CLASS 9 SCIENCE

Chapter 12 Notes

Patterns in Life: Diversity and Classification

Chapter focus
This chapter explains biodiversity, the need and criteria for biological classification, the development of classification systems, Whittaker's five kingdoms, major plant and animal groups, adaptations, classification hierarchy, binomial nomenclature, fossils and threats to biodiversity.

1. Biodiversity

Biodiversity
The immense variety of living organisms found in different forms and habitats on the Earth is called biodiversity.

- Biodiversity includes organisms ranging from microscopic life forms to giant trees and complex animals.
- Organisms are interconnected: plants produce food, microorganisms recycle nutrients and many animals help in pollination and seed dispersal.
- Humans depend on biodiversity for food, shelter, medicines and livelihoods.
- Crop diversity can reduce the risk of crop failure and strengthen food security.

2. India as a Biodiversity Hotspot

- India has mountains, deserts, rainforests, plateaus and long coastlines, creating diverse habitats.

Endemic species
Species naturally restricted to a particular geographical region and not found naturally elsewhere are called endemic species.

- Examples include Nilgiri tahr, lion-tailed macaque, Nepenthes khasiana and Neelakurinji.

Biodiversity hotspot
A region with a large number of endemic species that has also undergone significant habitat loss is called a biodiversity hotspot.

- Examples include the Western Ghats, Indo-Burma (including North East India), the Himalayas and Sundaland (including the Nicobar Islands).

3. How Biodiversity Evolved

- Biodiversity on Earth has changed over very long periods of time.
- Small differences among individuals can affect survival and reproduction under changing conditions.
- Such differences accumulate over generations and may give rise to new forms of life.
- Similar features among organisms can indicate common ancestry.

4. How Organisms are Classified

Biological classification
The scientific system of grouping living organisms on the basis of similarities and differences is called biological classification.

Criterion	What scientists examine
External features	Shape, size and body organisation
Mode of nutrition	Autotrophic or heterotrophic
Internal structures	Skeleton, organs and tissues
Cell structure	Unicellular/multicellular, prokaryotic/eukaryotic, cell wall
Ecological role	Producer, consumer or decomposer
Reproduction	Asexual and/or sexual methods
Genetic similarity	Similarities in inherited features studied using DNA

5. Why Classification is Needed

- Makes the study of millions of organisms organised and systematic.
- Helps compare similarities and differences among living beings.
- Helps understand relationships and interactions among organisms.
- Helps identify and name newly discovered organisms.
- Supports conservation by identifying organisms under threat of extinction.
- Provides a common system for scientists around the world.

6. Classification Systems Over Time

System / Scientist	Main idea
Aristotle - 4th century BCE	Artificial grouping of animals by habitat: land, water and air and by external appearance.
Two Kingdom - Carolus Linnaeus, 1758	Plantae and Animalia.
Three Kingdom - Ernst Haeckel, 1866	Protista added for microscopic life.
Four Kingdom - Herbert F. Copeland, 1938	Monera separated; Monera, Protista, Plantae and Animalia.
Five Kingdom - Robert H. Whittaker, 1969	Monera, Protista, Fungi, Plantae and Animalia.

- Classification systems change as new observations, microscopes, techniques and genetic evidence improve scientific understanding.

7. Five Kingdom Classification

Main basis
The five-kingdom system uses features such as cell type, level of organisation, cell structure and mode of nutrition.

Kingdom	Cell type / organisation	Nutrition / key feature	Examples
Monera	Prokaryotic; unicellular	Varied nutrition; primitive/unbounded nuclear region	Bacteria, Archaea, Cyanobacteria
Protista	Eukaryotic; unicellular	Autotrophic or heterotrophic; may or may not have cell wall	Amoeba, Paramecium, Chlamydomonas, Euglena
Fungi	Eukaryotic; mostly multicellular	Heterotrophic by absorption; chitin cell wall	Mushroom, Aspergillus, yeast
Plantae	Eukaryotic; multicellular	Autotrophic; cellulose cell wall; producers	Mosses, grasses, ferns, pines, roses
Animalia	Eukaryotic; multicellular	Heterotrophic; no cell wall; consumers	Ant, snake, frog, bird, cat, human

Kingdom Monera

- Bacteria and cyanobacteria are single-celled prokaryotes.
- Bacteria occur in soil, water, air, hot springs, other extreme environments and inside living bodies.
- Some bacteria are pathogens, while useful bacteria include Lactobacillus and Rhizobium.
- Some bacteria help in biogas production, nutrient cycling and breakdown of pollutants.

Kingdom Protista

- Protists are single-celled eukaryotic organisms, commonly found in water or moist places.
- Some are autotrophic while others are heterotrophic.
- They can produce oxygen, serve as food in aquatic food chains and contribute to decomposition and nutrient cycling.

Kingdom Fungi

- Fungi are mostly multicellular eukaryotes with cell walls made of chitin; yeast is a unicellular exception.
- They do not make their own food and commonly absorb nutrients from dead or decaying matter.
- Fine fungal filaments form a network called mycelium.
- Many fungi are saprophytes and important decomposers; some are symbiotic or parasitic.
- They reproduce sexually and asexually, often by spores and generally grow well in warm, moist conditions.
- Examples: yeast, bread mould, mushrooms, Aspergillus and Penicillium.

Kingdom Plantae

- Plants are multicellular, autotrophic eukaryotes that perform photosynthesis.
- Their cells have a rigid cell wall mainly made of cellulose.
- Plants form the base of most food chains and release oxygen.

8. Major Groups of Kingdom Plantae

Plant group	Important features	Examples
Thallophyta	Simple thallus body; mostly aquatic/moist; direct exchange with surroundings.	Spirogyra
Bryophyta	More differentiated body; rhizoids; moist and shady habitats; water required for reproduction; called amphibians of plant kingdom.	Marchantia, moss
Pteridophyta	True roots, stems and leaves; xylem and phloem; water needed for reproduction; no seeds.	Ferns
Gymnosperms	Seed plants adapted to dry/cold regions; water not required for fertilisation; naked seeds often on cones.	Pines, cycads
Angiosperms	Flowering plants; well-developed body; seeds enclosed in fruits; efficient pollination and seed dispersal.	Gulmohar and other flowering plants

- From algae to angiosperms, structural changes include increasing body differentiation, vascular tissues, seeds, flowers and fruits.

Lichens
Lichens are a symbiotic association between an autotrophic alga and a heterotrophic fungus. The fungal partner provides protection, while the algal partner photosynthesises and provides food. They can act as natural bioindicators of air quality.

9. Kingdom Animalia

- Animals are multicellular, heterotrophic eukaryotes.
- Most show locomotion, rapid response to stimuli and coordinated behaviour.

Notochord
A notochord is a flexible rod-shaped supporting structure. Its absence or presence is a major basis for classifying animals into non-chordata and chordata.

- Chordata is further divided into protochordata and vertebrata.

10. Non-chordata (Invertebrates)

Phylum	Key feature	Examples
Porifera	Multicellular but without true tissues/organs; porous body; aquatic and fixed.	Sponges
Cnidaria	Tissue-level organisation; tentacles for capturing prey; one opening for intake and waste removal.	Hydra, jellyfish, corals
Platyhelminthes	Flat body; bilateral symmetry; many are parasites; single digestive opening.	Flatworms
Nematoda	Elongated cylindrical body; digestive system has mouth and anus.	Roundworms
Annelida	Cylindrical segmented body; body cavity; organ-system organisation; muscles and nerve cord.	Earthworm
Arthropoda	Segmented body, jointed appendages and hard external skeleton.	Insects, crabs, spiders
Mollusca	Soft body; organ-system level; many have protective shell; distinct head and muscular foot.	Snails, squids, octopuses
Echinodermata	Marine animals with hard internal skeleton of calcium carbonate; no notochord.	Starfish, sea urchins

- Across invertebrate groups, the increasing complexity in feeding, movement, protection and body organisation.

11. Protochordates and Vertebrates

- Protochordates such as Amphioxus possess a notochord at least once during their life.
- Vertebrates possess a vertebral column or backbone that supports the body and protects structures such as the brain and spinal cord.
- The internal skeleton supports larger body size, efficient movement and complex organ systems.

Vertebrate group	Characteristic examples of adaptation
Fish	Fins and gills support movement and respiration in water.
Amphibians	Included as one of the five major vertebrate groups.
Reptiles	Included as one of the five major vertebrate groups.
Birds	Feathers and hollow bones make flight possible.
Mammals	Mammary glands improve survival of young ones; other structural adaptations occur in different habitats.

12. Adaptations as Outcomes of Structural Change

- Body structures change over long periods and can help organisms survive in particular environments.
- Examples include fins and gills in fish, feathers and hollow bones in birds, fat storage in camels and thick fur in polar bears.
- Different structural features show how organisms meet challenges of movement, feeding, protection and reproduction.

13. Hierarchy of Classification

Classification hierarchy
Kingdom → Phylum → Class → Order → Family → Genus → Species

- The hierarchy moves from broad groups to smaller and more specific groups.
- At each lower level organisms share more common features.

Organism	Kingdom	Phylum	Class	Order	Family	Genus	Species
Tiger	Animalia	Chordata	Mammalia	Carnivora	Felidae	Panthera	P. tigris
Pea	Plantae	Magnoliophyta	Magnoliopsida	Fabales	Fabaceae	Pisum	P. sativum

14. Binomial Nomenclature

Binomial nomenclature
A universal system in which every organism is given a two-part scientific name. It was introduced by Carolus Linnaeus in the 18th century.

Common name	Scientific name
Tiger	Panthera tigris
Mango	Mangifera indica

- The first word is the genus name and begins with a capital letter.
- The second word is the species name and is written in lower case.
- Scientific names are italicised when printed and underlined when handwritten.
- A species consists of similar individuals capable of interbreeding and producing offspring.

15. Beyond the Five Kingdom System

- Genetic studies compare organisms at the DNA level and can reveal common ancestry.
- Carl Woese proposed the three-domain system in 1977: Bacteria, Archaea and Eukarya.
- This showed that microscopic life is more diverse than earlier classification systems suggested.

16. Fossils as Evidence

Fossils
Fossils are preserved remains of plants and animals found in layers of rocks, sand and mud. They act as natural records of how life changed over millions of years.

- Generally, older layers contain simpler organisms, while newer layers show more complex forms.
- Birbal Sahni for his important work on fossil plants and palaeosciences in India.

17. Biodiversity Under Threat

- Pollution, deforestation, overuse of resources and climate change are reducing biodiversity.
- Loss of one species can affect other organisms that depend on it and disturb ecological balance.
- The Purple Frog from Kerala is used as an example linking scientific discovery, ancient lineages and conservation of the Western Ghats.
- The Sangai or dancing deer of Manipur depends on the unique floating phumdi habitat of Loktak Lake; habitat degradation threatens its survival.

18. Important Comparisons

Feature	Monera	Protista	Fungi	Plantae	Animalia
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Organisation	Unicellular	Unicellular	Mostly multicellular	Multicellular	Multicellular
Cell wall	Present in forms discussed	May or may not be present	Chitin	Cellulose	Absent
Nutrition	Varied	Autotrophic/heterotrophic	Heterotrophic by absorption	Autotrophic	Heterotrophic
Ecological role	Varied	Varied	Mainly decomposers	Producers	Consumers

19. Key Terms

Term	Meaning
Biodiversity	Variety of living organisms in different forms and habitats.
Endemic species	Species naturally restricted to a particular region.
Biodiversity hotspot	Region rich in endemic species that has suffered significant habitat loss.
Classification	Systematic grouping of organisms based on similarities and differences.
Prokaryote	Organism whose cell lacks a membrane-bound true nucleus.
Eukaryote	Organism whose cell has a membrane-bound nucleus.
Autotroph	Organism that makes its own food.
Heterotroph	Organism that depends on other organisms for food.
Mycelium	Network of fine fungal filaments.
Notochord	Flexible rod-shaped supporting structure in chordates.
Vertebrate	Animal with a vertebral column/backbone.
Binomial nomenclature	Two-part universal scientific naming system.
Genus	Group of closely related species sharing common features.
Species	Group of similar individuals capable of interbreeding and producing offspring.
Fossil	Preserved remains of past plants or animals.

20. Exam-Oriented Self-Check Questions

1. What is biodiversity? Why is it important for life on Earth?
2. Define endemic species and biodiversity hotspot with examples.
3. How has biodiversity evolved over long periods of time?
4. List the main criteria used to classify organisms.
5. Why is biological classification necessary?
6. Describe how classification systems developed from Aristotle to Whittaker.
7. Name the five kingdoms and state the major basis of their classification.
8. Write the important features of Kingdom Monera.
9. How is Protista different from Monera?
10. Explain the ecological importance of fungi.
11. Classify Kingdom Plantae into its five major groups.
12. Why are bryophytes called amphibians of the plant kingdom?
13. Differentiate between Pteridophyta, Gymnosperms and Angiosperms.
14. What is a lichen? Why can lichens be used as bioindicators?
15. On what basis is Kingdom Animalia divided into non-chordata and chordata?
16. Write the major features of Porifera, Cnidaria and Platyhelminthes.
17. Compare Nematoda, Annelida and Arthropoda.
18. Write the important features of Mollusca and Echinodermata.
19. What are protochordates? How are they related to chordates?
20. Name the five major groups of vertebrates.
21. Explain adaptations as outcomes of structural change with examples.
22. Write the hierarchy of biological classification in correct order.
23. What is binomial nomenclature? State its rules.
24. How has DNA evidence influenced modern classification?
25. What are fossils and how do they provide evidence about changes in life?
26. What human activities threaten biodiversity?

One-Minute Chapter Summary

Quick revision

Biodiversity is the enormous variety of life on Earth. Scientists organise this diversity through biological classification using features such as cell type, organisation, nutrition, structures, ecological role, reproduction and genetic similarity. Whittaker's five kingdoms are Monera, Protista, Fungi, Plantae and Animalia. Plantae includes Thallophyta, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms. Animalia is divided on the basis of the notochord into non-chordata and chordata; vertebrates include fish, amphibians, reptiles, birds and mammals. Classification follows the hierarchy Kingdom → Phylum → Class → Order → Family → Genus → Species. Binomial nomenclature gives every organism a universal two-part scientific name. Fossils and genetic studies help scientists understand relationships and changes in life over time, while conservation is essential because human activities are reducing biodiversity.