community on sand
- (c) Community on rock
- (d) Community on saline body

Answer: (a) Community in water – Hydrosere (b) Community on sand – Psammosere
(c) Community on rock – Lithosere (d) Community in saline body – Halosere

72. How do biodiversity, number of individuals (total number) and biomass vary during ecological succession?

Answer: Biodiversity, number of individuals and biomass tend to increase as succession proceeds and stabilise on attaining the climax stage.

73. What is the name of the process through which ecosystems can change?

Answer: Ecological succession

74. What is the final stage of ecological succession?

Answer: Climax community

75. Which stage of ecological succession has maximum diversity of organisms as well as complex food chains and food webs?

Answer: Climax community

76. Name the factors that contribute to ecological succession.

- Answer:* (a) Climate – It is the most important factor that affects succession (such as temperature, availability of sunlight, precipitation, etc.).
- (b) Soil – Salinity of soil, moisture, texture and fertility of the soil play significant role in succession.
- (c) Geographical features – Latitude, longitude, closeness to mountain ranges or large body of water are important in the process of succession.

77. What are seral communities?

Answer: The biotic communities, which develop in an area during ecological succession in between the pioneer community and the climax community, are called seral or transitional communities.

78. What are the characteristics of seral communities?

- Answer:* (a) They are slow growing and long lived.
- (b) They build slowly.
- (c) They increase biodiversity and biogeochemical cycling of materials.

79. What is ecesis?

Answer: Ecesis is the establishment and initial growth of vegetation during the process of ecological succession.

Long-Answer Questions

1. What is an ecosystem? Describe the different components of an ecosystem. What is the significance of an ecosystem?
2. Give an account of biotic communities of a pond ecosystem.
3. Write short notes on the following:
 - (a) Food chain
 - (b) Food web
 - (c) Ecological pyramids
 - (d) Plankton
 - (e) Role of decomposers in an ecosystem
4. Distinguish between:
 - (a) Food chain and food web
 - (b) Upright pyramid and inverted pyramid
 - (c) Grazing food chain and detritus food chain
 - (d) Producers and consumers
 - (e) Primary productivity and secondary productivity
 - (f) Gross primary productivity and net primary productivity
5. Give an account of flow of energy from producers to consumers in an ecosystem.
6. What is the first and second law of thermodynamics? Give their application in energy flow in an ecosystem.
7. What is a biogeochemical cycle? Describe carbon cycle and add a note on the significance of the carbon cycle.
8. Describe biogeochemical cycle of nitrogen.
9. What is ecological succession? Describe the process of ecological succession in a pond.

ENVIRONMENTAL FACTORS

Short-Answer Questions

1. Name the various environmental factors.
Answer: Abiotic environmental factors are of the following two types:
 - (a) Climatic factors – Light, temperature, humidity, rainfall, water, wind and atmospheric gases.
 - (b) Edaphic factors – It includes different factors such as soil texture, soil pH, topography, etc., of the soil.
2. What is cyclomorphosis?
Answer: Cyclomorphosis refers to the changes in body shape of certain planktonic organisms with seasonal variation in temperature (e.g., *Daphnia*).
3. Who first described cyclomorphosis?
Answer: Coker (1939)
4. What are eurythermal organisms?
Answer: Organisms that are able to tolerate a wide range of temperature fluctuations are called eurythermal organisms (e.g., humans).

5. Name an organism that produces females at normal temperature but both males and females at a higher temperature.
Answer: *Daphnia*
6. What are hekistotherms?
Answer: Hekistotherms are organisms which are adapted to short summer periods of below 10 °C and long snowy periods.
7. Name three snakes which are able to detect birds and mammals by their body heat.
Answer: (a) Rattlesnake (b) Pit vipers (c) Copper heads
8. What are psychrophytes?
Answer: Plants growing in extreme cold environment are called psychrophytes.
9. Define pedology and pedogenesis.
Answer: The study of soil is called pedology and the formation of soil is called pedogenesis.
10. What is soil? How is it formed?
Answer: Soil is the weathered surface of the earth's crust, mixed with organic material in which plants grow and microorganisms live. Soil is formed by disintegration and decomposition of rocks due to weathering as well as action of soil organisms (earthworms, fungi, bacteria, etc.)
11. Name the soil, the transport of which occurs through:
(a) Wind (b) Running water (c) Gravitational force (d) Glaciers
Answer: (a) Eolian soil (b) Alluvial (c) Colluvial (d) Glacial
12. Name different types of soils based on the size of particles.
Answer: (a) Clay soil (b) Sandy soil (c) Silt soil (d) Gravel soil
13. What is soil structure?
Answer: The arrangement of soil particles in soil mass is termed as soil structure.
14. What determines the texture of soil?
Answer: The proportion of sand, silt and clay in soil determines the texture of soil.
15. Which type of soil is good for the cultivation of cotton?
Answer: Black soil
16. Which type of soil is found in peninsular India?
Answer: Reddish soil
17. What is soil profile?
Answer: Soil profile refers to soil layers.
18. Name the horizon of soil profile that lacks litter.
Answer: Horizon B
19. Horizon B of soil profile lack humus. Why?
Answer: Because horizon B lacks litter.
20. Which horizon of soil profile contains most of the soil life?
Answer: Horizon A
21. Name the horizon of soil profile, which is, absent in desert soil and is well developed in grassland soil.
Answer: O horizon
22. In which horizon of soil profile is biological activity absent?
Answer: C horizon
23. Distinguish between hollard and chresard.

40 Ecology and Animal Behaviour

Answer: The total water content of soil is called hollard, while the amount of water in soil available to plants is called chresard.

24. What is ped?

Answer: Ped is the individual unit of soil structure.

25. What is humus and why is it important?

Answer: Humus is an amorphous, colloidal and dark substance which is the remains of incompletely decomposed organic matter after mineralisation. Humus is important because:

- (a) It is the source of energy and nutrients to most of the soil organisms.
- (b) It provides loose texture for better aeration.
- (c) It has the capacity to retain nutrients and water.
- (d) It enhances fertility of the soil.

26. Give an example where abiotic stress plays a constructive role in an ecosystem.

Answer: Natural wildfires

27. How do phytoplanktons and thermophilic zooplanktons react with elevated temperature?

Answer: Phytoplanktons react negatively with elevated temperature, while thermophilic zooplanktons react positively with elevated temperature.

28. Which type of fire is common in grasslands?

Answer: Surface fires

29. What types of changes occur due to fires?

Answer: Fires cause changes in the following:

- (a) Nutrient cycle
- (b) Water-holding capacity of soil as well as soil fauna
- (c) Light and rainfalls
- (d) Fertility of soil

30. Name the plant species that are adapted to reproduce after fire.

Answer: Jack pine and lodge pole pine

31. Name the plant that serves as a fire-indicating species.

Answer: *Epilobium angustifolium*

32. Which types of fires typically occur in coniferous forests?

Answer: Canopy fires

33. After a fire, the soil becomes acidic or basic?

Answer: More basic

34. Name the components of soil.

Answer: Soil consists of the following four components:

- (a) Mineral particles – 45 per cent
- (b) Organic matter – 5 per cent
- (c) Air – 25 per cent
- (d) Water – 25 per cent

Long-Answer Questions

1. Describe physiochemical properties of the following:

- (a) Soil
- (b) Water
- (c) Temperature
- (d) Light

2. What are environmental factors? Describe the role of the following as ecological factors:
(a) Water (b) Soil (c) Temperature (d) Light
(e) Fires
3. What is soil profile? Discuss the various horizons of a typical soil.
4. Describe the role of soil as an ecological factor.
5. Discuss the role of light as an important ecological factor.
6. Discuss the roles of temperature as an environmental factor.
7. Describe the role of fire as an eco factor.
8. Write short notes on the following:
(a) Photoperiodism (b) Dipause
(c) Thermal stratification (d) Cyclomorphosis
(e) Soil texture (f) Water as an ecological factor
9. Distinguish between the following:
(a) Stenohaline and euryhaline (b) Hibernation and aestivation
(c) Photokinesis and photoperiodism (d) Homiothermic and poikilothermic organisms
(e) Gravitational water and capillary water (f) Ground fires and crown fires

POPULATION ECOLOGY

Short-Answer Questions

1. Define population.
Answer: The total number of individuals of a species found in a particular area is called population.
2. Name the factors that affect population density.
Answer: Density is affected by natality, mortality, immigration and emigration.
3. When does population size not change through time?
Answer: When birth rates and death rates are matched, the population size does not change through time.
4. When do populations grow exponentially?
Answer: Populations grow exponentially when they reproduce continuously.
5. When do populations grow geometrically?
Answer: Populations grow geometrically when they have discrete reproductive periods.
6. When do exponential and geometric growths occur in natural populations?
Answer: Exponential and geometric growth occurs in populations when there is abundance of food in the environment in which they are living.
7. Exponential growth cannot be sustained indefinitely. Why?
Answer: Because the resources deplete over time.
8. What is age pyramid?
Answer: The age distribution of a population, represented in the form of a pyramid, is known as age pyramid.

42 Ecology and Animal Behaviour

9. Give one result of resource depletion.
Answer: Population crash
10. State two factors involved in biological equilibrium.
Answer: (a) Density independent factors (b) Density dependent factors
11. Define density independent factors.
Answer: External factors that cause reduction in populations, which are not due to overexploitation of resources, are termed as density independent factors such as droughts, floods, large storms, plagues, etc.
12. What is population growth?
Answer: Increase in the size of a population over a period is known as population growth.
13. Population growth may be positive or negative?
Answer: Population growth is the percent variation between the number of individuals at two intervals at two different times, so it may be positive or negative.
14. Define population growth form.
Answer: Populations show characteristic patterns of growth with time. This is termed as population growth form.
15. What are different factors that affect population growth?
Answer: Births and immigration are the main factors for population growth, while death and emigration are the main factors that cause decrease in populations.
16. Name the main limiting factors of population growth.
Answer: The main limiting factors of population growth are abiotic factors such as light, temperature, shelter) and biotic factors (such as population density, competition, predation, parasitism amensalism, etc.).
17. What is environmental resistance?
Answer: A combination of many factors that tends to prevent exponential growth is termed as environmental resistance.
18. Name two types of two growth forms.
Answer: (a) J-shaped growth form (b) S-shaped growth form
19. What is carrying capacity?
Answer: The level at which population growth ceases is known as carrying capacity.
20. What determines the carrying capacity?
Answer: Limited resource base
21. What is competitive exclusion principle?
Answer: Competitive exclusion principle states that the competition between populations of two species for the same limiting resource eventually results in the elimination of one of the species populations.
22. Distinguish between uniform distribution and clumped distribution.
Answer: In uniform distribution, animals are evenly spaced throughout the habitat, whereas in clumped distribution, animals are found in areas where resources are available.
23. What is density-dependent feedback?
Answer: If birth rate or death rate is influenced by the population size, the effect is termed as density dependent feedback.
24. Name one equation that expresses a change in population size through time and incorporates density dependent feedback.
Answer: Logistic equation

25. How does density feedback occur?

Answer: Density dependent feedback may occur in many ways:

- (a) Reduction in birth
- (b) Shortage of resource to nourish developing offsprings
- (c) Shortage of resource for egg production
- (d) Increase in deaths
- (e) Starvation
- (f) Lowered resistance to diseases
- (g) Less ability to escape from predators
- (h) Fewer nest sites

26. Distinguish between r-selected and k-selected species.

Answer:

r-selected species	k-selected species
(a) Small body size, many offsprings and short lifespan	Large body size and few large offsprings
(b) Early reproduction	Delayed reproduction
(c) Less competitive ability	High competitive ability
(d) Poor parental care	Extensive parental care
(e) Few reproductive attempts (semelparity)	Many reproductive attempts (iteroparity)
(f) Rapid development	Slow development

27. In which phase of sigmoid (S) growth curve, the natality and mortality becomes equal?

Answer: Stationary phase

28. What is vital index?

Answer: Vital index is the ratio of natality and mortality.

$$\text{Vital index} = \frac{\text{Natality}}{\text{Mortality}} \times 100$$

29. What is the name of the factor that controls a population from going beyond its limit?

Answer: Environmental resistance

Long-Answer Questions

- What is meant by population? Describe the characteristics of population.
- Write an essay on population ecology.
- Define population equilibrium. How does the biotic community maintain population equilibrium?
- Define survivorship curve. Describe the three general types of survivorship curves with examples. How is the survivorship curve used?
- Define ecological population. Describe the phases of the population growth curve. Add a note on the effect of the carrying capacity of the environment on growth.

6. Write short notes on the following:

(a) Age distribution	(b) Growth rate of population
(c) Biotic potential	(d) Survivorship curves
(e) Population dispersion	(f) Competitive exclusion principle
7. Distinguish between the following:

(a) Natality and mortality	(b) Immigration and emigration
(c) Stable population and declining population	(d) Population and community
(e) r-selection and k-selection	(f) J-shaped and S-shaped growth curves

BIOTIC INTERACTION

Short-Answer Questions

1. Name the interactions between members of two different species.
 Answer: The interactions between members of two different species are of the following three types:
 - (a) Positive interaction (Mutualism, photocooperation, commensalism etc.)
 - (b) Negative interaction (Parasitism, predation, amensalism, competition, etc.)
 - (c) Neutral interaction (Neutralism)
2. What is intraspecific competition? Why does it occur?
 Answer: Intraspecific competition occurs among individuals of the same species. Intraspecific competition occurs to obtain food, shelter, mate or for territorial control.
3. Name the association that refers to the following:
 - (a) Two organisms living together and benefiting each other
 - (b) The relationship between two species beneficial to each other but is not obligatory
 - (c) Association between two species in which one is benefited at the cost of the other
 - (d) Association in which one species is harmed, while the other interacting species experiences no effect
 - (e) Exploitation of one species by another for food
 Answer: (a) Mutualism (b) Photocooperation (c) Parasitism
 (d) Amensalism (e) Predation
4. Name the interaction occurring in the following:
 - (a) *Trichonympha* (a flagellate) living in the gut of termite
 - (b) Laying of eggs by a koel inside a crow's nest
 - (c) Shrews, rats and rabbits living together in grasslands
 - (d) Living of clownfish between the tentacles of a sea anemone
 - (e) Ferns growing on large plants in tropical rainforests
 - (f) Killing and eating of one species by another
 - (g) Association between sea anemone and hermit crab.
 Answer: (a) Mutualism (b) Brood parasitism (c) Neutralism
 (d) Commensalism (e) Commensalism (f) Predation
 (g) Photocooperation

5. Frank (1957) while culturing *Daphnia* with algae as food found that *Daphnia pulicaria* eliminates the closely related species *Daphnia magna*. Name the principle shown by it.
Answer: Gause's principle
6. Name the phenomenon in which death/inhibition of one organism occurs by another organism through the production of some substances in environmental conditions.
Answer: Antibiosis
7. Who gave the competitive exclusion principle?
Answer: G F Gause (1934)
8. What factors determine the prey risk?
Answer: (a) Density of prey population (b) Availability of food (c) Concealment place
(d) Size and age (e) Movement
9. Name a:
(a) Carnivorous plant (b) Carnivorous fungi
Answer: (a) *Drosera* (b) *Dactylella*
10. What is the name of the interaction which is detrimental to both species?
Answer: Competition
11. Give one most common example of nonsymbiotic mutualism in nature.
Answer: The relationship between flowering plants and their insect pollinators.
12. Which bacterium lives on human skin?
Answer: *Staphylococcus aureus*
13. What is called the type of predation in which both the predator and the prey belong to the same species.
Answer: Cannibalism

Long-Answer Questions

- What is biotic interaction? Describe positive interactions among organisms.
- Give an account of antagonistic relationships among organisms.
- Write short notes on the following:
(a) Symbiosis (b) Antagonism (c) Predation
(d) Parasitism (e) Antibiosis (f) Gause's principle
- Distinguish between the following:
(a) Parasite and predator
(b) Mutualism and commensalism
(c) Obligatory parasite and facultative parasite
(d) Parasite and hyperparasite
(e) Antagonism and neutralism
(f) Intraspecific relationship and interspecific relationship

BIODIVERSITY

Short-Answer Questions

1. What is biodiversity? Give importance of biodiversity to humankind.
Answer: The different types of genes, gene pools, species, populations, communities and ecosystems present in an area or different parts of the earth is called biodiversity or biological diversity. The term 'biodiversity' was coined by Walter Rosen (1986). Biodiversity is largely related with ecosystem productivity.
2. What are the three levels of biodiversity?
Answer: (a) Genetic diversity (b) Species diversity
(c) Community and ecosystem diversity
3. What is species diversity?
Answer: Species diversity is the whole range of organisms belonging to different species found on the earth.
4. Distinguish between genetic diversity and genetic variability.
Answer: The genetic variations found amongst the members of the same populations and geographically separated populations of the same species is termed as genetic diversity, whereas genetic variability refers to the tendency of genetic characteristics to vary.
5. What is the significance of biodiversity?
Answer: Biodiversity is very important both ecologically and economically.
 - (a) In agriculture, biodiversity helps in the production of new plants or crops by bringing change in the genetic make. It also helps in preventing plants from diseases.
 - (b) Biodiversity is the source of food, water as well as medicines.
 - (c) It provides materials for building construction. Many industrial products such as rubber, dyes, oils and fibres are produced as products from the biodiversity.
 - (d) Biodiversity is important to ecosystems for productivity, stability and healthy running of the ecosystem.
6. What are threats to biodiversity?
Answer: The important threats to biodiversity are as follows:
 - (a) Destruction of habitats
 - (b) Pollution
 - (c) Use of cloned crops
 - (d) Introduction of new species
7. Define biodiversity conservation.
Answer: Protection of diminishing plant and animal species in reduced space against the increased human activities is called biodiversity conservation.
8. Name the hypothesis concerning diversity on the earth, which states that biodiversity and ecosystem functions are not interlinked.
Answer: Idiosyncratic hypothesis
9. What are the three distribution patterns of biodiversity?
Answer: (a) α -diversity (Diversity within community) – It is the total number of species present in a particular area or a community.
(b) β -diversity (Diversity between communities) – The diversity which develops due to a change in the habitat or community due to environmental factors like light (intensity, duration), temperature, humidity, altitude, latitude and topography is called β -diversity.

(c) γ -diversity (Regional Diversity) – The number of species present in all the habitats of a region or landscape or geographical area.

10. What is ex-situ conservation?

Answer: The conservation of animals and plants outside their natural habitat is termed as ex-situ conservation.

11. Give examples of ex-situ conservation.

Answer: Zoos, botanical gardens, seed banks, etc.

12. Name the most intensely used region of the world.

Answer: Alps

13. Name the natural habitats that have been set for conservation of wild animals and plants.

Answer: (a) National parks (b) Wildlife sanctuaries
(c) Biosphere reserves (d) Sacred groves and lakes
(e) Several wetlands, mangrove and coral reefs

14. What is a biosphere reserve?

Answer: A large area of protected landmass to preserve the genetic diversity of the local ecosystems by protecting wildlife and other fauna, flora as well as the traditional lifestyle of the tribal populations is called a biosphere reserve.

15. What is a key threat to biodiversity?

Answer: Global warming is a key threat to biodiversity

16. How many zones are there in a biosphere reserve?

Answer: There are three zones in a biosphere reserve:
(a) Core zone (b) Buffer zone (c) Transition zone

17. From where was the concept of biosphere reserve developed?

Answer: The concept of biosphere reserve evolved by UNESCO's Man and Biosphere Programme (MABP).

18. How many biosphere reserves have been established by the Indian government?

Answer: 16

19. What is core zone?

Answer: It is the central, undisturbed and legally protected zone of a biosphere without any human activities or interference.

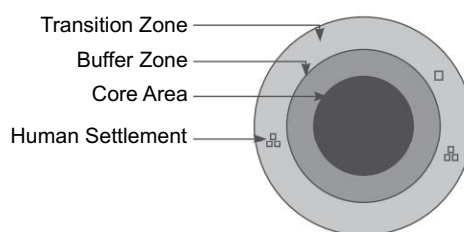
20. What are the two types of in-situ conservation?

Answer: Hot spots and protected areas

21. What are hot spots?

Answer: Hot spots are the areas of high endemism and very high levels of species richness.

22. Give the diagrammatic representation of different zones of a typical biosphere reserve.



Answer: A typical biosphere reserve

Long-Answer Questions

1. What is biodiversity? Give importance of biodiversity to humankind. Describe various threats to biodiversity.
2. Define the term biodiversity. What are the three patterns of biodiversity? Add a note on biodiversity conservation.
3. Give an account of biogeographical regions of India.
4. Write short notes on the following:
 - (a) Ecological diversity
 - (b) Species diversity
 - (c) Genetic diversity
 - (d) Project Tiger
 - (e) Biosphere reserves
 - (f) Threatened species
 - (g) Effects of wildlife loss
 - (h) Social forestry

BIOMES

Short-Answer Questions

1. What are biomes?
Answer: The large biogeographic areas having distinct climate, vegetation and animals are called biomes.
2. Name the major biomes of the world.
Answer: (a) Freshwater biome (b) Marine biome (c) Tundra biome
(d) Forest biome (e) Grassland biome (f) Desert biome
3. Name the major factor responsible for the distribution of terrestrial biomes.
Answer: Climate is the major factor responsible for the distribution of terrestrial biomes.
4. Name the two types of tundra biomes.
Answer: (a) Arctic tundra (b) Alpine tundra
5. Name the principal grassland biomes.
Answer:

	Name	Distribution
(a)	Prairies	North America
(b)	Pampas	South America
(c)	Steppes	Central Asia
(d)	Pusztas	Hungary
(e)	Veldts	South Africa
(f)	Tussocks	New Zealand

6. Name the continent where deserts are not found.
Answer: Europe
7. Which biome has four seasons and broad leaf trees?

Answer: Deciduous forests

8. Name the world's most ecologically rich biome.

Answer: Rainforests

9. Is weather the same in all deserts?

Answer: No

10. Name the two types of rainforest biomes.

Answer: Temperate and tropical rainforests

11. Why are rainforests important?

Answer: Because they play a key role in maintaining global weather patterns and rain.

12. Why is the population of tundra biome constantly changing?

Answer: Because animals of the tundra biome are generally migratory.

13. Give three characteristics of the tundra biome.

Answer: (a) Permafrost and short growing season
(b) Low primary productivity and species diversity
(c) Nutrient-rich soil

14. What is gallery forest?

Answer: Forests that grow in a narrow band along streams in deserts and grasslands are termed as gallery forest.

15. What is the difference between steppes and savanna?

Answer: In steppes, all the forage is provided only during the brief wet season but in savanna forage is mainly from grasses that grow only during the wet season as well as also from the smaller amount of regrowth in the dry season.

16. Name the biome that has low temperature and permafrost.

Answer: Tundra biome

17. What is the name of saltwater biome?

Answer: Marine biome

18. In which areas of the world are steppe grasslands generally found?

Answer: Steppe grasslands are usually found in areas of the world which are less prone to moisture.

19. Give two characteristics of savanna biomes.

Answer: (a) Warmer drier climates (b) Seasonal drought

20. Name the biome having mainly coniferous trees.

Answer: Boreal forest

21. What are the three major types of forests classified according to latitude?

Answer: (a) Tropical forests (b) Temperate forests (c) Boreal forests (Taiga)

22. What are the effects of deforestation?

Answer: Deforestation leads to:
(a) Soil erosion (b) Floods (c) Loss of top soil
(d) Disruption of natural cycle (e) Lowering of ground water levels
(f) Drought condition

23. What is desertification?

Answer: The process of destruction of the biological potential of land leading to desert-like condition is termed as desertification.

50 Ecology and Animal Behaviour

24. Give an example of desert biome.
Answer: Atacama of Chile
25. Name the biome having long and cold winter.
Answer: Taiga biome
26. How is savanna derived?
Answer: Savanna is derived from the humid forest due to shifting cultivation and sheep grazing.
27. What is Brazil's cerrado?
Answer: Brazil's cerrado is open woodland of short twisted trees.
28. Where does photosynthesis take place in water biomes?
Answer: Near the surface
29. What is permafrost?
Answer: The part of the earth that remains permanently frozen is called permafrost.
30. Which biome has the largest productivity?
Answer: Tropical rainforest
31. How is chaparral characterised?
Answer: Chaparral is characterised by being very hot and dry.
32. Where do savannas exist?
Answer: Savannas exist in areas with 6 to 8 months of wet summer season and 4 to 6 months of dry winter season.
33. What is the another name of differentiation diversity?
Answer: β -diversity
34. What is the name of the largest terrestrial biome?
Answer: Boreal forests (Taiga) are the largest terrestrial biome.
35. Name the major characteristic seasons of tropical rainforests.
Answer: In tropical rainforests, there are only two seasons, viz., rainy and dry. There is no winter season.
36. What are estuaries?
Answer: Estuaries are the areas where freshwater merges with oceans.

Long-Answer Questions

1. What is meant by the term 'biome'? Describe the typical rainforest biome.
2. What are biomes? Describe different biomes.
3. Give an account of grassland biome. Name the factors that control the development of grasslands.
4. What is wetland? Give an account of wetland biomes. Why are wetlands disappearing?
5. Write short notes on the following:
 - (a) Tundra
 - (b) Desert biome
 - (c) Chaparral biome
 - (d) Taiga
 - (e) Tropical deciduous forest
 - (f) Temperate deciduous forest
 - (g) Prairies
 - (h) Mulch
 - (i) Pasture land
 - (j) Mangroves in India

ALIEN SPECIES

Short-Answer Questions

1. What are alien species?
Answer: Species of plants and animals which are not native (natural) to an area that become established in the ecosystem and threaten the natural biological diversity are known as alien species.
2. What are other names of alien species?
Answer: Alien species are also called non-native, non-indigenous or exotic species.
3. For which type of species 'arrive, survive and thrive' is applicable?
Answer: Alien invasive species (IAS)
4. What are the common characteristics of alien invasive species?
Answer: (a) Rapid reproduction and growth rate
(b) Short generation time
(c) Ability to adapt physiologically in new environmental conditions
(d) Ability to survive on various types of food
(e) Ability to produce enormous amount of seeds that disperse easily
5. Islands are especially vulnerable to alien invasive species. Why?
Answer: Because they are naturally isolated from efficient competitors and predators.
6. Can alien invasive species affect all types of ecosystems?
Answer: Yes
7. Alien invasive species are able to grow more rapidly in comparison to other species?
Answer: Invasive species are likely to have relatively small amounts of DNA in their cell nuclei. As a result, the cells in these plants are able to divide and multiply more rapidly and the entire plant can grow more rapidly in comparison to species having higher amounts of DNA.
8. Name the second-biggest threat to biodiversity.
Answer: Invasive alien species
9. Name a worst invasive species.
Answer: African giant snails are among the worst invasive species anywhere in the world.
10. Can alien species affect human health?
Answer: Yes

Long-Answer Question

1. Give an account of invasive alien species.

ENVIRONMENTAL POLLUTION

(Pollution, Ecotoxicology and Global Warming)

Short-Answer Questions

1. What is environmental pollution?
Answer: Any undesirable change in the physical, chemical or biological characteristics of the environment which adversely affects living organisms directly or indirectly is called environmental pollution.
2. What is a pollutant?
Answer: A chemical that causes pollution is called a pollutant.
3. Distinguish between primary and secondary pollutants.
Answer: Primary pollutants are those pollutants that maintain their form in the environment (e.g., DDT) while those pollutants that not maintain their form in the environment are called secondary pollutants (PAN).
4. What determines the severity of pollution?
Answer: The severity of pollution is determined by:
(a) Its chemical nature (b) Its concentration (c) Its persistence
5. What are fund pollutants?
Answer: (a) Chemicals for which the environment has some absorptive capacity are called fund pollutants.
(b) They are not destroyed.
(c) They are converted into less harmful substance (e.g., carbon dioxide).
6. What are stock pollutants?
Answer: Those chemicals for which the environment has negligible or no absorptive capacity are called stock pollutants. They accumulate in the environment (e.g., nonbiodegradable pollutants).
7. What is PAN?
Answer: PAN is peroxyacyl nitrate which is a secondary pollutant present in photochemical smog and is more stable than ozone.
8. What are the effects of PAN?
Answer: (a) It causes irritation in the eyes and respiratory distress.
(b) It destroys spongy parenchyma of the young leaves, causing necrosis by damaging chloroplasts.
(c) Photosynthetic activity and growth is affected.
(d) Electron transport system is inhibited.
(e) Cellular metabolism is affected due to its interference with the enzyme system.
9. Name the chemical that causes depletion of the ozone layer.
Answer: Chlorofluorocarbons
10. What are the six common air pollutants?
Answer: (a) Ozone (b) Nitrogen oxides (c) Sulphur dioxides
(d) Carbon monoxide (e) Particulate matter (f) Lead

11. Name the major air pollutant.
Answer: Carbon monoxide, which accounts for 50 per cent of the total pollutants.
12. Name some pollutants added by nature in air.
Answer: (a) Gases from forest fire and decomposition
 (b) Gases and ashes from volcanic eruptions
 (c) Dust from storms
 (d) Pollen spores and bacteria from living organisms
13. Distinguish between biodegradable and nonbiodegradable pollutants.
Answer: Those pollutants, which are gradually degraded by microbes are called degradable pollutants (domestic waste products, urine, fecal matter, etc.), whereas nonbiodegradable pollutants are those pollutants which are not degraded by microbes (e.g., DDT, glass phenols, etc.).
14. What is water pollution and how does it occur?
Answer: Contamination of water bodies by harmful wastes is called water pollution. Water pollution occurs due to accumulation of waste materials in water bodies that adversely affect it.
15. What are the sources of water pollution?
Answer: (a) Domestic sewage (b) Industrial effluents
 (c) Radioactive wastes (d) Oils, greases from automobiles
 (e) Agricultural runoff containing pesticides
16. What are the sources of radioactive pollution?
Answer: (a) Nuclear explosions (b) Discharges from nuclear reactors
17. What are aerosols?
Answer: Aerosols are the chemicals which are discharged into the air with force (e.g., chlorofluorocarbons).
18. Ozone is commonly called chemical weed?
Answer: Ozone is commonly called chemical weed because it is harmful when present in the troposphere and quite useful in the stratosphere.
19. What will be the effect of depletion of the ozone layer?
Answer: Because of depletion of the ozone layer, more and more ultraviolet rays will reach the earth resulting in various types of diseases
20. What is eutrophication?
Answer: Eutrophication is the enrichment of nutrients in the water bodies which leads to the excessive growth of planktons, algae, cyanobacteria, bacteria and animals.
21. Where is photochemical smog formed?
Answer: Photochemical smog is formed in the area of intense solar radiation.
22. What is acid rain? How it is caused?
Answer: The rainfall with a pH less than 5 (generally 3 to 4.5) is called acid rain. Acid rain is caused due excessive production of SO_2 , NO_2 , volatile organic carbons (VOCs) and ammonia due to the burning of fossil fuels and processing. Nitrogen oxides are also formed due to lightning and radiation.
23. Which is the major gas responsible for acid rain?
Answer: Sulphur dioxide (SO_2) which contributes to 65 per cent of acid rain
24. What are common soil pollutants?
Answer: Following are common soil pollutants:
 (a) Agrochemicals (b) Manures (c) Industrial effluents

54 Ecology and Animal Behaviour

25. What is smog?

Answer: It is opaque, dark fog formed by smoke, oxides of sulphur and nitrogen H_2S and water vapour.

26. What are the effects of smog?

Answer: (a) Smog causes allergy, asthma and bronchitis in humans.

(b) In plants, it causes silvering, glazing and necrosis.

27. Animal dung is biodegradable or nonbiodegradable?

Answer: Biodegradable

28. What is the major source of carbon monoxide?

Answer: Vehicular exhaust is the major source of the carbon monoxide.

29. Name the dominant source of noise pollution.

Answer: Motor vehicles, which account for 90 per cent of noise pollution

30. Name the region where the largest ozone hole has been reported.

Answer: Over the Antarctic region

31. What is stone leprosy?

Answer: The oxides of sulphur and nitrogen dissolve into rainwater and form sulphuric acid and nitric acid. These acids convert CaCO_3 of marble and limestone into CaSO_4 and CaNO_3 . These converted regions peel off or wash off resulting in pit formation and corrosion. This phenomenon is called 'stone leprosy'.

32. What is the best solution to get rid of biodegradable wastes?

Answer: Recycling is the best solution to get rid of biodegradable wastes.

33. What is e-waste?

Answer: E-waste comprises rejected computer parts (such as keyboards, mouse, monitors, processing units, etc.) which are irreparable.

34. What is third pollution?

Answer: Landscape pollution is also known as third pollution.

35. What is the unit of measurement of noise pollution?

Answer: Decibel (dB)

36. Define oxygen depletion.

Answer: Organic matter present in the sewage causes growth of microorganisms, which utilise oxygen of the water leading to the deficiency of oxygen, known as oxygen depletion. Due to this, aquatic organisms are unable to survive.

37. Which is the major source of methane in India?

Answer: Rice fields

38. What is sludge?

Answer: Sludge is the solid content of the sewage.

39. What is BOD?

Answer: Biological demand of oxygen (BOD) is the amount of oxygen required for biological oxidation by microbes in any unit volume of water.

40. In nature, how is ozone formed?

Answer: In nature, ozone is formed in the stratosphere when ultraviolet light strikes an oxygen molecules.

41. Name the naturally occurring process that aids heat to the earth's surface and the atmosphere.

Answer: Greenhouse effect

42. Name the main greenhouse gases in the earth's atmosphere.
Answer: The main greenhouse gases in the earth's atmosphere are water vapour, carbon dioxide, methane, ozone and nitrous oxide.
43. What is the main effect of greenhouse gases?
Answer: Greenhouse gases mainly affect the temperature of the earth. In the absence of greenhouse gases, the earth's surface will be 33°C colder than the present temperature.
44. Which greenhouse gas accounts for the largest percentage of the greenhouse effect?
Answer: Water vapour
45. What amount of solar radiation is reflected by the earth?
Answer: The earth reflects about 30 per cent of the incoming solar radiation and remaining 70 per cent is absorbed warming the land, atmosphere and oceans.
46. What is greenhouse effect?
Answer: Warming of the earth's climate due to increased concentration of carbon dioxide and some other gases is termed as greenhouse effect.
47. What are the sources of methane?
Answer: Methane is produced by:
(a) The action of anaerobic bacteria on vegetation
(b) Decomposition of organic matter
(c) Incomplete combustion of vegetation
(d) Natural gas pipeline
48. What causes global warming?
Answer: Increased concentration of greenhouse gases is responsible for global warming.
49. What are the effects of global warming?
Answer: Global warming results in the following:
(a) Changes in climate
(b) Alter weather patterns
(c) Influence length of seasons
(d) Coastal flooding
(e) More frequent and severe storms
(f) Reduction of biodiversity
50. Name the temperature measuring method that measures accurate temperature of global warming.
Answer: Orbiting weather satellites
51. What is ecotoxicology?
Answer: The study of effects of chemicals on ecological systems is known as ecotoxicology.
52. Who coined the term 'ecotoxicology'?
Answer: Rene Truhaut (1969) coined the term 'ecotoxicology'.
53. Which is the most penetrative form of radiation?
Answer: Gamma rays
54. How can the penetration of gamma rays be stopped?
Answer: The penetration of gamma rays can be stopped by sheets of lead.
55. Which is the most common form of radioactive isotope in the air?
Answer: Carbon-14

Long-Answer Questions

1. Define pollution. Describe sources and harmful effects of air pollution.
2. What is pollution? Describe the different types of pollution and discuss the effects of water pollution on living beings.
3. Write short notes on the following:

(a) Photochemical smog	(b) Acid rain
(c) Ozone depletion	(d) Eutrophication
(e) Thermal pollution	(f) Wastewater treatment
(g) Greenhouse effect	(h) Global warming
4. Differentiate between the following:

(a) Primary and secondary pollutants	(b) Fog and smog
(c) Detergents and fertilisers	(d) BOD and COD
(e) Nitrate poisoning and lead poisoning	(f) Point and nonpoint source of pollution
5. Describe pollution caused due to:

(a) Acid rain	(b) Pesticide
(c) Eutrophication	(d) PAN
(e) Heavy metal toxicity	(f) Chlorofluorocarbons
6. Write short notes on the following:

(a) Radioactive pollution	(b) Biomagnification
(c) Sewage pollution	(d) Wastewater recycling
(e) Water-borne diseases	(f) Sewage culture
6. Discuss radioactive substances as environmental toxicants. Describe the effect of radioactive pollutants on human health.
7. Explain pollution. Describe the various sources of noise pollution and discuss its impact.
8. Describe control of:

(a) Air pollution	(b) Water pollution
(c) Noise pollution	(d) Radioactive pollution
9. Describe the effects of the following on aquatic biota:

(a) Heavy metals	(b) Detergents
(c) Dyes	(d) Coal washery
(e) Pesticides	
10. Give an account of water pollution due to industrial agricultural effluents.
11. Explain the reasons of depletion of ozone layer. Describe the ecological role of ozone.

STRUCTURE AND FUNCTIONS OF ECOSYSTEM

Multiple-Choice Questions

1. An ecosystem includes:
(a) An energy source (b) Air, water and soil
(c) Plants, animals and decomposers (d) All
2. Which one of the following is applicable to an ecosystem?
(a) Self-sustained (b) Self-regulated (c) Arthur Tansely (d) All
3. Which one of the following is the basic structural and functional unit of ecology?
(a) Ecotone (b) Ecosystem (c) Ecosphere (d) Ecotype
4. Energy and nutrients enter a community through:
(a) Producers (b) Primary consumers
(c) Secondary consumers (d) Consumers
5. Which one of the following is the largest and most uniform ecosystem?
(a) Freshwater ecosystem (b) Crop ecosystem
(c) Marine ecosystem (d) Forest ecosystem
6. Consider the following statements:
(A) Eugene Odum is the 'Father of Ecology'
(B) The central concept of ecosystem is that living organisms interact with every nonliving organism of their environment
(C) Ecosystems may be permanent or temporary
(D) Ecosystems generally form a number of food webs
The correct statements are:
(a) All (b) A, B and C (c) B and C (d) C and D
7. Marine ecosystem does not include:
(a) Oceans (b) Estuaries and lagoons
(c) Mangroves and coral reefs (d) None
8. Which one of the following about rifts is incorrect?
(a) Spreading cracks in the sea floor (b) Continental drift occurs
(c) Light reaches (d) Primary productivity occurs
9. Which one of the following is a lentic ecosystem?
(a) Spring (b) River (c) Stream (d) None
10. Natural balance is disturbed regularly in:
(a) Grassland ecosystem (b) Cropland ecosystem
(c) Pool ecosystem (d) Desert ecosystem

11. Nektonic animals are:
 - (a) Swimmers
 - (b) Found in all aquatic systems
 - (c) Large and powerful
 - (d) All
12. Recycling of nutrients will be blocked in the absence of:
 - (a) Producers
 - (b) Consumers
 - (c) Decomposers
 - (d) None
13. In which one of the following ecosystems, plankton, nekton and benthos are lacking?
 - (a) Pond ecosystem
 - (b) Ocean ecosystem
 - (c) Forest ecosystem
 - (d) River ecosystem
14. In a pond ecosystem, benthos is a:
 - (a) Producer
 - (b) Decomposer
 - (c) Primary consumer
 - (d) Secondary consumer
15. Zooplanktons are:
 - (a) Producers
 - (b) Primary consumers
 - (c) Secondary consumers
 - (d) Tertiary consumers
16. Which one of the following is lacking in marine ecosystem?
 - (a) Amphibians
 - (b) Reptiles
 - (c) Dino flagellates
 - (d) Brown algae
17. In marine ecosystem, the chemosynthetic sulphur bacteria form the food base in:
 - (a) Intertidal zone
 - (b) Profoundal zone
 - (c) Hypodermal vents
 - (d) Continental shelf
18. Which one of the following is dominated by vascular plants?
 - (a) Wetlands
 - (b) Ponds
 - (c) Rivers
 - (d) None
19. Aquatic ecosystems:
 - (a) Recycle nutrients
 - (b) Recharge ground water
 - (c) Purify water
 - (d) All
20. In a water body, which one of the following is a determining factor in types of species found?
 - (a) Temperature
 - (b) Salinity
 - (c) pH
 - (d) O₂
21. Which one of the following is incorrect?
 - (a) Chemosynthetic bacteria are found in benthic marine ecosystems.
 - (b) Due to productivity, wetlands are often converted into dry lands.
 - (c) Marine ecosystems generate 32 per cent of the world's net primary production.
 - (d) None
22. A pond ecosystem lacks:
 - (a) Algae
 - (b) Fungi
 - (c) Microorganisms
 - (d) None
23. Dragonflies mostly inhabit the:
 - (a) Surface film habitat
 - (b) Open water habitat
 - (c) Shore habitat
 - (d) Bottom water habitat
24. Which one of the following is incorrect?
 - (a) Ecosystems have energy flows.
 - (b) Ecosystems recycle materials.
 - (c) Both these processes are linked.
 - (d) Both these process are the same.
25. Which one of the following threatens the system's sustainability and results in eventual destruction?
 - (a) Overpopulation
 - (b) Removal of a species
 - (c) Climate change
 - (d) All
26. Consider the following statements:
 - (A) An excess of pond vegetation is an indicator of an unbalanced ecosystem
 - (B) Decomposers are autotrophic in nature
 - (C) Ecosystems have no specified size or limits
 - (D) An ecosystem without decomposers but with autotrophs and heterotrophs is not self-sustained

The correct statements are:

- (a) All (b) A and D (c) B, C and D (d) A and C
27. Which one of the following is applicable to pond ecosystem?
 (a) Xeric (b) Lotic (c) Lentic (d) Vent
28. Which one of the following is not a submerged aquatic plant of pond ecosystem?
 (a) *Hydrilla verticillata* (b) *Ceratophyllum demersum*
 (c) *Vallisneria* (d) *Myriophyllum spicatum*
29. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|----------------|------------------------|
| (A) Earthworms | 1. Producer |
| (B) Grass | 2. Secondary carnivore |
| (C) Frogs | 3. Primary carnivore |
| (D) Hawks | 4. Detrivore |
- Answer codes:
- | A | B | C | D |
|-------|---|---|---|
| (a) 4 | 1 | 2 | 3 |
| (b) 2 | 3 | 4 | 1 |
| (c) 3 | 4 | 1 | 2 |
| (d) 4 | 1 | 3 | 2 |
30. Chemosynthetic bacteria obtain energy for the synthesis of organic compounds from:
 (a) Hydrogen sulphide (b) Methane
 (c) Ammonia (d) All
31. Which one of the following gets its food from chemosynthetic bacteria?
 (a) Molluscs (b) Crabs (c) Giant worms (d) All
32. Which one of the following is a controlling factor in an ecosystem?
 (a) Temperature (b) Soil moisture (c) Predation (d) Light
33. Which one of the following is a recently discovered ecosystem?
 (a) Agro ecosystem (b) Vent (c) Crater (d) Floating iceberg
34. Which one of the following about coral reefs is incorrect?
 (a) Develops in shallow coastal warm water (b) Area of maximum productivity
 (c) Area of maximum diversity (d) None
35. Which one of the following has the maximum biomass?
 (a) Grassland ecosystem (b) Forest ecosystem
 (c) Pond ecosystem (d) Spring ecosystem
36. Which one of the following is a primary consumer?
 (a) Animals (b) Plants (c) Fungi (d) None
37. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|----------------|------------------|
| (A) Benthos | 1. Starfish |
| (B) Periphyton | 2. Beetle |
| (C) Nekton | 3. Sessile algae |
| (D) Neuston | 4. Blue whale |
- Answer codes:

60 Ecology and Animal Behaviour

	A	B	C	D
(a)	4	1	2	3
(b)	1	3	4	2
(c)	3	2	4	1
(d)	1	3	4	2

38. Which one of the following, with reference to net primary productivity, is the correct sequence of ecosystems?
- Open ocean → Savanna → Coral reefs → Tropical rainforests → Estuary
 - Tropical rainforests → Coral reefs → Open ocean → Savanna → Estuary
 - Coral reefs → Tropical rainforests → Estuary → Savanna → Open ocean
 - Coral reefs → Estuary → Tropical rainforests → Savanna → Open ocean
39. Which one of the following has the least net primary productivity?
- Estuary
 - Extreme desert
 - Savanna
 - Semidesert area
40. Which one of the following is an incorrect match?
- Goat – Second trophic level
 - Lion – Third trophic level
 - Bear – Occupy different trophic level
 - None
41. Which one of the following is applicable to decomposers?
- Reducers
 - Biophages
 - Scavengers
 - All
42. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-------------------------|--|
| (A) Desert alkali lakes | 1. Lake Baikal in Russia |
| (B) Dystrophic lakes | 2. High concentration of humic acid |
| (C) Desert salt lakes | 3. High pH and carbonate concentration |
| (D) Deep ancient lakes | 4. Evaporation exceeds precipitation |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 3 | 2 | 1 |
| (b) | 2 | 4 | 1 | 3 |
| (c) | 4 | 2 | 3 | 1 |
| (d) | 3 | 2 | 4 | 1 |
43. Which one of the following about bogs is incorrect?
- Soil waterlogged
 - Heath shrubs
 - Water fowl areas
 - Spongy covering of mosses
44. Which one of the following is a free-floating macrophyte of pond ecosystem?
- Wolffia*
 - Eichhornia*
 - Spirodella*
 - All
45. Consider the following statements:
- Ecosystems vary in size
 - An ecosystem may be as small as a puddle or as large as the earth itself
 - Any group of living and nonliving organisms interacting with each other constitute an ecosystem
 - An aquarium is a good example of a shared habitat
- The incorrect statements are:
- None
 - A and D
 - B and C
 - C and D
46. Which one of the following gases is more available to aquatic ecosystem than terrestrial ecosystem?
- Carbon dioxide
 - Nitrogen
 - Oxygen
 - None

47. The smallest land areas are occupied by:
 - (a) Grassland ecosystem
 - (b) Tundra
 - (c) Tundra and temperate grasslands
 - (d) Forest ecosystem
48. Tropical forests contribute _____ per cent of total estimated net primary productivity on land:
 - (a) 20
 - (b) 25
 - (c) 45
 - (d) 55
49. Grassland ecosystem constitute _____ per cent of the plant covers of the world:
 - (a) 25
 - (b) 32
 - (c) 40
 - (d) 45
50. The classification of different kinds of grassland ecosystems is based on:
 - (a) Similarity of dominant vegetation
 - (b) Presence or absence of specific dominant species
 - (c) Prevailing climate condition
 - (d) All
51. Which one of the following is the largest coral reef system in the world?
 - (a) New Caledonia barrier reef
 - (b) Red sea coral reef
 - (c) Great barrier reef
 - (d) Belize barrier reef
52. Which one of the following is the deepest photosynthetic coral reef?
 - (a) Red sea coral reef
 - (b) Pulley ridge
 - (c) Bahamas barrier reef
 - (d) New Caledonia barrier reef
53. Which one of the following contains enzymes to decompose lignin of wood?
 - (a) Fungi
 - (b) Termites
 - (c) Bacteria
 - (d) *Trichonympha*
54. Which one of the following is a decomposer?
 - (a) Millipede
 - (b) Snake
 - (c) Raven
 - (d) None
55. Wetlands contain _____ per cent of the carbon storage:
 - (a) 8–10
 - (b) 10–14
 - (c) 20–25
 - (d) 30–35
56. Wetlands occupy only about _____ per cent of the area of the world:
 - (a) 2
 - (b) 4
 - (c) 6
 - (d) 10
57. Which one of the following is incorrect?
 - (a) *Beggiatoa* is sulphur bacteria found abundantly in sulphur springs.
 - (b) The chemosynthetic bacteria help in recycling of minerals.
 - (c) The chemosynthetic bacteria save the energy being lost from the ecosystem.
 - (d) None
58. Which one of the following bacteria reduces sulphate in deep sediments to H_2S gas?
 - (a) *Desulfovibrio*
 - (b) *Aerobacter*
 - (c) *Beggiatoa*
 - (d) *Athiorhodaceae*
59. A newly formed water pond is an example of:
 - (a) Complete ecosystem
 - (b) Incomplete ecosystem
 - (c) Artificial ecosystem
 - (d) Aquatic ecosystem
60. Oxygen is not liberated by:
 - (a) Cyanobacteria
 - (b) Bacteria performing only an oxygenic photosynthesis
 - (c) Both (a) and (b)
 - (d) None
61. Which one of the following mode of photosynthesis is found in marine ecosystems?
 - (a) Oxygenic photosynthesis
 - (b) Anoxygenic photosynthesis
 - (c) Anaerobic anoxygenic photosynthesis
 - (d) All
62. Which mode of photosynthesis is found in low-nutrient ocean?
 - (a) Oxygenic photosynthesis
 - (b) Anoxygenic photosynthesis
 - (c) Anaerobic an oxygenic photosynthesis
 - (d) All

62 Ecology and Animal Behaviour

63. Which one of the following is present only in living organisms?
 (a) Proteins (b) Carbohydrates (c) ATP (d) Humic acid
64. Productivity of an ecosystem is affected by:
 (a) Availability of nutrients (b) Sunlight and temperature
 (c) Rainfall (d) All
65. Which one of the following is a limiting factor in most terrestrial ecosystems?
 (a) Water (b) Temperature (c) pH (d) Light
66. Consider the following statements:
 (A) Decomposers are not represented in ecological pyramids
 (B) Cherrapunji forest is extremely fragile
 (C) Both positive and negative feedback occur in ecosystems
 (D) In the deep oceans, producers are not present
 The correct statements are:
 (a) All (b) B, C and D (c) A and D (d) B and C
67. In India, salt lakes are abundant in:
 (a) Goa (b) Andhra Pradesh (c) Gujarat (d) Orissa
68. Which one of the following is not a keystone species?
 (a) Humans (b) Elephants (c) Crocodiles (d) Snakes
69. O₂ and CO₂ balance is maintained by:
 (a) Producers (b) Consumers (c) Decomposers (d) Abiotic factors
70. Biological equilibrium is shown by:
 (a) Abiotic factors, consumers and decomposers (b) Producers, consumers and decomposers
 (c) Consumers and decomposers (d) Producers and decomposers
71. Which one of the following is not depicted in ecological pyramids?
 (a) Humans (b) Litter and humus (c) Saprophytes (d) All
72. Which one of the following occupies a place in second, third and fourth trophic levels?
 (a) Lions (b) Humans (c) Bears (d) Deer
73. Which one of the following is not applicable to producers?
 (a) Transducers (b) Transformers (c) Nourishing organisms (d) Autotrophs
74. The energy transfers from one trophic level to the next are about:
 (a) 10 per cent (b) 25 per cent (c) 50 per cent (d) 90 per cent
75. Ecological pyramids start with:
 (a) Tertiary Consumers (b) Primary consumers
 (c) Producers (d) All
76. Which one of the following is incorrect?
 (a) Ecological pyramids represent the basic laws of energy.
 (b) Ecological pyramids represent the transfer of energy from one trophic level to the next.
 (c) Charles Elton (1927) developed the concept of ecological pyramid.
 (d) Pyramid of energy may be upright or inverted.
77. An ecological pyramid is:
 (a) Upright (b) Inverted (c) Spindle shaped (d) All
78. Which one of the following is not affected by size or metabolism of organisms?
 (a) Pyramid of numbers (b) Pyramids of biomass

- (c) Pyramids of energy (d) All
79. Which one of the following is applicable to food web?
 (a) Source web (b) Sink web (c) Community web (d) All
80. Which one of the following has the lowest primary production?
 (a) Open ocean (b) Swamps (c) Lake (d) Estuary
81. Which one of the following is lacking in the euphotic zone?
 (a) Phytoplankton (b) Zooplankton (c) Nekton (d) None
82. Which one of the following is the largest nekton?
 (a) Comb jelly (b) Blue Whale (c) Copepod (d) Sow bug
83. Which one of the following is an estuary?
 (a) River mouth (b) Coastal bay (c) Tidal marsh (d) All
84. Which one of the following is incorrect?
 (a) Estuaries are transitional zones.
 (b) The temperature in estuaries varies considerably diurnally and seasonally.
 (c) Phytoplanktons are abundant in estuaries.
 (d) In estuaries, the dissolved oxygen tends to be high.
85. Which one of the following about the Pacific ocean is incorrect?
 (a) Largest (b) Coldest (c) Deepest (d) More saline
86. All the seas:
 (a) Are interconnected by currents (b) Dominated by waves
 (c) Influenced by tides (d) All
87. Which one of the following has the highest specific heat?
 (a) Freshwater (b) Seawater (c) Wet mud (d) Solid rock
88. Decomposition of detritus is slow, if it contains:
 (a) Cellulose (b) Lignin (c) Chitin/tannin (d) All
89. Detritivores are abundant in:
 (a) Acidic soils (b) Neutral soils
 (c) Slightly alkaline soils (d) Neutral and slightly alkaline soils
90. Decomposers are abundant in:
 (a) Neutral and slightly acidic soils (b) Neutral and slightly alkaline soils
 (c) Highly acidic soils (d) Highly alkaline soils
91. The pyramid of biomass in a pond ecosystem is:
 (a) Upright (b) Linear (c) Inverted (d) Irregular
92. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-------------------------|--------------------------------------|
| (A) <i>Anabaena</i> | 1. Benefits legume crops |
| (B) <i>Frankia</i> | 2. Increases crop yields |
| (C) <i>Azospirillum</i> | 3. Reforestation and wood production |
| (D) <i>Rhizobium</i> | 4. Enhances yield of rice |
- Answer codes:
- | A | B | C | D |
|-------|---|---|---|
| (a) 2 | 3 | 4 | 1 |
| (b) 3 | 1 | 4 | 2 |

64 Ecology and Animal Behaviour

- (c) 4 3 2 1
(d) 2 1 4 3

93. Which one of the following is incorrect?
 (a) Pyramid of numbers is upright for grassland and pond ecosystems.
 (b) Pyramid of biomass is upright in terrestrial habitats and inverted in or spindle shaped in aquatic ecosystems.
 (c) Pyramid of numbers is inverted in parasitic food ecosystems.
 (d) None
94. Which one of the following about man-made ecosystem is correct?
 (a) Simple food web (b) Little recycling of nutrients
 (c) High diversity (d) Lack of self-regulatory mechanisms
95. The first man-made ecosystem is:
 (a) Villages (b) Agriculture (c) Tanks (d) Orchards
96. Maximum energy is absorbed by:
 (a) Sugarcane (b) Mixed forest
 (c) Aquatic ecosystem (d) Terrestrial ecosystem
97. Energy dissipation is higher in:
 (a) Terrestrial plants (b) Terrestrial animals (c) Aquatic plants (d) Aquatic animals
98. Pyramid of numbers and pyramid of biomass provide information on the:
 (a) Productivity (b) Turnover time
 (c) Quantity of organic material available (d) All
99. Which one of the following is not related with carbon cycle?
 (a) Burning of fossil fuels (b) Respiration
 (c) Photosynthesis (d) Excretion
100. Consider the following statements:
 (A) Ocean is the most stable ecosystem
 (B) Carbon limits the primary productivity of an ecosystem
 (C) Denitrifying bacteria are aerobic
 (D) Cyanobacteria play no role in global nitrogen cycle
 The incorrect statements are:
 (a) All (b) A, B and C (c) C and D (d) B and D

101. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Wrinnogradsky (1891)	1. Thermocline
(B) Johannes Warming (1909)	2. Discovered nitrogen fixation
(C) Biosphere	3. First to start work on ecology
(D) Metalimnion	4. Edward Suess

Answer codes:

- | | | | | |
|-----|---|---|---|---|
| | A | B | C | D |
| (a) | 4 | 2 | 1 | 3 |
| (b) | 3 | 1 | 4 | 2 |
| (c) | 2 | 3 | 4 | 1 |
| (d) | 4 | 3 | 1 | 2 |

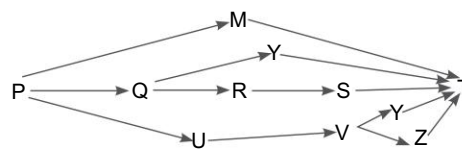
102. Which one of the following is both a gaseous and sedimentary cycle?
 (a) Carbon (b) Nitrogen (c) Sulphur (d) Phosphorus
103. Which one of the following is dependent upon biogeochemical cycles?
 (a) Global climate change (b) Stability of ecosystems
 (c) Temperature and precipitation (d) All
104. Oxidation of nitrites to nitrates is done by the bacteria:
 (a) *Nitrobacter* (b) *Nitrosomonas* (c) *Pseudomonas* (d) *Clostridium*
105. The reaction $2\text{NH}_3 + 3\text{O}_2 \rightarrow 2\text{NO}_2 + 2\text{H}^+ + 2\text{H}_2\text{O}$ is carried out by the bacteria:
 (a) *Thiobacillus* (b) *Nitrosomonas* (c) *Nitrobacter* (d) *Pseudomonas*
106. Disruption of the nitrogen cycle by human activity results in the:
 (a) Production of tropospheric smog (b) Perturbation of stratospheric ozone
 (c) Contamination of groundwater (d) All
107. The reaction $4\text{NO}_3 + 2\text{H}_2\text{O} \rightarrow 2\text{N}_2 + 5\text{O}_2 + 4\text{OH}$ is assisted by the bacteria:
 (a) *Pseudomonas* (b) *Frankia* (c) *Anabaena* (d) *Nitrosomonas*
108. The major nitrogen fixing cyanobacteria in oceans is:
 (a) Anaerobic (b) Anaerobic and nonheterocystous species
 (c) Aerobic and nonheterocystous species (d) Aerobic and heterocystous species
109. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|--------------|---|
| (A) Nekton | 1. Associated with surface film water |
| (B) Neuston | 2. Found on bottom of an aquatic ecosystem |
| (C) Benthos | 3. Active swimmer and able to overcome water currents |
| (D) Plankton | 4. Incapable of independent movement |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 1 | 2 | 3 |
| (b) | 3 | 1 | 2 | 4 |
| (c) | 2 | 4 | 1 | 3 |
| (d) | 4 | 3 | 2 | 1 |
110. Eutrophic lakes are:
 (a) Rich in nutrient content (b) Poor in dissolved oxygen
 (c) Rich in productivity (d) All
111. Different animals occupying similar ecological niche in different geographical regions are termed as:
 (a) Ecological equivalents (b) Ecotype
 (c) Ecologically efficient (d) Ecophenes
112. Which one of the following about oligotrophic lake is incorrect?
 (a) Deep (b) Low oxygen content
 (c) Rich in productivity (d) Less warm
113. Tropical oceans are:
 (a) Low in nitrate-nitrogen (b) Low in NH_4 -nitrogen
 (c) Both (a) and (b) (d) Low in nitrate-nitrogen but rich in NH_4 -nitrogen
114. Which one of the following is an incorrect match?
 (a) *Clostridium* – Anaerobic bacteria (b) *Rhizosprillum* – Aerobic photosynthetic bacteria
 (c) *Azotobacter* – Aerobic bacteria (d) *Chromatium* – Oxidise sulphur to sulphate

115. *Thiothrix* is found in _____ rich environment:
(a) Sulphur (b) Nitrogen (c) Carbon (d) Phosphorus
116. The reaction $6\text{CO}_2 + 12\text{H}_2\text{S} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{H}_2\text{O} + \text{S}$ is carried by the bacteria:
(a) *Proteus* (b) *Desulfovibrio* (c) *Chlorobium* (d) *Thiobacillus*
117. Mobilisation of organic phosphate by producing nitric and sulphuric acid is carried out by the bacteria:
(a) *Nitrosomonas* and *Thiobacillus* (b) *Beggiatoa* and *Thiothrix*
(c) *Thiobacillus* and *Thiothrix* (d) *Desulfomonas* and *Proteus*
118. Secondary productivity would be the greatest when:
(a) The animal's reproduction is minimum (b) Young individuals are growing slowly
(c) Both (a) and (b) (d) None
119. Which one of the following bacteria is not involved in the conversion of nitrite to nitrate?
(a) *Nitrobacter* (b) *Nitrosococcus* (c) *Nitrococcus* (d) *Nitrospira*
120. Chemosynthetic sulphur bacteria form the food base in:
(a) Estuaries (b) Coral reefs
(c) Hydrothermal vents (d) Salt marshes
121. Green plants trap radiant energy of the sun and convert it into chemical energy. This is:
(a) First law of thermodynamics (b) Second law of thermodynamics
(c) Law of mass action (d) First law of Newton
122. The rate of energy storage at consumer's levels is called:
(a) Primary productivity (b) Gross primary productivity
(c) Secondary productivity (d) Net productivity
123. Which one of the following is incorrect?
(a) Energy flow in an ecosystem is unidirectional.
(b) During the process of energy transfer from one trophic level to another, loss of energy occurs.
(c) In an ecosystem, energy flow can be quantified.
(d) None
124. Which one of the following about neritic zone is incorrect?
(a) Low water pressure (b) Stable temperature
(c) Low salinity (d) High salinity
125. Which one of the following refers to nitrogen fixation?
(a) Nitrogen \rightarrow Amino acids (b) Nitrogen \rightarrow Ammonia
(c) Nitrogen \rightarrow Nitrates (d) Nitrates \rightarrow Ammonia and nitrates
126. The minimum requirement for survival in an ecosystem:
(a) Producers and consumers (b) Producers, consumers and decomposers
(c) Producers and decomposers (d) Decomposers and primary consumers
127. Which one of the following is ammonifying bacteria?
(a) *Thiobacillus* (b) *Bacillus vulgaris* (c) *Nitrosococcus* (d) *Nitrocystis*
128. Which one of the following is a correct detritus pathway?
(a) Fungi \rightarrow Virus \rightarrow Dead grass \rightarrow Bacteria (b) Virus \rightarrow Dead grass \rightarrow Fungi \rightarrow Bacteria
(c) Dead grass \rightarrow Fungi \rightarrow Bacteria \rightarrow Virus (d) Dead grass \rightarrow Bacteria \rightarrow Fungi \rightarrow Virus
129. In which one of the following is an atmospheric component lacking?
(a) Phosphorous cycle (b) Carbon cycle
(c) Nitrogen cycle (d) None

130. A researcher found an average of 20.5 kg/m² of plant growth in a tropical forest. It means s/he is measuring:
 (a) Biomass (b) Trophic level
 (c) Effect of climatic factors on plants (d) Fertility of the soil
131. Key industry animals are:
 (a) Producers (b) Decomposers (c) Primary consumers (d) Tertiary consumers
132. An ecosystem is:
 (a) Natural or artificial (b) Temporary or permanent
 (c) Small or large (d) All
133. Which one of the following about changes in soil occurring during primary succession is incorrect?
 (a) Organic matter is added by the vegetation (b) Water-holding capacity decreases
 (c) Bulk density decreases (d) Water runoff decreases and infiltration increases
134. In succession, which one of the following is the end point of ecocline?
 (a) Pioneer communities (b) Climax communities
 (c) Both ((a) and ((b) (d) None
135. Consider the following statements:
 (A) In the beginning of heterotrophic succession, gross production exceeds community respiration
 (B) In the later stages of succession, niche specialisation is broad
 (C) In the later stages of succession, the food chain is linear
 (D) Net community production is high in later stages of succession
 The incorrect statements are:
 (a) All (b) A, B and C (c) B, C and D (d) A and D
136. Which one of the following about climax communities is incorrect?
 (a) High resistance (b) Low resilience (c) Fragile (d) None
137. Which one of the following causes allogenic changes?
 (a) Floods (b) Meteors (c) High winds (d) All
138. Which one of the following is an incorrect match?
 (a) Climax pattern theory – Whittaker (1953) (b) Polyclimax theory – Tansley (1935)
 (c) Climatic climax theory – Clements (1916) (d) Information theory – Connell and Slatyer (1977)
139. Which one of the following is the correct sequence of the process of succession?
 (a) Migration → Nudation → Competition → Reaction → Stabilisation
 (b) Nudation → Migration → Ecesis → Competition → Reaction → Stabilisation
 (c) Ecesis → Migration → Competition → Stabilisation → Reaction
 (d) Nudation → Ecesis → Migration → Competition → Reaction → Stabilisation
140. During the climax stage:
 (a) Production (P) > respiration (R) (b) R > P
 (c) R = P (d) Variable
141. Which one of the following models of succession suggests that the entry and growth of the later species is dependent upon the earlier species?
 (a) Inhibition model (b) Tolerance model (c) Facilitation model (d) Unified model
142. Which one of the following is responsible for stratification in lakes?
 (a) Oxygen (b) Temperature (c) Sunlight (d) All
143. During which season is summer stratification maximum?
 (a) Winter (b) Summer (c) Spring (d) Rainy

144. Consider the following statements:
 (A) Metalimnion zone of lakes is characterised by rapid fall in temperature
 (B) Nutrients in lakes may be used several times
 (C) Climax state cannot be regarded as static
 (D) The changes that occur during succession depends on the amount of moisture, temperature and wind
 The incorrect statements are:
 (a) None (b) A, C and D (c) B and C (d) C and D
145. In general communities, early succession maybe dominated by:
 (a) Opportunist species (b) Fungtive species
 (c) Species having r-selected life histories (d) All
146. Biodiversity is the highest when disturbance is neither too rare nor too frequent. This is known as:
 (a) Competitive exclusion hypothesis (b) Intermediate disturbance hypothesis
 (c) Polyclimax theory (d) Alternative stable theory
147. Which one of the following about pioneer species is incorrect?
 (a) Ability to tolerate diurnal and seasonal variations
 (b) Poor light demanders
 (c) Ability to produce an abundance of small seeds
 (d) None
148. Consider the following statements about resource-ratio hypothesis:
 (A) Resource-ratio hypothesis is given by Tilman (1980)
 (B) According to this hypothesis, intraspecific competition for resource and long-term pattern of supply of limiting resources are two key elements in succession
 (C) This hypothesis postulates that early successional, which are superior competitors for nitrogen, should also be superior competitors for light
 (D) The late successional species should be inferior competitors for both light and nitrogen
 The correct statements are:
 (a) All (b) A and B (c) B and C (d) A and D
149. The first ecologist to suggest mechanism of succession was:
 (a) F E Clements (b) P J Kramer (c) W C Allee (d) van der Valk
150. During the process of succession, reaction process refers to:
 (a) Intraspecific and interspecific competition between organisms (b) Modification of habitat by organisms
 (c) Community in equilibrium with the habitat (d) Establishment of plants
151. Initial floristic composition model of succession was proposed by:
 (a) Gleason (1967) (b) Egler (1954)
 (c) Clements (1916) (d) Connell and Slatyer (1917)
152. Which one of the following about climax community is incorrect?
 (a) Species composition maintains equilibrium (b) Complex food chains
 (c) An index of climate change of the area (d) Lack of equilibrium between gross primary production and respiration
153. Which one of the following theory suggests that the total environment of the ecosystem determines the composition of species structure and balance of a climax community?
 (a) Monoclimax theory (b) Climax pattern theory
 (c) Polyclimax theory (d) All

154. In the food web presented below, which one of the following has maximum mass?



- (a) T (b) M (c) P (d) Z

155. Which one of the following may be the pioneer organisms on a newly formed island?

- (a) Grasses (b) Lichens (c) Babuls (d) Rainforests

156. Consider the following statements:

- (A) Pioneer organisms modify the environment
 (B) Forest fires, floods and droughts are caused by ecological succession
 (C) Climax stage in an ecological succession persists until the environment changes
 (D) The study conducted by Henry Chandler Cowles (1890) on sand dune vegetation resulted in the development of ecological succession

The correct statements are:

- (a) A, B and D (b) B, C and D (c) A and C (d) B and D

157. Which one of the following decreases during ecological succession?

- (a) Community respiration (b) Net community production
 (c) Biomass (d) Gross production during early phase

Answers to Multiple-Choice Questions

- | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. (d) | 2. (d) | 3. (b) | 4. (a) | 5. (c) | 6. (a) | 7. (d) | 8. (c) |
| 9. (d) | 10. (b) | 11. (d) | 12. (c) | 13. (c) | 14. (c) | 15. (b) | 16. (a) |
| 17. (c) | 18. (a) | 19. (d) | 20. (b) | 21. (d) | 22. (d) | 23. (d) | 24. (d) |
| 25. (d) | 26. (b) | 27. (c) | 28. (c) | 29. (d) | 30. (d) | 31. (d) | 32. (c) |
| 33. (c) | 34. (d) | 35. (b) | 36. (a) | 37. (b) | 38. (c) | 39. (b) | 40. (d) |
| 41. (d) | 42. (d) | 43. (c) | 44. (d) | 45. (a) | 46. (d) | 47. (c) | 48. (c) |
| 49. (b) | 50. (d) | 51. (c) | 52. (b) | 53. (a) | 54. (a) | 55. (b) | 56. (a) |
| 57. (d) | 58. (a) | 59. (b) | 60. (c) | 61. (d) | 62. (a) | 63. (c) | 64. (d) |
| 65. (a) | 66. (a) | 67. (c) | 68. (d) | 69. (a) | 70. (b) | 71. (d) | 72. (c) |
| 73. (b) | 74. (a) | 75. (c) | 76. (d) | 77. (d) | 78. (c) | 79. (d) | 80. (a) |
| 81. (d) | 82. (b) | 83. (d) | 84. (c) | 85. (d) | 86. (d) | 87. (a) | 88. (d) |
| 89. (d) | 90. (b) | 91. (a) | 92. (c) | 93. (d) | 94. (c) | 95. (b) | 96. (a) |
| 97. (b) | 98. (d) | 99. (d) | 100. (c) | 101. (c) | 102. (c) | 103. (d) | 104. (a) |
| 105. (c) | 106. (d) | 107. (a) | 108. (c) | 109. (b) | 110. (d) | 111. (a) | 112. (c) |
| 113. (c) | 114. (b) | 115. (a) | 116. (d) | 117. (a) | 118. (d) | 119. (b) | 120. (c) |
| 121. (a) | 122. (c) | 123. (d) | 124. (d) | 125. (d) | 126. (c) | 127. (b) | 128. (c) |
| 129. (a) | 130. (a) | 131. (c) | 132. (d) | 133. (b) | 134. (c) | 135. (a) | 136. (d) |
| 137. (d) | 138. (d) | 139. (b) | 140. (c) | 141. (c) | 142. (d) | 143. (b) | 144. (a) |
| 145. (d) | 146. (b) | 147. (b) | 148. (b) | 149. (a) | 150. (b) | 151. (b) | 152. (d) |
| 153. (b) | 154. (c) | 155. (b) | 156. (a) | 157. (b) | | | |

Fill in the Blanks

1. Aphotic zone is permanently dark and is only populated by _____ autotrophs.
2. Stationary water systems are called _____ ecosystems.
3. All ecosystems have three types of organisms called _____, _____ and _____.
4. _____ is the largest ecological unit.
5. A kitchen garden is a _____ ecosystem.
6. A _____ level refers to the organism's position in the food chain.
7. _____ removes the last remaining energy from the remains of organisms.
8. In terms of energy flow, organisms can be either _____ or _____.
9. _____ and _____ are photosynthetic producers like plants.
10. _____ is a limiting factor in most terrestrial ecosystems.
11. The fixation of gaseous nitrogen to usable forms by plants involves breaking of the _____ bond of molecular nitrogen.
12. Ecological pyramids are also called _____ pyramids.
13. The water flowing over the falls contains _____ higher energy.
14. A decrease in the total available energy at each higher trophic level is called _____.
15. The graphic representation of the trophic relationships of an organism is called _____.
16. Nitrogen leaves an ecosystem as _____ formed by denitrifying bacteria.
17. The efficiency of any ecosystem mainly depends upon the production rates of its _____.
18. Autotrophs are able to produce organic compounds without sunlight in deep sea near _____.
19. Carbohydrates, proteins and fats are universally used as energy sources by living organisms except _____.
20. Many similar ecosystems constitute a _____.
21. In biological systems, energy enters as _____ energy.
22. The two types of freshwater ecosystems are _____ water and _____ water ecosystems.
23. In marine ecosystems, photosynthesis occurs in _____ zone.
24. Biogeochemical cycles involve _____, _____ and _____ processes.
25. $C_6H_{12}O_6 + 6O_2$ are the reactants for _____ and products of _____.
26. Energy flow through an ecosystem is in the form of _____ bonds and when _____ occurs, these bonds are broken.
27. _____ was believed to be extinct but was found alive in the Indian ocean in 1938.
28. Energy and nutrients pass from organism to organism through _____ as one organism eats the other.
29. The chief reservoirs of carbon dioxide are _____ and _____ biological fixation achieves _____ of the nitrogen fixation.
30. NH_3 in the soil combines with _____ ions to form _____ ion or without it to form _____.

31. Phosphorus is soluble in water as _____.
32. Sulphur enters the atmosphere as _____.
33. The sources of oxygen are _____ of water vapour and _____.
34. A series of organisms through which food energy is transferred is known as _____.
35. The process of eating and being eaten is called _____.
36. The pyramid of numbers shows the relationship between the numbers of _____ and _____ of different trophic levels.
37. The sedimentary cycle is tied to the hydrological cycle through _____.
38. The energy of an ecosystem occurs as a _____ system.
39. All the nutrients used in an ecosystem by living organisms operate on a _____ system.
40. Water undergoes _____, _____ and _____, falling back onto the earth.
41. Secondary production refers to production by _____ organisms.
42. The earth is _____ system for matter.
43. _____ is the beginning of journey of energy.
44. _____ are the first level in the food chain.
45. The six most important chemicals necessary for life are _____, _____, _____, _____, _____ and _____.
46. Biological fixation achieves _____ of nitrogen fixation.
47. Phosphorus-limited lakes are _____.
48. Leakage of fertilisers into rivers and lakes may cause _____.
49. The entire food web in a hydrothermal vent community is based on _____ energy.
50. Trophic interactions between different soil fauna are referred to as _____ food chain.
51. The transitional zone between two or more than two communities is known as _____.
52. Net primary productivity = _____.
53. Bacteria convert inorganic sulphate into _____.
54. The sedimentary phase of sulphur cycle involves the precipitation of sulphur in the presence of _____ under anaerobic conditions.
55. Vertical distribution of different species occupying different levels is called _____.
56. The unit of measurement of pyramid of energy is _____.
57. All the population of a species in a given area constitutes _____.
58. The species that invade a bare area is called _____ species.
59. _____ successional changes are brought about by the organisms themselves.
60. _____ changes are community changes, occurring over a geological period.
61. _____ is the community in saline body.
62. The end point of succession is called _____.
63. _____ is the community on sand.
64. The sequence of successional stages is called _____.
65. Ecological succession ends with a stage called _____.

Answers to Fill in the Blanks

- | | | |
|---|---|--|
| 1. Chemosynthetic | 2. Lentic | 3. Producers, consumers, decomposers |
| 4. Biome | 5. Nano | 6. Trophic |
| 7. Decomposers | 8. Producers, consumers | 9. Algae, cyanobacteria |
| 10. Water | 11. Triple | 12. Eltonian |
| 13. Kinetic | 14. Pyramid of energy | 15. Ecological pyramid |
| 16. Dinitrogen | 17. Primary producers | 18. Hydrothermal vents |
| 19. Lithotrophs | 20. Biome | 21. Light |
| 22. Flowing, standing | 23. Photic | 24. Biological, geological, chemical |
| 25. Aerobic respiration, photosynthesis | | 26. Carbon-carbon |
| 27. Coelacanth | 28. Food chain | 29. Oceans, rocks |
| 30. H^+ , NH_4 , NO_3 | 31. Phosphate (PO_4) | 32. Hydrogen sulfide (H_2S) |
| 33. Photodissociation, photosynthesis | | 34. Food chain |
| 35. Food web | 36. Primary producers, consumers | 37. Precipitation |
| 38. Open | 39. Closed | 40. Evaporation, condensation, precipitation |
| 41. Consumer | 42. Closed | 43. Photosynthesis |
| 44. Plants | 45. Carbon, hydrogen, oxygen, phosphorus, sulphur, nitrogen | 48. Eutrophication |
| 46. 90 per cent | 47. Oligotrophic | 51. Ecotone |
| 49. Geothermal | 50. Detritus | 53. Hydrogen sulphide |
| 52. Gross primary productivity, Respiration | | 56. $Kcal\ m^{-2}\ yr^{-1}$ |
| 54. Iron | 55. Stratification | 59. Autogenic |
| 57. Community | 58. Pioneer | 62. Climax |
| 60. Paleo-ecological | 61. Halosere | 65. Climax |
| 63. Psammosere | 64. Subsere | |

True or False

1. All living beings are part of the ecosystems.
2. Ecosystems are dynamic entities comprising biological community and abiotic environment.
3. Too much algae can destroy an ecosystem.
4. An ecologically balanced environment includes clean, clear water and fit fish.
5. Submerged, bog and floating plants are present in a healthy pond ecosystem.
6. The process of decomposition is completed by a single group of organisms.
7. Nektons are top layer dwellers.
8. Lakes are open systems.
9. Each river has a slow moving and fast moving zone.
10. Rivers are lentic ecosystems.
11. Estuaries support large organisms.
12. The largest and the only really complete ecosystem is the biosphere.

13. The largest land area is occupied by tropical forest.
14. Detritus feeders are the best-known animals of estuaries.
15. Energy cannot be recycled.
16. Periphytons are a free-swimming group of algae.
17. Rivers are open heterotrophic systems.
18. The temperature of estuary keeps on fluctuating.
19. Approximately 90 per cent energy is lost during transfer from one trophic level to another.
20. The flow of energy through life is an endless process.
21. The precipitation of phosphorus in marine habitats causes limit of primary productivity.
22. Some species belong to two or more trophic levels.
23. An ecosystem has more than one food web.
24. Detritus food chain is not found in all ecosystems.
25. The boundaries of ecosystems are determined by the environment.
26. In the ocean, a major proportion of carbon is held in living organisms.
27. Oceans are better energy-fixing systems than the earth.
28. Food chains in aquatic ecosystem are longer than terrestrial food chains.
29. Food web complexity is key in maintaining species diversity and ecological stability.
30. Parasites are important in food webs.
31. A food chain describes double pathway that energy and nutrients follow in an ecosystem.
32. In an ecosystem, ultimately the energy is lost as heat.
33. In a typical food chain, all animals and plants are not eaten by the next trophic level.
34. Oxygen is fatal to many anaerobic bacteria.
35. The continental shelf falls mostly in the aphotic zone.
36. Lack of light in the profundal zone determines the type of biological community.
37. Limnetic zone lacks phytoplanktons.
38. Landscape determines where plants and animals might live.
39. Seawater can change from acid to alkaline condition and vice versa.
40. Krills generally occupy the first trophic level.
41. Bears can be never primary consumers.
42. Food pyramids show the loss of energy from one organism to the next.
43. Snakes are third level consumers.
44. *Chlorobium* oxidises hydrogen sulphide to sulphur
45. Greater loss of energy occurs in longer food chains.
46. Sedimentary cycles are more perfect.
47. Recycling of materials and energy flow constitute the foundation of life.
48. Primary succession is a very slow process.
49. Net production is expected to have the highest energy in a pond ecosystem.
50. Phosphorous changes food into unusable energy.
51. In earlier stages of succession, the mineral cycle is closed.

74 Ecology and Animal Behaviour

52. In later stages of succession, the cycles of minerals is open.
53. The climax community is able to tolerate its own reactions.
54. Mature communities generally have high species diversity.
55. Succession is unidirectional.
56. Community on sand is called psammosera.
57. Allogenic succession is caused by vegetation.
58. Microsuccession occurs in animal droppings.
59. In seral stages, production/respiration (P/R) remains less than one.
60. Climax communities vary from place to place.
61. Autotrophic succession occurs mainly in an organic environment.
62. The rate of mixing of layers in tropical lakes is very slow.
63. Waters of oligotrophic lakes are cloudy.
64. Physical, chemical and biological conditions of the river change with distance.
65. Lakes are closed systems.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1. True | 2. True | 3. True | 4. True | 5. True | 6. False | 7. False | 8. False |
| 9. True | 10. False | 11. False | 12. True | 13. True | 14. True | 15. True | 16. False |
| 17. True | 18. True | 19. True | 20. False | 21. True | 22. True | 23. False | 24. False |
| 25. True | 26. False | 27. False | 28. True | 29. True | 30. True | 31. False | 32. True |
| 33. True | 34. True | 35. False | 36. True | 37. False | 38. True | 39. True | 40. False |
| 41. False | 42. True | 43. False | 44. True | 45. True | 46. False | 47. True | 48. False |
| 49. False | 50. False | 51. False | 52. False | 53. True | 54. True | 55. False | 56. True |
| 57. False | 58. True | 59. False | 60. True | 61. False | 62. False | 63. False | 64. True |
| 65. True | | | | | | | |

Give Reasons

1. The lentic and lotic ecosystems are different from one another.
 - Because of differences in energy input and flow as well as mineral input and its circulation.
2. Wetlands are the most productive natural ecosystems.
 - Because of the proximity of water and soil.
3. Decomposers are very important in the nutrient cycle.
 - Because they convert all the organic matter from the dead and decayed organisms into simple inorganic forms such as carbon dioxide, nitrogen, phosphorus, etc.
4. The earth is an open system with respect to energy.
 - Because if energy dissipated as heat once, it cannot be recycled and thus without the continued input of solar energy, the biological systems would quickly shut down. Hence, the earth is an open system with respect to energy.

5. The earth is a closed system with respect to elements.
 - Because complex materials present in the body of living organisms are broken to simpler forms after their death which are not destroyed and these elements are cycled endlessly between living and nonliving organisms.
6. The amount of the primary production varies from place to place.
 - Because of differences in the amount of solar radiation as well as the availability of nutrients and water.
7. All ecosystems must have a source of energy.
 - Because energy is needed for all functions of organisms (such as growth and reproduction).
8. Plants are essential to all ecosystems.
 - Because they produce food and oxygen needed by all organisms for their survival
9. Organisms are involved in a number of food chains.
 - Because organisms have more than one food source.
10. Small and relatively small ecosystems are called microcosms.
 - Because they represent miniature systems in which most of the characteristic ecological processes of larger ecosystems occur, but on a smaller scale.
11. Omnivores are important to an ecosystem
 - Because they prevent other species from getting overpopulated.
12. Fungi are the primary decomposers of forests.
 - Because they contain enzymes necessary to decompose lignin (found in wood) as well as they can use their hyphae to penetrate large pieces of organic matter.
13. Carbon and nitrogen cycles can be considered well buffered globally.
 - Because they have better capacity to adjust to change.
14. Phytoplanktons are uncommon in estuaries.
 - Because of turbid nature of water.
15. Humans have great impact on the carbon cycle.
 - Because when we burn fossil fuel, excess carbon dioxide is released into the atmosphere which affects the carbon cycle.
16. Most of the nitrogen in the atmosphere is unavailable for use by organisms.
 - Because the strong triple bond between N atoms in nitrogen molecules makes it relatively inert.
17. Phosphorus cycle is considered an imperfect cycle.
 - Because more phosphorus is lost in the deep sediment than the amount of phosphorus returned to the cycle.
18. Marshes and estuaries are highly productive.
 - Because water is rich in nutrient and there is presence of enough light.
19. During winter concentration of CO₂ rises in atmosphere.
 - Because of plant respiration, the decay of dying plants and animals occurs faster than photosynthesis.
20. The water of estuaries is turbid.
 - Because of the presence of more number of particulates in suspension in the water.
21. Phosphorous moves through its cycle very slowly.
 - Because phosphorus has no gaseous phase and it is relatively unreactive.
22. On average about 10 per cent of the energy available in one trophic will be passed to the next trophic level.
 - Mainly because:

76 Ecology and Animal Behaviour

- (a) Energy is always being lost as heat.
 - (b) In lower levels, not everything gets eaten.
 - (c) Not everything which is eaten is digested.
23. Plants are called producers.
- Because they are able to use light energy of the sun and produce food from carbon dioxide and water.
24. There are more herbivores than carnivores.
- Because when a herbivore eats, only a fraction of energy becomes new body mass, the rest is lost as heat or used by the herbivore to perform different physiological functions. So, when a herbivore is eaten by a carnivore, only a small fraction of a energy is transferred to the carnivore. Of the energy received by the carnivore from the herbivore, some energy is wasted by the carnivore. So, a carnivore has to eat many herbivores to get enough energy to grow.
25. Net energy production is only a fraction of gross production.
- Because organisms have to expend energy to stay alive.
26. Net primary productivity is less than gross primary productivity.
- Because loss of energy occurs in plant metabolism.
27. Wetlands assist moderate global climate conditions.
- Because plant communities and soil of wetlands store carbon dioxide instead of releasing it into the atmosphere as carbon dioxide.
28. Ecosystem is an open system.
- Because it involves requirement of an outside input in the form of solar radiation and an output to the environment as heat of respiration.
29. Ammonium is less used by plants for uptake.
- Because in large concentration it is extremely toxic.
30. Primary consumers are called key industry animals.
- Because they convert plant materials into animal materials
31. Changes in plant species causes changes in fungal species.
- Because many fungi are associated with a particular plant.
32. Succession occurs.
- Because through the processes of living, growing and reproducing, organisms interact with each other and affect the environment within an area and gradually change according to it.
33. Secondary succession is more rapid.
- Because the colonising area is rich in organic matter and seeds of the previous vegetation.
34. Thermal stratification in shallow lakes is absent.
- Because their waters are well mixed.
35. Ecosystems are in a constant process of change and restructuring.
- Because of internal species dynamics and external forces such as forest fires, wind storms and human activities like agriculture.
36. Nowadays ecologists are of the opinion that the state of equilibrium known as climax community does not occur in succession.
- Because of ongoing disturbance in ecosystems.
37. Pyramid of energy is always upright.
- Because the amount of energy decreases as we move upward, i.e., from base to top.

LIGHT, TEMPERATURE AND FIRE

Multiple-Choice Questions

1. Light:
 - (a) Affects opening and closing of stomata
 - (b) Governs primary productivity
 - (c) Controls the rate of transpiration
 - (d) All
2. Which one of the following is a long day plant?
 - (a) *Cannabis sativa*
 - (b) *Nicotiana sylvestris*
 - (c) *Nicotiana tabacum*
 - (d) *Allium cepa*
3. Aphids develop eggs in response to:
 - (a) Light
 - (b) Darkness
 - (c) Alternate light and darkness
 - (d) Mild darkness
4. Consider the following statements:
 - (A) Solar energy comes at the rate of about 5 millions kcal m⁻²yr⁻¹
 - (B) About 23 per cent of the solar energy flow is used to recycle water
 - (C) *Beta vulgaris* is a day neutral plant
 - (D) Light accelerates the development of *Mytilus* larvae
 The correct statements are:
 - (a) All
 - (b) A and B
 - (c) C and D
 - (d) B and D
5. Exposure to light stops germination in:
 - (a) *Primula*
 - (b) *Vanilla*
 - (c) Both *Primula* and *Vanilla*
 - (d) *Lactuca* and *Anagallis*
6. Which one of the following statements is incorrect?
 - (a) Light adaptations are genetically fixed.
 - (b) Latitudinal variation depends on the duration of sunlight.
 - (c) Heliophytes and sciophytes are plants adapted to high and low light environments respectively.
 - (d) Leaves of shade-grown species contain more dense mesophyll cells than sun-grown species.
7. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Long day plant	1. <i>Bougainvillea</i>
(B) Short day plant	2. <i>Brassica rapa</i>
(C) Day neutral plant	3. <i>Solanum tuberosum</i>
(D) Increase in respiratory rate with increase in light intensity	4. <i>Nicotiana tabacum</i>

 Answer codes:

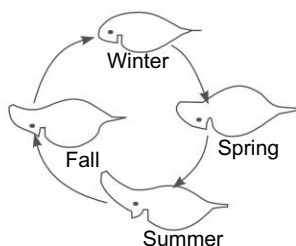
	A	B	C	D
(a)	4	1	2	3
(b)	2	4	3	1
(c)	4	2	3	1
(d)	1	2	4	3

78 Ecology and Animal Behaviour

8. Horned cattle cannot identify:
 - (a) Red light
 - (b) Green light
 - (c) Blue light
 - (d) Yellow light
9. Which one of the following is unable to distinguish spectra close to red and green?
 - (a) Deer
 - (b) Horses
 - (c) Sheep
 - (d) All
10. In seawater:
 - (a) Blue rays penetrate deeper than red rays
 - (b) Green rays penetrate deeper than red rays
 - (c) Red rays penetrate deeper than green and blue rays
 - (d) Green and blue rays penetrate deeper than red rays
11. The single most significant factor to limit plant distribution and abundance is:
 - (a) Light
 - (b) Temperature
 - (c) Rainfall
 - (d) None
12. Which one of the following plays an important role in an ecosystem?
 - (a) Quality of light
 - (b) Intensity of light
 - (c) Length of light
 - (d) All
13. Which one of the following sets of snakes is able to detect mammals and birds by their body heat?
 - (a) Rattlesnake, cobra and krait
 - (b) Copper head, pit viper and rattlesnake
 - (c) Copper head, krait and cobra
 - (d) Pit viper, rattlesnake and cobra
14. Fishes of colder waters have more vertebrae than those of warm waters. This is known as:
 - (a) Allen's rule
 - (b) Gloger's rule
 - (c) Jordan's rule
 - (d) Rensch's rule
15. Consider the following statements:
 - (A) This process was first described by Coker (1939)
 - (B) This phenomenon involves changes in body forms along with seasonal changes in temperature
 - (C) This phenomenon takes place in certain cladocerans
 - (D) During this phenomenon, a spring-like projection develops on the head which attains maximum size during summer

This phenomenon is termed as:

- (a) Retrogressive metamorphosis
 - (b) Cyclomorphosis
 - (c) Nongenetic adaptation
 - (d) Bioecogenetical adaptation
16. The figure alongside of *Daphnia* depicts:
 - (a) Cyclomorphosis
 - (b) Commensalism
 - (c) Ecotypic differentiation
 - (d) Lapse rate
 7. Hibernation does not occur in:
 - (a) Arctic region
 - (b) Tropical countries
 - (c) Temperate countries
 - (d) Antarctic region



18. Match column I with column II and select the correct answer using answer codes:

Column I

Column II

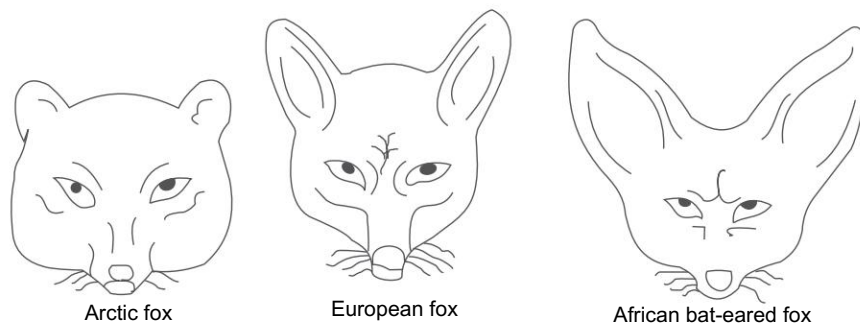
- | | |
|---|------------------|
| (A) Animals inhabiting colder regions have shorter extremities such as tails, ears and legs. | 1. Rensch's rule |
| (B) Birds of colder regions have relatively narrow and acuminate wings, while those in warmer climate tend to be broader. | 2. Gloger's rule |

- (C) Birds and mammals of colder regions are larger in size than those in warmer regions. 3. Allen's rule
- (D) Animals of warm and humid climates have darker pigmentation in comparison to races of some species found in cold and dry climates. 4. Bergman's rule

Answer codes:

	A	B	C	D
(a)	4	2	1	3
(b)	3	1	4	2
(c)	2	4	1	3
(d)	4	3	2	1

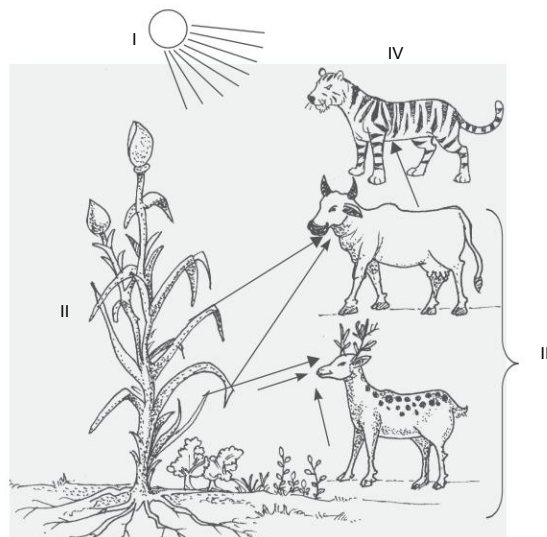
19. Low temperature is required for:
 (a) Germination of some seeds (b) Flowering
 (c) Sprouting of bulbs (d) All
20. The rate of respiration becomes doubled upon increasing the temperature 10° C above the optimum temperature if other factors are favourable. This is known as:
 (a) Jordon's rule (b) Vant Hoff's law
 (c) Shelford law of tolerance (d) Liebig Blackman law
21. The egg rule states that 'the average number of eggs in a set laid by songbirds and other kinds of birds increases as one moves':
 (a) South in latitudes (b) North in latitudes
 (c) West in latitudes (d) Both (a) and (b)
22. Which one of the following is a day neutral animal?
 (a) Deer (b) Goat (c) Guinea pig (d) Turkey
23. Which one of the following is applicable to rabbits?
 (a) Dusk and dawn (b) Diurnal (c) Vespereal (d) Auroral
24. Consider the following points about a bacterium:
 (A) It grows at temperatures up to 110°C
 (B) It is anaerobic
 (C) It grows autotrophically with H₂ as H donor and sulphur as hydrogen acceptor
 The name of this bacterium is:
 (a) *Thermoplasma acidophilus* (b) *Pyrodictium occulatum*
 (c) *Dialister pneumosintes* (d) *Beggiotoa mirabilis*
25. Light affects the movement and migration of:
 (a) Birds (b) Locusts
 (c) Honeybees (d) All
26. In which one of the following animals parthenogenetic eggs are produced at normal temperature, but at a higher temperature sexual eggs are produced, which after fertilisation may develop into male or female?
 (a) *Daphnia* (b) Honeybee
 (c) Locust (d) *Tetragoneuria*
27. Body temperature is independent of ambient temperature in:
 (a) Reptiles (b) Mammals (c) Fishes (d) Amphibians
28. The figure given below shows variation in ear length in three species occupying different geographical regions. This is an example of:



- (a) Gloger's rule (b) Bergman's rule (c) Allen's rule (d) Egg's rule

29. In the figure given below the limiting factor for autotrophs is:

- (a) I (b) II (c) III (d) IV



30. Consider the following statements with reference to fire cycles of shorter duration:

- (A) Do not cause loss of biodiversity
(B) Lead to well-marked tree regeneration
(C) Cause increase in grass-like *Imperata cylindrica*
(D) Cause decrease in grass-like *Pennisetum subangustum*

The correct statements are:

- (a) All (b) A, B and C (c) C (d) A and D

31. Which one of the following about affect of fire on soil is incorrect?

- (a) Change occurs in soil biota (b) Soil temperatures are raised
(c) Loss of some soil nutrients and organic matter (d) None

32. In the Himalayan region, fires are common during:

- (a) February to May (b) March to June
(c) May and June (d) November and December

33. Consider the following statements:
 (A) A decrease in soil pH occurs after burning
 (B) Frequent burning may increase microbial populations of soil
 (C) Burning of forests destroys an important sink for atmospheric carbon
 (D) The composition of plant community affects the spread of fire
 The correct statements are:
 (a) All (b) A and B (c) C and D (d) None
34. Behaviour of fire is determined by:
 (a) Weather condition and topography (b) Pattern of ignition
 (c) Fuel quality (d) All
35. Which one of the following is the most common cause of fire?
 (a) Volcanic activities (b) Lightning
 (c) Abrasive effects of falling rocks (d) Spontaneous combustion of very dry and hot material
36. Which one of the following is a fire-indicating species?
 (a) *Epilobium angustifolium* (b) *Aristida stricta*
 (c) *Sporobolus curtisii* (d) *Cedrus deodara*
37. Which one of the following is the fastest spreading fire?
 (a) Crown fire (b) Surface fire
 (c) Ground fire (d) Crown and surface fires
38. Crown fires are common in:
 (a) Chaparral-type shrub lands (b) Chaparral-type shrub lands and coniferous forests
 (c) Tropical savanna (d) Boreal coniferous forests and tropical savanna
39. Forest fire regulates:
 (a) Land pattern (b) Secondary succession
 (c) Vegetation composition (d) All
40. Which one of the following fire consumes material between low-level vegetation and tree canopies?
 (a) Ground fire (b) Ladder fire (c) Crown fire (d) Surface fire
41. Seeds of which plants only open after exposure to fire:
 (a) *Trifolium* (b) *Astragalus* (c) Yellow stone (d) All
42. Which one of the following about forest fires is incorrect?
 (a) Recycle nutrients bound up in litter (b) Reduce competition
 (c) Kill non-native plants that are not adapted to fire (d) None
43. Which one of the following is a characteristic of a fire-resistant plant?
 (a) Aromatic leaves (b) Sap is water like and lacks a strong odour
 (c) Leaves contain terpenes (d) Presence of fine, dry dead material
44. Which one of the following is a fire-resistant plant?
 (a) *Pinus ponderosa* (b) *Eucalyptus cypellocarpa*
 (c) Both (a) and (b) (d) None
45. Seeds of which plant would grow only after it gets fire treatment:
 (a) *Heteropogon* (b) *Rhesus* (c) *Stipa* (d) All
46. Growth of this plant is stimulated by fire:
 (a) *Andropogon* (b) *Populus tremuloides* (c) *Pinus rigida* (d) All

82 Ecology and Animal Behaviour

47. Nonwettability is a characteristic of forest of:
 (a) *Abeis concolor* (b) *Pinus ponderosa* (c) Chaparral community (d) All
48. The intensity of fire depends on:
 (a) Heat yield (b) Fuel availability (c) Rate of fire spread (d) All
49. Heat-shock-stimulated germination is common in members of the family:
 (a) Convolvulaceae (b) Fabaceae
 (c) Rhamnaceae and Sterculiaceae (d) All
50. Match column I with column II and select the correct answer using answer codes:

Column I (A) Fire-tolerant tree (B) Long seed viability (C) Sterotiny (D) Enhanced reproduction due to better setting following the fire	Column II 1. <i>Cynodon dactylon</i> 2. <i>Pinus contorta</i> 3. <i>Ceanothus velutinus</i> 4. <i>Quercus alba</i>
--	--
- Answer codes:

A	B	C	D
(a) 4	3	2	1
(b) 3	4	1	2
(c) 2	3	4	1
(d) 4	1	2	3
51. Some ecosystems depend on periodic fires:
 (a) To kill invading species (b) Germinate seeds
 (c) Release nutrients (d) All
52. Which one of the following does not change with reference to fire?
 (a) Geographical spread (b) Intensity
 (c) Frequency (d) None
53. Which one of the following about forest fires is incorrect?
 (a) Increase soil erosion (b) Cause soil loss and landslides
 (c) Do not alter the water infiltration rate (d) None
54. Fire is the topmost cause of damage to:
 (a) Europe's forests (b) Asia's forests
 (c) North America's forests (d) Africa's forests
55. Forest fires are causing mercury pollution in:
 (a) North America (b) Australia (c) Africa (d) Sri Lanka
56. In India, normal and peak fire season generally occur during:
 (a) January to June (b) March to June
 (c) December to March (d) November to January
57. Hekistotherm is applicable to:
 (a) Aquatic plants (b) Alpine vegetation
 (c) Plants of high altitudes (d) Desert vegetation
58. Match column I with column II and select the correct answer using answer codes:

Column I (a) Sternothermal (b) Eurythermal	Column II 1. <i>Daphnia</i> 2. <i>Heteronereis</i>
--	--

- (c) Cyclomorphosis
(d) Circalunar rhythms

3. Toads
4. Fishes

Answer codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	4	3	1
(c)	4	3	2	1
(d)	3	2	1	4

59. The warmest areas are localised in parts of:
(a) South America (b) Australia (c) Africa (d) All
60. The variation in temperature is primarily influenced by:
(a) Latitude (b) Latitude and altitude
(c) Distance from the water body (d) All
61. During dormancy:
(a) Body temperature becomes low (b) Metabolic rate becomes low
(c) Heartbeat is reduced (d) All
62. El Nino mainly affects the:
(a) Rainfall pattern of the west coast of South America (b) Fertility of soil of the west coast of South America
(c) Pattern of light scattering (d) Temperature pattern
63. The temperature of a region is affected by:
(a) Latitude (b) Amount of moisture in the soil
(c) The number of herbivores (d) Respiration by organisms
64. Which one of the following groups of factors of an ecosystem contains only abiotic factors?
- | Group I | Group II | Group III | Group IV |
|------------------|-----------------|------------------|-------------------|
| (i) Green plants | (i) Temperature | (i) Minerals | (i) Consumers |
| (ii) Minerals | (ii) Light | (ii) Gases | (ii) Green plants |
| (iii) Light | (iii) Minerals | (iii) Light | (iii) Light |
| (iv) Gases | (iv) Gases | (iv) Temperature | (iv) Temperature |
- The correct answer:
(a) Group I (b) Group II (c) Group III (d) Group IV
65. Which one of the following about abiotic factors of tundra is incorrect?
(a) Very long and cold winter (b) Strong winds
(c) Little rainfall (d) None

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (b) | 5. (c) | 6. (d) | 7. (c) | 8. (a) |
| 9. (d) | 10. (d) | 11. (a) | 12. (d) | 13. (b) | 14. (c) | 15. (b) | 16. (a) |
| 17. (b) | 18. (b) | 19. (d) | 20. (c) | 21. (b) | 22. (c) | 23. (a) | 24. (b) |
| 25. (d) | 26. (a) | 27. (b) | 28. (c) | 29. (a) | 30. (c) | 31. (b) | 32. (c) |
| 33. (c) | 34. (d) | 35. (b) | 36. (a) | 37. (a) | 38. (b) | 39. (d) | 40. (b) |
| 41. (d) | 42. (d) | 43. (b) | 44. (a) | 45. (d) | 46. (b) | 47. (d) | 48. (d) |
| 49. (d) | 50. (a) | 51. (d) | 52. (d) | 53. (c) | 54. (a) | 55. (a) | 56. (a) |
| 57. (b) | 58. (a) | 59. (d) | 60. (d) | 61. (d) | 62. (a) | 63. (a) | 64. (c) |
| 65. (d) | | | | | | | |

Fill in the Blanks

1. Crown fires normally occur in _____ forests.
2. Most common type of fire in India is _____ fire.
3. In India, the main source of forest fires almost entirely _____.
4. Subterranean fires are flameless and are called _____ fires.
5. Fungi growing in soils of burnt areas are called _____.
6. Crown fires are common in _____ vegetation.
7. In _____, a tubular swelling called lignotuber develops near the base when the crown is lost in a fire.
8. Crown fires spread from _____ to crown.
9. The severity of fire depends on the _____ and _____ of biomass as well as condition of _____ at the time of fire.
10. Grasslands are burnt to obtain _____, _____ and _____ herbage.
11. Wild fires occur in every continent except _____.
12. _____ is the oldest method used to clear land for farming and other uses.
13. Deforestation, especially by _____, is a key emitter of carbon dioxide.
14. About _____ of the forests in India are prone to fires.
15. Majority of long day plants have originated in the _____ region, while majority of the short plants have originated in the tropics.
16. During photosynthesis, plants absorb _____ and _____ light.
17. The relative lengths of daylight and darkness that affect the physiology and behaviour of an organism is called _____.
18. _____ is the movement of parts of plants in response to a light source.
19. Organisms that are active from dawn and/or dawn dusk are called _____ organisms.
20. The intensity of light at which the rate of photosynthesis is sufficient to meet the requirement of respiration is called _____.
21. A canopy is called open when considerable _____ reaches the lower layers.
22. Temperature values are maximum at the _____.
23. The organisms, which can tolerate large fluctuations in temperature, are called _____ organisms.
24. The organisms, which can tolerate only a narrow range of temperature, are called _____ organisms.
25. Dormancy of animals at high temperatures is called _____, while at low temperatures it is called _____.
26. _____ is the regulation of phenology to diurnal thermal changes.
27. Temperature variation in the tropics is about _____ on cloudy days, while it is about _____ on sunny days.
28. Cold exposure experienced by a plant species is known as _____.
29. _____ is an occasional phenomenon which causes vast changes in temperature and precipitation on a global scale.

30. Generally, El Nino first appears in the month of _____.
31. When the animal's core temperature is too high, the arteries carry heat to the _____ to be dissipated.
32. In an exothermic organism, the rate of various chemical reactions and physiological processes in its body vary with _____.
33. The hot and humid equatorial and tropical regions are full of _____ forests.
34. The ratio of rate of reaction at a difference of 10°C is referred to as _____.
35. Antifreeze glycoprotein is found in _____ fish.

Answers to Fill in the Blanks

- | | | |
|---|------------------------|---------------------------------|
| 1. Temperate | 2. Ground | 3. Anthropogenic |
| 4. Ground | 5. Pyrophilous | 6. Dense woody |
| 7. <i>Eucalyptus</i> | 8. Crown | 9. Quality, quantity, weather |
| 10. Young, succulent, nutritious | 11. Antarctica | 12. Fire |
| 13. Fire | 14. 50 per cent | 15. Temperate |
| 16. Red, blue | 17. Photoperiodism | 18. Photonasty |
| 19. Crepuscular | 20. Compensation point | 21. Sunlight |
| 22. Equator | 23. Eurythermal | 24. Stenothermal |
| 25. Aestivation, hibernation | 26. Thermoperiodism | 27. 2°C, 9°C |
| 28. Vernalisation | 29. El Nino | 30. December (Christmas season) |
| 31. Extremities | 32. Temperature | 33. Evergreen |
| 34. Temperature coefficient or Q_{10} | | 35. Antarctic |

True or False

1. In certain lower animals, the speed of locomotion is regulated by light.
2. Light regulates biological rhythms of all species.
3. Light is a lethal ecological factor.
4. Honeybees can see ultraviolet radiations.
5. Photosynthesis is greater in continuous light than in intermittent light.
6. Infrared rays are not visible to the human eye.
7. Primates can distinguish colours.
8. In sun-grown *Nerium oleander*, the loss of photosynthetic activity following water stress is light-dependent.
9. In tropical forests, as much as 95 per cent annual precipitation may be returned to the atmosphere by plants.
10. High intensity of light results in the formation of anthocyanin pigments.
11. Owl is a crepuscular organism.
12. Insects with the help of ultraviolet radiation can differentiate between productive and nonproductive flowers.

13. *Salmon* larvae undergo normal development only in the dark.
14. Leaf temperature is affected by the width of leaves.
15. Summarisation promotes seed germination.
16. In areas close to a large water body, there is less difference between temperature in winter and summer.
17. Narrow mountain valleys are warmed in comparison to broad open valleys.
18. Day neutral plants originated in the temperate region.
19. Temperature affects the density of substances.
20. Honeybees are exothermic.
21. Hives of honeybees are collectively endothermic.
22. Temperature inversions are of long duration and occur away from the earth's surface.
23. Arthropods are strictly stenothermic.
24. Some bacterial cysts can thrive in boiling water.
25. Endotherms are always thermoregulators.
26. Cotton boll weevil cannot develop if humidity is less than 40 per cent or more than 88 per cent.
27. Ground fire generally takes place where there is heavy accumulation of litter.
28. Fire is a key factor in vegetation dynamics of the Prairies.
29. In the southern part of India, fire season occurs from January to May.
30. Post-fire changes cause increase in soil fungi and decrease in bacteria.
31. Fire helps the *Pinus* cone to open.
32. Surface fires have the same destructive effect as crown fires.
33. Forest fires cause increase in soil erosion.
34. Grasses growing in burnt areas are richer in protein content than those growing in unburnt areas.
35. Fire suppresses germination of dormant leguminous seeds buried in the soil due to heat and smoke.

Answers to True or False

- | | | | | | | | |
|----------|-----------|-----------|----------|-----------|-----------|-----------|-----------|
| 1. True | 2. True | 3. False | 4. True | 5. False | 6. True | 7. True | 8. True |
| 9. False | 10. True | 11. True | 12. True | 13. False | 14. True | 15. True | 16. True |
| 17. True | 18. False | 19. True | 20. True | 21. True | 22. False | 23. False | 24. True |
| 25. True | 26. True | 27. True | 28. True | 29. True | 30. False | 31. True | 32. False |
| 33. True | 34. True | 35. False | | | | | |

Give Reasons

1. Visible light is of greatest importance to plants.
 - Because it is necessary for the photosynthesis.
2. The four seasons in an ecosystem are different.
 - Because during winter, less light and heat are available, while it is more in summer.

3. We feel warm at a temperature of 50°F in spring than at 50°F in autumn.
 - Because we are acclimatised to either the cold winter weather or hot summer weather.
4. Honeybees are exothermic but their hives are endothermic.
 - Because in winter the bees shiver to generate heat and warm the hive, while in summer, they bring in water and fan it with their wings to evaporate the water and cool the hive.
5. Sometimes valleys and low lands become much cooler than mountain tops.
 - Because of sinking of the heavier cold air.
6. In *Tarsius* the visual organ is well developed.
 - Because it is an insectivorous animal hunting bugs in thick and shady forests in insufficient light.
7. Burning causes increase in soil pH.
 - Because of the burning of litter which is acidic as well as more loss of elements that form anions (N, P and Cl) than those elements that form cations (e.g., Ca, K and Mg) occurs and conversion of soluble oxides of alkali earths into carbonates takes place.
8. Dried seeds, spores and cysts avoid freezing.
 - Because they lack liquids that can freeze.
9. Grasses and leaves are easier to ignite.
 - Because water content in them is less in comparison to branches and trunks.
10. In a ground fire, all herbaceous plants die but some shrubs and trees survive.
 - Because of the presence of a thick protective bark and deep roots.
11. Forest fire causes soil erosion.
 - Because burnt soil is exposed to more beating effect of rainfall causing soil erosion.

SOIL ECOLOGY

Multiple-Choice Questions

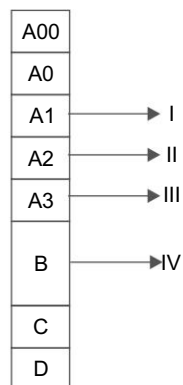
1. Soil horizons result from the process of:
(a) Chemical weathering (b) Eluviation and illuviation
(c) Organic decomposition (d) All
2. Consider the following statements:
(A) Hillgard and Dukuchaev independently suggested that pedogenesis was principally controlled by climate and vegetation
(B) The two most important climatic factors influencing soil formation are temperature and moisture
(C) At regional and local scales, climate becomes less important in soil formation
(D) Topography generally modifies the development of soil on a local or regional scale
The correct statements are:
(a) All (b) A, B and D (c) B and C (d) A and D
3. Which one of the following is responsible for favouring the storage of organic carbon in the mountains?
(a) Moisture (b) Temperature
(c) Characteristics of the litter (d) All
4. Which one of the following soil structural types is found in the B horizon?
(a) Columnar (b) Blocky (c) Prismatic (d) All
5. O horizon may be absent in:
(a) Deserts (b) Tundra (c) Taiga (d) None
6. Consider the following statements:
(A) Illuviation of clay in the B horizon (B) Moderate to high concentration of base cations
(C) Light coloured surface horizons (D) Form underforest vegetation
These are the characteristics of:
(a) Alfisols (b) Utisols (c) Spodosols (d) Entisols
7. Peaty soils are found more in:
(a) Maharashtra (b) Kerala (c) Bihar (d) Punjab
8. Red soils are:
(a) Light textured with porous structure (b) Lime is absent with low soluble contents
(c) Poor in sodium, potassium and phosphorous (d) All
9. Soil microbial life is essential for:
(a) Productivity (b) Soil structure (c) Soil softness (d) All
10. Soils of humid regions contain:
(a) Angular and sub-angular blocky structures (b) Granular structures
(c) Crumb and platy structures (d) Blocky and granular structures

11. Sierozem soil is found in:
 (a) Bog (b) Desert (c) Taiga (d) Tundra
12. Consider the following statements:
 (A) Glomalin is a glycoprotein
 (B) It stores carbon both in its protein and carbohydrate subunits
 (C) It is produced in hyphae and spores of arbuscular mycorrhizal fungi soil and root
 (D) It permeates organic matter binding it to silt, sand, and clay particles
 The incorrect statements are:
 (a) A, B and C (b) B and C (c) C and D (d) None
13. Glomalin was discovered by:
 (a) M O Andreae (1991) (b) C Folke (1998)
 (c) Sara F Wright (1996) (d) A A Berryman (2002)
14. Aerobic bacteria are most active in soil which is:
 (a) Moist and saturated (b) Moist and not saturated
 (c) Neutral soil having plenty of food (d) Both (b) and (c)
15. Horizon A of soil:
 (a) Prevents soil erosion (b) Holds moisture
 (c) Decays to form humus (d) All
16. Which one of the following is little affected by the soil-forming processes?
 (a) O Horizon (b) A Horizon (c) B Horizon (d) C Horizon
17. The formation of soil is affected by:
 (a) Climate and topography (b) Parent material and time
 (c) Organisms (d) All
18. Humus is the primary source of:
 (a) Carbon (b) Nitrogen
 (c) Nitrogen and carbon (d) Nitrogen and phosphorous
19. Hydrogen ions are made available to the soil matrix by:
 (a) Dissociation of water (b) Activity of many plants roots
 (c) Many chemical weathering reactions (d) All
20. Which one of the following soil horizons is strongly influenced by illuviation?
 (a) O (b) A (c) B (d) C
21. Which one of the following soil horizons is not significantly influenced by pedogenic processes, translocation and/or organic modification?
 (a) C (b) B (c) A (d) O
22. Which one of the following develops from volcanic parent materials?
 (a) Entisols (b) Vertisols (c) Andisols (d) Histosols
23. Consider the following statements:
 (A) Soil is a complex mixture of inorganic and organic materials
 (B) In India, mainly two types of soil are found, viz., reddish soil and black soil
 (C) Black soils are suitable for cultivation of cotton
 (D) The red colour of soil is due to the presence of iron peroxide
 The correct statements are:
 (a) All (b) A, B and C (c) A and C (d) C and D

90 Ecology and Animal Behaviour

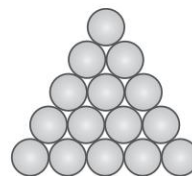
24. Red soils are rich in:
 (a) Calcium (b) Magnesium
 (c) Phosphorous and nitrogen (d) None
25. Black soils are rich in:
 (a) Clay (b) Potash
 (c) Calcium, magnesium and iron (d) All
26. Humus is:
 (a) Dark (b) Amorphous (c) Colloidal (d) All
27. Which one of the following is an incorrect match?
 (a) Colluvial soil – Lack of stratification
 (b) Aeolian soil – Weathered material transported by gravity
 (c) Alluvial soil – Weathered material transported by running water
 (d) Glacial – Lack of stratification
28. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|---------------|-------------------------|
| (A) Mollisols | 1. Rich in iron oxides |
| (B) Oxisols | 2. Dry riverbeds |
| (C) Histosols | 3. Prairie soils |
| (D) Vertisols | 4. Bogs, peats and musk |
- Answer codes:
- | A | B | C | D |
|-------|---|---|---|
| (a) 3 | 1 | 4 | 2 |
| (b) 4 | 3 | 2 | 1 |
| (c) 3 | 4 | 1 | 2 |
| (d) 2 | 3 | 4 | 1 |
29. A soil has the following characteristics:
 (a) A_1 horizon is rich in humus (b) A_2 horizon is of ash colour
 (c) Reddish to black B horizon
- This soil belongs to the category:
 (a) Histosols (b) Alfisols (c) Spodosols (d) Mollisols
30. Which one of the following about inceptisols is incorrect?
 (a) Well-developed horizons (b) Rich in iron oxides
 (c) Well-developed soils (d) All
31. Which one of the following increases the cation exchange capacity of the soil?
 (a) Humus (b) Clay (c) Humus and clay (d) Microorganisms
32. Swelling clay soils are:
 (a) Andisols (b) Vertisols (c) Entisols (d) Alfisols
33. Which one of the following set of cations is present in trace amounts in the soil?
 (a) Ca^{++} , Cu^{++} , and Mg^{++} (b) Cu^{++} , Mn^{++} and Zn^{++}
 (c) Zn^{++} , Ca^{++} and Mg^{++} (d) Mg^{++} , Mn^{++} and Cu^{++}
34. Highly acidic and alkaline soils make reduced availability of:
 (a) Iron and zinc (b) Molybdenum and copper
 (c) Copper and zinc (d) Calcium and potassium

35. Phosphorous and boron tend to be unavailable in:
- (a) Neural soils (b) Acid soils
(c) Alkaline soils (d) Highly alkaline soils
36. Clay particles have the ability to attract and hold ions on their surfaces like:
- (a) K^+ , Ca^{++} and NH_4^+ (b) Ca^{++} , K^+ and NO_3^-
(c) NH_4^+ , $H_2PO_4^-$ and NO_3^- (d) Ca^{++} , K^+ and $H_2PO_4^-$
37. Which one of the following is a brown forest soil?
- (a) Entisols (b) Histosols (c) Oxisols (d) None
38. Soil mineral matter is derived from horizon:
- (a) O (b) A_1 (c) B (d) C
39. Which one of the following is a horizon of weathered bedrock in the soil profile?
- (a) A_1 (b) C (c) B (d) None
40. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-----------------------------|------------------------------------|
| (A) Soils of high altitudes | 1. Tropical rainforests |
| (B) Soils of low altitudes | 2. Deciduous woodlands |
| (C) Soils of warm climates | 3. Mixed moist evergreen woodlands |
| (D) Soils of cool climates | 4. Tundra |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 3 | 2 | 1 |
| (b) | 2 | 3 | 4 | 1 |
| (c) | 4 | 1 | 2 | 3 |
| (d) | 4 | 1 | 3 | 2 |
41. Dark A horizon and high alkaline contents are the characteristics of:
- (a) Vertisols (b) Mollisols (c) Oxisols (d) Entisols
42. Which one of the following is not applicable to boron?
- (a) Nitrogen fixation (b) Cell division
(c) Translocation of water in plants (d) Carbohydrate metabolism
43. Soil controls ecosystem processes through its:
- (a) Physical properties (b) Chemical properties
(c) Biological properties (d) All
44. Chernozem soil is found in:
- (a) Deciduous forests (b) Temperate grasslands (c) Tropical rainforests (d) Deserts
45. Which one of the following statements is correct?
- (a) Strongly acidic soil is called black lock podzol.
(b) The availability of molybdenum decreases with increasing pH.
(c) Aluminium and manganese are soluble at high pH of soil.
(d) Sodic soils have pH less than 7.
46. Which one of the following has the maximum water-holding capacity?
- (a) Sand (b) Gravel (c) Clay (d) Silt
47. In the figure given below showing soil profiles, identify the zone of maximum leaching:
- (a) I (b) II (c) III (d) IV



48. In the figure above, which one of the following is a zone of mineral soil?
 (a) IV (b) III (c) II (d) I
49. Which one of the following is correct?
 (a) Neutral or slightly acidic soils are the best for the growth of majority of plants.
 (b) Mites flourish in moist organic soils.
 (c) Plants are unable to absorb hygroscopic water. (d) All
50. Micro Arthropods are a dominant component of the soil organisms in the:
 (a) Tundra (b) Taiga (c) Deserts (d) Tropical rainforests
51. Which one of the following about casts is incorrect?
 (a) Rich in organic matter (b) Rich in nutrients
 (c) Higher pH (d) Higher C:N ratio
52. The feeding and casting habit of earthworms causes increase in the availability of nutrient elements like:
 (a) Calcium and magnesium (b) Calcium and phosphorous
 (c) Sodium and potassium (d) All
53. Which one of the following is the least-porous soil?
 (a) Sandy soil (b) Clay soil (c) Loam soil (d) Gravel soil
54. Which one of the following is suitable for the growth of groundnut plants?
 (a) Loam soil (b) Sandy soil (c) Clay soil (d) None
55. Loam soils are suitable for:
 (a) Hydration (b) Aeration (c) Nutritive status (d) All
56. C horizon is rich in:
 (a) Organic matter (b) Moisture (c) Biological activity (d) Rocks
57. Young soil may have only:
 (a) A horizon (b) A and B horizons (c) A and C horizons (d) O and B horizons
58. Soils in grassland, forest and desert biomes differ markedly in their:
 (a) Organic matter content (b) Clay
 (c) Colour and depth (d) All
59. Zone of leaching, zone of extraction and zone of eluviation are applicable to:
 (a) O horizon (b) A horizon (c) B horizon (d) C horizon
60. Which one of the following is not involved in soil profile development?
 (a) Migration (b) Leaching (c) Aggregation (d) Dispersion

61. The A_2 subdivision of A horizon, is the zone of:
 (a) Maximum eluviation (b) Maximum humus
 (c) Maximum unweathered bedrock (d) Maximum temperature
62. Consider the following statements with reference to soil air:
 (A) Has high moisture content (B) Has high CO_2 content and low O_2 content
 (C) Evaporation reduces air content of the soil (D) Is continuous
 The correct statements are:
 (a) All (b) A and B (c) C and D (d) B and D
63. Which one of the following does not assist in bioturbation?
 (a) Gastropods (b) Bivalves (c) Annelids (d) Snakes
64. Humus:
 (a) Improves the water-holding capacity of the earth (b) Supplies plant nutrients
 (c) Contributes to soil aggregation (d) All
65. Which one of the following lives in the topsoil?
 (a) Earthworms (b) Plant roots (c) Bacteria and fungi (d) All
66. Humus bears:
 (a) Electropositive charge (b) Electronegative charge
 (c) Neutral charge (d) Both (a) and (b)
67. What is incorrect about the given figure of soil structure?
 (a) Relatively nonporous
 (b) Small and spheroidal peds
 (c) Not fitted in adjoining aggregates
 (d) All

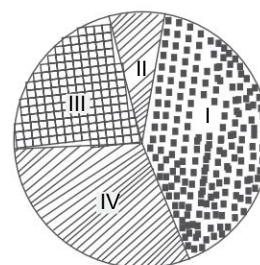


Soil structure

68. The soil microbes play an essential role in:
 (a) Conservation of soil nutrients (b) Decomposition of plant residues
 (c) Nutrient cycling (d) All
69. In which one of the following soils are oxides of iron and aluminium dominant?
 (a) Laterite soil (b) Black soil (c) Sandy soil (d) None
70. The alluvial soils are:
 (a) Rich in potash and calcium (b) Deficient in nitrogen and phosphorous
 (c) Deficient in organic matter (d) All
71. Which one of the following is incorrect?
 (a) Black soils are rich in phosphorous and organic matter.
 (b) Laterite soils are acidic.
 (c) Red soils are rich in potassium and poor in phosphorous.
 (d) The alluvial soils of the deltas are very fertile.
72. Coastal alluvial soils:
 (a) Have low water-holding capacity (b) Have low organic matter content
 (c) Low EC (d) All

94 Ecology and Animal Behaviour

73. The texture of soil depends on the amount of:
(a) Sand (b) Clay (c) Silt (d) All
74. Dark thick A horizon is a characteristic of:
(a) Alfisols (b) Histosols (c) Mollisols (d) Inceptisols
75. Zone of accumulation is applicable to:
(a) O Horizon (b) A Horizon (c) B Horizon (d) D Horizon
76. Which one of the following is the entry site for most of the materials into food webs?
(a) Soil (b) Air (c) Water (d) Humus
77. The type of soil is determined by the:
(a) Composition of the underlying rock materials (b) Climate
(c) Relief, elevation and drainages (d) All
78. Insectivorous plants grow in soil having deficiency of:
(a) Calcium (b) Nitrogen (c) Phosphorous (d) Potassium
79. Edaphic factors are applicable to:
(a) Soils (b) Air (c) Water (d) Wetlands
80. Majority of soil fungi are found in:
(a) Alkaline soils (b) Acidic soils (c) Neutral soils (d) All
81. Which one of the following is applicable to mull humus?
(a) Acidic (b) Neutral
(c) Contains rich microflora of bacteria (d) Slightly alkaline
82. Which one of the following about crumb is incorrect?
(a) Increases porosity of the soil (b) Provides good aeration
(c) Provides drainage (d) None
83. In the figure showing soil components given below, identify the labelled parts:
(a) I = Water, II = Air, III = Organic matter, IV = Mineral matter
(b) I = Organic matter, II = Air, III = Water, IV = Mineral matter
(c) I = Mineral matter, II = Organic matter, III = Water, IV = Air
(d) I = Air, II = Mineral matter, III = Organic matter, IV = Water



Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (a) | 3. (d) | 4. (d) | 5. (a) | 6. (a) | 7. (b) | 8. (d) |
| 9. (d) | 10. (a) | 11. (b) | 12. (d) | 13. (c) | 14. (d) | 15. (d) | 16. (d) |
| 17. (d) | 18. (c) | 19. (d) | 20. (c) | 21. (a) | 22. (c) | 23. (a) | 24. (d) |
| 25. (d) | 26. (d) | 27. (b) | 28. (a) | 29. (c) | 30. (d) | 31. (c) | 32. (b) |
| 33. (b) | 34. (c) | 35. (b) | 36. (a) | 37. (d) | 38. (d) | 39. (b) | 40. (d) |
| 41. (b) | 42. (a) | 43. (d) | 44. (b) | 45. (a) | 46. (c) | 47. (b) | 48. (a) |
| 49. (d) | 50. (a) | 51. (d) | 52. (d) | 53. (b) | 54. (b) | 55. (d) | 56. (b) |
| 57. (c) | 58. (d) | 59. (c) | 60. (b) | 61. (a) | 62. (b) | 63. (d) | 64. (d) |
| 65. (d) | 66. (b) | 67. (a) | 68. (d) | 69. (a) | 70. (d) | 71. (a) | 72. (d) |
| 73. (d) | 74. (c) | 75. (c) | 76. (a) | 77. (d) | 78. (b) | 79. (a) | 80. (b) |
| 81. (a) | 82. (d) | 83. (c) | | | | | |

Fill in the Blanks

1. Pedology is the study of _____.
2. The three main layers in a soil profile are _____, _____ and _____.
3. _____ and humus contents of the soil cause an increase in the cation-exchange capacity.
4. Soils having higher amount of sand and gravel are termed as _____ soils.
5. Clay bears _____ charge.
6. Soil aggregates are called _____.
7. Structure-less soil is termed as _____.
8. The structure of soil depends on the shape of _____.
9. _____ is the varying proportion of particles of different size groups.
10. In a soil profile, horizon _____ is known as horizon of illuviation.
11. The parent material from which the soil is formed is known as horizon _____.
12. Immature soils that lack vertical development of horizons are called _____.
13. _____ are organic soils that form the areas of poor drainage.
14. _____ soils are the most important soils from agricultural point of view.
15. The branch of biology dealing with the interaction among soil organisms and between the abiotic and biotic parameters of the soil environment is known as _____.
16. The formation of an illuvial _____ horizon is generally an indication of mature soil.
17. Wind-transported materials constitute the _____ soil.
18. Physical rearrangement of the soil profile by soil life is known as _____.
19. The _____ horizon marks the beginning of true mineral soil.
20. The soils that develop at the very site where the parental rock material is present are called _____ soils.
21. Humus is an intermediate product of _____.
22. _____ is the amount of water available to the plants in the soil.
23. Field capacity consists of _____ and _____ waters.
24. The rock, from which soil is formed, is called _____ material.
25. O horizon is known as _____.
26. B horizon is commonly referred to as _____.
27. _____ is the fine dust-like part of the soil when it is dry.
28. _____ is the part of the soil which gets sticky when wet.
29. _____ is the first step in the chemical breakdown of rock into soil.
30. The property of soil based on the size of its particles is referred to as _____.
31. Water logging occurs in _____ soil.

Answers to Fill in the Blanks

- | | | |
|-----------------|---------------------------------------|-------------------|
| 1. Soils | 2. Top soil, subsoil, parent material | 3. Clay |
| 4. Light | 5. Electronegative | 6. Peds |
| 7. Single grain | 8. Peds | 9. Soil texture |
| 10. B | 11. C | 12. Entisols |
| 13. Histosols | 14. Alluvial | 15. Soil ecology |
| 16. B | 17. Aedian | 18. Bioturbation |
| 19. A | 20. Residual | 21. Decomposition |
| 22. Chresard | 23. Capillary, hygroscopic | 24. Parent |
| 25. Humus | 26. Subsoil | 27. Silt |
| 28. Clay | 29. Weathering | 30. Texture |
| 31. Clay | | |

True or False

1. To built 2.5 cm of topsoil, nature takes about 600 to 1,000 years.
2. Trees are the primary medium for soil conservation.
3. Black soils are neutral to slightly alkaline in reactions.
4. Alluvial soils are rich in humus.
5. Soil fertility is directly influenced by pH.
6. Horizon A is commonly known as topsoil.
7. Horizon A provides plants with nutrients required for a great life.
8. C horizon contains parent material.
9. Soil edification is not a biologically derived process.
10. The amount of water in the soil is one thing that can affect the amount of air.
11. Podzols are generally fertile soils.
12. Latosols are good for agriculture.
13. Serpent soil is highly fertile.
14. Acid soils are derived from sands and slates, etc.
15. Solonachak soil is found in bogs.
16. Black earth lacks distinct zones of leaching and accumulation.
17. Dune soils are not suitable for agriculture.
18. Water infiltration through clay soils is rapid.
19. Soils with relatively small particle sizes are highly permeable.
20. Alkaline soil is suitable for the availability of potassium.
21. Capillary water is held in soil pores.
22. Black cotton soil is rich in calcium carbonate.
23. Loam soil is rich in iron and aluminium due to excessive leaching.

24. Land snails do not occur in acidic soil.
25. Earthworms prefer soils rich in humus.
26. Acidity or alkalinity of the soil is one of the important limiting factors for organisms.
27. Soils are less developed in areas with higher rainfall and more warmth.
28. Climate regulates soil formation.
29. Viruses play an important role in biogeochemical nutrient cycles.
30. Maximum soil fertility occurs in the pH range of 6 to 7.2.
31. Microorganisms directly affect soil aggregation.

Answers to True or False

- | | | | | | | | |
|----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
| 1. True | 2. True | 3. True | 4. False | 5. True | 6. True | 7. True | 8. True |
| 9. True | 10. True | 11. False | 12. False | 13. False | 14. True | 15. False | 16. True |
| 17. True | 18. False | 19. False | 20. True | 21. True | 22. False | 23. False | 24. True |
| 25. True | 26. True | 27. False | 28. True | 29. True | 30. True | 31. False | |

Give Reasons

1. Soils air contains higher amount of CO₂ and lower amount of O₂ in comparison to atmospheric air.
 - Because of respiration of soil organisms and roots of plants.
2. In A horizon, most biological activity takes place.
 - Because soil organisms like earthworms, nematodes, arthropods, bacteria and archaebacteria live in this horizon.
3. In conifer forests of the Himalayas, true podosols are not found.
 - Because of alternate phases of wet and dry seasons.
4. Study of soil structure is important.
 - Because of its influence on properties of soil such as aeration and water-holding capacity.
5. Humus is important.
 - Because it provides loose texture to soil ensuring better aeration.
6. Study of soil profile is important.
 - Because it throws light on characteristics and quality of soil.
7. Soils of humid tropics are red or yellow.
 - Because of the oxidation of iron or aluminium.
8. It is difficult to see humus in isolation.
 - Because it binds with large mineral and organic particles.
9. Clay particles are somewhat flexible and plastic.
 - Because of their lattice-like design.
10. Sandy soils are highly permeable.
 - Because of rapid drain of water.

11. The surface layers of soil contain the highest variety of microorganisms.
 - Because these layers receive more amounts of potential food sources from plants and animals.
12. B horizon of soils has higher bulk density than horizon A.
 - Because of its enrichment of clay particles.
13. Vertisols show significant contraction and expansion.
 - Because of the presence or absence of moisture.
14. A soil with good tilth is suitable for plant growth.
 - Because it is permeable to air, water and roots.
15. Animals do not inhabit peaty soils.
 - Because peaty soils are poorly aerated and more acidic.
16. Tarai soils are always saturated.
 - Because of sufficient rainfall and high groundwater level.
17. Horizon B may contain some elements of horizon A.
 - Because of the process of leaching.
18. A particular soil profile varies in different conditions.
 - Because of its origin, composition and formation.

POPULATION GROWTH AND REGULATION

Multiple-Choice Questions

1. Population biology is the study of:
(a) Births (b) Deaths
(c) Dynamic forces which regulate the number of individuals in a population (d) All
2. Density dependent factors of population control include:
(a) Competition (b) Predation
(c) Diseases and parasites (d) All
3. Which one of the following is a density independent factor of population regulation?
(a) Floods, parasites and diseases (b) Floods, storms and pollutants
(c) Competition, prey and weather (d) Weather, pollutants and predation
4. Density dependent factors of population regulation occur in:
(a) Ecosystems which are usually more stable
(b) Ecosystems where communities have more species
(c) Ecosystems where communities of few species are under periodical stress
(d) Both (a) and (b)
5. Which one of the following affects the size of the population?
(a) Extreme weather (b) Soil (c) Climate (d) All
6. Population size is influenced by:
(a) Natality (b) Mortality
(c) Immigration and Emigration (d) All
7. Which one of the following is not of much significance for a closed population?
(a) Immigration (b) Immigration and emigration
(c) Natality (d) Mortality
8. Open populations are more prevalent in:
(a) Marine environments (b) Terrestrial environments
(c) Forest environments (d) All
9. Natality is applicable to:
(a) Born ones (b) Hatched ones
(c) Those arising from germination or division (d) All
10. Which one of the following is correct?
(a) Ecological mortality is constant.
(b) Ecological density is not liable to vary with variation in environmental conditions.
(c) Ecological density does not vary with population size.
(d) None

100 Ecology and Animal Behaviour

11. Which one of the following is not a density dependent factor of population regulation?
(a) Food (b) Natural disasters (c) Space (d) Competition
12. In populations being controlled by density dependent factors, growth rates are generally:
(a) Directly proportional to population density (b) Inversely proportional to population density
(c) Not related to population density (d) All
13. Density dependent effects can be seen in:
(a) Birth rates (b) Mortality rates
(c) Both birth rates and mortality rate (d) None
14. Which one of the following types of spacing is shown by mating population?
(a) Clumped (b) Uniform (c) Random (d) None
15. Uniform spacing is shown by:
(a) Plants (b) Microbes (c) Invertebrates (d) All
16. Which one of the following is correct?
(a) Mortality differs among species (b) Mortality differs within species
(c) Mortality differs by sex (d) All
17. Which one of the following is correct?
(a) $(\text{Births} - \text{Deaths}) + (\text{Immigrations} + \text{Emigrations}) = \text{Change in population size}$
(b) $(\text{Births} + \text{Deaths}) + (\text{Immigrations} - \text{Emigrations}) = \text{Change in population size}$
(c) $(\text{Births} - \text{Deaths}) + (\text{Immigrations} - \text{Emigrations}) = \text{Change in population size}$
(d) $(\text{Births} - \text{Deaths}) \times (\text{Immigrations} - \text{Emigrations}) = \text{Change in population size}$
18. Which one of the following factors determines how much a population will change?
(a) Births (b) Deaths (c) Migration (d) All
19. Which one of the following affects biotic potential?
(a) Age of reproduction (b) Frequency of reproduction
(c) Number of offsprings produced and reproductive lifespan (d) All
20. Consider the following statements:
(A) Populations can vary in their distribution pattern
(B) Random distribution occurs when there is no distinct pattern in spacing
(C) Clumped or uniform patterns of dispersion are not common in nature
(D) Distribution of resources and the types of resources can influence how a population distributes itself in its environment

The correct statements are:

- (a) All (b) A, B and C (c) A, B and D (d) A and B

21. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Key factor analysis	1. Nicholson-Bailey (1935)
(B) Comprehensive theory of natural control	2. Bodenheimer (1928)
(C) First to propose that the population density of insects is primarily regulated by the effects of weather	3. Thompson (1929)
(D) Model for parasitoid-host population dynamics	4. Morris (1957)

Answer codes:

- | | | | |
|-------|---|---|---|
| A | B | C | D |
| (a) 4 | 3 | 2 | 1 |

- (b) 3 4 1 2
 (c) 2 4 3 1
 (d) 1 2 3 4
22. Random patterns of distribution in space depend on:
 (a) Resource distribution (b) Territoriality
 (c) Scale (d) All
23. Which one of the following statements is incorrect?
 (a) Lotka–Volterra equation is also known as predator-prey equation.
 (b) It is used to describe the dynamics of biological systems.
 (c) According to Nicholson–Bailey model, both parasites and hosts are distributed in uniform fashion in the environment.
 (d) Nicholson–Bailey model describes the population dynamics of coupled host-parasite or predator-prey systems.
24. Undercrowding as well as overcrowding may be limiting to populations. This is known as:
 (a) Allen’s rule (b) Allee’s principle (c) Jordon’s rule (d) Rensch’s rule
25. Organisms are congregated in groups in:
 (a) Aggregated distribution (b) Clumped distribution
 (c) Contagious distribution (d) All
26. The concept of r- and k-selection was given by:
 (a) Mac Arthur and Wilson (1967) (b) Pianka (1967)
 (c) Allee (1958) (d) Mooney and Billings (1961)
27. Which one of the following is always density dependent?
 (a) Parasitism (b) Disease
 (c) Competition for resources (d) Parasitoids and herbivory
28. Which one of the following is a density dependent inhibition curtailing population growth?
 (a) Competition (b) Predators (c) Crowding (d) All
29. Which one of the following represents the Verhulst equation of population dynamics?
 (a) $\frac{dN}{dt} = rN(1+N/K)$ (b) $\frac{dN}{dt} = rN(1-N/K)$
 (c) $\frac{dN}{dt} = rN/(1-N/K)$ (d) $\frac{dN}{dt} = rN + (1-N/K)$
30. Species less suited to compete for resources should either adapt or die out. This is known as:
 (a) Competitive exclusion principle (b) Evolutionary theory
 (c) Balance of nature theory (d) All or none law
31. Which one of the following is applicable to density dependent mortality?
 (a) Feedback regulation (b) Self-regulation
 (c) Lag effect (d) All
32. Which one of the following about r-selected species is incorrect?
 (a) Good competitors (b) Good exploiters (c) Good colonisers (d) All
33. Consider the following statements about k-selected species:
 (A) Live near the carrying capacity of their environment
 (B) Density dependent species
 (C) Food availability is one resource that controls population size
 (D) Long lifespan
 The correct statements are:
 (a) All (b) A and B (c) A and C (d) A, C and D

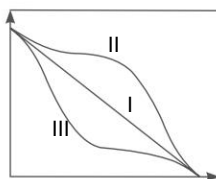
102 Ecology and Animal Behaviour

34. Consider the following statements about r-selected organisms:
(A) Small body size (B) High fecundity
(C) Long generation time (D) Late onset of maturation
The correct statements are:
(a) All (b) A and B (c) C and D (d) B and D
35. Which one of the following is not an organism with k-selected traits?
(a) Rodents (b) Trees (c) Whales (d) Humans
36. The density independent factors regulate population size:
(a) At or near the carrying capacity by regulating the availability of abiotic environment
(b) At or near the carrying capacity by regulating the availability of biotic environment
(c) At or near the carrying capacity by regulating the availability of abiotic and biotic environments as well as other sources
(d) None
37. In extreme k-strategists, the survivorship curve is:
(a) Linear curve type (b) Convex curve type
(c) Concave curve type (d) All
38. Self-thinning curve is the relationship between:
(a) Rate of growth and birth rates (b) Inhibition of rate of growth and mortality
(c) Plant density and plant biomass (d) Plant density and net yield
39. Which one of the following about a k-species is incorrect?
(a) Large size (b) Low reproductive allocation
(c) Large but few offspring (d) No parental care
40. Which one of the following is a k-selected species?
(a) *Daphnia* (b) Bacteria (c) Albatross (d) Dandelion
41. Which one of the following about r-strategists is incorrect?
(a) Higher hormones (b) Lowered immunity
(c) Compressed life cycles (d) All
42. Which one of the following is not applicable to r-species?
(a) Well-developed dispersal mechanism (b) Pioneer successional status
(c) Fairly constant population size (d) Survivorship curve is concave (type III)
43. Type II (Linear curve) survivorship curve is shown by:
(a) *Hydra* (b) Perennial plants (c) Many rodents (d) All
44. Which one of the following statements is incorrect?
(A) The ability of a population to increase is called natality.
(B) Ecological natality is constant for a population.
(C) The natality rate is never negative.
(D) The measurement of natality is highly dependent on the type of organism.
45. Each species affects the environment:
(a) Positively (b) Negatively (c) Has no effect (d) All
46. The growth rate of a population is not determined by:
(a) Population sex ratio (b) Age structure, birth rate and death rate
(c) Generation time (d) Optimal temperature required for reproduction
47. Type-I survivorship curve is a characteristic of organisms with:
(a) Higher mortality in older age class (b) Higher mortality in younger age groups

- (c) Constant mortality rate (d) None
48. Consider the following statements:
 (A) Carrying capacity is the population size at which population growth equals zero
 (B) If density is too high or too low, the rate of population growth declines
 (C) Exponential growth is not sustainable
 (D) Reproduction rate affects the shape of the growth curve
- The incorrect statements are:
 (a) None (b) A, B and C (c) B and C (d) A and D
49. Human growth phase is:
 (a) J-shaped (b) S-shaped (c) Z-shaped (d) O-shaped
50. If a population becomes stagnant after exponential growth, its growth curve is:
 (a) Z-shaped (b) S-shaped (c) J-shaped (d) O-shaped
51. Gause's principle is applicable to:
 (a) Interspecific competition (b) Niche specialisation
 (c) Competitive exclusion principle (d) All
52. In which one of the following phases of population growth is natality equal to mortality?
 (a) Exponential phase (b) Plateau phase
 (c) Lag phase (d) Log phase
53. Consider the following statements:
 (A) Humans are iteroparous (B) Pacific salmon are semelparous
 (C) 3/2 thinning law is not applicable to plants (D) Clutch size is not influenced by the number of times the parents can reproduce
- The incorrect statements are:
 (a) A and B (b) B and C (c) C and D (d) None
54. Survivorship curve is not highly convex curve type in:
 (a) Oysters (b) Deer (c) Mountain sheep (d) Small rotifers
55. The principle of competitive exclusion was first demonstrated in a laboratory by:
 (a) E Mayr (1942) (b) G F Gause (1934)
 (c) W C Allee (1958) (d) D W Goodall (1953)
56. Competitive species are not found in habitats that are:
 (a) Rich in resources (b) Relatively disturbed
 (c) With dense populations (d) All
57. Which one of the following is not applicable to S-shaped population growth form?
 (a) Occurs in stable type of population (b) Exponential phase is very rapid
 (c) A crash phase is lacking (d) Deceleration phase occurs before equilibrium is reached
58. J-shaped growth phase is found where:
 (a) Food chains are large
 (b) Food chains are short or there is no human interference
 (c) Food chains are large or there is no human interference
 (d) Food chains are short or there is excessive human interference
59. Population shows negative growth in:
 (a) Urn-shaped age pyramid (b) Bell-shaped age pyramid
 (c) Triangular age pyramid (d) None

104 Ecology and Animal Behaviour

60. All members of a population:
 (a) Share the same gene pool (b) Undergo the same life cycle
 (c) Have the same morphological and anatomical traits (d) All
61. Clumping in organisms depends on the:
 (a) Specific nature of habitats (b) Type of reproductive pattern
 (c) Seasonal weather changes (d) All
62. The biotic potential for a particular population varies when the population is:
 (a) Increasing (b) Decreasing (c) Both (a) and (b) (d) Remains constant
63. The proportion of old individuals is maximum in:
 (a) Declining population (b) Stable population
 (c) Expanding population (d) None
64. The pattern of dispersion is mainly controlled by _____ of the area:
 (a) Climatic condition (b) Biotic condition
 (c) Edaphic condition (d) All
65. In the figure showing survivorship curves below, remarkably low mortality is represented by the labelled part:
 (a) I (b) II (c) III (d) None



66. In the above survivorship curves, which one of the following is the most common in nature?
 (a) III (b) II (c) I (d) I and II
67. If the initial population size of a plant species is 50 and after one year the population size is 100, what will be the per cent growth rate increase per year?
 (a) 10 (b) 50 (c) 75 (d) 100
68. Which one of the following is applicable to (K-N) K in ecological study?
 (a) Crash phase (b) Log phase
 (c) Carrying capacity (d) Environmental resistance
69. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|----------------------|------------------------------|
| (A) $dN/dt = rN$ | 1. Vital index |
| (B) N/S | 2. Population density |
| (C) dN/dt | 3. Exponential growth |
| (D) $N/M \times 100$ | 4. Change in population size |

Answer codes:

	A	B	C	D
(a)	4	3	1	2
(b)	3	2	4	1
(c)	2	1	4	3
(d)	3	4	2	1

70. Which one of the following determines the carrying capacity of a population?
(a) Natality (b) Mortality (c) Limited resource (d) Niche
71. The size of population begins to decline beyond the carrying capacity due to:
(a) Higher mortality (b) Lower natality (c) Emigration (d) All
72. Which one of the following exhibits negative population growth?
(a) Urn-shaped age pyramid (b) Bell-shaped age pyramid
(c) Triangular age pyramid (d) None
73. Which one of the following is applicable to bell-shaped age pyramid?
(a) Growing population (b) Stable population
(c) Decline population (d) Exponential growth
74. In the given formula of sigmoid growth, r is the: $dN/dt = rN (K-N/K) = rN(1-N/K)$
(a) Rate of change in the population size (b) Carrying capacity of the area
(c) Biotic potential (d) Environmental resistance
75. In the above formula environmental resistance is represented by:
(a) rN (b) $(K-N/K)$ or $1-(N/K)$
(c) dN/dt (d) K
76. Environmental resistance:
(a) Decreases with rise in population size (b) Increases with decrease in population size
(c) Increases with increase in population size (d) Remains unaffected with increase or decrease in population size
77. Which one of the following equation is applicable to J-shaped growth form?
(a) $dN = dt \times rN$ (b) $dt = dN/rN$ (c) $dN/dt = rN$ (d) $rN = dN \times dt$
78. Increase in the size of gene pool is caused by:
(a) Immigration (b) Emigration
(c) Both immigration and emigration (d) None
79. Which one of the following about ruderal(R) plant species is incorrect?
(a) Evergreen leaves (b) Rapid growth rate
(c) Very short longevity (d) Early reproductive maturity
80. Which one of the following about stress(S) tolerant species is incorrect?
(a) Grow in serpentine soils (b) Grow rapidly
(c) Grow in deserts (d) Grow in tundra and peat bogs
81. Genotypes with the highest possible intrinsic rate of increase are favoured by:
(a) r-selection (b) k-selection
(c) Both r-selection as well as k-selection (d) Generally by k-selection and rarely by r-selection
82. Which one of the following does not tend to stabilise population densities?
(a) Social structure (b) Territoriality
(c) Interspecific competition (d) Intraspecific competition
83. Which one of the following is an example of structural population?
(a) Fishes (b) Trees (c) Sea turtles (d) All
84. Which one of the following about J-shaped growth curve is incorrect?
(a) Density dependent (b) Boom and bust cycles
(c) $dN/dt = r$ (d) Crash phase

106 Ecology and Animal Behaviour

85. Which one of the following is a semelparous species?
 (a) *Octopus* (b) Squid (c) Mayfly (d) All
86. Which one of the following is not a k-selected organism?
 (a) Hare (b) Elephant (c) Panda (d) *Cactus*
87. r-selected organisms are:
 (a) Highly mobile (b) Unpleasant in their behaviour
 (c) Visible (d) All
88. Exponential growth that has not reached its carrying capacity is applicable to:
 (a) Mutualism (b) J-shaped growth curve
 (c) S-shaped growth curve (d) Parasitism
89. Consider the following statements:
 (A) Predation rates may change with density (B) Snowshoe hares and lynx regulate boom and bust population cycle
 (C) Bamboo is a semelparity species (D) Exponential growth is not sustainable
 The incorrect statements are:
 (a) None (b) A and B (c) B and C (d) A and D

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (d) | 3. (b) | 4. (d) | 5. (d) | 6. (d) | 7. (b) | 8. (a) |
| 9. (d) | 10. (d) | 11. (b) | 12. (b) | 13. (c) | 14. (a) | 15. (a) | 16. (d) |
| 17. (c) | 18. (d) | 19. (d) | 20. (c) | 21. (a) | 22. (d) | 23. (c) | 24. (b) |
| 25. (d) | 26. (a) | 27. (c) | 28. (d) | 29. (b) | 30. (a) | 31. (d) | 32. (a) |
| 33. (a) | 34. (b) | 35. (a) | 36. (c) | 37. (b) | 38. (c) | 39. (d) | 40. (c) |
| 41. (d) | 42. (c) | 43. (d) | 44. (b) | 45. (d) | 46. (d) | 47. (a) | 48. (a) |
| 49. (b) | 50. (b) | 51. (d) | 52. (b) | 53. (c) | 54. (a) | 55. (b) | 56. (b) |
| 57. (b) | 58. (d) | 59. (a) | 60. (d) | 61. (d) | 62. (d) | 63. (a) | 64. (d) |
| 65. (a) | 66. (a) | 67. (b) | 68. (d) | 69. (b) | 70. (c) | 71. (d) | 72. (a) |
| 73. (b) | 74. (c) | 75. (b) | 76. (c) | 77. (c) | 78. (a) | 79. (a) | 80. (b) |
| 81. (a) | 82. (c) | 83. (d) | 84. (a) | 85. (d) | 86. (a) | 87. (d) | 88. (b) |
| 89. (a) | | | | | | | |

Fill in the Blanks

- Population regulation is the control of _____ of a population.
- Generally, population regulation is of two types, viz., _____ and _____.
- The number of individuals per unit area or per unit volume is known as _____.
- The amount of area available as living space is known as _____.
- The concept of population regulation was given by _____.
- The term 'density dependence' was coined by _____.
- _____ is a set of local populations connected by dispersing individuals.

8. The groups of individuals born at a time are called _____.
9. Measure of the change in population per individual per unit of time is referred to as _____.
10. Growth rate = Birth – _____
11. The first significant contribution to the theory of population was that of _____
12. Density dependent mortality factors are those that are _____ in effect.
13. Density independent mortality factors are those that are _____ in effect.
14. The logistic equation shows _____ growth.
15. If a population tends to be of the same size, then it is referred to as _____ population.
16. Empty niches are exploited by _____ - selected species.
17. The distribution of individuals of a species may be of _____, _____ or _____ pattern.
18. In _____ -selected populations, the population sizes can change very quickly.
19. Environmental resistance causes populations to stabilise _____ the carrying capacity.
20. Populations have an age distribution consisting of _____, _____ and _____ phases.
21. _____ is the percentage ratio of natality over mortality.
22. The actual increase in population is called _____ or _____ natality.
23. Seed longevity is long in _____ selection.
24. The important differences in the traits of r-and k-selection was given by _____.
25. In _____ selection mortality is more due to catastrophic events.
26. There are two main types of population growth forms, viz., _____ shaped and _____ shaped.
27. Mortality rate is _____ birth rate when a population reaches carrying capacity.
28. _____ includes all those factors which limit the population growth.
29. A change in the population overtime is referred to as _____.
30. When in an area, the population exceeds the carrying capacity, it is called _____.
31. The exponential growth model is also known as _____ model.
32. In an environment where resources become limited, populations show a pattern of growth called _____.
33. All individuals of a population born in the same year are called _____.
34. The survivorship curve of a human is highly _____.
35. The approximate biotic potential (r) of large mammals per years is _____.

Answers to Fill in the Blanks

- | | | |
|---|---|------------------------------|
| 1. Size | 2. Density dependent, density independent | |
| 3. Density | 4. Ecological density | 5. Verhulst (1838) |
| 6. Smith (1935) | 7. Meta population | 8. Cohort |
| 9. Growth rate | 10. Deaths | 11. Thomas Malthus (1798) |
| 12. Facultative | 13. Catastrophic | 14. Density dependent |
| 15. Stable | 16. r | 17. Uniform, random, clumped |
| 18. r | 19. At or below | |
| 20. Pre-reproductive, reproductive, post-reproductive | | 21. Vital index |
| 22. Ecological or realised | 23. r | 24. Pianka (1970) |

108 Ecology and Animal Behaviour

- | | | |
|------------------------------|-----------------------|--------------------|
| 25. r | 26. J, S | 27. < |
| 28. Environmental resistance | 29. Population growth | 30. Overpopulation |
| 31. Malthusian growth | 32. Logistic growth | 33. Cohort |
| 34. Convex | 35. 0.02 to 0.5 | |

True or False

1. Populations of organisms are constantly in a state of change.
2. A disease is a good example of a density dependent factor of population regulation.
3. Logistic growth is one way to limit the size of a population.
4. Logistic growth is based on the idea of carrying capacity of any environment.
5. Logistic growth model is discontinuous model.
6. All environmental effects are always density independent.
7. In geometric population growth, young ones are added at a discrete intervals or seasons.
8. In exponential growth, young ones are added continuously.
9. Density dependent regulation is the only way that the logistic model can be obtained.
10. Environmental resistance acts against maximum population growth.
11. Migration changes the size of a population.
12. Emigration may cause permanent loss from a population.
13. Potential natality is realised natality
14. Selection pressure may result in territoriality.
15. Competition is always straightforward.
16. Most crops are r-strategists.
17. Parasites and predators are k-strategists.
18. Extensive parental care is found in the members of r-species.
19. r-selected species are density independent.
20. K-selected species thrive best in ecosystems with unstable environmental conditions.
21. Cats are r-selected compared to humans and k-selected compared to cockroaches.
22. A species that reproduces quickly is called r-selected.
23. Pollution can lower the growth rate of a population.
24. The carrying capacity represents a stable equilibrium in the population size.
25. Dispersal mechanism is well developed in k-selected species.
26. Mortality is density dependent in k-selected species.
27. Natality pattern is similar in temperate and tropical populations.
28. In closely related species, differences in survivorship curve exit.
29. Mortality is both species-specific well as sex-specific.
30. Equilibrium phase is static in an S-shaped growth form.

31. Emigration reduces the size of a gene pool.
32. Most insects show J-shaped growth form.
33. Carrying capacity of any area for a population does not remain constant over a period of time.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
| 1. True | 2. True | 3. True | 4. True | 5. False | 6. False | 7. True | 8. True |
| 9. True | 10. True | 11. False | 12. True | 13. False | 14. True | 15. False | 16. True |
| 17. True | 18. False | 19. True | 20. False | 21. True | 22. True | 23. True | 24. True |
| 25. False | 26. True | 27. False | 28. True | 29. True | 30. False | 31. True | 32. True |
| 33. True | | | | | | | |

Give Reasons

1. Populations cannot continue to grow forever.
 - Because resources are limited as well as competition, mortality and density increases, while natality decreases. Thus population growth decreases.
2. Humans are not restricted by the rules of population regulation.
 - Because of their ability to create and adjust to habitats.
3. Logistic growth is a density dependent model.
 - Because population growth rate (dN/dt) is positive below the carrying capacity (K) and negative above the carrying capacity.
4. Ecological natality is not a constant.
 - Because of variation in the level of the physical constraints in nature, in time, as well as in space.
5. Populations are expected to reach a carrying capacity.
 - Because birth rates and death rates are density dependent.
6. As the population size increases, the population birth rate decreases.
 - Because of increased competition for resources.
7. A population with more females than males will grow faster.
 - Because there are more females to produce offsprings.
8. In human populations, the survivorship curve is highly convex.
 - Because of better nutrition, medical care and hygiene, the human mortality rate has decreased.
9. The age structure of a population may differ geographically.
 - Because of differential densities.
10. A population is inherently dynamic in nature.
 - Because of regular occurrence of immigration and emigration.
11. r-selection is an advantage in unstable environments.
 - Because a large number of offsprings are produced by r-selected organisms, which are likely to find favourable adaptation within the variation of the population.

110 *Ecology and Animal Behaviour*

12. Biologists study the factors that affect population dynamics.
 - To know about conservation of endangered species, management of fish and wildlife as well as to have a basic idea about the processes that affect population dynamics to predict the future patterns of human population growth.
13. Floods, forest fires and droughts are described as density independent factors.
 - Because these catastrophes exert their effect irrespective of the size of the population.
14. It is difficult to measure biotic potential.
 - Because optimum condition for growth never occurs (except in artificial laboratory conditions).
15. J-shaped growth curve is termed density independent.
 - Because the regulation of growth rate is not associated with the population density until the final crash.
16. S-shaped growth curve is termed density dependent.
 - Because of the fact that growth rate depends on the numbers present in the population.

SPECIES INTERACTION

Multiple-Choice Questions

1. Extract of *Croton bonplandianum* in higher concentration inhibits germination of seeds, except:
 - (a) Mustard
 - (b) Rice
 - (c) Pea
 - (d) Lettuce
2. In epiphytic species of *Tillandsia*, the absorption of water takes place through:
 - (a) Roots
 - (b) Stem
 - (c) Stem and leaves
 - (d) Leaves
3. Hartig net confined to the epidermal cells is a characteristic of:
 - (a) Ectomycorrhizae
 - (b) Lichens
 - (c) Endomycorrhizae
 - (d) Orchidaceous mycorrhizae
4. Which one of the following microflora is present in the digestive tract of herbivores?
 - (a) Bacteria
 - (b) Flagellates
 - (c) Protozoans
 - (d) All
5. Long lived trees, shrubs and grasses cannot escape by herbivores. This is known as:
 - (a) Resource availability theory
 - (b) Appearance theory
 - (c) Competitive exclusion theory
 - (d) Survival theory
6. Carnivorous plants differ in:
 - (a) Insect nitrogen requirement
 - (b) Type of trap
 - (c) Growth habit
 - (d) All
7. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Holoparasite	1. African lizard
(B) Hemiparasite	2. <i>Rafflesia</i>
(C) Protective mimicry	3. <i>Phyllium frondosum</i>
(D) Alluring	4. <i>Viscum</i>

Answer codes:

A	B	C	D
(a) 3	1	4	2
(b) 2	4	3	1
(c) 4	2	1	3
(d) 2	1	3	4
8. Shift from climbing to epiphytic habit is shown by:
 - (a) *Dischidia*
 - (b) *Nephrolepis*
 - (c) *Tillandsia*
 - (d) *Frankia*
9. Which one of the following classic ecological theories has focused on negative interaction?
 - (a) Niche separation
 - (b) Natural selection
 - (c) Meta population dynamics
 - (d) All
10. Which one of the following checks the growth of weeds?
 - (a) Barley
 - (b) Sunflower
 - (c) Sorghum
 - (d) All

112 Ecology and Animal Behaviour

11. Shrews, rats and rabbits live together in a grassland showing:
 - (a) Commensalism
 - (b) Parasitism
 - (c) Neutralism
 - (d) Amensalism
12. Consider the following statements:
 - (A) Recently it has been pointed out that grazing animals (deer and rabbits) are helping to spread plant diseases
 - (B) Two species may interact differently in different conditions
 - (C) Competition is not always straightforward
 - (D) Competition within and between species for resources plays an important role in natural selection
 The incorrect statements are:
 - (a) A and B
 - (b) A and C
 - (c) B and D
 - (d) None
13. The interaction that will not promote co-evolution:
 - (a) Intraspecific competition
 - (b) Parasitism
 - (c) Commensalism
 - (d) Mutualism
14. The relationship of barnacles and whale presents:
 - (a) Mutualism
 - (b) Commensalism
 - (c) Parasitism
 - (d) Neutralism
15. Which one of the following about herbivores is incorrect?
 - (a) Prevent encroachment of new forms into an area
 - (b) Influence distribution of plant species
 - (c) Destabilise plant succession
 - (d) None
16. Which one of the following feeds only on bamboo shoots?
 - (a) Iguanas
 - (b) Giant pandas
 - (c) Sloths
 - (d) None
17. The mutualism between animals, plants and microbes form the basis of:
 - (a) Nitrogen fixation and nutrient recycling
 - (b) Pollinations
 - (c) Seed dispersal
 - (d) All
18. Consider the following statements:
 - (A) Competition always occurs for a single resource
 - (B) Competition ability is not usually genetically fixed
 - (C) Competition vary from habitat to habitat
 - (D) Mimicry is a means of reducing competition
 The incorrect statements are:
 - (a) A, B and C
 - (b) A and B
 - (c) C and D
 - (d) All
19. Which one of the following is applicable to competition?
 - (a) $-$, $-$
 - (b) 0 , 0
 - (c) $+$, $-$
 - (d) $+$, 0
20. Which one of the following is a prey as well as predator?
 - (a) Rabbits
 - (b) Frogs
 - (c) *Pila*
 - (d) *Sacculina*
21. Altruism is manifested by:
 - (a) Honeybees and wasps
 - (b) Grasshoppers
 - (c) *Obelia* and hermit crabs
 - (d) Rhizospheres
22. The principle of competitive exclusion states that species cannot remain in the same community if they have the same:
 - (a) Habitat
 - (b) Niche
 - (c) Food
 - (d) All
23. Ecologically, which one of the following is more important?
 - (a) Commensalism
 - (b) Amensalism
 - (c) Mutualism
 - (d) Parasitism

24. Consider the following statements:
 (A) Epiphytism is a type of biotic association
 (B) Epiphytes are more common in warm and humid tropics
 (C) Drought is a limitation to the epiphytic mode of life
 (D) Epiphytism may evolve into parasitism
 The correct statements are:
 (a) All (b) A, B and C (c) B, C and D (d) B and C
25. Which one of the following is a negative interaction?
 (a) Amensalism (b) Predation (c) Competition (d) All
26. An association which is harmful to both partners is:
 (a) Competition (b) Amensalism (c) Neutralism (d) Parasitism
27. Elaiophores are found abundantly in:
 (a) *Utricularia* (b) Insects
 (c) Flowers of plants of Neotropical savannas (d) Roots of plants of Neotropical savannas
28. Effect of herbivores on plants is:
 (a) Positive (b) Negative (c) Neutral (d) All
29. The association of species in which both populations are benefited and the relation is obligatory, is called:
 (a) Amensalism (b) Commensalism (c) Mutualism (d) Photocooperation
30. Which one of the following is applicable to mycorrhiza?
 (a) Hyperparasitism (b) Brood parasitism (c) Symbiotic association (d) Exploitation
31. Match column I with column II and select the correct answer using answer codes:

Column I				Column II
(A) <i>Trichoderma</i>				1. Prevents growth of apple
(B) <i>Grevillea robusta</i>				2. Inhibits germination of wheat
(C) <i>Juglans regia</i>				3. Does not allow own seeds to grow
(D) <i>Convolvulus arvensis</i>				4. Prevents growth of <i>Aspergillus</i>

 Answer codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	3	4	1
(c)	3	4	1	2
(d)	1	2	4	3
32. Association of suckerfish and shark is:
 (a) Parasitism (b) Commensalism (c) Amensalism (d) Symbiosis
33. Herbivorous mammals are unable to digest:
 (a) Silica (b) Cutin (c) Lignin (d) All
34. Which one of the following about epiphytes is incorrect?
 (a) True epiphytes lack soil connection (b) Thickened cuticle
 (c) Sunken stomata (d) None
35. The nitrogen-fixing bacteria *Rhizobium* found in the root nodules of leguminous plants are an example of:
 (a) Neutralism (b) Parasitism
 (c) Mutualism (d) Amensalism

114 Ecology and Animal Behaviour

36. The association in which one species adversely affects of the population another but itself remains unaffected is called:
 (a) Neutralism (b) Amensalism (c) Predation (d) Parasitism
37. An epiphytic plant growing on the trunk of a tree is an example of:
 (a) Commensalism (b) Amensalism (c) Neutralism (d) Parasitism
38. The association in which a population lives on another without killing it is known as:
 (a) Amensalism (b) Commensalism (c) Neutralism (d) Parasitism
39. A deer feeding on shrubs and grass is a form of:
 (a) Predation (b) Parasitism (c) Competition (d) Amensalism
40. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Fungus gardens	1. Commensalism
(B) Velamen	2. Brood parasitism
(C) Indian koel and crow	3. Epiphytes
(D) Pea crab and sea mussels	4. Mutualism

 Answer codes:

A	B	C	D
(a) 3	1	4	2
(b) 4	3	2	1
(c) 2	4	1	3
(d) 2	1	4	3
41. The association of *Sacculina* with crabs is a:
 (a) Parasitic association (b) Mutualistic association
 (c) Commensalic association (d) Predation
42. Which one of the following is a parasitic plant?
 (a) *Epifagus* (b) *Cuscuta* (c) *Rafflesia* (d) All
43. Consider the following statements:
 (A) The flowers of most insectivorous plants are insect pollinated
 (B) Nitrogen requirement in *Darlingtonia californica* is more in comparison to *Drosera* species
 (C) L-canvanine is a toxin in many species of the bean family
 (D) *Caryedes sp* uses L-canvanine as a nitrogen source
 The correct statements are:
 (a) None (b) A and B (c) A and C (d) All
44. Niches can be altered by the presence of:
 (a) Competitors (b) Predators
 (c) Both competitors and predators (d) None
45. A fundamental niche is a maximum niche having no:
 (a) Competitors (b) Predators (c) Parasites (d) All
46. Consider the following statements:
 (A) Character displacement is the best evidence for limiting similarity
 (B) Character displacement has been shown for Darwin's finches in the Galapagos islands
 (C) Character displacement is the evidence of past competition forcing species that were too similar to become dissimilar in order to coexist
 (D) When the species are allopatric, their utilisation patterns overlap

The correct statements are:

- (a) All (b) A and B (c) A, B and D (d) A and D

47. Match column I with column II and select the correct answer using answer codes:

Column I (Competition)

Column II (Example)

- (A) Overgrowth
(B) Consumptive
(C) Chemical
(D) Preemptive

1. A barnacle occupying a space on a rock
2. Walnut trees releasing toxins
3. Eating all the berries on a plant
4. A tree shading out another

Answer codes:

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 4 | 1 | 3 |
| (b) | 4 | 3 | 2 | 1 |
| (c) | 3 | 4 | 1 | 2 |
| (d) | 2 | 3 | 1 | 4 |

48. Most common competition is:

- (a) Encounter competition (b) Territorial competition
(c) Consumptive competition (d) Overgrowth competition

49. Predator decreases:

- (a) Above prey isocline (b) Below prey isocline
(c) Above predator isocline (d) Below predator isocline

50. Alkaloid is produced by:

- (a) Bacteria (b) Frogs (c) Butterflies (d) All

51. This chemical compound is released when plant tissues are crushed by herbivores and is very toxic to cellular respiration as well as it can kill a cow in low dose. This chemical compound is:

- (a) Hydrogen cyanide (b) Pyrethroids
(c) Lignin (d) Mixed oxidases

52. Which one of the following is an incorrect match?

- (a) *Chlorella vulgaris* and *Hydra* – Mutualism (b) Tick bird and rhinoceros – Neutralism
(c) Lichens – Mutualism (d) *Azolla* and *Anabaena* – Symbiosis

53. Which one of the following is incorrect?

- (a) Some butterflies use plant alkaloids as a source of attractants.
(b) Alkaloids stimulate synthesis of DNA and RNA.
(c) Volatile terpenes are aromatic and sometimes used by plants to attract pollinators.
(d) Cellulose, lignin and tannins provide protection to plants from herbivores.

54. Which one of the following is an incorrect match?

- (a) Parasitoids – Used to control crop pest (b) Juglone – Parasitism
(c) Sex parasite – Male *Bonellia* (d) Haustoria – Total stem parasite

55. Space parasite is applicable to:

- (a) Epiphytes (b) Lichens (c) *Fagus* (d) Lianas

56. Newly hatched termites receive *Trichonympha* from the:

- (a) Female parent (b) Male parent
(c) Older termites through licking their anal area (d) Older termites through licking their mouth parts

57. Change in behaviour in some animals is due to increase in population density and is termed as:

- (a) Stress syndrome (b) Group effect (c) Inducible effect (d) Oscar syndrome

116 Ecology and Animal Behaviour

58. Competitive exclusion has not been seen in:
 - (a) Oligotrophic lake
 - (b) Induced succession
 - (c) Communities undergoing succession
 - (d) Autotrophic succession
59. Which one of the following became extinct due competitive exclusion?
 - (a) *Erythroneura*
 - (b) Abingdon tortoise
 - (c) *Parus*
 - (d) Milkweed
60. Red cotton bug is a:
 - (a) Hyperparasite
 - (b) Phytoparasite
 - (c) Ectoparasite
 - (d) None
61. Which one of the following about competition is correct?
 - (a) Population regulation
 - (b) Elimination of weaker species
 - (c) Density controls
 - (d) All

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (c) | 2. (c) | 3. (a) | 4. (d) | 5. (b) | 6. (d) | 7. (b) | 8. (b) |
| 9. (d) | 10. (d) | 11. (c) | 12. (d) | 13. (c) | 14. (b) | 15. (c) | 16. (b) |
| 17. (d) | 18. (b) | 19. (a) | 20. (b) | 21. (a) | 22. (b) | 23. (c) | 24. (a) |
| 25. (d) | 26. (a) | 27. (c) | 28. (d) | 29. (c) | 30. (c) | 31. (a) | 32. (b) |
| 33. (d) | 34. (d) | 35. (c) | 36. (b) | 37. (a) | 38. (d) | 39. (a) | 40. (b) |
| 41. (a) | 42. (d) | 43. (d) | 44. (c) | 45. (d) | 46. (a) | 47. (b) | 48. (c) |
| 49. (b) | 50. (d) | 51. (a) | 52. (b) | 53. (b) | 54. (b) | 55. (a) | 56. (c) |
| 57. (a) | 58. (c) | 59. (b) | 60. (a) | 61. (d) | | | |

Fill in the Blanks

1. A _____ is a group of different populations that live and interact with one another.
2. _____ is the association between two species which do interact but do not affect each other.
3. The black walnut secretes a chemical called _____, which harms or kills some of the neighbouring plants.
4. Coral reefs are the result of _____ between coral organisms and various types of algae that live inside them.
5. The interaction between organisms or species in which fitness of one is lowered by the presence of another is referred to as _____.
6. Most hyperparasitoid species are known in the insect order _____.
7. The term 'parasitoid' was coined by _____.
8. An organism that spends a significant part of its life cycle attached to or within a single host organism which it ultimately consumes or kills is called _____.
9. A _____ species is one whose impact on its ecosystem is disproportionately large in comparison to its abundance.
10. _____ bacterium lives on human skin.
11. Parasitism is a _____ interaction.

12. A virus is a hyperparasite of _____, which is a parasite in the intestine of humans.
13. Predator and prey are of the same species in the _____.
14. A few insects harbour microbes in a special organ in the digestive tract called _____.
15. A sheep contains _____ bacteria and _____ ciliated Protozoans in 1 ml in its rumen fluid.
16. The parasitoids which prevent any further development of the host after initial parasitisation are called _____ parasitoids.
17. *Pisaster ochraceus* (a starfish) is a classical example of _____ species in the rocky intertidal of the Pacific Northwest.
18. _____ model predicts cyclic oscillations in the abundance of predator and prey populations.
19. _____ crops do not allow weeds to grow in the field.
20. _____ is a device for concealment from predator/prey.
21. Specialised pollinators are _____ species.
22. Competitive exclusion occurs where there is more or less complete overlapping of different species _____.
23. *Microcystis* produces _____ that causes death of fishes and cattle.
24. _____ is the suppression of growth through the release of chemicals by higher plants.
25. The first detailed account of insectivorous plant was given by _____.
26. Competition between individuals of different species is called _____ competition, while competition between individuals of the same species is called _____ competition.
27. Actual space occupied by the species when other species are present is called _____ niche.
28. _____ species are those which produce strong indirect effects.
29. Species that share the same resources can coexist if their niches are _____.
30. _____ shows the first step towards the beneficial relations between species.
31. _____, which lives in root nodules of alders, is a well-known symbiotic nitrogen fixer.

Answers to Fill in the Blanks

- | | | |
|----------------------------------|----------------------------------|---|
| 1. Community | 2. Neutralism | 3. Juglone |
| 4. Mutualism | 5. Competition | 6. Hymenoptera |
| 7. O M Reuter (1913) | 8. Parasitoid | 9. Keystone |
| 10. <i>Staphylococcus aureus</i> | 11. Negative | 12. <i>E. coli</i> |
| 13. Cannibalism | 14. Mycetozoa | 15. 16100×10^6 , 3.3×10^5 |
| 16. Idiobiont | 17. Keystone | 18. Lotka–Volterra |
| 19. Smoother | 20. Mimicry | 21. Critical link |
| 22. Niches | 23. Hydroxylamine | 24. Allelopathy |
| 25. Charles Darwin (1875) | 26. Interspecific, intraspecific | 27. Realised |
| 28. Keystone | 29. Not too similar | 30. Commensalism |
| 31. <i>Frankia</i> | | |

True or False

1. A species may be stress tolerant as well as a good competitor.
2. Negative and positive interactions are not equally important in the evolution of species and stabilisation of ecosystems.
3. Grazing increases the net primary productivity of grassland communities.
4. Insectivores plants feed on insects to fulfill their nitrogen demand.
5. Competition is one reason for endemism.
6. Allelopathy is confined to root exudates only.
7. American ants do gardening of fungus in their nests to get regular supply of food directly or indirectly.
8. Glochidium larva is a temporary parasite.
9. Smoother crops are weed suppressors.
10. *Balanus* population is regulated by itself and predation.
11. In photocooperation, the relationship is obligatory.
12. Cannibalism is a special type of predation.
13. Parasitism and predation are antagonistic relationships.
14. Parasitism is the exploitation of one population by the other.
15. Competition is harmful to both populations.
16. The presence of green algae on the long, grooved hair of sloths exemplifies mutualism.
17. Social insects are the only animals (except humans) which have succeeded in domesticating other species.
18. Intraspecific competition may lead to speciation.
19. In nature, predator-prey populations never exhibit oscillations.
20. About 10 per cent of insect species are parasitoids.
21. Insectivores plants are heterotrophs.
22. Complete competitors cannot coexist.
23. Competition between individuals differs.
24. Scavenging is a negative interaction.
25. *Rafflesia* is a root parasite of *Vitis*.
26. Stress syndrome is found in some birds and mammals.
27. Predators select food on the basis of size.
28. Hyperparasite use host machinery for reproduction.
29. The Lotka–Volterra model does not explain the occurrence of population cycles.
30. Coexistence tends to decrease resource sharing among the competing populations.
31. *Nephrolepis* is an example for shift from climbing to epiphytic habit.

Answers to True or False

- | | | | | | | | |
|----------|----------|-----------|-----------|-----------|-----------|----------|-----------|
| 1. False | 2. False | 3. True | 4. True. | 5. True | 6. False | 7. True | 8. True |
| 9. True | 10. True | 11. False | 12. True | 13. False | 14. True | 15. True | 16. False |
| 17. True | 18. True | 19. False | 20. True | 21. False | 22. True | 23. True | 24. False |
| 25. True | 26. True | 27. True | 28. False | 29. False | 30. False | 31. True | |

Give Reasons

1. Predation plays a key role in structuring a biological community.
 - Because the predator-prey interaction at one trophic level affects the predator-prey interaction at the next trophic level.
2. Intraspecific competition is more serious.
 - Because it exploits only one zone of a habitat and the same types of resources.
3. In tropical rainforests, figs act as keystone species.
 - Because fig fruits provide food to a large number of animals such as birds, bats and monkeys at the time of food scarcity.
4. Cellulose, lignin and tannin extend protection to plants from herbivores.
 - Because their presence in higher concentration reduces palatability and digestivity and thus protects them from attacks by herbivores.
5. Developing leaves, buds and unripe fruits are vulnerable to attack by herbivores.
 - Because they are not supplemented with lignin.

NATURAL RESOURCES

Multiple-Choice Questions

1. Which one of the following is a biotic resource?
(a) Natural gas (b) Coal (c) Oil (d) All
2. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Agar	1. <i>Gloiopeltis</i>
(B) Carrageenin	2. <i>Chondrus</i>
(C) Funori	3. <i>Fucus</i>
(D) Algin	4. <i>Gracilaria</i>

Answer codes:

A	B	C	D
(a) 4	3	2	1
(b) 4	2	1	3
(c) 3	4	2	1
(d) 2	3	4	1
3. Which one of the following countries is known as the 'land of windmills'?
(a) Germany (b) France (c) Netherland (d) USA
4. Which one of the following can be reused by recycling?
(a) Metallic minerals (b) Coal (c) Petroleum (d) None
5. Alcohol is derived from:
(a) Sugarcane (b) Switch grass (c) Corn (d) All
6. Humans cannot live without:
(a) Oxygen and food (b) Fresh water (c) Proper temperature (d) All
7. Natural gas:
(a) Burns without smoke (b) Provides raw materials for making plastics, fertilisers and detergents
(c) Has high heat value (d) All
8. Burning of natural gas in urban areas contributes to ozone formation through:
(a) Nitrogen oxides (b) Carbon dioxide (c) Hydrocarbons (d) Sulphur dioxide
9. One of the oldest recorded uses of plant fibre for fabrics is the use of:
(a) Sisal (b) Hemp (c) Jute (d) Bamboo
10. Which one of the following is a plant source of fibres?
(a) Cotton (b) Abaca (c) Flax (d) All
11. In 2800 BC, hemp was being cultivated in:
(a) Japan (b) Peru (c) China (d) India

12. The second-largest agricultural use of pesticides in the world is in the production of:
 (a) Bamboo (b) Cotton (c) Jute (d) Sisal
13. Which one of the following is obtained from biomass?
 (a) Petrol (b) Alcohol (c) Biogas (d) All
14. The country having the largest supply of freshwater in the world is:
 (a) Australia (b) Brazil (c) France (d) Japan
15. Destruction of vegetation has resulted in:
 (a) Floods, droughts and an unbalanced ecosystem (b) Soil erosion
 (c) Denudation (d) All
16. India is rich in:
 (a) Copper (b) Lead (c) Zinc (d) All
17. Burning of natural gas in urban areas contributes to global climate change through:
 (a) Carbon dioxide (b) Nitrogen oxides (c) Sulphur dioxide (d) Water
18. Himalayan or Nilgiri nettle is a stem fibre obtained from:
 (a) *Girardinia diversifolia* (b) *Hesperable funifera*
 (c) *Anans comosus* (d) All
19. Which one of the following is a major flax producing country?
 (a) China (b) India (c) France (d) Japan
20. Which one of the following is an edible Mollusc?
 (a) Clams (b) Oysters (c) Mussels (d) All
21. Bromine is obtained from:
 (a) *Fucus* (b) *Gelidium* (c) *Rhodomela* (d) *Laminaria*
22. The lignite quality of coal is found in:
 (a) Jharkhand (b) Orissa (c) Tamil Nadu (d) Andhra Pradesh
23. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|----------------|--|
| (A) Peat | 1. A soft brown material made up of partly decayed plant |
| (B) Lignite | 2. A hard black form of coal |
| (C) Anthracite | 3. A fairly hard, dark brown or black form of coal |
| (D) Bitumen | 4. A soft brown form of coal |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 2 | 1 | 3 |
| (b) | 3 | 4 | 2 | 1 |
| (c) | 1 | 4 | 2 | 3 |
| (d) | 2 | 3 | 4 | 1 |
24. Which country has the largest renewable energy programme in the world?
 (a) England (b) Brazil (c) Australia (d) Japan
25. Deforestation causes:
 (a) Soil erosion (b) Desertification (c) Loss of nutrients (d) All
26. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|--------------|-------------|
| (A) Corundum | 1. Gasoline |

122 Ecology and Animal Behaviour

- (B) Vanadium
(C) Titanium
(D) Lead

2. Abrasives
3. Alloys
4. Pigments

Answer codes:

	A	B	C	D
(a)	4	2	1	3
(b)	2	3	4	1
(c)	3	4	1	3
(d)	4	1	3	2

27. *Prosopis cineraria* is grown in the semi-arid zone of _____ to increase yields of millet crops:
(a) India (b) China (c) Japan (d) Africa
28. *Paulownia elongata* is grown with wheat in the:
(a) Arid zone of India (b) Semi-arid zone of India
(c) Temperate zone of China (d) Himalayan zone of India
29. Indian forests having the least geographical area:
(a) Scrub (b) Mangrove (c) Dense forest (d) Open forest
30. Total forest cover in India is:
(a) 20.55 per cent (b) 25 per cent (c) 28.5 per cent (d) 35.7 per cent
31. Which one of the following is applicable to the cutting of banks?
(a) Riparian erosion (b) Wave erosion (c) Slip erosion (d) None
32. The biggest irrigated area of world is:
(a) China (b) Japan (c) USA (d) India
33. Gasification gives:
(a) Biogas (b) Pyrogas
(c) Both biogas and pyrogas (d) None
34. Silviculture is related with:
(a) Pisces (b) Silkworm (c) Forest management (d) Wildlife
35. As per WHO estimates, only _____ of all water on the earth is readily available for human consumption:
(a) 5 per cent (b) 3 per cent (c) 0.2 per cent (d) 0.007 per cent
36. Generation of biogas is mainly based on the principle of:
(a) Degradation (b) Distillation
(c) Fermentation (d) Purification and fermentation
37. Recycling is not applicable to:
(a) Solar energy (b) Petroleum (c) Plants (d) Animals
38. Natural resources vary greatly in:
(a) Location (b) Quality (c) Quantity (d) All
39. Which one of the following is a cultigen?
(a) Maize (b) Cabbage (c) Tomato (d) All
40. Which one of the following is applicable to natural resources?
(a) Exhaustible and renewable (b) Exhaustible and nonrenewable
(c) Inexhaustible (d) All

41. Seeds of which one of the following plants inhibits growth of bacteria and fungi?
(a) Tulasi (b) *Moringa* (c) *Inga sp* (d) *Zizyphus sp*
42. Which one of the following has antibacterial and insecticidal properties?
(a) Nirmali (b) Tulasi (c) *Moringa* (d) All
43. Which one of the following provides both power and manure?
(a) Biogas plants (b) Nuclear plants (c) Hydroelectric plants (d) None
44. The importance of forests first realised by:
(a) Asoka (b) Chandragupta Maurya (c) Akbar (d) Lord Dalhousie
45. Vermitin is used in:
(a) Poultry (b) Agrosystems (c) Aquaculture (d) All
46. Consider the following statements:
(A) Chandragupta Maurya realised the importance of forests
(B) It was Asoka who pointed out that wild animals and forests should be preserved
(C) Akbar ordered planting of trees in various parts of his kingdom
(D) In 1855, Lord Dalhousie framed regulations for conservation of forests in the entire country
The incorrect statements are:
(a) None (b) A and B (c) A and C (d) C and D
47. Which one of the following is applicable to nonrenewable resources?
(a) Exhaustible resources (b) Exist in fixed amount
(c) Replaced slowly than they are used (d) All
48. Exploitation of natural resources results in:
(a) Oil shortage (b) Ozone depletion (c) Extinction of species (d) All
49. The largest producer and consumer of natural gas in the world is:
(a) Japan (b) USA (c) Germany (d) UK
50. Flax is obtained from:
(a) *Tithonia diversifolia* (b) *Linum usitatissimum*
(c) *Leucanea leucocephala* (d) *Balanites roxburghii*
51. Linen fibre is:
(a) Allergy free (b) Absorbs humidity (c) Allows skin to breathe (d) All
52. Iodine is obtained from:
(a) *Laminaria* (b) *Fucus* (c) Both (a) and (b) (d) *Sargassum*
53. Renewable resources are obtained from:
(a) Agriculture (b) Rainfall (c) Fossil fuels (d) Tides
54. Demersal fish is obtained from:
(a) Rivers (b) Lakes (c) Sea bottom (d) Wetlands
55. Which one of the following can act as a supplement for production of biogas?
(a) *Hydrilla* (b) Water hyacinth (c) Duckweeds (d) All
56. Which one of the following is an exotic carp?
(a) *Ctenopharyngodon idelle* (b) *Notopterus chitala*
(c) *Mastocembalus armatus* (d) *Ompok bimaculatus*
57. About _____ of the existing forests are dense forests:
(a) 10 per cent (b) 40 per cent (c) 60 per cent (d) 80 per cent

124 Ecology and Animal Behaviour

58. Consider the following statements:
(A) Forests regulate floods and droughts
(B) Almost 10 per cent of tropical forests are lost each year
(C) Nearly 47 per cent of forests worldwide are tropical
(D) 45 per cent of the world's forests are under protected areas
The correct statements are:
(a) All (b) A, B and C (c) A and C (d) C and D
59. Which one of the following is not a biotic resource?
(a) Forests (b) Mineral fuels (c) Ores (d) All
60. Which one of the following is renewable?
(a) Wood (b) Air (c) Water (d) All
61. Forest fires destroy much more than trees in:
(a) Southern Europe (b) South Asia (c) Australia (d) Africa
62. The total degraded land is about _____ of the earth's vegetated surface:
(a) 15 per cent (b) 20 per cent (c) 43 per cent (d) 55 per cent
63. Which one of the following is incorrect?
(a) About 47 per cent world's forests occur in tropics
(b) 33 per cent of the world's forests occur in the boreal zone
(c) 9 per cent of the world's forests occur in the temperate zone
(d) None
64. Which one of the following continent has the largest area of forest plantations?
(a) Australia (b) Europe (c) Asia (d) Africa
65. Which one of the following countries has the largest plantation development programmes?
(a) India (b) China (c) Japan (d) Russian Federation
66. In India, Joint Forest Management was introduced in:
(a) 1980 (b) 1985 (c) 1990 (d) 2000
67. Which one of the following is a major direct cause of land degradation and subsequent soil erosion?
(a) Deforestation (b) Overgrazing
(c) Agricultural activities (d) Industrial activity
68. The Appiko Movement originated in:
(a) Uttarakhand (b) Karnataka (c) Bengal (d) Himachal Pradesh
69. A renewable source is considered economically depleted, when:
(a) 40 per cent of its supply has been used or removed
(b) 50 per cent of its total supply has been used or removed
(c) 80 per cent of its total supply has been used or removed
(d) 100 per cent of its total supply has been used
70. Which one of the following is used to protect agricultural lands from erosion?
(a) *Zizyphus* (b) *Balanites roxburghii* (c) *Moringa oleifera* (d) All
71. 5F is related with the:
(a) Chipko Movement (b) Appiko Movement
(c) Silent Valley (d) Social forestry programme
72. Social forestry programme was started in:
(a) 1970 (b) 1976 (c) 1985 (d) 1990

73. Gemstones are found in:
 (a) Uttarakhand (b) Rajasthan (c) Jammu and Kashmir (d) Karnataka
74. Which one of the following countries has the lowest water area?
 (a) South Africa (b) Nepal (c) Japan (d) Finland
75. The country having the highest total renewable water resources:
 (a) China (b) Venezuela (c) Brazil (d) China
76. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Indian Metrological Department	1. Water quality
(B) Central Pollution Control Board	2. Precipitation
(C) Ministry of Environment and Forests	3. Watershed management
(D) Department of Forests	4. Environmental impact assessment

 Answer codes:

A	B	C	D
(a) 4	3	2	1
(b) 3	1	4	2
(c) 2	1	4	3
(d) 4	2	1	3
77. Which one of the following about *Eucalyptus* is incorrect?
 (a) Quick growing (b) Used in the paper pulp industry
 (c) Used as fodder (d) Not suitable as firewood
78. Which one of the following is greatly threatened by desertification?
 (a) Asia (b) Africa (c) Latin America (d) All
79. Excessive use of groundwater does not cause:
 (a) Acidification (b) Salinisation (c) Alkalinisation (d) Water logging
80. Which one of the following is applicable to wetlands?
 (a) Purification of runoff water (b) Recharging of groundwater
 (c) Control of flood (d) All
81. Chipko movement started in:
 (a) Jammu and Kashmir (b) Uttaranchal
 (c) Himachal Pradesh (d) Arunachal Pradesh
82. Which one of the following is found in seabed or sea sands?
 (a) Platinum (b) Gold (c) Monozite (d) All
83. Which one of the following is an opportunist inquiline?
 (a) Crows (b) Mice (c) Scorpions (d) Lions
84. Which one of the following is not a petroplant?
 (a) *Lathyrus* (b) *Brickellia* (c) Maize (d) *Jatropha*
85. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Pines and junipers	1. Soil deposition
(B) <i>Argemone maxicana</i>	2. Acid grassland soil
(C) <i>Zizyphus rotundifolia</i>	3. Recently disturbed or flooded soil
(D) <i>Rumex acetosella</i>	4. Uranium rich soil

Answer codes:

	A	B	C	D
(a)	4	1	2	3
(b)	4	3	1	2
(c)	2	4	3	1
(d)	3	1	4	2

86. Burning of which one of the following increases forage yields?
 - (a) *Cynodon dactylon*
 - (b) *Perionyx excavatus*
 - (c) *Zizyphus jujuba*
 - (d) *Mangifera indica*
87. Vast majority of aquaculture occurs in:
 - (a) Asia
 - (b) Africa
 - (c) Australia
 - (d) North America
88. Cutting of banks is:
 - (a) Slip erosion
 - (b) Riparian erosion
 - (c) Gully erosion
 - (d) Wind erosion
89. Which one of the following region of the world has the least forest plantations?
 - (a) Asia
 - (b) Europe
 - (c) Oceania
 - (d) Africa
90. In India, what percentage of existing forests are dense forests?
 - (a) 70 per cent
 - (b) 76 per cent
 - (c) 55 per cent
 - (d) 40 per cent
91. Which one of the following is used to protect agricultural lands from erosion in dry areas prone to wind erosion?
 - (a) *Moringa oleifera*
 - (b) *Inga edulis*
 - (c) *Acacia nilotica*
 - (d) *Alnus nepalensis*
92. The plants which prevent soil erosion should not be:
 - (a) Perennials with above the ground parts
 - (b) Tolerant to floods
 - (c) Tolerant to droughts
 - (d) Invasive
93. A windbreak is a:
 - (a) Row of trees
 - (b) Row of bushes
 - (c) Plastic snow fence
 - (d) All
94. The removal of entire topsoil as a result of heavy rain is:
 - (a) Sheet erosion
 - (b) Gully erosion
 - (c) Rill erosion
 - (d) Riparian erosion
95. Which one of the following is incorrect?
 - (a) Approximately 41 per cent of the earth's land is threatened by desertification
 - (b) Desertification makes an area more prone to floods and droughts
 - (c) Innovation decreases the productivity of natural resources
 - (d) Pattern and distribution of rainfall in a region is an index of water resources
96. Consider the following points about:
 - (A) Gregarious species
 - (B) Moderate to slow growing species
 - (C) Grows well in well-drained, moist, sandy loam soil
 - (D) Its flowers are whitish and appear in early summer
 The name of this plant is:
 - (a) *Mangifera indica*
 - (b) *Shorea robusta*
 - (c) *Dalbergia sissoo*
 - (d) *Ficus indicus*
97. Which one of the following is a naturally lasting timber of the Asian subcontinent?
 - (a) Sal
 - (b) Teak
 - (c) Deodar
 - (d) All
98. Which one of the following is different?
 - (a) Minerals
 - (b) Wind power
 - (c) Oil and natural gas
 - (d) Coal

99. The area covered by man-managed grazing is _____ per cent of the global land surface:
 (a) 15 (b) 25 (c) 30 (d) 40

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (a) | 5. (d) | 6. (d) | 7. (d) | 8. (a) |
| 9. (b) | 10. (d) | 11. (c) | 12. (b) | 13. (d) | 14. (b) | 15. (d) | 16. (d) |
| 17. (a) | 18. (a) | 19. (c) | 20. (d) | 21. (c) | 22. (c) | 23. (c) | 24. (b) |
| 25. (d) | 26. (b) | 27. (a) | 28. (c) | 29. (b) | 30. (a) | 31. (a) | 32. (a) |
| 33. (c) | 34. (c) | 35. (d) | 36. (c) | 37. (b) | 38. (d) | 39. (d) | 40. (d) |
| 41. (b) | 42. (b) | 43. (a) | 44. (b) | 45. (d) | 46. (a) | 47. (d) | 48. (d) |
| 49. (b) | 50. (b) | 51. (d) | 52. (c) | 53. (a) | 54. (c) | 55. (d) | 56. (a) |
| 57. (c) | 58. (c) | 59. (c) | 60. (d) | 61. (a) | 62. (c) | 63. (c) | 64. (c) |
| 65. (b) | 66. (c) | 67. (b) | 68. (b) | 69. (c) | 70. (d) | 71. (a) | 72. (b) |
| 73. (b) | 74. (a) | 75. (c) | 76. (c) | 77. (c) | 78. (d) | 79. (a) | 80. (d) |
| 81. (b) | 82. (d) | 83. (a) | 84. (c) | 85. (b) | 86. (a) | 87. (a) | 88. (b) |
| 89. (c) | 90. (b) | 91. (a) | 92. (d) | 93. (d) | 94. (a) | 95. (c) | 96. (b) |
| 97. (d) | 98. (b) | 99. (b) | | | | | |

Fill in the Blanks

- Oil, _____ and _____ are three basic natural resources.
- Natural resources are derived from _____.
- The fuel derived from living organisms or their metabolic byproducts is called _____.
- A mixture of gasoline and ethanol is called _____.
- The energy derived from heat of the earth is called _____ energy.
- There are _____ active volcanoes on the earth.
- Fishes account for _____ of the total human consumption of protein.
- Soil is a _____ source.
- Mineral resources are _____.
- In India, per capita forest available is _____.
- The grassland areas are overgrazed in _____ and _____.
- Forests have three broad functions, viz., _____, _____ and _____.
- The world's oil deposits are found mainly around the _____.
- Windmills convert wind energy into _____ energy.
- On the whole, humans use _____ of the primary productivity.
- Sahara desert in West Africa expands southwards at the rate of _____ a year.
- Forests contain _____ of the terrestrial biomass.
- Biogas contains _____ methane.
- Saltwater wetlands are of two types, viz., _____ and _____.

128 Ecology and Animal Behaviour

20. Natural resources which are reproduced easily are called _____ resources.
21. Nuclear power is a _____ resource.
22. The _____ cell converts sunlight directly into electricity.
23. At present the main energy sources used by Indian population are _____ sources of energy.
24. India has a total water surface area of _____.
25. _____ is a hard and black form of coal.
26. _____ is a soft and brown material which is made up of partly decayed plant.
27. _____ is a soft and brown form of coal.
28. _____ is a fluid having 85 per cent ethanol and 15 per cent gasoline.
29. About _____ water on the earth is saltwater.
30. Freshwater is a _____ resource.
31. _____ of world's water is used for household purposes.
32. _____ is a process by which saline water is converted into freshwater.
33. Surface water is naturally replenished by the _____.
34. The sum total of degraded land is about _____ of the earth's vegetated surface.
35. India is predominantly rich in _____ resources.
36. _____ never changes and is consistent as the setting sun.
37. Flax is also known as _____.
38. The process that leads to the formation of deserts is called _____.
39. Deforestation causes global warming by releasing stored _____ into the atmosphere as _____.
40. About _____ of marine fisheries are overexploited.
41. _____ has become the world's wettest desert.
42. A major portion of energy in India is generated from _____.
43. The growing of plants from which alcohol can be obtained is known as _____.
44. _____ is the oldest coal deposit.
45. Tropical deforestation accounts for about _____ of global anthropogenic greenhouse gas emission.
46. It is estimated that India has around _____ billion tons of coal reserves.
47. Plantation of trees in short blocks are referred to as _____.
48. _____ greatly affects budget of greenhouse gases.
49. _____ is extensive plantation of trees.
50. Biogas contains _____, _____, _____ and _____.
51. Plant's evapotranspiration is about _____ kg water per kg of biomass production.

Answers to Fill in the Blanks

- | | | |
|----------------------|---------------------------|--|
| 1. Water, vegetation | 2. Environment | 3. Biofuel |
| 4. Gasohol | 5. Geothermal | 6. 600 |
| 7. 19 per cent | 8. Renewable | 9. Nonrenewable |
| 10. 0.06 ha | 11. Southern Asia, Africa | 12. Productive, regulative, protective |

- | | | |
|--------------------------|---|------------------------------|
| 13. Persian Gulf | 14. Mechanical | 15. 8 per cent |
| 16. 10 km | 17. 90 per cent | 18. 50 to 70 per cent |
| 19. Estuaries, mangroves | 20. Renewable | 21. Nonrenewable |
| 22. Photovoltaic | 23. Nonrenewable | 24. 3,14,400 km ² |
| 25. Anthracite | 26. Peat | 27. Igneous |
| 28. E85 | 29. 97 per cent | 30. Renewable |
| 31. 15 per cent | 32. Desalination | 33. Precipitation |
| 34. 43 per cent | 35. Iron | 36. Tides |
| 37. Linen | 38. Desertification | 39. Carbon, carbon dioxide |
| 40. 22 per cent | 41. Cherrapunji | 42. Coal |
| 43. Energy cropping | 44. Anthracite | 45. 20 to 29 per cent |
| 46. 120 | 47. Wind breaks | 48. Forests |
| 49. Shelter belts | 50. Methane, carbon dioxide, hydrogen, nitrogen | |
| 51. 530 | | |

True or False

1. India is rich in nonferric minerals.
2. India possesses one-fourth of the world's iron resources.
3. Gold, silver and copper occur in pure state.
4. Water is considered as a renewable resource.
5. Destruction of biopotential of land results in desertification.
6. Soil is a nonrenewable source.
7. Overgrazing causes deforestation.
8. Rate of infiltration is inversely related to grazing intensity.
9. Short jhoom cycles cause rapid growth of *Parthenium*.
10. The main natural resources of India are iron ore, bauxite and copper.
11. Heavily grazed areas have low runoff rates.
12. In overgrazed areas, the amount of water-storing capacity of the soil declines.
13. Burrowing animals lead to soil erosion.
14. Energy can be produced from urban garbage.
15. Carrageen is a brown alga and is rich in vitamins.
16. Cow dung is used in biogas plants to produce odourless, high-pressure gas.
17. Overhunting causes loss of soil fertility.
18. Ocean waves cause soil erosion.
19. Mulch decreases moisture content of the soil.
20. Nuclear energy is a source of energy which does not evolve CO₂.
21. Sedimentary rocks are the richest source of fossils.
22. Terracing is the most effective method of soil conservation in hilly areas.
23. Uranium is a fossil fuel.

130 Ecology and Animal Behaviour

24. Petroleum products are energy-rich components of carbon that have undergone aerobic degradation.
25. Zambia and Zaire produce about two third of the world's cobalt.
26. Coal and petroleum cannot be recycled.
27. Agriculture is a man-made resource.
28. India is rich in uranium.
29. Recycling is easy when products are made up of more than one mineral.
30. Windbreaks can reduce water erosion on cultivated lands.
31. In the US, 50 per cent of the land is affected by desertification.
32. Geothermal energy is abundant.
33. Air and solar energy are international sources of energy.
34. Guano is rich in phosphate and sulphur.
35. Generally, satellites are stationed in the thermosphere.
36. Contour ploughing cannot check soil erosion by water.
37. Chipko movement was started in 1973.
38. Maximum bamboo is used in the paper industry.
39. In India, 12 types of forests are found.
40. Bamboo is known as poor man's timber.
41. Largest amount of freshwater is found in polar ice and glaciers.
42. In India, *jhoom* is practiced in the northeastern states.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|
| 1. False | 2. True | 3. True | 4. True | 5. True | 6. False | 7. True | 8. False |
| 9. True | 10. True | 11. False | 12. True | 13. True | 14. True | 15. False | 16. False |
| 17. True | 18. True | 19. False | 20. True | 21. True | 22. True | 23. False | 24. False |
| 25. True | 26. True | 27. True | 28. True | 29. False | 30. True | 31. False | 32. False |
| 33. True | 34. False | 35. True | 36. False | 37. True | 38. True | 39. False | 40. True |
| 41. True | 42. True | 43. False | 44. True | 45. False | 46. True | 47. True | 48. True |
| 49. False | | | | | | | |

Give Reasons

1. Nonrenewable resources have high carbon content.
 - Because of their origin from photosynthetic activity of plants millions of years ago.
2. Minerals are often called nonrenewable resources.
 - Because new materials can be extracted from the earth's crust only once.
3. About 60 per cent of the world's biggest rivers have been fragmented.
 - Mainly because of construction of dams as well as canalisation, which has adverse effects on entire freshwater systems.

4. Erosion affects fertility of the soil.
 - Because it reduces:
 - (a) Water-holding capacity of the soil
 - (b) Soil water storage
 - (c) Soil nutrients
 - (d) Soil organic matter
 - (e) Water infiltration rates
5. Petroleum is a nonrenewable source.
 - Because it takes too long to make as compared to the rapid use.
6. Hill ranges have tremendous potential to develop horticulture.
 - Because of undulating topography and climatic conditions.
7. Renewable sources are also called inexhaustible sources.
 - Because they can be managed properly and renewed.
8. Wind energy cannot be used in all regions and days daily.
 - Because wind does not blow regularly with required intensity throughout the year in all the regions.
9. The earth is called a water planet.
 - Because 70 per cent of the earth is covered with water.
10. Life of Indian dams is becoming short.
 - Because of a greater sedimentation rate in comparison to reduction rate.
11. Land degradation should be checked.
 - Because of the following reasons:
 - (a) To produce more food biomass.
 - (b) To preserve biodiversity.
 - (c) For proper biogeochemical cycle.
 - (d) To regulate greenhouse gas influxes.
 - (e) For the maintenance of economic growth and social structure.
12. Native plants are best for preventing soil erosion.
 - Because they are well adapted to local climatic conditions.
13. Grasses are at the top for erosion control.
 - Because of the presence of spreading mat-like roots that hold the soil very well.
14. Removal of vegetation causes soil erosion.
 - Because removal of vegetation exposes the top soil which is removed by water and air.

BIODIVERSITY

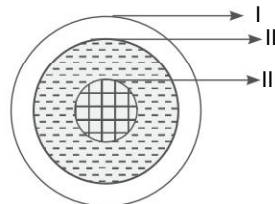
Multiple-Choice Questions

1. Biological diversity includes:
(a) Ecological diversity (b) Genetic diversity
(c) Species diversity (d) All
2. Biodiversity reflects:
(a) Number of living organisms (b) Variety of living organisms
(c) Variability of living organisms (d) All
3. Consider the following statements:
(A) Biodiversity is the contraction of the term 'biological diversity'
(B) Biodiversity is evenly distributed on the earth
(C) Biodiversity includes all organisms, from microscopic bacteria to complex plants and animals
(D) Biodiversity is not important in ecosystems managed by humans
The correct statements are:
(a) All (b) A and C (c) A and D (d) B and D
4. Flora and fauna diversity depends on:
(a) Climate (b) Altitude
(c) Soils and the presence of other species (d) All
5. Which one of the following is used to describe species level biodiversity?
(a) Simpson index (b) Shannon index (c) Species richness (d) All
6. The geological history of biological diversity is about _____ years old:
(a) 2 millions (b) 4 millions (c) 3.5 to 4 billion (d) 6 to 8 billion
7. During which one of the following periods was the highest biodiversity observed?
(a) Permian (b) Devonian
(c) Late Tertiary and early Quaternary (d) Quaternary
8. Which one of the following is a common currency for the study of biodiversity?
(a) Population (b) Individual (c) Genus (d) Species
9. Which one of the following diversity index is commonly used in ecological studies?
(a) Shannon index (b) Simpson index (c) Species richness (d) All
10. In which one of the following hot spots are the highest number of endemic plants and animals found?
(a) Polynesia (b) Tropical Andes (c) Caribbean (d) Wallacea
11. Which one of the following is an incorrect match?
(A) Productive hypothesis – Connell and Orias (1964)
(B) Evolutionary time hypothesis – Fisher (1960)
(C) Climate stability hypothesis – Schmidt–Nielsen (1964)
(D) Spatial heterogeneity hypothesis – Simposon (1964)

12. International Polar Year is applicable to:
 - (a) 2005
 - (b) 2007
 - (c) 2009
 - (d) 2010
13. Day for Biological Diversity is:
 - (a) 22nd May
 - (b) 30th June
 - (c) 5th July
 - (d) 10th October
14. New species are being discovered at a faster rate due to efforts of the project under:
 - (a) The United Nations Environmental Programme
 - (b) The World Conservation Monitoring Centre
 - (c) The World Conservation Union
 - (d) All
15. The number of genes in *Oryza sativa* is:
 - (a) 450 to 1,000
 - (b) 15,000
 - (c) 32,000 to 50,000
 - (d) 35,000 to 60,000
16. It has been estimated that for every 100 cm increase in rainfall _____ tree species are added:
 - (a) 15
 - (b) 30
 - (c) 50
 - (d) 75
17. Climate change is forcing living organisms and ecosystems to adapt by:
 - (a) Shifting habitat
 - (b) Changing life cycles
 - (c) Development of new traits
 - (d) All
18. The specific direct driver affecting biodiversity is:
 - (a) Pollution
 - (b) Habitat change
 - (c) Overexploitation and invasive alien species
 - (d) All
19. Insects constitute about _____ of the total number of species:
 - (a) 50 per cent
 - (b) 61 per cent
 - (c) 70 per cent
 - (d) 75 per cent
20. Out of the total number of insect species known about _____ species are of beetles:
 - (a) 35 per cent
 - (b) 40 per cent
 - (c) 50 per cent
 - (d) 62 per cent
21. The predicted number of species varies between:
 - (a) 3 to 5 million
 - (b) 5 to 10 million
 - (c) 5 to 30 million
 - (d) 20 to 40 million
22. To date, the number of biosphere reserves in the world is:
 - (a) 450
 - (b) 553
 - (c) 650
 - (d) 720
23. In a biosphere reserve, which one of the following provides long-term legal protection to the natural environment?
 - (a) Core area
 - (b) Buffer zone
 - (c) Transition zone
 - (d) All
24. Generally, the core area of a biosphere reserve is not subjected to human activity, except:
 - (a) Monitoring
 - (b) Research
 - (c) Traditional extractive uses by local communities
 - (d) All
25. Which one of the following zones of a biosphere reserve is related with agricultural activities and human settlements?
 - (a) Transition zone
 - (b) Buffer zone
 - (c) Core area
 - (d) None
26. The number of biosphere reserves in India is:
 - (a) 10
 - (b) 15
 - (c) 17
 - (d) 25
27. Out of 15 biosphere reserves in India, _____ are a part of the world network of biosphere reserves:
 - (a) 3
 - (b) 5
 - (c) 7
 - (d) 9
28. Species richness of the area is applicable to:
 - (a) α diversity
 - (b) β diversity
 - (c) γ diversity
 - (d) None
29. α diversity can be measured by counting:
 - (a) Genera
 - (b) Species

134 Ecology and Animal Behaviour

- (c) Families (d) Families genera and species
30. The diversity between taxa is known as:
 (a) γ -diversity (b) ω -diversity (c) β -diversity (d) Global diversity
31. The threatened species found in the Agasthiayamalai Biosphere Reserve are:
 (a) Lion-tailed macaque, slender loris and great pied hornbill
 (b) Rudraksh tree, black plums, wild dahman and gaub tree
 (c) Slender loris, lion-tailed macaque, black plums rudraksh tree and green pit viper
 (d) Both (a) and (b)
32. The first marine biosphere reserve established in India in:
 (a) Sunderbans Biosphere Reserve (b) Similipal Biosphere Reserve
 (c) Gulf of Mannar Biosphere Reserve (d) Great Nicobar Biosphere Reserve
33. Which one of the following about Khangchendzonga Biosphere Reserve is incorrect?
 (a) Located in Sikkim (b) One of the high altitudes reserve
 (c) Tibetan sheep, musk deer, snow partridge and monal pheasant are endemic fauna (d) None
34. Which one of the following is applicable to species columned in the Red Data book?
 (a) Endangered (b) Threatened (c) Vulnerable (d) All
35. Western Ghats possess a very large number of endemic:
 (a) Amphibian species (b) Reptilian species (c) Avian species (d) Mammalian species
36. Which one of the following is the largest biogeographic region of India?
 (a) Himalayas (b) Western Ghats (c) Deccan Peninsula (d) Gangetic plain
37. Which one of the following is an exotic species?
 (a) *Eichhornia crassipes* (b) *Lantana camara*
 (c) *Eupatorium odoratum* (d) All
38. Keoladeo Ghana National Park is located in:
 (a) Rajasthan (b) Assam (c) Gujarat (d) Uttaranchal
39. The Western Ghats region has important population of:
 (a) Indian tigers (b) Endangered lion-tailed macaque
 (c) Asian elephants (d) All
40. Which one of the following is critically endangered?
 (a) Sumatran rhinoceros (b) Indian rhinoceros
 (c) Red panda (d) Wild yak
41. Which one of the following is an incorrect answer?
 (a) Chilika lake – Orissa (b) Surinsar-Mansar lake – Kerala
 (c) Renuka wetland – Himachal Pradesh (d) Harike lake – Punjab
42. In the figure showing zonation of terrestrial Biosphere Reserves, which one of the following labelled parts is undisturbed and legally protected?
 (a) I
 (b) II
 (c) III
 (d) All



43. In the above figure, which one of the following labelled parts is an area of active cooperation between reserve management and the local people?
 (a) I (b) II (c) III (d) II and III
44. Which one of the following comprises the highest area?
 (a) Kachch Biosphere Reserve (b) Pachmarhi Biosphere Reserve
 (c) Nilgiri Biosphere Reserve (d) Sunderbans Biosphere Reserve
45. The International Union for Conservation of Nature (IUCN) was founded in:
 (a) 1940 (b) 1948 (c) 1965 (d) 1970
46. The idea of Biosphere Reserves was initiated by UNESCO in:
 (a) 1974 (b) 1980 (c) 1988 (d) 1990
47. Which one of the following is applicable to Helena olive (*Nesiota elliptica*)?
 (a) Monotypic (b) Endemic to Saint Helena
 (c) Became extinct in the wild (d) All
48. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|--|----------------|
| (A) International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) | 1. Mexico |
| (B) International Rice Research Institute (IRRI) | 2. India |
| (C) International Centre for Tropical Agriculture | 3. Philippines |
| (D) International Maize and Wheat Improvement Centre (CIMMYT) | 4. Colombia |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 4 | 2 | 1 |
| (b) | 2 | 3 | 4 | 1 |
| (c) | 4 | 3 | 2 | 1 |
| (d) | 2 | 4 | 1 | 3 |
49. Red coloured species are applicable to:
 (a) Threatened species (b) Keystone species
 (c) Flagship species (d) Exotic invasive species
50. A biodiversity hot spot is a region with a high level of:
 (a) Endemic species (b) Rare species (c) Threatened species (d) All
51. Loss of forests may cause:
 (a) Mass erosion (b) Mass flooding
 (c) Loss of oxygen in atmosphere (d) All
52. Which one of the following mega diverse countries has the highest number of vascular plant species?
 (a) Australia (b) Brazil (c) South Africa (d) Madagascar
53. Which one of the following mega diverse countries has the highest-level endemism for nonfish vertebrates?
 (a) Australia (b) India (c) Indonesia (d) Philippines
54. The world's largest financier of biodiversity is:
 (a) UNESCO (b) World Bank (c) WHO (d) IUCN
55. Which one of the following is an example of fragmented habitats?
 (a) Plantation (b) Orchard
 (c) A forest patch surrounded by croplands (d) All

136 Ecology and Animal Behaviour

56. A biosphere reserve lacks:
 (a) Transition zone (b) Buffer zone (c) Tidal zone (d) Core zone
57. Most of the terrestrial diversity is found in:
 (a) Tropical grasslands (b) Tropical forests
 (c) Tundra (d) Moist tropical forests
58. About 80 per cent of our food supply comes from only _____ kinds of plants:
 (a) 5 (b) 15 (c) 20 (d) 30
59. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Bioassay organism	1. <i>Vespula germanica</i>
(B) Accumulator species	2. Palm tree
(C) Keystone species	3. Woodlice
(D) Exotic species	4. Trout

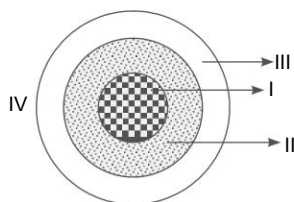
 Answer codes:

A	B	C	D
(a) 2	4	1	3
(b) 3	1	4	2
(c) 4	3	2	1
(d) 3	2	4	1
60. The concept of biosphere reserves was launched in:
 (a) 1970 (b) 1975 (c) 1980 (d) 1985
61. Among 25 hot spots of the world, _____ are found in India:
 (a) 2 (b) 3 (c) 4 (d) 6
62. The first national park established in India:
 (a) Kaziranga National Park (b) Jim Corbett National Park
 (c) Sunderbans National Park (d) Nanda Devi National Park
63. Which one of the following is a vulnerable animal species?
 (a) *Elephas maximus* (b) *Sus salvanius* (c) *Equus hemionus* (d) *Macaca silenus*
64. As per notification of the Ministry of Environment and Forests, there are _____ biosphere reserves in India:
 (a) 10 (b) 12 (c) 14 (d) 20
65. Consider the following points about a biosphere reserve:
 (A) It is the largest contiguous mangrove area
 (B) Tropical semi-evergreen forests
 (C) Agrosystems, silviculture, pisciculture and prawn culture
 (D) The largest mangal diversity in the world and its core area has been designated as a world heritage site
 This biosphere reserve is:
 (a) Nilgiri Biosphere Reserve (b) Gulf of Mannar Biosphere Reserve
 (c) Sunderbans Biosphere Reserve (d) Nanda Devi Biosphere Reserve
66. Project Tiger was started in the year:
 (a) 1973 (b) 1975 (c) 1980 (d) 1985
67. Which one of the following activities is allowed in national parks?
 (a) Forestry (b) Grazing (c) Habitat manipulation (d) None

68. Which one of the following is the world largest organisation, devoted mainly to the conservation and use of agricultural biodiversity?
 - (a) International Centre for Tropical Research, Colombia
 - (b) International Crops Research Institute for the Semi-Arid Tropics, India
 - (c) International Plant Genetic Research Institute Rome (Italy)
 - (d) International Centre for Agricultural Research in the Dry Areas, Syria
69. Which one of the following is associated with the decline of oriental white-backed vultures?
 - (a) Arsenic
 - (b) Diclofenac
 - (c) BHC
 - (d) Malathion
70. Which one of the following about protection from fishing is incorrect?
 - (a) Increase in biomass
 - (b) Increase in species diversity
 - (c) Increase in average size of the exploited organism
 - (d) None
71. Biodiversity is the source of:
 - (a) Food
 - (b) Fibers, rubber and timber
 - (c) Medicines and pharmaceutical drugs
 - (d) All
72. Norkek Biosphere Reserve is located in which one of the following biogeographical regions?
 - (a) Deccan peninsular
 - (b) Northeast Himalayas
 - (c) Western Ghats
 - (d) Coastal
73. *Claris gariepinus* is:
 - (a) An endemic species
 - (b) An exotic species
 - (c) A threatened species
 - (d) An endangered species
74. Rice, maize, wheat and potatoes provide about _____ of the human dietary energy:
 - (a) 40 per cent
 - (b) 50 per cent
 - (c) 60 per cent
 - (d) 80 per cent
75. Which one of the following is an area closed to all types of fishing?
 - (a) Great Barrier Marine Park in Australia
 - (b) Burmuda
 - (c) Belize
 - (d) All
76. The first national park was established in USA in the year:
 - (a) 1770
 - (b) 1820
 - (c) 1872
 - (d) 1910
77. Giant panda is the symbol of:
 - (a) China
 - (b) USA
 - (c) France
 - (d) Japan
78. To date, the total number of biosphere reserves in the world is _____ in _____ countries:
 - (a) 450, 50
 - (b) 500, 75
 - (c) 553, 107
 - (d) 580, 110
79. Biosphere reserve is related to:
 - (a) Conservation
 - (b) Sustainable development
 - (c) Logistic support
 - (d) All
80. The single most important factor threatening biodiversity is the:
 - (a) Change in land-use patterns
 - (b) Habit degradation loss due to human activities
 - (c) Global climate change
 - (d) Introduction of exotic species.
81. Ex-situ conservation includes:
 - (a) Tissue culture
 - (b) In vitro fertilisation
 - (c) Cryopreservation of gametes
 - (d) All
82. The Indian ruler who first established wildlife sanctuaries:
 - (a) Asoka
 - (b) Akbar
 - (c) Maurya
 - (d) Chauhan

138 Ecology and Animal Behaviour

83. The group comprising the highest number of endangered species:
 (a) Mammals (b) Reptiles (c) Aves (d) Fishes
84. Red panda is:
 (a) Critically endangered species (b) Extinct species
 (c) Endangered species (d) Vulnerable species
85. In-situ conservation is not applicable to:
 (a) Botanical gardens (b) Biosphere reserves (c) National parks (d) Sanctuaries
86. Identify the nonhuman activity zone in the given figure:



- (a) I
 (b) II
 (c) III
 (d) IV
87. In which year was the Biodiversity Act of India passed?
 (a) 1990 (b) 1995 (c) 2002 (d) 2006
88. Which one of the following is a vulnerable species?
 (a) Spotted deer (b) Asiatic wild ass (c) Black buck (d) All
89. Yak research centre is located in:
 (a) Sikkim (b) Assam
 (c) Arunachal Pradesh (d) Jammu and Kashmir
90. As per IUCN Red Column Criteria, about _____ are now columned as threatened species with extinction:
 (a) 25 per cent (b) 30 per cent (c) 40 per cent (d) 45 per cent
91. The exotic organisms are:
 (a) Predators (b) Parasites (c) Aggressive (d) All
92. Consider the following statements:
 (A) India has 8 percent of the world's biodiversity
 (B) India is one of the 12 mega diversity hot spots of the world
 (C) There are 167 crop species and over 350 wild relatives
 (D) Forests are the largest repository of biodiversity
 The incorrect statements are:
 (a) None (b) A and B (c) C and D (d) A and C
93. United Nations on the Law of the Sea was adopted in:
 (a) 1990 (b) 1995 (c) 2000 (d) 2005
94. A biodiversity hot spot (as per Myers 1000 edition of the hot spot map) must have at least:
 (a) 0.5 per cent species of vascular plants as endemic
 (b) Lost 70 per cent of its primary vegetation
 (c) Both (a) and (b)
 (d) 1 per cent species of vascular plants and has lost 50 per cent of its primary vegetation
95. Which one of the following countries hosts the world largest turtle nesting ground (arribada)?
 (a) China (Peking) (b) Japan (Tokyo) (c) India (Orissa) (d) Australia (Sydney)

96. Which one of the following about Western Ghats of South India is incorrect?
 (a) Rainmaker and biodiversity hot spot (b) Highest rate of endemism in all of India
 (c) Crucial for water regulation (d) None
97. Which one of the following is an invasive weed?
 (a) *Ageratum conyzoides* (b) *Galinsoga parviflora*
 (c) *Eupatorium odoratum* (d) All
98. The internal relationship between α - β - and γ - diversity can be shown as:
 (a) $\beta = \gamma / \alpha$ (b) $\gamma = \beta \times \alpha$ (c) $\alpha = \gamma \times \beta$ (d) $\gamma = \beta + \alpha$
99. Which one of the following is a correct equation for β -diversity?
 (a) $\beta = (S_1 - (c) \times (S_2 - (c)$ (b) $\beta = (S_1 - (c) + (S_2 - (c)$
 (c) $\beta = (S_1 - (c) - (S_2 - (c)$ (d) $\beta = (S_1 - (c) / (S_2 - (c)$
100. The Sorensen index is a very simple measure of:
 (a) α -diversity (b) β -diversity (c) γ -diversity (d) None
101. The total number of species that are unique between communities represent:
 (a) Point diversity (b) α -diversity (c) β -diversity (d) γ -diversity
102. The change in diversity as we sample large landscapes along major climatic or other physical gradients represents:
 (a) Δ -diversity (b) ε -diversity (c) γ -diversity (d) β -diversity
103. Comparison of diversity indices between different ecosystems or bioms represents:
 (a) γ -diversity (b) β -diversity (c) α -diversity (d) ε -diversity
104. Which one of the following is a component of biodiversity?
 (a) Genetic diversity (b) Species diversity
 (c) Community and landscape diversities (d) All
105. Which one of the following about diversity index is incorrect?
 (a) Some overall measure of diversity
 (b) Generally combines aspects of richness and evenness
 (c) Shannon index is the most commonly used diversity index
 (d) None
106. Species richness is negatively related to:
 (a) Environmental variability (b) Area
 (c) Latitude and altitude (d) None
107. Species richness is positively related to:
 (a) Latitude (b) Latitude and altitude
 (c) Area and environmental variability (d) All
108. Higher species richness is expected:
 (a) If a region is surrounded by different habitats (b) If there is more environmental variability
 (c) Regions with intermediate level of disturbance (d) All
109. No two species can coexist indefinitely on the same limited resource. This is known as:
 (a) Gause's principle (b) Gause's law
 (c) Competition exclusion principle (d) All
110. Species richness shows complex relationship with:
 (a) Nutrients and productivity (b) Production rate
 (c) Time since disturbance (d) All

140 Ecology and Animal Behaviour

111. Which one of the following is a sacred plant and is worshipped by the people?
 (a) *Ficus religiosa* (b) *Prosopis cineraria* (c) *Ocimum sanctum* (d) All
112. Reef fish diversity is less in ocean water:
 (a) Surrounding Polynesia (b) Caribbean islands
 (c) Portion of Indian Ocean (d) All
113. The 2008 IUCN Red Column was released on:
 (a) 6th January 2008 (b) 30th May 2008 (c) 6th October 2008 (d) 6th December 2008
114. Critically endangered refers to a 50 per cent probability of extinction in:
 (a) 6 months (b) 1 year (c) 5 years (d) 7 years
115. Vulnerable species has 10 per cent probability of extinction in:
 (a) 10 years (b) 25 years (c) 50 years (d) 100 years
116. Which one of the following is applicable to rare species?
 (a) Endangered (b) Vulnerable
 (c) Small world populations (d) Small world populations and endangered or vulnerable
117. Threatened species are:
 (a) Prone to extinction (b) Genetically impoverished
 (c) Rare species and of direct human value (d) All
118. The World Conservation Union was founded in:
 (a) 1940 (b) 1948 (c) 1960 (d) 1970
119. The Ramsar Convention came into force in:
 (a) 1975 (b) 1980 (c) 1985 (d) 1990
120. The uropeltidae snake family is only found in:
 (a) Western Ghats (b) Eastern Himalayas
 (c) Sri Lanka (d) Western Ghats and Sri Lanka
121. The only salamander species found within Indian limits is:
 (a) *Andrias japonicus* (b) *Tylototriton venucosus*
 (c) *Salamandra salamandra* (d) *Plethodon cinereus*
122. Which one of the following is extinct?
 (a) Asiatic cheetah (b) Himalayan quail (c) Pink-headed duck (d) All
123. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) World Conservation Day	1. 3rd December
(B) World Habitat Day	2. 21st March
(C) World Forest Day	3. 4th October
(D) World Water Day	4. 22nd March

Answer codes:

A	B	C	D
(a) 4	3	1	2
(b) 2	1	4	3
(c) 1	3	2	4
(d) 3	1	4	2
124. Which one of the following is not an invasive alien species?
 (a) *Bufo marinus* (b) *Lymantria dispar*

- (c) *Clarius batrachus* (d) *Ascaris megalocephala*
125. Which one of the following is the predominant alien species in marine and coastal areas?
 (a) Algae (b) Crustaceans (c) Molluscs (d) All
126. The Tura Range in Garo Hills of Meghalaya is a:
 (a) Wildlife sanctuary
 (b) Gene sanctuary for conserving rich diversity of wild citrus and musa species
 (c) Gene sanctuary for conserving rich diversity of potatoes
 (d) Gene sanctuary for conserving rich diversity of paddy
127. Which one of the following is a world heritage site?
 (a) Sunderbans National Park (b) Kaziranga National Park
 (c) Ghana National Park (d) All
128. Consider the following statements:
 (A) Ex-situ conservation of biodiversity restores degraded habitats within and outside parks
 (B) *Magnolia* and *Betula* plants are endemic to Western Ghats
 (C) Nilgiri Biosphere Reserve lacks tropical deciduous forests
 (D) Biodiversity cannot be measured at higher level of taxa
- The correct statements are:
 (a) All (b) A, B and C (c) B and D (d) None

Answers to Multiple-Choice Questions

- | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. (d) | 2. (d) | 3. (b) | 4. (d) | 5. (d) | 6. (c) | 7. (c) | 8. (d) |
| 9. (a) | 10. (b) | 11. (c) | 12. (b) | 13. (a) | 14. (d) | 15. (c) | 16. (c) |
| 17. (d) | 18. (d) | 19. (b) | 20. (d) | 21. (c) | 22. (b) | 23. (a) | 24. (d) |
| 25. (a) | 26. (b) | 27. (c) | 28. (a) | 29. (d) | 30. (b) | 31. (d) | 32. (c) |
| 33. (d) | 34. (d) | 35. (a) | 36. (c) | 37. (d) | 38. (a) | 39. (d) | 40. (a) |
| 41. (b) | 42. (c) | 43. (a) | 44. (a) | 45. (b) | 46. (a) | 47. (d) | 48. (b) |
| 49. (a) | 50. (d) | 51. (d) | 52. (b) | 53. (a) | 54. (b) | 55. (d) | 56. (c) |
| 57. (b) | 58. (c) | 59. (c) | 60. (b) | 61. (a) | 62. (b) | 63. (c) | 64. (c) |
| 65. (c) | 66. (a) | 67. (d) | 68. (c) | 69. (b) | 70. (d) | 71. (d) | 72. (c) |
| 73. (b) | 74. (c) | 75. (d) | 76. (c) | 77. (a) | 78. (c) | 79. (d) | 80. (b) |
| 81. (d) | 82. (a) | 83. (a) | 84. (c) | 85. (a) | 86. (a) | 87. (c) | 88. (d) |
| 89. (c) | 90. (c) | 91. (d) | 92. (a) | 93. (b) | 94. (c) | 95. (c) | 96. (d) |
| 97. (d) | 98. (a) | 99. (b) | 100. (b) | 101. (c) | 102. (a) | 103. (a) | 104. (d) |
| 105. (d) | 106. (c) | 107. (c) | 108. (d) | 109. (d) | 110. (d) | 111. (d) | 112. (d) |
| 113. (c) | 114. (c) | 115. (d) | 116. (c) | 117. (d) | 118. (b) | 119. (a) | 120. (d) |
| 121. (b) | 122. (d) | 123. (c) | 124. (d) | 125. (d) | 126. (b) | 127. (d) | 128. (d) |

Fill in the Blanks

- The biological diversity _____ as we move from high to low altitudes.
- Biodiversity reflects totality of _____, _____ and _____ of a region.

3. The term 'biodiversity' was coined by _____.
4. _____ is the variation of genes within species.
5. _____ is the number of species in a given area.
6. Convention on Biodiversity became applicable after the Earth Summit of _____.
7. MAB Programme of UNESCO was started in _____.
8. _____ is the study of the timing of natural events.
9. The overall natural extinction rate from fossil data was estimated to be _____ per species per year.
10. The formation of new species occurs mainly due to _____.
11. Any natural or human induced factor that directly or indirectly causes a change in an ecosystem is called _____.
12. Biodiversity change is caused by a range of _____.
13. The major direct anthropogenic force affecting the structure and function of the oceans is the _____.
14. The IUCN Red Column System was initiated in _____.
15. Most hot spots are located in the tropics and most of them are _____.
16. Biodiversity increases with increase in _____ layering of the vegetation.
17. The term 'hot spots' was coined by _____.
18. Myers et al. (2000) have identified _____ terrestrial biodiversity hot spots.
19. The world conservation union has recognised _____ Red Column categories of species
20. Tropical forests covers only _____ per cent of the earth's surface and contain more than _____ per cent of the world's species.
21. The assessment of biodiversity is done both at _____ and _____ scales.
22. Number of biogeographical regions in India is _____.
23. The World Conservation Union was founded in _____.
24. The _____ of the biosphere reserves must be reserved for conservation purposes.
25. _____ diversity is the change in species as we move from one habitat to another.
26. Whittaker (1972) describes _____, _____ and _____ diversity for measuring biodiversity.
27. _____ diversity is a measure of the overall diversity within a large region.
28. The Red Column Index is based on the _____ of threatened species.
29. The diversity of phytoplankton is essential for maintaining _____ in the atmosphere.
30. Article _____ of the Convention on Biodiversity (CBD) deals with ex-situ conservation.
31. A species restricted to a particular area is called _____ species.
32. The Royal Bengal Tiger is preserved in _____ park.
33. A biosphere reserve is an international conservation designation given by _____.
34. Extremely rich biodiversity is referred to as _____.
35. _____ and _____ are two important hot spots of India.
36. Project elephant was started in _____.
37. Red data book is a record which includes names of _____ species.
38. Gir lion project is located in _____ state.

39. _____ is the Asia's largest brackish water lake.
40. About _____ of the known amphibian species and _____ lizards are endemic to India.
41. There are _____ threatened species of mammals in India.
42. _____ and _____ are two strategies for the conservation of biodiversity.
43. _____ is the outermost part of a biosphere reserve.

Answers to Fill in the Blanks

- | | | |
|------------------------------|--------------------------------------|--------------------------|
| 1. Increases | 2. Genes, species and ecosystems | 3. Walter Rosen (1986) |
| 4. Genetic diversity | 5. Species richness | 6. Rio de Janeiro (1992) |
| 7. 1971 | 8. Phenology | 9. 10^{-7} |
| 10. Cladogenesis | 11. Driver | 12. Drivers |
| 13. Fishing | 14. 1963 | 15. Forests |
| 16. Vertical | 17. Myers (1988) | 18. 25 |
| 19. Nine | 20. 7, 70 | 21. Spatial, temporal |
| 22. 10 | 23. 1948 | 24. Core area |
| 25. Beta | 26. Alpha, beta, gamma | 27. γ |
| 28. IUCN Red column | 29. CO ₂ | 30. Nine |
| 31. Endemic | 32. Sunderbans | 33. UNESCO |
| 34. Hotspot | 35. Western Ghats, Eastern Himalayas | 36. 1991 |
| 37. Threatened | 38. Gujarat | 39. Chilka lake |
| 40. 62 per cent, 50 per cent | 41. 86 | 42. Ex-situ, in-situ |
| 43. Transition zone | | |

True or False

1. Biodiversity is richer in tropics.
2. Polar regions have fewer biodiversity.
3. Biodiversity declines from the equator to the poles.
4. Community consists of species of equal abundance.
5. The region poorer in species diversity may be richer in phyla level diversity.
6. 2004 is the second worst year for coral bleaching after 1998.
7. If the current rate of loss continues, the earth may lose up to 50 per cent of the species by the end of the 21st century.
8. Marine algae are source of polysaccharides.
9. Normally, the core area of a biosphere reserve is not subjected to human activity, except research and monitoring.
10. Biosphere reserves' designation alters the legal status of the land included within it.
11. Ex-situ conservation is also known as off-site conservation.
12. At present, freshwater ecosystems are the most threatened.

144 Ecology and Animal Behaviour

13. Extinction of species decreases the stability of an ecosystem.
14. Chilka lake is not protected under the Ramsar Convention.
15. International Seed Treaty came into force in June 2004.
16. Blue whales are not hunted commercially since 1964 and have been declared as endangered.
17. All biodiversity hot spots contain at least one of the global 200 eco-regions.
18. Pichavaram is known for its unique mangrove ecosystem.
19. India has five world heritage sites and six Ramsar wetlands.
20. In India, more than 40 per cent of the plant species are alien, of which 25 per cent are invasive.
21. β -diversity is also referred to as species turnover.
22. Global γ -diversity is the product of α - and β -diversity
23. β -diversity allows us to compare diversity between ecosystems.
24. Equitability is greatest when species are equally abundant.
25. Asiatic black bear is critically endangered.
26. Pygmy hog is vulnerable.
27. Sacred forests are located in Maharashtra, Kerala, Meghalaya and Karnataka.
28. Buffer zone of a biodiversity reserve is a zone of human settlement.
29. Fishing is not allowed in exclusive economic zones.
30. Cichlid is the endemic fish of Lake Victoria.
31. Extinction vertex is a combination of genetic and ecological factors.
32. Cheetah has become extinct in India.
33. Hoolock gibbon is the only ape in India.
34. Shahtoosh is obtained from great Indian bustard.
35. Ramsar sites are important for biodiversity conservation.
36. Western Ghats have most deciduous forests and rainforests.
37. *Eucalyptus* is native to Australia.
38. Comb jelly is an invasive alien species.
39. Invasive species are not found in all types of ecosystems.
40. Madagascar has the highest number of endemic vertebrates.
41. Introduction of invasive species results in change biotic interactions resulting in death of the native species.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|
| 1. True | 2. True | 3. True | 4. False | 5. True | 6. False | 7. True | 8. True |
| 9. True | 10. False | 11. True | 12. True | 13. True | 14. False | 15. True | 16. True |
| 17. True | 18. True | 19. True | 20. True | 21. True | 22. True | 23. True | 24. True |
| 25. False | 26. False | 27. True | 28. False | 29. False | 30. True | 31. False | 32. True |
| 33. True | 34. False | 35. True | 36. True | 37. True | 38. True | 39. False | 40. False |
| 41. True | | | | | | | |

Give Reasons

1. We need biosphere reserves.
 - Because due to increasing human population, urbanisation and industrialisation, human pressure on land and water resources is drastically reducing the diversity of plants, animals and gene, which threatens human welfare as biodiversity is the potential source of food, fibres and medicines as well as raw material for industry and building. Therefore, to preserve biodiversity, we need biosphere reserves.
2. Diversity is a matter of area.
 - Because there is a relationship between species and area.
3. It is difficult to measure ecological diversity.
 - Because each of the earth's ecosystem merges into the ecosystems around it.
4. Wild animals rarely breed in zoos.
 - Because of limited area in zoos which reduces free movement of animals resulting in lower reproductive capacity.
5. Humans impose a huge effect on biodiversity.
 - Because of:
 - (a) Destruction or fragmentation of habitat
 - (b) Introduction of new species
 - (c) Over harvesting
 - (d) Global climate change
6. Bioreserves differ from sanctuaries.
 - Because bioreserves lay emphasis on biodiversity and landscape rather than some specific species.
7. Larger animals have more risk for extinction.
 - Because of their need for more food and shelter as well as their low reproductive potential.
8. Hoolock gibbons are also called white browed gibbon.
 - Because of their brows.
9. Higher biodiversity controls spread of certain diseases.
 - Because pathogens will have to adopt to infect different species.
10. Higher species richness is expected if a region is surrounded by different habitats.
 - Because of constant dispersal from other habitats.
11. Tropics show higher level of biodiversity.
 - Because:
 - (a) Tropical latitudes remained less undisturbed for millions of years.
 - (b) They receive more solar energy leading to higher productivity and thus support greater diversity.
12. Greater spatial heterogeneity is responsible for low extinction rates.
 - Because of:
 - (a) Greater specialisation of taxa
 - (b) Smaller population size
 - (c) Less competition and
 - (d) More resources

BIOMES

Multiple-Choice Questions

1. Biomes are characterised by:
(a) Similar association of species (b) Consistent soil types
(c) Comparable climates (d) All
2. On the basis of which one of the following similarities can biomes be defined?
(a) Taxonomy (b) Genetics (c) Historical (d) None
3. Savannas can result from:
(a) Agricultural practices (b) Animal behaviour
(c) Climate/soil condition (d) All
4. A large, distinctive complex of plant communities created and maintained by climate is known as:
(a) Biosphere (b) Biome (c) Ecosystem (d) Eco zone
5. Which one of the following is incorrect?
(a) Oceans are the largest of the earth's biomes.
(b) Freshwater biomes are generally distinguished by characteristics such as water depth and whether the water is moving or standing.
(c) Marine biomes include oceans, coral reefs and estuaries.
(d) Each biome consists of only one ecosystem.
6. Grasslands are found in every continent except:
(a) Australia (b) Asia (c) Antarctica (d) South America
7. Consider the following statements:
(A) Climate is very important in the distribution of biomes
(B) A given biome is recognised by the type of vegetation
(C) The same type of biome is not found within the same general latitudes
(D) Biomes at a given altitude do not vary with latitude
The correct statements are:
(a) All (b) A and B (c) B and D (d) A and D
8. Termites are especially abundant in:
(a) Wetland biomes (b) Tropical savanna (c) Tropical rainforests (d) All
9. Tropical savannas are associated with:
(a) Tropical wet and dry climate (b) Cold and dry climate
(c) Temperate climate (d) Cold and wet climate
10. In tropical rainforests, days are:
(a) Much longer in summer (b) Much shorter in summer
(c) Much longer in winter (d) Of 12 hours duration throughout the year

11. Thorn forest is called caatinga in:
 (a) Brazil (b) Australia (c) India (d) Africa
12. Which of the following animals are common in African savanna?
 (a) Zebras and kangaroos (b) Giraffes and zebras
 (c) Zebras and deer antelopes (d) Giraffes and wild asses
13. The soil of temperate forest biome is:
 (a) Podzolic (b) Histosol (c) Oxisol (d) Spodosols
14. Which one of the following is correct?
 (a) Sandal – Deciduous forests (b) Mahogany – Tropical rainforests
 (c) Pine – Taiga (d) Oak – Tropical savanna
15. *Rhododendron* is a characteristic of:
 (a) Alpine zone (b) Tropical rainforests (c) Taiga (d) Tropical savanna
16. Which one of the following about deciduous forests is incorrect?
 (a) Grasses are generally absent. (b) Tree canopy is dense.
 (c) Peak leaf fall occurs in winter. (d) Herbaceous layer is poorly developed.
17. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Veldts	1. New Zealand
(B) Pampas	2. Eurasia
(C) Steppes	3. South America
(D) Tussocks	4. South Africa

 Answer codes:

A	B	C	D
(a) 4	3	1	2
(b) 3	1	4	2
(c) 4	3	2	1
(d) 2	3	4	1
18. In Indian forests, maximum dry months are found in:
 (a) Tropical rainforests (b) Tropical deciduous forests
 (c) Coniferous forests (d) Temperate broad leaved forests
19. Single species of coniferous tree is a characteristic of:
 (a) Tundra biome (b) Taiga biome (c) Desert biome (d) None
20. Daily variation in temperature reaches extremes in:
 (a) Desert (b) Savanna (c) Tundra (d) Taiga
21. Which one of the following is considered as the cradle of human evolution?
 (a) Savanna of Australia (b) Savanna of South America
 (c) Savanna of South Africa (d) None
22. Consider the following statements about tropical forests:
 (A) Occur near the equator within the area bounded by latitudes 23.5°N, 23.5° S (B) Greatest diversity of species
 (C) Winter is absent (D) Canopy is multilayered and continuous
 The correct statements are:
 (a) All (b) A, B and C (c) A and D (d) All

23. Which one of the following about taiga is incorrect?
 - (a) Temperature very low
 - (b) Soil is nutrient rich and alkaline
 - (c) Canopy permits low light penetration
 - (d) Precipitation is primarily in the form of snow
24. Arctic tundra is found across:
 - (a) Northern Alaska
 - (b) Canada
 - (c) Siberia
 - (d) All
25. Which one of the following is incorrect?
 - (a) Coral reefs are generally found in shallow, warm waters.
 - (b) Coral reefs are made up of algae and tissues of animal's polyp.
 - (c) Coral reef areas tend to be rich in nutrients.
 - (d) Coral gets nutrients from algae.
26. Consider the following statements:
 - (A) Fens have better nutrient supply than bogs
 - (B) Fens are less acidic
 - (C) Fens are more productive
 - (D) Fens develop in cool and wet climates
 The incorrect statements are:
 - (a) A, B and C
 - (b) B, C and D
 - (c) A and D
 - (d) None
27. Tundra lacks:
 - (a) Fishes
 - (b) Amphibians
 - (c) Amphibians and reptiles
 - (d) Reptiles and birds
28. Tropical savannas are:
 - (a) Scattered shrubs
 - (b) Scattered trees
 - (c) Without woody plants
 - (d) All
29. Marine biome regulates:
 - (a) Rainfall
 - (b) Atmospheric CO₂ balance
 - (c) Both (a) and (b)
 - (d) None
30. Consider the following statements about coral reef:
 - (A) Highly productive part of the coastal region
 - (B) Wave action and temperature fluctuations are more
 - (C) Mineral nutrients are not readily available
 - (D) Water is well oxygenated
 The correct statements are:
 - (a) A and B
 - (b) B and C
 - (c) A and D
 - (d) C and D
31. Freshwater, marine and estuarine ecosystems are characterised on the basis of differences in:
 - (a) Depth
 - (b) Salt content
 - (c) Fauna
 - (d) None
32. Which one of the following is not applicable to boreal forests?
 - (a) Spodosols soil
 - (b) Deep litter layer
 - (c) Minerals rich
 - (d) Slow decomposition
33. Spodosols, inceptisols and histosols are the characteristic soils of:
 - (a) Arctic tundra
 - (b) Alpine tundra
 - (c) Tropical rainforests
 - (d) Boreal coniferous forests
34. Which one of the following is found in tundra?
 - (a) Low rate of decomposition
 - (b) Accumulation of litter
 - (c) Retention of humus
 - (d) All
35. In India, tropical rainforests are found in:
 - (a) Assam
 - (b) Andaman Islands
 - (c) Western Ghats
 - (d) All
36. Which one of the following about tundra is correct?
 - (a) Thin light and short growing season
 - (b) Poor light
 - (c) Very low temperature
 - (d) All

37. The extent of mixing of saltwater and freshwater depends on the:
 - (a) Rate and volume of freshwater flow
 - (b) Amount of tidal inflow
 - (c) Morphology of the estuary basin
 - (d) All
38. Which one of the following is more productive?
 - (a) Tropical biome
 - (b) Temperate biome
 - (c) Arctic biome
 - (d) Desert biome
39. Which one of the following is of considerable variation in tundra?
 - (a) Plant communities
 - (b) Soils
 - (c) Climate
 - (d) All
40. Which one of the following lacks humus?
 - (a) Tundra
 - (b) Desert
 - (c) Tropical forests
 - (d) None
41. The trees of mangrove are characterised by:
 - (a) Pneumatophore
 - (b) Vivipary
 - (c) Knee roots
 - (d) All
42. Bogs are:
 - (a) Acidic
 - (b) Acidic and unproductive
 - (c) Alkaline and productive
 - (d) Alkaline and unproductive
43. Which is one of the following about tropical rainforests is incorrect?
 - (a) Poor in nutrients
 - (b) Highest standing crop biomass
 - (c) Nutrient cycle is slow
 - (d) Productivity is maximum
44. Which one of the following is a seed plant of intertidal region?
 - (a) *Zostera*
 - (b) *Fucus*
 - (c) *Dictyota*
 - (d) *Polysiphonia*
45. Arctic desert lacks:
 - (a) Rainfall
 - (b) Precipitation
 - (c) Both rainfall and precipitation
 - (d) None
46. Which one of the following has the maximum biomass?
 - (a) Marine ecosystem
 - (b) Forest ecosystem
 - (c) Lake ecosystem
 - (d) Pond ecosystem
47. Which one of the following is not a lentic ecosystem?
 - (a) Swamps
 - (b) Bogs
 - (c) Springs
 - (d) Lakes
48. Moose, bear, deer and lynx are the characteristic fauna of:
 - (a) Boreal coniferous forests
 - (b) Temperate deciduous forests
 - (c) Grasslands
 - (d) Tundra
49. In tropical rainforests:
 - (a) Evapotranspiration is high
 - (b) Decomposition of litter is rapid
 - (c) Canopy is never naked
 - (d) All
50. Greatest diversity of species and nutrient poor soils are characteristic of:
 - (a) Arctic tundra
 - (b) Temperate deciduous forests
 - (c) Tropical rainforests
 - (d) Tropical seasonal forests
51. Which one of the following is not a characteristic of subtropical desert?
 - (a) Epiphytes
 - (b) Annual herbs
 - (c) Sparse vegetation
 - (d) Succulent plants
52. Which one of the following about rainforests is incorrect?
 - (a) Vertical stratification of plants
 - (b) Epiphytes, lianas and orchids are quite common
 - (c) Floor is humid and dark
 - (d) None
53. Taiga is applicable to:
 - (a) Boreal coniferous forest
 - (b) Temperate grasslands
 - (c) Temperate deciduous forests
 - (d) Savannas

150 Ecology and Animal Behaviour

54. Which one of the following about temperate rainforests is incorrect?
 (a) High tree longevity (b) High species richness
 (c) Occurring in maritime climate (d) Winter rainfall and occur at higher altitudes
55. Savannas have maximum expression in:
 (a) Africa (b) Australia (c) Southern Asia (d) South America
56. CAM and C_4 plants are commonly adapted plants of:
 (a) Tropical rainforests (b) Desert climates
 (c) Taiga (d) Temperate woodlands
57. Shrubs and under-canopy trees are uncommon in:
 (a) Temperate woodlands and shrub lands (b) Temperate grasslands
 (c) Taiga (d) Temperate deciduous forests
58. Consider the following statements:
 (A) Firs, larches and evergreen spruces are the dominant trees of the taiga (B) Decomposition is very slow in the taiga
 (C) Savannas are lacking in Australia (D) Tropical seasonal forests are not found in India
 The correct statements are:
 (a) All (b) A and B (c) C and D (d) B and D
59. *Senecio* is a common shrub of the:
 (a) Alpine shrub lands (b) Moist tropical rainforests
 (c) Dry tropical forests (d) Temperate forests
60. In India, alkaline scrub savanna occurs:
 (a) In the Brahmaputra valley (b) In eastern Tamil Nadu
 (c) Throughout the Indo-Gangetic plain (d) Silent valley
61. Which one of the following presents the most common example of a fragile ecosystem?
 (a) Alpine biome (b) Tundra biome (c) Savanna biome (d) None
62. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) High seasonal arid climate	1. Subtropical desert
(B) Cool summer and cool winter	2. Taiga
(C) Moderate climate with winter freezing	3. Tropical rainforests
(D) High temperature and high rainfall	4. Temperate deciduous forests

 Answer codes:

A	B	C	D
(a) 1	2	4	3
(b) 4	3	2	1
(c) 2	1	4	3
(d) 1	4	3	2
63. Which one of the following about tundra is incorrect?
 (a) Rate of evaporation is high (b) The net primary productivity is high
 (c) High precipitation (d) All
64. Epiphytes are abundant in:
 (a) Temperate deciduous forests (b) Thorn woodlands
 (c) Tropical rainforests (d) Taiga

65. Consider the following statements about tropical savanna:
 (A) Supports the richest diversity of grazing mammals
 (B) The soils are nutrient poor
 (C) Species diversity is low
 (D) The climate is rainy season (May to October) and dry season (November to April)
 The correct statements are:
 (a) All (b) A, B and D (c) B, C and D (d) B and C
66. Boreal forest soils are:
 (a) Spodosols (b) Podzols (c) Oxisols (d) Laterite
67. Which one of the following is relatively high in the tundra?
 (a) Temperature (b) Evaporation (c) Precipitation (d) None
68. Desert soils are relatively rich in nutrients except for:
 (a) Phosphorous (b) Nitrogen (c) Calcium (d) Carbonate
69. In deserts:
 (a) Productivity is low (b) Litter layer is comparatively limited
 (c) Organic content is low (d) All
70. Permafrost is characteristic of:
 (a) Desert (b) Alpine tundra
 (c) Arctic tundra (d) Boreal coniferous forests
71. Fire is controlling factor in the:
 (a) Tropical savanna (b) Grassland
 (c) Desert (d) Temperate deciduous forest
72. In India, the temperate broad leaved forests occur mainly in:
 (a) Eastern Himalayas (b) Western Himalayas (c) Andaman Islands (d) Western Ghats
73. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Tropical rainforests	1. <i>Eucalyptus</i>
(B) Tropical deciduous forests	2. <i>Quercus</i>
(C) Temperate broad-leaved forests	3. <i>Shorea robusta</i>
(D) Savanna	4. <i>Ficus elastica</i>

 Answer codes:

A	B	C	D
(a) 3	4	2	1
(b) 4	3	2	1
(c) 2	4	3	1
(d) 4	3	1	2
74. Which one of the following is not found in tropical rainforests?
 (a) Clove (b) Bamboo (c) Tendu (d) Palm
75. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Gobi	1. South America
(B) Thar	2. Africa
(C) Kalahari	3. Mongolia
(D) Atacama and Patagonia	4. India

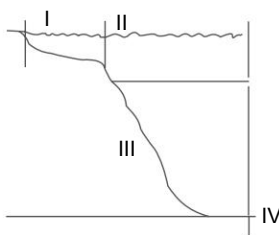
152 Ecology and Animal Behaviour

Answer codes:

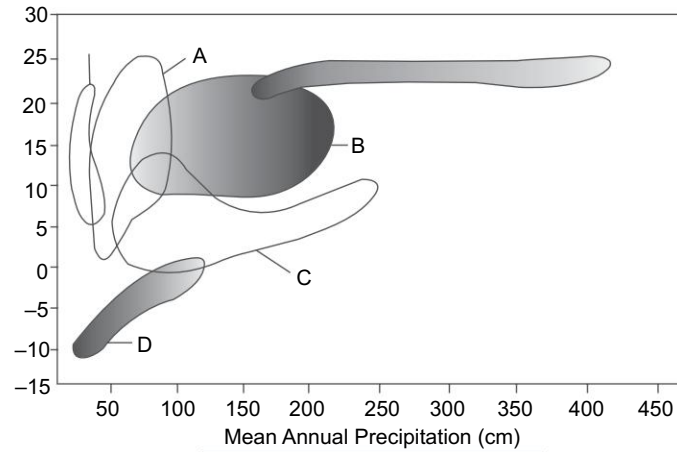
	A	B	C	D
(a)	3	4	2	1
(b)	2	1	4	3
(c)	4	3	2	1
(d)	3	4	1	2

76. Forests located in different climatic regions differ in their:
 - (a) Nutrient cycling
 - (b) Structure
 - (c) Productivity
 - (d) All
77. Which one of the following about tundra is incorrect?
 - (a) Short growing season
 - (b) Thin soils
 - (c) High wind and slow growth of plants
 - (d) None
78. Chaparrals are characterised by:
 - (a) Resinous plants
 - (b) Broad-leaved evergreen vegetation
 - (c) *Eucalyptus*
 - (d) All
79. Which one of the following about pH as we move from the tundra to temperate to tropical biomes is correct?
 - (a) Highly alkaline to alkaline to neutral to highly acidic to acidic
 - (b) Neutral to highly alkaline to alkaline to highly acidic to acidic
 - (c) Highly acidic to acidic to neutral to alkaline types
 - (d) Alkaline to neutral to highly acidic
80. Mangroves vegetation is found along the tropical coastlines of:
 - (a) Australia
 - (b) America
 - (c) Asia
 - (d) All
81. Estuaries function on:
 - (a) Planktonic based food web
 - (b) Detritus based food web
 - (c) Both (a) and (b)
 - (d) None
82. Consider the following points about a plant:
 - (A) It is found in the biome of Southeast Asian rainforest and is a grass
 - (B) It can reduce soil erosion
 - (C) It sucks water from heavy rains that might cause flooding
 - (D) It is used in the Indian pulp industry
 This plant is:
 - (a) *Papaver smmiferum*
 - (b) *Bambusa tulda*
 - (c) *Artemisia annua*
 - (d) *Prosopis cineraria*
83. Which one of the following is incorrect?
 - (a) Coral reefs are widely distributed in warm shallow waters
 - (b) Coral reefs comprise both algae and tissues of animal polyp
 - (c) Reefs waters tend to be nutritionally rich
 - (d) Corals obtain nutrients through the algae via photosynthesis and also by extending tentacles to obtain plankton from the water
84. The world's largest tropical rainforests are in:
 - (a) Amazon rainforest in South America
 - (b) Southeast Asia
 - (c) Africa
 - (d) New Zealand

85. Which one of the following about chaparrals is correct?
 (a) Found in coastline regions (b) Characterised by dense shrubs
 (c) Characterised by grasses (d) All
86. Many large animals like zebras, giraffes, elephants and rhinoceroses inhabit this biome as well as this biome is characterised by open grasslands with very few trees:
 (a) Savanna (b) Desert (c) Tundra (d) Chaparral
87. Which one of the following is applicable to tropical rainforests?
 (a) Dense vegetation
 (b) Seasonally warm temperatures and abundant rainfall
 (c) A vast majority of plant and animal species of the world are found
 (d) All
88. Mesophytic and deciduous forests and presence of many perennial herbs are the characteristics of:
 (a) Tropical seasonal forests (b) Tropical rainforests
 (c) Temperate deciduous forests (d) Temperate rainforests
89. The major land use of this biome are timbers harvest, grazing and agriculture:
 (a) Tropical rainforests (b) Temperate deciduous forests
 (c) Grasslands (d) Temperate rainforests
90. Which one of the following does not inhabit the same temperate grasslands?
 (a) Zebras and rhinoceroses (b) Wild horses and wolves
 (c) Skunks and jackrabbits (d) All
91. Which one of the following is low in tundra?
 (a) Temperature (b) Precipitation
 (c) Evaporation (d) All
92. Sclerophyll forest is applicable to:
 (a) Desert (b) Chaparral (c) Tundra (d) Taiga
93. Which one of the following is among the most ancient of ecosystems?
 (a) Desert (b) Tundra
 (c) Chaparral (d) Tropical rainforests
94. In the given diagram showing zonation of the ocean, identify which one of the following labelled parts shows the following characteristics.
 Organisms are heterotrophic and this zone is remarkably homogenous and stable in its physical and chemical parameters:
 (a) I (b) II (c) III (d) IV

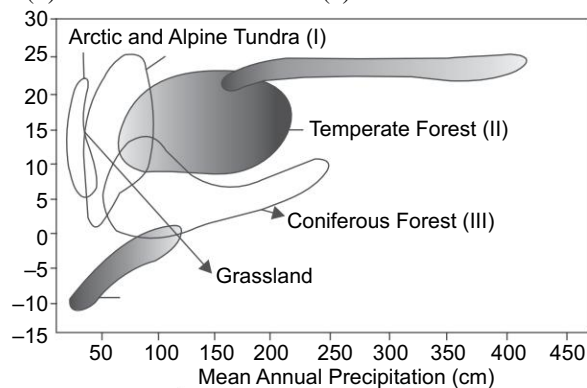


95. Identify the location of the coniferous biome in figure given below:
 (a) A (b) B (c) C (d) D



96. Alpine tundra is quite similar to some arctic tundra but differs in the:
- Absence of permafrost
 - Presence of better drainage
 - Long growing season
 - All
97. Which one of the following ecosystems has the highest species diversity?
- Freshwater
 - Marine
 - Wetlands
 - Tropical rainforests
98. The term 'biome' was coined by:
- Deitrich Malinger (1967)
 - J P Bray (1964)
 - L R Clarke (1964)
 - D W Goodall (1963)
99. Ecological districts with distinct climate and topography are applicable to:
- Biospheres
 - Biomes
 - Ecosystems
 - All
100. In which one of the following biomes have humans settled?
- Tropical dry forests
 - Tropical savanna
 - Temperate deciduous forests
 - Tropical rainforests
101. In which one of the following biomes tree shapes maximise sun exposure to receive maximum amount of energy flow from the sun?
- Tropical savanna
 - Temperate deciduous forests
 - Tropical dry forests
 - Tropical rainforests
102. Species diversity becomes higher with increase in:
- Net primary productivity
 - Moisture
 - Temperature
 - All
103. Consider the following statements:
- Mountain exists in all continents and cover almost one-fifth of the earth
 - Desert biomes can be found in every continent except Europe
 - Arctic biomes receive the least amount of sun
 - Nearly 5 per cent of the earth is covered with deserts
- The incorrect statements are:
- None
 - A and D
 - B and C
 - C and D
104. Deer, raccoons and salamanders are characteristic inhabitants of:
- Tropical rainforests
 - Temperate deciduous forests
 - Taiga
 - Tundra

105. Which one of the following biomes is dotted with lakes, bogs and marshes having low net primary productivity?
 (a) Desert (b) Taiga (c) Chaparral (d) Tundra
106. Swiftly moving ungulates are the dominant vertebrates of:
 (a) Taiga (b) Tundra (c) Grassland (d) Desert
107. Taiga biomes:
 (a) Cover 11 per cent of the earth (b) Comprise evergreen and tough plants
 (c) Contains few reptiles (d) All
108. Which one of the following is correct?
 (a) The Cree Indians have lived in the North American Taiga. (b) Grasslands have more precipitation than deserts.
 (c) Lichens are common in tundra. (d) All
109. Saline or alkaline soils are common in:
 (a) Tundra (b) Deserts (c) Grasslands (d) Tropical rainforests
110. Deserts and xeric sublands occur in:
 (a) Tropical climate (b) Subtropical climate (c) Temperate climate (d) All
111. In the figure showing distribution of biome below, which one of the following is incorrectly labelled?
 (a) I (b) II (c) III (d) IV



112. Majority of jungle biomes are located in:
 (a) Africa (b) South America (c) Australia (d) Brazil
113. Rainforests differ from each other in:
 (a) Rainfall (b) Average temperature
 (c) Plants and animals which live in each type (d) All
114. The world's longest river flows through:
 (a) Amazon rainforest in South America (b) Rainforest in Southeast Asia
 (c) Rainforest in Africa (d) Rainforest in Brazil
115. Match column I with column II and select the correct answer using answer codes:
- | | |
|-----------------------------|-------------------------------------|
| Column I | Column II |
| (A) <i>Mangifera indica</i> | 1. Grasslands |
| (B) <i>Tectona grandis</i> | 2. Tropical dry deciduous forests |
| (C) <i>Shorea robusta</i> | 3. Tropical moist deciduous forests |
| (D) <i>Acacia arabica</i> | 4. Tropical wet evergreen forests |

156 Ecology and Animal Behaviour

Answer codes:

	A	B	C	D
(a)	4	2	1	3
(b)	4	3	2	1
(c)	3	2	4	1
(d)	2	1	3	4

116. In India, the semi-arid region occupies about _____ per cent of the total area:
 (a) 15 (b) 20 (c) 30 (d) 35
117. Which one of the following is incorrect?
 (a) Chaparral is a temperate biome. (b) Chaparral has winter rain and summer draught.
 (c) Chaparral is highly prone to events of catastrophic wild fire. (d) None

Answers to Multiple-Choice Questions

- | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. (d) | 2. (d) | 3. (d) | 4. (b) | 5. (d) | 6. (c) | 7. (b) | 8. (b) |
| 9. (a) | 10. (d) | 11. (a) | 12. (b) | 13. (a) | 14. (c) | 15. (a) | 16. (c) |
| 17. (c) | 18. (b) | 19. (b) | 20. (a) | 21. (c) | 22. (d) | 23. (b) | 24. (d) |
| 25. (c) | 26. (d) | 27. (c) | 28. (d) | 29. (c) | 30. (c) | 31. (b) | 32. (c) |
| 33. (a) | 34. (d) | 35. (d) | 36. (d) | 37. (d) | 38. (a) | 39. (d) | 40. (b) |
| 41. (d) | 42. (b) | 43. (c) | 44. (a) | 45. (a) | 46. (b) | 47. (c) | 48. (a) |
| 49. (d) | 50. (c) | 51. (a) | 52. (d) | 53. (a) | 54. (b) | 55. (a) | 56. (b) |
| 57. (c) | 58. (b) | 59. (a) | 60. (c) | 61. (b) | 62. (a) | 63. (d) | 64. (c) |
| 65. (a) | 66. (a) | 67. (d) | 68. (b) | 69. (d) | 70. (c) | 71. (a) | 72. (a) |
| 73. (b) | 74. (c) | 75. (a) | 76. (d) | 77. (d) | 78. (d) | 79. (c) | 80. (d) |
| 81. (c) | 82. (b) | 83. (c) | 84. (a) | 85. (d) | 86. (a) | 87. (d) | 88. (c) |
| 89. (a) | 90. (d) | 91. (d) | 92. (b) | 93. (d) | 94. (c) | 95. (c) | 96. (d) |
| 97. (c) | 98. (a) | 99. (b) | 100. (a) | 101. (b) | 102. (d) | 103. (a) | 104. (b) |
| 105. (b) | 106. (c) | 107. (d) | 108. (d) | 109. (b) | 110. (d) | 111. (a) | 112. (b) |
| 113. (d) | 114. (a) | 115. (b) | 116. (a) | 117. (d) | | | |

Fill in the Blanks

- Each biomes consists of many _____.
- Areas on the earth with similar climate and plants are called _____.
- _____ is the deepest point of the marine biome.
- The plants in marine biome exist in the _____.
- There are four ocean zones, viz., _____, _____, _____ and _____.
- The pelagic zone is more commonly known as the _____ ocean.
- Alpine tundra occurs at high _____ on mountains, While arctic tundra occurs at high _____.
- Fens develop in _____ and _____ climates

9. Primary production in open ocean is carried out of _____ of diverse species.
10. Coral reefs are distinctive marine biome of _____ seas.
11. The three distinct zones of ponds and lakes are _____ zone, _____ zone and _____ zone.
12. Mountain biomes are called _____.
13. Nutrient poor soil biomes are called _____.
14. In India, tropical seasonal forests occupy extensive areas in the _____ and _____.
15. The total area of wetlands (excluding rivers) in India is _____ or _____ per cent of the country.
16. All deserts share a common feature, i.e., all are extremely _____.
17. Deserts cover _____ of the earth's land.
18. In India, the basal region of mountain is referred to as _____.
19. The sites where rivers enter the oceans are called _____.
20. Wetlands contain _____ per cent of the carbon storage.
21. Atolls are _____-shaped reefs.
22. In taiga, about _____ of all ecosystems' carbon remains locked in humus.
23. Elfin woods is a _____ biome.
24. Coral reefs are mainly grouped as _____, _____ and _____.
25. The tundra biome lies between the Arctic ocean and the _____.
26. In tundra, the grounds generally remain frozen as permafrost, except for the upper _____ deep.
27. _____ is the other major factor which determines the distribution of organisms besides temperature.
28. There are about _____ million acres of mangrove forests in the warm coastlines of tropical oceans all over the world.
29. The ocean connects to the land via the _____ zone.
30. The deepest part of the ocean is called the _____ zone.
31. _____ biome is the largest of all land biomes.
32. _____ is the ice desert.
33. Grassland biome is found in areas having a rainfall of about _____ cm per year.
34. Grasslands with tall grasses are called _____.
35. The two major nutrients of the tundra biome are _____ and _____.
36. _____ is open woodland of short stature and twisted trees.
37. Strong winds and low evaporation, with P/E ratio much above one are the characteristic climatic features of _____ biome.
38. In temperate grasslands, the warm season grasses have many _____ species, while in cold season _____ species are abundant.
39. Savannas have attained their maximum extensive expression in _____.
40. Pine forests are common in _____ habitats.
41. In tropical rainforests, the annual rainfall is about more than _____.
42. Fundamentally, biomes have been grouped into two types, viz., _____ biome and _____ biome.
43. Grasslands biomes are dominated by a variety of _____ and _____ species of grass.
44. _____ and _____ are the two important major factors controlling the distribution of biomes.

Answers to Fill in the Blanks

- | | | |
|---|--|---|
| 1. Ecosystems | 2. Biomes | 3. Marina trench |
| 4. Euphotic | 5. Inter tidal, pelagic, abyssal and benthic | |
| 6. Open | 7. Altitudes, latitudes | 8. Cool, wet |
| 9. Phytoplankton | 10. Tropical | 11. Littoral, limnetic, profound |
| 12. Orobionomes | 13. Peinobionomes | 14. Central highlands, Deccan peninsula |
| 15. 5,82,86,000 ha or 18.4 | 16. Dry | 17. One-fifth |
| 18. Terai | 19. Estuaries | 20. 10 to 14 per cent |
| 21. Horseshoe | 22. 60 per cent | 23. Tropical |
| 24. Barrier reefs, fringing reefs, atolls | | 25. Coniferous forests |
| 26. 10 or 20 cm | 27. Moisture | 28. 39-3 |
| 29. Intertidal | 30. Abyssal | 31. Taiga |
| 32. Tundra | 33. 25 to 75 | 34. Prairies |
| 35. Nitrogen, phosphorous | 36. Brazil's Cerrado | 37. Tundra |
| 38. C ₄ , C ₃ | 39. Africa | 40. Drier |
| 41. 200 to 225 cm | 42. Terrestrial, aquatic | 43. Annual, perennial |
| 44. Soil, Climate | | |

True or False

1. A biome is made of many similar ecosystems.
2. Tropical rainforests are among the most ancient ecosystems.
3. Soils of rainforests are oxisols.
4. The upper portion of soil of grasslands is dark.
5. The world ocean's have an even greater effect on global climate than forests.
6. Oceans are the same everywhere.
7. Baobab trees store water in their large trunks.
8. Similar biomes exist on mountains even when they are at low altitudes.
9. Tundra takes a short time to recover, if destroyed.
10. Marshes, bogs and ponds are abundant in the tundra.
11. Chaparral receives warm moist air from the oceans.
12. Bush fires are common in chaparral.
13. Sea floor is soft and highly uneven.
14. Some lakes are more saline than the oceans.
15. The concentration of nutrients in the oceans is low.
16. Saprophytes are common in tropical rainforests.
17. Sandal trees are found in tropical rainforests.
18. 80 to 85 per cent birds are found in tropical rainforests.
19. Epiphytes and climbers are present in temperate broad-leaved forests.

20. The tropical dry forests have fertile soil.
21. Tropical forests are common in the equatorial belt.
22. In dry deciduous forests, there are three to four layers of canopy.
23. Red wood tree is the tallest among living things.
24. CAM and C4 plants are not well adapted for desert climates.
25. In a biome, climax vegetation is not uniform.
26. Biomes may or may not be continuous.
27. Pedobiomes are named according to soil type.
28. The vegetation in rainforests grows in layers.
29. Rainforests are disappearing at the rate of 80 acres per second.
30. Tropical rainforests produce 40 per cent of the earth's oxygen.
31. In rainforests, the air beneath the lower canopy is almost always humid.
32. Dominant species exists in rainforests.
33. Soils of rainforests contain soluble minerals.
34. The rising and falling of the ocean's tide affects the mangrove forests.
35. Mudskippers are found in mangrove forests.
36. Plant life in boreal forest is sturdy.
37. Different biomes have different effect on plants.
38. In India, grassland biome is maintained by grazing and fire.
39. Shifting cultivation and sheep grazing of humid forests results in the formation of savanna.
40. Wetlands are a biome.
41. In temperate forests, a large portion of the nutrients is in the biomass rather than in the soil.
42. In tropical forests, a large portion of nutrients is present in the biomass.
43. Biomes have changed during the history of life on the earth.

Answers to True or False

- | | | | | | | | |
|-----------|----------|-----------|-----------|----------|-----------|----------|-----------|
| 1. True | 2. True | 3. True | 4. True | 5. True | 6. False | 7. True | 8. True |
| 9. False | 10. True | 11. False | 12. True | 13. True | 14. True | 15. True | 16. True |
| 17. False | 18. True | 19. True | 20. False | 21. True | 22. False | 23. True | 24. False |
| 25. False | 26. True | 27. True | 28. True | 29. True | 30. True | 31. True | 32. False |
| 33. False | 34. True | 35. True | 36. True | 37. True | 38. False | 39. True | 40. False |
| 41. False | 42. True | 43. True | | | | | |

Give Reasons

1. Forests are important.
– Because:

- (a) Forests are home to the most diverse communities in the world.
- (b) They contain potential medicinal plants.
- (c) They have a global climate buffering capacity.
2. Coastal areas are constantly changing with various animals and marine plants living on the bottom and the seashore.
 - Because of rising and falling of tides.
3. Temperature has major influence on the biomes.
 - Because temperature declines with altitude as well as longitude.
4. In the pelagic zone of the ocean, temperature changes frequently.
 - Because of constant mixing of cold and warm ocean currents.
5. Estuaries biome is unique.
 - Because it includes both freshwater and saltwater.
6. Without marine biomes, humans would have difficulty in breathing.
 - Because marine biomes supply much of the world's oxygen through algae plants and they also take a huge amount of carbon dioxide from our atmosphere.
7. Though occur in nutrient-poor waters, coral reefs typically sustain high productivity.
 - Because of their symbiotic association with unicellular algae which results in highly efficient acquisition and recycling of nutrients.
8. Low mountains lack tundra.
 - Because low mountains lack snowcaps.
9. Plant roots cannot penetrate permafrost.
 - Because permafrost has no cracks or pores.
10. In arctic tundra, plants grow together and low to the ground.
 - Because this growing pattern helps the plants to resist the effect of cold temperature as well as reduces the impact of tiny particles of ice and snow brought by the dry winds.
11. Polar regions of the oceans are highly productive.
 - Because up swelling brings nutrients to the surface.
12. There exists considerable variation within each biome.
 - Because of local conditions of the:
 - (a) Climate
 - (b) Soil
 - (c) Biota
 - (d) Variation in the temperature
13. Brown forest soils are more fertile than those of the taiga.
 - Because of high content of nitrates and other soil nutrients.
14. Soils of tundra are rich in organic matter.
 - Because of very slow decomposition rate.
15. Estuaries are the most productive ecosystem.
 - Because in estuaries there is swift circulation of nutrients as well as removal of wastes.
16. Soils of deciduous forests are fertile.
 - Because fall of leaves occurs seasonally and lying on the forest floor, the leaves decay. As the leaves decay, the nutrients are absorbed by the soil making the soils fertile.
17. In deserts, litter layer is comparatively limited.

- Because of low productivity.
- 18. Deciduous forests are also called seasonal forests.
 - Because during summer, the trees and shrubs lose their leaves as well as ground vegetation dries resulting in loss of forest-like appearance.
- 19. Wetlands play an important role in maintaining biodiversity.
 - Because they support an extraordinary variety of plant and birdlife.
- 20. In taiga biomes, the forest floor vegetation is thin.
 - Because the forest's canopy is dense.
- 21. Decomposition is rapid in tropical forests.
 - Because of high temperature and abundance of moisture.
- 22. Ponds and lakes may have limited species diversity.
 - Because they are often isolated from one another and other water sources like rivers and oceans.
- 23. Tropical rainforest is of much ecological significance.
 - Because of:
 - (a) Their high species diversity potential having source of food, fibre, medicinal and industrial products.
 - (b) Their influence on climate.
 - (c) Global balance of carbon and atmospheric pollutants.
- 24. Forest fire is a very important phenomenon.
 - Because it regulates:
 - (a) Vegetation composition and land use pattern.
 - (b) Secondary succession.
- 25. In rainforests, majority of trees have a smooth and thin bark.
 - Because there is no need to protect them from water loss and freezing temperatures as well as it also helps epiphytes and plant parasites to get a hold on the trunk.
- 26. Freshwater and marine biomes are the most important of all biomes.
 - Because they contain water, which is essential for life and they have the ability to keep temperature constant in the atmosphere.
- 27. In spite of low precipitation the ground surface of tundra is often waterlogged.
 - Because of low rates of evapotranspiration.
- 28. Similar biomes exist on mountains even when they are at low latitudes.
 - Because temperature declines with altitude as well as latitude.
- 29. Humans have settled in the tropical dry forest biome.
 - Because of its warm temperature and less rain and it is a very pleasant place to live.
- 30. Soils of tropical savannas are nutrient-rich.
 - Because of heavy leaching.
- 31. Coastal areas are constantly changing.
 - Because of regular rising and falling of tides.

ALIEN SPECIES

Multiple-Choice Questions

1. Consider the following statements:
(A) Alien species are considered to be a main driver of biodiversity loss across the globe
(B) An invasive species might be able to use resources previously unavailable to native species
(C) *Bromus tectorum* is highly fire-adapted
(D) Invasive species have the ability to create new niches that did not exist
The correct statements are:
(a) All (b) A and B (c) B and C (d) C and D
2. Which one of the following about alien species is incorrect?
(a) Alien species may be plants, animals or pathogens (b) Non-native to an ecosystem
(c) Cause economic or environmental harm (d) Cause no adverse effect on human health
3. Invasive species special interest group (ISSG) was established in:
(a) 1994 (b) 1996 (c) 2000 (d) 2005
4. Invasive species:
(a) Can cause loss of species diversity (b) Can cause increased soil erosion
(c) Affect the physical structure of the habitat (d) All
5. Members of which family form a dominant group of invasive species:
(a) Poaceae (b) Fabaceae (c) Asteraceae (d) All
6. Consider the following points:
(A) It is a widespread invasive weed
(B) All parts of this plant are poisonous to humans especially the berries
(C) This plant has the ability to crowd out native species
(D) Plants, if occurring sparsely, may act as nursery crop
This plant is:
(a) *Spartina anglica* (b) *Solanum mauritianum*
(c) *Spathodea campanulata* (d) *Schinus molle*
7. Which one of the following statements is incorrect?
(a) *Eichhornia crassipes* and *Salvinia sp* are the worst invasive plants in the aquatic ecosystem.
(b) Zebra mussel is an invasive species and is a native of Caspian Sea.
(c) Invasive species may lead to increase in genetic diversity.
(d) Soil chemistry and environments of the nitrogen-fixing exotic plants invaded area may be changed.
8. Which one of the following has the ability to compete with other species for space, light, nutrients and water?
(a) Zebra mussel (b) Kudzu vine (c) Water hyacinth (d) All

9. *Salvinia* is an indigenous species in:
 (a) Australia (b) Southeast Brazil (c) Africa (d) North Asia
10. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) <i>Myrica faya</i>	1. Reduces the soil water availability to plants
(B) <i>Tamarix</i>	2. Lowers water level
(C) <i>Bromus tectorum</i>	3. Reduces the diversity of annual plants
(D) <i>Orbea variegata</i>	4. Increased in nitrogen outputs

 Answer codes:

A	B	C	D
(a) 2	4	1	3
(b) 4	2	1	3
(c) 3	4	2	1
(d) 4	3	1	2
11. Allelopathy and phenotypic plasticity is applicable to:
 (a) *Eupatorium riparium* (b) *Mikania micrantha*
 (c) *Parthenium hysterophorus* (d) *Eichhornia crassipes*
12. Which one of the following is not an invasive alien species of fish?
 (a) *Heteropneustes fossilis* (b) *Clarius batrachus*
 (c) *Gambusia affinis* (d) *Cyprinus carpio*
13. Consider the following statements about *Parthenium*:
 (A) This weed was accidentally introduced in India around 1956
 (B) Initially it was present in wastelands, but now it is intruding into farmlands
 (C) It is known to cause asthma, dermatitis, bronchitis and hay fever in humans and livestock
 (D) Its fruits are rich source of proteins and fats
 The correct statements are:
 (a) All (b) A, B and C (c) B, C and D (d) B and D
14. In which one of the following large landscape areas do invasive species have greater prevalence?
 (a) South America (b) South America and India
 (c) South America and Australia (d) Africa and India
15. Which one of the following is not more prone to invasion by invasive species?
 (a) Deserts (b) Islands
 (c) Isolated lakes and streams (d) None
16. Match column I with column II and select the correct answer using answer codes:

Column I (Invading species)	Column II (Country of origin)
(A) <i>Ipomoea carnea</i>	1. Tropical America
(B) <i>Lantana camara</i>	2. Brazil
(C) <i>Eichhornia crassipes</i>	3. West Indies and tropical America
(D) <i>Prosopis juliflora</i>	4. Tropical and subtropical America

 Answer codes:

A	B	C	D
(a) 1	2	4	3
(b) 4	3	1	2
(c) 3	4	2	1
(d) 1	4	2	3

17. Consider the following statements about a marine animal:
 (A) It is an invasive species and can live in polluted water
 (B) It is inspiring to develop superior biomedical adhesives
 (C) Its adhesiveness has the potential to help form strong bonds in wet surfaces
 (D) The adhesive may be used to repair ships that have developed cracks while at sea
 This animal is:
 (a) Zebra mussel (b) Green mussel (c) Rosy wolf snail (d) Nile perch
18. The first and foremost impact observed in an ecosystem upon invasion by an invasive species is the:
 (a) Modification in soil biota (b) Change in nutrient dynamics
 (c) Alteration in litter dynamics (d) Modification in biogeochemical cycles
19. Which one of the following invades the jhoom-cultivated area?
 (a) *Mikania micrantha* (b) *Prosopis juliflora*
 (c) *Eupatorium adenophorum* (d) *Lantana camara*
20. Invasive species:
 (a) Tend to have very aggressive root systems (b) Produce large number of seeds
 (c) Lack the natural predators (d) All
21. Which one of the following is claimed to have destroyed the banni grassland in Kutch?
 (a) *Lantana camara* (b) *Prosopis juliflora*
 (c) *Mikania micrantha* (d) *Lymantria dispar*
22. Ballast water transportation is applicable to:
 (a) Zebra mussel (b) Rosy wolf snail (c) Red-eared slider (d) Giant reed
23. Which one of the following has escaped horticultural control and become invasive?
 (a) Salt cedar (b) Water hyacinth (c) Purple loose strife (d) All
24. Which one of the following is not associated with introduction of soil erosion control?
 (a) Garlic (b) Kudzu (c) Onion (d) Mustard
25. Cryptogenic species are:
 (a) Exotic (b) Clearly native (c) Both (a) and (b) (d) None
26. Which one of the following is more successful in establishing itself in disturbed areas such as roadside and agricultural fields and rarely colonise close to forests?
 (a) *Solenopsis invicta* (b) *Lymantria dispar*
 (c) *Bemisia tabaci* (d) All
27. Which one of the following is a common characteristic of alien invasive species?
 (a) Rapid reproduction and growth (b) High dispersal ability
 (c) Phenotypic plasticity as well as ability to survive on different foods (d) All
28. Which one of the following is not the most damaging invasive species to islands?
 (a) Rats (b) Mammalian carnivores
 (c) Mammalian herbivores (d) Feral cats
29. The species carried in ballast water are called:
 (a) Exotic species (b) Alien species (c) Invasive species (d) All
30. Consider the following statements:
 (A) A combination of vegetative and sexual reproduction provides potentiality to invasiveness
 (B) Vegetative reproduction is not a suitable means of invasiveness

(C) Seeds of *Lantana* are predominantly dispersed by fruit eating birds

(D) *Hyparrhenia rufa* raises rate of nitrogen cycling

The incorrect statements are:

- (a) None (b) A and B (c) B and D (d) A and D

31. Invasive species can:

- (a) Deplete water supplies (b) Clog water works
(c) Impede navigation (d) All

32. Which one of the following is not an invasive amphibian?

- (a) *Bufo marinus* (b) *Rana pipens*
(c) *Rana catesbeiana* (d) *Eleutherodactylus coqui*

33. Which one of the following is associated with invasion process?

- (a) 10's rule (b) 100's rule (c) Allen's rule (d) None

34. Which one of the following is an invasive land plant?

- (a) Pump wood (b) Quinine tree (c) Mimosa (d) All

35. Invasive species:

- (a) Tend to be hardy (b) Long lived
(c) Aggressively pervasive and very resilient (d) All

36. Consider the following statements:

- (A) Alien species are causing global warming and climate change by destroying natural resources
(B) For an alien species to become invasive, it must arrive, survive and thrive
(C) Ug⁹⁹ is a stem rust virus invading wheat causing the loss of almost the entire crop in many African countries
(D) All wheat varieties cultivated in Asia are susceptible to Ug⁹⁹

The incorrect statements are:

- (a) None (b) A, B and C (c) B and D (d) C and D

37. *Eupatorium* depresses the growth and yield of:

- (a) Rubber (b) Coffee (c) Tea and mango (d) All

38. Which one of the following invasive alien species grows 8 to 9 cm a day and chokes larger trees like coconut and oil palm?

- (a) *Parthenium* (b) *Mikania* (c) *Phalaris minor* (d) *Centaurea solstitialis*

39. Which one of the following has been introduced in India along with supply of P.L.480 wheat?

- (a) *Parthenium* (b) *Euphorbia* (c) *Tamarix* (d) *Myrica*

40. Which one of the following is highly fire-adapted species?

- (a) *Bromus tectorum* (b) *Aegilops triuncialis* (c) *Centaurea diffusa* (d) Zebra mussel

41. The roots of *Eichhornia crassipes* absorb:

- (a) Organic compounds (b) Lead and mercury
(c) Strontium-90 (d) All

42. 8-hydroxyquinoline is produced by the root of:

- (a) *Eichhornia crassipes* (b) *Bromus tectorum*
(c) *Centaurea diffusa* (d) *Aegilops triuncialis*

43. Which one of the following is not a trait of invasive species?

- (a) Fast growth (b) Ability to reproduce asexually and sexually
(c) Highly mutability rate (d) Phenotypic plasticity

166 Ecology and Animal Behaviour

44. Which one of the following Asian carp is invasive?
(a) Black carp (b) Grass carp (c) Silver carp (d) All
45. Which one of the following is rapidly colonising in the Thar desert in India?
(a) *Lantana camara* (b) *Euphorbia esula* (c) *Opuntia stricta* (d) *Prosopis juliflora*
46. Which one of the following from South America has been used in Australia to control water hyacinth?
(a) *Neohydronomous affinis* (b) *Neochetina bruchi*
(c) *Lymantria dispar* (d) *Vespula vulgaris*
47. Which one of the following causes decreased productivity in pastures and forests as well as poisons cattle?
(a) *Orbea variegata* (b) *Lantana camara*
(c) *Prosopis juliflora* (d) *Impatiens glandulifera*
48. Which one of the following is an invasive species of forests?
(a) *Achatina fulica* (b) *Bufo marinus* (c) *Boiga irregularis* (d) All
49. Which one of the following nematode is an invasive species of forests?
(a) *Bursaphelenchus xylophilus* (b) *Platydemus manokwari*
(c) *Wilsonema* (d) *Aproctonema*
50. Which one of the following is incorrect?
(a) More than 40 per cent of the plant species in India are alien, of which 25 per cent are invasive
(b) In India, most alien species are post-Columbian introductions
(c) Many of the aquatic invasive species in India were introduced as ornamentals
(d) All
51. Which one of the following is an Indian invasive weed?
(a) *Galinsoga parviflora* (b) *Parthenium hysterophorus*
(c) *Ageratum conyzoides* (d) All

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (a) | 2. (d) | 3. (a) | 4. (d) | 5. (d) | 6. (b) | 7. (c) | 8. (d) |
| 9. (b) | 10. (b) | 11. (c) | 12. (a) | 13. (b) | 14. (c) | 15. (d) | 16. (d) |
| 17. (b) | 18. (c) | 19. (a) | 20. (d) | 21. (b) | 22. (a) | 23. (d) | 24. (c) |
| 25. (d) | 26. (a) | 27. (d) | 28. (b) | 29. (d) | 30. (c) | 31. (d) | 32. (b) |
| 33. (a) | 34. (d) | 35. (d) | 36. (a) | 37. (d) | 38. (b) | 39. (a) | 40. (a) |
| 41. (d) | 42. (c) | 43. (c) | 44. (d) | 45. (d) | 46. (a) | 47. (b) | 48. (d) |
| 49. (a) | 50. (d) | 51. (d) | | | | | |

Fill in the Blanks

1. The three phases of plant invasion are _____, _____ and _____.
2. The alien species which locally become dominant and invade natural communities are called _____ species.
3. The major steps controlling the problem of invasive species are _____, _____, _____ and _____.

4. The ability of a genotype to modify its growth and development in response to environmental changes is referred to as _____.
5. Giant African snail was introduced in India around _____ in _____.
6. Eurasian carp was first introduced to the _____ as potential food source.
7. Zebra mussels were first discovered in the _____ in the year 1960.
8. _____ water is a major source of introducing non-native species into aquatic ecosystems.
9. In the 1980s, _____ were introduced in Australia to control rabbits.
10. Comb jelly was introduced to the Black Sea via _____ in the 1980s.
11. _____ and _____ are common woody invasive species.
12. Water hyacinth was introduced in India from _____ as an ornamental plant.
13. About _____ per cent of the Indian flora constitutes adventive aliens.
14. Excessive water used by invasion of _____ sp and _____ sp in South Africa has caused major water loss.
15. _____ and _____ are important sources of biological invasions within tropics and subtropics.
16. _____ was brought to India by the British in 1807 as an ornamental plant for the Botanical Garden of Kolkata.
17. *Phalaris minor* affects the _____ crop and has curtailed yield by 5 million tones a year.
18. _____ is an invasive alga, which was released into Mediterranean Sea in the 1980s.
19. One hectare of standing crop of *Eichhornia crassipes* can produce more than _____ of biogas.
20. The Global Invasive Species Programme was initiated in _____ for controlling alien species.
21. In article _____, the Convention on Biological Diversity (CBD), directs governments to prevent the introduction of, control or eradicate those alien species which are harmful to species, habitat or ecosystems.

Answers to Fill in the Blanks

- | | |
|--|---------------------------|
| 1. Introduction, colonisation, naturalisation | 2. Invasive |
| 3. Prevention, early detection, eradication, control | 4. Phenotypic plasticity |
| 5. 1857, Bengal | 6. United States |
| 8. Ballast | 9. Red foxes |
| 11. <i>Lantana camara</i> , <i>Pinus</i> | 10. Shipping industry |
| 14. <i>Acacia</i> , <i>Hakea</i> | 13. 18 |
| 17. Wheat | 16. <i>Lantana</i> |
| 20. 1997 | 19. 70,000 m ³ |
| | 21. Eight |

True or False

1. Species with specialised pollinators are very much invasive.
2. Angiospermic plants are a dominant group of invasive species.
3. The invasive species are known to alter fire regimes.
4. Disturbed habitats are more prone to invasion in comparison to undisturbed habitats.

168 Ecology and Animal Behaviour

5. The wetlands and the rice plants are being threatened by apple snail.
6. Homeostasis of ecosystem is disturbed by the invasive species.
7. Building fences is one of the management method used to fight invasive plants.
8. Fruits and seeds of invasive species are more nutritious.
9. Non-native crops and livestock comprise 98 per cent of food in USA.
10. Immigration by single species may cause a large number of extinction and drastically alter the physical environment.
11. Pigs are the worst invasive alien species.
12. Nutria is not an invasive alien species.
13. Invasive species represent all taxonomic groups but does not originate from all continents.
14. Invasive species can cause noise pollution.
15. Climate change favours invasiveness.
16. Invasive species are highly adaptable.
17. Species having shorter geographical ranges are potentially more invasive.
18. Invasion species cause change in geomorphology and hydrology of the invaded area.
19. Invasion is a smooth process.
20. Human actions are the primary means of introduction of invasive species.
21. Invasive aquatic animals have to live entirely in water.

Answers to True or False

- | | | | | | | | |
|-----------|----------|----------|-----------|-----------|----------|----------|----------|
| 1. False | 2. True | 3. True | 4. True | 5. True | 6. True | 7. False | 8. False |
| 9. True | 10. True | 11. True | 12. False | 13. False | 14. True | 15. True | 16. True |
| 17. False | 18. True | 19. True | 20. True | 21. False | | | |

Give Reasons

1. Islands are particularly vulnerable to invasive alien species.
 - Because of their natural isolation from strong competitors and predators.
2. Less isolated islands tend to support more species than remotes ones.
 - Because of higher rate of immigration.
3. Native ecosystems that have undergone human induced disturbance are more prone to alien invasions.
 - Because of less competition from the native species.
4. Zebra mussel is a highly invasive species.
 - Because it has displaced several species of Molluscs as well as clogs and colonises pipes.
5. *Tamarix sp* has reduced water level in the Mojave and Sonoran deserts of North America.
 - Because of its high transpiration rate.
6. *Eichhornia crassipes* is one of the best sources of biomass.
 - Because of its very high rate of growth.

ECOTOXICOLOGY

Multiple-Choice Questions

1. The term 'ecotoxicology' was coined by:
(a) C L Prosser (1964) (b) H T Odum (1956)
(c) Rene Truhaut (1959) (d) T S Perel (1975)
2. Which one of the following is used in aquatic toxicology tests?
(a) *Clarius batrachus* (b) *Mystus cavasius* (c) *Mytilus edulis* (d) All
3. Acute studies are short-term studies having exposure periods generally lasting for:
(a) 20 to 30 hours (b) 35 to 50 hours (c) 48 to 96 hours (d) 60 to 125 hours
4. Who gave the statement 'All substances are poisons; there is none which is not a poison. It is the right dose that differentiates a poison and a remedy':
(a) Aristotle (b) Paracelsus (c) Orfila (d) Hooper
5. Who is referred to as the 'Founder of Toxicology'?
(a) Orfila (b) Socrates (c) Claudius (d) Isacc
6. Which one of the following about toxicants is incorrect?
(a) Substances that produce adverse biological nature (b) May be physical or chemical in nature
(c) Effects may be acute or chronic (d) Usually have immediate effects
7. Benzene is mainly toxic to the:
(a) Blood-forming tissues (b) Brain-forming tissues
(c) Lungs and trachea forming tissues (d) Gonads forming tissues
8. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Toluene	1. Damages nerves and brain
(B) Formaldehyde	2. Phototoxic to plants
(C) Aldrin	3. Impaired coordination
(D) Ethylene	4. Lung carcinogen

Answer codes:

A	B	C	D
(a) 4	3	2	1
(b) 3	4	1	2
(c) 2	3	4	1
(d) 4	1	2	3
9. Elemental mercury does not cause:
(a) Irritability (b) Depression
(c) Coagulation of proteins (d) Insomnia

170 Ecology and Animal Behaviour

10. Which one of the following can reduce IQ in young children even in small doses?
(a) Mercury (b) Lead (c) Cadmium (d) Naphthalene
11. Organophosphorus compounds are absorbed by the:
(a) Skin (b) Gastrointestinal tract (c) Respiratory tract (d) All
12. Which one of the following isotopes has the highest half life?
(a) ^{14}C (b) ^{235}U (c) ^{90}Sr (d) ^{134}Cs
13. The radionuclide having principal radiation of α rays is:
(a) ^{90}Sr (b) ^{137}C (c) ^{238}U (d) ^{131}I
14. Which one of the following is the target tissue of head?
(a) Kidney (b) Central nervous system
(c) Hematopoietic system (d) All
15. The composition of gasoline varies with:
(a) Octane level (b) Manufacturer (c) Season (d) All
16. Highest accumulation of mercuric mercury (Hg^{2+}) occurs in:
(a) Brain (b) Lungs (c) Kidneys (d) Blood
17. Biological monitoring of mercuric mercury (Hg^{2+}) is done through:
(a) Urine (b) Blood
(c) Blood and urine (d) Hair, blood and urine
18. Which one of the following causes methaemoglobinemia?
(a) Malathion (b) Pentachlorophenol
(c) Aniline organonitrogen compounds (d) Paraquate
19. Which one of the following is not used in nuclear reactors?
(a) ^{137}Cs (b) ^{222}Rn (c) ^{40}K (d) None
20. Which one of the following is absorbed in bones?
(a) Strontium (b) Phosphorous (c) Cs (d) All
21. Polycyclic aromatic hydrocarbons (PAS) enter the body through:
(a) Inhalation (b) Ingestion (c) Absorption (d) All
22. Which one of the following is a suitable biomarker for polycyclic aromatic hydrocarbons in animals as well as humans?
(a) Cytochrome 1A1 (b) Cytochrome 1B1 (c) Both (a) and (b) (d) None
23. Which one of the following causes prostaglandin irregularities?
(a) Alkyl phenol resin (b) Naphthalene
(c) Acetone (d) Acetaldehyde
24. Dioxins cause:
(a) Vitamin A dysregulation (b) Genetic damage
(c) Altered fat metabolism (d) All
25. Thyroid hormone dysregulation is caused by:
(a) Polybrominated biphenyls (b) Polychlorinated biphenyls
(c) Pentachlorophenol (d) Phenols
26. Ricin is derived from:
(a) Caster oil plant (b) Wheat plant (c) Apple plant (d) Barley plant
27. Which one of the following is a pesticide?
(a) Mirex (b) Dioxin (c) Kepone (d) All

28. Consider the following statements:
 (A) Latent virus in symbiotic zooxanthellae, can be induced by ultra light and temperature stress
 (B) An organism's response to toxic materials can be influenced by other organisms in the community
 (C) A fish exposed to pollution may be able to escape from its predators
 (D) An ecosystem's response to toxic materials is not influenced by environmental conditions
 The incorrect statements are:
 (a) All (b) A and B (c) C and D (d) A and D
29. Which one of the following is incorrect?
 (a) Fipronil is a highly effective insecticide.
 (b) Fipronil degrades slowly on vegetation and more rapidly in water and soil.
 (c) Fipronil is a potent disrupter of insects' central nervous system.
 (d) Fipronil is relatively immobile in soil.
30. One of the main degradation products of fipronil in vertebrates and invertebrates is capable of accumulating _____ from the aquatic environment:
 (a) Lead (b) Zinc (c) Copper and cadmium (d) All
31. Clams tend to accumulate _____ in the greatest concentration:
 (a) Lead (b) Mercury (c) Zinc (d) Cadmium
32. Which one of the following causes bioaccumulation of acetylcholine?
 (a) Organophosphate (b) Nerve gases (c) Methyl mercury (d) Azide
33. Gold nanoparticles cause:
 (a) Increase level of dopamine (b) Decrease level of serotonin
 (c) Damage the learning and memory efficiency of mice (d) All
34. Bioaccumulation of cadmium does not occur in:
 (a) Kidneys (b) Liver (c) Animal fat (d) Tobacco plants
35. Cytotoxic anoxia is caused by:
 (a) Nerve gases (b) Cyanide and azide (c) Doxorubicin (d) Botulinum toxin
36. Which one of the following about paraoxon is correct?
 (a) More potent inhibitor of cholinesterase (b) Produces super oxide radicals
 (c) Stimulates synthesis of heme (d) Carcinogenic
37. Tributyltin (TBT):
 (a) Is a biocide (b) Disrupts sex organs
 (c) Disrupts sex-related hormones (d) All
38. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Parathion	1. Protoplasmic poison
(B) Dimethyl sulphate	2. Skin and respiratory disease
(C) Nerve gas	3. Poison to the central nervous system
(D) Phenol	4. Carcinogenic

 Answer codes:

A	B	C	D
(a) 2	4	3	1
(b) 4	3	1	2
(c) 3	2	4	1
(d) 4	1	3	2

39. Which one of the following is responsible for phocomelia?
 - (a) Thalidomide
 - (b) Tobacco
 - (c) Methyl sulfuric acid
 - (d) Paraquate
40. Which one of the following accumulates in animal fat?
 - (a) Dioxins
 - (b) Polychlorinated biphenyls
 - (c) Polycyclic aromatic hydrocarbons
 - (d) All
41. Which one of the following is a toxicant that blocks the release of acetylcholine at the neurotransmitter and causes death by paralysis of respiratory muscles?
 - (a) Lead
 - (b) Methyl mercury
 - (c) Botulinum toxin
 - (d) Adriamycin
42. Which one of the following causes anaemia and reduction in blood cells?
 - (a) Monochloride
 - (b) Carbofuran
 - (c) Naphthalene
 - (d) Phosphine
43. Which one of the following radio nuclides has the minimum half life?
 - (a) U_{235}
 - (b) ^{131}I
 - (c) ^{89}Sr
 - (d) ^{222}Rn
44. Consider the following statement:
 - (A) Oil solution toxin tends to penetrate tissues and cells and is utilised in metabolic activities
 - (B) Gamma rays are short wavelengths and have the ability of deep penetration
 - (C) ^{14}C and ^{40}K are the naturally occurring radio nuclides and have very long life
 - (D) Effective dose (ED) 50 is the dose that affects 50 per cent of the observed subjects
 The incorrect statements are:
 - (a) All
 - (b) A and B
 - (c) C and D
 - (d) A
45. Which one of the following is a group of most toxic metals?
 - (a) Zinc, copper and lead
 - (b) Copper, cobalt and mercury
 - (c) Cadmium, mercury and lead
 - (d) Selenium, nickel and iron
46. Which one of the following affects neurotransmitter activity?
 - (a) Aldrin
 - (b) Lindane
 - (c) Both lindane and aldrin
 - (d) None
47. Itai-itai disease is associated with:
 - (a) Mercury
 - (b) Cadmium
 - (c) Zinc
 - (d) Selenium
48. Which one of the following is a SO_2 resistant plant?
 - (a) Corn
 - (b) Barley
 - (c) Wheat
 - (d) Apple
49. Methyl mercury readily combines with:
 - (a) Nitrate
 - (b) Chloride
 - (c) Hydroxide
 - (d) All
50. The half life of methyl mercury in human blood is about:
 - (a) 5 days
 - (b) 50 days
 - (c) 75 days
 - (d) More than one year
51. Methyl mercury causes:
 - (a) Chromosomal abnormalities
 - (b) Neurological damage
 - (c) Congenital birth defects
 - (d) All
52. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Apple	1. Indicator of deep water table
(B) <i>Chlamydomonas</i> sp	2. Indicate the presence of seral communities
(C) <i>Prosopis</i>	3. Bioindicator of pollution by paper mill effluent
(D) <i>Polygonum</i>	4. Bioindicator of SO_2 pollution

Answer codes:

	A	B	C	D
(a)	4	1	2	3
(b)	4	3	1	2
(c)	3	1	2	4
(d)	2	3	4	1

53. Mercury poisoning causes:
 - (a) Minamata disease
 - (b) Hunter–Russell syndrome
 - (c) Pink disease
 - (d) All
54. Which one of the following appears to be more sensitive to cadmium?
 - (a) Crustaceans
 - (b) Molluscs
 - (c) Polychaetes
 - (d) Echinoderms
55. Treatment of fish with cadmium reduces their ability to:
 - (a) Reproduce
 - (b) Osmoregulate
 - (c) Swim
 - (d) Respire
56. Which one of the following about the most desirable species for toxicity testing is incorrect?
 - (a) Have large body size
 - (b) Have short life cycle
 - (c) Mature quickly
 - (d) Thrive in laboratory condition and can be easily handled
57. The activity of cytochrome oxidase is inhibited by:
 - (a) Nerve gases
 - (b) Methyl mercury
 - (c) Cyanide
 - (d) Methyl mercury
58. Bioaccumulation of organochlorine pesticides occurs in:
 - (a) Bones
 - (b) Kidneys
 - (c) Liver
 - (d) All
59. Warfarin is antimetabolite to vitamin:
 - (a) C
 - (b) B complex
 - (c) D
 - (d) Vitamin K
60. Which one of the following exerts its toxic effect by blockage of the Krebs cycle?
 - (a) Sodium fluoroacetate
 - (b) Azide
 - (c) Polycyclic aromatic hydrocarbons
 - (d) Thiourea
61. Atrazine interferes with the:
 - (a) Secretion of hormones
 - (b) Synthesis of hormones
 - (c) Binding of hormones with receptors
 - (d) All
62. Organochlorines:
 - (a) Are persistent in soils
 - (b) Bioaccumulates in fat
 - (c) Magnify through food chains
 - (d) All
63. In the food chains of vertebrates, which one of the following accumulates particularly at higher level?
 - (a) Uranium
 - (b) Strontium
 - (c) Strontium and cesium
 - (d) Cesium and thorium
64. Which one of the following does not accumulate in the food chains of Arthropods?
 - (a) Strontium
 - (b) Sodium
 - (c) Sodium and phosphorous
 - (d) Strontium and cesium
65. Which one of the following is applicable to sublethal effects?
 - (a) Behavioural changes
 - (b) Retardation of growth
 - (c) Reproductive impairment
 - (d) All
66. Which one of the following isotopes was not emitted in the accident of the Chernobyl Nuclear Power Plant in 1986?
 - (a) ^{134}Cs
 - (b) ^{131}I and ^{137}Cs
 - (c) ^{90}Sr
 - (d) ^{222}Rn

174 Ecology and Animal Behaviour

67. Which one of the following accumulates in the food chains of Arthropods?
 (a) Potassium (b) Sodium (c) Phosphorous (d) All
68. Effect of which one of the following is magnified through food webs?
 (a) Heavy metals (b) DDT
 (c) Polychlorinated biphenyls (d) All
69. Polar substances have definite advantage over lipid-soluble toxicants with regards to elimination from the body except:
 (a) Blood (b) Lungs (c) Intestine (d) Skin
70. Tetrodotoxin is produced from:
 (a) Puffer fish (b) *Clarius* (c) *Clostridium botulinum* (d) *Salmo gairdneri*
71. Consider the following statements:
 (A) There is evidence that presence of DDT in the environment causes birth defects
 (B) Plants such as corn, peas and wheat have very low levels of mercury, even if grown in soils containing higher levels of mercury
 (C) Mushrooms are unable to accumulate higher levels of mercury, even if grown in mercury-contaminated soils
 (D) Methyl mercury is the form of mercury easily absorbed by the gastrointestinal tract
- The incorrect statements are:
 (a) All (b) A, B and C (c) A, C and D (d) C and D

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (c) | 2. (d) | 3. (c) | 4. (b) | 5. (a) | 6. (d) | 7. (a) | 8. (b) |
| 9. (c) | 10. (b) | 11. (d) | 12. (b) | 13. (c) | 14. (d) | 15. (d) | 16. (c) |
| 17. (c) | 18. (c) | 19. (d) | 20. (d) | 21. (d) | 22. (c) | 23. (a) | 24. (d) |
| 25. (b) | 26. (a) | 27. (d) | 28. (c) | 29. (b) | 30. (d) | 31. (b) | 32. (a) |
| 33. (d) | 34. (c) | 35. (b) | 36. (a) | 37. (d) | 38. (a) | 39. (a) | 40. (d) |
| 41. (c) | 42. (c) | 43. (d) | 44. (d) | 45. (c) | 46. (c) | 47. (b) | 48. (a) |
| 49. (d) | 50. (b) | 51. (d) | 52. (b) | 53. (d) | 54. (a) | 55. (b) | 56. (a) |
| 57. (c) | 58. (d) | 59. (d) | 60. (a) | 61. (d) | 62. (d) | 63. (c) | 64. (d) |
| 65. (d) | 66. (d) | 67. (d) | 68. (d) | 69. (b) | 70. (a) | 71. (c) | |

Fill in the Blanks

- A field of science that studies the effects of toxic substances on the ecosystem is referred to as _____.
- The chemicals that cause birth defects are called _____.
- One of most important degradation products of fipronil is the fipronil _____, which is generally more toxic than the parent compound.
- Dioxin is very persistent in soil except when exposed to _____.
- _____ is a process by which organisms convert absorbed chemicals into other chemicals.

6. The process of hyper-accumulation of toxic chemicals from affected soil or water by plant or animal species is known as _____.
7. Methyl mercury is formed from inorganic mercury by the action of _____ organisms.
8. Methyl mercury has a half life of _____ days in aquatic organisms.
9. The _____ system is the critical organ for mercury vapour exposure.
10. Inorganic mercury is mainly deposited in the _____.
11. The inhalation of asbestos causes _____.
12. The radioactive dust that falls on the earth as a result of atomic explosions is referred to as _____.
13. Radioactive decay was discovered by _____.
14. _____ transfer is the most common way that xenobiotics cross cell membranes.
15. When the biotransformation results in metabolites of lower toxicity, the process is called _____.
16. Xenobiotic is converted into less toxic substances especially in the _____.
17. Generally, insecticides act upon the _____ system.
18. Chromium compounds will generally exist in air for about less than _____ days.
19. Chromium _____ helps the body to use sugar, protein and fat.
20. In general, chromium VI is more toxic than chromium _____.
21. Lead is widespread in soils in all areas of the world except those of _____.
22. All major _____ elements breakdown and create lead as one of their end products.
23. Paraquat exerts its toxicity through the formation of _____.
24. Botulinum toxin blocks the release of _____.
25. _____ is the only process that can completely mineralise a chemical to inert materials.
26. Bismuth poisoning mostly affects the _____ and _____.

Answers to Fill in the Blanks

- | | | |
|----------------------------|----------------------|-------------------------|
| 1. Ecotoxicology | 2. Teratogens | 3. Desulphinyl |
| 4. Light | 5. Biotransformation | 6. Bioremediation |
| 7. Anaerobic | 8. 72 | 9. Central nervous |
| 10. Kidney | 11. Asbestosis | 12. Radioactive fallout |
| 13. Henri Becquerel (1896) | 14. Passive | 15. Detoxification |
| 16. Liver | 17. Nervous | 18. 10 |
| 19. III | 20. III | 21. Polar regions |
| 20. Radioactive | 21. Free radicals | 24. Neurotransmitter |
| 25. Biodegradation | 26. Kidney, liver | |

True or False

1. Toxic substances always have constant composition.
3. Xenobiotic chemicals do not act as carcinogens.

176 Ecology and Animal Behaviour

4. Silver has bactericidal properties.
5. Polycyclic aromatic hydrocarbons modulate the expression profile of cytochrome P450 (CYP).
6. In most cases, chemical analysis cannot predict environmental consequences.
7. Kepone is a nonpersistent pesticide.
8. Toxins absorbed in the body are metabolised, transported or excreted.
9. Inorganic mercury compounds are more toxic than organic forms.
10. In seabirds, 70 per cent of mercury is contained in the plumage.
11. The inhibition of acetylcholine esterase by carbamate is irreversible.
12. Radionuclides are stable isotopes.
13. Atrazine is an endocrine disrupter.
14. Biotransformation is a key body defence mechanism.
15. The biotransformation process is perfect.
17. Polycyclic aromatic hydrocarbons are the constituents of tobacco smoke.
19. *Ryania speciosa* is a natural pesticide
20. Diet is the major source of human exposure to methyl mercury.
21. Methyl mercury is a neurotoxin.
23. Reduction reactions frequently result in activation of a xenobiotic substance rather than detoxification.
25. Chemicals bound to protein accumulate in the liver, kidneys and other tissues.
26. Lindane is an herbicide.
27. Allethrin is a growth hormone.
28. Fatty change is usually observed in the liver.
29. Fishes do not accumulate more chromium in their body from water.

Answers to True or False

- | | | | | | | | |
|----------|-----------|-----------|----------|-----------|-----------|----------|----------|
| 1. False | 2. False | 3. True | 4. True | 5. True | 6. False | 7. True | 8. False |
| 9. True | 10. False | 11. False | 12. True | 13. True | 14. False | 15. True | 16. True |
| 17. True | 18. True | 19. True | 20. True | 21. False | 22. False | 23. True | 24. True |

Give Reasons

1. Ecotoxicological studies involve only plants and animals.
 - Because toxicity is the study between a living system and a substance.
2. It is essential to keep ecosystems healthy.
 - Because people depend on ecosystems for food production, waste processing and biodiversity.
3. Ecotoxicologists test a few representative species to characterise toxicity.
 - Because each one of millions of species on this planet cannot be tested.

4. Methyl mercury is biomagnified in aquatic food chains.
 - Because it is formed in aquatic systems and is not readily eliminated from organisms.
5. Atrazine that enters groundwater or surface water can remain there for a much longer time.
 - Because of its slow nature of breakdown in water.
6. In mouth and oesophagus, xenobiotics are poorly absorbed.
 - Mainly because of their short residence in these parts of the gastrointestinal tract.
7. Skin is a barrier to most xenobiotics.
 - Because it is a complex multilayer tissue.
8. The plasma level of xenobiotic is important.
 - Because it generally reflects the concentration of the toxicant at the site of action.
9. Methyl mercury is of particular concern.
 - Because it can build up in certain edible freshwater and saltwater fishes and marine mammals to levels that are many times greater than levels in the surrounding water.
10. Lead is used for safe storage of radioactive materials.
 - Because lead can absorb radiation from radioactive isotopes.
11. In mammalian toxicology, toxicity is predictable
 - Because mammals are warm blooded and their body temperature is relatively constant and is almost independent of environmental temperature.
12. Aquatic toxicology is one of the most important branches.
 - Because of importance of water in day-to-day life as well as importance of aquatic animals in aquaculture and research.

POLLUTION

Multiple-Choice Questions

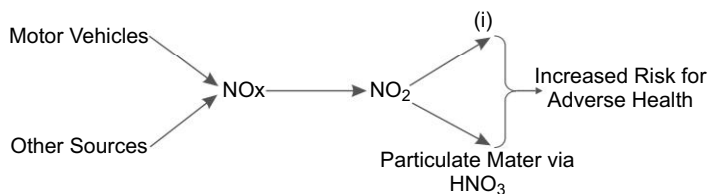
1. Which one of the following is not a primary pollutant?
(a) Sulphur dioxide (b) Suspended particulate matter
(c) Sulphuric acid (d) Oxides of nitrogen
2. Which one of the following constituents of air has not increased in recent years?
(a) Methane (b) Suspended particulate matter
(c) N₂O (d) None
3. Burning of biomass results in the formation of:
(a) N₂O (b) NO (c) NO₂ (d) All
4. Methane is not produced from:
(a) Paddy fields (b) Burning of biomass
(c) Guts of livestock (d) Photochemical reactions
5. Which one of the following about chlorofluorocarbons is incorrect?
(a) Toxic (b) Caustic (c) Corrosive (d) All
6. Depletion of ozone is caused by:
(a) NO_x (b) H₂S
(c) Photochemical smog (d) CH₄
7. Transport vehicles contribute to:
(a) CO (b) NO_x
(c) Hydrocarbon emission (d) All
8. Greenhouse gas is not applicable to:
(a) Chlorofluorocarbons (b) Oxygen
(c) Carbon dioxide (d) Methane
9. Which one of the following absorbs ultraviolet radiations?
(a) Ozone (b) Methane
(c) Nitric oxide (d) Photochemical smog
10. Chemically oxidising smog:
(a) Contains nitrogen oxides (b) Contains ozone and organic peroxide compounds
(c) Is free of sulphur dioxide (d) All
11. Match column I with Column II and select the correct answer using answer codes:

Column I	Column II
A) Ricin	1. Affects cellular oxidation
B) Phosphorus	2. Has suffocating effect
C) Chlorine	3. Irritant
D) Croton	4. Allergen

Answer codes:

	A	B	C	D
(a)	4	1	2	3
(b)	3	2	1	4
(c)	2	3	4	1
(d)	4	3	2	1

12. Particulate occurs as:
 (a) Mists (b) Dusts (c) Sprays (d) All
13. Particulate matter may significantly affect the:
 (a) Thermal budget of the atmosphere (b) Radiation
 (c) Both (a) and (b) (d) None
14. Blue lining along the gums is a characteristic feature of acute poisoning of:
 (a) Silver (b) Lead (c) Nitrate (d) Mercury
15. Which one of the following about corrosives is correct?
 (a) They coagulate the cellular protein (b) Change haemoglobin into acid haematin
 (c) Remove water from the tissues (d) All
16. Which one of the following is a sensitive indicator of SO_2 pollution?
 (a) *Poa annua* (b) *Taxus baccata* (c) *Petunia* (d) *Mangifera indica*
17. Consider the following statements:
 A) Air-pollution tolerant plant species rapidly synthesise abscisic acid
 B) Acid rain increases visibility through the air
 C) Air pollutants are first deposited upon the canopy of forests
 D) Increased input of nitrogen due to air pollution leads to increase in species diversity
 The correct statements are:
 (a) All (b) A, B and C (c) A and C (d) C and D
18. Which one of the following has positive effect on air pollutants?
 (a) Wind velocity (b) Mountain (c) Humidity (d) Plains
19. Which one of the following causes pollution by increasing acidity?
 (a) Carbon dioxide (b) Sulphur dioxide
 (c) Sulphur dioxide and nitrogen dioxide (d) Nitrogen dioxide and carbon monoxide
20. Which one of the following is formed in the presence of the sun?
 (a) O_3 (b) NO (c) NO_2 (d) All
21. At ground level, ozone is harmful to:
 (a) Plants (b) Animals (c) Humans (d) All
22. In the given chart, the products at labelled (I) are:
 (a) O_3 and smog (b) O and PAN
 (c) O_3 , smog and N_2O (d) O_3 , PAN and other oxidant



23. Pollution time bomb is applicable to:
 (a) Britain (b) South Africa (c) France (d) Kenya
24. Fire extinguishers contain:
 (a) Nitrogen oxides (b) Chlorofluorocarbons (c) Halons (d) Carbon dioxide
25. Which one of the following causes etching of marble limestone and jewellery?
 (a) Sulphur dioxide (b) Carbon dioxide (c) Carbon monoxide (d) Ozone
26. A gas is:
 A) Colourless B) Odourless C) Non-irritating D) Very poisonous
 This gas is:
 (a) Carbon dioxide (b) Carbon monoxide (c) Nitrogen dioxide (d) Sulphur dioxide
27. Which one of the following is not applicable to ammonia?
 (a) Pungent odor (b) Emitted from agricultural processes
 (c) Caustic and hazardous (d) Greenhouse gas
28. Persistent organic pollutants are:
 (a) Resistant to environmental degradation (b) Bioaccumulate in human and animal tissue
 (c) Biomagnify in food chains (d) All
29. Which one of the following is a fine particulate?
 (a) Sulphate (b) Dust (c) Asbestos fibres (d) Lead
30. Black carbon air:
 (a) Damages the cardiovascular system (b) Damages the respiratory system
 (c) Lowers IQ in children (d) All
31. Which one of the following is not a natural air pollutant?
 (a) Smoke (b) Pollen and spores (c) Volcanic ash (d) None
32. Which one of the following is associated with the depletion of oxygen in brain, heart, blood vessels, etc.?
 (a) Carbon dioxide (b) Carbon monoxide (c) Ammonia (d) Sulphur dioxide
33. Highest pollution emissions are shown by:
 (a) Cars (b) Light trucks (c) Full-size trucks (d) Motor cycles
34. Usually ozone occurs in higher concentrations during:
 (a) Summer and in rural areas (b) Winter and in urban areas
 (c) Summer and in urban areas (d) Winter and in rural areas
35. Which one of the following is affected by ozone?
 (a) Function of lungs (b) Function of kidneys
 (c) Function of brain (d) Development of organs
36. Which one of the following is not applicable to ozone?
 (a) Toxic bluish (b) Stable gas
 (c) Pungent odor (d) Found naturally in atmosphere
37. The major source of atmospheric carbon monoxide is the:
 (a) Combustion of organic matter (b) Waste incineration
 (c) Road transport (d) Paddy fields
38. Chlorine mainly causes the decomposition of ozone when it is a part of:
 (a) Hydrochloric acid (b) Chloro-fluor-carbohydrates (CFC-bonds)
 (c) Organochlorines (d) Both (a) and (b)

39. Carbon monoxide contributes to:
 (a) Greenhouse effect (b) Acidification (c) Smog (d) All
40. Lead poisoning of mothers leads to:
 (a) Miscarriage (b) Still birth and premature birth
 (c) Premature death (d) All
41. Which one of the following is more susceptible to lead?
 (a) Brain (b) Heart (c) Eyes (d) Liver
42. Which one of the following is a suitable tree for transplanting in SO₂ polluted areas?
 (a) *Picea omorika* (b) *Taxus baccata* (c) *Acer plantanoides* (d) All
43. Match column I with column II and select the correct answer using answer codes:
 Column I (Air pollutant) Column II (Plant species)
 (A) Ozone 1. *Spinacia oleracea*
 (B) Peroxy acetyl nitrate 2. *Eruca sativa*
 (C) Ammonia 3. *Typha latifolia*
 (D) Hydrogen sulphide 4. *Phaseolus vulgaris*
 Answer codes:

	A	B	C	D
(a)	2	3	4	1
(b)	2	4	3	1
(c)	4	3	1	2
(d)	3	4	2	1
44. Consider the following statements:
 (A) Black carbon air lowers IQ in children
 (B) Strength of the wind and stability of the air affect the dispersion of pollutants
 (C) Air pollution is likely to be less near the centre of an anticyclone
 (D) Ozone is good in the ground level atmosphere and bad in the upper atmosphere
 The incorrect statements are:
 (a) A and B (b) C and D (c) B and D (d) None
45. The colour code applicable to moderate air quality index:
 (a) Yellow (b) Green (c) Blue (d) Pink
46. Disappearance of lichens in a forest may indicate:
 (a) High levels of sulphur dioxide (b) Nitrogen oxides
 (c) Sulphur-based pollutants (d) All
47. Which one of the following pollutants causes direct damage to leaves of crops?
 (a) Peroxy acyl nitrate (PAN) (b) Ozone
 (c) Nitrogen oxides and sulphur dioxide (d) All
48. The formation of ozone can take several to 24 hours depending on:
 (a) Amount of solar radiation received (b) Temperature
 (c) Relative humidity (d) All
49. The chemistry behind formation of ozone hole was described by:
 (a) Rowland, Molina and Crutzen (1995) (b) Ernst Augstein (1987)
 (c) Cogle et al. (1986) (d) Pender and Walker (1990)
50. Automobile exhaust lacks:
 (a) Fly ash (b) Nitrogen oxides

182 Ecology and Animal Behaviour

- (c) Carbon monoxide (d) Unburnt hydrocarbons
51. Ozone layer in the upper atmosphere is destroyed by:
 (a) Methane (b) NO_2 (c) Chlorofluorocarbons (d) All
52. Which one of the following causes acid rain?
 (a) SO_2 (b) NO_2
 (c) Both SO_2 and NO_2 (d) Hydrocarbons and SO_2
53. The degree of resistance to SO_2 differs with:
 (a) Species (b) Varieties and ecotypes (c) Life stages (d) All
54. Depletion of ozone layer may result in:
 (a) Skin cancer (b) Premature ageing
 (c) Suppression of immune system (d) All
55. Which one of the following ozone-depleting substances has the longest lifetime (in years)?
 (a) CFC-115($\text{C}_2\text{F}_5\text{Cl}$) (b) CFC-114($\text{C}_2\text{F}_4\text{Cl}_2$) (c) CFC-113($\text{C}_2\text{F}_3\text{Cl}_3$) (d) CFC-11(CCl_3F)
56. Which one of the following ozone-depleting substances has shortest lifespan?
 (a) Halon 1211(CF_2ClBr) (b) Halon 1301(CF_3Br)
 (c) CFC-113($\text{C}_2\text{F}_3\text{Cl}_3$) (d) CFC-111(C_2FCl_3)
57. Frequent asthma attacks, sore throats, cough and breathing troubles are caused by:
 (a) Nitrogen oxide (b) Sulphur dioxide (c) Ozone (d) Carbon monoxide
58. Which one of the following is a greenhouse gas?
 (a) Methane (b) Carbon dioxide (c) Nitrous oxide (d) All
59. Which one of the following is not created directly?
 (a) Methane (b) Ozone (c) Nitrogen dioxide (d) Nitrogen oxide
60. Which one of the following is screened by ozone?
 (a) Smog (b) Ultraviolet radiation from the sun
 (c) Particulate matter (d) All
61. Ozone hole was discovered in:
 (a) Antarctic (b) Arctic (c) Siberia (d) Peru
62. About 90 per cent of ozone in the earth's atmosphere is found in the:
 (a) Troposphere (b) Stratosphere (c) Thermosphere (d) Mesosphere
63. Consider the following statements:
 (A) Volatile organic compounds are organic chemicals that form a gas at room temperature
 (B) Gasoline and natural gas are the major source of volatile organic compounds
 (C) Butadiene is found in gasoline engine exhaust and cigarette smoke
 (D) Oxygenates contain carbon, hydrogen and oxygen and come from car exhaust and atmospheric chemical reactions
- The incorrect statements are:
 (a) A and B (b) B and C (c) D (d) None
64. For good air, the air quality index should be:
 (a) Below 100 (b) Above 100 (c) Above 200 (d) Above 300
65. Which one of the following is not present in vehicular exhaust emissions?
 (a) Ammonia (b) Carbon monoxide (c) Lead (d) Particulate matter
66. The pollutants associated with stunted lung growth in kids are due to:
 (a) Particulates (b) Pesticides (c) Sulphur dioxide (d) Ozone

67. When inhaled, ozone does not cause:
 (a) Decrease formation of RBCs (b) Reduced lung capacity
 (c) Coughing (d) Chocking
68. Which one of the following pairs is not a set of national quality standard of air pollutants given by the EPA?
 (a) Nitrogen oxide and ozone (b) Methane and carbon dioxide
 (c) Sulphur dioxide and particulate matters (d) Lead and carbon monoxide
69. Which one of the following helps in determining the levels of air pollution in a state or city?
 (a) Wind (b) Temperature (c) Geography (d) All
70. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|--------------------------|--|
| (A) Cyclone | 1. Used in cars |
| (B) Scrubber | 2. Traps particles by forcing air containing dust |
| (C) Bag house | 3. Removes heavy particles |
| (D) Catalytic converters | 4. Uses a liquid spray to remove aerosol and greenhouse substances |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 1 | 2 | 3 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 3 | 4 | 2 | 1 |
| (d) | 2 | 3 | 4 | 1 |
71. Cracking and weakening of rubber is caused by:
 (a) Hydrogen sulphide (b) Ozone (c) Sulphur dioxide (d) Nitrogen oxides
72. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-------------------------|-------------------------------|
| (A) 3, 4 bezopyrene | 1. Osteoporosis |
| (B) Fluorine | 2. Secondary pollutant |
| (C) Peroxy acyl nitrate | 3. Lung cancer |
| (D) Organophosphates | 4. Affects the nervous system |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 1 | 2 | 4 |
| (b) | 4 | 3 | 2 | 1 |
| (c) | 2 | 4 | 3 | 1 |
| (d) | 3 | 1 | 4 | 2 |
73. Which one of the following is applicable to paddy fields?
 (a) Hydrogen peroxide (b) Hydrogen sulphide (c) Methane (d) Carbon monoxide
74. Consider the following statements with reference to carbon monoxide:
 (A) Formed by incomplete combustion of fossil fuels
 (B) Major pollutant for humans and animals
 (C) Nontoxic to plants as such
 (D) Vegetation and soil are regarded as its natural sinks
- The correct statements are:
 (a) All (b) A and B (c) B and C (d) A and D

184 Ecology and Animal Behaviour

75. Ozone destruction involving chlorine and bromine compounds occurs fastest in _____ season:
 (a) Summer (b) Spring (c) Winter (d) Rainy
76. Nitrous oxide destroys ozone fastest in:
 (a) Summer (b) Spring (c) Winter (d) Autumn
77. Greenhouse gases are generated by:
 (a) Fossil fuel combustion and cutting down of forests (b) Industrial activities
 (c) Waste disposal in landfills (d) All
78. Depletion of ozone is caused by:
 (a) Chlorofluorocarbons (b) NO_2
 (c) Halocarbons (d) All
79. Which one of the following is applicable to ozone hole?
 (a) Global warming (b) Reduction in the rate of photosynthesis
 (c) Easier path of ultraviolet rays to the earth (d) All
80. Which one of the following is not applicable to carbon monoxide?
 (a) Highly poisonous (b) Tasteless (c) Pungent odor (d) Colorless
81. If a human has the following symptoms:
 (A) Reduced memory (B) High blood pressure
 (C) Disturbed sleep and mood (D) Headache and irritability
 It means s/he is suffering from exposure to:
 (a) Aluminium (b) Lead (c) Ozone (d) Nitrogen dioxide
82. Which one of the following is not an ozone-sensitive species?
 (a) Cucumber (b) Green bean (c) Pear (d) Grape
83. Beet, carrot and corn are sensitive to:
 (a) Ammonia (b) Fluoride (c) Particulate matter (d) Sulphur dioxide
84. Which one of the following is not associated with NO_2 pollution?
 (a) Lung damage (b) Respiratory disease (c) Eye irritation (d) Increased mortality
85. The biggest contributor of nitrogen dioxide:
 (a) Motor vehicles (b) Industries (c) Bushfires (d) Burning wood
86. Which one of the following occurs in the presence of ultraviolet radiation?
 (a) $\text{HC} + \text{NO} + \text{O}_2 \rightarrow \text{NO}_2 + \text{PAN}$ (b) $\text{NO}_2 \rightarrow \text{NO} + \text{O}$
 (c) $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}_2$ (d) $\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$
87. Which of the following can metabolise carbon monoxide?
 (a) *Pisum sativum* (b) *Zea mays* (c) *Ficus variegata* (d) *Pyrus*
88. Which one of the following pollutants affects decomposition and mineralisation?
 (a) H^+ (b) S (c) N (d) All
89. *Brassica oleracea* is a pollution-sensitive indicator of:
 (a) Ammonia (b) Ozone (c) Hydrogen sulphide (d) PAN
90. Match column I, II and III and select the correct answer using answer codes:
- | Column I (Air Pollutant) | Column II (Material) | Column III (Effects) |
|--------------------------|----------------------|------------------------|
| (A) Ozone | 1. Paints | P. Fading |
| (B) Nitrogen oxide | 2. Copper | q. Corrosion |
| (C) Sulphur oxide | 3. Silver | r. Tarnish |
| (D) Hydrogen sulphide | 4. Rubber | s. Cracking, weakening |

Answer codes:

- | | A | B | C | D |
|-----|------|------|------|------|
| (a) | 4, s | 1, p | 2, q | 3, r |
| (b) | 3, p | 4, r | 2, s | 1, q |
| (c) | 2, s | 4, r | 3, p | 1, q |
| (d) | 4, s | 3, r | 2, q | 1, p |

91. Which one of the following causes direct damage to leaves of crop plants and trees?
 - (a) Sulphur dioxide
 - (b) Nitrogen oxides
 - (c) Ozone and PAN
 - (d) All
92. An example of air pollution found in gasoline is:
 - (a) Benzene
 - (b) Toluene
 - (c) Xylene
 - (d) All
93. Which one of the following contains methylene chloride, converted by body into carbon monoxide?
 - (a) Paint strippers
 - (b) Adhesive removers
 - (c) Aerosol spray paints
 - (d) All
94. The first organisms to disappear with the increasing acidity of water:
 - (a) Annelids
 - (b) Arthropods
 - (c) Molluscs
 - (d) Protozoans
95. Black lung disease is caused by:
 - (a) Coal dust
 - (b) Hydrogen sulphide
 - (c) Silicon dioxide
 - (d) Carbon monoxide
96. Which one of the following was associated with deaths in the Bhopal tragedy?
 - (a) Potassium cyanide fumes
 - (b) Methyl isocyanate
 - (c) Carbon monoxide
 - (d) Acid rain
97. Consider the following statements:
 - (A) Photochemical smog was first observed in Los Angeles
 - (B) Photochemical smog is common in low temperature areas
 - (C) Methane gas decreases stratospheric water vapour on oxidation
 - (D) On mixing with air, N_2O quickly changes its forms
 The correct statements are:
 - (a) All
 - (b) A, B and C
 - (c) A and B
 - (d) C and D
98. Which one of the following is not applicable to nitrogen oxide?
 - (a) Acidification
 - (b) Eutrophication
 - (c) Mineralisation
 - (d) Formation of ozone
99. Which one of the following is correct?
 - (a) Carbon dioxide is a good transmitter of sunlight
 - (b) Carbon dioxide partially restricts infrared rays going back from the earth to space
 - (c) Currently, carbon dioxide is responsible for 57 per cent of the global warming being caused
 - (d) All
100. Decomposition of ozone is catalysed by:
 - (a) Chlorine (Cl) and bromine (Br)
 - (b) Nitrogen oxides
 - (c) Hydroxide (OH)
 - (d) All
101. SO_2 is associated with:
 - (a) Climate change
 - (b) Eutrophication
 - (c) Winter smog
 - (d) Photochemical smog
102. Which one of the following is not associated with acidification?
 - (a) CH_4
 - (b) SO_2
 - (c) NH_3
 - (d) NO_x
103. NO_x is associated with:
 - (a) Photochemical smog
 - (b) Acidification
 - (c) Eutrophication and climate change
 - (d) All

104. Which one of the following is not applicable to carbon monoxide?
 (a) Acidification (b) Eutrophication (c) Photochemical smog (d) Climate change
105. Which one of the following is not associated with climate change?
 (a) NO_x (b) NH₃ (c) CH₄ (d) VOC
106. Consider the following statements about nitrous oxide (N₂O):
 (A) It is a natural component of the earth's atmosphere
 (B) Its resident time in the atmosphere is about 170 years
 (C) It is important in greenhouse effect and causes nitrogen loading
 (D) It is emitted from deforestation, burning of biomass and nitrogen-based fertilisation
 The incorrect statements are:
 (a) None (b) B and C (c) C and D (d) B
107. Black carbon pollution is applicable to:
 (a) Particulate matter (b) Carbon dioxide (c) Carbon monoxide (d) Carbon tetrachloride
108. Methane:
 (a) Main source is agriculture (b) Contributes to greenhouse effect
 (c) Causes loss of ozone (d) All
109. Sound is annoying at a level of:
 (a) 50 dB (b) 100 dB (c) 60 dB (d) 80 dB
110. Lombard vocal response is related to:
 (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution
111. Noise pollution may lead to:
 (a) Changes in the immune system and birth defects (b) Hearing impairment, sleep disturbance and ischemic heart disease
 (c) Necrosis, apoptosis and stereocilia (d) All
112. Which one of the following is a silent form of pollution?
 (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution
113. Which one of the following contributes to environmental noise pollution?
 (a) Mixer grinders (b) Dripping taps (c) Ticking of clocks (d) All
114. High noise levels may interfere with _____ of animals:
 (a) Feeding behaviours (b) Migratory paths
 (c) Breeding rituals (d) All
115. Repeated exposures to sound in excess of _____ may cause gradual loss of hearing:
 (a) 30 to 50 dB (b) 80 to 90 dB (c) 100 to 120 dB (d) 120 to 150 dB
116. Permanent deafness occurs at the noise levels of:
 (a) 80 dB (b) 100 dB (c) 120 dB (d) 140 dB or more
117. Which one of the following causes damage to the ability to synthesise protein?
 (a) Arsenic (b) Lead (c) Cadmium (d) Aluminium
118. Which one of the following is a major factor in eutrophication?
 (a) Agriculture (b) Industries (c) Population growth (d) Thermal plants
119. Ammonia constitutes a major contributor to the acidification of the environment:
 (a) In farming areas (b) In industrial areas
 (c) In areas with considerable intensive livestock farming (d) In power plants area

120. Which one of the following decreases oil pollution?
 (a) Emulsification (b) Degradation by microorganisms
 (c) Dispersion and oxidation by sunlight (d) All
121. Chromium is less toxic to plants than:
 (a) Zinc (b) Lead (c) Nickel (d) All
122. Arsenic accumulates in tissues rich in:
 (a) Lipid (b) Proteins (c) Carbohydrates (d) Cations
123. *Cladophora* is a good accumulator of:
 (a) Silver, zinc and iron (b) Cobalt, cadmium and silver
 (c) Lead, cobalt and silver (d) Iron, lead and zinc
124. Eutrophication is applicable to:
 (a) Air pollution (b) Water pollution (c) Land pollution (d) Noise pollution
125. Eutrophication causes:
 (a) Depletion of oxygen (b) Organic loading
 (c) Fouling of water (d) All
126. The Ganga Action Plan was started in:
 (a) 1970 (b) 1975 (c) 1980 (d) 1985
127. Silent spring is related to effect of DDT on:
 (a) Microorganisms (b) Invertebrates (c) Birds (d) Human beings
128. Algal bloom in surface water is caused by:
 (a) Phosphates (b) Phosphates and nitrates
 (c) Carbonates and sulphates (d) Nitrates and sulphates
129. Which one of the following may lead to eutrophication?
 (a) Phosphates and sulphates (b) Nitrates and nitrites
 (c) Phosphates and nitrates (d) Sulphates and carbonates
130. Which one of the following is a genotoxin?
 (a) Aflatoxin (b) Vinyl chloride (c) PAH's (d) All
131. The best-known heavy metal pollution in the oceans took place in the year:
 (a) 1920 (b) 1938 (c) 1950 (d) 1960
132. Nutrient-type water pollution is caused by:
 (a) Fertilisers and pesticides (b) Nitrates and phosphates
 (c) Nitrates and carbonates (d) Sulphates and nitrates
133. Aluminium toxicity does not cause:
 (a) Degeneration of dendrites (b) Osteomalacia
 (c) Reduction in the thickness of shell of eggs (d) Microcystic hypochromic anaemia
134. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|----------------------|------------------------------|
| A) Minamata disease | 1. SO ₂ pollution |
| B) Itai-itai | 2. Nitrate |
| C) Methenoglobinemia | 3. Mercury |
| D) Lichens | 4. Cadmium |
- Answer codes:
 A B C D
 (a) 3 4 2 1

188 Ecology and Animal Behaviour

- (b) 4 3 1 2
 (c) 2 3 4 1
 (d) 3 1 4 2

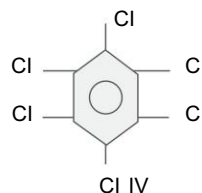
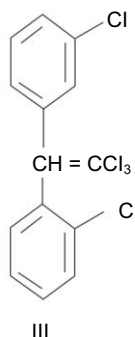
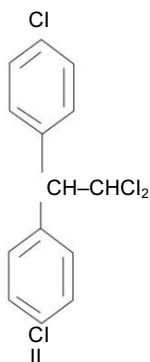
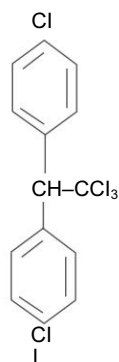
135. Spraying of DDT causes pollution of:
 (a) Air (b) Water (c) Land (d) All
136. *Eichhornia crassipes* accumulates:
 (a) Iron (b) Copper (c) Nickel (d) Selenium
137. Which one of the following algal groups is not present in oligotrophic water?
 (a) Chlorophyceae (b) Cyanophyceae (c) Chrysophyceae (d) Diatomaceae
138. Which one of the following is a persistent organic pollutant?
 (a) DDT (b) Polychlorinated biphenyl
 (c) Dioxins (d) All
139. Pine needles cannot accumulate:
 (a) Sulphur (b) Lead (c) Heavy metals (d) Fluorine
140. Rye grass is an accumulator of:
 (a) Copper, zinc and cadmium (b) Lead
 (c) Sulphur and fluorine (d) All
141. Which one of the following is an indicator of water pollution in rivers and streams?
 (a) Tse-tse flies (b) Mayflies (c) Water bugs (d) None
142. Consider the following statements:
 (A) Lichens function as an indicator of nitrogen pollution
 (B) Air pollution causes neurobehavioural diseases
 (C) Nutrient pollution may cause outbreaks of fish diseases
 (D) Soil pollution may alter metabolism of microorganisms and Arthropods in a given soil environment
 The incorrect statements are:
 (a) None (b) A and D (c) B and C (d) All
143. Lichens act as an accumulator of:
 (a) Trace metals (b) Radioactive elements (c) Sulphur (d) All
144. Which one of the following is both a primary as well as a secondary pollutant?
 (a) Ozone (b) Nitric oxide (c) Nitrogen dioxide (d) PAN
145. Which one of the following pollutants comes from intensive animal and rice production?
 (a) Methane (b) Ammonia (c) Nitric oxide (d) Nitrogen dioxide
146. Which one of the following statements is incorrect?
 (a) Forests are primary natural sources of volatile organic compounds
 (b) Volatile organic compounds contribute to sick building syndrome
 (c) Investments in environmentally conscious businesses are called green investments
 (d) None
147. Deforestation is a significant source of:
 (a) CO₂ (b) CO₂ and NO₂ (c) CO₂, NH₃ and NO (d) CO₂, CO and NH₃
148. Sulphur dioxide damages:
 (a) Alfalfa (b) Cotton (c) Barley (d) All
149. Ozone is very toxic to:
 (a) Cotton (b) Tomato and tobacco (c) Tobacco and maize (d) Maize and wheat

150. Which one of the following contributes to land pollution?
 (a) Urbanisation (b) Industrialisation activities
 (c) Agricultural activities (d) All
151. Soil pollution causes increased:
 (a) Erodibility (b) Soil fertility (c) Nitrogen fixation (d) Crop yield
152. Which one of the following acts as a sink for atmospheric sulphur dioxide?
 (a) Marble structures (b) Limestone
 (c) Geological sources of ammonia (d) All
153. $\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$
 $\text{O}_3 + \text{Sunlight} \rightarrow \text{O}_2 + \text{O}$ (Oxygen free radical)
 $\text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2$
 Net $2\text{O}_3 \rightarrow 3\text{O}_2$
 In the above reaction:
 (a) NO is a catalyst (b) NO_2 is an intermediate (c) O is an intermediate (d) All
154. Which one of the following comes out from furniture factories?
 (a) Benzene (b) Formaldehyde (c) Chloroform (d) Methane
155. Which one of the following is a piscicide?
 (a) Malathion (b) Phenyl mercury (c) Toxaphene (d) Carboxin
156. Salmon exposed to a sublethal dose of DDT becomes sensitive to:
 (a) Cold water (b) Warm water (c) Saline water (d) None
157. Carcinogenic, mutagenic and teratogenic effects are caused by the accumulation of:
 (a) Ozone (b) Pesticides (c) Cadmium (d) Mercury
158. Consider the following statements:
 (A) Dead zones are low oxygen areas in the world's oceans
 (B) Dead zones are irreversible
 (C) Lichens are indicators of sulphur dioxide and nitrogen oxides
 (D) Some microorganisms produce stress proteins on exposure to cadmium and benzene
 The correct statements are:
 (a) All (b) A, C and D (c) B, A and D (d) None
159. The world's most polluted city is:
 (a) Sydney in Australia (b) Linfen city in China
 (c) Tokyo in Japan (d) Berlin in Germany
160. Which one of the following is being adopted to tackle the problems of pesticide and metal pollution?
 (a) Biological control of disease-causing organisms (b) Bioremediation
 (c) Integrated pest management (d) All
161. Solid wastes include:
 (a) Only solids (b) Liquids (c) Liquefied gases (d) All
162. Which one of the following states of India generates maximum hazardous waste?
 (a) West Bengal (b) Maharashtra (c) Rajasthan (d) Gujarat
163. Pyrolysis is useful for:
 (a) Organic wastes (b) Plastics (c) Tyres (d) All

190 Ecology and Animal Behaviour

164. Which one of the following is shown both by living and dead cells?
 (a) Biomagnification (b) Bioaccumulation (c) Biosorption (d) None
165. Which one of the following is used in phytoremediation?
 (a) *Azolla pinnata* (b) *Lemna minor* (c) *Helianthus annuus* (d) All
166. Which one of the following is a source of methyl mercury?
 (a) Domestic sewage (b) Industrial wastes (c) Mining (d) Agriculture runoffs
167. *Fragaria vesca* is a pollution sensitive indicator of:
 (a) H_2S (b) NH_3 (c) HCl (d) HF
168. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|---------------------------------------|----------------------|
| (A) World Environment Day | 1. 16th September |
| (B) National Pollution Prevention Day | 2. 5th June |
| (C) Ozone Day | 3. 3rd December 1984 |
| (D) Bhopal gas disaster | 4. 2nd December |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 3 | 2 | 1 |
| (b) | 2 | 4 | 1 | 3 |
| (c) | 4 | 1 | 2 | 3 |
| (d) | 2 | 3 | 4 | 1 |
169. Which one of the following about bioremediation is incorrect?
 (a) Is a very useful technique for cleaning polluted soil, groundwater and streams. (b) It is only used for organic contaminants.
 (c) It prevents leachate formation. (d) None
170. Which one of the following air pollutants acts on textile and causes weakening?
 (a) Ozone (b) Hydrogen sulphide (c) Sulphur dioxide (d) Hydrogen fluoride
171. Which one of the following removes the heavy particles through centrifugal force?
 (a) Scrubber (b) Afterburner (c) Cyclone (d) Bag house
172. The tolerance limit of nitrate in drinking water is:
 (a) 20 mg/l (b) 30 mg/l (c) 45 mg/l (d) 60 mg/l
173. Large amounts of sewage in water generate:
 (a) High BOD and high dissolved oxygen (b) High BOD and low dissolved oxygen
 (c) Low BOD and high dissolved oxygen (d) High BOD and high COD
174. Which one of the following causes leaf curling?
 (a) Nitrogen dioxide (b) Ozone (c) Sulphur dioxide (d) PAN
175. The activity of enzyme acetyl cholinesterase is inhibited by:
 (a) Organophosphorus insecticides (b) Endosulphan
 (c) DDT (d) BHC
176. *Eichhornia crassipes* has the ability to reduce:
 (a) Organic carbon (b) BOD (c) COD (d) All
177. Bregoil rapidly absorbs:
 (a) Dust (b) Oil (c) Nitrate (d) DDT

178. Eardrum ruptures at a sound level of:
 (a) 140 dB (b) 160 dB (c) 180 dB (d) 195 dB
179. BOD is affected by:
 (a) pH (b) Presence of toxins (c) Microorganisms (d) All
180. Which one of the following is not applicable to tertiary treatment of municipal sewage?
 (a) Chlorination (b) Precipitation
 (c) Aerobic decomposition (d) Carbon absorption
181. Plastic industries are the source of:
 (a) Airborne lead (b) Benzene hexachloride
 (c) Polychlorinated biphenols (d) Hydrocarbons
182. Biological magnification is applicable to:
 (a) DDT (b) Lead (c) Strontium-90 (d) All
183. Which one of the following is a primary pollutant?
 (a) Nitric acid (b) Nitrogen oxide (c) Formaldehyde (d) Hydroxyl radical
184. Atmospheric methane has approximately doubled in the last 200 years. This increase is due to:
 (a) Increase in areas of paddy production (b) Increase in rearing of cattle
 (c) Garbage dumps and sanitary landfills (d) All
185. Acid rain:
 (a) Increases sensitivity of plants to droughts and diseases (b) Reduces photosynthesis
 (c) Causes retarded growth in many plants (d) All
186. Removal through photolysis is applicable to:
 (a) Nitrous oxide (b) Methane (c) CO₂ (d) None
187. Which one of the following is being collected by the 'Topex' (Topographic Experiment)?
 (a) Information on changes in sea level (b) Temperature across the globe
 (c) The amount of gases emitted into the atmosphere (d) All
188. The lichen, *Hypogymnia physodes* accumulates:
 (a) Zinc and lead (b) Iron (c) Manganese (d) All
189. Which one of the following is relatively nontoxic to insects, but seriously affects female birds by disrupting their calcium metabolism?
 (a) I (b) II (c) III (d) IV



Answers to Multiple-Choice Questions

- | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. (c) | 2. (d) | 3. (d) | 4. (d) | 5. (d) | 6. (a) | 7. (d) | 8. (b) |
| 9. (a) | 10. (d) | 11. (a) | 12. (d) | 13. (c) | 14. (b) | 15. (d) | 16. (c) |
| 17. (c) | 18. (a) | 19. (c) | 20. (d) | 21. (d) | 22. (d) | 23. (a) | 24. (c) |
| 25. (a) | 26. (b) | 27. (d) | 28. (d) | 29. (a) | 30. (d) | 31. (d) | 32. (b) |
| 33. (c) | 34. (d) | 35. (a) | 36. (b) | 37. (c) | 38. (b) | 39. (d) | 40. (d) |
| 41. (a) | 42. (d) | 43. (b) | 44. (b) | 45. (a) | 46. (d) | 47. (d) | 48. (d) |
| 49. (a) | 50. (a) | 51. (d) | 52. (c) | 53. (d) | 54. (d) | 55. (a) | 56. (a) |
| 57. (c) | 58. (d) | 59. (b) | 60. (b) | 61. (a) | 62. (b) | 63. (d) | 64. (a) |
| 65. (a) | 66. (a) | 67. (a) | 68. (b) | 69. (d) | 70. (c) | 71. (b) | 72. (a) |
| 73. (c) | 74. (a) | 75. (b) | 76. (a) | 77. (d) | 78. (d) | 79. (d) | 80. (c) |
| 81. (b) | 82. (c) | 83. (a) | 84. (c) | 85. (a) | 86. (b) | 87. (c) | 88. (d) |
| 89. (a) | 90. (a) | 91. (d) | 92. (d) | 93. (d) | 94. (c) | 95. (a) | 96. (b) |
| 97. (c) | 98. (c) | 99. (d) | 100. (d) | 101. (c) | 102. (a) | 103. (d) | 104. (b) |
| 105. (b) | 106. (a) | 107. (a) | 108. (d) | 109. (d) | 110. (d) | 111. (d) | 112. (d) |
| 113. (d) | 114. (d) | 115. (b) | 116. (d) | 117. (b) | 118. (a) | 119. (c) | 120. (d) |
| 121. (d) | 122. (a) | 123. (b) | 124. (b) | 125. (d) | 126. (d) | 127. (c) | 128. (b) |
| 129. (c) | 130. (d) | 131. (b) | 132. (b) | 133. (c) | 134. (a) | 135. (d) | 136. (a) |
| 137. (b) | 138. (d) | 139. (c) | 140. (d) | 141. (b) | 142. (a) | 143. (d) | 144. (c) |
| 145. (a) | 146. (d) | 147. (b) | 148. (d) | 149. (b) | 150. (d) | 151. (a) | 152. (d) |
| 153. (d) | 154. (b) | 155. (c) | 156. (a) | 157. (b) | 158. (b) | 159. (b) | 160. (d) |
| 161. (d) | 162. (c) | 163. (d) | 164. (c) | 165. (d) | 166. (b) | 167. (c) | 168. (b) |
| 169. (b) | 170. (a) | 171. (c) | 172. (c) | 173. (b) | 174. (c) | 175. (a) | 176. (d) |
| 177. (b) | 178. (c) | 179. (d) | 180. (c) | 181. (c) | 182. (d) | 183. (c) | 184. (d) |
| 185. (d) | 186. (a) | 187. (d) | 188. (d) | 189. (c) | | | |

Fill in the Blanks

- The burning of _____ and destruction of _____ are the primary causes of air pollution.
- Aerosols affect primary productivity by inhibiting _____.
- EPA stands for _____.
- BOD stands for _____.
- Chlorofluorocarbons are also known as _____.
- Photochemical air pollution is commonly referred to as _____.
- _____ gas forms a protective shield in the stratosphere.
- Water, air and soil pollution causes _____ per cent of deaths worldwide.
- The use of specialised plants to clean up polluted soil is known as _____.
- In cell walls, sulphur dioxide is dissolved forming _____ and _____.
- In India, the first instance of acid rain was recorded in 1974 in _____ and _____ area.
- The average lifetime of hydrogen sulphide ranges from _____ hours in summer to _____ days in winter.
- $\text{HCl} + \text{NO} + \text{O}_2 \rightarrow \text{NO}_2 + \text{_____}$.
- Particles of roots contain cancer-causing chemical called _____.

15. The term 'greenhouse effect' was given by _____.
16. _____ is the area left for the growth of vegetation.
17. The two important cycles that change the chemistry of the atmosphere are _____ and _____ cycles.
18. _____ tests the quality of air to find how clean or polluted it is.
19. _____ is a gas that occurs both at the earth's ground level and in the earth's upper atmosphere.
20. _____ is the main pollutant in the oxidant smog complex.
21. The effect of ozone in plants was first observed in the _____ area in 1944.
22. Sulphur deposited as _____ or _____ containing aerosols contributes directly to soil acidification.
23. Carbon monoxide combines with haemoglobin in the blood _____ times faster than oxygen.
24. Air pollution that reduces visibility is often called _____ or _____.
25. The intensity of sound is measured in _____ or _____.
26. Sound which is undesirable for human hearing is called _____.
27. Mixer grinders, vacuum cleaners and washing machines cause a cumulative sound of about _____ dB.
28. _____ for road uses are the first widely sold automobiles to achieve significant noise source reduction.
29. Many compounds that enter the body of an organism are known to cause damage to DNA. These compounds are called _____.
30. _____ is the most common chemosynthetic bacterium of coalmine.
31. Pollution load due to sewage or organic wastes is measured in terms of _____.
32. Biological oxygen demand of clean freshwater is _____.
33. Value of BOD exceeding _____ mg/l indicates pollution.
34. Ozone is created through photochemical transfer of _____.
35. _____, a greenhouse gas, is the main pollutant that is warming the earth.
36. Ozone is generated when oxides of nitrogen and hydrocarbons react in the presence of _____.
37. The total mass of aerosols per unit volume is called _____.
38. The amount of UV-B that reaches the earth's surface depends in part on the concentration of _____ in the stratosphere.
39. Ozone attacks the _____ double bonds in the polymers which make up natural rubber.
40. Ozone layer in the stratosphere is measured in _____ unit.
41. Carbon monoxide combines with haemoglobin to form _____.
42. The pollutants released by jet planes are _____.
43. Greenhouse effect is associated with _____.
44. _____ is the most abundant hydrocarbon pollutant in the air.
45. Smog is a combination of various gases with _____ and _____.
46. The first smog-related deaths were recorded in _____.
47. Ground level ozone is formed through a complex reaction involving _____, _____ and sunlight.
48. Ozone layer is present in the _____.
49. $\text{NO} + \text{O}_3 \rightarrow$ _____.
50. Maximum ozone depletion potential of chlorofluorocarbons is due to the release of _____ by them.
51. Ozone can be destroyed by a number of _____ catalysts.

194 Ecology and Animal Behaviour

52. Ozone layer in the stratosphere keeps _____ per cent of the sun's ultraviolet radiation from striking the earth.
53. The decrease of stratospheric ozone was first reported in _____ and soon it was realised that this depletion of ozone is due to the increasing presence of _____.
54. High ozone pollution levels are most likely to occur during _____ and _____ nights.
55. Out of each 10 million air molecules, about 2 million are normal oxygen but only _____ are ozone.
56. One chlorine atom can break more than _____ ozone molecules.
57. Peroxy acyl nitrate (PAN) is formed from nitrogen oxides (NO_x) and _____.
58. Waste deposition in landfills generates _____.
59. Radon gas is formed from the decay of _____.
60. _____ gases are gases that trap heat from sunlight.
61. The amount of oxygen required by microorganisms to decompose organic substances in sewage is known as _____.
62. Blue baby syndrome is due to _____ pollution.
63. The organisms which are affected by pollutants are called _____, while the elements or organisms that can consume a pollutant are called _____.
64. A part of SO₂ undergoes _____ and _____ oxidation in the atmosphere to form SO₃.
65. In water bodies, mercury is converted to _____ by bacterial action.
66. Pesticides remain in the environment through _____ and _____.
67. When excess of manure or sewage enters the water bodies, it causes _____ pollution.
68. Out of the 20 most polluted cities of the world, _____ are located in China.
69. _____ is the most polluted city in India.
70. Agent Orange is a _____ killer.
71. Gasohol is a mixture of _____ and ethyl alcohol.
72. Chemical oxygen demand (COD) is always _____ than BOD.
73. Acid rain occurs when atmosphere is heavily polluted with _____ and _____.
74. Most hazardous metal pollutant of automobile exhaust is _____.
75. Fly ash is produced by the _____.

Answers to Fill in the Blanks

- | | | |
|---------------------------------------|----------------------|---|
| 1. Fossil fuels, forests | 2. Photosynthesis | 3. Environmental Protection Agency |
| 4. Biological Oxygen Demand | 5. Ferons | 6. Smog |
| 7. Ozone | 8. 40 | 9. Phytoremediation |
| 10. Hydrogen sulphite, sulphate | 11. Trombay, Chembur | 12. 24, 42 |
| 13. PAN | 14. Benzopyren | 15. Arrhenius |
| 16. Green belt | 17. Carbon, nitrogen | 18. Environmental Protection Agency (EPA) |
| 19. Ozone | 20. Ozone | 21. Los Angeles |
| 22. SO ₂ , SO ₄ | 23. 200 | 24. Haze, smog |
| 25. Decibel (db), decibel-A(dbA) | 26. Noise | 27. 87 dB |
| 28. Hybrid vehicles | 29. Genotoxins | 30. <i>Thiobacillus thiooxidans</i> |
| 31. Biological Oxygen Demand | 32. 2 mg/l | 33. Five |

- | | | |
|--|----------------------------------|-------------------------------------|
| 34. Oxygen | 35. Carbon dioxide | 36. Sunlight |
| 37. Particulate matter | 38. Ozone | 39. Carbon |
| 40. Dobson | 41. Carboxyhaemoglobin | 42. Aerosols |
| 43. Global warming | 44. Methane | 45. Water vapour, dust |
| 46. London in 1873 | 47. Hydrocarbons, nitrogen oxide | 48. Stratosphere |
| 49. $\text{NO}_2 + \text{O}_2$ | 50. Chlorine | 51. Free radical |
| 52. 95 to 99 | 53. 1974, chlorofluorocarbons | 54. Cool, windy |
| 55. Three | 56. 1,00,000 | 57. Volatile organic compounds |
| 58. Methane | 59. Radium | 60. Greenhouse |
| 61. Biological Oxygen Demand | 62. Nitrate | 63. Receptors, sink |
| 64. Photolytic, catalytic | 65. Methyl mercury | |
| 66. Bioconcentration, biomagnification | | 67. Organic |
| 68. 16 | 69. Kolkata | 70. Weed |
| 71. Petrol | 72. Higher | 73. Sulphur dioxide, nitrogen oxide |
| 74. Lead | 75. Thermal power plants | |

True or False

- Air pollution is a local phenomenon.
- Air pollution has direct or indirect consequences on the structure and processes of ecosystems.
- Particulate matter constitutes about 5 per cent of the weight of all air pollutants.
- Ozone is a primary pollutant.
- Valleys trap pollutants.
- Ozone is a major component of photochemical smog.
- Rain is somewhat acidic having a pH of about 5.
- Uptake of ammonium by plants produces acidity while uptake of nitrate reduces acidity.
- Poor ventilation causes half of the indoor air pollution problems.
- Volatile organic compounds (VOC) cause acidification.
- Ammonia is one of the principal causes of winter smog.
- The decomposition and production of ozone is a natural process.
- Trees are not susceptible to radiation.
- UV-B radiation can affect aquatic life up to 20 m under the water's surface.
- Summer temperatures are the best circumstances for the creation of high ozone concentrations.
- Diesel smoke is a good example of particulate matter.
- Rain can remove pollutants from the air.
- Ammonia plays an important role in acidification and eutrophication.
- Pollen dispersal is a natural cause of air pollution.
- CF_4 is stable even in lower layers of the stratosphere.
- The mechanism of ozone depletion is generally catalytic in nature.
- The chlorine molecules combine with oxygen to generate oxygen and ClO .
- Acid rain generally kills trees directly.

24. The waxy coating of leaves, which makes them waterproof, is easily removed by acid.
25. C_3 members of polygonaceae are particularly less sensitive to SO_2 stress.
26. SO_2 cannot enter leaves via cuticles.
27. C_4 plants are more resistant to SO_2 stress.
28. Pneumoconiosis is used for all dust diseases caused by certain air pollutants.
29. Carbon monoxide is highly soluble in water.
30. Nitric oxide is insoluble in tissue water.
31. Acidification by nitrate and ammonium deposition is independent of the transformation of N compounds in the soil.
32. Smog causes a misty haze similar to fog having the same composition.
33. Chemical industries are responsible for smog.
34. Chlorofluorocarbons are lighter than air.
35. Ultraviolet radiation is dangerous only during summer months.
36. Exposure to air pollution in late stages of pregnancy increases the risk of a premature delivery.
37. Nitrogen oxides are emitted from low temperature combustion.
38. Sulphur dioxide, nitrogen oxides and lead are the main pollutants of diesel exhausts.
39. Ozone at breathing ground is bad.
40. Air pollution can increase to dangerous levels due to temperature inversion.
41. Acid fog is even more potent than acid rain.
42. Halocarbons have the ability to absorb more infrared radiation in comparison to CO_2 .
43. Photochemical smog contains primary pollutants.
44. Carbon dioxide is necessary for our survival.
45. Without carbon dioxide, the whole planet would be covered in ice.
46. Inhalation of ozone reduces lung capacity.
47. Noise pollution can cause dilation of pupils of the eyes.
48. Noise pollution decreases digestive spasms.
49. Most immediate effect of noise pollution is the deterioration of mental health.
50. Poor urban planning may give rise to noise pollution.
51. Noisy homes decrease cognitive and language development in young children.
52. Dangerous decibels of noise cannot be altered by distance.
53. Noise causes formation of molecules, which kill hair cells in the cochlea.
54. Pollutants can exist in water in different forms.
55. Detergents are nonpolar.
56. Whether a compound remains in water is determined by its vapour pressure.
57. Radioactive waste is not a water pollutant.
58. Carbonate works as a buffer in water.
59. Oil is the most harmful pollutant in water.
60. Ozone has high decomposition in water.
61. Trouts and salmons are excellent indicators of pollution.
62. Biological demand of oxygen is a good indicator of pollution.
63. At higher temperatures, air holds less water.

64. Glyphosate is an herbicide.
65. Smog is a cause of pollution.
66. DDT can alter chromosomes.
67. The 'Exxon Valdez oil spill' best illustrates a nonpoint source of pollution.
68. Malathion is rapidly broken down in a mammalian liver.
69. Burial causes soil pollution.
70. Phytoremediation affects the physical and chemical health of soil.
71. If flora decreases and fauna increases, the percentage of CO₂ will increase.
72. Atrazine enhances photosynthesis.
73. Radiation exposure is directly dietary in origin for Laplanders.
74. Kepone is a persistent pesticide.
75. Stones flies are pollution-intolerant species.
76. Hot springs and weathering are sources of nonbiological carbon dioxide.
77. Pyrolysis yields pollutants.
78. Ozone in the lower atmosphere can prevent plant respiration by blocking the stomata.
79. Combustion of fuels always produce both NO and NO₂.
80. The first regulation of air pollution resulted from particulates when the king of England, Edward I, banned smoky coal burning in London in 1272.
81. Methyl mercury is more toxic than elemental mercury.
82. When water smells like rotten eggs, it indicates that hydrogen is present due to shortage of oxygen.
83. Air is never perfectly clean.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1. False | 2. True | 3. True | 4. False | 5. True | 6. True | 7. True | 8. True |
| 9. True | 10. False | 11. False | 12. True | 13. False | 14. True | 15. True | 16. True |
| 17. True | 18. True | 19. True | 20. True | 21. True | 22. True | 23. False | 24. True |
| 25. True | 26. False | 27. True | 28. True | 29. False | 30. True | 31. False | 32. False |
| 33. True | 34. False | 35. False | 36. True | 37. False | 38. False | 39. True | 40. True |
| 41. True | 42. True | 43. False | 44. True | 45. True | 46. True | 47. True | 48. False |
| 49. True | 50. True | 51. True | 52. False | 53. True | 54. True | 55. False | 56. True |
| 57. False | 58. True | 59. True | 60. False | 61. True | 62. True | 63. False | 64. True |
| 65. False | 66. True | 67. False | 68. True | 69. True | 70. False | 71. True | 72. False |
| 73. True | 74. True | 75. True | 76. True | 77. False | 78. True | 79. True | 80. True |
| 81. True | 82. True | 83. True | | | | | |

Give Reasons

1. Air pollution is increasing.
 - Because of:

198 Ecology and Animal Behaviour

- (a) Increasing traffic
 - (b) Industrialisation
 - (c) Growing cities
 - (d) Rapid economic development
2. During winter, pollution level can increase near the ground level.
 - Because during the winter, wind speeds are low which cause smoke and fog to stagnate causing pollution level to increase near the ground level.
 3. It is difficult to control acid rain.
 - Because the contaminants are carried long distances, so it becomes difficult to pinpoint the sources of acid rain and thus it is difficult to control acid rain.
 4. People who exercise outdoors are also susceptible to the symptoms of air pollution.
 - Because it involves deeper and faster breathing.
 5. Nitrous oxide is more dangerous.
 - Because of its long residence time of 170 years.
 6. Carbon dioxide is called a greenhouse gas.
 - Because it makes the earth habitable by blocking the exit of some of the sun's radiation from the atmosphere.
 7. Extreme care should be taken while using aerosol spray paint.
 - Because it contains solvent methylene chloride which the body can convert to carbon monoxide.
 8. Unnatural metals may be very dangerous.
 - Because they are often derived from man-made nuclear reactions and can be strongly radioactive.
 9. Asbestos has become an important pollutant.
 - Because of its use in building for fire proofing as well as for improving acoustics.
 10. Fluorine affects calcification of bones and teeth.
 - Because of its very reactive oxidant property.
 11. Persistent organic pollutants persist in the environment.
 - Because they are resistant to environmental degradation through chemical, biological and photolytic process.
 12. Global warming is increasing.
 - Because polluted atmosphere acts as a better insulator, which prevents the escape of heat back into space and thus results in increase in global average temperature.
 13. Forests of high mountains are exposed to greater amounts of acid than other forests.
 - Because they may be surrounded by acidic clouds and fog which are more acidic than rainfall.
 14. Mosses and lichens accumulate heavy metals and other compounds very efficiently.
 - Because of their slow growth rate as well as their large specific surfaces.
 15. Emissions of nitrous oxide (N_2O) mainly stem from agriculture.
 - Because nitrogen in soils can easily be denitrified by bacteria and during this process nitrous oxide is emitted.
 16. Noise pollution has not received much attention.
 - Because we are unable to taste or smell it.
 17. Smoking causes inhalation of more than 90 per cent of cadmium.
 - Because tobacco plants concentrate cadmium.
 18. Ozone is very useful for all life on the earth.
 - Because it absorbs harmful UV-B radiations from the sun.

19. DDT is very dangerous.
 - Because it accumulates in fat tissues of lower animals and then enters the food chain.
20. Eutrophication may result in death of many species of fishes.
 - Because eutrophication lowers the levels of dissolved oxygen in water.
21. Water sometimes smells like rotten eggs.
 - Because when water is enriched in nutrients, eventually anaerobic become highly active and during this activity, they produce certain gases. Among these gases, one is hydrogen sulphide due to which water smells like rotten eggs.
22. Low level of dissolved oxygen accelerates bioaccumulation.
 - Because in fishes the rate of breathing increases with decrease in dissolved oxygen. Thus it results in taking of more water which is polluted with toxic metals and chemicals causing bioaccumulation.
23. Groundwater is susceptible to pesticides contamination.
 - Because pesticides are mobile in the soil.
24. Combustion of natural gas is not a major source of sulphur emissions.
 - Because sulphur is efficiently removed during the processing of gas before distribution.
25. Pesticides are often termed as biocides.
 - Because they kill not only the target organisms but also have adverse affect on many nontarget organisms.
26. Cadmium poisoning causes, degeneration of bones.
 - Because cadmium affects calcium metabolism.
27. Consumers are also responsible for air pollution.
 - Because:
 - (a) The products they use cause air pollution during production and distribution.
 - (b) Heating of houses and offices causes release of chemicals in the air.
28. Aluminium is one of the prior causes of forest decay.
 - Because high aluminium concentration may complicate nutrients uptake by plants.
29. Aerosols assist in the formation of fog.
 - Because they serve as condensation cores for water vapour.
30. Nitrogen oxide and volatile organic compounds cause air pollution in stagnant air.
 - Because the reaction between these compounds forms ozone and other oxidants.
31. The concentration of CFC-11(CCl_3F) is constant as a function of height in the troposphere.
 - Because CFC-11 is not destroyed by OH radicals.
32. Ultraviolet radiation A (UV-A) is the most dangerous.
 - Because it has the highest energy.
33. Accumulation of inorganic pollutants such as nitrogen and phosphates in aquatic ecosystems may lead to organic pollution.
 - Because high levels of these nutrients leads to an overgrowth of plants and algae, which when die become organic material in water and thus result in organic pollution.
34. Heat is a pollutant.
 - Because increased temperature results in the death of many organisms.
35. Acid rain reduces soil fertility.
 - Because it inhibits the activity of nitrogen-fixing bacteria in the soil.

GLOBAL WARMING

Multiple-Choice Questions

- Which one of the following is highly stable?
 (a) CFC-11 (b) CFC-12 (c) CFC-13 (d) All
- The increased levels of CO₂ increases yield of crop plants more in:
 (a) C₃ legumes (b) C₃ legumes and nonlegumes than in C₄ plants
 (c) Nonlegumes than in C₃ and C₄ plants (d) C₄ plants than C₃ and non-legume plants
- Match column I with column II and select the correct answer using answer codes:

Column I (Type)	Column II (Primary use)
(a) CFC-12	1. Fire extinguishers
(b) Halon-1301	2. Solvents
(c) CFC-11	3. Refrigeration
(d) CFC-113	4. Aerosol propellant

Answer codes:

A	B	C	D
(a) 3	1	4	2
(b) 4	3	2	1
(c) 2	3	4	1
(d) 3	4	1	2
- In the absence of greenhouse gases, the earth's average temperature would be a chilling:
 (a) 0°C (b) -5°C (c) -18°C (d) -55°C
- The average temperature of the earth is:
 (a) 5°C (b) 14°C (c) 18°C (d) 22°C
- A significant amount of infrared radiation is absorbed by:
 (a) Argon (b) Oxygen (c) Nitrogen (d) None
- Coral reef bleaching is a reduction in the density of:
 (a) Dinoflagellate algae (b) Zooplanktons
 (c) Corals (d) Fishes
- Which one of the following has the highest atmospheric lifetime?
 (a) Halon 1211 (b) CFC -12
 (c) CFC-113 (d) Carbon tetrachloride
- Which one of the following has the shortest atmospheric lifespan?
 (a) CFC-11 (b) Methyl chloroform (c) Halon-1211 (d) Halon-1301
- Which one of the following contributes to greenhouse effect?
 (a) Nitrogen (b) Argon (c) Oxygen (d) Water vapour

11. Out of the 20 warmest years, 19 have occurred since:
(a) 1970 (b) 1975 (c) 1980 (d) 1990
12. Temperatures in the lower troposphere have increased between:
(a) 0.5° and 1.5°C (b) 0.12°C and 0.22°C (c) 0.9° and 0.52°C (d) 0.16° and 0.75°C
13. Which one of the following causes least greenhouse effect?
(a) Ozone (b) Methane (c) Water vapour (d) Carbon dioxide
14. Consider the following statements:
(a) The annual increase of N_2O is 0.2 to 0.3 per cent per year
(b) Nitric oxide (N_2O) causes 5 to 6 per cent of the anthropogenic greenhouse effect
(c) Carbon dioxide contributes about 60 per cent of total warming
(d) Methane and chlorofluorocarbons contribute 20 per cent and 14 per cent respectively to global warming
The correct statements are:
(a) All (b) A, B and C (c) B and C (d) C and D
15. N_2O is produced during:
(a) Burning of nitrogen-rich fuels (b) Burning of nylon
(c) Denitrification (d) All
16. The amount of carbon released annually as CO_2 by clearing forest:
(a) 0.3 to 2.6 Gt (b) 0.4 to 4 Gt (c) 1 to 5 Gt (d) 1.5 to 5.5 Gt
17. Which one of the following is an ozone-depleting substance?
(a) Halon (b) Carbon tetrachloride (c) Chlorofluorocarbon (d) All
18. Halon contains:
(a) Carbon, fluorine and bromine (b) Carbon, iodine and fluorine
(c) Carbon, bromine and fluorine (d) Bromine, iodine and fluorine
19. Halons are mainly used as:
(a) Fire extinguishers (b) Insulators
(c) Refrigeration (d) Nonflammable materials
20. Which one of the following is not applicable to chlorofluorocarbons?
(a) Nonflammable (b) Nontoxic (c) Chemically active (d) Chemically inert
21. Chlorofluorocarbons are used in:
(a) Air conditioning (b) Refrigeration
(c) Cleaning of electronic components (d) All
22. Which one of the following is incorrect?
(a) The intact molecules of chlorine and bromine destroy ozone
(b) Nitric acid causes depletion of ozone
(c) Hydroxyl ions (OH^-) cause depletion of ozone
(d) It is the atomic form of oxygen that destroys the ozone layer
23. Consider the following points about a gas:
(a) It has both natural and anthropogenic sources
(b) It accounts for an estimated 20 per cent of current global warming
(c) It is primarily removed from atmosphere by reacting with the hydroxyl radical (OH)
(d) On a molecule basis, it is 21 times more powerful than CO_2
This gas is:
(a) Nitrous oxide (b) Methane (c) Carbon (d) Water vapour

24. Which one of the following is a correct match?
 - (a) Methane – A ticking bomb
 - (b) Carbon dioxide – Endless warming
 - (c) Greenhouse gases – Life givers and life takers
 - (d) Food additive E290 – Nitrous oxide
25. Bacteria in the soil release CO₂ when they digest:
 - (a) Leaves
 - (b) Carcasses
 - (c) Both leaves and carcasses
 - (d) None
26. Enhanced exposure of phytoplankton to UV-B radiation may cause:
 - (a) Changes in the species composition of phytoplankton community
 - (b) Reduced uptake of CO₂ in Antarctic and Arctic oceans
 - (c) Decrease in the availability of nitrogen
 - (d) All
27. Global warming may lead to:
 - (a) Coral reef bleaching
 - (b) Draughts and fires
 - (c) Spread of diseases
 - (d) All
28. Consider the following statements:
 - (a) During an atmospheric age, atmospheric CO₂ is low
 - (b) Cool water absorbs more CO₂
 - (c) Warming increases nutrient levels of the mesopelagic zone of oceans
 - (d) Atmospheric soot aerosols are unable to absorb solar radiation directly
 The correct statements are:
 - (a) All
 - (b) A and B
 - (c) B and C
 - (d) C and D
29. Forests affect the climate by:
 - (a) Absorbing carbon dioxide
 - (b) Evaporating water that forms clouds
 - (c) Absorbing sunlight
 - (d) All
30. Aerosols:
 - (a) Reflect and absorb solar radiation
 - (b) Modify cloud properties
 - (c) Both (a) and (b)
 - (d) Cause increase in the earth's temperature
31. Which one of the following is a major determinant of stomata conductance?
 - (a) CO₂
 - (b) CH₄
 - (c) N₂O
 - (d) CO
32. Which one of the following about the potential effect of global warming is incorrect?
 - (a) Melting of polar ice
 - (b) Elevated temperature
 - (c) Decrease in methane from permafrost
 - (d) More rainfall during shorter periods
33. Which one of the following is anthropogenic dust?
 - (a) Smoke from vegetation fires
 - (b) Dust
 - (c) Urban haze
 - (d) All
34. With the increase in global warming, there is an increase in:
 - (a) Heat waves
 - (b) Floods
 - (c) Hurricanes and tornados
 - (d) All
35. Greenhouse gases are:
 - (a) Vapour emitted from greenhouse
 - (b) Heat-trapping gases present in the earth's atmosphere
 - (c) Smog
 - (d) Aerosols
36. Which one of the following about aerosols is incorrect?
 - (a) Most aerosols have a regional distribution
 - (b) Show a high degree of spatial and temporal variation

- (c) Have a long residence time in the atmosphere
(d) The net result of aerosols is the cooling of the earth's surface
37. Hydroxyl radicals are most abundant in the:
(a) Troposphere (b) Stratosphere (c) Mesosphere (d) Thermosphere
38. A 5 per cent loss of ozone results in a _____ per cent increase in UV-B radiation reaching the earth's surface:
(a) 0 (b) 5 (c) 10 (d) 30
39. Which one of the following is a calcifying coccolithophorid?
(a) AFGP-21 (b) *Emiliana huxaleyi* (c) Terra satellite (d) Alifsol
40. Calcifying coccolithophorids are sensitive to:
(a) CO₂ (b) SO₂ (c) CH₄ (d) N₂O
41. Total rise in sea level in the 20th century estimated to be:
(a) 1.8 mm (b) 2.8 mm (c) 0.17 m (d) 0.35 m
42. La Nina involves the abnormal cooling of water of:
(a) Ecuador and Peru (b) Australia (c) Australia and Japan (d) Peru and Kenya
43. The El Nino of the _____ was the strongest and most devastating:
(a) 1977–78 (b) 1982–83 (c) 1984–85 (d) 1998–99
44. The El Nino appears around Christmas and disappears by the end of:
(a) January (b) March (c) May (d) June
45. Hydrofluorocarbons lack:
(a) Hydrogen (b) Carbon (c) Fluorine (d) Chlorine
46. Which one of the following about ferons is incorrect?
(a) Chemically active (b) Nontoxic and noncorrosive
(c) Nonflammable (d) Odorless
47. Which one of the following is the major contributor to greenhouse effect?
(a) Carbon dioxide (b) Water vapour (c) Aerosol sprays (d) Nitrous oxide
48. The highest concentration of CO₂ occurred during the:
(a) Jurassic period (b) Carboniferous period (c) Cambrian period (d) Ordovician period
49. The largest producer of carbon dioxide is:
(a) USA (b) India (c) Germany (d) China
50. Which one of the following countries produces below 5 metric tons per person of CO₂?
(a) Brazil (b) China (c) India (d) All
51. Global warming may affect human health by:
(a) Spreads of infectious diseases (b) Increasing heat waves and floods
(c) Fatal malnutrition (d) All
52. In human beings, ozone causes severe pulmonary oedema at the concentration of:
(a) 0.2 ppm (b) 0.3 ppm (c) 1.0 to 3.0 ppm (d) 9.0 ppm
53. The International Council for Scientific Union (ICSU) is the scientific sponsor of:
(a) International Human Dimensions (b) International Geosphere-Biosphere Programme
Programme on global environmental change
(c) World Climate Research Programme (d) All
54. Montreal Protocol is a series of international agreements related to the reduction of:
(a) Air pollutants (b) Water pollutants

- (c) CFCS and other ozone-depleting substances (d) None
55. Ozone day is:
 (a) 16th September (b) 16th November (c) 21st December (d) 25th February
56. Chlorofluorocarbons are responsible for:
 (a) Global warming (b) Acid rain
 (c) Depletion of ozone layer (d) Air pollution
57. Ozonosphere was discovered by:
 (a) William Hornday (1913) (b) Charles Fabry (1913)
 (c) Joseph Fourier (1824) (d) Svante Arrhenius (1896)
58. Which one of the following is being caused by carbon dioxide emitted into the atmosphere by human activities?
 (a) Changes in the earth's surface temperature (b) Changes in rainfall
 (c) Changes in sea level (d) All
59. In 1998, the temperature was unusually high because of:
 (a) High depletion of the ozone layer (b) Very high emission of greenhouse gases
 (c) Strongest El Nino (d) Unusual emission of CO₂
60. Global warming will affect:
 (a) Banks (b) Agriculture (c) Transportation (d) All
61. The world's largest emitter of greenhouse gases is the:
 (a) Japan (b) USA (c) China (d) UK
62. G₈ is applicable to:
 (a) UK and USA (b) Germany, Japan and Italy
 (c) Russia, France and Canada (d) All
63. Survival of this animal is the most immediate imperil due to the effect of global warming:
 (a) Giant Panda (b) Blue Whale (c) Polar bear (d) Skunk
64. Increase in temperatures from global warming has altered:
 (a) Size of hibernating animals (b) Sleeping patterns of hibernating animals
 (c) Feeding patterns of hibernating animals (d) Reproductive patterns of hibernating animals
65. Ozone removes all the:
 (a) UV-A radiation (b) UV-B radiation (c) UV-C radiation (d) All
66. The increase in UV-B radiation has been greatest at:
 (a) 65°N and S latitudes (b) 75°N and S latitudes
 (c) Both (a) and (b) (d) None
67. The marine carbon cycling is affected by:
 (a) UV-A and UV-B (b) UV-B and the longer wavelength UV-A
 (c) UV-B and UV-C (d) All
68. Increase in levels of ultraviolet radiation may cause a great decrease in the production of:
 (a) Paddy (b) Corn (c) Soybean (d) All
69. Which one of the following is strongly absorbed by the lens of eye?
 (a) UV-A (b) UV-B (c) UV-C (d) All
70. The amino acids mainly responsible for ultraviolet absorbance of proteins are:
 (a) Methionine and tryptophan (b) Serine and tyrosine
 (c) Leucine and valine (d) Tyrosine and tryptophan

71. Increase in UV-B does not cause:
(a) Suppression of human immune system (b) Skin cancer
(c) Eye cataracts (d) Increase BMR
72. Role of methane and nitrous oxide in the destruction of ozone layer was pointed out by:
(a) Paul Crutzen (b) Mario Molina (c) L R Kump (d) Bagla and Kaiser
73. In which one of the following layers of the atmosphere do changes in weather and climate occur?
(a) Troposphere (b) Stratosphere (c) Mesosphere (d) Thermosphere
74. In the skin, ultraviolet radiation is absorbed by:
(a) Melanin (b) Melanin and transuronic acid
(c) Melanin and aliphatic acid (d) Chromatophores

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (a) | 4. (c) | 5. (b) | 6. (d) | 7. (a) | 8. (b) |
| 9. (c) | 10. (d) | 11. (c) | 12. (b) | 13. (a) | 14. (a) | 15. (d) | 16. (a) |
| 17. (d) | 18. (c) | 19. (a) | 20. (c) | 21. (d) | 22. (a) | 23. (b) | 24. (d) |
| 25. (c) | 26. (d) | 27. (d) | 28. (b) | 29. (d) | 30. (c) | 31. (a) | 32. (c) |
| 33. (d) | 34. (d) | 35. (b) | 36. (c) | 37. (a) | 38. (c) | 39. (b) | 40. (a) |
| 41. (c) | 42. (a) | 43. (b) | 44. (b) | 45. (d) | 46. (a) | 47. (b) | 48. (c) |
| 49. (d) | 50. (d) | 51. (d) | 52. (d) | 53. (d) | 54. (c) | 55. (a) | 56. (c) |
| 57. (b) | 58. (d) | 59. (c) | 60. (d) | 61. (c) | 62. (d) | 63. (c) | 64. (b) |
| 65. (c) | 66. (a) | 67. (b) | 68. (d) | 69. (b) | 70. (d) | 71. (d) | 72. (a) |
| 73. (a) | 74. (b) | | | | | | |

Fill in the Blanks

- The gases, which actively absorb radiant heat energy, are referred to as _____ gases.
- _____ and _____ are the most abundant gases in the atmosphere.
- Most important naturally occurring greenhouse gases present in the atmosphere are _____ and _____.
- It has been estimated that a global temperature rise of 0.3°C per decade will release an extra _____ g $\text{CO}_2\text{-C}$ from the soil.
- Compounds containing _____, _____ and _____ are called chlorofluorocarbons.
- Freshwater wetlands produce methane due to incomplete _____ of organic matter.
- _____ is an ideal place for measuring exact concentration of CO_2 in the atmosphere.
- The El Nino generally appears around Christmas in the Pacific of _____ and _____.
- Ozone hole was also confirmed above _____ in 1990.
- The Arctic stratosphere warms faster in the _____.

206 Ecology and Animal Behaviour

11. Total Ozone Mapping Spectroptometer (TOMS) is a _____-borne instrument.
12. HFC-134a is an _____ safe refrigerant which is used in air conditioning.
13. The nodal agency for climate change issues in India is _____.
14. Ozone present in the stratosphere filters out ultraviolet radiation _____.
15. In oceans, warming reduces nutrient levels of the _____ ozone.
16. _____ is the world's primary international agreement on reducing greenhouse gas emissions.
17. The low frequency mode of atmosphere variability of the southern hemisphere is referred to as _____.
18. Global climate model is a _____ model of the world's climate system.
19. The most notable non-member country of the Kyoto Protocol is _____.
20. Intergovernmental Panel on Climate change (IPCC) has predicted an average global rise in temperature of _____ between 1990 and 2100.
21. Presently, the atmospheric concentration of CO₂ is about _____ ppm by volume.
22. The _____ ice sheet is the largest single mass of ice on the earth.
23. Quantitative methods to stimulate interactions of the atmosphere, oceans, land surface and ice are used in _____ models.
24. There are _____ cubic miles of water in ice caps, glaciers and permanent snow.

Answers to Fill in the Blanks

- | | | |
|---|-------------------------------|---------------------------------|
| 1. Greenhouse | 2. Nitrogen, oxygen | 3. Water vapour, carbon dioxide |
| 4. 61×10^{15} g | 5. Carbon, chlorine, fluorine | 6. Decomposition |
| 7. Mauna Loa | 8. Ecuador, Peru | 9. Arctic |
| 10. Spring | 11. Satellite | 12. Ozone |
| 13. Ministry of Environment and Forests | 14. B | 15. Mesopelagic |
| 16. Kyoto Protocol | 17. Antarctic oscillation | 18. Computer |
| 19. USA | 20. 4° to 5.8°C | 21. 383 |
| 22. Antarctic | 23. Climate | 24. 57,73,000 |

True or False

1. Tundra is more sensitive to global climate change.
2. Emission sources of methane are mostly nonbiological.
3. The annual rate of increase of N₂O is 0.2 to 0.3 per year.
4. Global warming causes migration of disease vectors.
5. Trees record climate change.
6. CO₂ enrichment causes much change in root to shoot ratio in woody plants and grassland species.
7. Wind plays a key role in ozone depletion in the polar region
8. Louisiana is losing an acre of land every 24 minutes.

9. The Arctic stratosphere warms faster in summer.
10. Phytoplanktons absorb CO_2 from the atmosphere.
11. UV-B radiation inhibits photosynthesis in majority of phytoplanktons.
12. Legumes are not sensitive UV-B radiation.
13. Gradual increase of the temperature of the earth's lower atmosphere, because of increase in greenhouse gases, is known as global warming.
14. The El Nino is a warm surface current.
15. Hydrogen fluoride (HF) affects the ozone layer.
16. Carbon dioxide from coal-fired power plants does not damage forests.
17. Herbaceous species are less sensitive to UV-B radiation than the tree species.
18. The global climate changes have the same effect on C_3 and C_4 plants.
19. Warmer temperatures may increase carbon output.
20. Rising sea levels are detrimental to coral reef species.
21. Methane absorbs 20 to 25 times more heat than CO_2 .
22. Motor vehicles are a powerful source of ozone precursors.
23. Greenhouse effect is increasing due to the hole in the ozone layer.
24. Rise in sea level is not uniform.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|----------|-----------|----------|----------|-----------|-----------|
| 1. True | 2. False | 3. True | 4. True | 5. True | 6. False | 7. True | 8. True |
| 9. False | 10. True | 11. True | 12. False | 13. True | 14. True | 15. False | 16. False |
| 17. False | 18. False | 19. True | 20. True | 21. True | 22. True | 23. False | 24. True |

Give Reasons

1. Methane and ozone have less effect on climate change.
 - Because of their smaller atmospheric concentration.
2. Forests are one of the world's most important sinks.
 - Because during the process of photosynthesis plants need CO_2 to produce sugar. During this process they absorb and bind CO_2 .
3. A decreases in phytoplankton production may result in global warming.
 - Because phytoplankton absorbs carbon dioxide from the atmosphere.
4. Oceans temperatures increase more slowly than land temperatures.
 - Because oceans have larger heat-effective capacity as well as the ocean lose more heat by evaporation
5. Global warming is extending the distribution of mosquitoes.
 - Because of increase in humidity levels and their frequent growth in warmer atmosphere.

208 *Ecology and Animal Behaviour*

6. Warmer temperatures may increase carbon output.
 - Because warmer temperatures may increase primary production leading to increase in carbon input and soil respiration and thus causing increase in carbon output.
7. The transformation of solar radiation into infrared radiation is crucial.
 - Because infrared radiation may be absorbed by the atmosphere.
8. Bromine is more destructive in comparison to chlorine.
 - Because hydrogen bromide and bromine nitrate are more susceptible to dissociation by ultraviolet light, thus destroying more ozone molecules.
9. Ozone levels sink in winter.
 - Primarily due to the lack of sunshine.

ANIMAL BEHAVIOUR

Brief History

- The organised and integrated patterns of activity by which an organism responds to its environment is termed as behaviour.
- The study of animal behaviour is called ethology.
- Behaviour is influenced by innate and learned factors.
- Aristotle (300 BC) published systematic observations and ideas about animal behaviour.
- John Ray (1672) published scientific texts on the study of modern instinctive behaviour in birds.
- Charles Darwin (1872) published *The Expression of Emotion in Man and Animals* (Probably the first modern work on comparative ethology).
- Douglas A Spalding (1840–1877) worked on development of behaviours in young chicks.
- Charles O Whiteman (1842–1910) studied the behaviour of pigeons and doves. He is regarded as the 'Founding Father of Ethology'.
- Ivan Pavlov (1849–1936) demonstrated conditioned reflex in dogs.
- Oskar Heinroth published papers on ethology of ducks and geese in 1910–1911 and used the term 'imprinting'.
- J S Szymanski in 1918 demonstrated the existence of biological clocks in animals.
- T Schjelderup-Ebb (1922) reported social dominance, subdominance hierarchies in birds.
- W Rown proposed photoperiodism hypothesis of bird migration in 1910.
- Wallace Craig (1876–1954) developed theoretical models of control of animal behaviour.
- Konard Zacharius Lorenz (1903–1989), Karl von Frisch (1886 – 1983) and Nikolaus Tinbergen (1907–1988) are the real founders of modern ethology. In 1973 Lorenz, Tinbergen and Frisch were awarded the Nobel Prize for their contribution to study on animal behaviour.
- Daniel Lehrman (1955, 1964) studied sexual behaviour in ring doves.

Innate Behaviour

- Innate behaviour is the outcome of inherited properties of the nervous system of organisms.
- It is also known as inborn or inherent behaviour.
- Innate behaviour is essential for life of animals such as reproduction, parental behaviour, aggressive behaviour and search of food and feeding, etc.



- Innate behaviour is genetically programmed. It is encoded in the DNA and is passed from generation to generation.
- It is present in animals raised in isolation from each other.
- Innate behaviour is performed in the same way, each time, by each individual.
- It is not modified by development or experience.
- No learning is involved in innate behaviour.
- It is fully developed or expressed at first performance.
- It is present in all members of the population.
- As innate behaviour is genetically programmed, it may undergo genetic changes through mutation, recombination as well as natural selection.
- Innate behaviour is sometimes called species specific as this type of behaviour occurs in every individual of an animal species.
- Innate behaviours are open to evolutionary analysis
- Innate behaviours include kinesis and taxis.

1. Kinesis

- Locomotion of organisms or cells in response to a specific stimulus is known as kinesis.
- The rate of movement depends on the density of the stimulus, but not on its direction.
- Kinesis is mainly of the following two types:
 - (a) Orthokinesis – It involves change in the speed of movement.
 - (b) Klinokinesis – It involves change in the rate of turning.

2. Taxis

- A movement in response to direction of stimulus is known as taxis.
- Movements towards a stimulus are positive while those away from the stimulus are negative.
- Taxis involve orientation of the whole body.
- In taxis, the direction of movement must be guided by external stimulation.
- Taxes are shown only by animals having bilateral symmetry as they have a definite side.
- Taxes are of adaptive value.

Types of Taxes

Taxes are of the following types:

- (a) Klinotaxis – The receptor is unable to discriminate the source of stimulation.
- (b) Tropotaxis – There is simultaneous comparison of stimulation by bilaterally symmetrical receptors.
- (c) Telotaxis – There is no simple balance between two sources of stimulation.
- (d) Menotaxis (Light compass response) – There is orientation at a constant angle to the direction of source of stimulation.
- (e) Menmotaxis – There is no involvement of configurational stimuli.
- (f) Phototaxis – There is locomotory movement caused by the light.
- (g) Thermotaxis – Response to temperature.
- (h) Chemotaxis – Response to chemical substances.

- (i) Rheotaxis – Response to current of water or air.
- (j) Thigmotaxis – Response to contact.
- (k) Galvanotaxis – Response to electric current.

3. Reflexes

- Reflexes are the simplest type of animal unlearned behaviour.
- A sudden stimulus induces automatic, involuntary and stereotyped responses.
- Reflexes are controlled by inherited neural mechanism.
- Generally, reflexes involve the movement of a part of the body.
- Reflex response is one of the modes of adaptation in animals.
- There are two types of reflexes:
 - (a) Tonic Reflexes – Tonic reflexes are slow long-lasting adjustments that maintain muscle tone, posture and equilibrium.
 - (b) Phasic Reflexes – They are quick, short-lived adjustments found in flexure response.

4. Instincts

- Instincts are complex behavioural patterns which are inborn and are inflexible.
- The entire body participates in instinct behaviour.
- They are inherited just as the structure of tissues and organs.
- The ability to react with external stimulus is one of the distinctive features of instinctive activity.
- Konrad Lorenz formulated the notion of the fixed action pattern (FAP), a type of instinct found to be the same stereotype in all members of a species.
- FAP is triggered by an external sign stimulus or releaser.
- Fixed action patterns when once initiated, cannot be interrupted.
- Fixed action patterns do not require previous experience and are the characteristic of species.
- They are valuable in the adaptation of the animal to its environment.
- Yawning and spider web formation are examples of fixed action patterns.

Learned Behaviour

- A persistent change in behaviour that develops through experience is known as learning behaviour.
- The animal develops this behaviour through trial and error.
- It is nonheritable and is absent in animals raised in isolation.
- Such behaviour is capable of modifications to suit changing conditions.
- Individuals of a population may show variation in this behaviour.
- Learned behaviours are not essential for life of the animal but are important for animal adaptation.

Habituation

- A type of learning that enables an animal to ignore unimportant and irrelevant stimuli is known as habituation.
- The art of learning what not to do has been defined as habituation (Razran).

- Habituation is very prevalent and is an important form of learning.
- In habituation, the response reappears if stimulus is not given for a long period of time.
- Habituation is a device by which animals are able to avoid wasting time and energy responding to unimportant stimuli that do not threaten survival and reproduction.
- If an unusual sound is produced in the presence of a family dog, the dog will respond generally by turning its head toward the sound. But if such stimulus is given repeatedly and if nothing pleasant or unpleasant happens to the dog, it will soon stop responding.

Imprinting

- Imprinting is a specialised and limited form of programmed learning that occurs early in life.
- It occurs within a short time which is not possible at all times of life.
- The imprinting period of time is species specific. In mallard ducks, imprinting must occur less than 24 hours after birth.
- Imprinting is adaptive as it enables the young ones to recognise and follow their parents.
- Oscar Heinroth (1910) is often given credit for being the first to use the term 'imprinting' as he observed that goslings tend to follow a large moving object soon after hatching.
- Konark Lorenz (1935) confirmed Heinroth's observations on goslings.
- Much of our knowledge of imprinting was learned from the research work of Konark Lorenz and for this work he shared the Nobel Prize in 1973.

Classical Conditioning

- A learning that associates one stimulus with another unrelated stimulus is known as classical conditioning.
- Classical conditioning is also known as Pavlovian conditioning as it was first described by the Russian physiologist, Ivan Pavlov.
- Pavlov discovered that it is possible to train a dog at the sound of a bell.
- Pavlov in his experiment with the dog noted that if food was given to a dog repeatedly accompanied by the sound of a bell, the dog responded by coming to the bell as if it was food.
- Pavlov pointed out that salivation on sight of food was an unconditional response and the subsequent salivation on the sound of bell alone was a conditional response.
- Typically, conditional response is very similar to unconditional response, but is not completely identical to it.
- Pavlov was awarded the Nobel Prize in 1904 for his work on digestive physiology (not for classical conditioning).
- Classical conditioning is helpful in understanding animals' conditioning to the environmental stimuli.

Operant Conditioning

- Operant conditioning is a method of learning that occurs through rewards and punishments for behaviours.
- The term 'operant conditioning' was coined by B F Skinner (1930).
- Operant conditioning is also known as trial and error learning as the animal is free to try various responses before finding the one that is rewarded.

- Operant conditioning is of the following four types:
 - (a) Positive reinforcement
 - (b) Negative reinforcement
 - (c) Punishment
 - (d) Extinction
- Both positive and negative reinforcement strengthen behaviour, while both punishment and extinction weaken behaviour.
- Operant behaviours operate on environment and are maintained by consequences.

Latent Learning

The learning that occurs but remains hidden until there is some incentive to demonstrate is known as latent learning.

COMMUNICATION IN ANIMALS

- Transfer of information from one animal to another is known as communication.
- The sender and receiver in a communication may be of the same species or of different species.
- Study of animal communication is called zoosemioties.
- The various means of communication in animals are visual, chemical, auditory, tactile and electrical communication.

1. Visual Communication

- Visual communication usually indicates an animal's identity (i.e., species, age or sex).
- Changes in colour and posture are the main means through which visual information is communicated.
- In visual signals, there is visibility of localisation of sender and receiver.
- There is rapid transmission of information.
- If the sender is not seen, its signals are useless.
- Visual signals cannot be used for a long distance.
- Visual signals cannot be used at night.

2. Chemical Communication

- Animals use chemical communication for attracting opposite sexes as well as for territorial marking.
- The chemicals used for communication between individuals are called pheromones.
- Pheromones are released in air, water or deposited on the ground.
- Pheromones remain in the environment for a long time.
- Chemical communication is better developed in termites, ants, bees and wasps.
- Pheromones (Bombykol) produced by a female gypsy moth is detected by male moths several metres away.
- Sharks have efficient sense of smell and some species can detect drops of blood in an ocean.

- Cats and dogs urinate to mark the edges of their territory.
- Dung is another readily available source of scent used by many animals (e.g., hippopotamuses, rabbits, etc.).
- Chemical signals can be used in low visibility situations.

3. Auditory Communication

- Sound signals can be transmitted over long distances.
- The frequency of auditory signals can be changed as per desire.
- Sound signals are species specific.
- Generally, low frequency sounds are useful for long distance communication.
- The signals used for communication do not remain limited between the sender and the receiver.
- The sender and the receiver of a communication may be of the same species or of different species.
- Sound signals help animals in food collection, reproduction and other purposes.
- Among invertebrates, crickets and cicadas are famous for their loud sound production.
- Whales are expert in the art of communication by sound, with each whale of the same species.

4. Tactile Communication

- Tactile communication requires close bodily contact between individuals.
- Tactile communication is more developed in social insects.
- Blind workers of termites communicate through tactile communication.
- Blind fishes know the presence of other fishes in the group by creating disturbances in water.
- Dance of honeybees is the most remarkable means of tactile communication.
- Copulation involves the most widespread use of the tactile communication.

5. Electrical Communication

- Some fishes use electrical signals for orientation and communication (e.g., knife fish (gymnotid) of South America and elephant nose fish (mormyrid) of Africa).
- Electric signals are generated in the electric organ.
- Electric organ develops from muscle cells in majority of fishes, but in gymnotids the electric organ is derived from nerves.
- The waveform of electrical field can be considered as a reliable indicator of the wave sender's identity, as the electrical signal is not propagated and its waveform is not distorted during transmission.
- Platypus and *Echidna* have the ability of electroreception.

Territorial Behaviour

- Territorial behaviour may be defined as the behaviour that prevents intruders of the same species from a fixed or defined area.
- Territorial behaviour is exhibited by every type of animal.
- Territorial boundary is marked by song calls (birds song), scents or even piles of dung.
- If such action fails to prevent the entry of intruders then chases and fighting occur.
- The size of territory defended is extremely variable.

- Males which are polygynous have large territories, monogamous males have slightly smaller territories, while unmated and bachelor males have the smallest territories.
- Dogs mark their territory by urinating.
- Bull moose urinate on the ground to mark their territory.
- Spider monkeys defend their territory by screams, barks and throwing branches of trees and faecal matter.
- Female American bullfrogs (*Rana catesbeiana*) select territories that are defended by older and larger males as mortality rate of embryos in such territories is low.
- During the mating season, the adult males of pong horns become territorial and mark their territories by their urine.
- Territories may be seasonal (generally for nesting and feeding the young) or maintained permanently for living and hunting.
- Territorial behaviour benefits the species as it increases their chances of survival as well as reproduction.
- Territorial behaviour prevents overcrowding and minimises competition.
- Ground sea nesting birds (gulls and terns) avoid cannibalism during breeding in their territories.
- In black-headed chicks, maternal yolk androgens stimulate territorial behaviour.
- Males may be in a better position to maintain pair bonding by defending territories.
- Territorial defence has both costs and benefits. Animals defend territories only when it is economical.
- Behavioural ecologists are of the opinion that the distribution of food determines whether a species will be territorial or not.

Courtship Behaviour

- Pattern of behaviour that results in copulation and mating is known as courtship behaviour.
- Courtship behaviour involves, visual, chemical or auditory stimuli or a complex series of acts by two or more individuals to show that they are ready for mating.
- Courtship behaviour permits one or both sexes to select a mate from several candidates.
- Generally choosing of a mate is done by the female.
- Courtship may be one-sided or interactive.
- Generally, courtship is initiated by males and behaviour patterns of courtship vary greatly in different groups of animals.
- Courtship displays lead to suppression of nonsexual behaviour in females.
- The negative aspect of courtship is that it may attract predators instead of mates.
- Selfish gene model is the best scientific model that explains courtship behaviour. This model has been proposed by Richard Dawkins which states that an individual of a particular species will mate with an individual of the same species having good genes.
- Some species of *Nereis* perform nuptial dance, in which males and females swim rapidly in a circle. The females produce a substance that attracts the males and stimulates them to shed sperm which, in turn, excites females leading to the shedding of ova.
- Females of some insect species produce pheromones that attract males from a long distance.
- Sexual cannibalism occurs in some families of spiders, scorpions and most mantids.
- In a three-spined stickleback (*Gasterosteus aculeatus*) the swollen abdomen of the mature female and the posture when the female is faced head upward at a 45° angle stimulates the male to undergo courtship behaviour.
- Many fish species release pheromones in water to attract a potential mate.

- Frogs give courtship calls to attract females.
- In painted turtles, courtship occurs by touch.
- The courtship behaviour of birds includes singing, display, dancing, preening, feeding and building.
- In mammals, olfaction plays a key role in courtship behaviour.

Parental Care

- Parental care is the behaviour of caring for offsprings by the parents for rearing and protection of their offsprings until they become self-reliable and independent.
- Parental care is of much importance as it increases the chances of survival of young ones as well as allows the young ones to learn patterns of behaviour from their parents.
- Caring of young ones requires time and energy.
- Care of young ones as parental behaviour is found in some animals.
- Parental care is provided by one or both parents.
- Parental care and filial cannibalism (feeding of own offsprings) may co-occur in many animals.
- Animals show great diversity in caring for their eggs and young ones during development.

1. Caring of Eggs

- In water bugs (*Belostoma flumineum*), males exhibit back brooding. Males carry the eggs on their back.
- Female Cyclop carries the eggs in its ovisacs.
- Earthworms and cockroaches lay eggs in a protective egg case called ootheca. The ootheca is deposited in a protected place.
- Male sea horse (*Hippocampus*) carries its eggs in its brood pouch which is present on its ventral abdominal wall.
- The female *Tilapia mossambica* broods the fertilised eggs in its mouth and likewise, the male of marine catfish (*Galeichthys felis*) carries its eggs in its mouth for a period of six weeks.

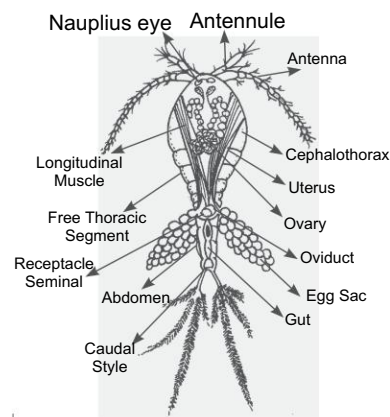


Fig. 1 Female Cyclop carrying eggs in its ovisacs

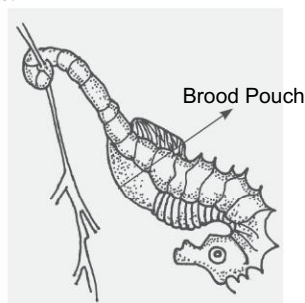


Fig. 2 Male sea horse carrying its eggs in its brood pouch

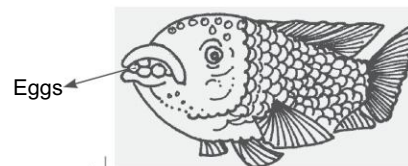


Fig. 3 Mouth brooding in *Tilapia*

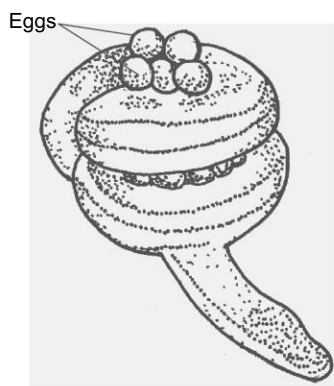


Fig. 4 Female *Ichthyophis* carrying eggs

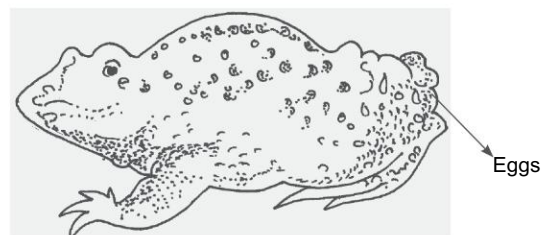


Fig. 5 Female *Alytes* carrying eggs

- In oviparous elasmobranches, such as rays and cat sharks (*Scyllium* and *Raja*) eggs are laid inside the protective egg capsule called Mermaids purse. The young hatch after rupturing the egg capsule.
- Male midwife toad (*Alytes*) carries its eggs on its hind limbs.
- In *Gastrotheca marsupialia*, the female develops a special brood pouch on her back for carrying eggs.
- Female dusky salamander (*Desmognathus*) carries its egg cluster wrapped around the neck.
- The Australian frog (*Rheobatrachus silus*) is the only amphibian showing gastric incubation of eggs by the female.
- In *Ichthyophis*, the eggs are strung together and the female coiled around these egg masses.
- Reptiles lay small clutches of eggs and some of them remain with their eggs and guard them until they hatch.
- Almost all birds incubate eggs to provide proper temperature for development. Generally incubation is done by females. Some males also incubate eggs, as in ostriches.
- An interesting case of parental care is shown by the Indian cuckoo. The cuckoo lays eggs in the nest of crow and the eggs are incubated by the crow.

2. Caring of Young Ones

- In honeybees (*Apis indica*) larvae are fed by the workers with a food called royal jelly and the development depends on the nature of food provided to the larvae by the worker bees.
- Female scorpions carry their young ones on their back for about seven days.
- *Dendrobates* is the only known amphibian that feed its larvae.
- The hatchlings of some birds such as swifts, pigeons, sparrows, etc., are naked, blind and helpless at the time of hatching and need more parental care for further development. Such young ones are known as altricial. While in some birds such as fowls, ducks and quails, the young ones are feathered and can run or swim and need less parental care. Such young ones are called precocial.
- In duck-billed platypuses, the mother holds the young one to her abdomen with its tail while feeding.
- In kangaroos, the female protects and nourishes the young ones in her abdominal pouch called marsupium.
- Parental care is highly developed in primates, particularly in human beings.

Migratory Behaviour

- Migration is a regular long distance journey, usually seasonal to and fro movement of animal population from a given area.
- Migration occurs when animals need different habitats for different stages in their life cycle.
- Migratory behaviour has a genetic basis.
- The migratory cycle is often annual and as such closely linked with the cyclic patterns of seasons.
- Migration of most of mammals, birds and fishes are on a yearly cycle.
- Generally, migrations involve horizontal travel.
- Certain insects, birds and mammals migrate altitudinally.
- The distance covered during migration may be few miles or several thousand miles.
- Migration is initiated by environmental factors such day length or temperature.
- Many species of animals possess time-compensated sun compass. Animals can determine absolute compass directions at any time of the day with the help of such a system.
- Many insects, fish, salamanders and birds have the ability to derive directional ability from the weak magnetic field of the earth.
- Star compass is present in only those birds that migrate at night.
- Animals may migrate from north/south or from one elevation to another.
- Generally, invertebrates do not migrate far, but the monarch butterfly (*Danatus plexippus*) has a return journey pattern of migration. Its population migrates from Canada and USA to Mexico.
- European eel (*Anguilla anguilla*) travels from freshwater to the Atlantic ocean to breed.
- Salmon migrates from marine habitats to freshwaters to lay eggs. Many Atlantic salmon return to their marine habitat after laying eggs.
- The California newt wanders on forest floor in search of food (in rainy season, fall and winter) and during summer it remains underground. However, during spring it comes to pools in mountain streams to breed.
- Certain turtles cover a long distance for breeding purpose.
- Migration is a widespread phenomenon among birds. Usually birds migrate to the northern hemisphere in spring to breed and return to the southern hemisphere in autumn to spend winter.
- The act of migration in birds leads to reduction in brain size. It has been suggested that probably it is due to a need to reduce energetic, metabolic and cognitive costs.
- Among mammal bats and ungulates such as caribou, wild beast, zebra gazelle, seals and whales migrate.
- Undoubtedly migration has several benefits including evolutionary benefits but it also leads to the death of many individuals due to several reasons.

PHEROMONES AND BEHAVIOUR

- Pheromones are naturally occurring compounds found in all insects, animals and humans.
- These are chemicals produced and released into the environment by one individual and influence the behaviour of the other individual of the same species.
- Pheromones were first identified in 1959 in animals as chemicals that attract the opposite sex and initiate mating behaviour.
- The term 'pheromone' was coined by Karlson and Butenandt in 1959.

- Pheromones are species specific and are molecules of communication in many species.
- Pheromones are released through urine or different glands located in different parts of the body in different species or into faeces.
- Pheromones stimulate an attractive response.
- They are very powerful (e.g., just one molecule of a moth pheromone is enough to attract another moth within a miles radius).
- Pheromones activate precoded genetic programme.
- Being species specific, they produce specific behavioural, reproductive and other developmental responses in the bodies of other individuals of the same species.
- The queen bee produces a substance called queen bee substance that suppresses the development of ovary in workers as well as prevent them from rearing another queen.
- In termites, the caste system and size of the colony is regulated by pheromone.
- Female rats produce a maternal pheromone for synchronising the mother and young relationships.
- If a pregnant female mouse is exposed to the urine of a strange male, she will abort the litter being carried by her. This is known as Bruce effect.
- Insects detect pheromones through several glands that are dependent on the species.
- Animals detect pheromones through the Jacobson organs.
- They affect central nervous system via chemoreception.

Types of Pheromones

1. Territorial Pheromones

- Territorial pheromones mark the boundary of an organism's territory.
- In dogs, these are present in the urine. The urine is deposited on landmarks serving to mark the area of the claimed territory.
- The urine of tigers contains a milky thick fluid called tigeramine (a pheromone) which is used by male tigers to mark their territories.

2. Trail Pheromones

- Trail pheromones are widespread in social insects (e.g., bees, termites and ants).
- Ants mark their paths with these hormones.

3. Sex Pheromones

- Sex pheromones are related with the availability of females for breeding.
- Many insect species emit sex pheromones to attract mates.
- Female silk moths (*Bombyx mori*) releases a sex pheromone called bombykol to attract males.
- The female gypsy moth (*Porthetria dispar*) release a sex pheromone called glypleure that attracts males from several hundred metres.
- Male animals also release sex pheromones that indicate information about what species they are and their genotype.
- Male beetle (*Harpobittacus*) produces a chemical substance that excites females for mating.
- In pigs, the pheromone androstenone triggers the female's receptivity to the male.

- In goats, sheep and pigs male dominance competition for females is determined by the strength of the male's pheromone.

4. Aggregation Pheromones

- Aggregation pheromones are produced by one or both sex and attract individuals of both sexes.
- These pheromones are found in members of the coleoptera, hemiptera, orthoptera and dictyoptera.

5. Epideictic Pheromones

- These pheromones have been reported in insects.
- Fabre has observed that females who lay eggs in fruits deposit these chemical substances in the vicinity of their egg clutch to warn other females of the same species to lay eggs somewhere else.

6. Alarm Pheromones

- Alarm pheromones are released by certain species when attacked by predator that can trigger a fight.
- Ants produce alarm pheromones in the form of formic acid to protect themselves from enemies.
- The ant, *Acanthomyops claviger* produces terpenes that may function as defensive repellents.
- Alarm pheromones are also produced by honeybees and wasps.
- Freshwater and marine fishes produce alarm pheromones, whenever an intruder approaches a fish.

Besides, there are other pheromones such as nasonov pheromone (worker bees), royal pheromone (bees) and calming pheromones (mammals).

BIOLOGICAL CLOCK

- Biological clock is an internal mechanism in organisms that controls the periodicity of various physiological functions.
- Biological clocks of various duration are found at all biological levels such as ecosystem, population, individual, organ, tissue and cell.
- The periodicity of biological clocks is genetically programmed.
- The various types of rhythms occurring in organisms are circadian (daily), circaseptan (weekly), circatrigintan (monthly) and circannual (annual).
- Among these circadian rhythms are the most common.
- The biological clock is linked with circadian rhythm which is roughly a 24 hour cycle in the physiological process of living beings (e.g., plants, fungi, cyanobacteria and animals).
- Circadian rhythms are endogenously generated but they can be modulated by external cycles such as light and temperature.
- The first endogenous circadian rhythm was observed by the French scientist Jean Jacques d'Ortous de Mairan in the 1700s. He observed that 24 hour patterns in the movement of plant leaves continued even when isolated from external stimuli.
- Circadian rhythms:
 - (a) Persist in a constant condition with a period of 24 hours.
 - (b) Period can be reset by exposure to a light or dark pulse.

(c) Is temperature compensated, i.e., the frequency of rhythm is affected only slightly by temperature fluctuations.

- Cyanobacteria exhibit the simplest known circadian rhythm.
- Circadian rhythms are essential in determining the sleeping and feeding patterns in animals including human beings.
- The circadian rhythm influences seasonal cycles that depend on day length including the regulation of flowering.
- *Arabidopsis thaliana* (a model species for plant genetics) shows visible circadian rhythms in the leaf movement while less obvious expression of many genes.
- In algae and phytoplankton, photosynthesis occurs during day light hours in the upper regions of a pond, lake or ocean. Many mobile zooplanktons are found well below the surface during midday, when the sunlight is too much intense. As darkness approaches, these zooplanktons come upward to feed upon phytoplankton.
- Humans have daily rhythms of sleep and wakefulness, which, in turn, is related with rhythmic activities of digestive, nervous, excretory and endocrine systems.
- A female human being has a monthly menstrual cycle, while catfish and birds exhibit annual reproductive rhythms.
- The circadian rhythm is linked to dark-light cycle.
- Disruption to rhythms generally has a negative effect in the short term. Recently it has been discovered that poor biological clocks of mammals are related to obesity and diabetes.
- The pineal gland regulates sleep-wake cycles in organisms.
- The circadian rhythm of mammals is located in the suprachiasmatic nucleus – a distinct group of cells located in the hypothalamus. Destruction of suprachiasmatic nucleus causes complete loss of a regular sleep-wake cycle.
- The individual cells themselves regulate circadian rhythms in protists and fungi.
- Circadian rhythms are similar in all species but the genes that form the clock mechanisms are quite different in different species. Clocks are most probably formed several times to perform similar functions, representing an example of convergent evolution.
- Molecular genetic studies revealed that the 24 hour period arises from a system of interconnected feedback loops that control the transcription of small number of genes.
- It has been suggested that circadian rhythms have evolved in the primitive cells to provide protection for replicating DNA from ultraviolet light during day time. Such a clock mechanism is present in *Neurospora*.
- Both plants and animals show yearly, monthly, daily and other rhythmic changes that appear to be genetically programmed.
- In plants the circadian clock regulates about 5 per cent of genome (>1000 genes in *Arabidopsis*). The rhythmic functions of these genes control processes like leaf and petal movements, the opening and closing of stomatal pores, the discharge of floral fragrances as well as many metabolic activities, particularly those associated with photosynthetic activities.
- Circadian rhythms are of adaptive significance as they are present at all level of phylogeny.
- Migratory fish and birds migrate over long distances using biological clocks that are entrained by the natural day-light cycle.
- On the whole, the biological rhythms play a key role in helping organisms to live in harmony with their rhythmic environment.

SOCIAL BEHAVIOUR

- Social behaviour is the interaction among individuals belonging to same species which are beneficial to one or more individuals.
- Social behaviour is an adaptation that enhances survival and reproductive fitness.
- Insects such as termites (order – isoptera), wasps, ants and bees (order – hymenoptera) exhibit well-developed social behaviour.
- Besides insects, naked mole rat is the only mammal showing social behaviour.
- Insects are eusocial and to qualify as eusocial a species must exhibit the following characteristics:
 - (a) Share a common nest site.
 - (b) Members of the same species cooperate in caring of the young.
 - (c) There is distinct division of labour. Sterile individuals work for the benefits of a few reproductive individuals.
 - (d) There is overlapping of at least two generations (i.e., offsprings contribute to a colony of labourers, while their parents are still alive) at any stage in a colony of insects.
- Social insects cannot survive individually.
- There is no central control in the operation of a social insect colony. No colony member directs the behaviour of another.
- One of the benefits of the social behaviour of insects is that different individuals are specialised in certain activities.
- It has been reported that a key region in the brain of social insects is crucial in the development of colonial behaviour of social insects.
- The life cycle of social insects consists of egg, larva and pupa (with the exception of termites).
- Except honeybee, in most insects new colonies are formed by single queen.

Social Life in Termites

- Termites are social and polymorphic insects.
- They have larger number of castes. In termites, both males and females are diploid.
- In a typical termite colony, the following four types of individuals are found:

1. Queen

- There is a single queen having the largest body size and perform only one function, i.e., laying of eggs.

2. King

- It is the fertile male. It lives with the queen and copulates frequently.

3. Workers

- Workers are small in size and numerous in number.
- They may be male and female individuals and are wingless.
- They lack ocelli and their antennae are short. Compound eyes are degenerated or vestigial except in Hodotermitidae.

- In some species they are of two types, viz., major workers (large in size) and minor workers (small in size) as found in *Macrotermes*, *Nasutitermes*, *Odontotermes*, *Trinervitermes*.
- Workers perform all the duties except reproduction and defence.
- In certain species, workers cultivate fungus in special chambers.

4. Soldiers

- Soldiers are sterile-like workers.
- They lack wings and reproductive organs but possess stronger mouth parts.
- The compound eyes of soldiers maybe vestigial (*Katotermes*) or well developed (*Hodotermes*) or totally lacking.
- Genetically, they may be males or females. In nasutitermitidae, all soldiers are male, while in macrotermitidae and termitinae all soldiers are females.
- Soldiers guard the colony.
- In termites, each colony is formed by a royal pair (king and queen). They mate and the queen after a short period lays eggs.
- There is no larval stage.
- On hatching from eggs the nymphs develop into one or more castes.
- In the beginning stages of colony, nymphs develop into sterile workers and soldiers and then reproductive castes are formed which may become the royal pair.
- Termites feed largely on wood (cellulose) which is digested by symbiotic Protozoan flagellate (*Trichonympha*). These flagellates are lost at each nymphal moult but they again enter the young termites (nymphs) when they feed on fresh faeces of adults.
- Termites do not have cellulose digesting enzyme (except termitidae).
- In termites, nutrition plays a key role in determining sociality.

Social Life in Honeybees

- Honey bee is a social and polymorphic insect.
- Social behaviour is highly developed in honeybees. They form permanent colonies.
- Honeybee is the only insect that forms food for human beings.
- The division of labour is well marked in a bee hive.
- In honeybees, sex determination is haplodiploidy.

Three types of individuals are found in a bee hive:

1. Queen

There is only one queen in a hive which develops from fertilised egg.

- Queens is diploid and fertile female.
- The queen lays eggs. It also secretes pheromones that regulate the behaviour of workers.

2. Workers

- Workers are sterile females.
- They are diploid and develop from fertilised eggs.
- Workers perform all functions except reproduction.

- In workers consumption of oxygen is more than the queen.

3. Drones

- Drones are fertile males.
- They are haploid and develop from unfertilised eggs.
- They fertilise the queen.
- After fertilisation, the queen lays two types of eggs, viz., fertilised and unfertilised.
- After three days, grubs (larvae) come out from the eggs.
- Larvae are fed with royal jelly by the workers.
- Those larvae that get royal jelly as food throughout the larval period develop into the queen and rest into workers.

Social Life in Ants

- All ants are social.
- They feed on a wide range of food.
- Some feed on fungus and cultivate fungus garden in the nests.
- They are adapted for trophallaxis.
- Some ants are adapted for slave making.
- In ants, the colony is founded by a single queen.
- A colony of ants consists of following castes:

1. Queen

- There are many queens in a nest.
- They are fertile females having well-developed sex organs.
- They are larger than males.

2. Males

- Males are small and fertile individuals.
- They are haploid.
- Males are dimorphic having large-sized macraners and small-sized micranares.

3. Workers

- Workers are generally sterile females.
- They are the smallest members of the colony.
- In advanced forms the workers are of three types, viz., minor, media and major workers.
- Minor and media workers serve the function of true workers while major ones act as soldiers.
- Food sharing is a method of communication in ants.
- Initially male and female reproductives are winged insects.
- After mating, the queen loses her wings while the male dies.
- Generally the first batch of eggs produces the queen and workers and later only workers.
- Eggs produced in spring produce queens and workers and those produced in summer produce only workers.

- After hatching, the larvae are fed on broken pieces of unchewed arthropods or on the saliva of the queen.
- In primitive ants, the pupa is enclosed in a cocoon while it is naked in advanced forms.

Social Life in Wasps

- Typically a wasp colony consists of three castes, viz., queen, drones and workers.
- Drones appear for a short period at the end of summer when they fertilise the queen.
- Workers are not totally sterile as some of them may lay eggs.
- Social wasps feed the larvae daily.
- There is exchange of food between the larvae and the workers.
- The colonies exist for a single season (spring to autumn).
- Males and female workers perish during autumn and the queen forms a new colony.
- It has been argued that social behaviour evolved as it is beneficial to those that are involved in it.
- Division of labour as well as pheromones for communication are primary requirements for successful social behaviour.
- In addition to differentiation of castes, pheromones stimulate specific receptors.
- It has been suggested that ecological factors could have promoted social behaviour by enhancing direct fitness opportunities of helper offsprings, rendering relatedness favouring kin selection less critical.

ANIMAL BEHAVIOUR

INNATE AND LEARNED BEHAVIOUR

Short-Answer Questions

1. Define behaviour.
Answer: The organised and integrated patterns of activity by which an organism responds to its environment is termed as behaviour.
2. What is ethology?
Answer: Ethology is the study of animal behaviour.
3. Why do scientists always find insects a key interest area for behavioural research?
Answer: Because:
 - (a) In comparison to vertebrates, insects have a relatively simpler nervous system.
 - (b) They manifest discrete responses to external stimuli.
 - (c) They are more conducive to ethical experimentation.
4. Who is regarded as the 'Founding Father of Ethology'?
Answer: Charles O Whiteman
5. Name the scientists who are regarded as the 'Fathers of Modern Ethology'.
Answer: Konard Zacharius, Karl von Frisch and Nikolaus Tinbergen
6. Distinguish between innate and learned behaviour.
Answer:

Innate behaviour	Learned behaviour
(a) Innate behaviours are present from birth and do not come from experience.	Learned behaviours are not present from birth and come from experience.
(b) These behaviours are genetically programmed.	These are not genetically programmed.
(c) Innate behaviours are inheritable.	Learned behaviours are not inheritable.
(d) Innate behaviours occur in animals raised in isolation.	Learned behaviours are not found in animals kept isolated from others or away from opportunity for trial and error.
(e) Innate behaviours are inflexible and cannot modified by experience.	Learned behaviours can be refined by experience.

7. What is kinesis?
Answer: Locomotion of organisms or cells in response to specific stimulus is termed as kinesis.
8. Define taxis.

Answer: A movement in response to direction of stimulus is known as taxis. It involves the movement of the whole body.

9. Name the scientist who performed the first systemic research on the phenomenon of transformation of unconditional stimulus to a conditional stimulus in classical conditioning.

Answer: Ivan Pavlov

10. Who developed the concept of imprinting?

Answer: Konard Lorenz

11. What is stereotyped behaviour?

Answer: Repetition of the same patterns of behaviour by an individual is termed as stereotyped behaviour.

12. What is open instinct?

Answer: The behaviour which becomes functional when it is first performed and has the ability of modification when interacting with the environment is termed as open instinct.

13. What is imprinting?

Answer: It is a specialised and limited form of programmed learning that occurs early in life.

14. Is imprinting adaptive?

Answer: Yes. Imprinting is adaptive as it enables the young ones to recognise and follow their parents.

15. Who discovered classical conditioning?

Answer: Ivan Pavlov

16. What is latent learning?

Answer: The learning that occurs but remains hidden until there is some incentive to demonstrate it is known as latent learning.

17. Who coined the term 'operant conditioning'?

Answer: B F Skinner (1930)

18. What are the different forms of operant learning?

Answer: Operant conditioning is of the following four types:

- (a) Positive reinforcement
- (b) Negative reinforcement
- (c) Punishment
- (d) Extinction

19. Animals with which type of body symmetry exhibit taxis?

Answer: Bilateral symmetry

20. Name the simplest type of unlearned animal behaviour.

Answer: Reflexes are the simplest type of unlearned animal behaviour.

31. Distinguish between tonic and phasic reflexes?

Answer: Tonic reflexes are slow and long-lasting adjustments that maintain muscle tone, posture and equilibrium, while phasic reflexes are quick, short-lived adjustments as found in flexure response.

22. Name an animal that exhibits klinokinesis.

Answer: *Paramecium*

23. Give two examples of instincts.

Answer: (a) Food-begging behaviour of gull chicks.
(b) Nest building behaviour in tailor birds.

Long-Answer Questions

1. Define behaviour. Discuss the features of innate behaviour with suitable examples. How does innate behaviour differ from learned behaviour?
2. What do you mean by taxis? Explain phototaxis, geotaxis and chemotaxis with suitable examples.
3. What is learned behaviour? Discuss different types of learned behaviours in animals with suitable examples.
4. Write short notes on the following:
(a) Innate behaviour (b) Learned behaviour (c) Fixed action plan (d) Kinesis
(e) Taxes
5. Distinguish between the following:
(a) Filial imprinting and sexual imprinting (b) Lateral learning and insight learning
(c) Phototaxis and thermotaxis and (d) Orthokinesis and klinokinesis
(e) Innate behaviour and learned behaviour (f) Territorial behaviour and courtship behaviour

BIOLOGICAL CLOCK

Short-Answer Questions

1. What is chronobiology?
Answer: Study of biological clock is known as chronobiology.
2. What is biological clock?
Answer: Biological clock is an internal mechanism in organisms that control periodicity of various physiological functions.
3. Is biological clock found at the levels of ecosystem and population levels?
Answer: Yes
4. What are the different types of rhythms occurring in organisms?
Answer: The various types of rhythms occurring in organisms are as follows:
(a) Circadian (daily) (b) Circaseptan (weekly)
(c) Circatrigintan (monthly) (d) Circannual (annual)
5. Which organism exhibits the simplest known circadian rhythm?
Answer: Cyanobacteria
6. Who first observed circadian rhythm?
Answer: Jean Jacques d'Ortous de Mairan in 1729
7. In humans, where is the biological clock located?
Answer: Scientists believe that biological clock in humans is located in the hypothalamus. The biological clock itself is believed to be a cluster of nerve cells called the supra chiasmatic nucleus.
8. What are the diagnostic features of circadian rhythms?

- Answer: (a) Persist in a constant condition with a period of 24 hours cycle
(b) Persist in the absence of external cues (endogenous)
(c) The frequency of rhythm is affected only slightly by temperature fluctuations (temperature compensated)
(d) Can be adjusted to local time (entrainable)
9. Name the most powerful synchroniser of the circadian rhythm.
Answer: Light is believed to be the most powerful synchroniser of the circadian rhythm.
10. In which cells have 24 hours biological rhythms been identified by scientists for the first time?
Answer: Red blood cells
11. Name the animal in which the first circadian gene was discovered.
Answer: Fruit fly (*Drosophila*) in 1971
12. Name a terrestrial animal that exhibits lunar rhythms.
Answer: Insect-eating lion (*Myrmelon obscurus*)
13. Give one word to the following:
(a) Endogenous rhythm of 24 hours
(b) An environmental stimulus that entrains a biological clock
Answer: (a) Circadian cycle (b) Zeitgeber
14. In which group of animals are lunar rhythms most common?
Answer: Marine invertebrates and insects
15. What is gene dosage network analysis (GDNA)?
Answer: It is a novel strategy developed by Baggs et al. (2009) to describe network features in the human circadian clock.

Long-Answer Questions

1. What is biological clock? Explain the phenomenon of biological clock in animals.
2. What is circadian rhythm? How does it influence exogenous and endogenous systems of animal behaviour?
3. Write short notes on the following:
(a) Circadian rhythm (b) Circalunar clocks
(c) Circannual rhythms (d) Circatidal clocks
(e) Functional importance of biological clock

ANIMAL COMMUNICATION

Short-Answer Questions

1. What is communication?

230 Ecology and Animal Behaviour

Answer: Transfer of information from one animal to another is known as communication.

2. Name the various means of communication in animals.

Answer: (a) Visual communication
(b) Chemical communication
(c) Auditory communication
(d) Tactile communication
(e) Electrical communication

3. Name a mammal having the ability of electroreception.

Answer: *Echidna*

4. Name the means of communication in whales.

Answer: Auditory communication

5. How do the blind workers of termites communicate?

Answer: Blind workers of termites communicate through tactile communication.

6. What is bombykol?

Answer: Bombykol is a pheromone secreted by female gypsy moth, which is detected by males several metres away.

7. Name the invertebrates famous for their auditory communication.

Answer: Crickets and cicadas

8. Name two animals that use the scent of dung as a means of communication.

Answer: Rabbits and hippopotamuses

9. What is the shape of waggle dance performed by honeybees?

Answer: 8-shaped

10. In honeybees, dancing language is used between which types of individuals?

Answer: Worker to worker

11. Give one example of visual communication.

Answer: Expansion of skin on the neck by cobra as a sign of attack

Long-Answer Questions

1. Define communication. Describe the different means of communication in animals.
2. Describe communication behaviour in honeybees.
3. Write short notes on the following:
 - (a) Alarm calls
 - (b) Releasers
 - (c) Adaptive significance of aggression
 - (d) Echolocation in bats
 - (e) Electric communication

PHEROMONES AND BEHAVIOUR

Short-Answer Questions

1. Pheromones are volatile or nonvolatile?
Answer: Pheromones may be volatile or may be nonvolatile.
2. What is nasonov pheromone?
Answer: Nasonov pheromone is secreted by worker bees and is used for orientation.
3. What is Bruce effect?
Answer: If a pregnant female mouse is exposed to the urine of a strange male, she will abort the litter being carried by her. This is known as Bruce effect.
4. What is queen bee substance?
Answer: The queen bee produces a substance called the queen bee substance that suppresses the development of ovary in workers as well as prevents rearing of other queens by the workers.
5. Name the hormones secreted by silk moths, gypsy moths and ants.
Answer: (a) Silk moth – Bombykol
(b) Gypsy moth – Glypleure
(c) Ant – Formic acid
6. What is the function of the primer pheromone?
Answer: Primer pheromone change the physiology of the recipient.
7. What is the importance of pheromones?
Answer: Pheromones are important to a variety of behaviours such as mate attraction, territoriality, trail marking, danger alarms as well as social recognition and regulation.
8. Which organ in animals is used to detect pheromones?
Answer: The organ responsible for detecting pheromones in animals is a chemosensory structure located in the nose called the vomeronasal organ.
9. Aggregation pheromone is produced by which sex male or female?
Answer: Aggregation pheromone is produced by both sexes (males and females).

Long-Answer Questions

1. What are pheromones? Describe the different types of pheromones and their functions.
2. Give an account of pheromones in insects.
3. Write short notes on the following:
 - (a) Mandibular glands
 - (b) Nasonov gland
 - (c) Anal glands
 - (d) Bombykol
 - (e) Alarm pheromones

SOCIAL BEHAVIOUR

Short-Answer Questions

1. Define social behaviour.
Answer: Social behaviour is the interaction among individuals belonging to the same species which are beneficial to one or more individuals.
2. Name the insects that exhibit well-developed social behaviour.
Answer: Termites (order – isoptera), wasps, ants and bees (order – hymenoptera).
3. Which mammal exhibits social behaviour?
Answer: Naked mole rat
4. Why are social insects called eusocial?
Answer: Due to following reasons:
 - (a) They share a common nest site.
 - (b) Members of the same species cooperate in caring for young ones.
 - (c) There is distinct division of labour. Sterile individuals work for the benefits of a few reproductive individuals.
 - (d) There is overlapping of at least two generations at any stage in a colony of insects.
5. Give five characteristics of honeybees.
Answer: (a) Honeybee is a social and polymorphic insect.
(b) Social behaviour is highly developed in honeybees. They form a permanent colony.
(c) Honeybee is the only insect that forms food for human beings.
(d) Division of labour is well marked in a bee hive.
(e) In honeybees, sex determination is haplodiploidy.
6. Name the termite having cellulose-digesting enzyme.
Answer: Termitidae
7. Name the families of termites in which all soldiers are males and females. In nasutitermitidae all soldiers are males, while in macrotermitidae and termitinae all soldiers are females.
8. Name two primary requirements for social behaviour.
Answer: (a) Division of labour (b) Pheromones for communication
9. Name the birds in which:
 - (a) Only females participate in incubation
 - (b) Only males participate in incubation
 - (c) Both the sexes (males and females) participate in incubation*Answer:* (a) Blue goose, golden pheasant (b) Kiwi, emu and emperor penguin
(c) Pigeon, dove and wood pecker
10. In which animals is cooperative hunting common?
Answer: Wild dog, wolves, killer whales, lions, etc
11. Name the factors that affect foraging of worker bees.
Answer: (a) Distance of flower (b) Source of water
(c) Environmental temperature

12. Which type of dance is performed by honeybees when:
(a) Food source is nearby (b) Food source is far away
Answer: (a) Round dance (b) Waggle dance
13. What are the different stages in the life cycle of a social insect?
Answer: Egg, larvae, pupa and adult
14. Name the social insect, whose life cycle does not include the larval stage.
Answer: Termites

Long-Answer Questions

- Describe social behaviour in insects.
- What do you mean by the term social organisation? Give an account of social organisation in termites.
- Give an account of social behaviour in honeybees.
- Write short notes on the following:
 - Eusocial behaviour in naked mole rats
 - Genetic basis of social behaviour
 - Kin selection concept
 - Origin of social behaviour in insects
 - Territorial behaviour
 - Reciprocal altruism
 - Castes in social insects

PARENTAL CARE

Short-Answer Questions

- What is courtship behaviour?
Answer: Pattern of behaviour that results in copulation and mating is known as courtship behaviour.
- Name the model that explains courtship behaviour.
Answer: Selfish gene model given by Richard Dawkins
- Give examples of sexual cannibalism.
Answer: Some families of spiders, scorpions and most of mantids.
- Define parental care.
Answer: The caring of eggs or juveniles until their reproductive age is known as parental care.
- Name the animals that lay eggs in ootheca.
Answer: Earthworms and cockroaches
- Why is parental care essential?
Answer: Because it increases the chances of survival of young ones as well as allows the young ones to learn patterns of behaviour from their parents.

234 Ecology and Animal Behaviour

7. Name the amphibian in which the female coils around the eggs and does not feed during the period of parental care.
Answer: *Icthyophis*
8. In which amphibian do mothers provide their own cast skin as food to offsprings?
Answer: Mothers of Kenyan caecilian, *Boulengerula taitanus*
9. Name the vertebrate in which gastric incubation/brooding occurs.
Answer: Australian frog (*Rheobatrachus silus*)
10. In which order of amphibia, viviparity is widespread.
Answer: *Gymnophiona* (apoda)
11. Name three viviparous amphibians.
Answer: (a) *Typhlonectes* (b) *Dermophis* (c) *Salamandra atra*
12. Name the only genus of caecilian that includes both viviparous as well as oviparous species.
Answer: *Gegeneophis*
13. In which family of fish is parental care primarily done by the males?
Answer: Family *Syngnathidae* (Sea horses and Pipefishes)
14. Name the fishes in which development of eggs take place in the uterus.
Answer: (a) *Scoliodon* (b) *Mustelus*
15. Give an example of transport of froglets by females.
Answer: Jamaican cave frog (*Eleutherodactylus cundalli*)
16. Name the genus of frog that lays eggs on land and tadpoles are lacking.
Answer: *Pristimantis*
17. Name the bony fishes in which fertilisation is internal.
Answer: (a) *Gambusia* (b) *Zoarces* (c) *Poicilia*
18. Distinguish between altricial and precocial.
Answer: The hatchlings of some birds (such as swifts, pigeons, sparrows, etc.) are naked, blind and helpless and need more parental care for further development. Such young ones are known as altricial. The young ones of birds which are feathered and can run or swim (such as fowls, ducks, quails etc.) and need less parental care are called precocial.

Long-Answer Questions

1. Define parental care. Describe the different modes of parental care in animals.
2. Give an account of parental care in fishes.
3. Describe the different modes parental care in amphibian.
4. Write short notes on the following:
 - (a) Brood pouch
 - (b) Nest building in fishes
 - (c) Egg capsules

INNATE AND LEARNED BEHAVIOUR

Multiple-Choice Questions

1. Innate behaviour can be changed through:
(a) Mutation (b) Genetic recombination (c) Natural selection (d) All
2. Which one of the following behaviour is due to combined effect of both external and internal stimulus?
(a) Mating behaviour (b) Observing a predator (c) Hunger (d) All
3. Which one of the following is an innate behaviour?
(a) Aggression (b) Escape (c) Defensive maneuvers (d) All
4. Which one of the following is a way of learning?
(a) By trial and error (b) By initiation (c) By instruction (d) All
5. Which one of the following about learned behaviour is incorrect?
(a) Acquired only through experience or observation
(b) Absent in animals raised in isolation from others
(c) Fully developed or expressed at first performance
(d) Capable of modification to suit changing condition
6. Teal-hunting behaviour is shown by:
(a) Falcons (b) Ostriches (c) Lions (d) Cheetahs
7. Which one of the following is not phase-specific learning?
(a) Imprinting (b) Sensitisation (c) Language learning (d) Avian song learning
8. Insight learning is more common in:
(a) Mammals (b) Fishes (c) Reptiles (d) Insects
9. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(a) Controls reflex action	1. Frontal lobe
(b) Hunger and thirst monitoring	2. Peripheral nervous system
(c) Destruction causes loss of memory	3. Hypothalamus
(d) Involved in planning decision	4. Cerebrum

Answer codes:

	A	B	C	D
(a)	4	3	1	2
(b)	3	4	2	1
(c)	2	3	4	1
(d)	4	1	2	3
10. The mammary gland of which one of the following mammals emits a pheromone that releases immediate nursing behaviour by their babies?
(a) Kangaroos (b) Rabbits (c) Whales (d) Koalas

11. Which one of the following about orthokinesis is correct?
 - (a) Animal does not show movement.
 - (b) The animal alters its rate of movement according to the intensity of stimulus.
 - (c) The animal alters its direction of movement according to the intensity of stimulus.
 - (d) The animal can change its position, direction or speed of movement according to the intensity of light.
12. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Negative photo taxis	1. <i>Paramecium</i>
(B) Orthokinesis	2. <i>Larva of Musca domestica</i>
(C) Klinokinesis	3. <i>Dendrocoelum lacteum</i>
(D) Chemotaxis	4. <i>Oniscus porcellio</i>

Answer codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	4	3	1
(c)	3	1	4	2
(d)	2	4	1	3
13. Which one of the following about stereotyped behaviours is correct?
 - (a) Initially stimulus dependent
 - (b) Result as a consequence of experience
 - (c) Not sex specific
 - (d) Are not predictable
14. Which one of the following is responsible for survival of higher animals?
 - (a) Instinct
 - (b) Learning
 - (c) Body changes
 - (d) A combination of instinct, learning and body changes
15. Which one of the following is a stereotyped behaviour?
 - (a) Instinct
 - (b) Motivation
 - (c) Reflexes
 - (d) All
16. Which one of the following about innate behaviour is correct?
 - (a) Inheritable
 - (b) Inflexible
 - (c) Intrinsic
 - (d) All
16. Consider the following statements:
 - (A) Innate behaviours is genetically programmed
 - (B) Innate behaviours are not triggered by external and/or internal stimuli
 - (C) Innate behaviours is intrinsic
 - (D) Young birds have innate behaviour, which allows them to hatch from eggs

The correct statements are:

 - (a) All
 - (b) A, B and C
 - (c) B, C and D
 - (d) B and D
17. Which one of the following is an example of innate behaviour?
 - (a) Instinct
 - (b) Taxes
 - (c) Reflexes
 - (d) All
18. If newly hatched geese are exposed to a moving object of normal size and emitting reasonable sounds, they will begin to follow it in a manner they would normally follow their mother. This is termed as:
 - (a) Imprinting
 - (b) Motivation
 - (c) Conditioned response
 - (d) None
19. A behaviour occurs due to:
 - (a) An external stimulus
 - (b) An internal stimulus
 - (c) Orientation
 - (d) All

20. Which one of the following is an innate behaviour?
(a) Fish swimming (b) Baby crying
(c) Mother bird feeding its chick (d) All
21. The tendency of an animal to follow the first moving thing they observe is known as:
(a) Imprinting (b) Motivation (c) Altruism (d) Bow riding
22. Which one of the following about motivation is incorrect?
(a) Internal stimuli (b) Psychological
(c) Both psychological or physiological (d) None
23. Which one of the following is a key feature of those animals in which the photoreceptor is asymmetrically placed in the body?
(a) Klinotaxis (b) Phototaxis (c) Geotaxis (d) Phonotaxis
24. A type of behaviour in which animals learn to ignore stimulus which is repeated is known as:
(a) Imprinting (b) Habituation (c) Motivation (d) Sensitisation
25. The scientist associated with classical conditioning:
(a) Konard Lorenz (b) Pavlov (c) Robert Woodworth (d) Darlington
26. Which one of the following is applicable to innate behaviour?
(a) Inherited (b) Inborn (c) Instinctive (d) All
27. The scientist associated with the formulation of the notion of the fixed action pattern:
(a) Nike Tinbergen (b) Charles Leroy (c) Konrad Lorenz (d) Oskar Heinroth
28. The building of a web by a spider is an example of:
(a) Fixed action pattern (b) Imprinting
(c) Associative learning (d) Conditional reflex
29. Skinner studied operant conditioning in:
(a) *Drosophila* (b) Rats (c) Dogs (d) Geese
30. Which one of the following is opposite to habituation?
(a) Sensitisation (b) Imprinting (c) Operant conditioning (d) Orientation
31. The book entitled *The Study of Instinct* was published by:
(a) Karl von Frisch (1943) (b) Niko Tinbergen (1951)
(c) Rick and Hall (1962) (d) Rothenbuhler (1964)
32. Which one of the following about imprinting is incorrect?
(a) It is genetically programmed.
(b) Generally occurs in very young ones.
(c) It is not critical to normal behavioural developments.
(d) A lot of work has been carried out on ground nesting birds.
33. Consider the following statements about habituation:
(A) Negative process of learning
(B) Acquisition of new responses but the loss of old ones
(C) Similar to sensory adaptation and fatigue
(D) Important in interspecific relationship among animals as well as habit selection
The correct statements are:
(a) All (b) A, B and C (c) B, C and D (d) A, B and D
34. Most of the imprinting work has been done on:
(a) Fishes (b) Amphibians (c) Birds (d) Insects

238 Ecology and Animal Behaviour

35. Habituation is shown by:
 (a) *Hydra* (b) Snails (c) *Nereis* (d) All
36. Which one of the following scientist is not associated with imprinting?
 (a) Oscar Heinroth (b) G Osche (c) Splingand (d) K Z Lorenz
37. Which one of the following is correct?
 (a) Imprinting is possible at all times in life (b) Timing is critical in habituation
 (c) Teloaxis depends on balance (d) All
38. Light compass reaction of ants and bees is an example of:
 (a) Menotaxis (b) Mnemotaxis (c) Telotaxis (d) Tropotaxis
39. Insight learning does not include:
 (a) Intelligence (b) Reasoning (c) Cognitive thinking (d) Sensitisation
40. Which one of the following is associated with the arousal of aggression?
 (a) Hypothalamus (b) Neocortex
 (c) Frontal parts of the cerebral hemispheres (d) Medulla oblongata
41. Which one of the following is considered as the centre of motivated behaviour?
 (a) Hypothalamus (b) Frontal parts of the cerebral hemispheres
 (c) Basal region of the cerebral cortex (d) Diencephalon
42. Which one of the following is incorrect?
 (a) Imprinting occurs at particular time during early post-natal life.
 (b) Imprinting is irreversible.
 (c) All behaviours are affected by imprinting.
 (d) Imprinting is more important in precocial species.
43. The dominant sense involved in imprinting is:
 (a) Sight (b) Sound (c) Olfaction (d) Temperature
44. Sexual imprinting:
 (a) Varies depending on whether the youngster is male
 (b) Varies depending on whether the youngster is female
 (c) Varies depending on whether the youngster is male or female
 (d) Does not vary whether the youngster is male or female
45. Which one of the following is an example of classical conditioning?
 (a) Dogs learn to salivate on hearing a bell (b) Reproductive behaviour of salmon
 (c) Dog phobia (d) Goslings follow the first moving object
46. Which one of the following about fixed action pattern is incorrect?
 (a) Performed without prior experience (b) Breeding crosses produce hybrid behaviours
 (c) Adaptive in nature (d) None
47. Which one of the following about reflexes is incorrect?
 (a) Does not involve the movement of body parts (b) Automatic
 (c) Involuntary (d) Stereotyped
48. Detour experiment is related with:
 (a) Habituation (b) Imprinting (c) Reasoning (d) Motivation
49. The mating behaviour of which one of the following fishes includes many examples of instinct?
 (a) New guinea fish (b) Surf perch
 (c) Three-spined stickle back (d) All

50. Instinct almost completely determines the behaviour of:

- (a) Spiders (b) Crustaceans (c) Insects (d) All

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (a) | 3. (d) | 4. (d) | 5. (c) | 6. (a) | 7. (b) | 8. (a) |
| 9. (c) | 10. (b) | 11. (b) | 12. (b) | 13. (a) | 14. (d) | 15. (d) | 16. (a) |
| 17. (d) | 18. (a) | 19. (d) | 20. (d) | 21. (a) | 22. (d) | 23. (a) | 24. (b) |
| 25. (b) | 26. (d) | 27. (c) | 28. (a) | 29. (b) | 30. (a) | 31. (b) | 32. (c) |
| 33. (d) | 34. (c) | 35. (d) | 36. (b) | 37. (b) | 38. (a) | 39. (d) | 40. (b) |
| 41. (a) | 42. (c) | 43. (a) | 44. (c) | 45. (a) | 46. (d) | 47. (a) | 48. (c) |
| 49. (c) | 50. (d) | | | | | | |

Fill in the Blanks

- The study of animal behaviour is called _____.
- The action that alters the relationship between an organism and its environment is known as _____.
- The behaviour of an animal may be categorised as either _____ or _____.
- The behaviour which is more or less can be altered by experience is called _____ behaviour.
- Response of an organism to a stimulus by automatically moving directly towards or away from or at some defined angle to it is called _____.
- Kinesis is an example of _____ behaviour.
- The behaviour in which an organism changes the speed of random movement is called _____.
- A reflex action is directly proportional to the _____.
- Orientation of animals in relation to a sound source is called _____.
- _____ is the most basic unit of innate behaviour.
- Signals that trigger instinctive acts are called _____.
- The interaction of heredity and learning can be observed in the learning programme termed as _____.
- The way to solve problems without trial and error is known as _____.
- Orientation of an animal in response to an external stimulus known as _____.
- Skinner studied operant conditioning in rats by placing them in an apparatus called _____.
- _____ and _____ are form of simple non-associative learning.
- Egg-rolling behaviour of the grey lag goose is an example of _____.
- _____ was the first man to study imprinting objectively and systematically.
- The highest form of learning is _____ learning.
- Oscar Heinroth is often given the credit for being the first man to use the term _____.
- Operant conditioning occurs during _____ learning.

240 Ecology and Animal Behaviour

22. The behaviour caused directly by external and internal factors is termed as_____.
23. _____ is the most elementary way of learning
24. The process by which a young individual learns the characteristic of a desirable mate is called _____.
25. Filial imprinting is found in many species of birds and _____.

Answers to Fill in the Blanks

- | | | |
|--------------------------------|--------------------------|-----------------------|
| 1. Ethology | 2. Behaviour | 3. Innate, learned |
| 4. Learned | 5. Taxes | 6. Innate |
| 7. Kinesis | 8. Stimulus strength | 9. Phono taxis |
| 10. Reflex arc | 11. Releasers | 12. Imprinting |
| 13. Reasoning | 14. Tropism | 15. Skinner box |
| 16. Habituation, sensitisation | 17. Fixed action pattern | 18. Konrad Lorenz |
| 19. Insight | 20. Imprinting | 21. Trial and error |
| 22. Motivation | 23. Habituation | 24. Sexual imprinting |
| 25. Mammals | | |

True or False

1. Innate behaviour can be modified.
2. Instinctive behaviour never depends on conditions of the internal environment.
3. Jerking of our hand away from a hot spot is innate behaviour.
4. Innate behaviour is intrinsic.
5. Instinct behaviours are flexible.
6. Probably, the conditioned reflex is the simplest form of learned behaviour.
7. Instinct behaviours are valuable in the adaptation of an animal to its environment.
8. Instinct behaviours differ from reflexes in their complexity.
9. Solving a complex mathematic sum is innate behaviour.
10. Body temperature is a biological motive that operates within a homeostatic cycle.
11. Hibernation in bears is an example of innate behaviour.
12. Innate behaviour develops through the process of natural selection.
13. Reflexes are continuously guided by stimulus.
14. The entire body participates in instinctive behaviour.
15. All responses to stimuli are automatic.
16. *Echidna* and marsupials develop changes in their genetic structures overtime, creating different innate behaviours.
17. Closed instincts are not modified by the environment.
18. Innate behaviour is open to evolutionary analysis.

19. Imprinting is a rapid form of learning.
20. Many behaviours are instinctively programmed by an individual's hormones.
21. Imprinting persists for years.
22. Phasic reflexes are slow.
23. Habituation changes the responses.
24. Lorenz is regarded as the 'Founder of Ethology'.
25. Latent learning is not immediately expressed.

Answers to True or False

- | | | | | | | | |
|----------|-----------|----------|-----------|-----------|-----------|-----------|----------|
| 1. True | 2. False | 3. True | 4. True | 5. False | 6. True | 7. True | 8. True |
| 9. False | 10. False | 11. True | 12. True | 13. False | 14. True | 15. False | 16. True |
| 17. True | 18. True | 19. True | 20. False | 21. False | 22. False | 23. False | 24. True |
| 25. True | | | | | | | |

Give Reasons

1. Humans learn about themselves and the world around them.
 - Because they have the ability to use language and thought.
2. Imprinting is adaptive.
 - Because it helps young ones to recognise their parents as well as to follow them.
3. Innate behaviour is inheritable.
 - Because it is encoded in DNA and passed from generation to generation.
4. Innate behaviour is flexible.
 - Because it is not modified by development or experience.
5. Innate behaviour is subject to genetic changes.
 - Because it is encoded by DNA.
6. A baby crying is innate behaviour.
 - Because they know how to cry when they are born.
7. Insects are more suitable for behavioural research.
 - Because in comparison to vertebrates:
 - (a) They have a relatively simpler nervous system.
 - (b) They exhibit discrete response to external stimuli.
 - (c) They are more conducive to ethical experimentation.
8. Reflexes are very similar to taxes.
 - Because of their relatively stereotyped nature and they are an outcome of inherited neural mechanism.

BIOLOGICAL CLOCK

Multiple-Choice Questions

1. Which one of the following lacks a biological clock?
(a) Animals (b) Plants (c) Humans (d) None
2. Consider the following statements:
(A) We have different clocks in our body, possibly even one in every cell
(B) Biological clocks take care that things happen at the right time
(C) The external behaviour of an animal is regulated by biological clocks
(D) Biological clocks are affected by metabolic inhibitors
The correct statements are:
(a) All (b) A, B and C (c) B and C (d) A, B and D
3. *Arenicola marina* shows:
(a) Circadian rhythm (b) Lunar rhythm
(c) Epicycle (d) Circannual rhythm
4. Biological clocks help animals to change their behavioural priorities in relation to the time of:
(a) Year (b) Month (c) Day (d) All
5. Biological clocks of various frequencies or durations are found in:
(a) Individual organs (b) Tissue and cells
(c) Ecosystems and populations (d) All
6. Consider the following statements about an animal:
(A) The sensitivity of the eyes of this animal changes twice a day
(B) During night, the receptors of its eyes are 10,00,000 times as sensitive as during the day
(C) This animal walks the bottom of the ocean for 350 million years
(D) This animal belongs to phylum Arthropoda
The animal is:
(a) Goose barnacle (b) *Limulus* (c) Crayfish (d) Tadpole shrimp
7. Which one of the following is longer than a day?
(a) Infradian rhythms (b) Circadian rhythms (c) Ultradian rhythms (d) None
8. Which one of the following about ultradian rhythms is incorrect?
(a) Shorter than a day (b) With a length from thousands of a second (like pulses in neurons) or seconds (like the heartbeat)
(c) Rhythms of 90 minutes in our sleeping cycle (d) Last about one day
9. Which one of the following is a true biological rhythm?
(a) Epicycle (b) Lunar rhythm (c) Circadian rhythm (d) Circannual rhythm
10. Who first identified a genetic compound of the biological clock?
(a) Harlow (1949) (b) Gibson (1950)
(c) Konapik and Benzer (1971) (d) Guyomarch et al (1998)

11. The secretion of melatonin is shorter during _____ season:
 (a) Summer (b) Winter (c) Rainy (d) None
12. Which one of the following is applicable to circadian rhythm?
 (a) Roughly 24 hour cycle (b) Endogenously generated
 (c) Zeitgebers (d) All
13. Melatonin:
 (a) Regulates circadian rhythms (b) Relieves the symptoms of jet lag.
 (c) Level in bloodstream is affected by ageing (d) All
14. Which one of the following about circadian rhythm is incorrect?
 (a) The first endogenous circadian rhythm was observed by Jean-Jacques d'Ortous de Mairan (1700).
 (b) Circadian rhythm can be modulated by external cues such as sunlight and temperature.
 (c) It persists in constant conditions.
 (d) It cannot proceed at the same rate within a range of temperature.
15. Which one of the following is under the control of biological clock?
 (a) Sleep cycle (b) Metabolic changes (c) Photosynthesis (d) All
16. Which one of the following is applicable to jet lag?
 (a) Disturbed sleep pattern (b) Disorientation
 (c) Fatigue (d) Low speed travel
17. Consider the following statements:
 (A) Biological clocks are not sensitive to temperature (B) They are affected by light intensity
 (C) They are under genetic control (D) Biological clocks are adjustable
 The incorrect statements are:
 (a) None (b) A and B (c) C and D (d) B and D
18. The permanent *Zeitgeber* of circadian rhythms are:
 (a) Light and temperature (b) Temperature and humidity
 (c) Light and dark (d) Light, dark, pH and humidity
19. Circannual cycle is shown by:
 (a) Hedgehog (b) Periwinkle (c) Palolo worm (d) None
20. Which one of the following genes regulates biological clock in mammals?
 (a) *freq* (b) *per* (c) *tim* (d) None
21. In humans, circadian clocks regulate:
 (a) Behaviour (b) Metabolism (c) Physiology (d) All
22. Which one of the following hormones is only delivered to blood during the night?
 (a) Growth hormone (b) Serotonin (c) Cortisol (d) Serotonin
23. Which one of the following hormones has its climax in the evening?
 (a) Serotonin (b) Cortisol (c) Both (a) and (b) (d) Melatonin
24. Cortisol and nor epinephrine have their climax in the blood during:
 (a) Night (b) Morning (c) Evening (d) Always
25. Lunar rhythms are characteristics of many species of:
 (a) Diptera (b) Lepidoptera (c) Trichoptera (d) All
26. Which one of the following uses moon as an environmental cue for spawning?
 (a) Oyster (b) *Lenresthes* (c) *Asterias* (d) *Limulus*

244 *Ecology and Animal Behaviour*

27. Woodlice show circadian rhythm under the influence of:
 (a) Light (b) Dark (c) Rain (d) Temperature
28. Consider the following characteristics of an endocrine gland:
 (A) Activated by light (B) Controls the various bio-rhythms of the body
 (C) Important in initiating supernatural powers (D) Size of pea
 This gland is:
 (a) Hypothalamus (b) Pituitary (c) Pineal (d) Parathyroid
29. Which one of the following hormones has the ability to entrain biological rhythms?
 (a) Melatonin (b) Serotonin (c) Cortisol (d) None
30. Which one of the following is not applicable to melatonin?
 (a) Dracula hormone (b) Triggers seasonal breeding in animals
 (c) Sets the timing of the body's biological clock (d) Secretion is stimulated by light
31. A clear rhythm is shown by:
 (a) Migraine (b) Asthma (c) Rheumatism (d) All
32. In human beings, testosterone is lowest in:
 (a) Winter (b) Spring (c) Autumn (d) Summer
33. Which one of the following about cyanobacteria is incorrect?
 (a) Oldest biological clock (b) Have photosynthesis during daytime
 (c) Have nitrogen fixation during night (d) None
34. The first mammalian clock gene has been identified and cloned in:
 (a) Opposum (b) Koala (c) Mouse (d) Hamster
35. Which one of the following is a circadian rhythmicity?
 (a) Colour change in fishes (b) Variation of body temperature in birds
 (c) Locomotor activity in insects (d) All
36. Which one of the following about naked mole rats is incorrect?
 (a) Effectively ectothermic and eusocial (b) Lack a circadian biological clock
 (c) Have practically no hair (d) None
37. Which one of the following can cause disruption of biological rhythms?
 (a) Alcohol consumption (b) Shift work
 (c) Jet lag (d) All
38. Consider the following statements:
 (A) Within the first few hours of sleep, there is huge release of the growth hormone
 (B) Irregular functioning of circadian rhythms may lead to bipolar and sleep disorders
 (C) Humans have a natural circadian rhythm of exactly 24 hours
 (D) Circaseptan rhythm is an annual cycle
 The correct statements are:
 (a) All (b) A and B (c) B and C (d) C and D
39. Which one of the following about circadian rhythms is incorrect?
 (a) Vary according to time of a day (b) Include changes in body temperature
 (c) Include opening and closing of flowers (d) No effect on urine production
40. Which one of the following is not a circannual cycle?
 (a) Hibernation in mammals (b) Migration in birds
 (c) Weight changes in men (d) Reproduction in mammals

41. First circadian mutant was discovered in:
 (a) *Neurospora* (b) *Drosophila melanogaster*
 (c) *Drosophila melanogaster* (d) Yeast
42. Match column I with column II and select the correct answer using answer codes:
 Column I (Gene) Columns II (Protein)
 (A) *d Clock* 1. PER
 (B) *d Bmall* 2. JRK
 (C) *Double Time* 3. CYC
 (D) *Period (pr)* 4. DBT
 Answer codes:
 A B C D
 (a) 4 3 2 1
 (b) 2 3 4 1
 (c) 3 2 4 1
 (d) 3 4 1 2
43. Which one of the following is used as a cure for jet lag?
 (a) Cortisol (b) Epinephrine (c) Melatonin (d) Serotonin
44. Consider the following statements:
 (A) Melatonin reflects the light-dark cycle in its rhythmical production
 (B) Mutations in clock genes cause an alternate pattern of wheel running in hamsters
 (C) Biological clocks continue to run under constant conditions
 (D) Biological clocks are under genetic control and are adjustable
 The incorrect statements are:
 (a) None (b) A, B and C (c) B and D (d) A and B
45. Circadian rhythms are important in determining the pattern of _____ animals:
 (a) Sleeping (b) Feeding (c) Both (a) and (b) (d) None
46. Which one of the following lacks genes-controlling circadian rhythms?
 (a) Cyanobacteria (b) Molds (c) Fishes (d) None
47. The gene responsible for running internal clock:
 (a) Period (*per*) (b) Clock (*clk*)
 (c) Timeless, (*tim*), frequency (*frq*) (d) All
48. Delayed sleeping phase syndrome is linked to gene:
 (a) *hPer3* (b) *hPer2* (c) *Wc-1* (d) *mPer2*
49. Circadian rhythm in *Drosophila* was demonstrated by:
 (a) W C Allee (1926) (b) Kalmus and Bunning (1930)
 (c) Kleitman and Richardson (1938) (d) Curt Richter (1969)
50. Which one of the following is incorrect?
 (a) Circadian rhythm can be changed with light therapy and by consuming melatonin
 (b) Longer term disruption of biological rhythms may increase risk for cardiovascular disease and cancer
 (c) Biological clock cannot be entertained
 (d) American Air Force exploited the concept of biological rhythms during attack on Serbia in 1999
51. Animals receive information from cues about periodicity of environment variables called:
 (a) Pacemakers (b) Zeitgebers (c) Oscillators (d) Amplitudes

246 Ecology and Animal Behaviour

52. Circannual clocks are shown by:
 (a) Warblers (b) Ground squirrels
 (c) White-crowned sparrow (d) All
53. Which one of the following is incorrect?
 (a) The onset of the particular phase of any rhythm occurs at the same time each day.
 (b) The frequency of self-generating rhythms is known as free running period.
 (c) The sensitivity of the rhythms to phase shifting effects of light depends upon the time, duration and intensity of the light signal.
 (d) Catfish shows an annual breeding rhythm.
54. Which one of the following is controllable?
 (a) The phase of the rhythm (b) The period of the rhythm
 (c) Both (a) and (b) (d) None
55. Cyclical with a periodicity shorter than 24 hours is called:
 (a) Ultradian (b) Infradian (c) Circadian (d) Biorhythm
56. Melanopsin is most efficiently excited by:
 (a) Red light (b) Green light (c) Blue light (d) Yellow light
57. In humans, the damage of genetic material in sperm cells begins with the age of:
 (a) 25 years (b) 30 years (c) 35 years (d) 40+ years
58. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-----------------------|--|
| (A) Lunar rhythm | 1. Behavioural and physiological rhythms occurring within a period of one year |
| (B) Circannual rhythm | 2. Common among marine invertebrates and insects |
| (C) Tidal rhythm | 3. Ability to time and repeat functions at an interval of 24 hours |
| (D) Circadian rhythm | 4. Opening of oyster shell |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 2 | 4 | 1 |
| (b) | 4 | 3 | 1 | 2 |
| (c) | 2 | 1 | 4 | 3 |
| (d) | 2 | 4 | 1 | 3 |
59. If a human infested with *Wuchereria bancrofti* changes its habit from diurnal to nocturnal, the worm will:
 (a) Change its periodicity accordingly (b) Will not change its periodicity
 (c) Change in periodicity will depend on physiological condition of both the host as well the parasite (d) May or may not change its periodicity
60. Lunar rhythm is shown by:
 (a) Jellyfish (b) Starfish (c) Palolo worm (d) Acorn worm
61. Which one of the following may cause circadian rhythm disorders?
 (a) Time zone change (b) Pregnancy (c) Medications (d) All
62. Rapid time zone change syndrome is applicable to:
 (a) Shift worker sleep disorder (b) Jet lag

- (c) Delayed sleep phase syndrome (d) Advanced sleep phase syndrome
63. Which one of the following is incorrect?
- (a) Actigraphy is generally useful for assessing nighttime sleeping
 (b) Electric light in the evening may delay circadian phase
 (c) The activity of digestive system increases during sleep but that of urinary system decreases
 (d) In a circadian cycle (24 hours) generally a human sleeps approximately 8 hours and is awake for 16 hours
64. Cryptochromes are:
- (a) Located in the retina (b) Occur in two forms CRY 1 and CRY 2 and are linked to vitamin B-2
 (c) Enable animals and humans to synchronise their circadian clocks (d) All
65. Which one of the following is not applicable to circadian rhythms?
- (a) Cyclical changes (b) Approximately 24 hour cycle
 (c) Biorhythms (d) Affected by personality and environmental factors

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (d) | 5. (d) | 6. (b) | 7. (a) | 8. (d) |
| 9. (a) | 10. (c) | 11. (a) | 12. (d) | 13. (d) | 14. (d) | 15. (d) | 16. (d) |
| 17. (a) | 18. (c) | 19. (a) | 20. (d) | 21. (d) | 22. (a) | 23. (a) | 24. (b) |
| 25. (d) | 26. (b) | 27. (a) | 28. (c) | 29. (a) | 30. (d) | 31. (d) | 32. (b) |
| 33. (d) | 34. (c) | 35. (d) | 36. (d) | 37. (d) | 38. (b) | 39. (d) | 40. (c) |
| 41. (b) | 42. (b) | 43. (c) | 44. (a) | 45. (c) | 46. (d) | 47. (d) | 48. (a) |
| 49. (b) | 50. (c) | 51. (b) | 52. (d) | 53. (a) | 54. (c) | 55. (a) | 56. (c) |
| 57. (c) | 58. (c) | 59. (a) | 60. (c) | 61. (d) | 62. (b) | 63. (a) | 64. (d) |
| 65. (c) | | | | | | | |

Fill in the Blanks

- Biological rhythms are generated by two processes, viz., _____ and _____.
- A cyclical, repeated variation in a biological function is called _____.
- _____ is the study of biological rhythms.
- Biological clock contains repeating units called _____.
- The circadian clock in mammals is located in the _____ of the hypothalamus.
- The term 'circadian rhythm' was coined by _____.
- Circadian rhythms are popularly called _____.
- The duration of melatonin secretion is directly proportional to the length of the _____.
- Circadian rhythm persists with a period close to _____ hours.
- The suprachiasmatic nucleus receives information about illumination through the _____.

11. A biological clock that persists under constant conditions and has a period of 1 day is called _____ rhythm.
12. In human beings, complete destruction of _____ nucleus causes complete lack of sleep-wake rhythm.
13. Rhythms that stop without environmental hints are termed as _____.
14. Circadian rhythms are _____ generated.
15. Serotonin is converted into melatonin by the _____ gland when light fades.
16. Sleep-wake cycle is an example of _____ rhythm.
17. The suprachiasmatic nucleus causes release of melatonin by its effect on the _____.
18. The average human temperature reaches its minimum at _____ a.m.
19. The first circadian mutant was discovered by _____.
20. _____ was the first of several clock genes to be discovered.
21. *per* gene is expressed mainly in the _____ system of *Drosophila*.
22. _____ and _____ are two most common causes of disturbances in circadian rhythms in humans.
23. _____ are compounds that are capable of shifting biological clocks.
24. The circadian clock of the prokaryotic _____ is the simplest known circadian clock.

Answers to Fill in the Blanks

- | | | |
|------------------------------|----------------------------------|-------------------------|
| 1. Exogenous, endogenous | 2. Biological rhythm | 3. Chronobiology |
| 4. Cycles | 5. Suprachiasmatic nucleus (SCN) | 6. Franz Halberg (1959) |
| 7. Biological clocks | 8. Night | 9. 24 |
| 10. Eyes | 11. Circadian | 12. Suprachiasmatic |
| 13. Exogenous | 14. Endogenously | 15. Pineal |
| 16. Circadian | 17. Pineal | 18. Five |
| 19. Ronald J Konopka (1971) | 20. Period (<i>per</i> gene) | 21. Visual |
| 22. Shift work, long flights | 23. Chronobiotics | 24. Cyanobacteria |

True or False

1. Rutting in deer is a circadian cycle.
2. Blind individuals are unable to experience disruption in rhythms.
3. Circadian rhythms are important in determining sleeping and feeding pattern.
4. A plant circadian rhythms come solely from its environment.
5. Circadian rhythms are cyclical expression of genes in individual cells.
6. In many birds biological clock is located in the pineal gland.
7. A circadian rhythm cannot be disrupted by a change in daily schedule.

8. Circadian rhythms are very similar in all species but the genes that make up the clock mechanisms are quite different.
9. Circadian rhythms also occur in plants.
10. Men have a strong daily cycle in their testosterone levels.
11. Biological rhythms are always coordinated with the onset of some ecological events.
12. Melatonin has been shown to exhibit a circadian rhythm.
13. Mammalian biological clock mechanism is in fact not only endogenous but is also of genetic origin.
14. The effectiveness of drugs may depend on the time of the day they are taken.
15. Clock gene is not highly conserved among vertebrates.
16. Cocaine-induced effects have circadian influences.
17. Genes controlling insulin can alter timing of the biological clock.
18. Both men and women have biological fertility clocks.
19. Kangaroos and rats breed seasonally.
20. Dreaming is an example of circadian rhythm.
21. Menstrual period in women is a monthly biological rhythm.
22. Blind mole rats are unable to maintain their endogenous clocks in the absence of apparent external stimuli.
23. TIM protein is light insensitive.
24. Chronic alcohol consumption may adversely affect the body's biological clock ability.

Answers to True or False

- | | | | | | | | |
|----------|----------|-----------|-----------|----------|-----------|-----------|----------|
| 1. False | 2. False | 3. True | 4. False | 5. True | 6. True | 7. False | 8. True |
| 9. True | 10. True | 11. False | 12. True | 13. True | 14. True | 15. False | 16. True |
| 17. True | 18. True | 19. False | 20. False | 21. True | 22. False | 23. False | 24. True |

Give Reasons

1. Every living organism has a biological clock.
 - Because it is thought that biological clock helps a species to survive.
2. Many of us experience our clocks in the form of jet lag, which occurs:
 - Because different clocks of our body react differently. The lag can last a week before the clock works in tune again.
3. Biological clocks are regarded as an example of convergent evolution.
 - Because probably they have evolved several times to perform very similar functions.
4. New born babies lack a clear rhythm.
 - Because in newborn babies, the part of the brain controlling the clock is not yet ready.
5. Circadian rhythms may be of adaptive significance.
 - Because they are present at all levels of phylogeny.

250 *Ecology and Animal Behaviour*

6. In desert mammals, most births occur during the wet season.
 - Because water is essential for milk production.
7. Growing happens during the night.
 - Because hormones have a daily cycle. Growth hormone is delivered to the blood only during the night.
8. Shortening mechanism of telomeres can be regarded as a biological clock.
 - Because it limits cells to a fixed number of divisions.
9. The levels of TIM proteins are low during the day.
 - Because TIM protein is light sensitive.
10. The exposure of night workers to bright light is beneficial.
 - Because it suppresses the production of melatonin.
11. Environmental rhythms are very important biological rhythms.
 - Because they effect the activity of animals as well as have important implications on the functioning of biological clocks.

ANIMAL COMMUNICATION

Multiple-Choice Questions

1. Animals communicate to their own kind or other species to:
(a) Attract mates and search for food (b) Bring up young ones
(c) Escape from danger (d) All
2. The first form of animal communication is by:
(a) Showing visual acts (b) Means of sound
(c) Touching (d) Through chemical transmission
3. Which one of the following animals show alarm by flicking up their tails?
(a) Dogs (b) Deer (c) Elephants (d) Kangaroos
4. Olfaction as a signal of communication is generally:
(a) Used between prey and predator (b) Used between sexual partners
(c) In territorial limitations (d) All
5. The most important signal used in private and short range communication is:
(a) Visual (b) Olfaction (c) Tactile (d) Auditory
6. The dancing language in honeybees is applicable between:
(a) Queen and drone (b) Worker and drone
(c) Worker and worker (d) Queen, worker and drone
7. Which one of the following about alarm call in birds is incorrect?
(a) Is very similar in many species of birds (b) Is of short duration
(c) Is of long duration (d) Is of high frequency
8. Blind worker of termites communicate through:
(a) Hormonal communication (b) Pheromonal communication
(c) Tactile communication (d) Auditory communication
9. Production of sound as wing beating does not occur in:
(a) Mosquitoes (b) *Schistocerca* (c) *Drosophila* (d) *Apis*
10. In which one of the following orders of insects, the mechanism of sound production and reception is well developed?
(a) Orthoptera and coleoptera (b) Diptera
(c) Diptera and hemiptera (d) All
11. In Octopus, sexual displays are made by:
(a) Producing sound (b) Rapid colour changes of the body
(c) Raising of arms in upward direction (d) Producing sex attractant
12. Interspecies communication occurs in various kinds of:
(a) Mutualism (b) Symbiosis
(c) Both mutualism and symbiosis (d) None

13. Communication through electroreception occurs in:
 (a) Dolphins (b) Bats (c) Echidnas (d) None
14. Which one of the following does largely rely upon pheromone as a means of communication?
 (a) Bees and moths (b) Ants (c) Wasps (d) All
15. Which one of the following male animals waves their giant claw to attract females?
 (a) Horseshoe crab (b) Fiddler crabs (c) Chimpanzees (d) Hermit crabs
16. Consider the following statements:
 (A) Animals having smaller heads can receive and transmit higher frequency of sound
 (B) Whales appear to be experts in communication by sound
 (C) Grasshoppers and crickets create sound by fiddling
 (D) Elephants use interlinking of trunks as a means of close communication
 The incorrect statements are:
 (a) A and B (b) B and C (c) A and D (d) None
17. Which one of the following animal lacks simple form of echolocation?
 (a) Shrew (b) Owl
 (c) South American oil bird (d) Himalayan cave swift let
18. Who first noted that bats emit pulses of high frequency sound?
 (a) Donald Griffin (1958) (b) Tinbergen (1951)
 (c) Baerends (1959) (d) Tinbergen and Perdeck (1950)
19. In which one of the following animals, size, motion and colour are involved in male-female interaction?
 (a) Sawfly (b) Fritillary butterfly (c) Silkworm (d) Swift
20. Which one of the following is incorrect?
 (a) Generally, birds defend their ownership of large territories by vocalisation as means of chemical communication
 (b) Birds defending smaller areas such as nest sites, use visual communication
 (c) In fireflies, sexes are attracted to each other on the basis of their flash intervals
 (d) Visual signals can be started or stopped immediately
21. A submissive posture in elephant is indicated by:
 (a) Moving head (b) Moving ear
 (c) Inward curling of trunk (d) Forwardly directed trunk
22. Social insects communicate through:
 (a) Tactile communication (b) Chemical communication
 (c) Auditory communication (d) Visual communication
23. Blind fishes know the presence of other fishes in groups by:
 (a) Tactile communication (b) Chemical communication
 (c) By creating disturbances in water through their lateral line organs (d) Auditory and chemical communications
24. Intraspecific communication is useful in:
 (a) Alarming dangers (b) Sexual reproduction (c) Parenting offsprings (d) All
25. Baby birds indicate their hunger by:
 (a) Secreting a pheromone (b) Flapping their wings
 (c) Opening their beaks and chipping loudly (d) Restless motion
26. Which one of the following sings to attract a mate?
 (a) Frogs (b) Whales (c) Crickets (d) All

27. Which one of the following animal plays a dead role to fool their enemies?
(a) *Echidna* (b) Opossum (c) Koala (d) Horned toad
28. In which one of the following orders of bird is song best developed?
(a) Galliformes (b) Passeriformes (c) Apodiformes (d) Piciformes
29. Drumming is used in courtship and to declare territory by:
(a) Purple martins (b) Western sandpipers (c) Wood peckers (d) Ovenbirds
30. Consider the following points about avian brain:
(A) Controls song output (B) Generally larger in males
(C) Expands during mating season (D) The number of songs a bird can produce are proportional to its size

The name of this part is:
(a) Forebrain (b) Midbrain (c) Hindbrain (d) Cerebellum
31. Which one of the following species of birds mimics the songs of other birds?
(a) Starlings (b) Catbirds (c) Mockingbirds (d) All
32. Which one of the following is incorrect?
(a) Some fish use electric signals to communicate and to locate prey.
(b) Electric eels are aggressive.
(c) Paddle fish uses a passive electro location to detect its prey.
(d) The electric organ is derived from myocytes but functions like an array of giant neurons.
33. Which one of the following birds produces audible sound to echolocate in the darkness of caves?
(a) Oil bird (b) Babbler (c) Quail (d) All
34. Duetting song occurs in:
(a) Quails (b) Scimitar babblers (c) Parrots (d) All
35. Knollen organs are tuberous electro receptors found embedded in the skin of:
(a) American koi (b) Mormyrid electric fishes from Africa
(c) Angler fish (d) Khalisha fish
36. In monkeys, rushing up trees is a call in response to:
(a) Snake (b) Eagle (c) Leopard (d) Mating
37. Barn owl locates and catches its prey only when the sound of movement of the prey:
(a) Reaches first to the right ear (b) Reaches first to the left ear
(c) Can stimulate the two ears equally (d) Can stimulate the two ears unequally
38. Antennal tapping is an essential component of communication in:
(a) Termites (b) Ants (c) Blister beetles (d) All
39. Which one of the following about advantage of tactile communication is incorrect?
(a) Effective in the dark (b) Individual recipient
(c) Vibration signals can be intercepted by predators (d) Localised area
40. In most species of fish, electric organs are derived from muscles, except in family:
(a) Gymnotids (b) Mormyrids (c) Synodontidae (d) Gobiidae
41. In which one of the following does the queen release pheromones to convey all sorts of messages to the rest of the colony?
(a) Bees (b) Ants (c) Wasps (d) All
42. Match column I with column II and select the correct answer using answer codes:

Column I

- (A) Frog
- (B) Bat
- (C) Howler monkey
- (D) Grasshopper

Column II (Frequency scale)

- 1. 7,000 to 1,00,000 Hz
- 2. 50 to 8,000 Hz
- 3. 12,000 to 1,50,000 Hz
- 4. 400 to 6,000 Hz

Answer codes:

	A	B	C	D
(a)	4	3	1	2
(b)	2	3	4	1
(c)	3	2	1	4
(d)	4	2	1	3

43. Which one of the following animals produces sound of both higher frequency (audible to humans) as well as sound of lower frequency (not audible to humans)?
 - (a) *Echidna* (b) Opossum (c) Elephant (d) Tiger
44. Which one of the following is a priming pheromone?
 - (a) Aggression inducer (b) Fear substance
 - (c) Adrenocortical activator (d) Male sex attractant
45. Males of this animal rub their chest on trunks and branches of trees to mark their territory:
 - (a) Koala (b) Opossum (c) Gibbon (d) Shrew
46. Consider the following statements:
 - (A) An electrical signal propagates away from the sender
 - (B) The waveform of an electrical signal is distorted during transmission
 - (C) Electrical signals are not ideally suited for aggressive tendencies
 - (D) The detection of a chemical signal does not depend on the quantity of chemicals emitted

The incorrect statements are:

 - (a) A, B and C (b) B, C and D (c) C and D (d) All
47. In which one of the following animals do males secrete a chemical substance from their face during breeding season to mark their territory?
 - (a) Tigers (b) Red foxes (c) Ringed seals (d) Dolphins
48. Which one of the following sounds is used by dolphins?
 - (a) Mews and whistles (b) Clicks, moans and barks
 - (c) Chirps, squeaks, yaps and creaks (d) All
49. Consider the following statements:
 - (a) Mormyrid electric fishes are quite sensitive to sound
 - (b) Fishes make two most common types of sounds for courtship and agonistic behaviours
 - (c) In gymnotid and mormyrid groups of fishes, electrical signals are used for electro location and communication
 - (d) Chimpanzees lack the motor ability to pronounce human sounds

The correct statements are:

 - (a) All (b) A, B and C (c) B and C (d) C and D
50. In which one of the following reptiles is tympanic membrane lacking?
 - (a) Snakes (b) Tuatara (c) Amphisbaenians (d) All
51. Acoustic signals can be quickly:
 - (a) Started (b) Stopped (c) Modified (d) All

52. Substrate vibrations can be sensed by:
 (a) Bees (b) Termites (c) Treehoppers (d) All
53. Which one of the following about pheromones is incorrect?
 (a) Effective only in small quantities (b) Effective in day or night
 (c) Effective in an upwind direction (d) Longer lasting than visual or auditory signal
54. Pheromone is heavily used in:
 (a) Cobras (b) Kraits (c) Garter snakes (d) Sea snakes
55. In chameleons, bobbing of head indicates:
 (a) Claim to territory (b) Overheating (c) Danger (d) Sexual urge
56. Most animals use odors to communicate between sexes and within sexes, except:
 (a) Insects (b) Fishes (c) Reptiles (d) Birds
57. Lizards communicate with:
 (a) Vision (b) Body language (c) Pheromones (d) All
58. Gauche habit of drawing air into the cloaca and loudly expelling it when irritated occurs in:
 (a) Geckos (b) Coral snake (c) Tortoises (d) Rattle snake
59. Sound through substrate vibration is received by:
 (a) Urodela (b) Anura (c) Caecilians (d) None
60. Hiss as a warning occurs in:
 (a) Gila monster (b) Snakes (c) Crocodiles (d) All

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (a) | 3. (b) | 4. (d) | 5. (a) | 6. (c) | 7. (c) | 8. (c) |
| 9. (b) | 10. (d) | 11. (b) | 12. (c) | 13. (c) | 14. (d) | 15. (b) | 16. (d) |
| 17. (b) | 18. (a) | 19. (b) | 20. (a) | 21. (c) | 22. (b) | 23. (c) | 24. (d) |
| 25. (c) | 26. (d) | 27. (b) | 28. (b) | 29. (c) | 30. (a) | 31. (d) | 32. (b) |
| 33. (a) | 34. (d) | 35. (b) | 36. (c) | 37. (c) | 38. (d) | 39. (c) | 40. (a) |
| 41. (d) | 42. (b) | 43. (c) | 44. (c) | 45. (a) | 46. (d) | 47. (c) | 48. (d) |
| 49. (a) | 50. (d) | 51. (d) | 52. (d) | 53. (c) | 54. (c) | 55. (a) | 56. (d) |
| 57. (d) | 58. (b) | 59. (c) | 60. (d) | | | | |

Fill in the Blanks

1. Transfer of information is called _____.
2. Most communication is done through _____.
3. _____ and _____ make up an animals' language and are essential to survival.
4. Peacocks attract mates using _____.
5. Animals use scent signals called _____ to affect the behaviours of others.
6. Sounds that happen outside our frequency range are called _____ or _____.
7. We can recognise more than _____ smells.

256 Ecology and Animal Behaviour

8. Bird vocalisation includes both _____ and _____.
9. _____ of teeth seems to be a universal body signal among predators.
10. Elephants produce a sound of _____.
11. Grasshoppers have ears on their _____.
12. The visual signals are useless at night or less luminated places, except for _____ producing organisms.
13. The most widespread use of tactile stimuli occurs in _____.
14. The _____ is widely accepted as a key component of the Wrenicke's language area of the brain.
15. The _____ and _____ systems are two major sensory modalities employed in communication.
16. The anal sac secretions of lions contains putrecine and _____.
17. The anal sac secretions of minks are released in _____.
18. Dolphins use clicking noises in _____.
19. _____ communication is the most important to most fish.
20. Mirror neurons were first discovered in _____ monkeys.
21. Bird vocalisations can be divided into three categories, viz., _____ notes, _____ notes and _____.
22. Birds with _____ pairs of syrinx muscle, produce complex and elaborate sounds.
23. In birds, song output is controlled by the _____.
24. The electric organ is located in the _____ of a weakly electric fish.
25. Knollen organs have been termed as _____ sensors.

Answers to Fill in the Blanks

- | | | |
|---------------------|---------------------------|--------------------------------|
| 1. Communication | 2. Body language | 3. Sound signals, body posture |
| 4. Bright colours | 5. Pheromones | 6. Ultrasonic, infrasonic |
| 7. 10,000 | 8. Birds calls, birdsongs | 9. Snaring and baring |
| 10. 10 to 10,000 Hz | 11. Abdomens | 12. Light |
| 13. Copulation | 14. Planum temporale | 15. Visual, auditory |
| 16. Cadaverine | 17. Aggressive encounters | 18. Echolocation |
| 19. Visual | 20. Macaque | 21. Chip, call, songs |
| 22. 5 to 9 | 23. Forebrain | 24. Tail |
| 25. Communication | | |

True or False

1. Most animals have five senses like humans.
2. All species do not have the same capacity for communication.
3. Communication is influenced by a species genetic make up and its environment.

4. Cusk eels use several sets of muscles to produce sound.
5. Horses rub noses as a sign of affection.
6. Gorillas stick out their tongues to show anger.
7. An *amoeba* communicates with other *amoebas* by chemical discharge.
8. Giraffes press their necks together when they are attracted to each other.
9. Bees may not dance for longer periods, even if the food source is rich.
10. All birds have only one alarm call.
11. A cringing dog is the one likely to attack.
12. Often, chimpanzees use complex forms of communication.
13. Whenever there is danger, birds flash their wings and tail feathers.
14. Both humans and animals use body language as a means of communication.
15. In some mammals, vaginal stimulation induces ovulation.
16. Sound signals are unable to convey messages in dense vegetation.
17. Bees dance when they find nectar.
18. Courtship display of the Mandarin duck has the highest degree of ritualisation of all species of ducks.
19. Ruffling often occurs in aggressive displays.
20. Fishes and whales produce sound in water for communication purposes.
21. Many birds inhabiting in cavities are known to produce snake-like hissing sound.
22. Zebra finches are the most popular species for birdsong research.
23. Mirror neurons have both sensory and motor activity.
24. Birds songs are the same within a species
25. Recently, it has been reported that robins in urban areas sing at night because it is too noisy during the day.

Answers to True or False

- | | | | | | | | |
|----------|-----------|-----------|----------|----------|----------|----------|-----------|
| 1. True | 2. False | 3. True | 4. True | 5. True | 6. True | 7. True | 8. True |
| 9. False | 10. False | 11. False | 12. True | 13. True | 14. True | 15. True | 16. False |
| 17. True | 18. True | 19. True | 20. True | 21. True | 22. True | 23. True | 24. False |
| 25. True | | | | | | | |

Give Reasons

1. Demarcation of territorial boundaries by an odiferous signal is more efficient.
 - Because it exists, even after the signaler has gone.
2. Animals living in a circus have greater skills of communication than those living in homes.
 - Because they are exposed to an environment that offers new avenues to both learning and training continuously.

258 *Ecology and Animal Behaviour*

3. Male koalas rub their chests on trunks and branches of trees.
 - Because sternal gland is located in the chest of males, the secretion of which is used to mark their territory.
4. Birds sing.
 - Because they try to impress mates and proclaim their territories.
5. Electric fish can see in the dark.
 - Because electric fish can sense the distortion of their electric organ discharge produced by the nearby objects, so they can see in the dark.
6. Low-frequency sounds are useful for long distance communication
 - Because such sounds get scattered by incoming obstacles.
7. Acoustic signals can be quickly started, stopped or modified.
 - Because sound waves move rapidly through air.
8. Pheromones are metabolically inexpensive.
 - Because they are needed in small quantities.
9. Birds produce their territorial sound from an elevated area.
 - Because it increases effectiveness to cover more area.
10. Visual powers are not used for long distance communication.
 - Because visual powers weaken with distance.

PHEROMONES

Multiple-Choice Questions

1. Consider the following statements:
(A) Pheromones are produced by exocrine glands
(B) Pheromones are present in faeces or in urine
(C) Pheromones are secreted in external environments
(D) Pheromones are species specific
The correct statements are:
(a) All (b) A, B and C (c) B and C (d) B and D
2. Hormones and pheromones differ in the:
(a) Site of secretion (b) Mode of transport (c) Mode of action (d) All
3. Which one of the following is the principal alarm pheromone of the sting apparatus of the honeybee?
(a) Isoamyl acetate (b) Geranyl acetate
(c) Nerolic acid (d) 9-keto-1 decenoic acid
4. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Gyptol	1. Ants
(B) Bombykol	2. White ants
(C) Pinene	3. Gypsy moths
(D) Tridecane	4. <i>Bombyx mori</i>

Answer codes:

A	B	C	D
(a) 3	4	2	1
(b) 2	3	1	4
(c) 4	2	1	3
(d) 4	3	2	1
5. Which one of the following is not an alarming pheromone of white ants?
(a) Terapenolene (b) Limonene (c) Unidecane (d) Pinene
6. Which one of the following communicates by using pheromones?
(a) Insects (b) Some vertebrates (c) Some plants (d) All
7. Nasonov pheromone is produced by:
(a) Queen of honeybees and is used for attracting drones
(b) Workers of honeybees and is used for orientation
(c) Drones of honeybees and is used to promote drone aggregations at sites suitable for mating with the queen
(d) Queen, workers and drones of honeybees and is used for communication

8. Which one of the following is a moth pheromone?
 - (a) Undecan-1-ol
 - (b) (Z)-6-cis-9, 10 Epoxyheneicosene
 - (c) Undecyl acetate and 2-methylheptadecane
 - (d) All
9. Which one of the following about pheromones is incorrect?
 - (a) Travel fast
 - (b) Do not fade quickly
 - (c) Effective over a long range
 - (d) Direction is not limited to straight lines
10. Seducin pheromone is produced by:
 - (a) Wasps
 - (b) Crickets
 - (c) Some male cockroaches and crickets
 - (d) Spiders and wasps
11. Alarm pheromones are found in:
 - (a) Termites and aphids
 - (b) Hyenas and shrews
 - (c) Rats, skunks, termites, aphids and schooling fishes
 - (d) All
12. Alarm chemicals are released by:
 - (a) Poison gland
 - (b) Mandibular gland and Dufour's gland
 - (c) Anal gland
 - (d) All
13. Which one of the following about alarm pheromones is incorrect?
 - (a) Have the simplest structure
 - (b) Have low molecular weight
 - (c) Highly volatile
 - (d) Appear to be the highly specific of all pheromones
14. In honeybees, mandibular gland is not well developed in:
 - (a) Drones
 - (b) Workers
 - (c) Queen
 - (d) Queen and drones
15. $\text{CH}_3-(\text{CH}_2)_3-\text{CH}=\text{CH}-\text{CH}=\text{CH}-(\text{CH}_2)_8-\text{CH}_2\text{OH}$
The above given structure is of:
 - (a) Bombykol
 - (b) Gyptol
 - (c) Z-9-tricosene
 - (d) 9-ketodecanoic acid
16. Releaser pheromone is present in the urine of:
 - (a) Sheep
 - (b) Rhesus monkeys
 - (c) Hamsters
 - (d) All
17. In termites, social pheromone is produced by:
 - (a) Queen
 - (b) King
 - (c) Both queen and king
 - (d) Workers and queen
18. Releaser pheromones are not used in:
 - (a) Sexual maturation cycle
 - (b) Recognition of species members
 - (c) Ejection of milk
 - (d) Aggression
19. The territory marker pheromone of spotted hyenas is secreted by:
 - (a) Anal glands
 - (b) Subcaudal scent glands
 - (c) Side glands
 - (d) Gular glands
20. In which one of the following animals is trail pheromone secreted by its rectal gland?
 - (a) *Myrmica*
 - (b) *Lasius*
 - (c) *Solenopsis*
 - (d) *Iridomyrmex humilis*
21. In camels, the scent glands are located on the:
 - (a) Tail
 - (b) Head
 - (c) Neck
 - (d) Area between eye and ear
22. In which one of the following animals is saliva not used as a marking agent?
 - (a) Dogs
 - (b) Rats
 - (c) Bears and pigs
 - (d) Red brockets
23. A pregnant female mouse will abort the litter being carried by her if she is exposed to the urine of a strange male. This is known as:

- (a) Allen effect (b) Bruce effect (c) Fountain effect (d) Trafalgar effect
24. Consider the following statements:
 (A) Pheromones are also called ectohormones (B) Kairomones favour emitter
 (C) Spray of skunk is an allomone (D) Releaser pheromones induce immediate and reversible behavioural responses
- The correct statements are:
 (a) A, B and C (b) B, C and D (c) A, C and D (d) B and D
25. The anal gland secretion of a mongoose contains:
 (a) Lipids (b) Lipids and proteins (c) Methyl ketones (d) 2-hexenol acetate
26. Which one of the following is not a sex pheromone?
 (a) Brevicommin (b) Gypitol (c) Hair pencil secretion (d) Bomykol
27. Consider the following statements about a chemical substance:
 (A) It is produced in the hind gut of the male beetle, *Ips confusus*
 (B) It is secreted with the faeces
 (C) It is a pheromone attracting both sexes and is non-anal
- This chemical substance is:
 (a) Gypitol (b) Nerolic acid
 (c) Geranyl acetate (d) Monocyclic diterpene hydrocarbon
28. Which one of the following about bombykol is incorrect?
 (a) It is produced by abdominal gland of females.
 (b) It is an alcohol, 10, 12-hexadecadien-1-ol.
 (c) Its chemical formula is $C_{16}H_{30}O$.
 (d) Males usually perceive it by means of their anal cerca.
29. Match column I with column II and select the correct answer using answer codes:

Column I (Pheromone)	Column II (Animal)
(a) Methyl ketones	1. Tarsal gland of the male black-tailed deer
(b) Isovaleric acid	2. Interdigital gland of antelope
(c) Saturated alcohols and aldehydes	3. Tarsal scent gland secretions of reindeer
(d) Cis-4-hydroxydodec-6-enoic acid lactone	4. Secretion of the sub-auricular gland of male pronghorn
- Answer codes:

	A	B	C	D
(a)	2	4	1	3
(b)	3	4	2	1
(c)	2	4	3	1
(d)	4	3	1	2
30. Urine-moistened palms are used to mark tree branches in:
 (a) Slender loris (b) Ring tail lemurs (c) Baboons (d) Gorillas
31. Copullins are present in the vaginal secretion of:
 (a) Sheep (b) Hamsters (c) Primates (d) Pigs
32. Which one of the following is a recruitment pheromone of termites?
 (a) Nerolic acid (b) Hexanol acid (c) Geraniol (d) Hexanyl acetate
33. In which one of the following animals do both males and females rub their glands to mark their territory?

- (a) Desert hedgehogs (b) Ring-tailed lemurs (c) Squirrel monkeys (d) Slow loris
34. The pheromone secreted by mandibular gland of honeybee queen:
 (a) Induces worker to feed and groom her (b) Inhibits development of ovary in workers
 (c) Inhibits workers from building queen cells (d) All and rearing new queens
35. 11-cis vaccenylacetate is a pheromone present in the _____ of *Drosophila*.
 (a) Cuticle of the male (b) Cuticle of the female
 (c) Ovary of the female (d) Testis of the male
36. Citronellal is a pheromone secreted by:
 (a) Dufour's gland (b) Mandibular gland (c) Hind gut (d) Pavane's gland
37. 11-cis-vaccenylacetate promotes:
 (a) Flying in *Drosophila* (b) Aggression in pairs of male *Drosophila* flies
 (c) Aggression in male and female *Drosophila* flies (d) Females to copulate
38. Consider the following statements:
 (A) Chloride increases response to pheromones and odours in mouse
 (B) Insect pheromones are a reliable and an ecofriendly source of pest management
 (C) Insects use pheromones as a silent alarm system, altering others to danger
 (D) Myrmicine genera of ants emphasise 3-alkanones as alarm releasers
 The incorrect statements are:
 (a) None (b) A, B and C (c) B and C (d) A and D
39. Methyl ketones, primarily of terpenoidal origin, are widely used as alarm pheromone in the subfamily:
 (a) Formicine (b) Dolichoderinae (c) Vespinae (d) Cephidae
40. Aggregation pheromones function in:
 (a) Defence against predators (b) Mate selection
 (c) Overcoming host resistance by mass attack (d) All
41. Which one of the following pheromones are among the most ecologically selective pest suppression methods?
 (a) Alarm pheromones (b) Aggregation pheromones
 (c) Food trail pheromones (d) Territory pheromones
42. Which one of the following pheromones causes change in the behaviour of the recipient?
 (a) Epideictic pheromones (b) Signal pheromones
 (c) Releaser pheromones (d) Primer pheromones
43. Which one of the following plants produces allomones?
 (a) *Desmodium* (b) *Zizyphus* (c) *Hydrilla* (d) *Santalum*
44. Ethyl oleate is a:
 (a) Footprint pheromone (b) Forager pheromone
 (c) Drone pheromone (d) Brood-recognition pheromone
45. Which one of the following human gene is linked to pheromones?
 (a) *VIRL1* (b) *CRY1* (c) *BTX1* (d) *VRL5*
46. Aphrodisin is a:
 (a) Female hamster pheromone (b) Male hamster pheromone
 (c) Both male female hamster pheromones (d) Pheromone of pigs
47. Pheromones:

- (a) Specifically disrupt the life cycle of harmful insects (b) Do not damage other animals
(c) Do not affect health risk to people (d) All
48. Honeybees use alarm pheromones to:
(a) Recruit nest mates (b) Sting intruders
(c) Sting and pursue intruders (d) All
49. The alarm chemicals are typically in the form of:
(a) Terpenoids (b) Ketones (c) Aldehydes (d) All
50. Inguinal gland secretion of rabbits contains:
(a) Methyl ketones (b) Acid lactone (c) Phenyl acetic acid (d) Lipids
51. In which one of the following animals does a secretion from the mature eggs and the gravid females induce the males to spawn?
(a) *Polygordius* (b) *Nereis succinea*
(c) *Chaetopterus* (d) *Hirudinaria granulosa*
52. Slavery in ants was discovered by:
(a) Pierre Huber (1810) (b) W Garstang (1928)
(c) C E Lucas (1949) (d) U B Wiggles Worth (1954)
53. Vaginal secretion of primate species does not contain:
(a) Acetic and propionic acid (b) Isobutyric and n-butyric acid
(c) Phenyl acetic acid (d) Isovaleric acid
54. Which one of the following pheromones is secreted by the queen of honeybee?
(a) $C_{18}H_{34}O_3$ (b) $C_{10}H_{16}O_3$ (c) Methyl ketones (d) 2-hexenol acetate
55. Which one of the following is the first isolated algal hormone?
(a) Isoamyl acetate (b) Cis-3-Hexenal (c) Actinidine (d) Ectocarpene
56. Sex pheromones are widely used by mammals to:
(a) Communicate (b) Detect sexual status of the potential mate
(c) Both (a) and (b) (d) None
57. Functional vomeronasal organ is lacking in:
(a) Rhinoceroses (b) Deer (c) Humans (d) Chimpanzees
58. Puberty onset in female mice can be advanced by pheromones. This is known as:
(a) Lee-Boot effect (b) Whitten effect (c) Bruce effect (d) Vandenbergh effect
59. The grouping of several female mice in a cage suppresses or modifies estrous. This is known as:
(a) Lee-Boot effect (b) Fountain effect (c) Whitten effect (d) Trafalgar effect
60. Which one of the following pheromones controls initiation and maintenance of suckling behaviour in rabbits?
(a) Di methylamine (b) 2-Methylbut-2-enal (2MB2)
(c) 4-hydroxy-3-methoxy phenyl ethanol (d) Methyl-p-hydroxy benzoate
61. Which one of the following is incorrect?
(a) Mammalian pheromones from the opposite sex typically cause an increase in GnRH pulse frequency.
(b) Mammalian pheromones from the same sex cause a decrease in GnRH pulse frequency.
(c) The pheromones of adult human females alter adult levels of LH in other human females.
(d) None
62. Consider the following statements:
(a) Copulins are C_2 and C_5 aliphatic acids that are secreted from the vaginal barrel

- (b) Couplins vary with menstrual cycle phase
- (c) The odor and behavioural effects of copulins appear to vary with menstrual cycle
- (d) Copulins are referred to as pheromones

The correct statements are:

- (a) All (b) A, B and D (c) A and C (d) B and D
63. Which one of the following can mask a bee's alarm pheromone?
- (a) Heat (b) Light (c) Smoke (d) Cloudy weather
64. Which one of the following about 2-heptanone is incorrect?
- (a) Secreted by mandibular glands of honeybees (b) Highly volatile
 - (c) Amounts decreases with age (d) Has a repellent effect
65. Which one of the following is a natural pesticide for mites and is a pheromone for many insects?
- (a) Geranic acid (b) Farnesol (c) Grandisol (d) Verbenone
66. Grandisol is a sex attractant of the:
- (a) Cotton boll weevil (b) Southern pine bark beetle
 - (c) Codling moth (d) Termites
67. Which one of the following is an incorrect match?
- (a) Civetone – African civet (b) Muscone – Musk
 - (c) Cembrene A – *Nephthea* (d) Blattellaquinone – Secreted by male cockroaches
68. Cembrene A is trail pheromone for:
- (a) Ants (b) Termites (c) Moths (d) Honeybees
69. Dimethylamine pheromone is used by _____ for communication:
- (a) Wasps (b) Termites (c) German cockroaches (d) Elephants
70. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-------------------|--|
| (A) Periplanone B | 1. Acts as pheromone for bark beetles |
| (B) E-Myrcenol | 2. Primer pheromone in honeybees |
| (C) Ethyl oleate | 3. Acts as an attractant to many predatory insects |
| (D) Cis-3-Hexenal | 4. Produced by the American female cockroach |
- Answer codes:
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 1 | 2 | 3 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 2 | 3 | 4 | 1 |
| (d) | 3 | 1 | 4 | 2 |
71. Flehmen response is shown by:
- (a) Primates (b) Primates and felids (c) Ungulates (d) Ungulates and felids
72. Androstenol is found in:
- (a) Sweat of males (b) Sweat of females (c) Saliva of pigs (d) All
73. Which one of the following is an orally acting pheromone?
- (a) Tylacogens (b) Grandisol (c) Queenbee substance (d) Gyptol
74. Chemical communication is found in:
- (a) Unicellular plants (b) Microorganisms
 - (c) Animals (d) All

75. Which one of the following affects the physiology or behaviour of other species?
 (a) Allomones (b) Kairomones (c) Synomones (d) All
76. Consider the following statements:
 (a) Women living in dormitories have synchronised menstrual cycles
 (b) Underarm sweat contains a key pheromone component called dehydroepiandrosterone which can cause women to alter their menstrual cycle habits
 (c) Male pheromones are completely odorless
 (d) *Chemicromis* fish fry release a chemical in water under the influence of which parents are compelled to take care of their young ones
- The correct statements are:
 (a) All (b) B, C and D (c) A and D (d) B and C
77. Pheromones are:
 (a) Wind borne (b) May be placed on soil
 (c) May be placed on vegetation (d) All
78. In insects, pheromones are released by the glands located on the:
 (a) Head (b) Abdomen (c) Wings (d) All
79. Which one of the following is a cat attractant?
 (a) Actidine (b) Dihydroactinidiolide (c) Nepetalactone (d) All
80. All species of *Apis* have an alarm pheromone and their compounds are generally similar among the common honeybee species with the exception of:
 (a) *Apis dorsata* (b) *Apis laboriosa* (c) *Apis adamsoni* (d) *Apis florea*
81. Which one of the following animals, everts its cloaca and rubs it on the ground leaving a scent mark:
 (a) Male cobra (b) Spiny anteater (c) Hare (d) Skunk
82. In this animal, spawning of female is evoked by some substance present in the sperm and testes of the males:
 (a) *Unio* (b) *Sepia* (c) *Oysters* (d) *Polygordius*
83. Which one of the following is a host specific attractant of mite?
 (a) Formic acid (b) Glycosaminoglycan
 (c) 2, 2 dimethyl-3-isopropylidene (d) Grandisol
84. In which one of the following pheromone is effective through water?
 (a) Minnow (b) *Lymantria* (c) Stingray (d) *Echidna*
85. The molecular formula of pheromone of *Lymantria* (Gpsymoth) is:
 (a) $C_{16}H_{30}O$ (b) $C_{18}H_{34}O_3$ (c) $C_{10}H_{16}O_3$ (d) None
86. The Protozoan, *Dictyostelium, discoideum* releases _____ as a pheromone resulting in the aggregation:
 (a) 3' - 5' AMP (b) Ethyl oleate (c) Actidine (d) Formic acid
87. The pheromone 2-methoxy-5-ethylphenol is produced from faeces of:
 (a) Termites (b) Wasps (c) Migratory locusts (d) Migratory birds

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (a) | 2. (d) | 3. (a) | 4. (a) | 5. (c) | 6. (d) | 7. (b) | 8. (d) |
| 9. (a) | 10. (c) | 11. (d) | 12. (d) | 13. (d) | 14. (a) | 15. (a) | 16. (d) |
| 17. (c) | 18. (a) | 19. (b) | 20. (b) | 21. (c) | 22. (d) | 23. (b) | 24. (c) |
| 25. (a) | 26. (a) | 27. (c) | 28. (d) | 29. (c) | 30. (a) | 31. (c) | 32. (b) |
| 33. (b) | 34. (d) | 35. (a) | 36. (b) | 37. (b) | 38. (a) | 39. (b) | 40. (d) |

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 41. (b) | 42. (c) | 43. (a) | 44. (b) | 45. (a) | 46. (a) | 47. (d) | 48. (d) |
| 49. (d) | 50. (c) | 51. (b) | 52. (a) | 53. (c) | 54. (b) | 55. (d) | 56. (c) |
| 57. (c) | 58. (d) | 59. (a) | 60. (b) | 61. (d) | 62. (a) | 63. (c) | 64. (c) |
| 65. (b) | 66. (a) | 67. (d) | 68. (b) | 69. (c) | 70. (a) | 71. (d) | 72. (d) |
| 73. (c) | 74. (d) | 75. (d) | 76. (a) | 77. (d) | 78. (d) | 79. (d) | 80. (b) |
| 81. (b) | 82. (c) | 83. (b) | 84. (a) | 85. (b) | 86. (a) | 87. (c) | |

Fill in the Blanks

- The term 'pheromone' was proposed by _____.
- _____ are chemicals emitted by living organisms to send message to individuals of the same species.
- Alarm pheromones in termites were first discovered by _____ over 40 years ago.
- In termites, alarm pheromones are only produced by _____.
- Ants produce alarm pheromones in the form of _____.
- In mammals, release pheromone is present in the _____ and _____.
- The first pheromone to be discovered was _____.
- Trail pheromones are common in _____ insects.
- Short-term changes are caused by _____ pheromones.
- Chemicals that stimulate escape or defence behaviour are called _____ pheromones.
- Chemicals that mediate mutualistic interaction, and benefit both the receiver and the emitter, are called _____.
- _____ pheromones are produced by honeybees and aphids to help in colony defence.
- The pheromone excreted by mandibular glands of the queen honeybee has been identified as _____.
- Tigers produce a pheromone called _____.
- The pheromones of female mammals are primarily detected by the _____ organ.
- Pheromones are used for _____ communication.
- Isoamyl acetate is released by _____ of honeybees.
- The first mammalian pheromone to be identified was _____.
- Production of pheromones in insects is regulated by _____.
- The first insect from which the sex pheromone was chemically identified is the _____.
- Nepetalactone is a sex attractant to _____.
- Estratetraenol has pheromone-like activities in _____.
- Nasonov pheromone is produced by _____ bees.
- Pheromones belong to a larger class of organic compounds called _____.
- European minnow releases an alarm hormone only when its _____ is damaged.
- Vaccenyl acetate acts as a pheromone in _____.

27. _____ pheromones lead to the formation of animal groups near the signal's source.
28. Trail pheromones of ants are _____ hydrocarbons.
29. _____ spiders produce moth sex pheromones to lure males.
30. _____ and _____ can tag an enemy with the alarm pheromone.
31. Alarm pheromones are frequently in the form of _____, _____ and _____.
32. 4-methyl-3-heptanone is a repellent to predacious _____.
33. Leaf-cutting ants release an alarm pheromone from their _____.
34. The only wasps that are considered social and exhibit alarm pheromone communication belong to family _____.
35. _____ is a sex attractant secreted by the female gypsy moth.
36. Male sex pheromone of Indian water bug, *Belostoma indica* is _____.
37. Bees mark the nest as well as fields having rich pollen-loaded flowers with the help of contents of _____ glands.
38. Mature males of _____ produce a pheromone that accelerates maturation in other males and females.
39. Unidecane is an alarming pheromone of _____.
40. Foxes use _____ to mark their territories.

Answers to Fill in the Blanks

- | | | |
|------------------------------------|------------------------|---|
| 1. Karlson and Butenand (1959) | 2. Pheromones | 3. Ernst |
| 4. Soldiers | 5. Formic acid | 6. Urine, foot pads |
| 7. Bombykol | 8. Social | 9. Signal |
| 10. Alarm | 11. Synomones | 12. Alarm |
| 13. 9-ketodecanoic acid | 14. Tigeramine | 15. Vomeronasal |
| 16. Intraspecific | 17. Sting apparatus | 18. Androstenone |
| 19. Hormones | 20. <i>Bombyx mori</i> | 21. Aphids |
| 22. Primates | 23. Worker | 24. Stereochemicals |
| 25. Skin | 26. <i>Drosophila</i> | 27. Aggregation |
| 28. Nonvolatile | 29. Bolas | 30. Ants, stinging wasps |
| 31. Terpenoids, ketones, aldehydes | 34. Vespidae | 32. <i>Solenopsis invicta</i> (Fireant) |
| 33. Mandibular glands | 37. Nasonov | 35. Gyptol |
| 36. Δ^2 -hexanylacetate | 40. Urine | 38. <i>Schistocerca gregaria</i> |
| 39. Ants | | |

True or False

1. Pheromones are highly effective in low doses.
2. Pheromones may be volatile or nonvolatile.
3. The reproductive functions in mice are affected by smell.
4. Pheromones are single chemicals.

5. Anisole is a precursor of perfumes and insect pheromones.
6. Actinidine is a cat attractant.
7. 9-keto-1-decenoic acid is a primer pheromone.
8. Isoamyl acetate is the principal alarm pheromone of the sting apparatus of honeybees.
9. Bears mark their territory by scratching and chewing the bark of a tree and then frequently urinating on such trees.
10. Slow loris marks its territory with its faeces.
11. The saliva of boar contains steroids.
12. The tarsal gland secretion of antelopes contains proteins, lipids and carbohydrates.
13. Androconia is a scent-producing gland in reptiles.
14. Bombykol is produced by sacculi lateralis of female *Bombyx mori*.
15. Toad's tadpoles produce alarm pheromones by certain skin in cells.
16. Alarm pheromones are produced by antelopes during frightened condition.
17. Spray of skunk is an allomone.
18. The larvae of driver ants produce a larval pheromone which nurtures the larvae.
19. Each nest of ants has its own distinctive smell.
20. Male Tasmanian devil has scent glands around its ear.
21. Whenever *Solenopsis* finds a large food source requiring so many ants, then mass acting pheromones are released.
22. Mammalian pheromones are mostly of olfactory nature.
23. Geranic acid is an orally acting pheromone.
24. Generally, sex pheromones are blends of several chemicals.
25. Sex pheromones often function as species isolating mechanism.
26. The pheromone produced by male grain beetle during feeding acts as aggregation pheromone.
27. Most pheromonal molecules are lipid insoluble.
28. Aggregation pheromones are effective in very high concentration.
29. Pheromones are critical to manipulate insect behaviours.
30. Gular glands of mongoose secrete isovaleric acid.
31. Genes *VIR* and *V2R* are lacking in genome of the platypus.
32. Nonacosane plays a role in chemical communication of several insects.
33. Dihydroactinidiolide is found in fire ants.
34. The trail pheromone does not evaporate quickly.
35. The spider, *Mastophora cornigera* releases a mixture of volatile compounds that mimic the sex pheromone of the moth species it preys upon.
36. Sex pheromones can be used to determine what insect pests are present in a crop.
37. The production of female sex pheromones in moths sometimes may be triggered by a chemical signal from the host plant.
38. Sexual maturity in female mice is accelerated by the presence of an adult male mouse.
39. Sound and sight receptors are needed by some pheromones for detection.
40. Seducin pheromone is an aphrodisiac.

Answers to True or False

- | | | | | | | | |
|----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|
| 1. True | 2. True | 3. True | 4. False | 5. True | 6. True | 7. False | 8. True |
| 9. True | 10. False | 11. True | 12. False | 13. False | 14. True | 15. True | 16. True |
| 17. True | 18. True | 19. True | 20. False | 21. True | 22. True | 23. False | 24. True |
| 25. True | 26. True | 27. False | 28. False | 29. True | 30. False | 31. False | 32. True |
| 33. True | 34. False | 35. True | 36. True | 37. True | 38. True | 39. False | 40. True |

Give Reasons

1. Mammals are believed to be macrosmatic, while humans are believed to be microsmatic.
 - Because mammals have more receptor cells in their nasal mucosa than humans.
2. Civetone is closely related to muscone.
 - Because both are macrocyclic ketones.
3. Oleic acid is referred to as smell of death.
 - Because oleic acid is emitted by decaying corpses of a number of insects.
4. Allomones, kairomones and synomones are interspecific semiochemicals.
 - Because they act between species.
5. The polyphemus moth does not mate unless oak leaves are present.
 - Because it has been found that the leaves give off a volatile aldehyde that stimulates the female to release a male-attracting pheromone.

SOCIAL BEHAVIOUR

Multiple-Choice Questions

1. Which one of the following is a social insect?
(a) Termites (b) Ants and bees (c) Wasps (d) All
2. Which one of the following about *Apis* is incorrect?
(a) Chemical alarm communication is lacking. (b) Recruitment among workers is lacking.
(c) The queen plays direct role in colony growth. (d) All
3. Consider the following statements about ants:
(A) They are trimorphic consisting of queen, males and workers
(B) Initially males and females reproductive's are winged
(C) Generally, the eggs of the first batch give rise to the queen and workers, while the later batches of eggs produce only queens
(D) Eggs laid in spring produce workers only, while eggs laid in summer produce only queens and workers
The correct statements are:
(a) All (b) A, B and D (c) A and B (d) C and D
4. In which one of the following does the same generation use the same nest without cooperating in brood care?
(a) Communal (b) Semisocial (c) Quasisocial (d) Subsocial
5. Highest number of species showing eusociality is found in:
(a) Bees (b) Termites (c) Wasps (d) Ants
6. Haplodiploidy is not applicable to:
(a) Termites (b) Wasps (c) Ants (d) Bees
7. Which one of the following presents a classic example of self-organised decentralised system?
(a) Growth in bacteria (b) Schools of fishes
(c) Flocks of birds (d) All
8. Which one of the following damages our homes and property?
(a) Queen termite (b) Soldier termite
(c) Female worker termite (d) King termite
9. Which one of the following is not applicable to termites?
(a) Social organisation (b) Hierarchical structure
(c) Communal and swarm intelligence (d) Fertilisation during nuptial flight
10. Consider the following statements about termites:
(A) Belong to order isoptera
(B) In lower termites, caste is mainly based on pheromones
(C) Worker castes consist of both males and females
(D) Social parasitism between species is found

The correct statements are:

- (a) All (b) A, B and C (c) B and C (d) C and D

11. Which one of the following about ants is incorrect?
 (a) They have perfect social organisation.
 (b) If ants are taken away from their nest, they generally die.
 (c) The colony of ants contains only one queen, many female workers and drones.
 (d) The queen emits a scent that makes all the workers behave in the way they do.
12. Which one of the following provokes a significant reaction in bees?
 (a) Perfumes (b) Lotions (c) Shampoos (d) None
13. Which one of the following termites are mainly involved in the destruction of man-made structures?
 (a) Subterranean and dry wood termites (b) Dry wood and damp wood termites
 (c) Soil feeding and subterranean termites (d) Grass eating and dry wood termites
14. Consider the following statements about eusocial hymenoptera:
 (A) The worker castes consist of females only
 (B) Social parasitism between species is rare
 (C) Anal trophallaxis is common
 (D) Caste determination is based mainly on nutrition and in some cases pheromones also play some role in it
- The incorrect statements are:
 (a) A and B (b) B and C (c) A and D (d) C and D
15. The foraging of worker honeybee is not affected by:
 (a) Distance of flower (b) Types of flower
 (c) Source of water (d) Temperature of the environment
16. Nasonov scent gland is found in _____ of honeybees:
 (a) Workers (b) Queen (c) Drones (d) All
17. In all termites, the proctodeal feeding distributes the Protozoan fauna among members of the colony, except:
 (a) Rhinotermitidae (b) Hodotermitidae (c) Termitidae (d) Serritermitidae
18. The soldiers are mandibulate, nasute, nasutoid and phragmatic in:
 (a) Rhinotermitidae (b) Nasutitermitidae (c) Kalotermitidae (d) All
19. In which one of the following primitive termites are true workers lacking?
 (a) Mastotermitidae (b) Termopsidae (c) Kalotermitidae (d) All
20. In soldiers of termites, the compound eyes are:
 (a) Well developed (b) Totally wanting (c) Vestigial (d) All
21. Match column I with column II and select the correct answer using answer codes:
 Column I (Termite) Column II (Types of nests)
 (A) *Macrotermes* 1. Exclusively subterranean nest
 (B) *Coptotermes* 2. Partially subterranean nest
 (C) *Microcerotermes* 3. Termite mound
 (D) *Acanthotermes* 4. Cartoon nest

Answer codes:

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 4 | 3 |
| (b) | 3 | 2 | 4 | 1 |
| (c) | 4 | 3 | 2 | 1 |
| (d) | 3 | 2 | 1 | 4 |

22. The insects including termites lack cellulose-digesting enzyme except:
 (a) Hodotermitidae (b) Termitidae (c) Serritermitidae (d) Rhinotermitidae
23. All soldiers are males in:
 (a) Nasutitermitidae (b) Macrotermitidae (c) Termitinae (d) All
24. Workers are both male and female in:
 (a) Wasps (b) Ants (c) Termites (d) Bees
25. In which one of the following is parental care more developed?
 (a) Birds (b) Reptiles (c) Amphibians (d) Fishes
26. The bird society is:
 (a) Open (b) Open or closed (c) Organised or unorganised (d) All
27. Polyandry is more prevalent in:
 (a) Mammals (b) Birds (c) Reptiles (d) Amphibians
28. In termites, the caste system is mainly determined by:
 (a) Moisture content and temperature of the colony
 (b) Food fed to the larva
 (c) Pheromones (d) Both (a) and (c)
29. In social hymenoptera, control of sex ratios does not allow for the:
 (a) Overproduction of female workers (b) Limited production of fertile males
 (c) Overproduction of fertile females (d) Limited production of fertile females
30. In eusocial species, the control of sex ratio is:
 (a) Determined entirely by the queen (b) Can be altered by the workers
 (c) Not entirely determined by the queen but can be altered by the workers (d) Can be determined and altered by the workers
31. According to Hamilton's model of inclusive fitness (1964), full sisters share:
 (a) Three fourth of their genome with their sisters (b) Only half with their mother
 (c) One fourth with their brothers (d) All
32. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Guarding behaviour	1. Zebra
(B) Mobbing and running away	2. Deer
(C) Detection of predators	3. Bovine
(D) Mutual vigilance	4. Langoor

Answer codes:

	A	B	C	D
(a)	4	3	2	1
(b)	3	1	4	2
(c)	2	4	1	3
(d)	4	1	2	3
33. Which one of the following shows typical monogamy?
 (a) Swans (b) Songbirds (c) Eagles (d) All
34. In which one of the following do eggs remain in oviduct until hatching?
 (a) Garter snakes (b) Python
 (c) Alligators (d) Rattlesnakes and garter snakes

35. Consider the following statements:
 (A) In primates, social organisation is determined by patterns of food distribution and predation pressure
 (B) Naked mole rats are haplodiploid
 (C) In red fire ants, *Solenopsis invicta*, colonies typically have only one queen
 (D) In reindeers, the unmated females dominate the young groups
 The incorrect statements are:
 (a) A and B (b) B and C (c) C and D (d) B and D
36. Which one of the following orders of Arthropoda exhibit social organization?
 (a) Hymenoptera and coleoptera (b) Coleoptera and isoptera
 (c) Hymenoptera and isoptera (d) Hymenoptera, isoptera and odonata
37. In a social organisation:
 (a) More aggressive males are created (b) Fitness level goes down
 (c) More chance of disease occurrence (d) All
38. In a bee colony, which one of the following shows altruistic behaviour?
 (a) Queen (b) Workers (c) Drones (d) None
39. Which one of the following is in between nonsocial and social states?
 (a) Termites (b) Honeybees (c) Wasps (d) Ants
40. Highest level of social organisation is referred to as:
 (a) Presocial (b) Eusocial (c) Parasocial (d) Quasisocial
41. Which one of the following is shown by social insects?
 (a) Group foraging (b) Task allocation (c) Nest building (d) All
42. The relationship shown by ants is:
 (a) Mutyalistic (b) Parasitic
 (c) Mimetic and commensal (d) All
43. Velvet ants are:
 (a) White ants (b) Wingless male wasps
 (c) Wingless female wasps (d) Winged male or female wasps
44. Ants are found in:
 (a) Hawaiian islands (b) Antarctica (c) Greenland (d) None
45. Which one of the following species of ants is known to be all female?
 (a) *Mycocepurus smithii* (b) *Atta mexicana*
 (c) *Linepithema humile* (d) *Mymecia pilosula*
46. Peperidine alkaloids are present in the poison of:
 (a) Bullet ants (b) Fire ants (c) Jack jumper ants (d) Brazilian ants
47. Consider the following statements about termites:
 (a) They are social insects with different castes
 (b) Only the king and queen have wings, break off after nuptial flight
 (c) Workers produce partially digested fecal pellets containing bacteria, which breakdown tough cellulose of plant cells
 (d) In workers, compounds eyes are well developed
 The correct statements are:
 (a) All (b) A, B and C (c) B and C (d) A and D

48. In hymenoptera, when a female mates with a male containing selfish chromosome, called the paternal sex ratio (PSR), it produces:
(a) Only males having PSR chromosomes (b) Only females having PSR chromosomes
(c) Both males and females having PSR chromosomes (d) None
49. Metamorphosis is incomplete as well as monogamous pairing is found in:
(a) Termites (b) Wasps (c) Ants (d) Bees
50. Which one of the following is a eusocial shrimp?
(a) *Triops* (b) *Synalpheus regalis*
(c) *Spelaeogriphus lepidops* (d) *Bathynella natans*
51. Social insects are interesting because:
(a) It is easy to follow them individually (b) It is easy to mark them individually
(c) One can see their pattern form (d) All
52. Overlap between generations occurs in:
(a) Semisocial (b) Quasisocial (c) Communal (d) Eusocial
53. Cooperative brood care occurs in:
(a) Eusocial (b) Semisocial (c) Quasisocial (d) All
54. Which one of the following adults cooperates in constructing a nest but rear their brood separately?
(a) Solitary (b) Communal (c) Quasi social (d) Semisocial
55. Which one of the following about *Bombus* is incorrect?
(a) Life cycle is perennial. (b) Chemical alarm communication is well developed.
(c) Recruitment among workers is lacking. (d) Temporal division of labour is poorly developed.
56. Autothysis is found in:
(a) Carpenter ants (b) Honeybees (c) Wasps (d) All
57. Xylophagy is applicable to:
(a) Honeybees (b) Wasps (c) Termites (d) Ants
58. In which one of the following does the colony comprise a large number of symbionts and inquilines of different order, besides their own community?
(a) Wasps (b) Termites (c) Ants (d) Honeybees
59. In the workers of termite, the compound eyes are absolutely degenerated or vestigial, except in:
(a) Macrotermitidae (b) Hodotermitidae (c) Termitinae (d) Naustitermitidae
60. Chemically, the pheromones in termites are:
(a) Terpenoids (b) Aliphatic ketones (c) Esters (d) All
61. Which one of the following about weaver ants is incorrect?
(a) Social insects (b) Have complex biochemical communication
(c) Known for their painful irritating sting (d) Make elaborate underground nests
62. Which one of the following wasps do not construct an underground nest?
(a) *Vespula vulgaris* (b) *Vespula crabro* (c) *Vespula rufa* (d) *Vespula germanica*
63. In which one of the following wasps is the nest made up of single tier of cells?
(a) *Polistes* (b) *Polybia sericea* (c) *Vespa orientalis* (d) *Vespula rufa*
64. In honeybees, syngamy is applicable to:
(a) Queen (b) Queen and workers (c) Drones (d) All

65. Consider the following statements about honeybees:
 (A) In adult workers, corpora allata is more active than in the queen
 (B) Pharyngeal wax and nassanoff glands are present both in queen and workers
 (C) The rate of oxygen consumption is higher in workers than the queen
 (D) Workers lack long-lasting memory
 The correct statements are:
 (a) All (b) A, B and C (c) A, C and D (d) A and C
66. *Psithyrus* (Cuckoobee) is:
 (a) A social parasite (b) Without worker caste
 (c) Lack pollen-collecting apparatus (d) All
67. Autoparasitism is shown by:
 (a) *Bombus* (b) *Encarisa formosa* (c) *Psithyrus* (d) All
68. The exclusively apterous forms in termite colony are:
 (a) Queen and king (b) Queen and workers
 (c) Workers and soldiers (d) Queen, workers and soldiers
69. Which one of the following is lacking in the king of termites?
 (a) Functional legs (b) Ocelli (c) Wing scales (d) None
70. Which one of the following is not an ant-alarming pheromone?
 (a) Pinene (b) Geraniol (c) Limonene (d) Tridecane
71. Social behaviour:
 (a) Is the interaction among individuals of the same species (b) Generally beneficial to one or more individuals
 (c) Serves many purposes (d) All
72. Which one of the following is essential for a eusocial species?
 (a) Brood care (b) Reproductive caste differentiation
 (c) Overlap between generations (d) All
73. Consider the following statements:
 (A) When snakes are in groups, their metabolism decreases
 (B) The rate of cleavage in sea urchin eggs increases with the density of individuals
 (C) Quails form family flocks
 (D) Insectivorous birds are gregarious
 The correct statements are:
 (a) All (b) A, B and D (c) A, C and D (d) B and D
74. The only mammal that has evolved a sterile caste that works for the fertile members of the species is:
 (a) Kangaroo rats (b) Pangolins (c) Naked mole rats (d) Armadillos
75. Semisocial does not exhibit:
 (a) Cooperative brood caring (b) Reproductive caste differentiation
 (c) Overlapping of generations (d) None
76. Social organisation allows organism to:
 (a) Share labour (b) Coordinate efforts (c) Specialise in tasks (d) All
77. Which one of the following with reference to ants is correct?
 (a) Depending upon the species, the queen lives around 5 to 30 years
 (b) Workers live around 1 to 3 years

- (c) The activity of workers is coordinated mostly through pheromones and body contact
(d) All
78. Which one of the following is applicable to pupae?
(a) Eat (b) Move (c) Change (d) None
79. Which one of the following ants herd aphids?
(a) Daring ants (b) Leaf cutter ant (c) Carpenter ants (d) All
80. The ants that grow their own food are:
(a) Leaf cutter ants (b) Fire ants (c) Carpenter ants (d) None
81. In workers of honeybees, glandular activity declines after _____ weeks and they begin a period of foraging outside of the hive:
(a) One (b) Two (c) Three (d) Five
82. Which one of the following about termites is incorrect?
(a) Social insects (b) Polymorphic (c) Polygamous (d) Nocturnal
83. Workers may be dimorphic or trimorphic in:
(a) Termites (b) Honeybees (c) Wasps (d) None
84. In which one of the following termites are true workers lacking?
(a) *Rhinotermes* (b) *Hodotermes* (c) *Stolotermes* (d) *Coptotermes*
85. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|-----------------------|-----------------------------|
| (A) <i>Termes</i> | 1. Dry wood termites |
| (B) <i>Hodotermes</i> | 2. Damp wood termites |
| (C) <i>Porotermes</i> | 3. Harvester termites |
| (D) <i>Kalotermes</i> | 4. Ground-dwelling termites |
- Answer codes:
- | A | B | C | D |
|-------|---|---|---|
| (a) 3 | 1 | 4 | 2 |
| (b) 4 | 3 | 2 | 1 |
| (c) 2 | 3 | 4 | 1 |
| (d) 4 | 1 | 2 | 3 |
86. Which one of the following is the environmental influence on group size (flocks)?
(a) Food (b) Predators (c) Food and predators (d) None
87. Herding in mammals centre around:
(a) Social grooming (b) Reproductive behavior (c) Antipredator defence (d) All
88. Which one of the following about monogamous primates is incorrect?
(a) Generally larger in size (b) The parental investment is unequal
(c) They feed on carbohydrate-rich diet (d) All
89. Drones are:
(a) Haploid fertile males (b) Diploid fertile males
(c) Haploid sterile males (d) Diploid sterile females
90. Which one of the following is incorrect?
(a) The term 'reciprocal altruism' was coined by Trivers (1976) (b) Reciprocal altruism is quite rare
(c) In vampire bats, reciprocal altruism occurs (d) None

91. Which one of the following is monogamous?
(a) Lemurs (b) Gibbons (c) Tree shrews (d) All
92. Bonobo is found in:
(a) Zaire (b) Uganda (c) Tanzania (d) None
93. In ants, which one of the following develops from unfertilised eggs?
(a) Winged males (b) Winged females
(c) Wingless workers (d) Wingless workers and soldiers
94. In most social insects, new colonies are founded by a single queen, except:
(a) Termites (b) Wasps (c) Honeybees (d) Ants
95. Kin selection concept was proposed by:
(a) W D Hamilton (1964) (b) Barnard and Burk (1979)
(c) Balmford (1991) (d) Cooper and Uzmann (1971)
96. In which one of the following is the trail pheromone released from Pavan's gland?
(a) *Lasius* (b) *Solenopsis* (c) *Iridomyrmex* (d) *Myrmica rubra*
97. Sociality is common among:
(a) Primates (b) Sheep and cattle (c) Deer and wolves (d) All
98. The phrase 'reproducing by poxy' was used by:
(a) Brain Bertram (1978) (b) Packer et al. (1991)
(c) Craig Packer (1991) (d) Boomsma and Ratnieks (1996)
99. Lek system is observed in:
(a) Termites (b) Wasps (c) Birds (d) Primates
100. Which one of the following is incorrect?
(a) Humans can smell bombykol. (b) Locusts are colonial in habit.
(c) In a social group, dominance increases the amount of overt aggression. (d) All
101. Cooperative breeding occurs when more than one pair:
(a) Share in building a nest (b) Lay eggs in a single nest
(c) Help to feed one brood (d) All
102. Males defend territories by head-to-head pushing contests in:
(a) Rattlesnakes (b) Marine iguana of the Galapagos's islands
(c) Raccoons (d) Song sparrows
103. Which one of the following animals have always twins and males help in the care of infants:
(a) Baboons (b) Marmosets (c) Water bucks (d) Pong horns
104. Cooperative hunting is common in:
(a) Killer whales (b) Wolves (c) Wild dogs (d) All
105. Which one of the following about termitidae is incorrect?
(a) Smallest family (b) Soldiers with frontal rostrum on the head
(c) Construct very high mounds (d) Ocelli present
106. Which one of the following is not a damp wood termite?
(a) *Porotermes* (b) *Zootermopsis*
(c) *Kaloterme* (d) *Stoloterme*
107. Which one of the following is enormously developed in the queen of termites?
(a) Corpora allata (b) Thorax (c) Jaw muscles (d) Mid and hind guts

108. Consider the following statements:
 (A) Social wasps construct the paper nests (B) In wasps, juvelling hormone plays a vital role in caste differentiation
 (C) Wasps lack trophallaxis (D) *Vespula vulgaris* makes the nest in hollow trees
 The correct statements are:
 (a) All (b) A, B and C (c) A and B (d) C and D
109. Which one of the following is not applicable to drones of honeybees?
 (a) Fertile male (b) Parthenogenesis
 (c) Syngamy (d) Haploid set of chromosomes
110. Which one of the following has the largest comb?
 (a) *Apis indica* (b) *Apis florea* (c) *Apis dorsata* (d) *Apis mellifera*
111. Slave making is shown by:
 (a) *Formica sanguinea* (b) *Andricus kollari* (c) *Vespula austriaca* (d) *Encarsia formosa*
112. In honeybees, the queen substance (a pheromone) is produced by the:
 (a) Pharyngeal glands (b) Mandibular glands (c) Corpora allata (d) Nassanoff glands
113. Both queen and workers are blind in:
 (a) Formicinae (b) Dorylinae (c) Leptaleinae (d) All
114. Multiple queens are present in the colony of:
 (a) *Solenopsis invicta* (b) *Vespa basalis* (c) *Dorylus orientalis* (d) *Vespula germanica*
115. Which one of the following is not a eusocial haplodiploid species?
 (a) Termites (b) Kangaroo rats
 (c) Termites and naked mole rats (d) All
116. Which one of the following families of hymenoptera, being haplodiploid are not eusocial?
 (a) Pompilidae (b) Pompilidae and mutilidae
 (c) Multilidae and formicidae (d) Sphecidae and vespidae
117. Pseudergates refer to:
 (a) Immature larva (b) Immature pupa (c) Permanent nymphs (d) Permanent larva
118. Which one of the following has been described as model system for social behaviour?
 (a) *Apis indica* (b) *Apis mellifera* (c) *Apis dorsata* (d) *Vespula germanica*
119. Hornets are:
 (a) Large eusocial ants (b) Small eusocial termites
 (c) Large eusocial wasps (d) Eusocial insects
120. Consider the following statements:
 (A) Grooming is a common primate activity
 (B) In all primates (except humans) females are seasonally or cyclically receptive
 (C) Pair bonding of any sort is rare in primates
 (D) The single female and her offspring group pattern is rare for primates
 The incorrect statements are:
 (a) None (b) A and B (c) B and C (d) A and D
121. Pseudergates are lacking in:
 (a) *Cryptotermes* (b) *Zootermopsis* (c) *Microtermes* (d) *Porotermes*
122. Which one of the following about ants is incorrect?
 (a) All ants are eusocial. (b) In some ants, the workers do not even have ovaries.

- (c) Other worker can lay male eggs. (d) None
123. Which one of the following is correct?
 (a) Fish form social aggregations called shoals. (b) Cadmium affects the social behaviour of rainbow trout.
 (c) Some coral fishes bond in monogamous pairs. (d) All
124. Consider the following statements:
 (A) Wasps have voluntary control over the sex of their offsprings
 (B) All female wasps are potentially capable of becoming a colony's queen
 (C) *Polistes* (paper wasp) construct their nests in tiers
 (D) Wasps have wax glands
 The incorrect statements are:
 (a) A, B and C (b) A and D (c) C and D (d) None
125. Which one of the following members of *Zootermopsis* produces sound?
 (a) Workers (b) Soldiers (c) Nymphs (d) All
126. Which one of the following is a fungus of termite nests?
 (a) *Basidiomycete* (b) *Termitomyces*
 (c) *Ascomycete* and *xylaria* (d) All
127. Which one of the following about termites is incorrect?
 (a) Males and females both arise from fertilised eggs.
 (b) The two sexes do not differ in the balance between the sex chromosomes and the other remaining chromosomes.
 (c) They are hemimetabolous.
 (d) None
128. $\text{CH}_3 - \underset{\text{O}}{\underset{\parallel}{\text{C}}} - (\text{CH}_2)_5 - \text{CH} = \text{CH} - \text{COOH}$ Consider the following points about the above-mentioned compound:
 (A) It is one of the compound of the queen substance
 (B) It is secreted by the mandibular gland of the queen
 (C) It partially inhibits the development of the ovaries of the workers that ingest it
 (D) Workers obtain this substance by licking it from the queen's body
 The compound is:
 (a) 9-oxodecenoic acid (b) 9-hydroxydecenoic acid
 (c) Gyptol (d) Nerolic acid
129. Which one of the following is an environmental influence on group size?
 (a) Food (b) Predators (c) Food and predators (d) None

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (d) | 3. (c) | 4. (a) | 5. (d) | 6. (a) | 7. (d) | 8. (c) |
| 9. (d) | 10. (b) | 11. (c) | 12. (d) | 13. (a) | 14. (b) | 15. (b) | 16. (a) |
| 17. (c) | 18. (d) | 19. (d) | 20. (d) | 21. (b) | 22. (b) | 23. (a) | 24. (c) |
| 25. (a) | 26. (d) | 27. (a) | 28. (c) | 29. (c) | 30. (c) | 31. (d) | 32. (a) |
| 33. (d) | 34. (d) | 35. (b) | 36. (c) | 37. (d) | 38. (b) | 39. (c) | 40. (b) |
| 41. (d) | 42. (d) | 43. (c) | 44. (d) | 45. (a) | 46. (b) | 47. (b) | 48. (a) |
| 49. (a) | 50. (b) | 51. (d) | 52. (d) | 53. (d) | 54. (b) | 55. (c) | 56. (a) |

- | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 57. (c) | 58. (b) | 59. (b) | 60. (d) | 61. (d) | 62. (b) | 63. (a) | 64. (b) |
| 65. (d) | 66. (d) | 67. (b) | 68. (c) | 69. (c) | 70. (b) | 71. (d) | 72. (d) |
| 73. (a) | 74. (c) | 75. (c) | 76. (d) | 77. (d) | 78. (c) | 79. (a) | 80. (a) |
| 81. (c) | 82. (c) | 83. (a) | 84. (c) | 85. (b) | 86. (d) | 87. (d) | 88. (a) |
| 89. (d) | 90. (d) | 91. (a) | 92. (d) | 93. (d) | 94. (a) | 95. (b) | 96. (d) |
| 97. (a) | 98. (c) | 99. (d) | 100. (d) | 101. (b) | 102. (b) | 103. (d) | 104. (a) |
| 105. (c) | 106. (a) | 107. (c) | 108. (c) | 109. (c) | 110. (a) | 111. (b) | 112. (b) |
| 113. (a) | 114. (c) | 115. (b) | 116. (c) | 117. (b) | 118. (c) | 119. (a) | 120. (c) |
| 121. (d) | 122. (d) | 123. (c) | 124. (d) | 125. (d) | 126. (b) | 127. (a) | 128. (c) |

Fill in the Blanks

- The term 'eusocial' was given by _____.
- The honeybees, _____ is the best-known social insect.
- Each type or kind of individual in an insect colony is called a _____.
- The language of honeybees has been studied by _____.
- The distance and direction of food and water sources are marked by a _____ in honeybees.
- Honeybees show _____ dance and _____ dance.
- Ants communicate with each other through tapping with the _____ and smell.
- In a waggle dance, a figure of _____ is traced against the vertical surface of the comb.
- In honeybees, when food sources are at a long distance, the _____ dances are converted into _____ dances.
- The social wasps belong to family _____.
- The process of feeding one member of the colony by another is called _____.
- Mounds are also called _____.
- At the onset of cold weather, all the wasps including old queen die, except _____.
- Nests of ants are called _____.
- The pheromone used by social insects to recruit others of the species to a food source is called _____ pheromone.
- In *Bombus*, soon after fertilisation, the females hibernate in ground for about _____ months.
- In honeybees, development of workers requires _____ days.
- Honeybees utilise, the _____ for orientation during foraging activities.
- _____ is the principal pheromone of the sting apparatus in honeybees.
- The most dangerous ant colonies are those of _____ and the _____ ants.
- An ant colony cannot survive without its _____.
- Fungus-growing ants are found only in the _____.
- Adult winged termites are called _____ or _____.
- In _____ termite species, the queen adds an extra set of ovaries with each molt.
- All members communicate through _____ and _____ in primates.

26. _____ are other insects and Arthropods living in the termitarium.
27. Inquilinism is a special form of _____.
28. _____ dance set the honeybees apart from all other social insects.
29. In ants, the wingless workers and soldiers develop from _____ eggs.
30. Honeybees communicate through the language of _____.
31. In all termites, except the _____, the proctodeal feeding distributes the Protozoan fauna among the members of the colony.
32. The workers of honeybees have a modified ovipositor called _____.
33. Honeybees need an internal temperature of _____ to fly.
34. Honeybees originated in the _____.
35. The waggle dance may be _____ or _____.

Answers to Fill in the Blanks

- | | | |
|---------------------------|--------------------------|-----------------------------|
| 1. Suzanne Batra (1966) | 2. <i>Apis mellifera</i> | 3. Caste |
| 4. Karl Von Frisch (1944) | 5. Distance language | 6. Waggle, round |
| 7. Antennae | 8. Eight | 9. Round, waggle |
| 10. Vespidae | 11. Trophallaxis | 12. Termitaria |
| 13. Young mated females | 14. Formicaria | 15. Trail |
| 16. Nine | 17. 21 | 18. Sun and polarised light |
| 19. Isoamyl acetate | 20. Army, driver | 21. Workers |
| 22. New world | 23. Alates, Swarms | 24. Physogastric |
| 25. Sound, gestures | 26. Termitophiles | 27. Commensalism |
| 28. Tail wagging | 29. Unfertilised | 30. Dance |
| 31. Termitidae | 32. Stinger | 33. 35°C |
| 34. Africa | 35. Horizontal, vertical | |

True or False

1. Termites are adapted to live in high humidity and dark conditions.
2. Termites mostly absorb acetic acid.
3. Army ants lack nests.
4. In *Apis*, queens and workers are morphologically similar.
5. The life cycle of *Apis* is perennial.
6. Naked mole rats and damaraland mole rats are eusocial.
7. In hymenoptera, dominance hierarchies are universal.
8. In *Bombus*, the queen regulates colony growth.
9. In termites, larvae and nymphs contribute to colony labour.
10. In ants, the queen mates once with the males and stores the sperms for life.
11. In some termite species, true workers are lacking.

282 Ecology and Animal Behaviour

12. Weaver ants act as natural pest control.
13. Wasp queens generally construct new nests each year.
14. In advanced ants, workers are of three types, viz., minor, media and major workers.
15. In ants, males are diploid.
16. Workers of wasps are large females.
17. In wasps, a single queen is capable of making an entire colony.
18. All ants are true social insects.
19. Bonbo forms a permanent relationship with individual partners.
20. Grooming is a highly social behaviour.
21. Social behaviour is only displayed by animals having well-developed brain and nervous systems.
22. In many ants and bees, colonies, all workers and soldiers are females.
23. Sting-less bees communicate by olfactory means.
24. Some fungus-growing ants construct their gardens from insect droppings.
25. Vampire bats are noncolonial mammals.
26. Polygynous males have the largest territories.
27. Group size of chimpanzees is proportional to food availability.
28. Parasitic wasps lay eggs inside the body of prey.
29. In naked mole rats, the colony contains more than one queen.
30. The main predators of naked mole rats are certain carnivorous birds.
31. The breeding in naked mole rats is seasonal.
32. In wasps, both males and females are diploid.
33. Ant queens are dimorphic.
34. In the queen of termites, the corpora allata show hyperactivity.
35. Phragmatic soliders lack broad plug-like head.
36. In the workers of termites, brain, optic lobes and corpora allata are greatly reduced.

Answers to True or False

- | | | | | | | | |
|-----------|----------|-----------|----------|-----------|----------|-----------|-----------|
| 1. True | 2. True | 3. True | 4. False | 5. True | 6. True | 7. False | 8. True |
| 9. True | 10. True | 11. True | 12. True | 13. True | 14. True | 15. False | 16. False |
| 17. True | 18. True | 19. False | 20. True | 21. False | 22. True | 23. True | 24. True |
| 25. False | 26. True | 27. True | 28. True | 29. False | 30. True | 31. False | 32. True |
| 33. True | 34. True | 35. False | 36. True | | | | |

Give Reasons

1. Termites can accurately be described as tiny social cockroaches.
 - Because they evolved from a common ancestor with wood-dwelling cockroaches to whom they are very closely related.
2. Bees are considered as social insects.
 - Because they live and work together.
3. Parasitic wasps are used in agricultural pest control.
 - Because they prey mostly on pest insects and cause little damage to crops.
4. In honeybees, strong vigorous dance causes excitement.
 - Because the source is newer and abundant.
5. Social behaviour evolved.
 - Because it is believed that it is beneficial to those who are engaged in it, i.e., these individuals are more likely to survive and reproduce.
6. Armies of fire ants are agricultural pests.
 - Because they destroy young crop plants.
7. Termites like dead plants.
 - Because of their cellulose content, which is rich in energy source and is staple to their diet.
8. Social insects are particularly suited to post-genome era biology.
 - Because they can be studied at different levels of biological organisation, from genome to ecosystem and much is known about their natural history.
9. An ant sting is a good defence against other insects.
 - Because it produces a poison that contains an insect-repellent gas.
10. Ants are social insects.
 - Because they live and work together in communities.
11. Daring ants keep the aphids together and protect them from other insects.
 - Because aphids produce honeydew, which is liked by these ants.
12. Worker termites provide regurgitated food to soldiers termites.
 - Because soldiers are not capable of feeding themselves.
13. Matrifilial colonies have received much attention.
 - Because they are a characteristic of temperate zone groups, such as *polistes* and the *vespine*, that are most broadly sympatric with interested biologists.

MIGRATORY BEHAVIOUR

Multiple-Choice Questions

1. Highly migratory species is applicable to:
(a) Swordfishes (b) Dolphins (c) Tunas (d) All
2. Which one of the following is an amphidromous fish?
(a) Bull shark (b) Pacific salmon (c) Sailfish (d) Marlin
3. Butterfly showing return journey pattern of migration:
(a) *Sitotroga cerealella* (b) *Danasus plexippus*
(c) *Papilio demoleus* (d) *Achaea janata*
4. Which one of the following migratory locusts is confined to peninsular India?
(a) *Calliptamus ictericus* (b) *Locusta paradalina*
(c) *Cyrtacanthacris succincta* (d) *Melanoplus spretus*
5. All species of locusts migrate over only short distances (about 150 km) except:
(a) *Locusta migratoria* (b) *Locusta migratoria* and *Locusta paradalina*
(c) *Melanoplus spretus* (d) *Schistocerca gregaria* and *Locusta migratoria*
6. Which one of the following swarms damage *kharif* crops of vast area of India but without breeding?
(a) Westward swarms (b) Northward swarms
(c) Southward swarms (d) Eastward swarms
7. Cyclic migration is shown by:
(a) Snowy owls (b) House sparrows (c) Cranes (d) Cotton teals
8. Thermal current for soaring is used by:
(a) Storks (b) Cranes (c) Eagles (d) All
9. Night and day migration occurs in:
(a) Geese (b) Robins (c) Titmice (d) None
10. Small and irregular migration is shown by:
(a) Hawks (b) Parrots (c) Woodpeckers (d) Hornbills
11. Which one of the following about boreal finches is incorrect?
(a) Irruptive species (b) Migration is generally associated with food
(c) Generally found at a location in one year and absent in the next year (d) None
12. Which one of the following birds migrate large distances, generally at night?
(a) Humming birds (b) Flycatchers
(c) Warblers (d) All
13. Lesser cuckoo breeds in India while spends the nonbreeding season in:
(a) America (b) Australia
(c) Africa (d) Sri Lanka

14. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Anadromous fish	1. Carps and trouts
(B) Catadromous fish	2. <i>Anguilla anguilla</i>
(C) Amphidromous fish	3. <i>Salmo solar</i> and <i>Hilsa</i>
(D) Protamodromous fish	4. Gobies

Answer codes:

	A	B	C	D
(a)	4	3	2	1
(b)	3	2	4	1
(c)	2	4	1	3
(d)	4	2	1	3

15. Which one of the following fishes migrate only within the sea?
 (a) *Acipenser* (b) *Chanos*
 (c) *Thunnus* (d) *Scomber* and *Thunnus*
16. Feeding migration occurs in:
 (a) *Harpodon* (b) *Hilsa ilisha* (c) *Clupea* (d) *Oncorhynchus nerka*
17. Which one of the following fishes is broadly tolerant to salinity changes?
 (a) *Anguilla* (b) *Salmon* (c) *Fundulus* (d) All
18. Which one of the following about *Salmon* is incorrect?
 (a) Reproductive migrants (b) Starts live in freshwater, move to open ocean for adult lives
 (c) Return to home freshwater to lay eggs (d) None
19. Which one of the following fishes uses smell to find the exact stream that they were born in?
 (a) Herring (b) *Hilsha* (c) *Salmon* (d) Swordfish
20. Forage fish occasionally perform long migrations between their _____ grounds:
 (a) Feeding (b) Spawning (c) Nursery (d) All
21. Anadromous migration is shown by:
 (a) Lampreys (b) *Salmon* (c) Sturgeon (d) All
22. Which one of the following is a forage fish?
 (a) Tuna (b) Capelin (c) Swordfish (d) Marlin
23. One-way journey migration is shown by:
 (a) Pacific salmon (b) Arctic tern (c) Monarch butterfly (d) Sub-alpine warbler
24. Which one of the following amphibians exhibits short migration?
 (a) Toads (b) Frogs (c) Newts (d) All
25. In which one of the following birds is the direction of migration reversed with the season?
 (a) White-caped redstarts (b) Mountain quail
 (c) Violet green swallow of UK (d) Blue grouse of USA
26. Consider the following statements:
 (A) In monarch butterflies (*Danaus plexippus*) short days suppress mating while triggering migratory behaviours
 (B) Dragonflies migrating across the Indian Ocean use the monsoon winds
 (C) Insect muscle must be warmed to about 34°C to allow them to fly
 (D) Dragonflies and butterflies may fly even when the temperature is below 10°C

The correct statements are:

- (a) All (b) A, C and D (c) B, C and D (d) B and D

27. Monarch migration was first studied by:

- (a) Mullis and Smith (b) Frederick Urquhart (c) Paul Greengard (d) W L Franklin

28. *Diade los Muertos* is associated with:

- (a) Monarch butterflies (b) Yellow wagtail
(c) Starling (d) Siberian cranes

29. Consider the following statements:

- (A) Many bats of temperate climates migrate annually
(B) Many migratory species of frogs tend to return to the same breeding grounds year after year
(C) Reptiles and amphibians make migration-like movement only during the reproductive period
(D) Migratory behaviour and flight metabolism are influenced by many neuro-endocrine factors

The incorrect statements are:

- (a) A, B and C (b) B, C and D (c) A and C (d) None

30. Which one of the following induces migration to water and second metamorphosis in amphibians?

- (a) Prolactin (b) Cortical steroids (c) Thyroid hormone (d) Gonadotropins

31. Red fish and black fish are applicable to:

- (a) American eel (b) *Salmon* (c) Herring (d) *Hilsa*

32. Which one of the following is not applicable to *Salmon*?

- (a) Alevir stage (b) Smolt stage
(c) Contranant migrant (d) Protocephaline larva

33. Which one of the following does not migrate?

- (a) Bees (b) Moths (c) Butterflies (d) All

34. Which one of the following is not a migratory bird coming in India during the winter season?

- (a) Wood sandpiper (b) White wagtail (c) Comb duck (d) Rosy pelican

35. Consider the following statements:

- (A) The timing of bird migration is usually a mixture of internal and external stimulus
(B) Spotted sandpiper migrate to India during winter
(C) The ongoing climatic changes will increasingly threaten vulnerable bird species, documenting their extinction risk
(D) Plovers and sandpipers are migratory water birds

The correct statements are:

- (a) All (b) A, B and C (c) B, C and D (d) B and D

36. Which one of the following birds migrates from the North Pole to the South Pole and back to the North Pole?

- (a) Penguin (b) Arctic tern (c) Rosy pelican (d) Nile plover

37. Moul migration occurs in:

- (a) Finch (b) White-caped redstarts (c) Most ducks (d) Titmouse

38. Partial migration occurs in the members of:

- (a) Redbreast (b) Songthrus (c) Titmouse (d) All

39. Daily migration is shown by:

- (a) Starlings and rockery herons (b) Finch and house sparrow
(c) Willows and plovers (d) Teal and crow

40. Which one of the following is responsible for initiating migration in birds?
 (a) Bad climatic condition (b) Shortage of food
 (c) Day length affecting the endocrine system (d) Breeding
41. Which one of the following is the slowest flying bird?
 (a) *Pygoscelis papua* (b) *Scolopax minor* (c) *Passer domesticus* (d) *Mellisuga minima*
42. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Partial migration	1. Herons
(B) Irregular migration	2. Barn owls
(C) Longitudinal migration	3. Starling
(D) Latitudinal migration	4. Golden plover

 Answer codes:

A	B	C	D
(a) 4	3	2	1
(b) 3	1	4	2
(c) 2	1	3	4
(d) 4	3	1	2
43. Altitudinal migration occurs in:
 (a) Blue birds (b) Grebes (c) Cuckoos (d) Swans
44. The longest nonstop bird flight occurs in:
 (a) Golden plover (b) Swifts (c) Redbreast (d) Arctic tern
45. Which one of the following migrates during both day and night?
 (a) Songbirds (b) Wildfowls (c) Mountain quails (d) Warblers
46. Consider the following statements:
 (A) Dead trees and bush piles provide shelter, nest sites and food (insects) for migrating birds
 (B) Super oxide plays a key role in bird migration
 (C) Bats use a magnetic substance in their body called magnetite as an internal compass for navigation
 (D) Majority of bats migrate with a the intention to find better breeding grounds
 The correct statements are:
 (a) All (b) A, B and C (c) B, C and D (d) A and B
47. Which one of the following mammals covers the longest migratory distance?
 (a) Bats (b) Dolphins (c) Humpback Whales (d) Blue Whales
48. Which one of the following is a neotropical migrant?
 (a) Waterfowls (b) Songbirds (c) Raptors (d) All
49. Zugunruhe is applicable to:
 (a) Migratory restlessness (b) Navigation
 (c) Reproduction (d) Ecological diversity
50. Which one of the following birds migrates twice during a year?
 (a) Red crested pochard (b) Pin tail
 (c) Garganiteals (d) Shoveller
51. Consider the following statements:
 (A) Human infants survive on the heat of their mother's breasts
 (B) Pin tail and shoveller are permanent resident birds
 (C) American coot (*Fulica*) migrates by walking for miles across the country

(D) Migration in birds decreases the rate of evolution

The correct statements are:

- (a) All (b) A, B and C (c) A and C (d) B and D

52. Breeding migration occurs in:

- (a) *Harpodon* (b) *Hilsa ilisha* (c) *Xiphias gladius* (d) All

53. Which one of the following is a nonmigrant species?

- (a) Zebra (b) Warthog (c) Green sea turtle (d) Garden warbler

54. Herrings migrate during:

- (a) Day (b) Night (c) Full moon (d) Both day and night

55. Which one of the following larvae migrate from its breeding ground to freshwater, where it becomes an adult?

- (a) Tornaria (b) Ammocoete (c) Leptocephalus (d) Planula

56. Oceanodromous migration does not occur in:

- (a) *Chanos* (b) *Clupea* (c) *Scomber* (d) *Thunnus*

57. Removal migration occurs in:

- (a) Pintail (b) Locusts (c) Black pole warbler (d) Golden plover

58. Which one of the following is a true migrant?

- (a) Silver-haired bat (b) Red bat (c) Large hoary bat (d) All

59. Nerile snail (*Neritina asperulata*) is:

- (a) Amphidromous (b) Catadromous (c) Anadromous (d) Potamodromous

60. Which one of the following bird flies across the Himalayas at a height of 29000 feet?

- (a) Bar-headed geese (b) Shoveller (c) Comb duck (d) Spot bill duck

61. Match column I with column II and select the correct answer using answer codes:

Column I

- (A) Sea turtle
(B) Arctic tern
(C) Dall sheep
(D) Golden eagle

Column II

1. Altitudinal migrants
2. Partial migrants
3. Complete migrants
4. Reproductive migrants

Answer codes:

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 4 | 3 |
| (b) | 4 | 3 | 1 | 2 |
| (c) | 3 | 4 | 2 | 1 |
| (d) | 4 | 1 | 2 | 3 |

62. A single migration may take the entire life of an individual in:

- (a) Arctic tern (b) Pacific salmon (c) Humpback whales (d) Raptors

63. Irruption is a common phenomenon in:

- (a) Lemmings (b) *Locusta* (c) *Melanoplus* (d) All

64. Monthly migration pattern influenced by the phases of the moon is shown by:

- (a) Milk fish (b) Palolo worm (c) Cod fish (d) Tunnas

65. Echolocation to navigate is used by:

- (a) Bats (b) Whales (c) Seals (d) All

66. Which one of the following marine form migrates upstream and spawns in freshwater areas of the estuary?

- (a) *Hilsa ilisha* (b) *Polynemus* (c) *Pama pama* (d) All

67. In a single trip, which generally takes a month, an albatross can fly _____ km without coming down to rest:
 (a) 500 (b) 1,000 (c) 15,000 (d) 30,000
68. Spine-tailed swifts can fly at a speed up to _____ km/hr.
 (a) 50 (b) 100 (c) 160 (d) 200
69. Which one of the following birds during the course of migration has been found to fly close to where the stratosphere begins?
 (a) Whooper swans (b) Bar-headed geese (c) Golden plover (d) None
70. The largest bird that flies by flapping its wings:
 (a) Pelican (b) White stork (c) Red knot (d) Arctic tern
71. Which one of the following is the longest migrant insect?
 (a) Stonefly (b) Damselfly (c) Dragonfly (d) Caddishfly
72. Migration may affect the:
 (a) Behaviour of young fish (b) Population dynamics
 (c) Size density relations (d) All

Answers to Multiple-Choice Questions

- | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (a) | 3. (b) | 4. (c) | 5. (d) | 6. (b) | 7. (a) | 8. (d) |
| 9. (a) | 10. (b) | 11. (d) | 12. (d) | 13. (c) | 14. (b) | 15. (d) | 16. (a) |
| 17. (d) | 18. (d) | 19. (c) | 20. (d) | 21. (d) | 22. (b) | 23. (a) | 24. (d) |
| 25. (d) | 26. (a) | 27. (b) | 28. (a) | 29. (d) | 30. (a) | 31. (b) | 32. (d) |
| 33. (a) | 34. (c) | 35. (a) | 36. (b) | 37. (c) | 38. (d) | 39. (a) | 40. (c) |
| 41. (b) | 42. (c) | 43. (b) | 44. (a) | 45. (b) | 46. (b) | 47. (c) | 48. (d) |
| 49. (a) | 50. (c) | 51. (c) | 52. (b) | 53. (b) | 54. (c) | 55. (c) | 56. (a) |
| 57. (b) | 58. (d) | 59. (a) | 60. (a) | 61. (b) | 62. (b) | 63. (c) | 64. (b) |
| 65. (d) | 66. (d) | 67. (c) | 68. (c) | 69. (b) | 70. (a) | 71. (c) | 72. (d) |

Fill in the Blanks

- Migration is a _____ adaptation.
- Migration confined to freshwater is called _____ migration.
- Migration from sea to freshwater is called _____.
- _____ fishes migrate from freshwater to sea.
- Migration from seawater to freshwater and vice versa is known as _____.
- _____ migration is mainly for the search of food.
- The movement of animals north and south is called _____ migration.
- _____ is the migration in which animals do not come back.
- Tunas migrate to the north and _____ annually following temperature variation in the ocean.
- The most important catadromous fishes are _____.

11. Study of migration in animals in relation to changes, climatic and other ecological factors is called _____.
12. Starlings move from East Europe or Asia to _____.
13. Migrations that are not seasonally or geographically predictable are called _____ migration.
14. The first natural historian to write about migration on the observable fact was _____.
15. Movement occurring in the direction of water is called _____.
16. Movement occurring against water current is called _____.
17. _____ needs shallow water to breed and open sea to grow as adult.
18. Among mammals, true migration occurs in _____.
19. Sea turtles migrate between nesting and nursery grounds as well as between _____ and _____ grounds.
20. In general, flight velocity of birds ranges from _____ miles per hour.
21. _____ move each year from the Arctic to the Antarctic with subsequent return.
22. Wagtails appear in India in the beginning of the _____ season.
23. Partial migration of birds is very common in _____ continents.
24. Migration of birds from east to west or vice versa is called _____ migration.
25. Pectoral sandpiper breeds in _____.
26. The bogong moth is a native of Australia, which migrates to _____ climates.
27. Birds began flying in the _____ period.
28. _____ migration is the longest repeated migration in the insect world.
29. In birds, mostly migrations comprise flying of birds _____ for the winter and _____ in the spring to breed.
30. The arctic tern makes an annual round trip of about _____ km from the Arctic breeding grounds to the Antarctic seas.
31. _____ and _____ are the two important natural causes of death of birds during migration.
32. _____, _____ and porpoises are marine-migrating mammals.
33. _____ is a terrestrial-migrating mammal.
34. Lepidoptera species migrate in all continents, except _____.
35. Migratory lepidoptera *Vanessa cardui* is found all over the world, except _____.

Answers to Fill in the Blanks

- | | | |
|-----------------------|----------------------|--------------------|
| 1. Behavioral | 2. Potamodromous | 3. Anadromous |
| 4. Catadromous | 5. Amphidromous | 6. Alimential |
| 7. Latitudinal | 8. Removal migration | 9. South |
| 10. Freshwater eels | 11. Phenology | 12. Atlantic coast |
| 13. Irruptive | 14. Aristotle | 15. Denatant |
| 16. Contranatant | 17. Salmon | 18. Artiodactyls |
| 19. Breeding, feeding | 20. 20 to 25 | 21. Arctic terns |
| 22. Winter | 23. Southern | 24. Longitudinal |
| 25. Arctic tundra | 26. Cooler | 27. Jurassic |
| 28. Monarch | 29. South, north | 30. 30,000 |

- | | | |
|---------------------------|----------------------|---------------|
| 31. Predation, badweather | 32. Whales, dolphins | 33. Pronghorn |
| 34. Antarctica | 35. South America | |

True or False

1. Migration brings exchange of genes pools.
2. Before migration, birds show migratory restlessness.
3. Ducks show seasonal migration.
4. Night fliers are usually small birds.
5. Migration of birds always occurs through flight.
6. Prolactin and/or thyroid hormones often play key roles in migration of fishes from freshwater to seas.
7. *Chanos* is an amphidromous fish.
8. Eel and salmon grow up and feed in one area but breed in another area.
9. Migratory guillemots mostly walk.
10. Many migratory species of insects tend to have polymorphic forms.
11. In insect migration sometimes, the individuals migrate in one direction may not return and the next generation may migrate in the opposite direction.
12. In certain insects sense of homing instinct is well developed.
13. Butterflies resume reproductive activity during northward migration and the new generation produced in spring and summer complete the migratory path.
14. Migratory insects soar like albatrosses and vultures.
15. Irruptive migration occurs annually.
16. Swallows and crows migrate by day.
17. Once birds start migrating, the process cannot be stopped, except only by very bad weather.
18. Migratory routes are fixed eternally.
19. Juvenile hormone stimulates oogenesis and migratory behaviour in several insects.
20. Bees and wasps exhibit local migration.
21. Spawning migration is against the current.
22. Lampreys are day migrant.
23. *Gasterosteus* is narrowly tolerant to salinity.
24. Most birds migrate shorter distances.
25. Termites and Japanese beetles move downward into the soil.
26. Migration has both positive and negative effects on the home region.
27. Locust swarms migrate, but each part of the circuit is completed by a different generation.
28. Seasonal movements are widespread among terrestrial species of mammals.
29. Birds use their tail feathers to navigate.
30. Geese fly by constantly flapping their wings.

31. Amphidromous migration occurs for the purpose of breeding.
32. Tropical butterflies do not change their migrational direction throughout the day.
33. Blue jays are completely migrant.

Answers to True or False

- | | | | | | | | |
|-----------|-----------|----------|-----------|-----------|----------|-----------|----------|
| 1. True | 2. True | 3. True | 4. True | 5. False | 6. True | 7. False | 8. True |
| 9. False | 10. True | 11. True | 12. True | 13. True | 14. True | 15. False | 16. True |
| 17. True | 18. False | 19. True | 20. True | 21. True | 22. True | 23. False | 24. True |
| 25. True | 26. True | 27. True | 28. False | 29. False | 30. True | 31. False | 32. True |
| 33. False | | | | | | | |

Give Reasons

1. Animals migrate.
 - Because the habitats in which animals live are not suitable to survive in year-round and so, they must evolve a way to cope up with the difficult time of the year. Therefore, to overcome this difficult period, some animals move to long distant habitats that are more favourable for part of the year or part of their life.
2. Some organisms are euryhaline.
 - Because in their life cycle there is migration between freshwater and marine environment.
3. During migration many birds prefer to fly at a higher altitude.
 - Because winds prevail at higher altitudes, as well as low temperature at these altitudes help them to diffuse body heat, generated by their flight muscles.
4. Migration increases an individual's survival value.
 - Because the predator pressure decreases as it becomes divided into a large number of eggs laid in breeding grounds by a large number of migratory birds.
5. In birds, orientation of the sun compass is an instinctive behaviour.
 - Because young birds that have never migrated before use the same sun compass orientation when traveling independent of their parents.
6. Wildebeests migrate from the Serengeti to the Masai Mara at the start of the dry season.
 - Because the grassland of the Masai Mara is very low in phosphorous. Thus during dry season, wildebeests face shortage of this vital element, so they migrate. Upon the return of rain, they return to their original place, where the grass has begun to grow having higher content of phosphorous.
7. Geese fly in a V-shape formation.
 - Because it decreases the wind drag on all the flying geese along both the sides.
8. Golden eagles are considered partial migrants.
 - Because those golden eagles that live far enough south do not migrate.
9. The gradual shortening of days is one of the most important factors of migration of birds.
 - Because change in the length of daylight has an effect on the hormonal system of birds.

COURTSHIP AND PARENTAL CARE IN ANIMALS

Multiple-Choice Questions

- Courtship includes:
(a) Mating calls (b) Nest building (c) Dancing and singing (d) All
- Consider the following statements:
(a) In vertebrates, the parental care of offsprings has evolved several times
(b) Evidence for parental care is extremely rare in fossil amniotes
(c) Among amniotes, parental care is found in all mammal crocodiles, some birds and some squamata
(d) The late middle Permian, age of the varanopid family presents the oldest fossil evidence of parental care in terrestrial vertebrates
The incorrect statements are:
(a) None (b) A, B and C (c) B, C and D (d) B and D
- Food, defence, heat, sanitation and guidance for young ones are performed by:
(a) Bees (b) Wasps (c) Ants (d) All
- Zigzag swimming pattern of courtship behaviour is shown by:
(a) *Gasterosteus aculeatus* (b) *Salmo solar*
(c) *Pomatoschistos minutus* (d) *Amia calva*
- The male provides all post fertilisation parental care and has morphological and physiological adaptations to osmoregulate, aerate, and even nourish the developing embryos in:
(a) Seahorses (b) Pipefishes
(c) Both seahorses and pipefishes (d) Pholis
- Which one of the following about parental care is correct?
(a) There is no parental care. (b) Uniparental
(c) Biparental (d) All
- Consider the following statements about an insect:
(a) It lives in intertidal mud (b) The mother keeps the burrow ventilated
(c) The mother renews burrowing activity (d) If the mother is removed, the brood will perish for lack of oxygen
This insect is:
(a) Staphylinid beetle (b) Gypsy moth (c) *Ambrosia* beetle (d) Burying beetle
- In which one of the following animals are the young ones fed with the faeces of adults?
(a) *Ambrosia* beetles (b) Naked mole rats (c) Kangaroo rats (d) Viviparous mites
- Which one of the following is a mouth-brooding fish?
(a) *Arius* (b) *Macropodus* (c) *Amia* (d) All

10. Scattering of eggs over aquatic plants is not found in:
 - (a) *Carrassius auratus*
 - (b) *Salmo solar*
 - (c) *Cyprinus carpio*
 - (d) *Esox lucius*
11. Nest building is not performed by:
 - (a) *Protopterus*
 - (b) *Amia calva*
 - (c) *Rhodeus amarus*
 - (d) *Etheostoma*
12. Which one of the following fishes deposits eggs in the siphon of a freshwater mussel?
 - (a) *Rhodeus amarus*
 - (b) *Pholis gunnellus*
 - (c) *Apelts quadracus*
 - (d) *Betta splendens*
13. Bubble nests are built using sticky saliva by many species of:
 - (a) Fighting fish
 - (b) Gourami
 - (c) Siamese
 - (d) All
14. Nests are built for laying eggs by:
 - (a) King cobra
 - (b) Turtles
 - (c) Crocodilians and many lizards
 - (d) All
15. In which one of the following birds does the male solely incubate the egg for two months?
 - (a) Flamingos
 - (b) Emperor penguins
 - (c) Kiwis
 - (d) Emus
16. Youngs are active soon after birth and can fend for themselves in:
 - (a) Hares
 - (b) Cavies
 - (c) Artiodactyls
 - (d) All
17. Communal care of young ones occurs in:
 - (a) Wolves
 - (b) Lion
 - (c) Capé hunting dogs
 - (d) All
18. Interspecific brood parasitism occurs in:
 - (a) Honey guides
 - (b) Cuckoos
 - (c) Ducks and cowbirds
 - (d) All
19. In which one of the following do males incubate the single egg on the top of their webbed feet?
 - (a) Ostriches
 - (b) Emperor and king penguins
 - (c) Skinks and glass lizards
 - (d) Alligators and lizards
20. True viviparity occurs in:
 - (a) Most mammals
 - (b) Some skinks and a few species of sharks
 - (c) Several species of snakes
 - (d) All
21. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(a) Whistling sound	1. Peacock
(b) Mutual tactile stimulation	2. Stickle back
(c) Nesting and dancing	3. Uromastix
(d) Courtship dancing	4. Cicado

Answer codes:

A	B	C	D
(A) 4	2	1	3
(B) 4	3	2	1
(C) 2	3	4	1
(D) 3	4	2	1
22. Which one of the following stores paralysed spiders in their nest for the hatchlings to feed upon?
 - (a) Male dauber wasps
 - (b) Female dauber wasps
 - (c) Female scorpions
 - (d) All
23. Social monogamy has been found in:
 - (a) Insects
 - (b) Reptiles
 - (c) Birds
 - (d) All

24. Promiscuous mating occurs in:
 (a) Chimpanzees (b) Bonobos
 (c) Both chimpanzees and bonobos (d) None
25. The selfish gene model for courtship behaviour has been given by:
 (a) Richard Dawkins (b) N Tinbergen (c) A Wetmore (d) J P Hailman
26. Consider the following statements about a fish:
 (a) It is a marine fish (b) Both fertilisation and development are internal
 (c) Developing embryos are nourished by yolk sac placenta (d) Youngones are borne with characteristics of the adult
 The name of this fish is:
 (a) *Gasterosteus aculeatus* (b) *Cymatogaster aggregatus*
 (c) *Pholis gunnellus* (d) *Apelts quadracus*
27. In which one of the following fishes, the sticky secretion of kidneys assists in the formation of a nest:
 (a) *Etheostoma* (b) *Clupea harengus*
 (c) *Gadusia chapra* (d) *Gasterosteus aculeatus*
28. In fishes, parental care is quite common in:
 (a) Mugiliformes (b) Microcyprini (c) Gasterosteiformes (d) Beryciformes
29. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(a) Brood pouch	1. <i>Platystystacus</i>
(b) Mermaid's purse	2. <i>Hippocampus</i>
(c) Viviparity	3. <i>Scyllium</i>
(d) Integumentary cups	4. <i>Scoliodon</i>

 Answer codes:

A	B	C	D
(a) 2	4	1	3
(b) 2	3	4	1
(c) 4	3	1	2
(d) 3	1	4	2
30. In which one of the following fishes are fertilised eggs kept in the intestine till hatching occurs?
 (a) *Tachysurus* (b) *Geophagus* (c) *Macropodus* (d) All
31. Consider the following statements:
 (A) In most mammals, the females care for the young ones and the males play little or no part in parental care
 (B) In coho salmon, there is a close relation between the size of eggs, early growth and adult size
 (C) In reptiles, 5 to 20 per cent of the annual energy requirement is spent on laying eggs
 (D) In *Daphnia magna*, females reared at high food supply produce larger eggs and the young ones from these eggs are more resistant to starvation
 The correct statements are:
 (a) A, B and D (b) B, C and D (c) A and D (d) All
32. An animal has the following characteristics:
 (a) Monogamous (b) Exhibits considerable parental care
 (c) Feeds on dead wood (d) Proctodeal trophallaxis
 This animal is:
 (a) *Drosophila* (b) *Cryptocercus punctulatus*

- (c) *Hyloicus pinastri* (d) *Misumena vatia*
33. Which one of the following birds uses the geothermal heat of volcanic sand as its source of energy for incubation?
 (a) *Dinopium benaghalensis* (b) *Rhea americana*
 (c) *Macrocephalon maleo* (d) *Ceryle rudis*
34. Multiple parental cares occur in:
 (a) Penduline tits (b) St. Peter's fish (c) Kentish plover (d) All
35. In which one of the following is scent the main factor for recognition of sex and species?
 (a) Toads (b) Salamanders
 (c) Mexican helmeted lizards (d) Herring gulls
36. Match column I with column II and select the correct answer using answer codes:
- | Column I | Column II |
|---|------------------|
| (A) Nuptial dance and fertillium | 1. Scorpion |
| (B) Silk balloon as wedding gift | 2. <i>Nereis</i> |
| (C) Males rub their legs together to produce a typical call | 3. <i>Empis</i> |
| (D) Promenada a deus' dance | 4. Cricket |
- Answer codes:
- | A | B | C | D |
|-------|---|---|---|
| (a) 2 | 3 | 4 | 1 |
| (b) 3 | 4 | 1 | 2 |
| (c) 2 | 1 | 4 | 3 |
| (d) 4 | 3 | 1 | 2 |
37. Longest period of parental care occurs in:
 (a) Gerbes (b) Quails (c) Great frigate birds (d) Passerines
38. Which one of the following has precocial young birds?
 (a) Quails (b) Fowls (c) Ducks (d) All
39. Which one of the following is incorrect?
 (a) About 95 per cent birds are monogamous.
 (b) Next to mammals, parental care is highly developed in birds.
 (c) In birds, the duration of incubation is generally related to the size of birds.
 (d) The incubation temperature of most birds is 65°F.
40. In scorpion, coitus:
 (a) Is of shorter duration (b) Is of longer duration
 (c) May be of short or long duration (d) Does not occur
41. Match column I with column and select the correct answer using answer codes:
- | Column I (Type of nests) | Column II (Bird) |
|--|-------------------|
| (A) Loose framework of twigs | 1. Woodpeckers |
| (B) Nest may be a mere pit in the sand | 2. Cliff swallows |
| (C) Nest in hollow trees | 3. Doves |
| (D) Chimney made of mud | 4. Ostriches |
- Answer codes:
- | A | B | C | D |
|-------|---|---|---|
| (a) 4 | 1 | 2 | 3 |
| (b) 3 | 4 | 2 | 1 |

- (c) 2 3 4 1
(d) 3 4 1 2
42. Which one of the following birds incubates eggs not by sitting, but by standing on them?
(a) Hoopoes (b) Boobies (c) Galliform birds (d) Owls
43. Nearly all birds provide extended care to their offsprings, except:
(a) Some megapodes (b) Turkey-like birds of the Southwest Pacific
(c) Brood parasites (d) All
44. The mating system of birds includes:
(a) Polygyny and polyandry (b) Polygamy and polygynandry
(c) Promiscuity (d) All
45. Courtship behaviour in animals involves:
(a) Fighting powers (b) Dance or touching (c) Vocalisations (d) All
46. Courtship refers to the behavioural interaction which occurs between males and females _____ the acting of mating:
(a) Before (b) During (c) Just after (d) All
47. Synchronisation of courtship activities of male and female is particularly important in species in which:
(a) Fertilisation is external (b) Fertilisation is internal
(c) Eggs are yolky (d) Larval development occurs
48. In *Drosophila*, longest duration of copulation occurs in:
(a) *Drosophila bipectinata* (b) *Drosophila melanogaster*
(c) *Drosophila enigma* (d) *Drosophila ancanthoptera*
49. Which one of the following species of *Drosophila* has the shortest duration of copulation?
(a) *Drosophila ananassae* (b) *Drosophila enigma*
(c) *Drosophila pseudoananassae* (d) *Drosophila acanthoptera*
50. Which one of the following is not a male courtship element of *Drosophila*?
(a) Wing fluttering (b) Abdomen elevation (c) Wing flicking (d) Tapping
51. Male parental care is common in:
(a) Fishes (b) Amphibians (c) Birds (d) Insects
52. Which one of the following is applicable to prototheria?
(a) Oviparous (b) No uterine gestation
(c) Incubation of eggs by the mother (d) All
53. Which one of the following about young ones of metatheria is incorrect?
(a) Tiny (b) Naked
(c) Blind (d) Without clawed forelimbs
54. Back brooding is found in males of:
(a) Water bugs (b) Wasps (c) Catfishes (d) Silverfishes
55. In which one of the following cockroaches, shortly after expelling the hatching egg case, a whitish translucent material exudes from the abdominal tip of the female on which neonates actively feed?
(a) *Blattella germanica* (b) *Periplaneta americana*
(c) *Gromphadorhina portentosa* (d) *Shelfordella tartara*
56. Lynx spider:
(a) Do not spin webs (b) Do not retreat (c) Make egg sacs on leaves (d) All
57. Biparental care is the norms in birds and it occurs in more than _____ per cent of living species:

- (a) 50 (b) 60 (c) 75 (d) 90
58. An extreme case of viviparity is found in _____ in which males are sexually mature at birth:
 (a) Surf perch (b) Salamander (c) Skink (d) None
59. Match column I with column II and select the correct answer using answer codes:
- | | |
|-------------------------|---------------------------------|
| Column I | Column II |
| (A) Mud nest | 1. <i>Salamandra atra</i> |
| (B) Foam nest | 2. <i>Ichthyophis</i> |
| (C) Coiling around eggs | 3. <i>Rhacophorus schlegeli</i> |
| (D) Viviparity | 4. <i>Hyla fabre</i> |
- Answer codes:
- | | | | |
|-------|---|---|---|
| A | B | C | D |
| (a) 2 | 3 | 4 | 1 |
| (b) 3 | 4 | 2 | 1 |
| (c) 4 | 3 | 2 | 1 |
| (d) 4 | 2 | 1 | 3 |
60. Consider the following statements:
 (a) *Andrias japonicus* shakes the eggs for proper aeration
 (b) *Rhacophorus malabaricus* deposits its eggs on land
 (c) In *Arthroleptis*, males keep the larvae in their mouth
 (d) Males of *Hyla rosenbergi* are highly territorial and aggressive
- The correct statements are:
 (a) All (b) A, B and C (c) A, C and D (d) B and D
61. During breeding season, the skin of the female's back becomes thick, vascular, soft and gelatinous in:
 (a) *Pipa pipa* (b) *Hyla goeldii*
 (c) *Rhacophorus reticulatus* (d) *Alytes obstetricans*
62. In which one of the following amphibians does either the male or the female may attend to the eggs?
 (a) *Desmognathus fuscus* (b) *Rhacophorus reticulatus*
 (c) *Proteus anguineus* (d) *Hylambates breviceps*
63. Communal nest is prepared by:
 (a) *Phrynxalus biroii* (b) *Nectophrynoides malcolmi*
 (c) *Rhinoderma darwinii* (d) *Phyllobates*
64. In amphibians, viviparity is common in order:
 (a) Anura (b) Apoda (c) Urodela (d) Apoda and urodela
65. A short incipient brood pouch in which eggs are exposed is found in:
 (a) Female *Hyla goeldii* (b) Male *Hyla goeldii*
 (c) Male *Rhacophorus reticulatus* (d) Female *Geotrypetes*
66. Shoot nest is prepared by:
 (a) *Hyla faber* (b) *Rhacophorus maculatus* (c) *Phyllomedusa* (d) *Triton*
67. In which one of the following amphibians is metamorphosis fully completed inside the brood pouch?
 (a) *Nototrema pygmaeum* (b) *Nototrema oviferum*
 (c) *Nototrema marsupiata* (d) *Ascaphus*
68. Uterine wall functions as primitive placenta in:
 (a) *Salamandra maculosa* (b) *Pipa dorsigera*
 (c) *Alytes obstetricans* (d) *Rhacophorus maculatus*

69. Viviparity is shown by:
 (a) *Dermophis* (b) *Typhlonectes* (c) *Geotrypetes* (d) All
70. Gastric brooding in vertebrates is found in the:
 (a) *Philetairus socius* (b) *Hylambates breviceps*
 (c) *Rheobatrachus silus* (d) *Gastrotheca marsupium*
71. The only known amphibian which feeds its young ones:
 (a) *Rheobatrachus silus* (b) *Pseudophryne*
 (c) *Dendrobates* (d) *Dermophis*
72. Which one of the following males coils around the eggs for parental care?
 (a) *Pseudophryne* (b) *Sooglossus seychellensis*
 (c) *Plethodon cinereus* (d) *Megalobatrachus maximus*
73. Eggs directly hatch into little frogs in:
 (a) *Hyla nebulosa* (b) *Hylodes* (c) *Eleutherodactylus* (d) All
74. Consider the follow statements about an amphibian:
 (a) Avoid laying eggs in ponds and streams
 (b) Eggs develop on land until the tadpoles are ready to hatch.
 (c) The mother carries the tadpoles in her back to water-filled bromeliads in trees
 (d) The mother feeds the tadpoles with unfertilised eggs
 This amphibian is:
 (a) *Oophaga pumilio* (b) *Rhinoderma darwinii* (c) *Conraua goliath* (d) *Plethodon cinereus*
75. Which one of the following about *Rheobatrachus silus* is incorrect?
 (a) Development of young occurs in the stomach (b) Do not feed at all during the developmental period
 (c) May have over 20 young ones (d) None
76. Skin feeding is an ancient mode of parental care in:
 (a) Anurans (b) Caecilians (c) Urodela (d) Lacertilian
77. Which one of the following is documented to show true parental care?
 (a) *Ptyas mucosus* (b) *Naja naja* (c) *Ophiophagus hannah* (d) *Micrurus fulvius*
78. Young ones are fed with crop milk in:
 (a) Doves (b) Penguins (c) Flamingoes (d) All
79. Both parents may help to defend a territory for their young in:
 (a) Kloss's gibbon (b) Geese (c) Koalas (d) Baboons
80. Egg clutch is periodically moistened by males by urinating in:
 (a) *Hyla nebulosa* (b) *Plethodon cinereus* (c) *Dendrobates auratus* (d) *Hyla rosenbergi*
81. In which one of the following amphibians does the female carry eggs in her mouth?
 (a) *Hylambates breviceps* (b) *Rhacophorus reticulatus*
 (c) *Hemisus marmoratus* (d) *Dendrobates pumilio*
82. Which one of the following carries fertilised eggs in vocal sacs?
 (a) *Desmognathus fuscus* (b) *Rhinoderma darwinii*
 (c) *Alytes obstetricans* (d) *Idiocaranium russeli*
83. Floating foam nest is prepared by:
 (a) *Phrynxalus biroii* (b) *Hyla fabre*
 (c) *Leptodactylus mystacinus* (d) *Adelotus brevis*

300 Ecology and Animal Behaviour

84. The level of parental care depends on:
 (a) Any early development inside an adult of the same species (b) The degree of vulnerability during childhood
 (c) The length of vulnerable childhood (d) All
85. Which one of the following about the chameleon (*Furcifer labordi*) is incorrect?
 (a) An annual chameleon, living mostly as an egg (b) Post hatching lifespan of 4 to 5 months
 (c) Hatchlings grow rapidly and reaches sexual maturity in less than two months (d) None
86. Which one of the following about superprecocial is incorrect?
 (a) Young ones are completely independent at hatching (b) No parental care
 (c) Examples are young megapodes (d) All
87. Which one of the following is a subprecocial bird?
 (a) Gerbes (b) Gulls (c) Humming birds (d) Owls
88. Consider the following statements:
 (A) Incubation time varies from species to species
 (B) Birds that nest in deserts often sprinkle water on their eggs or shade them with their bodies
 (C) Nest placement in birds does not make a big difference in nest temperature
 (D) In thinner nest, less time and energy is needed for incubation
 The correct statements are:
 (a) All (b) A and B (c) B and C (d) C and D
89. Bonds made between sexes largely depend upon the:
 (a) Level of parental care that each is to provide (b) Defence of territory
 (c) Access of food (d) All
90. Match column I with column II and select the correct answer using answer codes:

Column I	Column II
(A) Altricial	1. Shorebirds
(B) Semiprecocial	2. Wood peckers and pigeons
(C) Semi-altricial	3. Young gulls and terns
(D) Precocial	4. Hawks and owls

 Answer codes:

A	B	C	D
(a) 4	3	1	2
(b) 2	3	4	1
(c) 3	4	2	1
(d) 4	1	2	3
91. Precocial birds have:
 (a) Large egg size (b) Higher yolk content (c) Longer incubation time (d) All
92. In which one of the following fishes is fertilisation internal and the development of young ones occurs within the ovary but they are not attached to the wall of the ovary?
 (a) *Gambusia* (b) *Zoarcis* (c) *Poicilia* (d) All
93. Identity the brooder fish that does not take any food during brooding:
 (a) *Syngnathus acus* (b) *Aspredo* (c) *Galeichthys felis* (d) *Apeltes quadracus*
94. Which one of the following builds a massive pyramidal nest of stones?
 (a) Minnows (b) *Nocomis* (c) *Lophius* (d) *Solea*

95. Which one of the following is incorrect?
- Birds can regulate body temperature very effectively at birth
 - Covering of down feathers provide a big help in the early stages of thermoregulatory development
 - Brooding time decreases as chicks age
 - Majority of birds try to time their broods to coincide with the seasonal peak in insect abundance
96. Female does not exhibit parental care in:
- Hypogeophis*
 - Amphiuma*
 - Xenopus*
 - All
97. In which one of the following does a hedonic gland develop on the chin of male during breeding season, the secretion of which stimulates the female during courtship?
- Amphiuma*
 - Plethodon*
 - Pipa pipa*
 - Macrognathus*
98. Consider the following statements:
- In *Hyla nebulosa*, fertilisation is internal and tadpoles remain attached with the body, deriving their nutrition from the skin of the parent
 - Hyla resinifictrix* is viviparous
 - In *Scyllium*, fertilised eggs are laid inside a horny egg capsule called Mermaid's purse
 - The *Pholis gunnellus* rolls the eggs into a ball-like structure and curls around it
- The correct statements are:
- All
 - A and B
 - C and D
 - A and D
99. Parental care promotes:
- Survival
 - Growth
 - Development of immature
 - All
100. Which one of the following is the primary factor in the evolution of parental care in insects?
- Protection against a harsh environment
 - Protection against predators
 - Protection against parasites
 - All
101. Which one of the following shows parental care in relation to physical and biotic environmental factors?
- Nicrophorous*
 - Bledius spectabilis*
 - Both (a) and (b)
 - None
102. Female of which frog produces a call reciprocal to the male's call?
- Polypedates leucomystax*
 - Rhinoderma darwinii*
 - Rana catesbiana*
 - Neobatrachus*
103. Consider the following statements:
- Dual parental care
 - Males defend as well as water the nest
 - Females feed the tadpole larvae with unfertilised eggs
 - Amplexus is absent
- On the basis of the above statements, identity the amphibian:
- Hylambates breviceps*
 - Sooglossus seychellensis*
 - Oophaga pumilio*
 - Megalobatrachus maximus*
104. Ovoviviparity is applicable to:
- All rays
 - Many teleosts
 - Most sharks
 - All
105. In which one of the following does the male deposit a spermatophore on the bottom of the pond, which the female picks up and inserts into her cloaca?
- Pipidae
 - Urodelids
 - Bufonidae
 - None
106. Preparation and use of courtship pad occurs in:
- Peacocks
 - Gulls
 - Ostriches
 - Emus
107. In which one of the following, during parental care, stomach acid secretion as well as contraction of stomach does not occur?

- (a) *Rheobatrachus* (b) *Assa darlingtoni* (c) *Bufo marinus* (d) None
108. Which one of the following amphibians lays eggs on land, which develop directly into miniature adults with no tadpole stages?
- (a) *Hydromantis* (b) *Neobatrachus*
(c) *Pristimantis* (d) *Hydromantes platycephalus*

Answers to Multiple-Choice Questions

- | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 1. (d) | 2. (a) | 3. (d) | 4. (a) | 5. (c) | 6. (d) | 7. (a) | 8. (b) |
| 9. (a) | 10. (b) | 11. (c) | 12. (a) | 13. (d) | 14. (d) | 15. (b) | 16. (d) |
| 17. (d) | 18. (d) | 19. (b) | 20. (d) | 21. (b) | 22. (b) | 23. (d) | 24. (c) |
| 25. (a) | 26. (b) | 27. (d) | 28. (b) | 29. (b) | 30. (a) | 31. (d) | 32. (b) |
| 33. (c) | 34. (d) | 35. (b) | 36. (a) | 37. (c) | 38. (d) | 39. (d) | 40. (d) |
| 41. (d) | 42. (b) | 43. (d) | 44. (d) | 45. (d) | 46. (d) | 47. (a) | 48. (d) |
| 49. (b) | 50. (b) | 51. (c) | 52. (d) | 53. (d) | 54. (a) | 55. (c) | 56. (d) |
| 57. (d) | 58. (a) | 59. (c) | 60. (c) | 61. (a) | 62. (c) | 63. (b) | 64. (b) |
| 65. (a) | 66. (d) | 67. (b) | 68. (a) | 69. (d) | 70. (c) | 71. (c) | 72. (d) |
| 73. (d) | 74. (a) | 75. (d) | 76. (b) | 77. (c) | 78. (d) | 79. (a) | 80. (c) |
| 81. (a) | 82. (b) | 83. (d) | 84. (d) | 85. (d) | 86. (d) | 87. (a) | 88. (b) |
| 89. (d) | 90. (b) | 91. (d) | 92. (d) | 93. (c) | 94. (b) | 95. (a) | 96. (c) |
| 97. (b) | 98. (c) | 99. (d) | 100. (d) | 101. (b) | 102. (a) | 103. (c) | 104. (d) |
| 105. (b) | 106. (a) | 107. (a) | 108. (c) | | | | |

Fill in the Blanks

- The behaviour, in which parents invest time/energy in carrying its offsprings is called _____.
- In invertebrates, with the exception of _____, any form of parental care is uncommon.
- At the time of hatching, young birds are of two types, viz., _____ and _____.
- _____ provides a subsocial example of parental care in the insect world.
- All birds, except _____, incubate their eggs using body heat.
- Young ones of _____ and _____ birds are carried on the backs of the parent.
- In mammals, _____ care is the predominant form of parental care.
- Marsupials brood their young ones in _____.
- Lactation period tends to be short in _____ and _____.
- In _____ rats, there is a single breeding female and several males in a colony.
- Brood parasitism is only known among _____ and fishes.
- _____ care is extremely rare in amphibians.
- Some sharks secrete _____ from the walls of the oviduct which is absorbed by the embryos.
- A female Cyclops carries the eggs in the _____.
- A female dusky salamander carries its egg cluster wrapped around the _____.

16. In _____ (Dayak fruit bat) males have been found to lactate.
17. The young ones of African amphibian (*Boulengerula taitanus*) nourish themselves by eating the fat-rich outer layer of their _____.
18. _____ is an area of the breast of female birds that gets thicker after having laid eggs.
19. Polyandrous species of birds are all _____.
20. _____ chicks need thermoregulation and must be brood for a long time.
21. _____ is the mating of any male and female within a social group.
22. Female cats are stimulated by the male to ovulate only during _____.
23. A species of chameleon having an entire life cycle under a year _____.
24. _____ crabs are remarkable examples of brood care in the cockpit.
25. Incubation consumes _____ per cent of a bird's daily energy requirements.
26. Eggs lose about _____ per cent of their water content during incubation.
27. In birds, _____ is free of feather and functions to convey body heat directly to the eggs.
28. In baby birds, _____ and hatching muscle disappear soon after birth.
29. Protection of eggs is quite common in insect orders, especially in the family _____.
30. In _____, males supply all the female needs during incubation.

Answers to Fill in the Blanks

- | | | |
|----------------------------------|-----------------------------|-------------------------|
| 1. Parental care | 2. Eusocial insects | 3. Altricial, precocial |
| 4. Burying beetles | 5. Megapodes | 6. Grebes, loons |
| 7. Maternal care | 8. Marsupium | 9. Pinnipeds, whales |
| 10. Naked mole | 11. Birds | 12. Biparental |
| 13. Uterine milk | 14. Ovisacs | 15. Neck |
| 16. <i>Dyacopterus spadiceus</i> | 17. Mother's skin | 18. Brood patch |
| 19. Precocial | 20. Altricial | 21. Promiscuity |
| 22. Copulation | 23. <i>Furcifer labordi</i> | 24. Snail |
| 25. 25 | 26. 15 | 27. Brood patch |
| 28. Egg tooth | 29. Pentatomidae | 30. Hornbills |

True or False

1. Courtship behaviour is a form of imprinting.
2. Care of the zygote after fertilisation is called parental care.
3. The amount of parental care is similar in males and females.
4. Multiple paternity in caecilian has been found.
5. Among invertebrates, parental care is highly developed in social insects.
6. *Adrias japonicus* shakes the eggs for proper aeration.
7. Wood roaches are good parents.

304 Ecology and Animal Behaviour

8. The complexity of nests decreases as parental care increases.
9. Terrestrial carnivores are often monogamous.
10. In scorpions, the male stimulate sexual behaviour of females as well as also suppress her nonsexual behaviour.
11. Pythons incubate their eggs for a while.
12. Some species restrict courtship only during darkness.
13. Crocodiles actively defend their nest and young ones for a short period of time.
14. In *Mustelus*, eggs develop in the uterus.
15. The nest of *Apeltes quadracus* is cup-shaped.
16. Courtship provides a chance for better survival.
17. In herring gulls (*Harus argentatus*), both males and females preen feathers during courtship.
18. In fishes, parental care may be paternal, maternal or biparental.
19. Hawks do not incubate their eggs.
20. In hens and ducks, incubation starts when the last egg laid.
21. If the number of sexes is unequal, monogamy may result.
21. In mammals, olfaction plays a major role in the regulation of courtship behaviour.
23. Burying beetles exhibit advanced parental care by feeding and guarding their offspring on buried vertebrate carrion.
24. In stink bugs, the mother bug guards not only the eggs, but also the 1st instars until they become 2nd instars.
25. Majority of insects do not invest their energy in their young ones after birth.
26. In acorn woodpeckers, nonbreeding adults or juvenile may help care for the young ones.
27. Polygynous bird species are precocial.
28. Biparental care is common in amphibians.
29. Communal care of young ones is associated with cooperative breeding.
30. Paternal and maternal care occurs with equal frequency in species of amphibians.
31. More than half of all fish families have no species that exhibit parental care.
32. Tailed frog uses its tail as an intromittent organ.
33. Mating for most species is instinct.
34. Many fish species secrete pheromone in water to attract potential mates.
35. Female reptiles and birds invest significantly more nutrition resources plus time to produce the egg.
36. Promiscuity is more likely when parental care is necessary.
37. Parrots form long lasting pair bonds.

Answers to True or False

- | | | | | | | | |
|-----------|----------|-----------|-----------|----------|----------|----------|----------|
| 1. False | 2. True | 3. False | 4. True | 5. True | 6. True | 7. True | 8. False |
| 9. True | 10. True | 11. True | 12. False | 13. True | 14. True | 15. True | 16. True |
| 17. False | 18. True | 19. False | 20. True | 21. True | 22. True | 23. True | 24. True |
| 25. True | 26. True | 27. True | 28. False | 29. True | 30. True | 31. True | 32. True |
| 33. True | 34. True | 35. True | 36. False | 37. True | | | |

Give Reasons

1. Courtship may be spectacular:
 - Because :
 - (a) Partners try to attract a suitable mate
 - (b) Nest building
 - (c) Plumage ruffling
 - (d) Emission of scents
2. Young ones of komodos often roll in faecal material.
 - Because large komodos cannibalise young ones, so young ones often roll in faecal material, thereby assuming a scent that the large dragons avoid.
3. Incubation period of hole-nesting birds as compared to open-nesting birds is slightly longer.
 - Most probably because predation is lower in hole-nesting birds.
4. Parental care is a form of altruism.
 - Because it involves increasing the fitness of the offspring at the expense of the parent.
5. Typically oviparous species can reproduce more frequently than viviparous species.
 - Because oviparous species do not have to wait for the young one to develop in order to produce a new clutch of eggs.
6. Altricial young ones must be brooded by one or the other parent.
 - Because altricial young ones cannot thermoregulate at first.
7. Birds in drier climates have shorter incubation periods.
 - Because of the loss of water content during incubation and if water loss exceeds 20 per cent, the embryo may die.
8. The brood patch is well supplied with blood vessels.
 - To maximise heat transfer to the eggs.
9. Birds that are frugivorous shift their diet to protein during parental care.
 - Because baby birds need protein and only insects can provide that protein in sufficiently concentrated form.
10. Courtship and mating behaviour differs in different species.
 - Because of evolution of different languages which prevents hybridisation or due to geographical isolation.
11. Brood parasitism does not occur in mammals.
 - Because they are not oviparous and the females are alert over their litters.
12. The saltmarsh staphylinid beetle (*Bledius spectabilis*) is of peculiar interest.
 - Because parental care in it is important in relation to both physical and biotic environmental factors.
13. Tadpoles of *Oophaga pumilio* are considered obligate egg feeders.
 - Because they are not able to accept any other form of nutrition.
14. Male lions display courtship behaviour.
 - To attract females; this behaviour also induces females to go into heat.