

Biodiversity and Classification

STUDENTS LEARNING OUTCOMES (SLO's)

After studying this unit, the students will be able to

- ✎ Discuss the meaning of the terms species and speciation.
- ✎ Describe the classification of organisms into three domains: Archaea, Bacteria and Eukarya.
- ✎ Describe the classification of organisms in the Eukarya domain into the taxonomic hierarchy of kingdom, phylum, class, order, family, genus and species.
- ✎ Outline the characteristic features of the kingdoms Monera, Protocista, Fungi, Plantae and Animalia.
- ✎ Outline how viruses are classified.
- ✎ Define the terms ecosystem and niche.
- ✎ Explain the different levels at which biodiversity can be assessed.
- ✎ Explain the importance of random sampling in determining the biodiversity of an area.
- ✎ Describe and use suitable methods to assess the distribution and abundance of organisms in an area.

1.1 THREE-DOMAIN SYSTEM OF CLASSIFICATION



1. What is biodiversity, and why is its classification important in Biology? Explain the concept in detail.

Ans. Definition of Biodiversity:

Biodiversity refers to the variety of life on Earth, encompassing the diversity of genes, species, and ecosystems. It is a fundamental concept in Biology that helps scientists understand the vast array of organisms that inhabit the planet and how they are interconnected through evolutionary relationships.

Importance of Biodiversity:

The classification of biodiversity is essential because it allows biologists to organize and categorize organisms systematically. This organization helps in studying organisms more efficiently, understanding their evolutionary history, and identifying their relationships with other forms of life. Without classification, the immense diversity of life would be chaotic and difficult to study.

Scientists use various principles and methods of biological classification to group organisms based on shared characteristics, evolutionary history, and genetic similarities. Modern classification systems also utilize molecular and genetic data to provide more accurate groupings. Overall, biodiversity and classification provide a structured framework for the study of life, its origins, and its ongoing processes.

The evolutionary relationship among organisms is called **phylogeny**. The diagram to show phylogeny, is called phylogenetic or evolutionary tree.

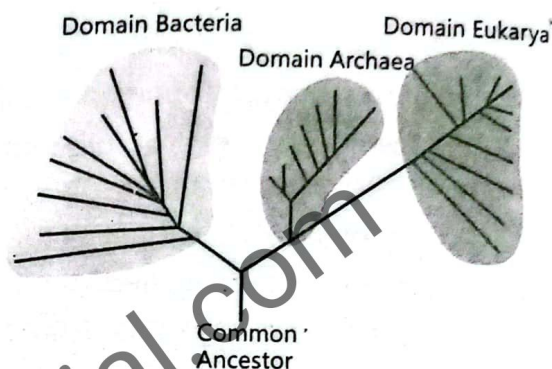


Fig. 1.1: Evolutionary tree of the three domains



2. Describe the three-domain system of classification proposed by Carl Woese. How is it different from the five-kingdom system?

Ans. Three-Domain System of Classification

Introduction:

The three-domain system of classification was proposed by American microbiologist Carl Woese in 1990. It is a modern system that classifies all living organisms into three domains: Archaea, Bacteria, and Eukarya.

Basis of Classification

This system was based on molecular studies, particularly comparisons of ribosomal RNA sequences. Woese discovered that prokaryotes, which were previously grouped under the single kingdom Monera in the five-kingdom system, actually consist of two fundamentally different groups: Archaea and Bacteria.

Description of the Three Domains

Domain Archaea includes ancient prokaryotic organisms that differ significantly from bacteria in terms of genetics, metabolism, and cell structure.

Domain Bacteria includes true bacteria that are also prokaryotic but have distinct differences from archaea.

Domain Eukarya includes all eukaryotic organisms such as protists, fungi, plants, and animals.

Comparison with the Five-Kingdom System

The five-kingdom system proposed by Robert Whittaker in 1969 divided life into Monera, Protista, Fungi, Plantae, and Animalia. In this system, all prokaryotes were lumped into one kingdom—Monera.

Key Differences between the Two Systems

The key difference lies in the recognition by Woese that Archaea and Bacteria are fundamentally different groups of prokaryotes and should be classified separately. Moreover, the three-domain system highlights that Eukarya evolved from Archaea, showing a closer evolutionary relationship between these two domains.



3. What are the major groups of Archaea? Describe the unique characteristics of Archaea that differentiate them from Bacteria and Eukarya?

Ans. Major Groups of Archaea

The major groups of Archaea include Methanogens (produce methane

Archaea were initially classified as a group of bacteria, and were called archaeobacteria.

as a metabolic by-product), Halobacteria (live in extremely saline environments), Thermococci (found in hot environments), and Thaumarchaeota (involved in nitrogen cycle).

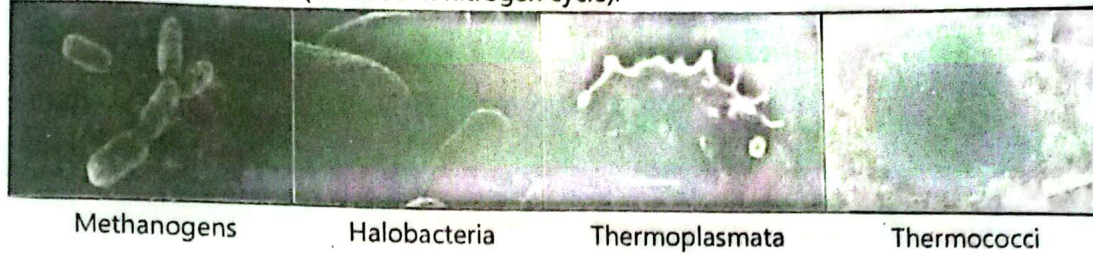


Fig. 1.3: Major groups of Archaea

Unique Characteristics of Archaea

Archaea possess several unique characteristics that set them apart from both Bacteria and Eukarya:

Cell Membrane Structure:

Archaea have cell membranes composed of lipids with **ether linkages** between glycerol and branched fatty acid chains. This structural difference makes archaeal membranes more stable and resistant to extreme environmental conditions. Methanogens Halobacteria Thermoplasmata

In humans, intestinal gas is largely the result of the metabolism of methanogens.

In contrast, the membranes of Bacteria and Eukarya contain lipids with **ester linkages** and **unbranched fatty acid chains**.

Cell Wall Composition:

Unlike bacterial cell walls that contain **peptidoglycan**, archaeal cell walls lack both **cellulose** and **peptidoglycan**. Instead, they are composed of **distinct polysaccharides and proteins**. Some archaea have a special type of wall material called **pseudopeptidoglycan**.

Eukaryotic cells, if they have walls (such as in plants and fungi), possess **cellulose** or **chitin**, not peptidoglycan.

Genetic Similarities with Eukarya:

Although Archaea are prokaryotic, they share several **genetic sequences and regulatory features** with Eukaryotes. These include similarities in the mechanisms of **DNA replication, transcription, and translation**, suggesting a closer evolutionary relationship with Eukarya than with Bacteria.

Metabolic Processes:

Archaea exhibit unique metabolic processes such as **methanogenesis**—the biological production of methane. This process is not found in Bacteria or Eukarya.

In contrast, Bacteria perform processes like photosynthesis, nitrogen fixation, and fermentation, while Eukarya carry out more complex metabolism including cellular respiration and photosynthesis in plants and algae.

These distinctions in structural, genetic, and metabolic traits clearly differentiate Archaea from the other two domains and reflect their ancient evolutionary lineage.



4. Discuss the structure, reproduction and habitat of Archaea.

Ans. Structure:

Archaea are prokaryotic organisms that lack a nucleus and membrane-bound organelles. They range in size from 0.1 μm to over 15 μm in diameter. Some species form aggregates or filaments up to 200 μm in length. Archaea can exist in various shapes including spherical, rod-shaped, spiral, lobed, or rectangular.

Their cell membranes are made up of **ether-linked branched lipids**, which makes them highly stable and able to survive in extreme

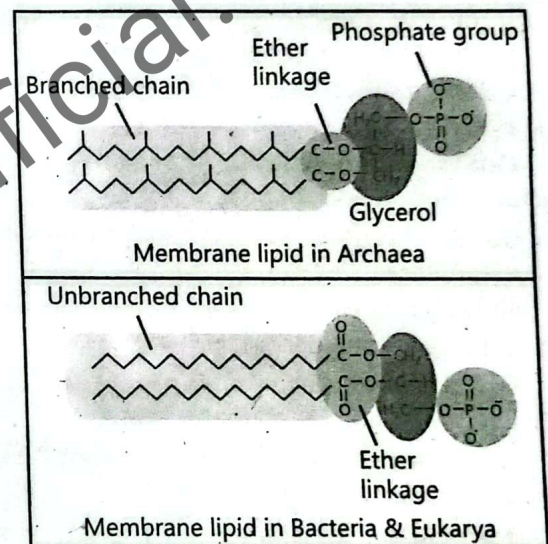


Fig. 1.2: Difference in membrane lipids of Archaea and other organisms

Significance of Archaea

The archaeans which live in high acidity and alkalinity are a source of enzymes that can function under harsh conditions. For example, the enzymes of DNA replication have been extracted from such archaeans. These enzymes can work best at high temperatures and allow rapid cloning of DNA in laboratory. Similarly, the methanogen archaeans are a vital part of sewage treatment. They carry out anaerobic digestion and produce

environments. Their cell walls do not contain peptidoglycan but may include **pseudopeptidoglycan, polysaccharides, and proteins**.

biogas. Acidophilic Archaea are used to extract metals such as gold, cobalt and copper from ores in mineral processing.

Reproduction:

Archaea reproduce **asexually** through several methods:

Binary fission: One cell divides into two identical cells.

Multiple fission: One cell divides into multiple daughter cells.

Fragmentation: A part of the cell breaks off to form a new organism.

Budding: A new organism grows from the body of the parent.

Unlike eukaryotic organisms, Archaea do **not undergo mitosis or meiosis** during reproduction.

Habitat:

Archaea are known for thriving in **extreme environments**, which is why they are sometimes referred to as **extremophiles**. These environments include:

High-temperature areas such as **hot springs** and **hydrothermal vents**

High-salinity areas like **salt lakes**

Anaerobic environments where **methanogenic archaea** produce methane

However, they are also found in **normal environments** such as soils, oceans, and even inside the human gut.



5. Describe the general characteristics of domain Bacteria.

Ans. In the five-kingdom system, this domain was included in kingdom Monera. They are the true bacteria. They possess several distinct characteristics that differentiate them from other domains i.e., Archaea and Eukarya.

Cell Structure: Like archaea, bacteria possess prokaryotic cell i.e., lack a true nucleus and membrane-bound organelles.

Cell Wall Composition: Bacteria have a cell wall composed of peptidoglycan, a unique polymer that provides structural support and shape.

Genetic Material: Like Archaea, bacteria possess a single, circular chromosome composed of DNA, located in the nucleoid region.

Plasmids: Most bacteria have small, circular DNA molecules that can be transferred between bacteria, aiding in genetic diversity and adaptation.

Reproduction: Bacteria primarily reproduce asexually through binary fission, a process where a single cell divides into two identical daughter cells.

Nutritional Modes: Include autotrophs (self-feeding, e.g., photosynthetic bacteria) and heterotrophs (feeding on organic matter, e.g., decomposers).

Morphology: Bacteria exhibit a variety of shapes, such as cocci (spherical), bacilli (rod-shaped), spirilla (spiral-shaped), and vibrios (comma-shaped).

Arrangement: Cells may be found singly, in pairs (diplococci), chains (streptococci), clusters (staphylococci), or other arrangements based on species-specific characteristics.

Flagella: Many bacteria have one or more flagella, whip-like structures that enable movement.

Pili and Fimbriae: These are hair-like structures in some bacteria. They help in attachment to surfaces and in exchange of genetic material with other bacteria.

Respiration: Bacteria can be obligate aerobes, obligate anaerobes, facultative anaerobes, microaerophiles, or aerotolerant anaerobes. Some bacteria perform fermentation to produce energy in the absence of oxygen.

Extremophiles: Some bacteria thrive in extreme conditions, such as high temperatures (thermophiles), high salinity (halophiles), and low pH (acidophiles).

Pathogenicity: Some bacteria cause diseases in humans, animals, and plants, producing toxins or other virulence factors.

Symbiosis: Many bacteria live in symbiotic relationships with other organisms, including mutualism (both benefit) and commensalism (one benefits, the other is not harmed).



Fig. 1.4: Different forms of Bacteria



6. What are the major groups of bacteria? Give examples.

Ans. The domain Bacteria is divided into numerous groups. For example:

Proteobacteria e.g., *Escherichia coli*, *Rhizobium*, *Helicobacter pylori*

Firmicutes e.g., *Bacillus subtilis*, *Lactobacillus*, *Clostridium botulinum*

Actinobacteria e.g., *Streptomyces*, *Mycobacterium tuberculosis*

Cyanobacteria e.g., *Anabaena*, *Spirulina*

Spirochaetes e.g., *Treponemapallidum*

Acidobacteria e.g., *Acidobacterium*

Aquificae e.g., *Aquifexpyrophilus*



7. Describe the general characteristics of the domain Eukarya that justify its classification as a separate domain.

Ans. The domain Eukarya encompasses all organisms with eukaryotic cells, which are fundamentally different from the prokaryotic cells of Bacteria and Archaea. Here are the general characteristics of the domain Eukarya that justify its classification as a separate domain:

Cell Structure:

They possess eukaryotic cells - with true nucleus enclosed by a nuclear membrane. Cells have membrane-bounded organelles e.g., mitochondria, chloroplasts (in plants and algae), endoplasmic reticulum, Golgi apparatus, lysosomes, and peroxisomes. Cells also have cytoskeleton i.e., a complex network of microtubules, microfilaments, and intermediate filaments that provides structural support, enables cell movement, and facilitates intracellular transport.

Genetic Material:

Their DNA is organized into multiple linear chromosomes within the nucleus. DNA is associated with histone proteins, which help in the organization and regulation of genetic material.

Reproduction:

Most eukaryotes undergo sexual reproduction involving meiosis and fertilization, leading to genetic diversity. Some eukaryotes can also reproduce asexually through mitosis, producing genetically identical offspring.

Complex Cellular Organization:

In multicellular eukaryotes, cells differentiate into specialized types forming tissues and organs with specific functions.

Evolutionary Relationships:

Eukaryotes are believed to have originated through endosymbiosis, where certain prokaryotic cells (such as mitochondria and chloroplasts) were engulfed by a host cell, leading to a symbiotic relationship.



1. Who proposed the five-kingdom system of classification in 1969?

- (a) Carl Woese (b) Charles Darwin
(c) Robert Whittaker ✓ (d) Carolus Linnaeus

2. The three-domain system consists of:

- (a) Monera, Protista, Eukarya
(b) Archaea, Bacteria, Eukarya ✓
(c) Plantae, Fungi, Animalia

(d) Prokaryotes, Eukaryotes, Fungi

3. Archaea are more closely related to:

- (a) Bacteria (b) Fungi
(c) Eukaryotes ✓ (d) Protists

4. Which type of linkage is found in archaeal membrane lipids?

- (a) Ester linkage (b) Peptide linkage
(c) Ether linkage ✓ (d) Glycosidic linkage

5. **What kind of reproduction occurs in Archaea?**
 (a) Sexual
 (b) Binary and multiple fission ✓
 (c) Mitosis (d) Meiosis
6. **What is the unique metabolic process found in Archaea?**
 (a) Fermentation (b) Methanogenesis ✓
 (c) Photosynthesis (d) Nitrogen fixation
7. **The wall of fungi in domain Eukarya is made of:**
 (a) Cellulose (b) Peptidoglycan
 (c) Chitin ✓ (d) Glycogen
8. **Halobacteria thrive in which type of environment?**
 (a) Acidic (b) Saline ✓
 (c) Cold (d) Anaerobic
9. **Bacteria differ from Archaea and Eukarya by having:**
 (a) Linear chromosomes
 (b) Peptidoglycan in their cell wall ✓
 (c) Membrane-bound organelles
 (d) A nuclear envelope
10. **The genetic material of bacteria is:**
 (a) Multiple linear chromosomes
 (b) A single, circular chromosome ✓
 (c) RNA-based
 (d) Double helix with histones
11. **Bacteria reproduce mainly through:**
 (a) Budding (b) Mitosis
 (c) Binary fission ✓ (d) Conjugation
12. **Which of the following structures enable bacteria to move?**
 (a) Pili (b) Fimbriae
13. **Pili and fimbriae help bacteria to:**
 (a) Reproduce (b) Attach to surfaces ✓
 (c) Perform photosynthesis (d) Produce toxins
14. **Facultative anaerobes:**
 (a) Require oxygen to survive
 (b) Die in the presence of oxygen
 (c) Can live with or without oxygen ✓
 (d) Only live in high temperature
15. **Mutualism is a symbiotic relationship in which:**
 (a) Both organisms are harmed
 (b) One benefits, one is harmed
 (c) Both benefit ✓ (d) Neither benefits
16. **Which protein is associated with eukaryotic DNA?**
 A) Actin B) Tubulin
 C) Histone ✓ D) Collagen
17. **Eukaryotes are believed to have originated through:**
 A) Binary fission B) Spontaneous generation
 C) Endosymbiosis ✓ D) Budding
18. **Sexual reproduction in eukaryotes involves:**
 A) Mitosis only B) Conjugation
 C) Meiosis and fertilization ✓
 D) Fragmentation
19. **Which taxonomic rank is the highest?**
 A) Species B) Genus
 C) Domain ✓ D) Kingdom
20. **Which domain includes humans?**
 A) Archaea B) Bacteria
 C) Eukarya ✓ D) Protista



1. What is biodiversity and why is it important in Biology?

Ans. Biodiversity refers to the variety of life forms at genetic, species, and ecosystem levels. It is important in Biology because it provides insight into the vast range of life on Earth and helps scientists understand evolutionary relationships among organisms.

2. What is classification in Biology?

Ans. Classification in Biology is the method by which scientists organize and categorize organisms based on shared characteristics and evolutionary relationships. It allows biologists to systematically study the diversity of life.

3. Who proposed the five-kingdom system of classification and when?

Ans. The five-kingdom system of classification was proposed by American ecologist Robert Whittaker in 1969. It divided life into Monera, Protista, Fungi, Plantae, and Animalia.

4. What is the major difference between the kingdoms Monera and the other four kingdoms in the five-kingdom system?

Ans. Kingdom Monera included prokaryotic organisms, while the other four kingdoms—Protista, Fungi, Plantae, and Animalia—included eukaryotic organisms.

5. Who proposed the three-domain system of classification and what are the three domains?

Ans. The three-domain system was proposed by American microbiologist Carl Woese in 1990. The three domains are Archaea, Bacteria, and Eukarya.

6. How do Archaea differ from Bacteria according to the three-domain system?

Ans. Although both Archaea and Bacteria are prokaryotes, they differ in many structural and genetic features. Archaea have unique membrane lipids, lack peptidoglycan in their cell walls, and share some genetic features with eukaryotes. They also have unique metabolic processes like methanogenesis.

7. **How is the relationship between Archaea and Eukarya different from that between Archaea and Bacteria?**
Ans. Molecular evidence suggests that Archaea are more closely related to Eukarya than to Bacteria. Eukarya are believed to have evolved from Archaea after Archaea diverged from Bacteria.
8. **What is the origin of the name 'Archaea'?**
Ans. The name 'Archaea' is derived from the Greek word *archaios*, which means "ancient," reflecting their ancient evolutionary origin.
9. **What is the size and shape range of Archaea?**
Ans. Archaea range in size from 0.1 μm to over 15 μm in diameter, and can form aggregates or filaments up to 200 μm long. They occur in various shapes such as spherical, rod-shaped, spiral, lobed, or rectangular.
10. **How do Archaea reproduce?**
Ans. Archaea reproduce asexually through binary or multiple fission, fragmentation, or budding. Mitosis and meiosis do not occur in Archaea.
11. **How is the cell membrane of Archaea unique?**
Ans. The cell membrane of Archaea contains lipids with ether linkages between glycerol and branched fatty acid chains, making them more resistant to extreme conditions. In contrast, Bacteria and Eukarya have ester linkages and unbranched fatty acid chains.
12. **What is the composition of cell walls in Archaea?**
Ans. The cell walls of Archaea lack cellulose and peptidoglycan. Instead, they may contain distinct polysaccharides and proteins, and in some cases, pseudopeptidoglycan.
13. **How does the cell wall composition in Archaea differ from Bacteria and Eukarya?**
Ans. Bacterial cell walls contain peptidoglycan, while Archaea do not. Eukarya, if they have cell walls, contain cellulose (in plants) or chitin (in fungi), not peptidoglycan.
14. **What genetic similarities do Archaea share with Eukarya?**
Ans. Archaea share several genetic sequences and regulatory features with Eukarya, highlighting their closer evolutionary relationship compared to Bacteria.
15. **What is methanogenesis and in which domain is it found?**
Ans. Methanogenesis is the process of producing methane as a metabolic byproduct. It is a unique metabolic process found only in Archaea, not in Bacteria or Eukarya.
16. **What are some of the metabolic processes found in Bacteria?**
Ans. Bacteria exhibit various metabolic processes including photosynthesis, nitrogen fixation, and fermentation.
17. **What kinds of metabolic processes are found in Eukarya?**
Ans. Eukarya perform complex metabolic processes such as cellular respiration, photosynthesis (in plants and algae), and various forms of fermentation.
18. **How do the metabolic pathways of Archaea differ from Bacteria and Eukarya?**
Ans. Archaea have unique metabolic processes such as methanogenesis that are not found in Bacteria or Eukarya. Bacteria and Eukarya have distinct sets of metabolic pathways like photosynthesis, respiration, and fermentation.
19. **What are the major groups of Archaea?**
Ans. The major groups of Archaea include Methanogens (produce methane as a metabolic by-product), Halobacteria (live in extremely saline environments), Thermococci (found in hot environments), and Thaumarchaeota (involved in nitrogen cycle).
20. **In which kingdom was domain Bacteria included in the five-kingdom system?**
Ans. In the five-kingdom system, this domain was included in kingdom Monera.
21. **What are the general characteristics of domain Bacteria?**
Ans. They are the true bacteria. They possess several distinct characteristics that differentiate them from other domains i.e., Archaea and Eukarya.
22. **What is the cell structure of bacteria?**
Ans. Like archaea, bacteria possess prokaryotic cell i.e., lack a true nucleus and membrane-bound organelles.
23. **What is the composition of bacterial cell walls?**
Ans. Bacteria have a cell wall composed of peptidoglycan, a unique polymer that provides structural support and shape.

24. Describe the genetic material of bacteria.

Ans. Like Archaea bacteria possess a single, circular chromosome composed of DNA, located in the nucleoid region.

25. What are plasmids in bacteria?

Ans. Most bacteria have small, circular DNA molecules that can be transferred between bacteria, aiding in genetic diversity and adaptation.

26. How do bacteria reproduce?

Ans. Bacteria primarily reproduce asexually through binary fission, a process where a single cell divides into two identical daughter cells.

27. What are the nutritional modes of bacteria?

Ans. Nutritional modes include autotrophs (self-feeding, e.g., photosynthetic bacteria) and heterotrophs (feeding on organic matter, e.g., decomposers).

28. What are the morphological shapes of bacteria?

Ans. Bacteria exhibit a variety of shapes, such as cocci (spherical), bacilli (rod-shaped), spirilla (spiral-shaped), and vibrios (comma-shaped).

29. What are the bacterial cell arrangements based on species-specific characteristics?

Ans. Cells may be found singly, in pairs (diplococci), chains (streptococci), clusters (staphylococci), or other arrangements based on species-specific characteristics.

30. What are flagella and their function in bacteria?

Ans. Many bacteria have one or more flagella, whip-like structures that enable movement.

31. What are pili and fimbriae and what is their function?

Ans. These are hair-like structures in some bacteria. They help in attachment to surfaces and in exchange of genetic material with other bacteria.

32. What are the types of bacterial respiration?

Ans. Bacteria can be obligate aerobes, obligate anaerobes, facultative anaerobes, microaerophiles, or aerotolerant anaerobes. Some bacteria perform fermentation to produce energy in the absence of oxygen.

33. What are extremophile bacteria?

Ans. Some bacteria thrive in extreme conditions, such as high temperatures (thermophiles), high salinity (halophiles), and low pH (acidophiles).

34. What is pathogenicity in bacteria?

Ans. Some bacteria cause diseases in humans, animals, and plants, producing toxins or other virulence factors.

35. What is meant by symbiosis in bacteria?

Ans. Many bacteria live in symbiotic relationships with other organisms, including mutualism (both benefit) and commensalism (one benefits, the other is not harmed).

36. What type of cells do organisms in the domain Eukarya possess?

Ans. They possess eukaryotic cells - with true nucleus enclosed by a nuclear membrane. Cells have membrane-bounded organelles e.g., mitochondria, chloroplasts (in plants and algae), endoplasmic reticulum, Golgi apparatus, lysosomes, and peroxisomes. Cells also have cytoskeleton i.e., a complex network of microtubules, microfilaments, and intermediate filaments that provides structural support, enables cell movement, and facilitates intracellular transport.

37. How is genetic material organized in domain Eukarya?

Ans. Their DNA is organized into multiple linear chromosomes within the nucleus. DNA is associated with histone proteins, which help in the organization and regulation of genetic material.

38. What are the modes of reproduction in eukaryotes?

Ans. Most eukaryotes undergo sexual reproduction involving meiosis and fertilization, leading to genetic diversity. Some eukaryotes can also reproduce asexually through mitosis, producing genetically identical offspring.

39. How is cellular organization different in multicellular eukaryotes?

Ans. In multicellular eukaryotes, cells differentiate into specialized types forming tissues and organs with specific functions.

40. How did eukaryotes originate according to evolutionary theory?

Ans. Eukaryotes are believed to have originated through endosymbiosis, where certain prokaryotic cells (such as mitochondria and chloroplasts) were engulfed by a host cell, leading to a symbiotic relationship.

1.2 TAXONOMIC HIERARCHY



8. Explain the taxonomic hierarchy used for the classification of living organisms.

Ans. The classification of living organisms is organized into a hierarchical system that allows scientists to categorize and understand the relationships between different forms of life. This system includes several levels, known as taxa (singular: taxon), each representing a rank in the biological classification system. The primary levels of this hierarchy are: kingdom, phylum, class, order, family, genus, and species. Below is a detailed description of each level.

1. Domain

It is the highest level of classification. Currently, there are three domains: Archaea, Bacteria, and Eukarya.

2. Kingdom

The kingdom is one of the highest taxonomic ranks, just below domain. It groups together all forms of life that share fundamental characteristics.

Example: In the domain Eukarya, there are several kingdoms, such as Animalia (animals), Plantae (plants), Fungi (fungi), and Protista (protists).

3. Phylum

Phylum is the next level of classification below kingdom. Organisms within a phylum share a basic body plan and significant structural features.

Example: In the kingdom Animalia, the phylum Chordata includes all animals with a notochord, such as mammals, birds, reptiles, amphibians, and fish.

4. Class

Class further divides organisms within a phylum based on more specific common traits.

Example: Within the phylum Chordata, the class Mammalia includes all mammals, which are characterized by having hair and mammary glands.

5. Order

Order categorizes organisms within a class based on additional shared characteristics and evolutionary history.

Example: Within the class Mammalia, the order Primates includes humans, monkeys, and apes, characterized by their large brains and opposable thumbs.

6. Family

Family groups organisms within an order that are even more closely related, sharing more precise common attributes.

Example: Within the order Primates, the family Hominidae includes great apes and humans.

7. Genus

Genus is a more specific rank within a family, grouping species that are very closely related and often visually similar.

Example: Within the family Hominidae, the genus Homo includes humans and our closest extinct relatives.

8. Species

Species is the most specific level of classification, representing a single type of organism. Members of a species can interbreed and produce fertile offspring.

Example: Within the genus Homo, the species Homo sapiens refers to modern humans.

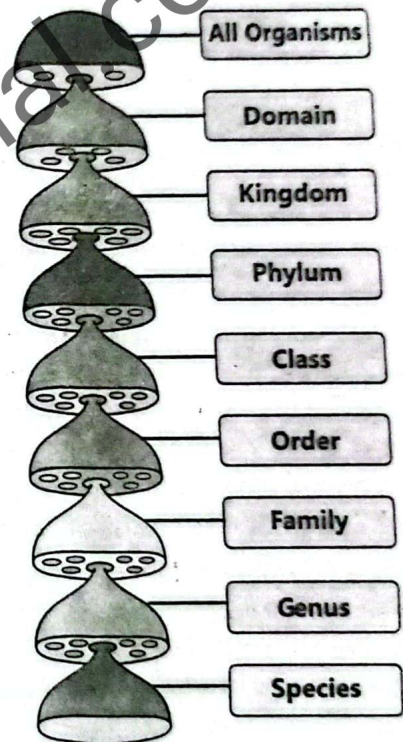


Fig. 1.5: Taxonomic hierarchy

Table 1.1 Classification of living organisms

Taxonomic Rank	Domain	Kingdom	Phylum	Class	Order	Family	Genus	Species
Human (<i>Homo sapiens</i>)	Eukarya	Animalia	Chordata	Mammalia	Primates	Hominidae	Homo	Homo sapiens
Sparrow (<i>Passer domesticus</i>)	Eukarya	Animalia	Chordata	Aves	Passeriformes	Passeridae	Passer	Passer domesticus
Onion (<i>Allium cepa</i>)	Eukarya	Plantae	Angiosperms	Monocots	Asparagales	Amaryllidaceae	Allium	Allium cepa

mQs ✓

- Which class do humans belong to?
A) Mammalia ✓ B) Aves
C) Reptilia D) Amphibia
- In taxonomy, what comes directly after kingdom?
A) Order B) Phylum ✓
C) Class D) Genus
- The order 'Primates' includes:
A) Only humans B) Only monkeys
C) Mammals with notochords
D) Humans, monkeys, and apes ✓
- Which family includes modern humans?
A) Hominidae ✓ B) Felidae
- Which taxonomic level includes organisms that can interbreed and produce fertile offspring?
A) Family B) Genus
C) Species ✓ D) Class
- What is the scientific name of the onion?
A) *Passer domesticus* B) *Homo sapiens*
C) *Allium cepa* ✓ D) Angiosperms monocot
- Which class do birds like sparrows belong to?
A) Mammalia B) Aves ✓
C) Amphibia D) Reptilia



1. What is taxonomic hierarchy?

Ans. The classification of living organisms is organized into a hierarchical system that allows scientists to categorize and understand the relationships between different forms of life. This system includes several levels, known as taxa (singular: taxon), each representing a rank in the biological classification system.

2. What is the domain in taxonomic hierarchy?

Ans. It is the highest level of classification. Currently, there are three domains: Archaea, Bacteria, and Eukarya.

3. What is a kingdom in taxonomic classification?

Ans. The kingdom is one of the highest taxonomic ranks, just below domain. It groups together all forms of life that share fundamental characteristics.

4. Give examples of kingdoms in domain Eukarya.

Ans. In the domain Eukarya, there are several kingdoms, such as Animalia (animals), Plantae (plants), Fungi (fungi), and Protista (protists).

5. What is phylum in biological classification?

Ans. Phylum is the next level of classification below kingdom. Organisms within a phylum share a basic body plan and significant structural features.

6. Give an example of phylum from kingdom Animalia.

Ans. In the kingdom Animalia, the phylum Chordata includes all animals with a notochord, such as mammals, birds, reptiles, amphibians, and fish.

7. What is class in taxonomic hierarchy?

Ans. Class further divides organisms within a phylum based on more specific common traits.

8. Give an example of class within phylum Chordata.

Ans. Within the phylum Chordata, the class Mammalia includes all mammals, which are characterized by having hair and mammary glands.

9. What does the order level represent in classification?

Ans. Order categorizes organisms within a class based on additional shared characteristics and evolutionary history.

10. Give an example of order within class Mammalia.

Ans. Within the class Mammalia, the order Primates includes humans, monkeys, and apes, characterized by their large brains and opposable thumbs.

11. What does family represent in taxonomy?

Ans. Family groups organisms within an order that are even more closely related, sharing more precise common attributes.

12. Provide an example of family from the order Primates.

Ans. Within the order Primates, the family Hominidae includes great apes and humans.

13. What is genus in biological classification?

Ans. Genus is a more specific rank within a family, grouping species that are very closely related and often visually similar.

14. Give an example of genus within the family Hominidae.

Ans. Within the family Hominidae, the genus Homo includes humans and our closest extinct relatives.

15. What is species in taxonomy?

Ans. Species is the most specific level of classification, representing a single type of organism. Members of a species can interbreed and produce fertile offspring.

16. Give examples of species classification for humans, sparrows, and onions.

Ans. Human (*Homo sapiens*): Eukarya, Animalia, Chordata, Mammalia, Primates, Hominidae, *Homo*, *Homo sapiens*.

Sparrow (*Passer domesticus*): Eukarya, Animalia, Chordata, Aves, Passeriformes, Passeridae, *Passer*, *Passer domesticus*.

Onion (*Allium cepa*): Eukarya, Plantae, Angiosperms, Monocots, Asparagales, Amaryllidaceae, *Allium*, *Allium cepa*.

1.3 SALIENT FEATURES OF KINGDOMS OF DOMAIN EUKARYA

Domain Eukarya.

Domain Eukarya consists of the following kingdoms: Protista, Fungi, Plantae and Animalia. All kingdoms are eukaryotes and consist of complex, eukaryotic cells containing nucleus and other membrane-bound organelles.



9. What are the characteristics and major groups of Kingdom Protista?

Ans. Introduction to Kingdom Protista

Kingdom Protista includes eukaryotes which are unicellular or colonial or filamentous or simple multicellular. Simple multicellular means that they do not have multicellular sex organs.

There are three types of protists.

Major Groups of Protists

1. Protozoa – Animal-like Protists

The group Protozoa includes animal-like protists. They are unicellular and are heterotrophic. Examples are Paramecium, Amoeba, Plasmodium, and Trypanosoma.

2. Algae – Plant-like Protists

The group Algae includes plant-like protists. They have cell walls made of cellulose. They have chlorophyll and are autotrophs. Examples include Euglena, diatoms.

3. Myxomycota and Oomycota – Fungi-like Protists

The groups Myxomycota and Oomycota include fungi-like protists. They have hyphae-like structure and are saprophytic e.g., slime molds and water molds.

Certain protists are parasitic and cause diseases like malaria (*Plasmodium*), amoebic dysentery (*Entamoeba histolytica*), and sleeping sickness (*Trypanosoma*).

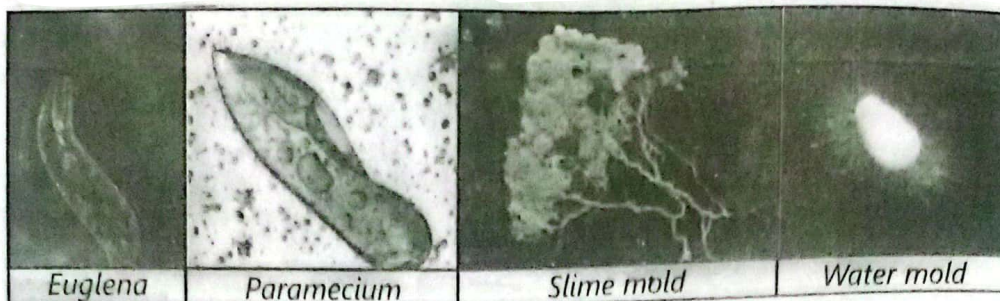


Fig. 1.6: Common protists



10. Explain the main characteristics and classification of Kingdom Fungi.

Ans. Introduction to Fungi

Fungi are eukaryotic, heterotrophic organisms that are unicellular or multicellular. Their cells are covered by cell wall made of chitin (a polysaccharide). Fungi get nutrients in a unique way. They do not ingest food like animals and some protists. They absorb food from surroundings. Examples are mushrooms, rusts, smuts and molds.

Some fungi are used in the production of bread, cheese and beer. Others have medicinal properties, such as penicillin, an antibiotic derived from the fungus *Penicillium*.

Major Groups of Fungi

The following are the major groups of fungi:

1. Zygomycota

Zygomycota includes the fungi which lack septa in their hyphae. Examples are *Rhizopus* (bread molds), which grow on moist bread, fruits etc.

2. Ascomycota

Ascomycota includes the largest groups of fungi. They have septate hyphae. Examples include common molds, morels, truffles, cup fungi, *Neurospora* and yeasts.

There are about 100,000 known species of fungi. Most of the Ascomycetes are found in lichens and some are found in mycorrhizae.

3. Basidiomycota

Basidiomycota includes the fungi with septate hyphae. Examples are mushrooms, toadstools, puffballs, jelly fungi and bracket/shelf fungi, rusts and smuts.



Smut fungi on leaf

Toadstool

Bracket fungi

Sweet Tooth Fungi

Fig. 1.7: Common fungi



11. Discuss the structure, characteristics, and major groups of Kingdom Plantae.

Ans. Introduction to the Plant Kingdom

It includes plants which are eukaryotic, multicellular organisms with cell walls made of cellulose. They are autotrophic and prepare food through photosynthesis. All plants develop from embryos. Examples are mosses, ferns, conifers and flowering plants.

Major Groups of Plants

Plants are divided into two major groups:

1. Nonvascular Plants (Bryophytes)

Nonvascular plants or bryophytes lack conducting tissues (xylem and phloem). Examples include liverworts, hornworts, and mosses.

2. Vascular Plants

Vascular plants have conducting tissues. Vascular plants are of two types i.e., seedless plants (e.g., ferns) and seed plants (e.g., conifers and flowering plants).



Fig. 1.8. Major Groups of Kingdom Plantae



12. Discuss the structure, characteristics, and major groups of Kingdom Plantae.

Ans. The table 1.2 below compares the major characteristics of the kingdoms under the three domains: Bacteria, Archaea, and Eukarya.

Table 1.2 Comparison of characteristics of the kingdoms of three domains

Domain	Bacteria	Archaea	Eukarya			
Kingdom	Monera	Monera	Protista	Fungi	Plantae	Animalia
Cell Type	Prokaryotic	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Nuclear Envelope	Absent	Absent	Present	Present	Present	Present
Presence of Cell Wall	In all	In all	In some	In all	In all	Absent
Composition of Cell Wall	Peptidoglycan	Various chemicals	Various chemicals	Chitin	Cellulose and other polysaccharides	No Cell wall
Mode of Nutrition	Autotroph or heterotroph	Autotroph or heterotroph	Photosynthetic or heterotroph or combination	Absorptive heterotroph	Photosynthetic autotrophs	Ingestive heterotroph
Multicellularity	Absent	Absent	Absent in most forms	Present in most forms	Present in all forms	Present in all forms

1. **What kind of organisms are included in the domain Eukarya?**
 A. Only bacteria
 B. Only unicellular organisms
 C. Only animals
 D. All organisms with eukaryotic cells ✓
2. **Kingdom Protista includes:**
 A. Only multicellular animals
 B. Only unicellular bacteria
 C. Unicellular, colonial, or simple multicellular eukaryotes ✓
 D. Viruses
3. **Which group of protists is animal-like?**
 A. Algae
 B. Protozoa ✓
 C. Myxomycota
 D. Oomycota
4. **Which of the following is NOT a protozoan?**
 A. Paramecium
 B. Amoeba
 C. Diatoms ✓
 D. Plasmodium
5. **What do plant-like protists possess?**
 A. No cell wall
 B. Chitin in the wall
 C. Cell walls made of cellulose and chlorophyll ✓
 D. No chloroplasts
6. **Which group of protists includes slime molds?**
 A. Algae
 B. Protozoa
 C. Myxomycota ✓
 D. Diatoms
7. **Zygomycota fungi lack:**
 A. Nucleus
 B. Chitin
 C. Septa in hyphae ✓
 D. Hyphae
8. **Which group includes rusts and smuts?**
 A. Ascomycota
 B. Zygomycota
 C. Myxomycota
 D. Basidiomycota ✓
9. **All plants develop from:**
 A. Spores
 B. Buds
 C. Embryos ✓
 D. Hyphae
10. **Which plant group lacks vascular tissues?**
 A. Angiosperms
 B. Gymnosperms
 C. Bryophytes ✓
 D. Ferns
11. **Which kingdoms show multicellularity in all forms?**
 A. Protista and Fungi
 B. Plantae and Animalia ✓
 C. Bacteria and Archaea
 D. Fungi and Protista



1. **What kingdoms are included in domain Eukarya?**

Ans. Eukarya consists of kingdoms Protista, Fungi, Plantae and Animalia. It includes all eukaryotes which consist of complex, eukaryotic cells containing nucleus and other membrane-bound organelles.

2. **What type of organisms does Kingdom Protista include?**

Ans. Kingdom Protista includes eukaryotes which are unicellular or colonial or filamentous or simple multicellular. Simple multicellular means that they do not have multicellular sex organs.

3. **Name the three major groups of protists.**

Ans. The three major groups of protists are Protozoa, Algae, and Fungi-like protists (Myxomycota and Oomycota).

4. **Describe the group Protozoa.**

Ans. The group Protozoa includes animal-like protists. They are unicellular and are heterotrophic. Examples are Paramecium, Amoeba, Plasmodium, and Trypanosoma.

5. **Describe the group Algae.**

Ans. The group Algae includes plant-like protists. They have cell walls made of cellulose. They have chlorophyll and are autotrophs. Examples include Euglena and diatoms.

6. **What are fungi-like protists?**

Ans. The groups Myxomycota and Oomycota include fungi-like protists. They have hyphae-like structure and are saprophytic e.g., slime molds and water molds.

7. **What are the characteristics of Kingdom Fungi?**

Ans. Fungi are eukaryotic, heterotrophic organisms that are unicellular or multicellular. Their cells are covered by cell wall made of chitin (a polysaccharide). Fungi get nutrients in a unique way. They do not ingest food like animals and some protists. They absorb food from surroundings. Examples are mushrooms, rusts, smuts and molds.

8. **Name the major groups of fungi.**

Ans. The major groups of fungi are Zygomycota, Ascomycota, and Basidiomycota.

9. **What is Zygomycota? Give examples.**

Ans. Zygomycota includes the fungi which lack septa in their hyphae. Examples are Rhizopus (bread molds), which grow on moist bread, fruits etc.

10. **What is Ascomycota? Give examples.**

Ans. Ascomycota includes the largest groups of fungi. They have septate hyphae. Examples include common molds, morels, truffles, cup fungi, Neurospora and yeasts.

11. **What is Basidiomycota? Give examples.**
Ans. Basidiomycota includes the fungi with septate hyphae. Examples are mushrooms, toadstools, puffballs, jelly fungi and bracket/shelf fungi, rusts and smuts.
12. **What are the characteristics of Kingdom Plantae?**
Ans. Kingdom Plantae includes plants which are eukaryotic, multicellular organisms with cell walls made of cellulose. They are autotrophic and prepare food through photosynthesis. All plants develop from embryos. Examples are mosses, ferns, conifers and flowering plants.
13. **Into how many major groups are plants divided?**
Ans. Plants are divided into two major groups: Nonvascular plants or bryophytes, and vascular plants.
14. **What are nonvascular plants? Give examples.**
Ans. Nonvascular plants or bryophytes lack conducting tissues (xylem and phloem). Examples include liverworts, hornworts, and mosses.
15. **What are vascular plants?**
Ans. Vascular plants have conducting tissues. Vascular plants are of two types i.e., seedless plants (e.g., ferns) and seed plants (e.g., conifers and flowering plants).
16. **What type of cells do Bacteria and Archaea have?**
Ans. Both Bacteria and Archaea have prokaryotic cells.
17. **Which kingdoms have a nuclear envelope in their cells?**
Ans. Protista, Fungi, Plantae, and Animalia have a nuclear envelope.
18. **Which kingdom under domain Eukarya lacks a cell wall?**
Ans. Animalia lacks a cell wall.
19. **What is the composition of the cell wall in Fungi?**
Ans. The cell wall in fungi is composed of chitin.
20. **Which kingdoms exhibit multicellularity in all forms?**
Ans. Plantae and Animalia exhibit multicellularity in all forms.
21. **Which domain includes organisms with peptidoglycan in their cell walls?**
Ans. The domain Bacteria includes organisms with peptidoglycan in their cell walls.
22. **What is the mode of nutrition in kingdom Animalia?**
Ans. The mode of nutrition in Animalia is ingestive heterotroph.
23. **Which kingdoms include organisms that are always unicellular?**
Ans. Bacteria and Archaea (Monera) include organisms that are always unicellular.
24. **What is the composition of the cell wall in Plantae?**
Ans. It is composed of cellulose and other polysaccharides.
25. **Which kingdom includes both autotrophs and heterotrophs or a combination?**
Ans. Kingdom Protista includes organisms that are photosynthetic, heterotrophic, or a combination of both.

1.4 CLASSIFICATION OF KINGDOM ANIMALIA

Kingdom Animalia

Definition: The kingdom of eukaryotes (includes animals) which are eukaryotic, multicellular and heterotrophic is called animalia. They develop from embryos. They ingest food and digest it within their bodies.

Classification of Kingdom Animalia

The kingdom Animalia is broadly divided into the following phyla:

PHYLUM PORIFERA



13. Describe the general characteristics of Phylum Porifera.

Ans. Habitat and Examples:

This phylum contains sponges. Most of them are marine while some live in freshwaters. *Leucosolenia* and *Euplectella* (Venus' flower basket) are marine sponges. *Spongilla* is a common freshwater sponge.

A commercial sponge is prepared by drying, beating, and washing a sponge until all cells are removed.

Body Symmetry and Organization:

Sponges do not have tissue level organization. Most sponges are asymmetrical but some have radial symmetry. They do not have nervous system.

Body Structure:

There are numerous pores in body wall called ostia. Through ostia, water enters the body. The larger pore through which water leaves the body is called osculum.

Body Layers:

The outer layer of body is made of thin, flat cells called pinacocytes. The second layer is jelly-like and is called mesohyle. It contains amoeboid cells. The third layer, which lines the spongocoel, is made of choanocytes or collar cells.

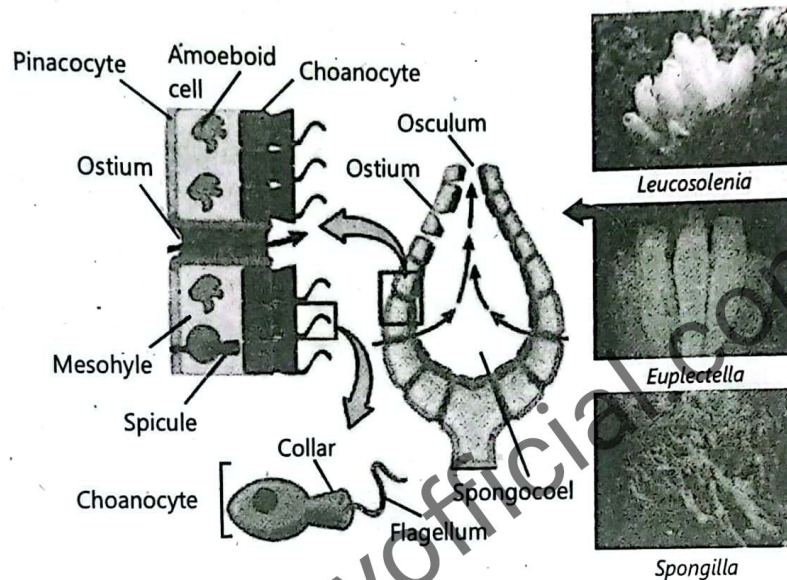


Fig. 1.9: Representative sponges and general structure

Skeletal Support:

They have skeleton in the form of minute needles of calcium carbonate or silica.

Asexual Reproduction:

Most sponges reproduce asexually by budding or regeneration. Some sponges form resistant capsules, called gemmules. When parent sponge dies, it releases its gemmules. In favourable environment, amoeboid cells come out of the gemmules and form a new sponge.

PHYLUM CNIDARIA



14. Describe the general characteristics of Phylum Cnidaria.

Ans. Habitat and Examples:

Almost all cnidarians are marine, although a few are found in freshwater e.g., hydra and jellyfish. Most cnidarians are colonial e.g., obelia, corals, sea fans etc.

Sessile and Motile Forms:

Most of them are sessile e.g., hydra, coral, obelia etc. Some cnidarians are motile e.g., jellyfish.

Symmetry and Tissue Layers:

They are radially symmetrical animals and are diploblastic. It means that the adult body contains two tissue layers i.e., the epidermis and the gastrodermis, derived from ectoderm and endoderm respectively.

Mesoglea:

Between the epidermis and gastrodermis, a jelly-like mesoglea is present. It contains amoeboid cells that have originated either from ectoderm or endoderm.

Corals are colonial cnidarians. They produce hard exoskeleton of Calcium carbonate. The skeleton makes coral islands and coral reefs.



Coral reef

Cnidocytes and Nematocysts:

They possess special cells, called cnidocytes. A cnidocyte contains a special organelle, called nematocyst. Nematocysts defend the body and capture prey.

Digestive System:

Cnidarians have a blind-ending cavity, called gastrovascular cavity or enteron. It opens outside by a single opening, the mouth. Mouth also acts as anus for the removal of undigested material. Mouth is surrounded by a series of projections, called tentacles. This type of digestive system in which there is a single opening for the entry of food and removal of undigested matter is called sac-like digestive system.

Nervous and Other Systems:

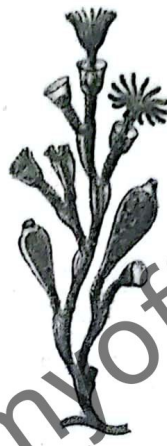
The nervous system is in the form of a network of neurons in the body wall. There is no central nervous system (brain and spinal cord). They do not have respiratory, excretory and transport systems.

Body Forms and Reproduction:

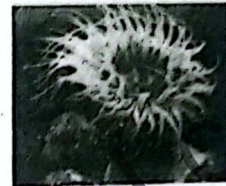
There are two body forms in cnidarians i.e., polyps and medusae. Polyps are cylindrical and are attached to a substrate at the aboral end. They reproduce asexually. Medusae are umbrella-like and are free-swimming. They reproduce sexually.



Hydra



Obelia



Sea anemone



Jellyfish

Fig. 1.10: Representative cnidarians

PHYLUM PLATYHELMINTHES



15. Describe the general characteristics of Phylum Platyhelminthes.

Ans. Common Name and Body Structure:

They are called "flatworms". They are unsegmented and body is soft and dorsoventrally compressed.

Habitat and Examples:

Most of them are free-living e.g., planaria. Some are endoparasites of humans and other animals e.g., liver fluke, tapeworm, and blood-fluke.

Tissue Layers and Symmetry:

They are triploblastic i.e., the tissues of the body are derived from three embryonic layers; ectoderm, mesoderm and endoderm. They are acoelomates. A loose connective tissue called parenchyma fills space between the body wall and body organs.

They have bilateral symmetry with distinct left and right sides as well as dorsal and ventral sides.

Circulatory and Respiratory Systems:

They do not have respiratory and circulatory (transport) systems.

Excretory System:

They have a network of tubular protonephridia. These tubules have numerous branches. Each branch ends in a bulb-like cell called flame cell. The cilia of flame cells beat to suck surrounding fluid into the tubules. The tubules filter the waste materials from fluid and release them out of body wall through a small opening called a nephridiopore.

Nervous System:

They have a network of neurons. There are cerebral ganglia in the anterior end (head). These ganglia are attached to longitudinal nerve cords that are interconnected across the body by transverse branches. Most free-living flatworms have two simple eyespots at their anterior end.

Reproduction:

Flatworms reproduce asexually by "fission" in which the animal constricts in the middle and then divides into two pieces. Each piece then regenerates the missing part. The sexually-reproducing flatworms are hermaphrodites (bisexual).



Fig. 1.11: Representative flatworms

PHYLUM NEMATODA



16. Describe the general characteristics of Phylum Nematoda.

Ans. Body Structure and Habitat

They are roundworms with elongated worm-like (round) body with pointed ends. Some roundworms are free-living (in water and soil) e.g., *Caenorhabditis elegans*. Many are parasites e.g., ascaris, hookworm, pinworm, and whipworm.

Symmetry and Body Organization

They are triploblastic, bilateral symmetrical, and possess unsegmented body.

Coelom and Digestive System

They are pseudocoelomates because they possess a false body cavity called pseudocoelom filled with fluid. They possess tube-like digestive system. It consists of an alimentary canal with two openings; mouth at anterior end and anus at posterior end. The parasitic roundworms have simplified digestive systems.

The pseudocoelomates are classified into seven phyla. These phyla are grouped as a unit called Aschelminths. Phylum Nematoda is the representative phylum of this group.

Excretory System

Their excretory system consists of protonephridia and two excretory canals, which unite at the anterior end to form a single canal. The single canal then opens outside through a nephridiopore on the ventral surface.

Nervous System and Sensory Organs

They possess a network of neurons in body. There is a nerve ring around the pharynx, which is attached to four longitudinal nerve cords. They have raised hair-like sense organ called sensory papillae, present on lips.

Circulatory and Respiratory Systems

They do not have defined respiratory and circulating systems.

Reproductive System

They are unisexual i.e.; male nematodes have testes and female nematodes have ovaries.

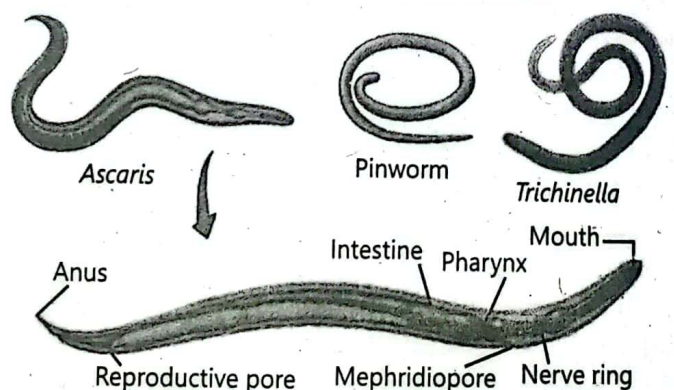


Fig. 1.12: Representative roundworms and general structure

PHYLUM MOLLUSCA



17. Describe the body structure and systems of organisms in Phylum Mollusca.

Ans. Body Structure and Habitat

Molluscs have soft un-segmented bodies. They are widely distributed in natural habitats. Some of them are exclusively aquatic e.g., mussels, octopus and oyster. The others live in moist places e.g., land snail.

Symmetry and Body Organization

Molluscs are triploblastic and have bilateral symmetry. They possess true coelom. Among coelomates, they are included in the group called protostomes.

Body Division and Mantle Structure

Their body can be divided into three parts i.e., head, visceral mass (contains organs of digestion, excretion and reproduction), and foot (attached with visceral mass). They have an epithelial envelope around the visceral mass, called as mantle. The space between mantle and visceral mass is called as mantle cavity. In most molluscs, the outer surface of mantle secretes a calcareous shell.

In open-type system, the blood does not retain the vessel. Rather, it directly bathes cells in tissue spaces (sinuses).

Feeding Organ

All molluscs (except bivalvia) have a rasping tongue-like organ, called radula.

Circulatory System

All of them (except cephalopods) have open type blood circulatory system. Their heart consists of a single ventricle and two auricles.

Digestive and Excretory Systems

They possess tube-like digestive system in which the gut has two openings, i.e., mouth and anus. Their excretory system consists of paired tubular structures called nephridia. Wastes are gathered from sinuses and discharged into coelom around the heart. The nephridia open in this coelom. They have tiny cilia around their openings, which move the fluid from coelom into the nephridia. Nephridia discharge waste materials in mantle cavity, from where they are expelled out.

Respiratory System

In molluscs, gills work for the exchange of gases.

Nervous System

They have three pairs of interconnected ganglia present in the head, visceral mass and foot. The ganglia are interconnected by means of nerve cord.

Locomotion and Reproduction

They move with the help of muscular foot. Some molluscs are sessile. Most molluscs are unisexual.

Class Gastropoda



Slug



Garden snail

Class Bivalvia



Freshwater mussel



Oyster

Class Cephalopoda



Cuttlefish



Octopus

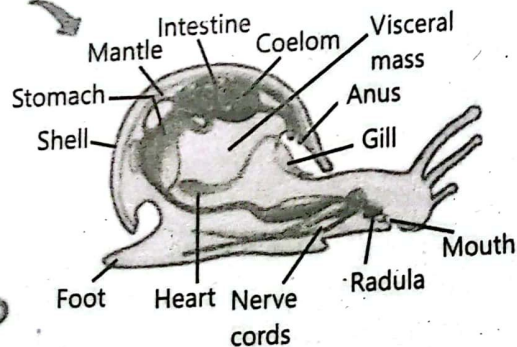


Fig. 1.13: Representative molluscs and general structure

PHYLUM ANNELIDA



18. Explain the structure and systems of organisms in Phylum Annelida.

Ans. Habitat and Examples

Annelids are commonly called segmented worms. They are found in marine water (e.g., *nereis*), freshwater (e.g., leech), and in damp soil (e.g., earthworm). Some annelids are ectoparasites e.g., leeches.

Segmentation and Symmetry

Their body is divided transversely into a number of similar parts called segments. Internally, the segments are separated from each other by cross walls called septa. Each segment is provided with its own circulatory, excretory and neural elements. This type of segmentation in body is called metameric segmentation. Annelids are bilaterally symmetrical and triploblastic. They are protostome coelomates.

The segments are indicated externally by constrictions of the body surface in the form of little rings ("Annelid" means "littlering").

Special Structures: Setae and Cuticle

Annelids have special parts called setae. Setae are chitinous bristles in the ventral wall of each segment. Setae are absent in leeches. Their body wall is surrounded by a moist, acellular cuticle secreted by epidermis.

Digestive System

They possess tube-like digestive system. The digestive tube is divided into distinct parts, each performing a specific function. The parasitic annelids have simplified digestive system.

Excretory System

Their excretory system consists of ciliated, funnel-shaped metanephridia. Each segment has one pair of metanephridia.

Circulatory System

They possess a closed-type circulatory system. Blood always flows in blood vessels. They have specialized pulsating blood vessels (pseudohearts). Blood of most annelids has respiratory pigment, haemoglobin, dissolved in blood plasma.

Respiratory System

Gaseous exchange occurs through the skin.

Nervous System

There is a cerebral ganglion or brain in the anterior segment. A double, longitudinal ventral nerve cord arises from brain and gives nerves in each segment. Ganglia are also present in each segment.

Sensory Organs

They have tactile receptors, chemoreceptors, balance receptors, and photoreceptors. Some annelids also have well-developed eyes with lenses.

Reproductive System

Most annelids are hermaphrodite (e.g., earthworm, leech) and some are unisexual (e.g., *nereis*).

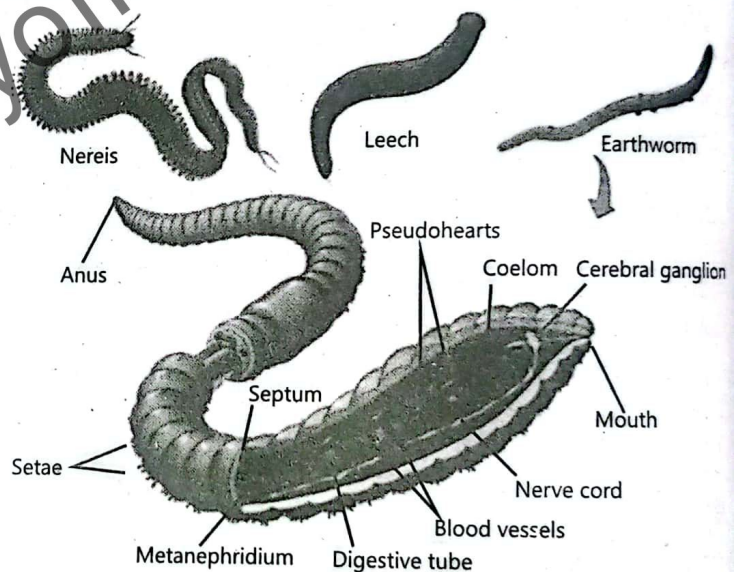


Fig. 1.14: Representative annelids and general structure

PHYLUM ARTHROPODA



19. Describe the characteristics of Phylum Arthropoda.

Ans. Diversity and Habitat

Diverse groups such as insects, crustaceans, spiders, scorpions, and centipedes are included in this phylum. They are found in every type of habitat. Many of terrestrial members can also fly.

Body Structure and Symmetry

They are triploblastic, bilateral symmetrical, protostome coelomates. The coelom is reduced and is present only around reproductive and excretory systems. They have jointed appendages.

Arthropods are the most successful of all invertebrates. About 900,000 species –two thirds of all the named species on Earth arthropods.

which are modified for specialized functions e.g., running, crawling swimming, capturing prey, respiration, reproduction etc.

Mouth Parts and Body Segmentation

In different arthropods, the jointed appendages around the mouth, are modified in different ways and form mouth parts. The body is segmented. Some segments are fused to form specialized body regions called tagmata. These include head, thorax and abdomen.

Exoskeleton and Ecdysis

They have exoskeleton or cuticle, which is secreted by the epidermis of body wall. It is made chiefly of chitin. In young arthropods, exoskeleton is shed from time to time. After shedding the exoskeleton, the animal grows at a fast rate and then re-secretes new exoskeleton. This process is called ecdysis or molting.

Circulatory System

They possess open-type circulatory system. Most of the time, blood flows in hemocoel, which is derived from an embryonic cavity called blastocoel. Their blood is colourless as it is without haemoglobin and is known as haemolymph.

Respiratory System

Most arthropods possess a respiratory system that consists of air tubes called trachea. Main tracheal tubes open out through openings called spiracles. Aquatic arthropods respire through gills.

Digestive System

Arthropods have tube-like digestive system. The alimentary canal is divided into different parts.

Excretory System

Their excretory system comprises of Malpighian tubules. These are narrow tubules projected from the alimentary canal, attached at the junction of midgut and hindgut. The nitrogenous wastes are excreted in the form of solid uric acid crystals.

Nervous System

They have well-developed central nervous system with three fused pairs of cerebral ganglia (brain) in head. There is a double ventral nerve cord which has ventral ganglia in each segment. Smaller nerves arise from ventral ganglia in each segment.

Sense Organs and Movement

They have well developed compound eyes and antennae. They can swim, crawl or fly depending on their habitat.

Reproduction and Examples

They are unisexual. Important arthropods include insects (e.g., mosquito, butterfly, moth, wasp, beetles, grasshopper), crabs, lobsters, prawn, shrimps, crayfishes, spider, tick, mite, scorpion, centipedes and millipedes.

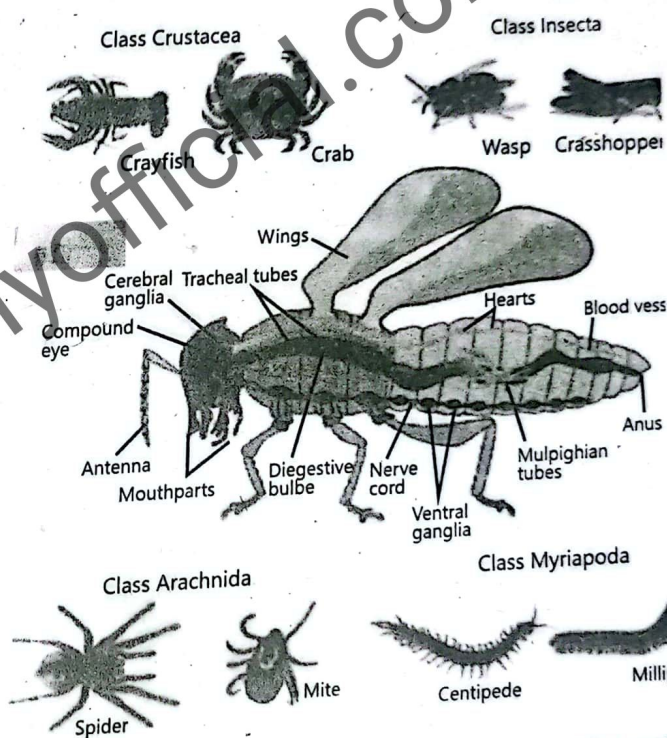


Fig. 1.15: Representative arthropods and general structure

PHYLUM ECHINODERMATA



20. Describe the characteristics of Phylum Echinodermata.

Ans. Habitat and Body Forms

They are exclusively marine animals. Some are flattened like biscuit (e.g., cake urchin), some are star-shaped with short arms (e.g., sea star or starfish), some are globular (e.g., sea urchin), some are star-shaped with long arms (e.g., brittle star), and some are elongated (e.g., sea cucumber).

Symmetry and Body Structure

They are triploblastic and deuterostomes coelomates. Their larvae are bilateral symmetrical but the adults show radial symmetry. In their radial symmetry, the body parts are arranged in five, or multiple of five, around an oral-aboral axis.

Endoskeleton

They possess a calcareous endoskeleton in the form of plates called ossicles. These plates are derived from mesoderm but come out of skin also and make spines on the skin.

Water-Vascular System

They have water-vascular system consisting of tubes and spaces present in the coelom. A ring canal surrounds the mouth. It opens outside through a sieve-like plate, called madreporite. Five (or a multiple of five) radial canals branch from the ring canal. Many lateral canals emerge from each radial canal and each lateral canal ends at a tube foot.

Tube Feet Function

Tube feet are the extensions of water vascular system. The tube feet extend and attach with some substrate. When water is drawn back from the sucked tube feet, they contract.

Digestive System

The mouth leads to oesophagus, stomach, intestine and rectum. The rectum opens out through anus.

Respiration and Excretion

There are no specialized organs for respiration and excretion.

Nervous System and Sensory Receptors

They possess a poorly developed nervous system made of a nerve net, a nerve ring, and five (or multiple of five) radial nerves. Most sensory receptors are distributed over the surface of the body and tube feet.

Reproduction

Asexual reproduction involves division of the body, followed by the regeneration of each half. Echinoderms are unisexual.

Many echinoderms are able to regenerate the lost parts, and some, especially sea stars and brittle stars, drop various parts when they are under attack and then regenerate the lost parts.

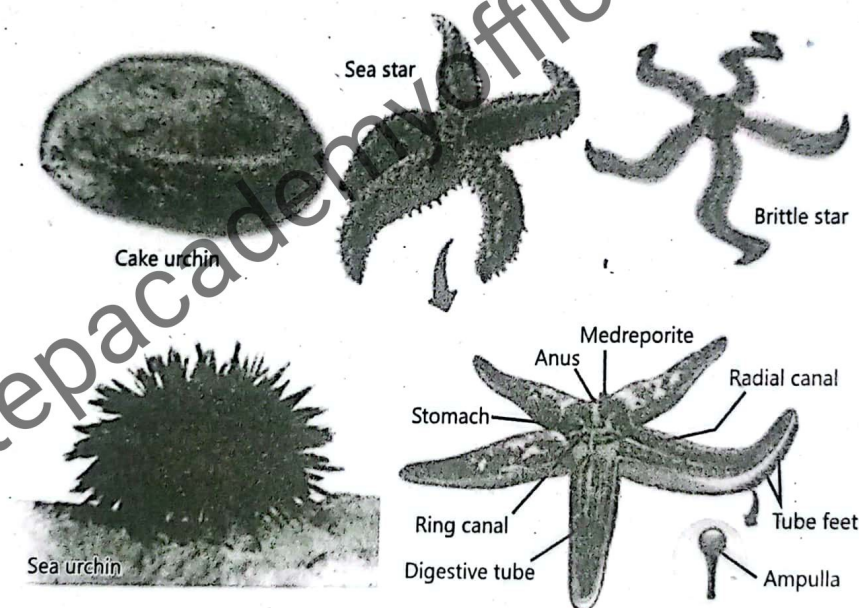


Fig. 1.16: Representative echinoderms and general structure

PHYLUM CHORDATA



21. Describe the general characteristics of Phylum Chordata.

Ans. General Characteristics

Chordates are bilateral symmetrical, triploblastic, deuterostome coelomates.

Unique Features

The following four characteristics are unique to chordates, present at some stage in development:

Notochord:

All chordates develop notochord during embryonic life. It is a rod-like semi rigid body of vacuolated cells. It extends throughout the length of body between gut and dorsal nerve cord. The lower chordates retain this notochord throughout life. While, in vertebrates it is partly or entirely replaced by vertebral column, during development.

Pharyngeal Slits:

These are a series of openings in the lateral walls of pharynx. All chordates develop paired gill slits in embryonic stage. In some chordates (e.g., Amphioxus and fishes), these develop into gills. In some (e.g., most amphibians), these are functional for some period in their life history. In others (e.g., reptiles, birds and mammals), these are modified for various purposes.

Tubular Nerve Cord:

In all chordates, a tubular nerve cord runs through the longitudinal axis of the body, just dorsal to the notochord. It expands anteriorly as a brain.

Post-Anal Tail:

All chordates develop a tail, posteriorly beyond the anal opening. Some chordates retain it throughout life while others degenerate it during embryonic life.

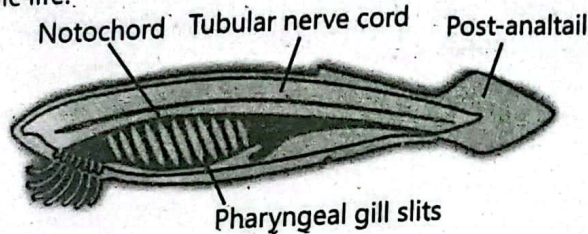


Fig. 1.17: Diagnostic characters of chordates



22. Explain the classification of Phylum Chordata into major groups.

Ans. Major Groups of Chordates

Phylum chordata includes two major groups i.e., invertebrate chordates and vertebrates.

Subphylum Urochordata

Subphylum Urochordata includes the invertebrates chordates in which notochord and nerve cord are present only in their free-swimming larvae. Sea squirts are the examples of urochordates.

Subphylum Cephalochordata

Subphylum Cephalochordata includes the invertebrate chordates in which notochord persists throughout life. Amphioxus is a common cephalochordate.



Fig. 1.18: Sea squirts



Fig. 1.19: Amphioxus



1. Which of the following kingdoms includes animals that are eukaryotic, multicellular, and heterotrophic?

- A) Plantae
- B) Protista
- C) Animalia ✓
- D) Fungi

2. In which phylum do sponges belong?

- A) Cnidaria
- B) Platyhelminthes
- C) Mollusca
- D) Porifera ✓

3. What type of symmetry is mostly found in sponges?

- A) Bilateral
- B) Radial

4. What are the small pores on a sponge's body wall called?

- A) Ostia ✓
- B) Oscula
- C) Choanocytes
- D) Mesohyle

5. What is the name of the large pore through which water exits a sponge's body?

- A) Pinacocyte
- B) Ostia
- C) Mesohyle
- D) Osculum ✓

6. Which cells form the inner layer or the sponge's body cavity?

- A) Pinacocytes
B) Amoeboid cells
C) Choanocytes ✓
D) Nematocysts

7. Which of the following is a freshwater sponge?

- A) Leucosolenia
B) Euplectella
C) Spongilla ✓
D) Obelia

8. What substance forms the skeleton of most sponges?

- A) Cellulose
B) Silica or calcium carbonate ✓
C) Keratin
D) Chitin

9. What are gemmules?

- A) Feeding structures
B) Reproductive organs
C) Resistant capsules for asexual reproduction ✓
D) Excretory structures

Phylum Cnidaria

10. Which phylum contains organisms like hydra, jellyfish, and corals?

- A) Porifera
B) Cnidaria ✓
C) Platyhelminthes
D) Mollusca

11. What type of symmetry is found in cnidarians?

- A) Bilateral
B) Radial ✓
C) Asymmetrical
D) None

12. What are cnidocytes?

- A) Muscle cells
B) Digestive cells
C) Stinging cells ✓
D) Reproductive cells

13. What organelle is found in cnidocytes?

- A) Flagellum
B) Chloroplast
C) Nematocyst ✓
D) Contractile vacuole

14. What type of digestive system is present in cnidarians?

- A) Complete
B) Sac-like ✓
C) Incomplete with anus
D) External digestion

15. What type of body forms are found in cnidarians?

- A) Polyp and medusa ✓
B) Amoeboid and spherical
C) Flat and round.
D) None of these

16. Which of the following cnidarians is freshwater?

- A) Coral
B) Obelia
C) Jellyfish
D) Hydra ✓

17. What type of nervous system is found in cnidarians?

- A) Centralized with brain.
B) None
C) Nerve net ✓
D) Nerve cord

18. How do medusae reproduce?

- A) Asexually
B) Sexually ✓
C) By budding
D) By gemmules

3. Phylum Platyhelminthes

19. Which phylum includes flatworms like tapeworm and liver fluke?

- A) Annelida
B) Platyhelminthes ✓
C) Cnidaria
D) Arthropoda

20. What type of body symmetry do flatworms show?

- A) Radial
B) Spherical
C) Bilateral ✓
D) Asymmetrical

21. Flatworms are:

- A) Diploblastic
B) Triploblastic ✓
C) Monoblastic
D) None

22. Flatworms lack a:

- A) Nervous system
B) Skeletal system
C) Circulatory and respiratory system ✓
D) Digestive system

23. What are flame cells in flatworms used for?

- A) Digestion
B) Movement
C) Excretion ✓
D) Respiration

24. The flatworm nervous system includes:

- A) Brain and spinal cord
B) Nerve net
C) Cerebral ganglia and longitudinal nerve cords ✓
D) None of the above

25. What type of reproduction occurs in free-living flatworms?

- A) Asexual by budding
B) Asexual by fission ✓
C) Only sexual
D) None

26. What type of reproduction is shown by most sexually reproducing flatworms?

- A) Asexual
B) External fertilization
C) Hermaphroditism ✓
D) Parthenogenesis

27. What fills the space between body wall and organs in flatworms?

- A) Blood
B) Parenchyma ✓
C) Coelom
D) Water

28. Which of the following flatworms is free-living?

- A) Liver fluke
B) Blood fluke
C) Tapeworm
D) Planaria ✓

29. What is the function of the cilia in flame cells?

- A) Capture prey
B) Digest food
C) Move waste fluids ✓
D) Provide insulation

30. What structure allows communication between nerve cords in flatworms?

- A) Axons
B) Dendrites
C) Transverse branches ✓
D) Myelin sheaths

4. Phylum Nematoda

31. Which body shape is typical of organisms in Phylum Nematoda?

- A) Flat and segmented
B) Round and pointed at ends ✓
C) Cylindrical and branched
D) Spherical

32. Which of the following is a free-living nematode?

- A) Hookworm
B) Pinworm
C) Ascaris
D) *Caenorhabditis elegans* ✓

33. Which symmetry is found in roundworms?

- A) Radial
B) Asymmetrical
C) Bilateral ✓
D) Spherical

34. What type of body cavity do nematodes possess?
 A) Acoelom B) True coelom
 C) Pseudocoelom ✓ D) No cavity
35. What type of digestive system is present in nematodes?
 A) Incomplete B) Sac-like
 C) Tube-like with two openings ✓ D) No digestive system
36. What is the excretory opening in nematodes called?
 A) Anus B) Nephridium
 C) Nephridiopore ✓ D) Pore canal
37. Where is the nerve ring located in nematodes?
 A) Around the intestine
 B) Around the pharynx ✓

Phylum Mollusca

41. What type of body do molluscs possess?
 A) Segmented B) Soft unsegmented ✓
 C) Hard and spiny D) Pseudocoelomic
42. Which mollusc lives in moist places?
 A) Mussel B) Oyster
 C) Land snail ✓ D) Octopus
43. Molluscs have what type of symmetry?
 A) Radial B) Bilateral ✓
 C) Asymmetrical D) None
44. Molluscs belong to which group among coelomates?
 A) Deuterostomes B) Acoelomates
 C) Protostomes ✓ D) Pseudocoelomates
45. Which structure surrounds the visceral mass in molluscs?
 A) Foot B) Shell
 C) Mantle ✓ D) Head
46. What is the mantle cavity?
 A) Fluid-filled coelom
 B) Space between head and foot
 C) Space between mantle and visceral mass ✓
 D) Digestive sac
47. Which mollusc group lacks a radula?
 A) Gastropods B) Bivalvia ✓
 C) Cephalopods D) All of them
48. The molluscan heart has how many auricles?

- C) Around the anus
 D) Around the excretory canal
38. Which sense organs are found on the lips of nematodes?
 A) Eyes B) Antennae
 C) Sensory papillae ✓ D) Statocysts
39. Nematodes lack which of the following systems?
 A) Digestive B) Nervous
 C) Circulatory and Respiratory ✓
 D) Excretory
40. Which term describes the sex of nematodes?
 A) Hermaphrodite B) Unisexual ✓
 C) Asexual D) Bisexual

- A) One B) Two ✓
 C) Three D) Four
49. How do molluscs excrete waste?
 A) Through anus
 B) Through mantle cavity ✓
 C) Through gills D) Through skin
50. What helps in movement of fluid into the nephridia?
 A) Tentacles B) Setae
 C) Cilia ✓ D) Papillae
51. Which structure aids respiration in molluscs?
 A) Skin B) Lungs
 C) Gills ✓ D) Book lungs
52. Where are the ganglia located in molluscs?
 A) Only in foot
 B) Head, visceral mass, and foot ✓
 C) Only in visceral mass D) Only in mantle
53. Which organ helps molluscs in locomotion?
 A) Cilia B) Shell
 C) Muscular foot ✓ D) Antennae
54. What type of reproduction is mostly observed in molluscs?
 A) Asexual B) Hermaphrodite
 C) Unisexual ✓ D) Budding

Phylum Annelida

55. What is the common name for annelids?
 A) Flatworms B) Roundworms
 C) Segmented worms ✓ D) Shell animals
56. Which annelid is found in damp soil?
 A) Leech B) Nereis
 C) Earthworm ✓ D) Octopus
57. What separates the internal segments of annelids?
 A) Cuticle B) Septa ✓
 C) Gills D) Membranes
58. What is metameric segmentation?
 A) External segmentation only
 B) Uniform segmentation with repeated organs ✓
 C) Pseudocoelomic division

- D) Asymmetrical division
59. What are setae made of?
 A) Protein B) Muscle
 C) Chitin ✓ D) Bone
60. Which annelid lacks setae?
 A) Earthworm B) Leech ✓
 C) Nereis D) Polychaetes
61. What type of circulatory system do annelids have?
 A) Open B) Closed ✓
 C) Absent D) Double-loop
62. Where does gaseous exchange occur in annelids?
 A) Gills B) Skin ✓
 C) Mantle D) Tentacles

63. What pigment is dissolved in annelid blood?
 A) Chlorophyll B) Hemocyanin
 C) Haemoglobin ✓ D) Myoglobin
64. Which type of excretory structure is present in annelids?
 A) Protonephridia B) Malpighian tubules
 C) Metanephridia ✓ D) Kidneys
65. What type of nervous system do annelids have?
 A) Nerve net
 B) Brain and longitudinal nerve cords ✓
 C) Nerve ring D) No nervous system
66. Which annelid has well-developed eyes?
 A) Earthworm B) Leech
 C) Nereis ✓ D) Snail

67. Which of the following are tactile and chemical receptors in annelids?
 A) Ganglia B) Nephridia
 C) Setae D) Sensory receptors ✓
68. Which annelids are hermaphrodite?
 A) Nereis B) Earthworm and leech ✓
 C) Snails D) Roundworms
69. Which annelid is unisexual?
 A) Earthworm B) Leech
 C) Nereis ✓ D) Planaria
70. Which body covering is secreted by annelid epidermis?
 A) Hair B) Shell
 C) Moist acellular cuticle ✓
 D) Mantle

Phylum Arthropoda

71. Which of the following groups is included in Phylum Arthropoda?
 A) Mollusks B) Jellyfish
 C) Crustaceans ✓ D) Sponges
72. What type of symmetry do arthropods exhibit?
 A) Radial B) Asymmetrical
 C) Bilateral ✓ D) None
73. Arthropods are triploblastic, which means they have:
 A) One germ layer B) Two germ layers
 C) Three germ layers ✓ D) No germ layers
74. The coelom in arthropods is:
 A) Well-developed B) Absent
 C) Present only around reproductive and excretory systems ✓
 D) Found throughout the body
75. Which of the following is NOT a function of jointed appendages in arthropods?
 A) Reproduction B) Respiration
 C) Flying D) Photosynthesis ✓
76. In arthropods, body segments may fuse to form:
 A) Spiracles B) Tagmata ✓
 C) Ossicles D) Tube feet
77. Which substance makes up the exoskeleton of arthropods?
 A) Cellulose B) Calcium carbonate
 C) Chitin ✓ D) Keratin
78. The process of shedding the exoskeleton is called:
 A) Moulting ✓ B) Budding
 C) Regeneration D) Fusion
79. Arthropod blood is called haemolymph because:
 A) It contains haemoglobin
 B) It is red in color
 C) It is green in color
 D) It lacks haemoglobin and is colourless ✓
80. Main tracheal tubes open outside through:
 A) Gills B) Spiracles ✓

- C) Setae D) Pores
81. Aquatic arthropods breathe using:
 A) Skin B) Spiracles
 C) Gills ✓ D) Lungs
82. Which excretory structure is found in arthropods?
 A) Kidneys B) Nephridia
 C) Malpighian tubules ✓ D) Flame cells
83. What waste product is excreted by arthropods?
 A) Ammonia B) Urea
 C) Uric acid ✓ D) Carbon dioxide
84. The nervous system of arthropods includes:
 A) Single nerve cord B) Nerve net only
 C) Three fused cerebral ganglia and double ventral nerve cord ✓
 D) Spinal cord
85. Which of the following is NOT an arthropod?
 A) Mosquito B) Sea cucumber ✓
 C) Spider D) Crab
86. Arthropods reproduce by:
 A) Binary fission B) Budding
 C) Asexual reproduction D) Sexual reproduction ✓
87. Hemocoel in arthropods is derived from:
 A) Coelom B) Ectoderm
 C) Blastocoel ✓ D) Endoderm
88. Which arthropods are capable of flight?
 A) Aquatic crustaceans B) Terrestrial insects ✓
 C) Spiders D) Scorpions
89. Compound eyes and antennae in arthropods are used for:
 A) Reproduction B) Respiration
 C) Movement D) Sensory functions ✓
90. Example of a unisexual arthropod group:
 A) Starfish B) Crabs ✓
 C) Sea urchin D) Hydra

Phylum Echinodermata

91. **Echinoderms live in:**
 A) Freshwater ✓ B) Soil
 C) Marine habitats only ✓ D) Terrestrial habitats
92. **Which is a star-shaped echinoderm with short arms?**
 A) Brittle star B) Starfish ✓
 C) Sea cucumber D) Sea urchin
93. **Echinoderm adults exhibit:**
 A) Bilateral symmetry B) Radial symmetry ✓
 C) Asymmetry D) No symmetry
94. **Ossicles in echinoderms are made of:**
 A) Chitin B) Cartilage
 C) Calcium carbonate ✓ D) Protein
95. **Water-vascular system opens outside through:**
 A) Spiracles B) Mouth
 C) Anus D) Madreporite ✓
96. **Tube feet function in:**
 A) Excretion only B) Feeding only
 C) Locomotion and attachment ✓
 D) Reproduction
97. **Echinoderm digestive tract opens out through:**
 A) Spiracle B) Mouth
 C) Anus ✓ D) Nephridia
98. **Which organ is absent in echinoderms?**
 A) Nervous system B) Digestive system
 C) Respiratory and excretory organs ✓
 D) Mouth
99. **The nervous system in echinoderms is:**
 A) Highly developed
 B) Made of brain and spinal cord
 C) Poorly developed with nerve ring ✓
 D) Absent
100. **Most sensory receptors in echinoderms are located on:**
 A) Stomach B) Spines

- C) Tube feet and body surface ✓
 D) Ossicles
101. **Which of these shows asexual reproduction by division and regeneration?**
 A) Insects B) Spiders
 C) Echinoderms ✓ D) Crustaceans
102. **Echinoderms are:**
 A) Bisexual B) Hermaphrodite
 C) Unisexual ✓ D) Asexual only
103. **The symmetry of echinoderm larvae is:**
 A) Radial B) Spiral
 C) Bilateral ✓ D) Spherical
104. **The radial canals in echinoderms are branches of:**
 A) Tube foot B) Digestive tract
 C) Ring canal ✓ D) Nervous ring
105. **Brittle star is an example of:**
 A) Mollusk B) Arthropod
 C) Echinoderm ✓ D) Annelid
106. **Which echinoderm is elongated in shape?**
 A) Sea urchin B) Sea cucumber ✓
 C) Starfish D) Brittle star
107. **Ossicles in echinoderms originate from:**
 A) Endoderm B) Ectoderm
 C) Mesoderm ✓ D) Coelom
108. **Function of madreporite:**
 A) Digestion B) Water intake ✓
 C) Excretion D) Reproduction
109. **Which echinoderm is globular?**
 A) Sea star B) Brittle star
 C) Sea urchin ✓ D) Sea cucumber
110. **The nervous system in echinoderms includes all EXCEPT:**
 A) Nerve ring B) Nerve net
 C) Radial nerves D) Brain and spinal cord ✓

Phylum Chordata

111. **What type of body symmetry do chordates exhibit?**
 A) Radial B) Bilateral ✓
 C) Asymmetrical D) None of the above
112. **The notochord is a:**
 A) Tubular nerve cord
 B) Semi-rigid rod of vacuolated cells ✓
 C) Part of digestive system
 D) Respiratory structure
113. **Where is the notochord located in chordates?**
 A) Below the gut B) Dorsal to the nerve cord
 C) Between gut and dorsal nerve cord ✓
 D) Ventral to the heart
114. **In vertebrates, the notochord is:**
 A) Retained for life B) Absent
 C) Replaced partially or entirely by vertebral column ✓
 D) Present in the skin
115. **Pharyngeal slits are found in:**
 A) Only adult mammals

- B) All chordates during embryonic stage ✓
 C) Amphibians only
 D) Fish only
116. **Which chordates retain pharyngeal slits as gills?**
 A) Mammals B) Amphibians
 C) Amphioxus and fishes ✓
 D) Reptiles
117. **The tubular nerve cord in chordates is located:**
 A) Ventral to notochord B) Dorsal to notochord ✓
 C) Inside the gut D) Within the tail
118. **What does the tubular nerve cord expand in anteriorly?**
 A) Liver B) Heart
 C) Brain ✓ D) Eye
119. **What is the position of the tail in chordates?**
 A) Anterior to the mouth
 B) Between the head and stomach
 C) Posterior to anal opening ✓

- D) Ventral to pharynx
120. Which group retains the notochord throughout life?
 A) Amphibians B) Reptiles
 C) Cephalochordates ✓ D) Urochordates
121. Sea squirts belong to which subphylum?
 A) Cephalochordata B) Urochordata ✓
 C) Vertebrata D) Amphibia

122. Which subphylum shows notochord and nerve cord only in larval stages?
 A) Urochordata ✓ B) Cephalochordata
 C) Vertebrata D) Mammalia
123. Amphioxus is an example of:
 A) Urochordata B) Vertebrata
 C) Pisces D) Cephalochordata ✓



1. What are the general characteristics of animals in Kingdom Animalia?

Ans. This kingdom of eukaryotes includes animals which are eukaryotic, multicellular and heterotrophic. They develop from embryos. They ingest food and digest it within their bodies.

2. What organisms are included in Phylum Porifera and where are they found?

Ans. This phylum contains sponges. Most of them are marine while some live in freshwaters. *Leucosolenia* and *Euplectella* (Venus' flower basket) are marine sponges. *Spongilla* is a common freshwater sponge.

3. Describe the symmetry and organization level of sponges.

Ans. Sponges do not have tissue level organization. Most sponges are asymmetrical but some have radial symmetry. They do not have nervous system.

4. What are ostia and osculum in sponges?

Ans. There are numerous pores in body wall called ostia. Through ostia, water enters the body. The larger pore through which water leaves the body is called osculum.

5. Describe the body layers of sponges.

Ans. The outer layer of body is made of thin, flat cells called pinacocytes. The second layer is jelly-like and is called mesohyle. It contains amoeboid cells. The third layer, which lines the spongocoel, is made of choanocytes or collar cells.

6. How do sponges reproduce asexually?

Ans. Most sponges reproduce asexually by budding or regeneration. Some sponges form resistant capsules, called gemmules. When parent sponge dies, it releases its gemmules. In favourable environment, amoeboid cells come out of the gemmules and form a new sponge.

Phylum Cnidaria

7. What is the habitat and example of Cnidarians?

Ans. Almost all cnidarians are marine, although a few are found in freshwater e.g., hydra and jellyfish. Most cnidarians are colonial e.g., obelia, corals, sea fans etc.

8. What is meant by diploblastic and mesoglea in cnidarians?

Ans. They are radially symmetrical animals and are diploblastic. It means that the adult body contains two tissue layers i.e., the epidermis and the gastrodermis, derived from ectoderm and endoderm respectively. Between the epidermis and gastrodermis, a jelly-like mesoglea is present. It contains amoeboid cells that have originated either from ectoderm or endoderm.

9. What is the function of cnidocytes and nematocysts in cnidarians?

Ans. They possess special cells, called cnidocytes. A cnidocyte contains a special organelle, called nematocyst. Nematocysts defend the body and capture prey.

10. Describe the digestive system of cnidarians.

Ans. Cnidarians have a blind-ending cavity, called gastrovascular cavity or enteron. It opens outside by a single opening, the mouth. Mouth also acts as anus for the removal of undigested material. Mouth is surrounded by a series of projections, called tentacles. This type of digestive system in which there is a single opening for the entry of food and removal of undigested matter is called sac-like digestive system.

11. Describe the nervous and organ systems in cnidarians.

Ans. The nervous system is in the form of a network of neurons in the body wall. There is no central nervous system (brain and spinal cord). They do not have respiratory, excretory and transport systems.

12. What are the body forms in cnidarians and their reproduction methods?

Ans. There are two body forms in cnidarians i.e., polyps and medusae. Polyps are cylindrical and are attached to a substrate at the aboral end. They reproduce asexually. Medusae are umbrella-like and are free-swimming. They reproduce sexually.

Phylum Platyhelminthes

13. **What are flatworms and what is their body structure?**

Ans. They are called "flatworms". They are unsegmented and body is soft and dorsoventrally compressed. Most of them are free-living e.g., planaria. Some are endoparasites of humans and other animals e.g., liver fluke, tapeworm, and blood-fluke.

14. **What embryonic layers are present in flatworms and what type of symmetry do they show?**

Ans. They are triploblastic i.e., the tissues of the body are derived from three embryonic layers; ectoderm, mesoderm and endoderm. They are acoelomates. They have bilateral symmetry with distinct left and right sides as well as dorsal and ventral sides.

15. **Describe the excretory system in flatworms.**

Ans. They have a network of tubular protonephridia. These tubules have numerous branches. Each branch ends in a bulb-like cell called flame cell. The cilia of flame cells beat to suck surrounding fluid into the tubules. The tubules filter the waste materials from fluid and release them out of body wall through a small opening called a nephridiopore.

16. **Describe the nervous system in flatworms.**

Ans. They have a network of neurons. There are cerebral ganglia in the anterior end (head). These ganglia are attached to longitudinal nerve cords that are interconnected across the body by transverse branches. Most free-living flatworms have two simple eyespots at their anterior end.

17. **How do flatworms reproduce?**

Ans. Flatworms reproduce asexually by "fission" in which the animal constricts in the middle and then divides into two pieces. Each piece then regenerates the missing part. The sexually-reproducing flatworms are hermaphrodites (bisexual).

Phylum Nematoda

18. **What is the shape of the body in phylum Nematoda?**

Ans. They are roundworms with elongated worm-like (round) body with pointed ends.

19. **Where are free-living nematodes found? Give an example.**

Ans. Some roundworms are free-living (in water and soil) e.g., *Caenorhabditiselegans*.

20. **Name some parasitic roundworms.**

Ans. Many are parasites e.g., ascaris, hookworm, pinworm, and whipworm.

21. **What is the symmetry and body type of nematodes?**

Ans. They are triploblastic, bilateral symmetrical, and possess unsegmented body.

22. **Why are nematodes called pseudocoelomates?**

Ans. They are pseudocoelomates because they possess a false body cavity called pseudocoelom filled with fluid.

23. **Describe the digestive system of nematodes.**

Ans. They possess tube-like digestive system. It consists of an alimentary canal with two openings; mouth at anterior end and anus at posterior end. The parasitic roundworms have simplified digestive systems.

24. **Describe the excretory system of nematodes.**

Ans. Their excretory system consists of protonephridia and two excretory canals, which unite at the anterior end to form a single canal. The single canal then opens outside through a nephridiopore on the ventral surface.

25. **What type of nervous system is present in nematodes?**

Ans. They possess a network of neurons in body. There is a nerve ring around the pharynx, which is attached to four longitudinal nerve cords.

26. **What are sensory papillae in nematodes?**

Ans. They have raised hair-like sense organ called sensory papillae, present on lips.

27. **Do nematodes have respiratory and circulatory systems?**

Ans. They do not have defined respiratory and circulating systems.

28. **What type of reproduction is found in nematodes?**

Ans. They are unisexual i.e., male nematodes have testes and female nematodes have ovaries.

Phylum Mollusca

29. Describe the body of molluscs.

Ans. Molluscs have soft un-segmented bodies.

30. Where are molluscs found?

Ans. They are widely distributed in natural habitats. Some of them are exclusively aquatic e.g., mussels, octopus and oyster. The others live in moist places e.g., land snail.

31. Describe the symmetry and germ layers of molluscs.

Ans. Molluscs are triploblastic and have bilateral symmetry.

32. What type of coelom do molluscs have?

Ans. They possess true coelom.

33. To which group of coelomates do molluscs belong?

Ans. Among coelomates, they are included in the group called protostomes.

34. What are the three body parts of a mollusc?

Ans. Their body can be divided into three parts i.e., head, visceral mass (contains organs of digestion, excretion and reproduction), and foot (attached with visceral mass).

35. What is a mantle and mantle cavity in molluscs?

Ans. They have an epithelial envelope around the visceral mass, called as mantle. The space between mantle and visceral mass is called as mantle cavity.

36. What is the function of the outer surface of mantle in most molluscs?

Ans. In most molluscs, the outer surface of mantle secretes a calcareous shell.

37. What is radula?

Ans. All molluscs (except bivalvia) have a rasping tongue-like organ, called radula.

38. Describe the circulatory system of molluscs.

Ans. All of them (except cephalopods) have open type blood circulatory system. Their heart consists of a single ventricle and two auricles.

39. Describe the digestive system of molluscs.

Ans. They possess tube-like digestive system in which the gut has two openings, i.e., mouth and anus.

40. Describe the excretory system of molluscs.

Ans. Their excretory system consists of paired tubular structures called nephridia. Wastes are gathered from sinuses and discharged into coelom around the heart. The nephridia open in this coelom. They have tiny cilia around their openings, which move the fluid from coelom into the nephridia. Nephridia discharge waste materials in mantle cavity, from where they are expelled out.

41. How do molluscs exchange gases?

Ans. In molluscs, gills work for the exchange of gases.

42. Describe the nervous system of molluscs.

Ans. They have three pairs of interconnected ganglia present in the head, visceral mass and foot. The ganglia are interconnected by means of nerve cord.

43. How do molluscs move?

Ans. They move with the help of muscular foot. Some molluscs are sessile.

44. What type of reproduction do molluscs exhibit?

Ans. Most molluscs are unisexual.

Phylum Annelida

45. What are annelids commonly called?

Ans. Annelids are commonly called segmented worms.

46. Where are annelids found? Give examples.

Ans. They are found in marine water (e.g., nereis), freshwater (e.g., leech), and in damp soil (e.g., earthworm). Some annelids are ectoparasites e.g., leeches.

47. **Describe segmentation in annelids.**
Ans. Their body is divided transversely into a number of similar parts called segments. Internally, the segments are separated from each other by cross walls called septa. Each segment is provided with its own circulatory, excretory and neural elements. This type of segmentation in body is called metameric segmentation.
48. **What is the body structure of annelids?**
Ans. Annelids are bilaterally symmetrical and triploblastic. They are protostome coelomates.
49. **What are setae in annelids?**
Ans. Annelids have special parts called setae. Setae are chitinous bristles in the ventral wall of each segment. Setae are absent in leeches.
50. **What is the cuticle of annelids like?**
Ans. Their body wall is surrounded by a moist, acellular cuticle secreted by epidermis.
51. **Describe the digestive system of annelids.**
Ans. They possess tube-like digestive system. The digestive tube is divided into distinct parts, each performing a specific function. The parasitic annelids have simplified digestive system.
52. **What is the excretory system of annelids?**
Ans. Their excretory system consists of ciliated, funnel-shaped metanephridia. Each segment has one pair of metanephridia.
53. **Describe the circulatory system of annelids.**
Ans. They possess a closed-type circulatory system. Blood always flows in blood vessels. They have specialized pulsating blood vessels (pseudohearts). Blood of most annelids has respiratory pigment, haemoglobin, dissolved in blood plasma.
54. **How does gaseous exchange take place in annelids?**
Ans. Gaseous exchange occurs through the skin.
55. **Describe the nervous system in annelids.**
Ans. There is a cerebral ganglion or brain in the anterior segment. A double, longitudinal ventral nerve cord arises from brain and gives nerves in each segment. Ganglia are also present in each segment.
56. **What types of receptors do annelids have?**
Ans. They have tactile receptors, chemoreceptors, balance receptors, and photoreceptors. Some annelids also have well-developed eyes with lenses.
57. **What types of sexes are present in annelids?**
Ans. Most annelids are hermaphrodite (e.g., earthworm, leech) and some are unisexual (e.g., nereis).
- Phylum Arthropoda**
58. **Which groups are included in phylum Arthropoda?**
Ans. Diverse groups such as insects, crustaceans, spiders, scorpions, and centipedes are included in this phylum.
59. **Where are arthropods found?**
Ans. They are found in every type of habitat.
60. **Can terrestrial arthropods fly?**
Ans. Many of terrestrial members can also fly.
61. **What type of body symmetry do arthropods have?**
Ans. They are triploblastic, bilateral symmetrical, protostome coelomates.
62. **How is the coelom of arthropods characterized?**
Ans. The coelom is reduced and is present only around reproductive and excretory systems.
63. **What are jointed appendages in arthropods used for?**
Ans. Jointed appendages are modified for specialized functions e.g., running, crawling, swimming, capturing prey, respiration, reproduction etc.
64. **How are the appendages around the mouth modified in arthropods?**
Ans. In different arthropods, the jointed appendages around the mouth are modified in different ways and form mouth parts.

- 65. What is tagmata in arthropods?**
Ans. Some segments are fused to form specialized body regions called tagmata, which include head, thorax and abdomen.
- 66. What is the exoskeleton in arthropods made of?**
Ans. It is made chiefly of chitin.
- 67. How is the exoskeleton formed?**
Ans. They have exoskeleton or cuticle, which is secreted by the epidermis of body wall.
- 68. What happens to exoskeleton in young arthropods?**
Ans. In young arthropods, exoskeleton is shed from time to time.
- 69. What is the process of shedding and regenerating exoskeleton called?**
Ans. This process is called ecdysis or molting.
- 70. What type of circulatory system do arthropods possess?**
Ans. They possess open-type circulatory system.
- 71. What is hemocoel and how is it formed?**
Ans. Most of the time, blood flows in hemocoel, which is derived from an embryonic cavity called blastocoel.
- 72. What is haemolymph?**
Ans. Their blood is colourless as it is without haemoglobin and is known as haemolymph.
- 73. How do most arthropods respire?**
Ans. Most arthropods possess a respiratory system that consists of air tubes called trachea.
- 74. What are spiracles?**
Ans. Main tracheal tubes open out through openings called spiracles.
- 75. How do aquatic arthropods respire?**
Ans. Aquatic arthropods respire through gills.
- 76. Describe the digestive system of arthropods.**
Ans. Arthropods have tube-like digestive system. The alimentary canal is divided into different parts.
- 77. What comprises the excretory system in arthropods?**
Ans. Their excretory system comprises of Malpighian tubules.
- 78. Where are Malpighian tubules located?**
Ans. These are narrow tubules projected from the alimentary canal, attached at the junction of midgut and hindgut.
- 79. In what form is nitrogenous waste excreted in arthropods?**
Ans. The nitrogenous wastes are excreted in the form of solid uric acid crystals.
- 80. Describe the nervous system of arthropods.**
Ans. They have well-developed central nervous system with three fused pairs of cerebral ganglia (brain) in head.
- 81. What is the structure of the nerve cord in arthropods?**
Ans. There is a double ventral nerve cord which has ventral ganglia in each segment.
- 82. What arises from the ventral ganglia?**
Ans. Smaller nerves arise from ventral ganglia in each segment.
- 83. What sensory organs do arthropods have?**
Ans. They have well developed compound eyes and antennae.
- 84. How do arthropods move?**
Ans. They can swim, crawl or fly depending on their habitat.
- 85. Are arthropods unisexual or bisexual?**
Ans. They are unisexual.
- 86. Name some important arthropods.**
Ans. Important arthropods include insects (e.g., mosquito, butterfly, moth, wasp, beetles, and grasshopper), crabs, lobsters, prawn, shrimps, crayfishes, spider, tick, mite, scorpion, centipedes and millipedes.

Phylum Echinodermata

87. **Where are echinoderms found?**
Ans. They are exclusively marine animals.
88. **Name different shapes found in echinoderms.**
Ans. Some are flattened like biscuit (e.g., cake urchin), some are star-shaped with short arms (e.g., sea star or starfish), some are globular (e.g., sea urchin), some are star-shaped with long arms (e.g., brittle star), and some are elongated (e.g., sea cucumber).
89. **What type of coelomates are echinoderms?**
Ans. They are triploblastic and deuterostomes coelomates.
90. **What kind of symmetry do larval and adult echinoderms show?**
Ans. Their larvae are bilateral symmetrical but the adults show radial symmetry.
91. **How are body parts arranged in echinoderms?**
Ans. In their radial symmetry, the body parts are arranged in five, or multiple of five, around an oral-aboral axis.
92. **What kind of skeleton do echinoderms possess?**
Ans. They possess a calcareous endoskeleton in the form of plates called ossicles.
93. **What are ossicles derived from?**
Ans. These plates are derived from mesoderm but come out of skin also and make spines on the skin.
94. **What is the water vascular system in echinoderms?**
Ans. They have water-vascular system consisting of tubes and spaces present in the coelom.
95. **What is madreporite?**
Ans. It opens outside through a sieve-like plate, called madreporite.
96. **What are radial canals in echinoderms?**
Ans. Five (or a multiple of five) radial canals branch from the ring canal.
97. **What are tube feet?**
Ans. Tube feet are the extensions of water vascular system.
98. **How do tube feet function?**
Ans. The tube feet extend and attach with some substrate. When water is drawn back from the sucked tube feet, they contract.
99. **Describe the alimentary canal in echinoderms.**
Ans. The mouth leads to oesophagus, stomach, intestine and rectum. The rectum opens out through anus.
100. **Do echinoderms have specialized organs for respiration and excretion?**
Ans. There are no specialized organs for respiration and excretion.
101. **Describe the nervous system of echinoderms.**
Ans. They possess a poorly developed nervous system made of a nerve net, a nerve ring, and five (or multiple of five) radial nerves.
102. **Where are sensory receptors located in echinoderms?**
Ans. Most sensory receptors are distributed over the surface of the body and tube feet.
103. **How do echinoderms reproduce asexually?**
Ans. Asexual reproduction involves division of the body, followed by the regeneration of each half.
104. **Are echinoderms unisexual?**
Ans. Echinoderms are unisexual.

Chordates

105. **What type of body symmetry do chordates have?**
Ans. Chordates are bilateral symmetrical, triploblastic, deuterostome coelomates.
106. **What is the notochord in chordates?**
Ans. It is a rod-like semi-rigid body of vacuolated cells that extends throughout the length of the body between gut and dorsal nerve cord.

107. Do all chordates retain the notochord throughout life?

Ans. The lower chordates retain this notochord throughout life, while in vertebrates it is partly or entirely replaced by vertebral column during development.

108. What are pharyngeal slits?

Ans. These are a series of openings in the lateral walls of the pharynx.

109. When do chordates develop pharyngeal slits?

Ans. All chordates develop paired gill slits in the embryonic stage.

110. What happens to pharyngeal slits in Amphioxus and fishes?

Ans. In Amphioxus and fishes, these develop into gills.

111. What is the function of pharyngeal slits in amphibians?

Ans. In most amphibians, these are functional for some period in their life history.

112. How are pharyngeal slits modified in reptiles, birds, and mammals?

Ans. In reptiles, birds and mammals, these are modified for various purposes.

113. Describe the nerve cord in chordates.

Ans. A tubular nerve cord runs through the longitudinal axis of the body, just dorsal to the notochord, and expands anteriorly as a brain.

114. What is the post-anal tail in chordates?

Ans. All chordates develop a tail posteriorly beyond the anal opening.

115. Do all chordates retain the post-anal tail throughout life?

Ans. Some chordates retain it throughout life while others degenerate it during embryonic life.

116. Into which two major groups is phylum Chordata divided?

Ans. Phylum Chordata includes two major groups i.e., invertebrate chordates and vertebrates.

117. What is Subphylum Urochordata?

Ans. It includes invertebrate chordates in which notochord and nerve cord are present only in their free-swimming larvae.

118. Give an example of Urochordata.

Ans. Sea squirts are the examples of urochordates.

119. What is Subphylum Cephalochordata?

Ans. It includes invertebrate chordates in which notochord persists throughout life.

120. Name a common cephalochordate.

Ans. Amphioxus is a common cephalochordate.

121. What structures do vertebrates possess?

Ans. Vertebrates have a vertebral column and cranium.

122. How many classes are vertebrates divided into?

Ans. Vertebrates are divided into seven classes which are placed into two groups.

1.5 CLASSIFICATION OF VERTEBRATES

Vertebrates

Vertebrates have a vertebral column and cranium. Vertebrates are divided into seven classes which are placed into two groups.



23. Write a detailed note on Group Pisces.

Ans. Habitat

Members of Class Pisces are aquatic vertebrates, meaning they live exclusively in freshwater or marine environments.

Body Shape

Their bodies are streamlined or fusiform (spindle-shaped) which helps in reducing water resistance during swimming.

Body Covering

The body is covered with scales (dermal in origin), such as placoid, cycloid, or ctenoid scales, depending on the type of fish.

Skeleton

Skeleton can be cartilaginous (as in sharks and rays) or bony (as in most modern fish).

Respiration

Respiration takes place through gills. Gills are usually covered by an operculum in bony fishes.

Circulatory System

They have a closed circulatory system. The heart is two-chambered (one auricle and one ventricle). Blood circulation is single and incomplete.

Locomotion

Locomotion is achieved with the help of paired and unpaired fins. Fins also provide balance and direction during swimming.

Reproduction

Mostly oviparous (egg-laying), but some are viviparous (give birth to young ones). Fertilisation may be external (common in bony fishes) or internal (common in cartilaginous fishes).

Temperature Regulation

Pisces are ectothermic (cold-blooded), meaning their body temperature varies with the environment.

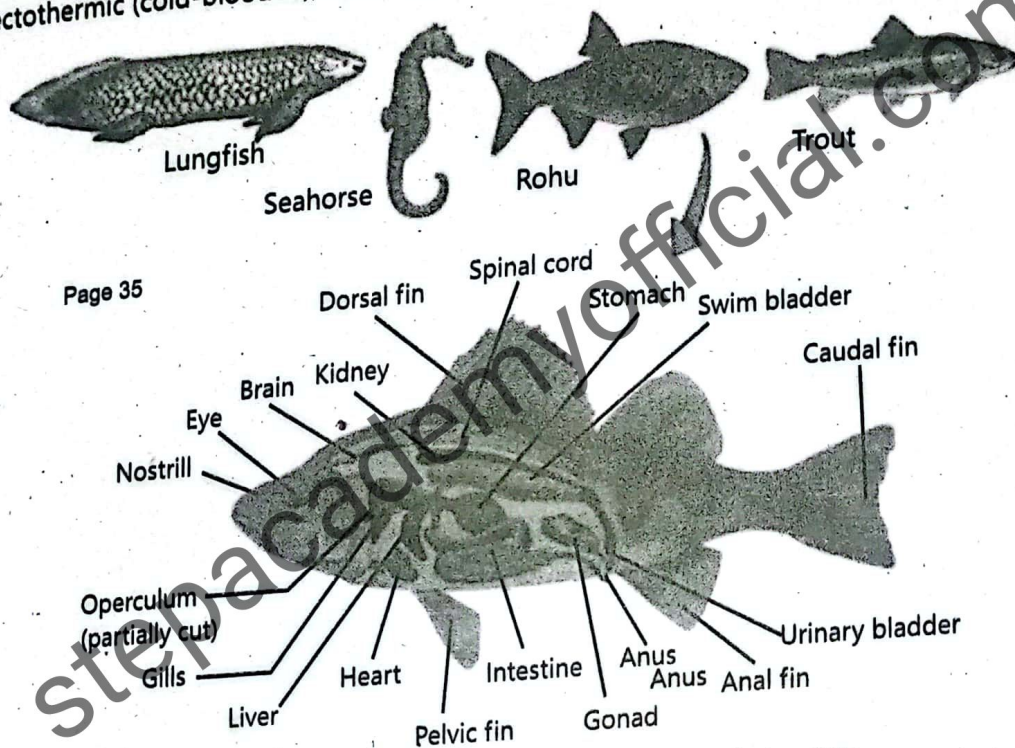


Fig. 1.20: Representative bony fishes and general structure



24. Describe the major classes of jawless and jawed fishes under Agnathans and Gnathostomes, their key characteristics, and examples.

Ans. The classification of fishes includes two main groups: **Agnathans (jawless fishes)** and **Gnathostomes (jawed fishes)**. Each group contains distinct classes that are characterized based on structural and functional features. Below is the detailed classification along with their key characteristics and examples:

	Class	Key characteristics	Examples
Agnathans (Jawless Fishes)	Class Myxini	Mouth with four pairs of tentacles; five to fifteen pair of pharyngeal slits.	Hagfish
	Class Cephalaspidomorphi	Sucking mouth, seven pair of pharyngeal slits.	Lamprey

Gnathostomes (Jawless Fishes)	Class Chondrichthyes	Cartilaginous skeleton, tail fin with large upper lobe and lack swim bladder or lungs.	Sharks, skates, ratfish
	Class Osteichthyes	Bony skeleton, pneumatic sac function as lungs or swim bladder.	Lungfish, Coelacanth



25. Describe the characteristics of Class Amphibia.

Ans.

(i) Endoskeleton and Neck Movement

They have bony endoskeleton. Unlike fishes, amphibians have a neck. The first vertebra (cervical vertebra) moves against the back of skull and allows the skull to nod vertically.

(ii) Skin Structure and Functions

Their skin is smooth (without scales) and moist. It helps in gas exchange, temperature regulation, and absorption and storage of water.

(iii) Circulatory System

Their heart is double circuit. It is three-chambered, with two atria and one ventricle.

(iv) Respiration

They respire by gills in the larval stage and by lungs and skin in the adult stage.

(v) Thermoregulation

They depend on external heat source and so are ectotherms. They cannot regulate their body temperature and cannot maintain it constant. So, they are poikilothermic animals and hibernate in winter.

Reproduction

Amphibians are unisexual. Fertilization is usually external.

Examples of Amphibians

Salamander, newts, and mud puppies are tailed amphibians. Frogs and toads are tail-less amphibians, and caecilians are leg-less amphibians.

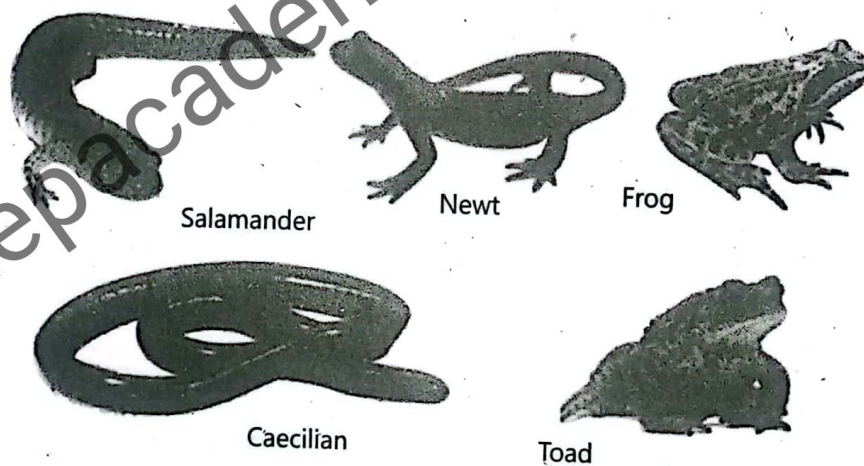


Fig. 1.21: Representative amphibians



26. Explain the structure and adaptations of Class Reptilia.

Ans. Amniotic Eggs

Reptiles are the first animal group that possess amniotic eggs. Amniotic eggs make protective extra-embryonic membranes i.e., amnion, allantois, and chorion. These membranes protect the embryo from drying out, nourish it and enable it to develop on land. The amniotic eggs also contain a large amount of yolk, the primary food supply for the embryo. Such eggs have abundant albumin, which provides additional nutrients and water. The amniotic eggs are also covered with leathery calcareous shell which is partly permeable to gases but not to water.

Skin and Skeleton

Reptiles have dry scaly skin. The bony endoskeleton of reptiles is harder than amphibians. The skull is longer than amphibians. In reptiles, first two cervical vertebrae (atlas and axis) allow more movements of head.

Circulatory System

In their heart, ventricle is incompletely partitioned, into left and right ventricles.

Thermoregulation

Reptiles, like amphibians, are ectothermic and use external heat source for thermoregulation. They cannot keep their body temperature at constant, and are poikilotherms.

Reproduction

Fertilization in internal. They are oviparous (egg-laying).

Examples of Reptiles

The present day reptiles are lizards, snakes, tuatara and crocodiles.

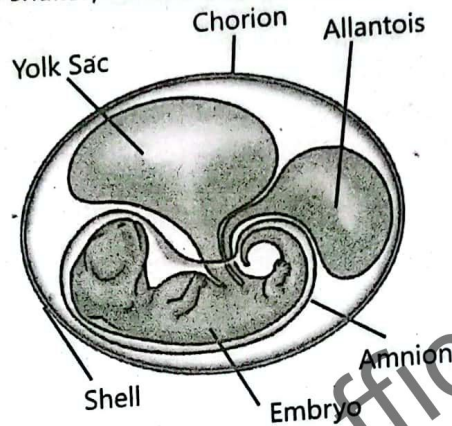


Fig. 1.22: Amniotic egg

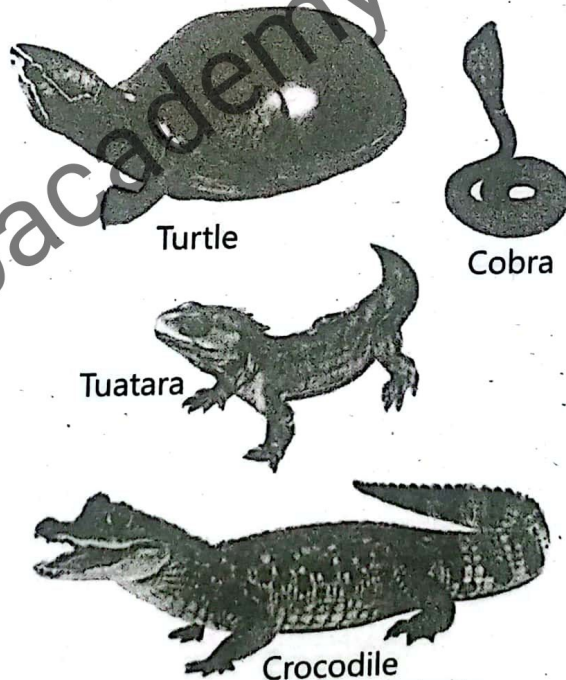


Fig. 1.23: Representative reptiles



27. Discuss the main features of Class Aves.

Ans. **Body Covering and Function of Feathers**

Birds have a covering of feathers on the body. Feathers form the flight surfaces that provide lift and aid in steering. Feathers also prevent heat and water loss.

Thermoregulation

Birds are endotherms. It means that they can obtain heat from cellular processes. A source of internal heat allows them to maintain a nearly constant core temperature. The animals who can maintain their core temperature are known as homeotherms.

Body Structure

The body of birds is streamlined and spindle shaped. The forelimbs are modified into wings. Their bones are light due to large air spaces. A lighter sheath called bill replaces the teeth. The sternum (chest bone) bears a large bone called keel for the attachment of flight muscles.

Digestive Adaptations

In many birds a diverticulum of the oesophagus, called crop, is a storage structure that allows birds to quickly ingest large quantities of food. A region of stomach, called gizzard, has muscular walls to crush food.

Circulatory and Nervous Systems

Their heart is four-chambered, with complete separation of atria and ventricles. Birds have much developed nervous system. Vision and hearing are important senses for most birds.

Respiratory System

Their external nares open in pharynx through nasal passage ways. The pharynx leads to trachea and then bronchi. The organ of voice, called syrinx, is situated at the lower end of trachea. The bronchi lead to a complex system of air sacs that occupy much of the body and even extend to some of the bones. The air sacs connect to lungs, which are made of small air tubes called parabronchi.

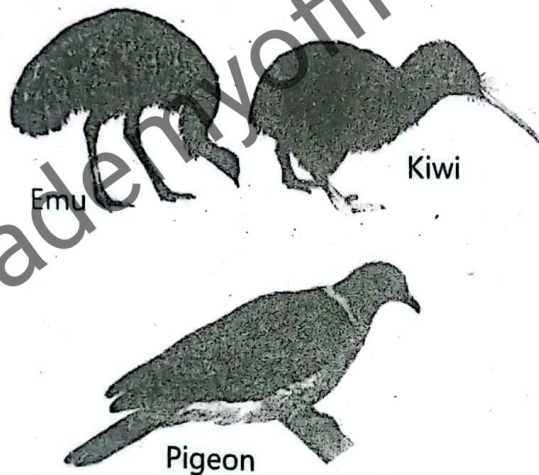
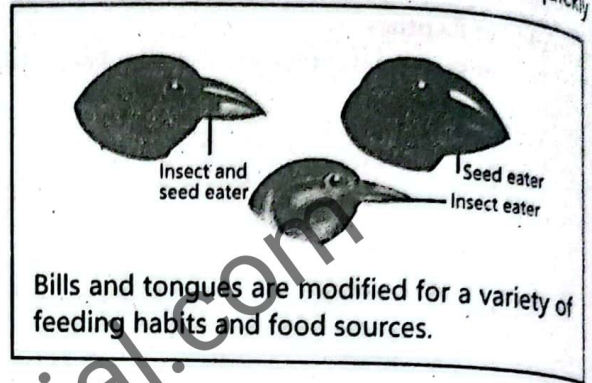


Fig. 1.26: Representative birds

Reproduction

Like reptiles and mammals, birds have amniotic eggs with large amounts of yolk and albumin. Such eggs are also covered with leathery shell. In birds, fertilization is internal and development is external i.e., they are oviparous.

Examples of Different Types of Birds

Some birds have secondarily lost the power of flight and are called running birds e.g., ostrich, kiwi, rheassowary, and emu. The flying birds include pigeon, parrot, crow, eagle, robin etc.



28. Describe the major characteristics of class Mammalia. Also explain the types of mammals with examples.

Ans. General Characteristics of Mammalia

Mammalia includes the group of vertebrates which are nourished by milk from the mammary glands of mother and have hair on their body.

Skin Glands in Mammals

Mammals have skin glands, developed from epidermis. Sebaceous (oil) glands secrete oily secretion, while sudoriferous (sweat) glands release watery secretions used in evaporative cooling.

Mammary Glands

The mammary glands are functional only in female mammals and are used to feed the young ones.

Teeth in Mammals

Most mammals possess two sets of teeth during their lives: milk teeth and permanent teeth.

External and Middle Ear

An external ear or pinna is present in mammals. The middle ear has a chain of three bones called incus, malleus, and stapes which help in sound transmission.

Temperature Regulation and Circulatory System

Mammals are endothermic and homoeothermic animals, meaning they can regulate their internal body temperature and maintain it constant. They have a four-chambered heart which ensures complete separation of oxygenated and deoxygenated blood.

Diaphragm in Mammals

A muscular diaphragm separates the body cavity into thoracic and abdominal cavities.

Voice Box and Sound Production

Mammals also have a well-developed voice box called larynx, equipped with vocal cords and epiglottis, which plays a role in sound production.

Fertilization in Mammals

Internal fertilization occurs in mammals.



Duckbill platypus

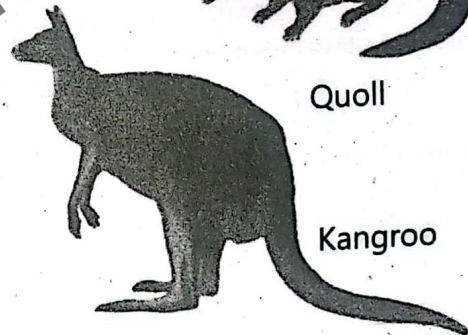


Spiny anteater

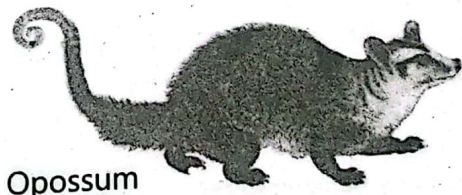
Fig. 1.27: Representative egg-laying mammals



Quoll



Kangaroo



Opossum

Fig. 1.28: Representative pouched mammals

Types of Mammals

Mammals are classified into three major groups:

Monotremes

Monotremes are egg-laying mammals.

In these animals, the embryo develops completely inside the egg outside the mother's body.

They are oviparous.

Examples include the Duckbill platypus and echidna (spiny anteater).

Marsupials

Marsupials have a pouch (marsupium) on the abdomen of the female.

These mammals give birth to immature young ones, which then complete their development inside the mother's pouch.

Examples include opossum and kangaroo.

Placental Mammals

Placental mammals are the most advanced mammals.

A specialized structure called placenta forms between the mother's uterus wall and the body of the foetus during development.

This structure nourishes the foetus and also removes its waste products.

These mammals give birth to well-developed young ones, so they are viviparous.

Examples include dolphin, rat, monkey, bat, elephant, and human.

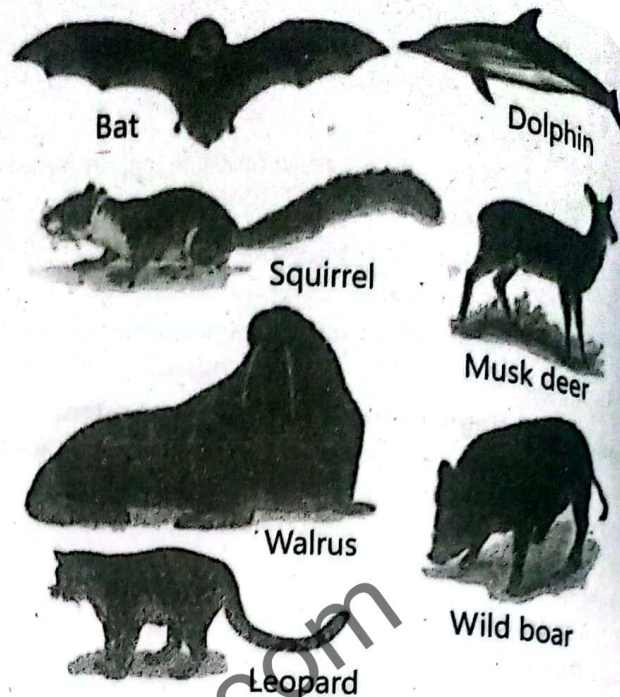


Fig. 1.29: Representative eutherians

mcqs

- Vertebrates possess a:**
 - Nerve ring
 - Vertebral column and cranium ✓
 - Shell
 - Water vascular system
- Members of Class Pisces are:**
 - Terrestrial
 - Amphibious
 - Aquatic ✓
 - Arboreal
- The body shape of fish is:**
 - Cylindrical
 - Spindle-shaped (fusiform) ✓
 - Conical
 - Spherical
- Fish scales are:**
 - Epidermal
 - Dermal in origin ✓
 - Made of cellulose
 - Cartilaginous
- Cartilaginous skeleton is found in:**
 - Amphioxus
 - Mammals
 - Sharks and rays ✓
 - Frogs
- How do bony fishes respire?**
 - Through lungs
 - Through skin
 - Through gills covered by operculum ✓
 - Through spiracles
- Fish heart consists of:**
 - Three chambers
 - Two atria
 - One auricle and one ventricle ✓
 - Four chambers
- What type of circulatory system do fishes have?**
 - Open
 - Double and complete
 - Closed, single and incomplete ✓
 - Closed and double
- Paired and unpaired fins help in:**
 - Breathing
 - Excretion
 - Locomotion and balance ✓
 - Digestion
- Fertilisation in cartilaginous fishes is usually:**
 - External
 - Asexual
 - Internal ✓
 - Absent
- Most fishes reproduce by:**
 - Budding
 - Binary fission
 - Laying eggs (oviparous) ✓
 - Fragmentation
- Fishes are ectothermic, meaning:**
 - They produce constant body heat
 - Body temperature remains stable
 - Body temperature varies with environment ✓
 - They have no body temperature
- Which of the following is a key characteristic of Class Myxini?**
 - Sucking mouth and seven pair of pharyngeal slits
 - Mouth with four pairs of tentacles; five to fifteen pair of pharyngeal slits ✓
 - Bony skeleton, pneumatic sac function as lungs or swim bladder
 - Cartilaginous skeleton, tail fin with large upper lobe and lack swim bladder or lungs
- Which of the following organisms is an example of Class Cephalaspidomorphi?**
 - Hagfish
 - Coelacanth
 - Lamprey ✓
 - Shark
- What is the skeletal structure of Class Chondrichthyes?**
 - Bony skeleton
 - No skeleton
 - Cartilaginous skeleton ✓
 - Mixed skeletal structure

16. Which class lacks swim bladder or lungs and has a tail fin with a large upper lobe?
 A) Class Osteichthyes
 B) Class Myxini
 C) Class Chondrichthyes ✓
 D) Class Cephalaspidomorphi

17. What is the function of the pneumatic sac in Class Osteichthyes?
 A) It stores food
 B) It helps in digestion
 C) It functions as lungs or swim bladder ✓
 D) It produces enzymes

Class Amphibia

18. What type of endoskeleton is present in amphibians?
 A) Cartilaginous
 B) Bony ✓
 C) Fibrous
 D) None
19. What is the function of the first cervical vertebra in amphibians?
 A) Rotate the tail
 B) Support wings
 C) Allow skull to nod vertically ✓
 D) Helps in breathing
20. How is the skin of amphibians described?
 A) Scaly and dry
 B) Smooth and moist ✓
 C) Rough and thick
 D) Feathery
21. How many chambers are there in the amphibian heart?
 A) Two
 B) Four
 C) One
 D) Three ✓

22. What is the primary method of respiration in adult amphibians?
 A) Only gills
 B) Only skin
 C) Lungs and skin ✓
 D) Spiracles
23. What term describes amphibians' dependence on external heat?
 A) Endothermic
 B) Ectothermic ✓
 C) Homeothermic
 D) Thermogenic
24. What type of fertilization do amphibians usually exhibit?
 A) Internal
 B) Parthenogenesis
 C) External ✓
 D) Self-fertilization
25. Which of the following is a tailed amphibian?
 A) Frog
 B) Toad
 C) Salamander ✓
 D) Caecilian

Class Reptilia

26. What kind of egg do reptiles possess?
 A) Soft jelly eggs
 B) Amniotic eggs ✓
 C) Larval eggs
 D) Aquatic eggs
27. Which membrane in reptile eggs helps in nourishment?
 A) Chorion
 B) Amnion
 C) Allantois
 D) Yolk and albumin ✓
28. What type of skin do reptiles have?
 A) Moist skin
 B) Feathered skin
 C) Dry scaly skin ✓
 D) Hair-covered skin
29. How many cervical vertebrae allow head movement in reptiles?
 A) One
 B) Two ✓
 C) Three
 D) Four

30. What describes the reptilian heart structure?
 A) Four chambers completely separated
 B) Two chambers
 C) Ventricle is incompletely partitioned ✓
 D) One chamber only
31. What mode of reproduction is common in reptiles?
 A) Viviparous
 B) Asexual
 C) Oviparous ✓
 D) Budding
32. Which of these is a present-day reptile?
 A) Salamander
 B) Crocodile ✓
 C) Frog
 D) Emu

Class Aves

33. What covers the body of birds?
 A) Scales
 B) Hair
 C) Feathers ✓
 D) Shell
34. Birds are classified as:
 A) Ectothermic
 B) Cold-blooded
 C) Endothermic ✓
 D) Amphibious
35. The sternum of birds bears a special structure for flight muscle attachment called:
 A) Gizzard
 B) Crop
 C) Keel ✓
 D) Beak
36. Which part of bird's stomach grinds food?
 A) Crop
 B) Gizzard ✓
 C) Intestine
 D) Syrinx
37. What is the function of the crop in birds?
 A) Sound production
 B) Water absorption
 C) Food digestion
 D) Food storage ✓

38. How many chambers does a bird's heart have?
 A) Two
 B) Three
 C) Four ✓
 D) Five
39. What is the function of the syrinx in birds?
 A) Breathing
 B) Voice production ✓
 C) Grinding food
 D) Egg-laying
40. What are bird lungs made of?
 A) Air sacs
 B) Spiracles
 C) Parabronchi ✓
 D) Tracheoles
41. Which birds have secondarily lost the power of flight?
 A) Eagle and parrot
 B) Pigeon and crow
 C) Ostrich and emu ✓
 D) Parrot and robin
42. Birds reproduce through:
 A) Internal fertilization and live birth
 B) Asexual reproduction
 C) Internal fertilization and external development ✓
 D) External fertilization

Class Mammalia

43. **Mammals are nourished by:**
 A. Placenta B. Sweat glands
 C. Mammary glands ✓ D. Salivary glands
44. **The body of mammals is covered with:**
 A. Scales B. Feathers
 C. Hair ✓ D. Cuticle
45. **Sebaceous glands in mammals secrete:**
 A. Water B. Oil ✓
 C. Mucus D. Milk
46. **The function of sudoriferous glands is:**
 A. Oil secretion B. Milk secretion
 C. Cooling the body ✓ D. Hormone secretion
47. **Which mammals have functional mammary glands?**
 A. Only males B. Only females ✓
 C. Both genders D. Infants
48. **Most mammals have how many sets of teeth?**
 A. One B. Two ✓
 C. Three D. Four
40. **External ear or pinna is a characteristic of:**
 A. Fish B. Amphibians
 C. Birds D. Mammals ✓
41. **Which bones are found in the mammalian middle ear?**
 A. Tibia, fibula, humerus B. Incus, malleus, stapes ✓
 C. Radius, ulna, clavicle D. Femur, tibia, patella
42. **Mammals are:**
 A. Ectothermic B. Mesothermic
 C. Endothermic and homoeothermic ✓
 D. Cold-blooded
43. **How many chambers are present in the mammalian heart?**
 A. Two B. Three
 C. Four ✓ D. Five
44. **The diaphragm in mammals separates:**
- A. Heart and lungs B. Skull and spine
 C. Thoracic and abdominal cavities ✓
 D. Liver and kidneys
45. **Larynx and vocal cords in mammals help in:**
 A. Breathing B. Sound production ✓
 C. Digestion D. Vision
46. **Fertilization in mammals is:**
 A. External B. Asexual
 C. Internal ✓ D. Binary
47. **Monotremes reproduce by:**
 A. Giving birth to live young
 B. Asexual means
 C. Egg laying ✓
 D. Budding
48. **Example of a monotreme is:**
 A. Kangaroo B. Bat
 C. Duckbill platypus ✓ D. Rat
49. **Marsupials give birth to:**
 A. Fully developed young B. Eggs
 C. Immature young ✓ D. Twin embryos
50. **Marsupium refers to:**
 A. Tail B. Milk gland
 C. Pouch on the female abdomen ✓
 D. Placenta
51. **Placental mammals are:**
 A. Primitive B. Advanced ✓
 C. Intermediate D. Amphibians
52. **Placenta functions to:**
 A. Protect bones B. Nourish the foetus ✓
 C. Digest food D. Store fats
53. **Which of the following is a placental mammal?**
 A. Echidna B. Kangaroo
 C. Platypus D. Human ✓



1. **What kind of vertebrates belong to Group Pisces?**

Ans. Members of Class Pisces are aquatic vertebrates, meaning they live exclusively in freshwater or marine environments.

2. **What is the body shape of Pisces?**

Ans. Their bodies are streamlined or fusiform (spindle-shaped), which helps in reducing water resistance during swimming.

3. **What type of body covering do Pisces have?**

Ans. The body is covered with scales (dermal in origin), such as placoid, cycloid, or ctenoid scales, depending on the type of fish.

4. **What types of skeletons are found in Pisces?**

Ans. Skeleton can be cartilaginous (as in sharks and rays) or bony (as in most modern fish).

5. **How do Pisces respire?**

Ans. Respiration takes place through gills. Gills are usually covered by an operculum in bony fishes.

6. **Describe the circulatory system of Pisces.**

Ans. They have a closed circulatory system. The heart is two-chambered (one auricle and one ventricle). Blood circulation is single and incomplete.

7. **How do Pisces move and maintain balance?**

Ans. Locomotion is achieved with the help of paired and unpaired fins. Fins also provide balance and direction during swimming.

8. **What are the key characteristics of Class Myxini under Agnathans?**
 Ans. Mouth with four pairs of tentacles; five to fifteen pair of pharyngeal slits.
9. **Which organism is an example of Class Cephalosplidomorphi?**
 Ans. Lamprey.
10. **What is the main feature of the tail fin in Class Chondrichthyes?**
 Ans. Tail fin with large upper lobe and lack swim bladder or lungs.
11. **Which class of Gnathostomes has a bony skeleton and pneumatic sac functioning as lungs or swim bladder?**
 Ans. Class Osteichthyes.
12. **Name two examples of Class Chondrichthyes.**
 Ans. Sharks and skates.

2. Class Amphibia

13. **What type of endoskeleton do amphibians have?**
 Ans. They have bony endoskeleton.
14. **What feature allows amphibians' skull to nod vertically?**
 Ans. The first vertebra (cervical vertebra) moves against the back of skull and allows the skull to nod vertically.
15. **Describe the skin of amphibians.**
 Ans. Their skin is smooth (without scales) and moist. It helps in gas exchange, temperature regulation, and absorption and storage of water.
16. **What is the structure of amphibian heart?**
 Ans. Their heart is double circuit. It is three-chambered, with two atria and one ventricle.
17. **How do amphibians respire at different life stages?**
 Ans. They respire by gills in the larval stage and by lungs and skin in the adult stage.
18. **What is the thermoregulatory nature of amphibians?**
 Ans. They depend on external heat source and so are ectotherms.
19. **Can amphibians regulate their body temperature?**
 Ans. They cannot regulate their body temperature and cannot maintain it constant.
20. **What is the term for animals like amphibians that cannot maintain constant body temperature?**
 Ans. They are poikilothermic animals and hibernate in winter.
21. **Name the tailed amphibians.**
 Ans. Salamander, newts, and mud puppies are tailed amphibians.
22. **Name the tail-less and leg-less amphibians.**
 Ans. Frogs and toads are tail-less amphibians, and caecilians are leg-less amphibians.
23. **What is the reproductive nature of amphibians?**
 Ans. Amphibians are unisexual.
24. **What type of fertilization do amphibians have?**
 Ans. Fertilization is usually external.

3. Class Reptilia

25. **What kind of eggs do reptiles lay?**
 Ans. Reptiles are the first animal group that possess amniotic eggs.
26. **What are the protective membranes of amniotic eggs in reptiles?**
 Ans. Amniotic eggs make protective extra-embryonic membranes i.e., amnion, allantois, and chorion.
27. **What does the amniotic egg provide to the embryo?**
 Ans. These membranes protect the embryo from drying out, nourish it and enable it to develop on land.
28. **What are the nutritional contents of reptile eggs?**
 Ans. The amniotic eggs contain a large amount of yolk and abundant albumin, which provides additional nutrients and water.
29. **What is the structure of the reptile egg shell?**
 Ans. The eggs are covered with leathery calcareous shell which is partly permeable to gases but not to water.

30. Describe the skin and skeleton of reptiles.

Ans. Reptiles have dry scaly skin. The bony endoskeleton of reptiles is harder than amphibians.

31. How is the skull and neck different in reptiles compared to amphibians?

Ans. The skull is longer than amphibians. In reptiles, first two cervical vertebrae (atlas and axis) allow more movements of head.

32. Describe the heart of reptiles.

Ans. In their heart, ventricle is incompletely partitioned, into left and right ventricles.

33. How do reptiles regulate their temperature?

Ans. Reptiles, like amphibians, are ectothermic and use external heat source for thermoregulation.

34. Are reptiles homeotherms or poikilotherms?

Ans. They cannot keep their body temperature at constant, and are poikilotherms.

35. What type of fertilization and reproduction is found in reptiles?

Ans. Fertilization is internal. They are oviparous (egg-laying).

36. Name some present-day reptiles.

Ans. The present day reptiles are lizards, snakes, tuatara and crocodiles.

4. Class Aves

37. What is the function of feathers in birds?

Ans. Feathers form the flight surfaces that provide lift and aid in steering. Feathers also prevent heat and water loss.

38. What is the body covering of birds and its function?

Ans. Birds have a covering of feathers on the body. Feathers form the flight surfaces that provide lift and aid in steering. Feathers also prevent heat and water loss.

39. What does it mean that birds are endotherms?

Ans. Birds are endotherms. It means that they can obtain heat from cellular processes.

40. How do birds maintain their core body temperature?

Ans. A source of internal heat allows birds to maintain a nearly constant core temperature. The animals who can maintain their core temperature are known as homeotherms.

41. Describe the body shape of birds.

Ans. The body of birds is streamlined and spindle shaped.

42. How are the forelimbs of birds modified?

Ans. The forelimbs of birds are modified into wings.

43. Why are bird bones light in weight?

Ans. Their bones are light due to large air spaces.

44. What replaces the teeth in birds and why?

Ans. A lighter sheath called bill replaces the teeth.

45. What is the function of the keel in birds?

Ans. The sternum (chest bone) bears a large bone called keel for the attachment of flight muscles.

46. What is the crop in birds and its function?

Ans. In many birds, a diverticulum of the oesophagus called crop is a storage structure that allows birds to quickly ingest large quantities of food.

47. What is the function of the gizzard in birds?

Ans. A region of stomach, called gizzard, has muscular walls to crush food.

48. Describe the heart of birds.

Ans. Their heart is four-chambered, with complete separation of atria and ventricles.

49. What are the important senses in birds?

Ans. Birds have much developed nervous system. Vision and hearing are important senses for most birds.

50. What is the function and location of syrinx in birds?

Ans. The organ of voice, called syrinx, is situated at the lower end of trachea.

51. How do the air sacs help in bird respiration?

Ans. The bronchi lead to a complex system of air sacs that occupy much of the body and even extend to some of the bones. The air sacs connect to lungs, which are made of small air tubes called parabronchi.

52. **What type of eggs do birds lay and how do they develop?**
Ans. Like reptiles and mammals, birds have amniotic eggs with large amounts of yolk and albumin. Such eggs are also covered with leathery shell. In birds, fertilization is internal and development is external i.e., they are oviparous.

5. Class Mammalia

53. **What is the source of nourishment for young mammals?**
Ans. Mammalia includes the group of vertebrates which are nourished by milk from the mammary glands of mother.
54. **What body covering do mammals have?**
Ans. Mammals have hair on their body.
55. **From which layer of skin are mammalian glands derived?**
Ans. Mammals have skin glands, developed from epidermis.
56. **What is the function of sebaceous glands in mammals?**
Ans. Sebaceous (oil) glands secrete oily secretion.
57. **What do sudoriferous glands do in mammals?**
Ans. Sudoriferous (sweat) glands release watery secretions used in evaporative cooling.
58. **In which sex are the mammary glands functional?**
Ans. Mammary glands are functional in female mammals.
59. **How many sets of teeth do mammals typically have?**
Ans. Most mammals have two sets of teeth during their lives i.e., milk teeth and permanent teeth.
60. **What is the external ear structure in mammals called?**
Ans. External ear or pinna is present.
61. **Name the three bones found in the middle ear of mammals.**
Ans. The middle ear has a chain of three bones i.e., incus, malleus and stapes.
62. **What kind of thermoregulation do mammals exhibit?**
Ans. Mammals are endothermic and homoeothermic animals.
63. **What kind of heart do mammals possess?**
Ans. They possess four-chambered heart.
64. **What structure separates the thoracic and abdominal cavities in mammals?**
Ans. They have a muscular diaphragm that separates the coelom into thoracic and abdominal cavities.
65. **What type of voice apparatus do mammals have?**
Ans. They have well developed voice apparatus in the form of larynx (with vocal cords) and epiglottis.
66. **What is the mode of fertilization in mammals?**
Ans. In mammals, fertilization is internal.
67. **Name the three groups of mammals.**
Ans. Mammals are monotremes, placental and marsupials.
68. **What are monotremes and how do they reproduce?**
Ans. Monotremes are egg-laying mammals that lay eggs in which whole development of their embryo proceeds. They are oviparous e.g., Duckbill platypus and echidna (spiny anteater).
69. **What feature is found on the female marsupial's abdomen?**
Ans. Marsupials have a pouch (marsupium) on the abdomen of female.
70. **How do marsupials reproduce?**
Ans. These mammals give birth to immature young ones which complete their development in mothers' pouch. Opossum and kangaroo are the examples of such mammals.
71. **What makes placental mammals the most advanced mammals?**
Ans. During development, a structure called placenta, is formed between mother's uterus wall and foetus body. The foetus is nourished and wastes from foetus are removed through this placenta.
72. **Name six examples of placental mammals.**
Ans. Dolphin, rat, monkey, bat, elephant and human are some examples of placental mammals.

1.6 CLASSIFICATION OF VIRUSES



29. What are viruses? Explain their characteristics and classification in detail.

Ans. Nature and Characteristics of Viruses

Viruses are unique biological entities that are not considered organisms because they are acellular, meaning they are not made of cells.

Unlike living organisms, viruses lack the characteristics that define life in the three domains (Bacteria, Archaea, Eukarya).

Therefore, they are not classified in any domain or kingdom.

A virus is composed of nucleic acid (either DNA or RNA) enclosed in a protein coat called the capsid.

Viruses are incapable of performing metabolism on their own and thus depend entirely on a host cell for replication and protein synthesis.

They can infect plants, animals, and bacteria.

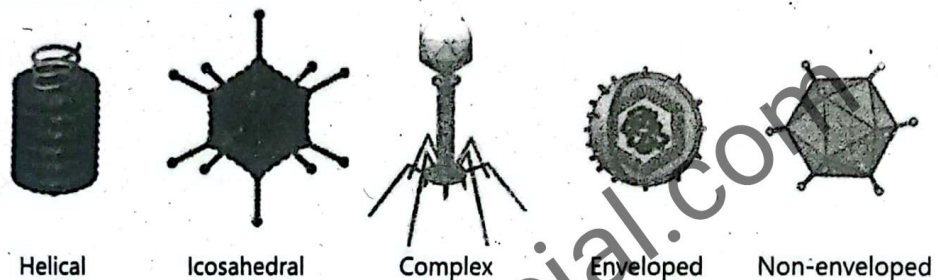


Fig. 1.30: Basic shapes of viruses

Basis of Virus Classification

The classification of viruses is based on several key features and follows guidelines set by the **International Committee on Taxonomy of Viruses (ICTV)**. The main bases for classification include:

1. Based on Host Range

a. Animal Viruses

These viruses infect animals, including humans.

Examples: Influenza virus, Rabies virus.

b. Bacteriophages

These viruses infect bacteria.

Examples: T4 phage, Lambda phage.

c. Archaea Viruses

These viruses infect archaea.

Examples: Sulfolobus spindle-shaped virus.

2. Based on Morphology

a. Helical Viruses

Have a helical-shaped capsid surrounding the nucleic acid.

Examples: Tobacco mosaic virus, Rabies virus.

b. Icosahedral Viruses

Have a symmetrical icosahedral capsid.

Examples: Adenoviruses, Herpesviruses.

c. Complex Viruses

Possess a complex structure, combining helical and icosahedral features and often additional structures like tails.

Examples: Bacteriophages.

d. Enveloped Viruses

Have an outer lipid envelope derived from the host cell membrane.

Examples: Influenza virus, HIV.

Prions and viroids are also acellular. They are also not considered living organisms. Prions are composed of protein only and Viroids are composed of circular RNA only. Both these particles cause infectious diseases in certain plants.

e. Non-enveloped (Naked) Viruses

Lack an outer lipid envelope and consist only of a capsid enclosing nucleic acid.

Examples: Poliovirus, Adenovirus.

Based on Genetic Material

3. **a. DNA Viruses**

Contain **DNA** as their genetic material, which can be either single-stranded (ssDNA) or double-stranded (dsDNA).

dsDNA viruses: Adenoviruses (respiratory infections), Herpesviruses (herpes, chickenpox).

ssDNA viruses: Parvoviruses (gastroenteritis).

b. RNA Viruses

Contain **RNA** as their genetic material, which can be **single-stranded (ssRNA)** or **double-stranded (dsRNA)**.

ssRNA viruses: Coronaviruses (COVID-19), Influenza viruses (flu).

dsRNA viruses: Rotaviruses (gastroenteritis).

4. **Based on Replication Strategy**

a. Positive-Sense RNA Viruses

RNA genome is **directly translated** into proteins by the host cell's ribosomes.

Examples: Poliovirus, Hepatitis C virus.

b. Negative-Sense RNA Viruses

RNA genome must first be **transcribed into mRNA** by a viral RNA polymerase before translation.

Examples: Rabies virus, Ebola virus.

c. Reverse Transcribing Viruses

These viruses replicate through a **DNA intermediate** using the enzyme **reverse transcriptase**.

RNA genome: Retroviruses like HIV (AIDS).

DNA genome: Hepadnaviruses like Hepatitis B virus.

mQs

1. **Viruses are not classified as living organisms because they are:**

- A. Small
- B. Acellular ✓
- C. Bacteria
- D. Fungal

2. **A virus is made of:**

- A. Protein only
- B. DNA only
- C. Nucleic acid and protein coat ✓
- D. Lipid and sugar.

3. **Viruses require a host cell to:**

- A. Digest food
- B. Grow
- C. Metabolize independently
- D. Replicate ✓

4. **The ICTV classifies viruses based on:**

- A. Kingdom
- B. Size
- C. Replication strategy and host ✓
- D. Cell structure

5. **Viruses that infect animals are called:**

- A. Archaeaviruses
- B. Animal viruses ✓
- C. Bacteriophages
- D. Naked viruses

6. **Example of animal virus is:**

- A. T4 phage
- B. Influenza virus ✓
- C. Adenovirus
- D. Parvovirus

7. **T4 phage infects:**

- A. Plants
- B. Animals
- C. Bacteria ✓
- D. Fungi

8. **Shape of helical viruses is:**

- A. Spherical
- B. Helical ✓
- C. Cuboidal
- D. Pyramidal

9. **Icosahedral viruses have:**

- A. Tail fibers
- B. Envelopes
- C. 20-sided symmetrical capsid ✓
- D. Rod-shaped body

10. **An example of helical virus is:**

- A. Herpesvirus
- B. Rabies virus ✓
- C. Poliovirus
- D. Adenovirus

11. **Viruses with outer lipid envelope are called:**

- A. Complex
- B. Naked
- C. Enveloped ✓
- D. Helical

12. **Naked viruses:**

- A. Have no protein
- B. Have no nucleic acid
- C. Lack envelope ✓
- D. Are only found in animals

13. **DNA in viruses can be:**

- A. Only single-stranded
- B. Only double-stranded
- C. Either ssDNA or dsDNA ✓
- D. Absent

14. **Herpesvirus contains:**

- A. ssDNA
- B. dsDNA ✓
- C. ssRNA
- D. dsRNA

15. **RNA viruses include:**

- A. Parvoviruses
- B. Herpesviruses

16. **dsRNA viruses include:**
 A. Influenza viruses
 C. Rabies virus
 17. **Positive-sense RNA viruses can:**
 A. Act directly as mRNA ✓
 B. Infect only plants
 C. Destroy host DNA
 18. **Negative-sense RNA viruses must first:**
 A. Be digested

- B. Be transcribed into mRNA ✓
 C. Replicate DNA
 19. **Reverse transcribing viruses use:**
 A. DNA ligase
 C. Reverse transcriptase ✓
 D. Amylase
 20. **HIV is an example of:**
 A. DNA virus
 C. Complex virus
 D. Leave the host cell
 B. RNA polymerase
 B. Retrovirus ✓
 D. Helical virus



1. Why are viruses not considered organisms?

Ans. Viruses are not considered living organisms because they are acellular, meaning they are not made up of cells, which are the basic units of life. They lack essential cellular structures and do not carry out metabolic processes on their own. Therefore, they do not fulfill the criteria used to define living organisms.

2. Why are viruses not classified into any domain or kingdom?

Ans. Viruses are not placed in any of the domains or kingdoms of life because they do not exhibit the fundamental characteristics shared by cellular life forms. They lack cellular structure, do not grow, and cannot reproduce independently. Since they do not meet the biological criteria for living organisms, they are excluded from the traditional classification system.

3. What are viruses composed of?

Ans. Viruses are composed primarily of genetic material, either DNA or RNA, which carries the instructions for replication. This nucleic acid is enclosed within a protective protein coat called a capsid. Some viruses may also have an outer lipid envelope derived from the host cell membrane.

4. Why do viruses depend on host cells?

Ans. Viruses are unable to perform basic life processes such as metabolism or protein synthesis on their own. They rely entirely on a host cell's machinery to replicate their genetic material and produce viral proteins. This makes them obligate intracellular parasites, meaning they must infect a host to reproduce.

5. On what basis are viruses classified?

Ans. Viruses are classified based on a variety of characteristics including the type of nucleic acid they contain (DNA or RNA), their replication method, shape and structure (morphology), and the specific organisms they infect. This classification helps scientists better understand and study viral behavior and evolution.

6. What is the role of the ICTV in virus classification?

Ans. The International Committee on Taxonomy of Viruses (ICTV) is responsible for developing and maintaining a universal system for naming and classifying viruses. It sets the rules for how viruses should be grouped and named based on their genetic and structural properties. The ICTV ensures consistency and clarity in virology research and communication.

7. What are animal viruses? Give examples.

Ans. Animal viruses are viruses that specifically infect animal hosts, including humans. These viruses can cause a variety of diseases and spread through different means such as air, contact, or bodily fluids. Examples include the Influenza virus and Rabies virus.

8. What are bacteriophages? Give examples.

Ans. Bacteriophages, or phages, are viruses that infect and replicate within bacteria. They attach to the bacterial cell surface, inject their genetic material, and use the bacterial machinery to multiply. Examples include the T4 phage and Lambda phage.

9. What are archaea viruses? Give examples.

Ans. Archaea viruses are a group of viruses that specifically infect archaea, which are microorganisms distinct from bacteria and eukaryotes. These viruses are usually found in extreme environments such as hot springs or salty lakes. An example of an archaea virus is the Sulfolobus spindle-shaped virus.

10. Describe the morphology of complex viruses.

Ans. Complex viruses have intricate structures that go beyond the simple helical or icosahedral shapes seen in many viruses. They often have additional features like tail fibers or base plates, especially in bacteriophages, which help them attach to and penetrate host cells. A well-known example of a complex virus is the T4 bacteriophage.

1.7 BIODIVERSITY

Q 30. Define biodiversity and explain its assessment levels.

Ans. Definition of Biodiversity

Biodiversity, a term derived from "biological diversity," refers to the variety of life forms present in different ecosystems, encompassing the diversity of species, genes, and ecosystems. It represents the richness and variability of living organisms and their interactions with each other and their environments.

Biodiversity Assessment Levels

The assessment of biodiversity involves multiple levels, each providing unique insights into the complexity of life.

Species Level:

At the species level, biodiversity is assessed by identifying and counting the different species present within a given area. Species diversity includes not only the number of species but also their relative abundance and distribution.

Genetic Level:

At the genetic level, biodiversity refers to the variety of genetic information contained within all individual organisms of a species. This genetic diversity is crucial for the adaptability and survival of species, enabling them to cope with environmental changes and challenges.

Ecosystem Level:

At this level, biodiversity assessment includes the range of habitats, from forests and wetlands to grasslands and deserts. It involves understanding how different ecosystems function and how they contribute to overall ecological health.

Ecosystem:

An ecosystem is a dynamic and interactive system composed of living organisms and their physical environment. It includes all the biotic factors as well as the abiotic factors.

Niche:

A niche refers to the role or function of an organism or species within an ecosystem. It includes its habitat, its interactions with other organisms (predation, competition, and symbiosis), and its role in energy flow within

Q 31. Describe the importance of random sampling in determining biodiversity.

Ans. Importance of Random Sampling in Determining Biodiversity

Random sampling is a fundamental technique in ecological studies for assessing biodiversity within a specific area. This method is crucial for several reasons:

Minimizes Bias:

It ensures that every part of the study area has an equal chance of being sampled, which provides a more accurate representation of the overall biodiversity.

Provides Reliable Estimates:

Random sampling allows for the collection of data that can be statistically analyzed to estimate species richness, abundance, and distribution.

Facilitates Comparisons:

It enables comparisons between different areas or habitats by providing standardized methods of data collection.

Enhances Representativeness:

By covering different parts of the study area, random sampling ensures that the sample represents the diversity of the entire area.

Supports Conservation Efforts:

Accurate biodiversity assessments through random sampling are essential for identifying areas of high conservation value and for monitoring changes in biodiversity over time.

Q 32. Discuss various methods to assess the distribution and abundance of organisms.

Ans. Methods to Assess Biodiversity

Various methods are employed for assessing the distribution and abundance of organisms in an area:

Methods to Assess Distribution

Quadrat Sampling:

It involves dividing the study area into a grid and sampling within randomly selected squares (quadrats). This method is particularly useful for studying plant populations or sessile organisms. For example, in a forest, a researcher might lay out quadrats of a fixed size and record the presence or absence of each plant species within these quadrats.

Transect Sampling:

It involves laying out a line or strip (transect) across the study area and recording species at regular intervals along this line. This method is effective for studying the distribution of species across environments. For example, in a coastal zone, a transect can be laid from the high tide line to the low tide line, to record the types and abundance of intertidal organisms.

Aerial Surveys:

Aerial surveys use aircraft or drones to observe and record the distribution of organisms over large areas. For example, it can be used to track the distribution of bird species across a large wetland area or to monitor large mammal populations in savannas.

Methods to Assess Abundance

Point Counts:

Point counts involve observing and recording the number of individuals of a species from a fixed point over a specified period. This method is commonly used for birds and other mobile animals.

Mark-Recapture:

It involves capturing, marking, and releasing individuals of a species, then recapturing them later to estimate population size and density. This method is useful for animals that are difficult to count directly.

Quadrat Counts:

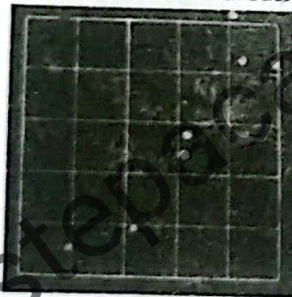
In this method, researchers use quadrats to count the number of individuals of a species within each quadrat and then infer these counts to estimate overall abundance.

Capture-Recapture Methods:

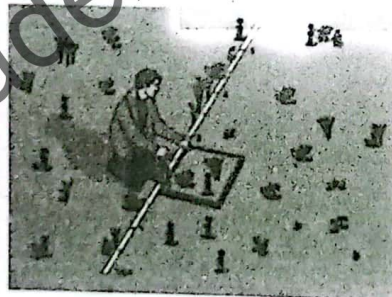
These models account for variables such as varying capture probabilities and movement between areas.

Remote Sensing:

Remote sensing uses satellite or drone imagery to assess the abundance and distribution of species, particularly for large-scale or inaccessible areas.



Quadrat Sampling



Transect Sampling



Aerial Surveys

Fig. 1.31: Methods to assess distribution of organisms

mQs

- | | |
|--|--|
| 1. What does the term "biodiversity" refer to?
A) The study of fossils
B) Variety of climates
C) Variety of life forms in ecosystems ✓
D) Life expectancy of organisms | B) Counting and identifying species ✓
C) Climate changes
D) Habitat structure |
| 2. Which of the following is not a level of biodiversity assessment?
A) Species level
B) Genetic level
C) Cellular level ✓
D) Ecosystem level | 4. Why is genetic diversity important?
A) It increases fossilization
B) It prevents mutation
C) It enables species to adapt and survive ✓
D) It reduces biodiversity |
| 3. What is the main focus at the species level of biodiversity?
A) Genetic variation | 5. Which level of biodiversity involves understanding how habitats like forests or wetlands function?
A) Species level
B) Genetic level
C) Ecosystem level ✓
D) Organismal level |

6. What does random sampling aim to minimize?
A) Errors
B) Costs
C) Time
D) Bias ✓
7. Which method divides the study area into squares for sampling?
A) Transect sampling
B) Aerial survey
C) Quadrat sampling ✓
D) Mark-recapture
8. Which sampling method involves a line across the study area?
A) Quadrat
B) Aerial
C) Point count
D) Transect ✓
9. Which method is useful for assessing bird populations?
A) Aerial survey
B) Quadrat sampling
C) Point counts ✓
D) Transect
10. What technique uses drones to assess species distribution?
A) Point count
B) Aerial survey ✓
C) Mark-recapture
D) Quadrat sampling
11. Which method is ideal for sessile organisms?
A) Mark-recapture
B) Quadrat sampling ✓
C) Point counts
D) Remote sensing
12. Which biodiversity level is concerned with DNA variation among individuals?
A) Species
B) Genetic ✓
C) Ecosystem
D) Morphological
13. Which method helps estimate population size by tagging animals?
A) Aerial survey
B) Point count
C) Mark-recapture ✓
D) Remote sensing
14. Remote sensing is most suitable for:
A) Studying bacteria
B) Small ponds
C) Large-scale or inaccessible areas ✓
D) Urban development
15. Which of the following contributes most directly to species adaptability?
A) Species count
B) Food chain
C) Genetic diversity ✓
D) Climatic conditions
16. Why is random sampling used in biodiversity assessment?
A) It is faster
B) It provides a complete census
C) It ensures equal chance for sampling ✓
D) It avoids human involvement
17. Transect sampling is particularly useful for:
A) Microbes
B) Studying changes across habitats ✓
C) Isolated species
D) Underground organisms
18. What is measured in point count method?
A) Vegetation growth
B) Animal tracks
C) Number of individuals from a fixed point ✓
D) Soil nutrients

19. What does quadrat count help estimate?
A) Climate
B) Species movement
C) Individual abundance ✓
D) Soil type
20. Which method combines marking and later capturing the same individuals?
A) Remote sensing
B) Quadrat sampling
C) Transect
D) Mark-recapture ✓
21. Biodiversity encompasses which of the following?
A) Weather, terrain, and population
B) Species, genes, and ecosystems ✓
C) Soil types and minerals
D) Food chains and food webs
22. Which method is effective in a coastal zone to study intertidal organisms?
A) Quadrat
B) Transect ✓
C) Remote sensing
D) Point count
23. Aerial surveys are least suitable for:
A) Birds in wetlands
B) Large mammals in savannas
C) Plants in a small garden ✓
D) Monitoring ecosystems
24. Which method involves counting organisms within fixed square areas?
A) Mark-recapture
B) Quadrat counts ✓
C) Point count
D) Aerial survey
25. Which factor is crucial for comparisons between habitats?
A) Number of observers
B) Sampling consistency ✓
C) Climate type
D) Animal size
26. What does ecosystem diversity include?
A) Only forest types
B) Only aquatic habitats
C) Variety of ecosystems and their functions ✓
D) Number of animals
27. Which of the following is a goal of biodiversity assessment?
A) To develop crops
B) To map cities
C) To monitor species richness ✓
D) To predict weather
28. Capture-recapture models consider which factor?
A) Age of species
B) Movement between areas ✓
C) Temperature
D) Water availability
29. Why is representativeness important in sampling?
A) For reducing cost
B) For statistical testing
C) To ensure diversity of entire area is reflected ✓
D) To save time
30. What supports conservation through biodiversity assessment?
A) Urban planning
B) Random sampling ✓
C) Pollination
D) Erosion control



1. What is biodiversity?

Ans. Biodiversity, a term derived from "biological diversity," refers to the variety of life forms present in different ecosystems, encompassing the diversity of species, genes, and ecosystems. It represents the richness and variability of living organisms and their interactions with each other and their environments.

2. What does species-level biodiversity assessment involve?

Ans. At the species level, biodiversity is assessed by identifying and counting the different species present within a given area. Species diversity includes not only the number of species but also their relative abundance and distribution.

3. What is meant by genetic-level biodiversity?

Ans. At the genetic level, biodiversity refers to the variety of genetic information contained within all individual organisms of a species. This genetic diversity is crucial for the adaptability and survival of species, enabling them to cope with environmental changes and challenges.

4. What does ecosystem-level biodiversity assessment include?

Ans. At this level, biodiversity assessment includes the range of habitats, from forests and wetlands to grasslands and deserts. It involves understanding how different ecosystems function and how they contribute to overall ecological health.

5. Why is random sampling important in biodiversity assessment?

Ans. Random sampling is a fundamental technique in ecological studies for assessing biodiversity within a specific area. This method is crucial for several reasons.

6. How does random sampling minimize bias in biodiversity studies?

Ans. It ensures that every part of the study area has an equal chance of being sampled, which provides a more accurate representation of the overall biodiversity.

7. How does random sampling provide reliable estimates?

Ans. Random sampling allows for the collection of data that can be statistically analyzed to estimate species richness, abundance, and distribution.

8. How does random sampling facilitate comparisons?

Ans. It enables comparisons between different areas or habitats by providing standardized methods of data collection.

9. What does random sampling enhance in biodiversity studies?

Ans. By covering different parts of the study area, random sampling ensures that the sample represents the diversity of the entire area.

10. How does random sampling support conservation efforts?

Ans. Accurate biodiversity assessments through random sampling are essential for identifying areas of high conservation value and for monitoring changes in biodiversity over time.

11. What is quadrat sampling?

Ans. It involves dividing the study area into a grid and sampling within randomly selected squares (quadrats). This method is particularly useful for studying plant populations or sessile organisms.

12. Give an example of quadrat sampling.

Ans. For example, in a forest, a researcher might lay out quadrats of a fixed size and record the presence or absence of each plant species within these quadrats.

13. What is transect sampling?

Ans. It involves laying out a line or strip (transect) across the study area and recording species at regular intervals along this line. This method is effective for studying the distribution of species across environments.

14. Give an example of transect sampling.

Ans. For example, in a coastal zone, a transect can be laid from the high tide line to the low tide line, to record the types and abundance of intertidal organisms.

15. What are aerial surveys in biodiversity assessment?


Ans. Aerial surveys use aircraft or drones to observe and record the distribution of organisms over large areas.

16. Give an example of an aerial survey.

Ans. For example, it can be used to track the distribution of bird species across a large wetland area or to monitor large mammal populations in savannas.

17. **What are point counts?**
 Ans. Point counts involve observing and recording the number of individuals of a species from a fixed point over a specified period. This method is commonly used for birds and other mobile animals.
18. **What is the mark-recapture method?**
 Ans. It involves capturing, marking, and releasing individuals of a species, then recapturing them later to estimate population size and density. This method is useful for animals that are difficult to count directly.
19. **How is abundance estimated using quadrats?**
 Ans. In this method, researchers use quadrats to count the number of individuals of a species within each quadrat and then infer these counts to estimate overall abundance.
20. **What are capture-recapture methods?**
 Ans. These models account for variables such as varying capture probabilities and movement between areas.
21. **What is the role of remote sensing in biodiversity studies?**
 Ans. Remote sensing uses satellite or drone imagery to assess the abundance and distribution of species, particularly for large-scale or inaccessible areas.
22. **Why is genetic diversity crucial for species survival?**
 Ans. Genetic diversity is crucial for the adaptability and survival of species, enabling them to cope with environmental changes and challenges.
23. **What does species diversity include?**
 Ans. Species diversity includes not only the number of species but also their relative abundance and distribution.
24. **Why is it important to understand how ecosystems function?**
 Ans. It helps in understanding how different ecosystems function and how they contribute to overall ecological health.
25. **Why are standardized methods important in biodiversity studies?**
 Ans. Standardized methods enable comparisons between different areas or habitats by providing consistent techniques for data collection.
26. **How does biodiversity reflect the richness of life?**
 Ans. It represents the richness and variability of living organisms and their interactions with each other and their environments.
27. **How does random sampling ensure representativeness?**
 Ans. By covering different parts of the study area, random sampling ensures that the sample represents the diversity of the entire area.
28. **How does remote sensing help in inaccessible areas?**
 Ans. Remote sensing uses satellite or drone imagery to assess the abundance and distribution of species, particularly for large-scale or inaccessible areas.
29. **What is the significance of monitoring changes in biodiversity over time?**
 Ans. Monitoring changes in biodiversity over time is essential for identifying areas of high conservation value and evaluating the success of conservation efforts.
30. **What does biodiversity encompass at the ecosystem level?**
 Ans. At this level, biodiversity assessment includes the range of habitats, from forests and wetlands to grasslands and deserts.

1.8 SPECIES AND SPECIATION

-  33. **Define the term "species" and explain the challenges in identifying species. Also describe Ernst Mayr's concept of species.**

Ans. Definition of Species
 The term "species" is a fundamental concept in Biology. A species is generally defined as a group of individuals that can interbreed and produce fertile offspring under natural conditions.

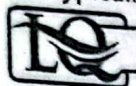
Common Features of a Species
 Members of the same species share common characteristics and genetic makeup, which distinguishes them from individuals of other species.

Challenges In Identifying Species

Identification of species by using physical traits and similarities can sometimes be problematic due to the existence of cryptic species - organisms that appear similar but are genetically distinct.

Ernst Mayr's Concept of Species

To address this, German-American biologist, Ernst Mayr, emphasized reproductive isolation as the key criterion. According to this concept, species are groups of interbreeding natural populations. Members of different species do not typically mate or produce viable, fertile offspring.



34. What is speciation? Describe the mechanisms through which new species arise.

Ans. Definition of Speciation

Speciation is the evolutionary process by which new species arise from a common ancestor. It involves the accumulation of genetic changes that lead to reproductive isolation between populations.

1. Allopatric Speciation

It occurs when a population is geographically separated into two or more isolated groups. These groups experience different environments and evolve independently. Over time, the accumulated differences can become significant enough to prevent interbreeding, even if the geographical barrier is removed.

Example: An example is the speciation observed in Darwin's finches on the Galápagos Islands, where different populations adapted to diverse environments.

2. Peripatric Speciation

It involves a small, isolated population at the edge of a larger population. The small population undergoes rapid evolutionary changes, leading to divergence from the original population.

Example: An example can be seen in island species that evolve from a small founding population.

3. Parapatric Speciation

This occurs when populations are adjacent to each other but occupy different environments along a gradient. Gene flow between the populations is limited, and they evolve adaptations to their specific environments. Over time, this can lead to reproductive isolation.

Example: An example is the grass species *Anthoxanthum odoratum*, which exhibits different adaptations to varying soil conditions across a gradient, leading to reproductive isolation in different soil types.

4. Sympatric Speciation

In this form, new species arise within the same geographical area without physical barriers. Sympatric speciation often occurs through mechanisms such as polyploidy (where an organism has multiple sets of chromosomes) or niche differentiation (where different subpopulations exploit different resources).

Example: For instance, certain plants can undergo polyploidy, leading to immediate reproductive isolation and the formation of new species.

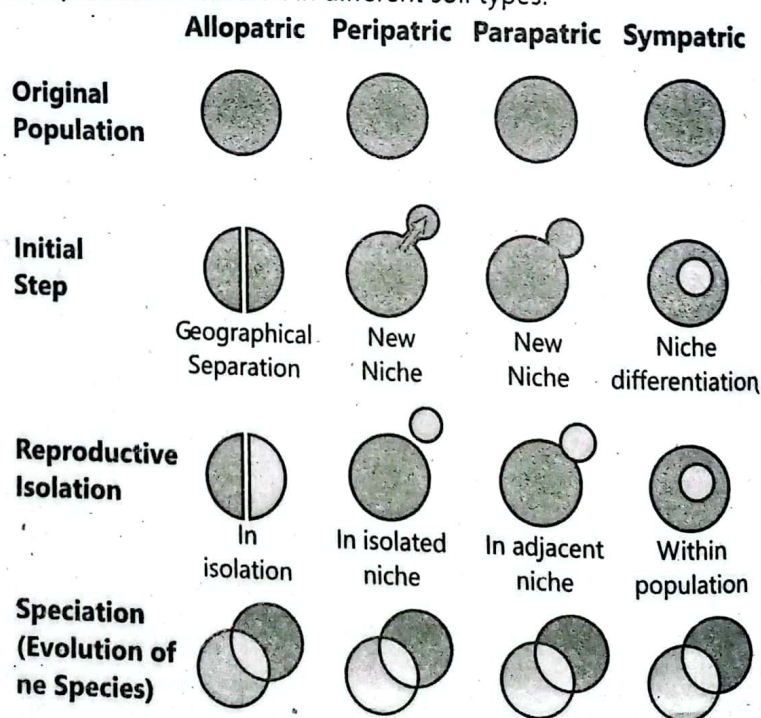


Fig. 1.32: Modes of speciation

1. Which of the following best defines a species?
 - A. A group of organisms living in the same habitat
 - B. Organisms with similar physical traits
 - C. A group of individuals that can interbreed and produce fertile offspring ✓
 - D. Organisms that are genetically unrelated
2. Who emphasized reproductive isolation as the key criterion for defining species?
 - A. Charles Darwin
 - B. Ernst Mayr ✓
 - C. Gregor Mendel
 - D. Jean-Baptiste Lamarck
3. What problem arises when identifying species using only physical traits?
 - A. They are always correct
 - B. Physical traits evolve slowly
 - C. Cryptic species may be genetically different ✓
 - D. Traits are always identical across species
4. Speciation refers to the:
 - A. Disappearance of a species
 - B. Formation of new genes
 - C. Evolution of new species from a common ancestor ✓
 - D. Mixing of different species
5. What is the main factor in reproductive isolation according to Ernst Mayr?
 - A. Behavioral similarity
 - B. Physical appearance
 - C. Inability to produce fertile offspring ✓
 - D. Living in the same area
6. Allopatric speciation occurs due to:
 - A. Behavioral changes
 - B. Geographic isolation ✓
 - C. Chromosomal mutations
 - D. Niche differentiation
7. Which of the following is an example of allopatric speciation?
 - A. Darwin's finches on Galápagos Islands ✓
 - B. Polyploid plants
 - C. Grass species on different soils
 - D. Frogs mating in the same pond
8. Peripatric speciation typically involves:
 - A. A large population
 - B. Gene flow between populations
 - C. A small isolated population ✓
 - D. Polyploidy
9. Which process can lead to rapid evolutionary changes in small populations?
 - A. Gene flow
 - B. Migration
 - C. Peripatric speciation ✓
 - D. Stabilizing selection
10. Parapatric speciation involves populations that are:
 - A. Completely isolated
 - B. Interbreeding freely
 - C. Living adjacent to each other ✓
 - D. Separated by oceans
11. Limited gene flow is a feature of which type of speciation?
 - A. Allopatric
 - B. Sympatric
 - C. Parapatric ✓
 - D. Peripatric
12. Which grass species is an example of parapatric speciation?
 - A. Triticumaestivum
 - B. Zea mays
 - C. Anthoxanthumodoratum ✓
 - D. Oryzasativa
13. Sympatric speciation occurs without:
 - A. Evolutionary change
 - B. Reproductive isolation
 - C. Geographic barriers ✓
 - D. Mutation
14. Which of the following can lead to sympatric speciation in plants?
 - A. Geographic separation
 - B. Niche overlap
 - C. Polyploidy ✓
 - D. Migration
15. Niche differentiation is a mechanism of:
 - A. Allopatric speciation
 - B. Parapatric speciation
 - C. Sympatric speciation ✓
 - D. Peripatric speciation
16. A key requirement for speciation to occur is:
 - A. Mutation only
 - B. Reproductive isolation ✓
 - C. Migration
 - D. Extinction
17. Which type of speciation involves species arising from founding populations on islands?
 - A. Allopatric
 - B. Sympatric
 - C. Parapatric
 - D. Peripatric ✓
18. Which of the following involves divergence along an environmental gradient?
 - A. Allopatric speciation
 - B. Parapatric speciation ✓
 - C. Sympatric speciation
 - D. Peripatric speciation
19. Polyploidy is most commonly associated with speciation in:
 - A. Animals
 - B. Bacteria
 - C. Plants ✓
 - D. Fungi
20. The most immediate result of polyploidy in a plant is:
 - A. Genetic uniformity
 - B. Reproductive isolation ✓
 - C. Extinction
 - D. Habitat loss

- Q1. What is the definition of a species in Biology?**
 Ans. A species is generally defined as a group of individuals that can interbreed and produce fertile offspring under natural conditions.
- Q2. What common features do members of the same species share?**
 Ans. Members of the same species share common characteristics and genetic makeup, which distinguishes them from individuals of other species.

3. Why can identifying species based on physical traits be problematic?

Ans. Identification of species by using physical traits and similarities can sometimes be problematic due to the existence of cryptic species - organisms that appear similar but are genetically distinct.

4. What are cryptic species?

Ans. Cryptic species are organisms that appear similar but are genetically distinct.

5. How did Ernst Mayr address the problem of identifying species?

Ans. To address this, German-American biologist, Ernst Mayr, emphasized reproductive isolation as the key criterion.

6. According to Ernst Mayr, how are species defined?

Ans. According to this concept, species are groups of interbreeding natural populations.

7. What is the role of reproductive isolation in defining species?

Ans. Reproductive isolation is the key criterion in defining species, as members of different species do not typically mate or produce viable, fertile offspring.

8. Do members of different species usually produce fertile offspring?

Ans. Members of different species do not typically mate or produce viable, fertile offspring.

9. What is speciation?

Ans. Speciation is the evolutionary process by which new species arise from a common ancestor.

10. How does speciation occur?

Ans. It involves the accumulation of genetic changes that lead to reproductive isolation between populations.

11. What does allopatric speciation involve?

Ans. Allopatric speciation occurs when a population is geographically separated into two or more isolated groups.

12. What happens to the separated groups in allopatric speciation?

Ans. These groups experience different environments and evolve independently.

13. What can accumulated differences in allopatric speciation lead to?

Ans. Over time, the accumulated differences can become significant enough to prevent interbreeding, even if the geographical barrier is removed.

14. What is an example of allopatric speciation?

Ans. An example is the speciation observed in Darwin's finches on the Galápagos Islands, where different populations adapted to diverse environments.

15. What is peripatric speciation?

Ans. Peripatric speciation involves a small, isolated population at the edge of a larger population.

16. What happens to the small population in peripatric speciation?

Ans. The small population undergoes rapid evolutionary changes, leading to divergence from the original population.

17. Where can peripatric speciation commonly be observed?

Ans. An example can be seen in island species that evolve from a small founding population.

18. What is parapatric speciation?

Ans. Parapatric speciation occurs when populations are adjacent to each other but occupy different environments along a gradient.

19. How does gene flow function in parapatric speciation?

Ans. Gene flow between the populations is limited, and they evolve adaptations to their specific environments.

20. What is the eventual outcome of parapatric speciation?

Ans. Over time, this can lead to reproductive isolation.

21. What is an example of parapatric speciation?

Ans. An example is the grass species "Anthoxanthum odoratum", which exhibits different adaptations to varying soil conditions across a gradient, leading to reproductive isolation in different soil types.

22. What does sympatric speciation involve?

Ans. In this form, new species arise within the same geographical area without physical barriers.

23. **What mechanisms often lead to sympatric speciation?**
 Ans. Sympatric speciation often occurs through mechanisms such as polyploidy (where an organism has multiple sets of chromosomes) or niche differentiation (where different subpopulations exploit different resources).
24. **What is polyploidy in the context of sympatric speciation?**
 Ans. Polyploidy is a condition where an organism has multiple sets of chromosomes.
25. **How does polyploidy contribute to sympatric speciation?**
 Ans. Certain plants can undergo polyploidy, leading to immediate reproductive isolation and the formation of new species.
26. **What is niche differentiation?**
 Ans. Niche differentiation is where different subpopulations exploit different resources.
27. **How does niche differentiation lead to sympatric speciation?**
 Ans. Niche differentiation allows subpopulations to evolve separately within the same geographical area, eventually leading to reproductive isolation.
28. **Can sympatric speciation occur without physical barriers?**
 Ans. Yes, in sympatric speciation, new species arise within the same geographical area without physical barriers.
29. **Which species of grass provides an example of parapatric speciation?**
 Ans. The grass species "Anthoxanthum odoratum" provides an example, with different adaptations to varying soil conditions leading to reproductive isolation.
30. **Why is reproductive isolation central to all forms of speciation?**
 Ans. Because reproductive isolation prevents gene flow between populations, allowing them to evolve independently and form new species.

SOLVED EXERCISE

MULTIPLE CHOICE QUESTIONS

Tick (✓) the correct answer.

- Which domain of life is characterized by organisms that often inhabit extreme environments and have cell membranes with ether-linked lipids?
 (a) Bacteria (b) Archaea ✓ (c) Eukarya (d) Protista
- What is a key difference between the domains Bacteria and Archaea?
 (a) Bacteria have membrane-bound organelles, while Archaea do not.
 (b) Bacterial cell walls have peptidoglycan, while Archaeal cell walls do not have it. ✓
 (c) Archaea are only found in extreme environments, while Bacteria are not.
 (d) Bacteria are all unicellular, while Archaea include multicellular organisms.
- Which of the following kingdoms includes organisms that are mostly unicellular, eukaryotic, and can be autotrophic or heterotrophic?
 (a) Fungi (b) Animalia (c) Plantae (d) Protocista ✓
- In which kingdom are organisms predominantly multicellular, autotrophic, and have cell walls made of cellulose?
 (a) Animalia (b) Fungi (c) Plantae ✓ (d) Protocista
- Which of the following criteria is commonly used to classify viruses?
 (a) Their ability to cause specific diseases
 (b) The type of nucleic acid they contain ✓
 (c) The colour of the virus particles
 (d) Their mode of transmission
- Which virus group includes viruses such as Coronaviruses and Influenza viruses?
 (a) Double-stranded DNA viruses
 (b) Single-stranded DNA viruses
 (c) Double-stranded RNA viruses
 (d) Single-stranded RNA viruses ✓
- At which level of biodiversity assessment do we evaluate the variety of different species within a particular habitat or ecosystem?
 (a) Genetic diversity (b) Ecosystem diversity (c) Species diversity ✓ (d) Functional diversity

8. Which method is best suited for assessing the distribution of species across a gradient of environmental conditions within a single geographical area?
 (a) Quadrat Sampling (b) Point Counts (c) Transect Sampling ✓ (d) Remote Sensing
9. Which of the following statements is true regarding the concept of a species?
 (a) A species is always defined by its physical characteristics alone.
 (b) Different species can interbreed and produce fertile offspring.
 (c) Members of the same species are reproductively isolated from members of other species. ✓
 (d) The concept of a species can be defined solely based on genetic similarity.
10. What type of speciation occurs when populations are geographically separated by a physical barrier?
 (a) Sympatric Speciation (b) Parapatric Speciation (c) Allopatric Speciation ✓ (d) Peripatric Speciation

SHORT ANSWER QUESTIONS

1. What are the three domains of life and how do they differ in terms of cellular structure?
Ans. The three domains of life are Archaea, Bacteria, and Eukarya. Archaea and Bacteria are **prokaryotic** (no nucleus), but differ in cell wall and membrane composition. Eukarya are **eukaryotic**, having a true nucleus and membrane-bound organelles.
2. Describe one key feature that differentiates Archaea from Bacteria.
Ans. One key feature that differentiates Archaea from Bacteria is that Archaea have cell membranes with ether-linked branched lipids, while Bacteria have **ester-linked unbranched lipids**.
3. Which kingdom is characterized by organisms with chitin in their cell walls and that are mostly decomposers?
Ans. The **Fungi** kingdom is characterized by organisms with **chitin** in their cell walls and that are mostly decomposers.
4. What type of speciation occurs when populations are geographically separated?
Ans. **Allopatric speciation** occurs when populations are **geographically separated**, leading to the formation of new species.
5. Which kingdom is characterized by organisms with chitin in their cell walls and that are mostly decomposers?
Ans. The Fungi kingdom is characterized by organisms with chitin in their cell walls and that are mostly decomposers.
6. What type of speciation occurs when populations are geographically separated?
Ans. **Allopatric speciation** occurs when populations are **geographically separated**, leading to the formation of new species.
7. What is the role of genetic drift in the process of speciation?
Ans. **Genetic drift** causes random changes in allele frequencies, especially in small populations, which can lead to genetic divergence and contribute to speciation over time.
8. What is the primary method used to assess species distribution along an environmental gradient?
Ans. The primary method used to assess species distribution along an environmental gradient is **transect sampling**.
9. Which level of biodiversity assessment involves evaluating the variety of ecosystems in a region?
Ans. The **ecosystem level** of biodiversity assessment involves evaluating the variety of **ecosystems** in a region.

LONG QUESTIONS

- Q1. Compare and contrast the domains Archaea and Bacteria and discuss how these differences reflect their evolutionary histories.

Ans.

Feature	Archaea	Bacteria	Evolutionary Implications
Cell Membrane Lipids	Ether-linked branched lipids	Ester-linked unbranched fatty acids	Archaea's ether bonds provide membrane stability in extreme environments; distinct membrane chemistry suggests early divergence from bacteria.
Cell Wall Composition	Lack peptidoglycan; contain pseudopeptidoglycan,	Contain peptidoglycan	Peptidoglycan is unique to bacteria, showing a fundamental biochemical

Feature	Archaea	Bacteria	Evolutionary Implications
	polysaccharides, proteins		difference and separate lineage.
Genetic Similarity	Genes and transcription machinery resemble Eukarya	Unique bacterial genetic sequences	Archaea share molecular machinery with eukaryotes, indicating a closer evolutionary relationship to Eukarya than to Bacteria.
Metabolic Processes	Methanogenesis (methane production), extremophilic adaptations	Photosynthesis, nitrogen fixation, fermentation	Unique archaeal metabolisms reflect adaptation to extreme niches; bacterial diversity includes many ecological roles.
Reproduction	Asexual (binary fission, budding, fragmentation) without mitosis or meiosis	Primarily asexual binary fission	Both reproduce asexually, but differences in cell division mechanisms align with genetic machinery differences.
Morphology	Various shapes (spherical, rod, spiral, lobed, rectangular)	Various shapes (cocci, bacilli, spirilla, vibrios)	Morphological diversity reflects adaptation, but shape types overlap broadly.
Habitat	Often extremophiles: hot springs, salt lakes, anaerobic environments; also common habitats	Ubiquitous: soil, water, living hosts, and some extremophiles	Archaea adapted to extreme environments early, showing ancient lineage; bacteria are more broadly distributed.
Flagella and Motility	Present, but structurally different from bacterial flagella	Present, structurally distinct flagella	Structural differences in motility apparatus underline evolutionary divergence.
Plasmids and Genetic Exchange	Limited knowledge, but genetic exchange mechanisms exist	Plasmids common, aid in horizontal gene transfer	Horizontal gene transfer is widespread in bacteria, influencing rapid adaptation.
Pathogenicity	No known pathogens	Many pathogens of humans, animals, plants	Pathogenicity mainly evolved in bacteria, reflecting different ecological interactions.
Symbiotic Relationships	Found in symbiosis, e.g., in human gut	Many symbiotic forms, mutualism, commensalism	Both participate in symbiosis, but bacterial symbiosis is more widespread and varied.

How These Differences Reflect Their Evolutionary Histories

Archaea and Bacteria diverged very early in the tree of life, representing two distinct evolutionary lineages of prokaryotes.

The **unique lipid chemistry in Archaea** suggests adaptations to harsh environments, indicating they may represent some of the earliest life forms capable of surviving extreme conditions.

Genetic and molecular similarities between Archaea and Eukarya (e.g., DNA replication, transcription, translation mechanisms) imply that Archaea are more closely related to Eukarya than to Bacteria, supporting the idea that Eukaryotes may have evolved from an archaeal ancestor.

The presence of **peptidoglycan in Bacteria** is a hallmark of their distinct evolutionary path, linked to their structural and ecological diversity, including pathogenicity.

Metabolic pathways such as **methanogenesis in Archaea** are unique and ancient, reflecting ecological niches that were possibly prevalent in early Earth environments.

The absence of **peptidoglycan** and presence of **pseudopeptidoglycan** in Archaea underscore their unique biochemistry and evolutionary adaptation, distinct from bacterial cell wall evolution.

In summary, these differences illustrate that while Archaea and Bacteria share prokaryotic organization, they represent fundamentally different domains with unique evolutionary trajectories shaped by ancient adaptations and genetic divergence.

Q2. Explain the concept of a species according to the biological species concept. How does this definition help in understanding species boundaries and the process of speciation? Provide examples to illustrate your points.

Ans. Biological Species Concept (BSC)

The **Biological Species Concept**, formulated primarily by Ernst Mayr, defines a **species** as:

"A group of interbreeding natural populations that are reproductively isolated from other such groups."

This means individuals within a species can mate and produce fertile offspring under natural conditions, but they cannot successfully breed with members of other species.

How BSC Helps in Understanding Species Boundaries

Reproductive Isolation: The core idea is that species boundaries are maintained by barriers to reproduction, preventing gene flow between different species. These barriers can be:

Prezygotic (before fertilization): different mating behaviors, physical incompatibilities, or temporal isolation (breeding at different times).

Postzygotic (after fertilization): hybrid inviability or sterility (e.g., mule – offspring of horse and donkey – is sterile).

By focusing on **reproductive compatibility**, BSC helps biologists determine whether populations are separate species or part of the same species.

Understanding Speciation with BS

Speciation is the evolutionary process where one species splits into two or more reproductively isolated groups. According to BSC, speciation occurs when populations develop **reproductive barriers** that prevent gene flow.

Initially, populations may interbreed freely. Over time, factors like geographic isolation, natural selection, or genetic drift cause divergence and reproductive isolation.

Once reproductive isolation is complete, two distinct species exist.

Examples

Eastern and Western Meadowlarks (Birds)

Though very similar in appearance, they do not interbreed in the wild because their mating calls differ significantly, a **prezygotic barrier**.

According to BSC, they are distinct species because they are reproductively isolated.

Horse and Donkey

Horses and donkeys can mate and produce offspring (mules), but the mules are sterile.

This **postzygotic barrier** means horses and donkeys are separate species.

Ring Species (e.g., Salamanders)

Neighboring populations can interbreed, but populations at the ends of the "ring" cannot.

Shows gradual speciation and how reproductive isolation can define species boundaries.

Limitations of BSC

It cannot be applied to **asexual organisms** (bacteria, some plants).

It is hard to apply to fossils or geographically separated populations that do not overlap.

Sometimes different species can hybridize (e.g., some plants), blurring boundaries.

Q3. Explain the concept of a species according to the biological species concept. How does this definition help in understanding species boundaries and the process of speciation? Provide examples to illustrate your points.

Ans. Biological Species Concept (BSC)

The **Biological Species Concept**, formulated primarily by Ernst Mayr, defines a **species** as:

"A group of interbreeding natural populations that are reproductively isolated from other such groups."

This means individuals within a species can mate and produce fertile offspring under natural conditions, but they cannot successfully breed with members of other species.

How BSC Helps in Understanding Species Boundaries

Reproductive Isolation: The core idea is that species boundaries are maintained by barriers to reproduction, preventing gene flow between different species. These barriers can be:

Prezygotic (before fertilization): different mating behaviors, physical incompatibilities, or temporal isolation (breeding at different times).

Postzygotic (after fertilization): hybrid inviability or sterility (e.g., mule – offspring of horse and donkey – is sterile).

By focusing on **reproductive compatibility**, BSC helps biologists determine whether populations are separate species or part of the same species.

Understanding Speciation with BS

Speciation is the evolutionary process where one species splits into two or more reproductively isolated groups. According to BSC, speciation occurs when populations **develop reproductive barriers** that prevent gene flow.

Initially, populations may interbreed freely. Over time, factors like geographic isolation, natural selection, or genetic drift cause divergence and reproductive isolation.

Once reproductive isolation is complete, two distinct species exist.

Examples

Eastern and Western Meadowlarks (Birds)

Though very similar in appearance, they do not interbreed in the wild because their mating calls differ significantly, a **prezygotic barrier**.

According to BSC, they are distinct species because they are reproductively isolated.

Horse and Donkey

Horses and donkeys can mate and produce offspring (mules), but the mules are sterile.

Ring Species (e.g., Salamanders)

This **postzygotic barrier** means horses and donkeys are separate species.

Neighboring populations can interbreed, but populations at the ends of the "ring" cannot.

Shows gradual speciation and how reproductive isolation can define species boundaries.

Limitations of BSC

It cannot be applied to **asexual organisms** (bacteria, some plants).

It is hard to apply to fossils or geographically separated populations that do not overlap.

Sometimes different species can hybridize (e.g., some plants), blurring boundaries.

Q4. Discuss the mechanisms of allopatric and sympatric speciation.

Ans. See long question number 34 section 1.8-Species and Speciation

Q5. Describe the main characteristics of the kingdoms Protocista, Fungi, Plantae, and Animalia. Provide examples for each kingdom.

Ans. See question 1 section 1.3 (Salient Features of Kingdoms of Domain Eukarya)

Outline the major classification systems for viruses based on their structural features and replication methods.

Q6. Discuss the significance of these classifications in virology.

Ans. For major classification systems for viruses see section 1.6-Classification of Viruses. And the significance of these classifications is given below:

Understanding Virus Biology

Classification by structure and replication reveals how viruses infect hosts, replicate, and evolve.

Epidemiology and Control

Knowing virus classification aids in predicting transmission routes, environmental survival, and potential hosts, which is essential for controlling outbreaks.

Vaccine and Antiviral Development

Structural and replication features identify viral targets for vaccines and drugs (e.g., targeting reverse transcriptase in retroviruses).

Diagnostic Tools

Classification informs molecular diagnostic tests, helping detect specific viral groups based on genome type or proteins.

Evolutionary Insights

Understanding relationships between virus groups clarifies viral evolution and the emergence of new pathogens.

Q7. Discuss the mechanisms of allopatric and sympatric speciation.

Ans. See section 1.8-Species and Speciation

Q8. Describe the main characteristics of the kingdoms Protocista, Fungi, Plantae, and Animalia. Provide examples for each kingdom.

Ans. See question 1 section 1.3 (Salient Features of Kingdoms of Domain Eukarya)

Outline the major classification systems for viruses based on their structural features and replication methods.

Q6. Discuss the significance of these classifications in virology.

Ans. For major classification systems for viruses see section 1.6-Classification of Viruses. And the significance of these classifications is given below:

Understanding Virus Biology

Classification by structure and replication reveals how viruses infect hosts, replicate, and evolve.

Epidemiology and Control

Knowing virus classification aids in predicting transmission routes, environmental survival, and potential hosts, which is essential for controlling outbreaks.

Vaccine and Antiviral Development

Structural and replication features identify viral targets for vaccines and drugs (e.g., targeting reverse transcriptase in retroviruses).

Diagnostic Tools

Classification informs molecular diagnostic tests, helping detect specific viral groups based on genome type or proteins.

Evolutionary Insights

Understanding relationships between virus groups clarifies viral evolution and the emergence of new pathogens.

Q9. Explain the different levels at which biodiversity can be assessed. How do these levels contribute to our understanding of biological diversity and conservation efforts?

Ans. See Section 1.7- Biodiversity

Q10. Discuss the importance of random sampling methods in ecological studies.

Ans. See Section 1.7- Biodiversity

Q11. Describe the concept of an ecosystem and niche.

Ans.

1. Ecosystem:

Definition: An **ecosystem** is a community of living organisms (**biotic components**) interacting with each other and with their non-living environment (**abiotic components**) within a particular area. These interactions involve the flow of energy and the cycling of nutrients.

i. Components of an Ecosystem:

- a) **Biotic Factors:** Plants, animals, bacteria, fungi, and other living organisms.
- b) **Abiotic Factors:** Sunlight, temperature, water, air, soil, and minerals.

ii. Types of Ecosystems:

- a) **Terrestrial ecosystems:** Forests, deserts, grasslands.
- b) **Aquatic ecosystems:** Freshwater (lakes, rivers), marine (oceans, coral reefs).

iii. Ecosystem Functions:

- a) **Energy Flow:** Sun → Producers → Consumers → Decomposers.
- b) **Nutrient Cycling:** Recycling of nutrients like carbon, nitrogen, and water.

Example: Forest ecosystem **includes:**

- a) **Producers:** Trees and plants that make food through photosynthesis.
- b) **Consumers:** Deer, birds, and insects feeding on plants or other animals.
- c) **Decomposers:** Fungi and bacteria that break down dead organisms.

2. Ecological Niche

Definition: A **niche** refers to the role or function of an organism within an ecosystem, including how it **obtains its food, survives, and interacts** with other organisms and its environment.

i. Aspects of a Niche:

- a) **Habitat:** Where the organism lives.
- b) **Trophic Role:** What it eats and what eats it (its position in the food chain).
- c) **Behavior:** Activity patterns, reproduction, etc.
- d) **Interactions:** Competition, predation, symbiosis.

ii. Types of Niche:

- a) **Fundamental Niche:** The full range of environmental conditions an organism can theoretically occupy.
- b) **Realized Niche:** The actual conditions the organism occupies due to competition and other limiting factors.

Example:

The niche of a **honeybee** includes:

- a) **Pollinating flowers (ecological role)**
- b) **Living in hives (habitat)**
- c) **Feeding on nectar (diet)**

INQUISITIVE QUESTIONS

1. **How are viruses classified based on their nucleic acid content and replication method?**

- Ans.** Viruses are primarily classified based on:
Type of nucleic acid: Either DNA or RNA, which can be single-stranded (ss) or double-stranded (ds).
Polarity of the nucleic acid: For RNA viruses, whether the RNA is positive-sense (can directly act as mRNA) or negative-sense (needs to be transcribed into positive-sense RNA first).
Replication strategy: How the virus synthesizes its RNA or DNA and assembles new virions. For instance:
(i) Retroviruses (like HIV) use reverse transcriptase to convert RNA into DNA.
(ii) DNA viruses typically replicate in the host's nucleus, while RNA viruses usually replicate in the cytoplasm.
Baltimore Classification System groups viruses into seven classes based on these characteristics.

2. **What may be the drawback in the definition of species according to the biological species concept?**

Ans. The Biological Species Concept defines a species as a group of organisms that can interbreed and produce fertile offspring under natural conditions. However, it has several drawbacks, including:
(i) It does not apply to asexual organisms (like bacteria) which do not reproduce sexually.
(ii) It is inapplicable to fossils where breeding behavior cannot be observed.
(iii) It struggles with organisms that hybridize, such as some plants or closely related animal species.
(iv) It can be difficult to test reproductive isolation in practice, especially for geographically separated populations.

3. **How does biodiversity help maintain balance in an ecosystem?**

- Ans.** Biodiversity plays a crucial role in ecosystem stability and health by:
(i) **Enhancing resilience:** Diverse ecosystems can better withstand environmental changes, diseases, and disruptions.
(ii) **Providing ecosystem services:** Including pollination, nutrient cycling, water purification, and climate regulation.
(iii) **Supporting food webs:** A variety of producers, consumers, and decomposers ensure energy flow and nutrient recycling.
(iv) **Reducing dependency on single species:** Prevents ecological collapse if one species declines or goes extinct.

In essence, the greater the biodiversity, the more robust and sustainable the ecosystem tends to be.

Self-Assessment Unit 1

Max. Marks: 28

Time allowed 60 Mins

Q1. Each of the following question has four options. Select the correct answer. (10x1=10)

1. **Which domain includes organisms that commonly live in extreme conditions and have membranes made of ether-linked lipids?**
(a) Bacteria (b) Archaea
(c) Eukarya (d) Protista
2. **What is a distinguishing feature between Bacteria and Archaea domains?**
(a) Bacteria possess membrane-bound organelles, Archaea do not
(b) Bacterial cell walls contain peptidoglycan, Archaeal walls lack it
(c) Archaea live only in hot springs, Bacteria do not
(d) Bacteria are single-celled, Archaea form multicellular bodies
3. **Which kingdom is mainly made up of unicellular eukaryotes that may be autotrophs or heterotrophs?**
(a) Fungi (b) Animalia
(c) Plantae (d) Protocista
4. **Organisms that are largely autotrophic, multicellular, and have cellulose in their cell walls belong to which kingdom?**
(a) Animalia (b) Fungi (c) Plantae (d) Protocista
5. **Viruses are primarily classified based on which of the following features?**
(a) Their ability to infect specific hosts (b) The nature of their nucleic acid
(c) Their shape or size (d) Their method of spreading
6. **Coronaviruses and influenza viruses fall under which virus category?**
(a) Double-stranded DNA viruses (b) Single-stranded DNA viruses
(c) Double-stranded RNA viruses (d) Single-stranded RNA viruses
7. **Which level of biodiversity focuses on the number of different species in an ecosystem or community?**
(a) Genetic diversity (b) Habitat diversity
(c) Species diversity (d) Ecological diversity
8. **Which sampling technique is most appropriate for studying species changes across an environmental gradient in one area?**
(a) Quadrat method (b) Point count technique
(c) Transect line sampling (d) Satellite imaging
9. **Which of the following best describes a biological species?**
(a) Defined only by external appearance
(b) Able to interbreed with other species and produce fertile offspring
(c) Reproductively isolated from other species
(d) Determined solely by comparing DNA sequences
10. **What is the term for the formation of new species due to physical geographic separation?**
(a) Sympatric speciation (b) Parapatric speciation
(c) Allopatric speciation (d) Peripatric speciation

Q2. Write short answers to the following questions.

(5x2=10)

1. What are the three domains of life and how do they differ in terms of cellular structure?
2. Describe one key feature that differentiates Archaea from Bacteria.
3. Which kingdom is characterized by organisms with chitin in their cell walls and that are mostly decomposers?
4. What type of speciation occurs when populations are geographically separated?
5. What is the role of genetic drift in the process of speciation?

Q3. Write detailed answer to the following question.

(4+4=8)

1. Discuss the mechanisms of allopatric and sympatric speciation.
2. Discuss the importance of random sampling methods in ecological studies.