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SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 12

Patterns in Life: Diversity and Classification

Complete Questions and Activities Solutions

In-text Questions | Revise, Reflect, Refine | The Journey Beyond

Contents

Class 9 Science · Exploration · Chapter 12 — Patterns in Life: Diversity and Classification

12.1 **In-text Questions** — 3
34 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30 Q31 Q32 Q33 Q34

12.2 **Revise, Reflect, Refine** — 31
15 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15

12.3 **The Journey Beyond** — 44
8 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8

Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

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12.1

CLASS 9 SCIENCE · CHAPTER 12

In-text Questions

Solutions · 34 questions

Directions (Questions 1–34): These are the questions that appear inside the chapter (Think It Over, Pause and Ponder, the Activities, and the questions asked in the text and in Bridging Science and Society), numbered in the order in which they appear. Model answers based on the chapter are given; open-ended and observation questions show a sample you can extend from your own surroundings.

QUESTION 1 *Think It Over · p. 228*

What do you understand by biodiversity?

ANSWER

Biodiversity is the immense variety of living organisms found on the Earth, in all kinds of habitats.

a Meaning

Life exists in countless forms and habitats, from microscopic organisms to giant trees, from glowing jellyfish to soaring eagles, and from the snow-clad Himalayas to the coral reefs of the Andaman Sea. This variety of living organisms is called **biodiversity**.

b Why it is essential

- Every organism plays a role in keeping nature stable and functioning.
- Microscopic algae release most of the oxygen we breathe; fungi and bacteria decompose fallen leaves and make the soil fertile.
- Birds, bees and bats pollinate flowers, and plants capture sunlight to prepare food that supports nearly all life.
- Humans depend on biodiversity for food, shelter, medicines and livelihoods.

Therefore, biodiversity is the variety of living organisms on the Earth, and it keeps ecosystems stable and supports human life.

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QUESTION 2 *Think It Over · p. 228*

How does the grouping of organisms help us understand diversity?

ANSWER

Organisms share certain similarities while also showing many differences. Grouping them on the basis of these features makes the vast diversity easier to study.

a How grouping helps

- Scientists group and classify organisms based on their shared characteristics and evolutionary relationships.
- It helps us understand how organisms are related and how they function.
- The knowledge can be used in ecosystem management, biodiversity conservation and sustainable farming.
- The same organism can fit into different groups depending on the criterion chosen, so the criteria must be chosen carefully.

Therefore, grouping organises the information about millions of organisms and shows their similarities, differences and relationships.

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QUESTION 3 *Think It Over · p. 228*

On what basis, are plants and animals classified?

ANSWER

Scientists use a number of characteristics, looking first at broad and easily visible features and then at more detailed ones (Section 12.3.1).

a Criteria to classify living organisms

Criterion	What is studied
External features	Visible characteristics such as shape, size and body organisation
Mode of nutrition	Autotrophic or heterotrophic
Internal structures	Skeletal patterns, presence or absence of organs and types of tissues
Cell structure	Unicellular or multicellular; eukaryote or prokaryote; presence or absence of a cell wall
Ecological role	Producer, consumer or decomposer
Reproduction	Asexual and/or sexual methods
Genetic similarity	Similarities in inherited features, studied using DNA

b Examples for plants and animals

- Plants are placed in five classes by body organisation, presence of vascular tissue, seeds, flowers and fruits.
- Animals are grouped by the presence or absence of a notochord, and then by body organisation, symmetry, segmentation, body cavity and skeleton.

Therefore, plants and animals are classified on the basis of their cell structure, body organisation, nutrition, reproduction and genetic similarity.

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QUESTION 4 *Think It Over · p. 228*

How does classification help address problems in farming?

ANSWER

The chapter begins with the questions why some plants survive long droughts while others cannot, and how certain insects protect crops while others damage them.

a Ways in which classification helps

- Farmers relied on their knowledge to conserve diverse crop varieties with useful characteristics such as drought tolerance, pest resistance and the ability to grow in nutrient-poor soils.
- Diversity reduces the risk of crop failure and strengthens food security, and classification helps to identify and name these varieties and organisms correctly.
- It helps to tell insects that protect crops from those that damage them, and to identify useful organisms such as *Rhizobium* bacteria and decomposer fungi that make the soil fertile.
- The knowledge supports sustainable farming.

Therefore, classification helps farmers identify useful varieties and organisms, reduce crop failure and practise sustainable farming.

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QUESTION 5 *Activity 12.1 · p. 230*

Ponder on the questions given below: Which animals can you identify in the given picture? Where are they seen? Which animals in the picture seem active: (i) during the day? (ii) during the night? (iii) both during the day and the night?

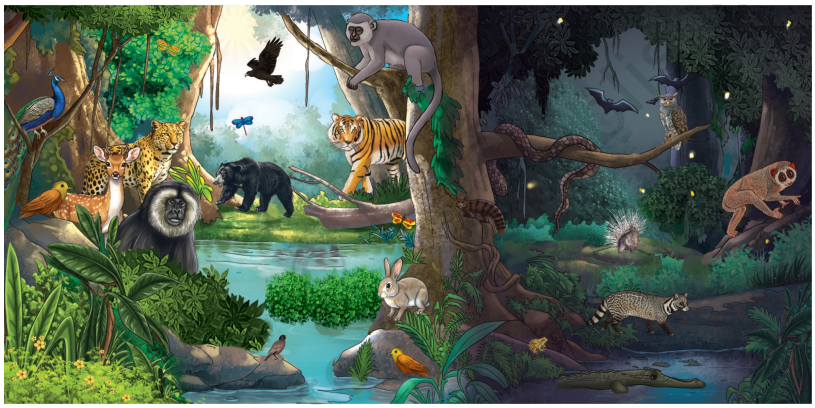


Fig. 12.2: Day and night view of an ecosystem

ANSWER

Fig. 12.2 shows the day view (left half) and the night view (right half) of one ecosystem. A model answer is given; add the animals you identify yourself.

a Animals identified and where they are seen

Animal	Where seen
Peacock, spotted deer, sloth bear, tiger, leopard, langur, hare	Trees and forest floor
Eagle, dragonfly, butterflies	Flying (high in the air or near the ground)
Frog, crocodile (gharial)	Water and its banks
Owl, bats, slow loris, porcupine, civet	Tree branches, flying and forest floor (night view)

b Activity of the animals

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Active	Animals (from the picture)
(i) During the day	Peacock, spotted deer, langur, eagle, dragonfly, butterflies
(ii) During the night	Owl, bats, slow loris, porcupine, civet
(iii) Both day and night / unsure	Tiger, leopard, snake, crocodile, frog

Therefore, animals can be grouped by where they live and when they are active; your answers may differ with the animals you identify.

QUESTION 6 *Activity 12.1 · p. 231*

Record your observations in Table 12.1.

ANSWER

Table 12.1 records the organism, where it is seen, when it appears active and a visible feature. The first row is the example given in the book; the others are model entries based on Fig. 12.2.

a Table 12.1: Observation table for recording the data

Organism	Where do you see it?	When does it appear to be active?	Any visible feature(s)
Owl	Tree	Night	Feathers
Peacock	Tree / forest floor	Day	Feathers, long coloured tail
Tiger	Forest floor	Unsure	Stripes on fur, four legs
Dragonfly	Flying near the ground or water	Day	Two pairs of wings, jointed legs
Bat	Flying high in air	Night	Wings, fur
Crocodile	Water	Unsure	Scales, long snout

Therefore, a table of this kind helps to compare organisms by habitat, activity and visible features.

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QUESTION 7 *Activity 12.1 · p. 231*

Now, try grouping the same organisms in more than one way. Each time change the criterion you are using for grouping (Table 12.2).

ANSWER

The same organisms can be grouped in different ways by changing the criterion. The first row is the example given in the book.

a **Table 12.2: Grouping the organisms**

The grouping criterion	Which organisms fit in this group?	What feature or pattern helped you decide?
Carnivore	Eagle, tiger, leopard	Eating habits
Herbivore	Spotted deer, hare	They feed on plants
Active at night	Owl, bats, slow loris, porcupine	Time of activity
Animals that fly	Eagle, owl, bats, dragonfly, butterflies	Presence of wings
Animals with feathers	Peacock, owl, eagle	Feathers on the body

The eagle appears in two groups (carnivore and flying animals). This shows that the same organism can fit into different groups depending on the criterion chosen.

Therefore, changing the criterion changes the groups, which leads us to the idea of classification.

QUESTION 8 *Pause and Ponder 1 · p. 231*

If many organisms share common features, could they also share a common ancestry?

ANSWER

Yes, it is quite possible.

a **Reasoning**

- Small differences among individuals accumulate over many generations and give rise to new forms of life (Section 12.2).

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- Organisms that have arisen from the same ancestor are therefore expected to keep many features of that ancestor.
- The chapter states that similar features in organisms suggest that they have evolved from common ancestors.
- Organisms with similar DNA are also considered to have a common ancestry.

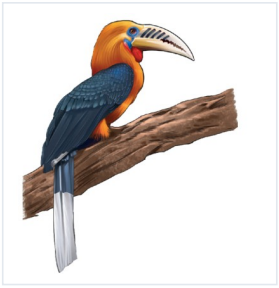
Therefore, organisms that share many common features are likely to share a common ancestry.

QUESTION 9 *Activity 12.2 · p. 232*

Studying such patterns allows scientists to ask precise questions about biodiversity, such as — How are species distributed within a forest? Which plants and animals are closely linked? How does classifying the four hornbill species help us understand biodiversity?

ANSWER

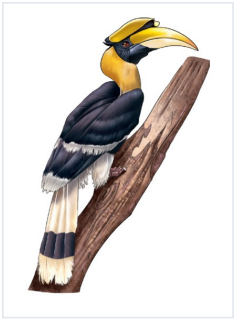
The case study is about the Pakke Tiger Reserve, where four hornbill species live (Fig. 12.3).



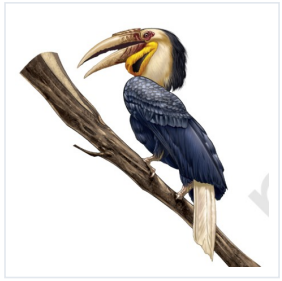
(a) Rufous-necked hornbill



(b) Oriental Pied hornbill



(c) Great hornbill



(d) Wreathed hornbill

a Distribution and links

- Hornbills nest only in large, old trees with suitable cavities and feed on specific fruits.
- Different hornbill species are found in different parts of the forest depending on tree size and fruit availability.
- So the hornbills are closely linked with large old trees and the fruit-bearing plants of the forest.

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b How classifying the four species helps

- Grouping puts the four similar birds together as hornbills, while naming each species separately lets scientists tell them apart.
- It helps to record where each species lives and what it needs, which helps to understand the diversity of the forest and to protect it.

Therefore, classifying the hornbills helps to study their distribution, their links with trees and their conservation.

QUESTION 10 *Activity 12.2 · p. 232*

Think and discuss the case based on the following questions —

(i) How can scientists keep track of so many species?
(ii) The four hornbills look similar in some ways. What features can help scientists distinguish them from one another?
(iii) What would happen if the large, old trees disappeared from the forest?

ANSWER

Pakke has nearly 300 bird species, while India has about 1,300 bird species.

a (i) Keeping track of so many species

Scientists group the species into larger groups on the basis of shared features and give each species a unique scientific (binomial) name. This system lets scientists everywhere identify, record and discuss each species in the same way.

b (ii) Features that distinguish the four hornbills

Size of the body, shape and colour of the beak and the casque above it, colour of the head and neck, and the colour pattern of the tail (see Fig. 12.3) can be used to tell them apart.

c (iii) If large, old trees disappeared

- The hornbills nest only in large old trees with cavities, so they would lose their nesting places.
- The trees that give the specific fruits would also be lost, so the birds would lose their food.
- The hornbill species would decline and could disappear, and other organisms that depend on the trees would also be affected.

Therefore, scientists track species by classifying and naming them, and losing the old trees would threaten the hornbills.

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QUESTION 11 *Activity 12.3 · pp. 234–235*

Study the concept map (Fig. 12.5). List the criteria which form the basis of five kingdom classification.
Compare the criteria you have listed after studying the concept map and the criteria given below: Cell type — prokaryote or eukaryote; Cell structure — presence or absence of a cell wall; Level of organisation — unicellular or multicellular; Mode of nutrition — autotrophic or heterotrophic.

ANSWER

The concept map divides the living organisms step by step using the criteria shown in green in Fig. 12.5.

a Criteria listed from the concept map

- Cell type: prokaryotes (primitive nucleus) and eukaryotes (membrane-bound nucleus).
- Level of organisation: unicellular or multicellular.
- Cell structure: with a cell wall (made of chitin or cellulose) or without a cell wall.
- Mode of nutrition and ecological role: autotrophic producers, or heterotrophic decomposers or consumers.

b Comparison with the given criteria

The four given criteria (cell type, cell structure, level of organisation and mode of nutrition) are the same as those in the concept map. The concept map also uses the nature of the cell wall (chitin or cellulose) and the ecological role.

c How the criteria separate the five kingdoms

Kingdom	Cell type	Level	Cell wall	Nutrition
Monera	Prokaryote	Unicellular	Present (bacteria)	Varied
Protista	Eukaryote	Unicellular	May or may not	Autotrophic or heterotrophic
Fungi	Eukaryote	Mostly multicellular	Chitin	Heterotrophic decomposers
Plantae	Eukaryote	Multicellular	Cellulose	Autotrophic producers
Animalia	Eukaryote	Multicellular	Absent	Heterotrophic consumers

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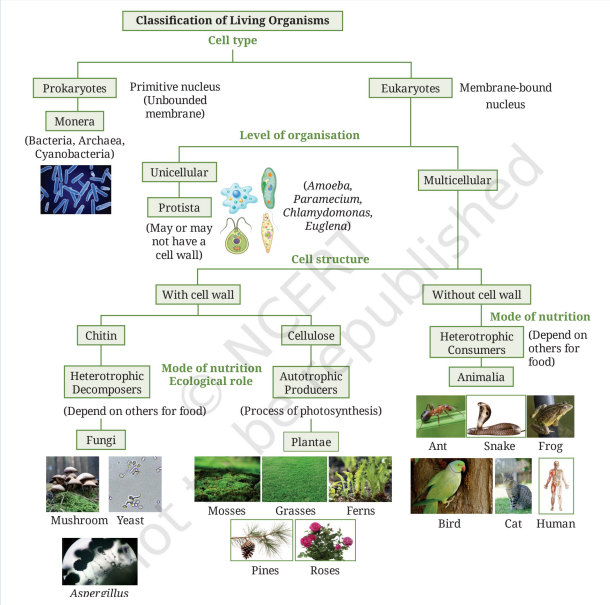


Fig. 12.5: Five kingdom classification

Therefore, five kingdom classification is based on cell type, level of organisation, cell structure and mode of nutrition (with ecological role).

QUESTION 12 *Activity 12.4 · p. 235*

In the school laboratory, observe the available permanent slides of bacteria and cyanobacteria under the microscope. Compare them with Fig. 12.6. What do you observe?

ANSWER

Bacteria and cyanobacteria are single-celled prokaryotes grouped under the Kingdom Monera.

a Observations

- Each organism is a single cell and is very small; it is seen only under a microscope.
- The cells have different shapes, as in Fig. 12.6: round, rod-shaped, comma-shaped and spiral.
- There is no membrane-bound nucleus, which is the feature of prokaryotes.
- Cyanobacteria (blue-green algae) are autotrophs.

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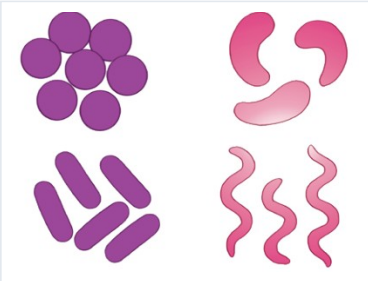


Fig. 12.6: Members of the Kingdom Monera

Therefore, bacteria and cyanobacteria are single-celled prokaryotes of different shapes, grouped in Monera.

QUESTION 13 *Activity 12.5 · p. 236*

Do you notice moving organisms in the drop of water under the microscope? Can you identify them by comparing them with Fig. 12.7?

ANSWER

The hay infusion is prepared from grass and stagnant water kept covered for a week. A drop of it is observed under the microscope.

a Observation

Yes, small moving organisms can be seen. They can be compared with the common protists of Fig. 12.7: *Amoeba* (irregular body that changes shape), *Paramecium* (slipper-shaped) and *Euglena* (spindle-shaped with a long thread-like part). What you see depends on your sample.

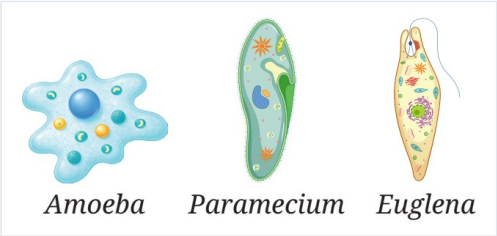


Fig. 12.7: Microscopic illustration of common protists

b Group

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These are single-celled eukaryotes, so they belong to the Kingdom Protista. Some are autotrophic and others are heterotrophic. Wear a lab coat, mask and gloves, and discard the infusion after autoclaving.

Therefore, the moving organisms seen in the hay infusion are protists such as Amoeba, Paramecium and Euglena.

QUESTION 14 *Pause and Ponder 2 · p. 236*

How can a single-celled organism carry out all its life processes when billions of cells are required to perform similar functions in multicellular organisms like us?

ANSWER

A single cell is a complete living unit; a multicellular body is built from many cells that share the work.

a Explanation

- In a single-celled organism the one cell performs all the life processes, such as taking food, exchanging gases, getting rid of waste and reproduction. Such an organism is microscopic and has a very small body.
- In multicellular organisms like us the body is large, and the cells are specialised to perform specific functions. They form tissues and organs and work together, so billions of cells are needed.

Therefore, a single cell performs all its life functions by itself because the organism is very small, while the large multicellular body divides the work among many specialised cells.

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QUESTION 15 *Activity 12.6 · p. 238*

Observe some bryophytes with the help of a hand lens … How do they differ from the leaves that you usually observe in plants in your surroundings?

ANSWER

Bryophytes (mosses and liverworts) are small plants of damp, shady places.

a **Differences**

Usual leaves of plants	Bryophytes
Borne on a true stem and attached to true roots	Have root-like rhizoids and simple stem-like and leaf-like structures
Contain vascular tissues (xylem and phloem) for transport	Lack vascular tissues for transporting water and food
Found on plants of many habitats	Grow as green mats in moist and shady places

Bryophytes require water for reproduction. Therefore, they are called the ‘amphibians’ of the plant kingdom.

Therefore, the leaf-like structures of bryophytes are simple and lack vascular tissue, unlike the leaves of higher plants.

QUESTION 16 *Pteridophyta · p. 238*

Look at Fig. 12.11a. What changes do you observe in the plant structure as compared to thallophytes and bryophytes? … How do you think that the transport of water and food takes place in all parts of these plants? … How can you test this explanation?

ANSWER

Fig. 12.11a shows a fern, a pteridophyte.

a **Changes in structure**

A fern has true roots, stems and leaves, while thallophytes have an undifferentiated body and bryophytes only simple root-like and leaf-like parts.

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b Transport of water and food

One possible explanation is that ferns have specialised transport tissue.

c Testing the explanation

- Cut a cross section of the stem of a fern and observe it under a microscope, or observe a permanent slide of it.
- It shows vascular tissues: xylem carries water and phloem carries food throughout the plant (Fig. 12.11b).

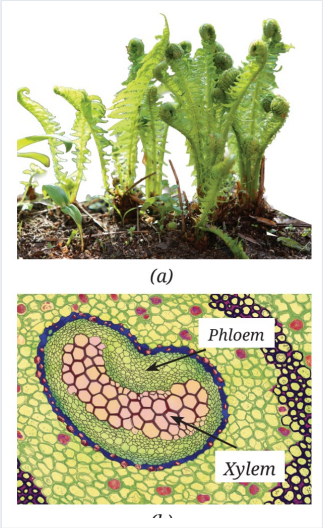


Fig. 12.11: (a) Fern, and (b) cross section of a fern stem

Therefore, ferns have true roots, stems and leaves, and xylem and phloem transport water and food in them.

QUESTION 17 *Pause and Ponder 3 · p. 238*

Which plant features reduce their dependence on water but still require moist conditions?

ANSWER

This refers to the pteridophytes, which have moved a step further from the bryophytes.

- True roots, stems and leaves.
- Vascular tissues (xylem and phloem) that carry water and food to all parts, so the plant does not depend on direct contact with water for transport.

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- They still need aquatic or moist conditions for reproduction and do not produce seeds.

Therefore, true roots, stems, leaves and vascular tissues reduce the dependence on water, but pteridophytes still need moist conditions for reproduction.

QUESTION 18 *Pause and Ponder 4 · p. 238*

Why do taller plants need specialised transport tissues?

ANSWER

In a tall plant, the parts are far apart from one another.

- Water taken in by the roots has to reach the leaves at the top, and the food prepared in the leaves has to reach all other parts.
- Simple direct exchange with the surroundings, as in thallophytes, works only for small bodies.
- Xylem and phloem transport water and food over long distances.

Therefore, taller plants need xylem and phloem to carry water and food to all their parts.

QUESTION 19 *Pause and Ponder 5 · p. 238*

How do seeds and fruits affect, where and how plants can survive?

ANSWER

Seeds and fruits allow plants to reproduce and spread without needing water.

a **Seeds**

Seeds protect the developing embryo and contain stored food. Gymnosperms do not need aquatic conditions for fertilisation, so they survive in cold and dry regions.

b **Fruits and flowers**

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Flowers attract pollinators, which increases the efficiency of reproduction. Fruits enclose the seeds and help spread them to new locations. These features allow angiosperms to occupy a wide range of environments.

Therefore, seeds and fruits help plants survive in dry or varied environments and spread to new places.

QUESTION 20 *Activity 12.7 · p. 238*

Recall the cross section of the sunflower stem you have studied in Chapter 3 (Fig. 3.7). Compare the cross section of the stem of a fern, a pteridophytic plant (Fig. 12.11) with a cross section of sunflower stem you studied in Chapter 3 (Fig. 3.7). What difference do you observe in the vascular tissue of the fern stem and of the stem of higher plants? Write your observations. Share and discuss them in class.

ANSWER

Both stems have vascular tissues (xylem and phloem). The comparison below is based on Fig. 12.11b and on the sunflower stem of Chapter 3 (Fig. 3.7, which is not part of this chapter; recall it from your book).

Point	Fern stem (pteridophyte)	Sunflower stem (higher plant)
Arrangement	Vascular tissue forms a single central strand, with xylem inside surrounded by phloem	Vascular bundles are arranged in a ring around the centre of the stem
Tissues present	Xylem and phloem	Xylem and phloem

Therefore, both have xylem and phloem, but the vascular tissue is arranged differently in the fern stem and in the stem of higher plants.

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QUESTION 21 *Activity 12.8 · p. 239*

Collect different leaves from your surroundings, and observe their shape and venation. Group them as monocots or dicots. Discuss how their structures help them adapt in different conditions to survive.

ANSWER

Angiosperm leaves are grouped on the basis of venation (the pattern of veins).

Group	Venation	Examples of leaves
Monocots	Parallel venation	Grass, maize, wheat, banana
Dicots	Reticulate (net-like) venation	Mango, peepal, hibiscus, rose

a Discussion (model points)

- The veins carry water and food and give support to the leaf; the venation pattern decides how they are spread in the leaf.
- Broad leaves with net-like veins spread water and food over a wide surface for photosynthesis, while narrow leaves with parallel veins are strong and less exposed to the sun and wind.

Therefore, leaves can be grouped as monocots or dicots on the basis of venation, and their structure suits the conditions in which they live.

QUESTION 22 *Activity 12.9 · pp. 239–240*

Carefully study the salient features of each plant group. Analyse the salient features, and write the advantages for survival of the group and the exceptions or challenges faced in the given columns (Table 12.3).

ANSWER

The blank lines of Table 12.3 are completed below with additional points for each group, over and above those already printed in the book.

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Plant group	Additional advantages for survival	Additional exceptions / challenges
Thallophyta	Body takes in water, nutrients and gases directly from the surroundings, so no special organs are needed; well adapted to aquatic habitats.	No root, stem or leaf or transport tissue, so the body stays simple and small and depends on water.
Bryophyta	Rhizoids hold the plant and take up water; can grow as mats in moist, shady places, especially in the monsoon.	Lack vascular tissues, so water and food cannot move over long distances; male cells must swim, so reproduction needs water.
Pteridophyta	True roots, stems and leaves; xylem and phloem carry water and food, so the plant can grow larger.	No seeds are produced; reproduction in water or moist surroundings restricts them to damp places.
Gymnosperm	Seeds protect the embryo and hold stored food; needle-like leaves reduce water loss, so they live in cold and dry regions.	Seeds are exposed on cones and not protected by a fruit.
Angiosperm	Flowers attract pollinators; seeds in fruits are protected and spread by insects, birds, animals, wind or water.	Depend on pollinating agents; need a complex tissue system and more resources.

Therefore, each plant group has advantages and challenges; from algae to angiosperms, transport tissues, seeds and flowers help plants meet the challenges of life on land.

QUESTION 23 *Porifera · p. 241*

Sponges remain fixed in one place and are found in aquatic environments. Do you think they would be able to survive on land? Why or why not?

ANSWER

Sponges are multicellular animals without tissues and organs.

- Numerous pores allow water to flow through the body continuously, bringing food particles and oxygen directly to individual cells and carrying the waste away.
- On land there is no flowing water, and the sponge is fixed, so it cannot go to the food.

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- It has no tissues or organs to protect it from drying up or to carry food and oxygen inside the body.

Therefore, sponges could not survive on land, because they depend on flowing water for food, oxygen and removal of waste.

QUESTION 24 *Cnidaria · p. 241*

However, cnidarians possess a single opening that functions for both food intake and waste removal. Can you hypothesise what limitations this body structure might have?

ANSWER

A hypothesis is a reasoned guess that can be tested.

- Food and waste use the same opening, so they may get mixed up.
- The animal cannot take in new food and remove waste at the same time.
- Digestion cannot go in a one-way direction with separate regions for different tasks, which limits efficiency.

Flatworms also have a single opening, but roundworms have two openings (mouth and anus).

Therefore, the single opening limits the efficiency of feeding and digestion; two openings, as in roundworms, are more efficient.

QUESTION 25 *Annelida · p. 242*

What advantages segmentation might offer to an organism? Observing how an earthworm moves may help you form a hypothesis.

ANSWER

The body of an annelid is cylindrical and divided into segments.

- Segmentation allows greater flexibility and more precise control of movements.
- Muscles present in the body help the earthworm in locomotion; each part can contract or expand separately while it moves.

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- The nerve cord helps in control and coordination.

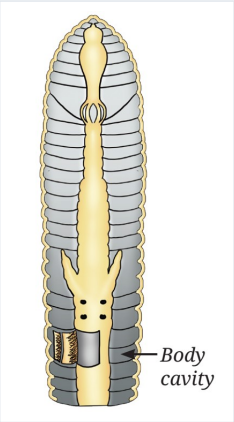


Fig. 12.15: Internal structure of an earthworm: Organ formation and body cavity

Therefore, segmentation gives the organism flexibility and better controlled movement.

QUESTION 26 *Arthropoda · p. 242*

A defining structural feature of arthropods is the development of a hard external skeleton (rigid external covering). What advantages can the outer covering provide?

ANSWER

Arthropods include insects, crabs and spiders.

- Protection to the body.
- Reduced loss of water.
- Support for powerful muscles.

These advantages allow arthropods to survive in dry and exposed environments.

Therefore, the hard outer covering protects the arthropod, reduces water loss and supports its muscles.

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QUESTION 27 *Pause and Ponder 6 · p. 242*

An earthworm (annelida) and a beetle (arthropoda), both have segmented bodies but the beetle has a hard external skeleton. How does the beetle’s external skeleton help it survive?

ANSWER

Both animals have segmented bodies, but the beetle has an additional hard covering.

Feature	Earthworm (Annelida)	Beetle (Arthropoda)
External skeleton	Absent	Present (exoskeleton)
Habitat	Moist soil / water	Land / water, even dry places
Appendages	Absent	Jointed legs

- The hard covering protects the beetle’s body.
- It reduces the loss of water from the body.
- It supports powerful muscles, which help in movement.

Therefore, the external skeleton lets the beetle survive in dry and exposed environments, where a soft-bodied earthworm cannot.

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QUESTION 28 *Section 12.7.1 · p. 244*

Observe and analyse Fig. 12.17. What do you infer?

ANSWER

Fig. 12.17 shows the levels of classification for a tiger and a pea plant.

a Levels shown in the figure

Level	Tiger	Pea
Kingdom	Animalia	Plantae
Phylum	Chordata	Magnoliophyta
Sub-phylum / Class	Vertebrata / Mammalia	Magnoliopsida (class)
Order	Carnivora	Fabales
Family	Felidae	Fabaceae
Genus	Panthera	Pisum
Species	P. tigris	P. sativum

b Inferences

- Classification follows a step-by-step order from very broad groups to smaller and more specific ones: Kingdom → Phylum → Class → Order → Family → Genus → Species.
- At each lower level, organisms share more common features.
- Every lower group is a part of the group above it.
- This arrangement works like an address, which helps scientists identify, compare and study organisms accurately.

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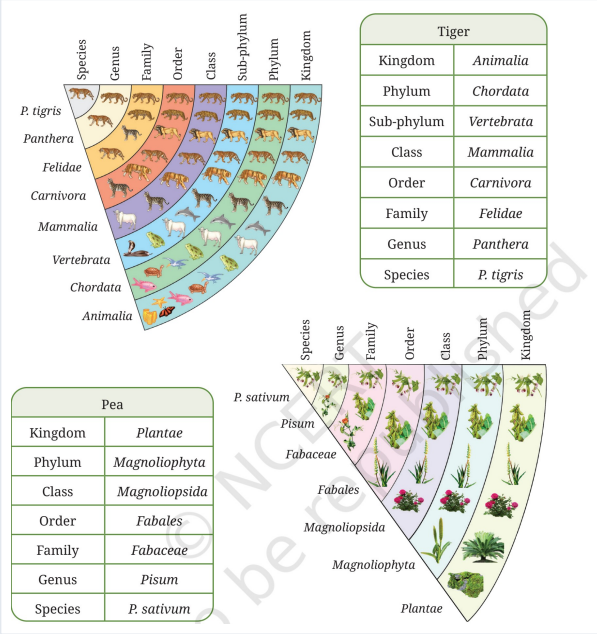


Fig. 12.17: Pyramids showing levels, from kingdom at the top to species at the base, with the examples of a tiger and a pea plant

Therefore, classification is hierarchical: the groups become smaller and more specific, with more shared features, from kingdom down to species.

QUESTION 29 *Pause and Ponder 7 · p. 247*

Does the term ‘biodiversity’ relate only to the variety of organisms, or does it encompass other elements?

ANSWER

Biodiversity is more than a count of the kinds of organisms.

- Variety of organisms: from microscopic organisms to giant trees.
- Variety within a species, such as the diverse crop varieties with different useful characteristics conserved by farmers.
- Variety of habitats and regions, such as mountains, deserts, rainforests, plateaus and coasts that support different species.

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- Interconnections among organisms and their roles, such as producers, consumers and decomposers, which sustain ecosystems.

Therefore, biodiversity covers the variety of organisms and also their habitats, the differences within species and the interactions among them.

QUESTION 30 *Pause and Ponder 8 · p. 247*

If you find a new organism in a pond, what features will you observe to classify it and why?

ANSWER

The features are the criteria of five kingdom classification, observed first with the naked eye and then with a microscope.

Feature to observe	Why it is observed
Unicellular or multicellular	Separates Monera and Protista from Fungi, Plantae and Animalia
True nucleus present or absent	Separates prokaryotes (Monera) from eukaryotes
Cell wall present or absent (chitin / cellulose)	Separates Animalia from Fungi and Plantae
Mode of nutrition: green and autotrophic, or heterotrophic	Separates Plantae from Fungi and Animalia
Movement, body shape and external features	Helps to identify the group (e.g. cilia or flagella in protists)
Ecological role and reproduction	Shows its role as producer, consumer or decomposer

Therefore, I would observe cell structure, level of organisation, nutrition and external features, since these are the criteria used to place an organism in a kingdom.

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QUESTION 31 *Pause and Ponder 9 · p. 247*

Why do genetic studies provide deep information about living beings?

ANSWER

Every living cell contains genetic material (DNA), which carries the instructions for its growth and function.

- Organisms with similar DNA are considered to have a common ancestry, so DNA shows how closely organisms are related.
- Comparing DNA looks at the basic level of organisms, beyond visible features.
- Genetic data led Carl Woese (1977) to propose the three domain system (Bacteria, Archaea and Eukarya) and showed that microscopic life forms are far more diverse than previously believed.

Therefore, genetic studies tell us about the relationships and ancestry of organisms in great detail.

QUESTION 32 *Pause and Ponder 10 · p. 247*

How can changes in climate affect the biodiversity?

ANSWER

Each region has its own temperature and rainfall, which decide the habitat and the species it supports.

- If the climate changes, the habitat changes, and species adapted to the earlier conditions may not survive.
- Species that cannot adapt decline in number and may disappear; others that depend on them also decline.
- The chapter lists climate change, along with pollution, deforestation and overuse of resources, as a human-caused factor reducing biodiversity.

Therefore, climate change disturbs habitats and can reduce biodiversity.

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QUESTION 33 *Bridging Science and Society · p. 244*

How do forests with rich and highly diverse flora and fauna work as a barrier and reduce the impact of disasters?

ANSWER

Forests with rich biodiversity create physical, biological and chemical barriers against challenges.

- **Physical barrier:** a large diversity of trees in mangrove forests helped during the super cyclone that hit Orissa in 1999; villages with more mangroves experienced less destruction.
- **Biological barrier:** rich biodiversity generally lowers tick-borne disease risk. In the Western Ghats many animals are hosts where the Kyasanur Forest Disease (Monkey Fever) virus cannot replicate.
- **Chemical barrier:** diverse microorganisms in forest soils and plant roots absorb, transform or break down pollutants, which improves water quality. Mangrove soils trap sediments and heavy metals.

Therefore, biodiverse forests protect against cyclones, diseases and pollution.

QUESTION 34 *Bridging Science and Society · p. 248*

Efforts for the conservation of phumdis and the Sangai deer are currently in progress. Provide your suggestions to save habitat and the Sangai deer.

ANSWER

The Sangai is found only in the floating grasslands (phumdis) of Loktak lake in Manipur. The phumdis are degenerating, and the deer is listed in the IUCN Red Data list.

a Suggestions

- Protect the phumdis from degeneration and keep the water of the lake clean.
- Control activities that harm the habitat, such as pollution and the overuse of resources.
- Involve the local communities in conservation and make people aware of the importance of the deer and its habitat.

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- Monitor the population of the Sangai regularly, since habitat loss will affect it significantly.
- Create other protected areas where possible, as the deer depends on a very small area.

Therefore, protecting the phumdis habitat with the help of the local people is the key to saving the Sangai deer.

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12.2

CLASS 9 SCIENCE · CHAPTER 12

Revise, Reflect, Refine

Solutions · 15 questions

Directions (Questions 1–15): These are the Revise, Reflect, Refine questions at the end of the chapter (pages 249–251). Multiple-choice questions are answered with reasons, and the case study (Question 15) is answered part by part.

QUESTION 1

Meena and Hari observed an animal in their garden. Hari called it an insect while Meena said it was an earthworm. Choose the correct option which confirms that it is an insect.

(i) Bilateral symmetrical body
(ii) Body with jointed legs
(iii) Cylindrical body
(iv) Body with little segmentation

ANSWER

An insect is an arthropod, and an earthworm is an annelid. Look for the feature that only the arthropod has.

Option	Insect	Earthworm	Confirms insect?
(i) Bilateral symmetry	Yes	Yes	No
(ii) Jointed legs	Yes (jointed appendages)	No	Yes
(iii) Cylindrical body	Not typical	Yes	No
(iv) Little segmentation	Segmented body	Segmented body	No

Therefore, the correct option is (ii): body with jointed legs.

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QUESTION 2

Sponges represent one of the simplest animal body plans. Their bodies lack true tissues and organs. Which feature of sponge cells supports its classification under the animal kingdom?

(i) Absence of mitochondria
(ii) Ability to photosynthesise
(iii) Presence of a cell membrane
(iv) Presence of a cell wall

ANSWER

Animals are multicellular, heterotrophic eukaryotes whose cells have no cell wall.

- (i) is wrong: sponge cells are eukaryotic and have mitochondria.
- (ii) is wrong: photosynthesis is a feature of autotrophs.
- (iv) is wrong: a cell wall is present in plants, fungi and some protists, but not in animals.
- (iii) fits: animal cells are enclosed only by a cell membrane, without a cell wall.

Therefore, the correct option is (iii): presence of a cell membrane (and no cell wall).

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QUESTION 3

Observe two different animals in your immediate environment. What features help you distinguish between them? How do these features help place them into different groups?

ANSWER

This is an observation question. A model answer for a goat and a butterfly is given; use the two animals you observe.

Feature	Goat	Butterfly
Backbone	Present	Absent
Legs	Four legs	Six jointed legs
Body covering	Hair	Hard outer covering (exoskeleton)
Other	Mammary glands	Wings

a Placing them in groups

- Goat: Animalia → Chordata → Vertebrata → Mammalia.
- Butterfly: Animalia → non-chordata → Arthropoda.
- The presence of a backbone separates vertebrates from invertebrates, and body covering, jointed appendages and mammary glands place them in their classes or phyla.

Therefore, features such as the backbone, body covering and legs help to place different animals in different groups.

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QUESTION 4

How would a scientist justify choosing cellular organisation as a more fundamental characteristic for the basis of classification rather than the presence of xylem and phloem?

ANSWER

A basic criterion should be present in all organisms and should separate the biggest groups.

- Cellular organisation (prokaryote or eukaryote, unicellular or multicellular, cell wall) applies to every living organism, but xylem and phloem occur only in some plants.
- Bacteria, protists, fungi, animals and even algae and bryophytes have no xylem and phloem, so these tissues cannot classify them.
- Cell type and organisation separate the kingdoms, while vascular tissue is useful only for grouping within Plantae (e.g. bryophytes and pteridophytes).

Therefore, cellular organisation is more fundamental because it is common to all organisms and helps in the first and broadest division of life.

QUESTION 5

You find an unlabelled slide of a single-celled organism that has a well-defined nucleus and multiple cilia. Which group would it most likely belong to? Give reasons.

ANSWER

Use the criteria of cell type, level of organisation and movement.

- Single-celled: so it belongs to Monera or Protista.
- Well-defined nucleus: it is a eukaryote, so it is not in Monera.
- Cilia for movement: like *Paramecium*, a common protist.

Therefore, the organism most likely belongs to Kingdom Protista.

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QUESTION 6

How does the diversity of organisms contribute to the balance and stability of an ecosystem?

ANSWER

Every organism plays a role in keeping nature stable and functioning.

- Algae and plants produce oxygen and food by capturing sunlight.
- Fungi and bacteria decompose waste and make the soil fertile.
- Birds, bees and bats pollinate flowers and disperse seeds.
- These interconnections form food webs and sustain ecosystems. When one species disappears, others that depend on it may also decline.

Therefore, the diversity of organisms keeps ecosystems balanced and stable.

QUESTION 7

If all unicellular organisms were grouped into a single kingdom, what problems would arise?

ANSWER

Unicellular organisms differ widely.

- Bacteria (no true nucleus) would be placed with *Amoeba* and *Paramecium* (true nucleus).
- Autotrophic ones like *Euglena* would be placed with heterotrophic ones, and yeast, which has a chitin cell wall, with organisms without it.
- Important differences and relationships would be hidden, and the confusion of the earlier two and three kingdom systems would come back.

Therefore, one kingdom for all unicellular organisms would group very different organisms together, which is why Monera, Protista and Fungi are kept separate.

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QUESTION 8

Viruses were studied in earlier classes. Why are they not placed in any of the five kingdoms? Give reasons.

ANSWER

The five kingdoms are based on cell type, cell structure, level of organisation and nutrition.

- Viruses are acellular; they have no cellular organisation, so they cannot be classed as prokaryotes or eukaryotes.
- They contain genetic material but remain inactive outside a host cell.
- They cannot be described by the mode of nutrition or level of organisation used for the kingdoms.

Therefore, viruses are not placed in any kingdom because they lack cellular organisation.

QUESTION 9

If you were asked to revise the five kingdom classification, would you create a separate category for viruses or keep them outside the system? Justify your answer and explain what this indicates about the evolving nature of scientific classification.

ANSWER

This asks for an opinion with reasons; one justified answer is given.

a My answer

I would keep the viruses outside the five cellular kingdoms in a separate category for acellular forms. They do not fit the cell-based criteria, so putting them into a kingdom would force them into a group to which they do not belong, but leaving them unclassified would also be wrong.

b What this indicates

- Classification changes as new knowledge and tools come up, as the two, three, four and five kingdom systems and the three domain system show.

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- Science is an ongoing process of reasoning and change.

Therefore, a separate category for viruses shows that classification systems are revised as our knowledge grows.

QUESTION 10

Viruses contain genetic material like living organisms but lack cellular organisation. Which features prevent them from fitting into the five kingdom system? What does this tell us about the limitations of classification systems?

ANSWER

Compare the virus with the criteria of the five kingdoms.

a **Features that prevent the fit**

- Acellular: no cell, so cell type, cell wall and level of organisation cannot be assigned.
- Inactive outside a host cell; they cannot carry out life processes on their own.

b **Limitations**

Classification systems are made by people on the basis of chosen criteria. Some organisms do not fit any group, so the system has limits and is modified as understanding grows.

Therefore, viruses lack cellular organisation, and they show that no classification system can fit every organism.

QUESTION 11

Both pteridophytes and bryophytes lack flowers and seeds, yet they are placed in different groups. Explain this classification using their key features.

ANSWER

Lacking flowers and seeds is a shared feature, but the groups differ in other key features.

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Feature	Bryophyta	Pteridophyta
Body	Slightly differentiated; no true root, stem or leaf	True roots, stems and leaves
Root-like part	Rhizoids	True roots
Vascular tissue	Absent	Xylem and phloem present
Habitat	Moist and shady places	Land, moist conditions
Seeds and flowers	None	None
Water for reproduction	Needed	Needed

Therefore, they are placed in different groups because pteridophytes have true roots, stems, leaves and vascular tissues, while bryophytes do not.

QUESTION 12

In the classification hierarchy, which group — class or genus — has fewer members but more features in common? Explain your answer.

ANSWER

The hierarchy is: Kingdom → Phylum → Class → Order → Family → Genus → Species.

- Genus lies lower than class; each lower group is a part of the group above it, so it contains fewer members.
- At each lower level organisms share more common features.
- For example, *Panthera tigris* and *Panthera leo* are in one genus and share similar skull structure and the ability to roar, while a class like Mammalia includes many different animals.

Therefore, genus has fewer members but more features in common than class.

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QUESTION 13

A scientist discovers a new organism with the characteristic features of locomotion and autotrophic nutrition. Which character(s) would help the scientist identify the organism belonging to Protista according to the five kingdom classification?

ANSWER

Plants are autotrophic and animals move, but neither has both features together as a single cell, so more characters are needed.

- It is unicellular and microscopic.
- It has a true nucleus (a eukaryote).
- It may or may not have a cell wall, and if present the cell wall is of cellulose.
- It moves, for example with flagella or cilia, and makes food by photosynthesis, like *Euglena*.

Therefore, a unicellular eukaryote with a true nucleus that moves and makes its own food belongs to Protista.

QUESTION 14

A researcher identified a unicellular eukaryotic organism as fungi. What identification key would you suggest according to the five kingdom classification to keep a unicellular organism in the Kingdom Fungi?

ANSWER

Yeast is a unicellular organism that is still placed in the fungi.

a **Identification key**

- Eukaryotic organism with a true nucleus.
- Cell wall made of chitin.
- Heterotrophic, absorbing nutrients from dead and decaying matter or a host; no chlorophyll.

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- Reproduces by forming spores.

Therefore, a unicellular eukaryote with a chitin cell wall and absorptive heterotrophic nutrition is kept in Kingdom Fungi, as with yeast.

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QUESTION 15

During a long-term ecological study, students examined organisms collected from three different environments — a freshwater pond, damp soil near decaying logs and the digestive tract of animals. Instead of naming organisms directly, scientists recorded only structural, cellular and nutritional features as given in the table below.

P: Microscopic; no true nucleus; rigid cell covering; survives high salinity and temperature

Q: Multicellular; filamentous body; cell wall present; no chlorophyll; grows on dead organic matter

R: Unicellular; true nucleus; contractile vacuole present; moves using flagella; shows photosynthesis in light but heterotrophic in the absence of light

S: Multicellular; well-differentiated tissues; backbone present; aquatic respiration during early life stage

T: Acellular; contains genetic material; remains inactive outside a host cell

Based on the case study, answer the following questions —

(i) Identify one organism that clearly belongs to the Kingdom Fungi. State one observation that supports your answer.

(ii) Which organism would be placed in the Kingdom Monera? Mention one characteristic that justifies this placement.

(iii) Organisms R and Q are both eukaryotic, yet they are placed in different kingdoms. Analyse the criteria that separate them.

(iv) Explain why organism S cannot be classified using the mode of nutrition alone.

(v) Organism T does not fit into any of the five kingdoms. Which fundamental characteristic used in classification does it lack and what does this reveal about the limitations of classification systems?

(vi) If classification were based only on habitat, which organisms might be incorrectly grouped together? Explain the scientific consequences of such a classification.

(vii) Imagine scientists discover a new organism that is multicellular, eukaryotic, lacks chlorophyll and absorbs nutrients from a host externally. Should it be placed under fungi or animalia? Justify your reasoning using classification criteria.

ANSWER

First place each organism in its probable group using the criteria of the five kingdoms.

a Summary of P to T

Organism	Key criteria	Group
P	No true nucleus (prokaryote), microscopic	Kingdom Monera
Q	Multicellular, chitin-type cell wall, no chlorophyll, feeds on dead matter	Kingdom Fungi

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Organism	Key criteria	Group
R	Unicellular eukaryote, flagella, photosynthesis in light	Kingdom Protista
S	Multicellular with tissues, backbone	Kingdom Animalia (a vertebrate)
T	Acellular, inactive outside host	Outside the five kingdoms

b (i) Organism of the Kingdom Fungi

Organism Q. It is multicellular and filamentous, has a cell wall, has no chlorophyll and grows on dead organic matter, so it is a saprophyte that absorbs nutrients from dead matter.

c (ii) Organism of the Kingdom Monera

Organism P. It has no true nucleus, which shows that it is a prokaryote.

d (iii) Organisms R and Q

- Level of organisation: R is unicellular, Q is multicellular.
- Nutrition: R makes food by photosynthesis in light but is heterotrophic in the dark, whereas Q is only heterotrophic and absorbs nutrients from dead matter.
- Movement and structure: R moves with flagella, but Q has a filamentous body with a cell wall.

e (iv) Organism S and the mode of nutrition

Heterotrophic nutrition is found in fungi, in some protists and in animals, so it does not identify a group. S is placed as an animal because it is multicellular with tissues and no cell wall, and it has a backbone, which makes it a vertebrate. Aquatic respiration in the early life stage shows its life stages, which nutrition does not.

f (v) Organism T

It lacks cellular organisation, which is the basis of the first division of life. It also cannot carry out life processes outside a host cell. This shows that classification systems have limits and need revision when new organisms or knowledge do not fit.

g (vi) Classification by habitat only

- Fish, whales, jellyfish and algae would all be grouped together as water organisms, and birds, bats and insects as air organisms.
- Organisms of very different structure and ancestry would be placed together, and closely related organisms would be separated (this was the limit of Aristotle’s system).
- The relationships and evolutionary history could not be traced, which would make the study and conservation less accurate.

h (vii) The new organism

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It should be placed under Fungi. Fungi absorb nutrients from the surroundings or from a host, as parasitic fungi do. Animals ingest food, move and have no cell wall. An organism that is a multicellular eukaryote without chlorophyll and absorbs nutrients externally matches the fungi (provided a chitin cell wall is found).

Therefore, Q is a fungus, P belongs to Monera, R to Protista, S to Animalia, and T lies outside the five kingdoms.

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12.3

CLASS 9 SCIENCE · CHAPTER 12

The Journey Beyond

Solutions · 8 questions

Directions (Questions 1–8): These are the activity-based questions of The Journey Beyond and The Quest Continues... (page 251). Model answers and formats are given; fill in your own observations wherever a survey or project is involved.

QUESTION 1 *The Journey Beyond · p. 251*

Visit a nearby park or a water body. Observe the water body and its surroundings. Identify ten organisms and classify them into kingdoms.

ANSWER

This is an observation project. A model list is given; write the organisms you actually observe.

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Organism	Kingdom	Reason
Cyanobacteria (green scum on water)	Monera	Single-celled prokaryotes
Paramecium (pond water, under a microscope)	Protista	Unicellular eukaryote
Green algae (*Spirogyra*)	Plantae (Thallophyta)	Autotrophic; simple body in water
Moss on a damp wall	Plantae (Bryophyta)	Rhizoids; needs moisture
Fern	Plantae (Pteridophyta)	True roots, stem, leaves; no seeds
Peepal or gulmohar tree	Plantae (Angiosperm)	Flowers and fruits
Mushroom	Fungi	Cell wall of chitin; heterotrophic
Earthworm	Animalia (Annelida)	Segmented body
Ant or butterfly	Animalia (Arthropoda)	Jointed legs
Crow or frog	Animalia (Chordata)	Backbone present

Therefore, organisms of a park or water body can be placed in the five kingdoms using cell type, level of organisation and nutrition.

QUESTION 2 *The Journey Beyond · p. 251*

Interview a gardener or a forest worker. Ask them how they identify species. Compare the traditional scientific methods of identification.

ANSWER

Gardeners and forest workers identify plants by experience. Model points for the comparison are given.

Point	Traditional methods (gardener / forest worker)	Scientific methods
Basis	Leaf shape, flowers, fruits, bark, smell and habitat learned by experience	Shared features and evolutionary relationships; cell structure, internal structures, DNA
Names	Local names, which differ by region (tiger is *bagh* in Hindi and *puli* in Tamil)	A universal scientific name of two parts (binomial nomenclature)
Grouping	By use or appearance	Hierarchy: kingdom to species

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Both are useful; traditional knowledge such as the Sangam Tinai classification and the knowledge of sacred groves has helped to preserve habitats.

Therefore, traditional methods rely on experience and local names, while scientific methods use a common system that works worldwide.

QUESTION 3 *The Journey Beyond · p. 251*

If you were studying the Pakke Tiger Reserve or any other bird sanctuary of your choice, how would you organise the information about the bird species?

ANSWER

A systematic record of each species is the best way to keep track of nearly 300 species.

Heading in the record	Example (hornbills of Pakke)
Common and scientific name	Great hornbill, Wreathed hornbill and so on
Group (family, genus, species)	Hornbills grouped together
Distinguishing features	Size, beak and casque, colour of head, neck and tail
Habitat and where seen	Large, old trees with cavities; part of the forest
Food	Specific fruits
Nesting	Cavities of large old trees
Threats and conservation	Loss of large trees

Therefore, I would classify and name each bird species and record its features, habitat, food and nesting in a table.

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QUESTION 4 *The Journey Beyond · p. 251*

Conduct a survey in a forest area near a village, identify edible and poisonous mushrooms with the help of indigenous knowledge of community resource person(s).

ANSWER

Wild mushrooms are conserved by communities, including tribal communities, who know the edible and poisonous types through folk taxonomy.

a Steps

- Visit the forest area with a community resource person and note the local names of the mushrooms.
- Record where each grows (soil, decaying wood or leaf litter), its size, shape, colour and smell, and draw or photograph it.
- Write down what the community says about which are edible and which are poisonous.
- Present the survey as a table.

b Safety

Do not taste or eat any wild mushroom. Wear gloves and let the experts confirm the identification, since poisonous ones can look like edible ones.

Therefore, the survey records mushrooms with their local names and the community's knowledge, without eating any of them.

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QUESTION 5 *The Journey Beyond · p. 251*

Collect and study the postal stamps of India and the world released over time on diversified flora and fauna. Based on your learning, make your own criteria and classify them. Organise a philately (collection of postage stamps) exhibition in your school and showcase your work in this exhibition.

ANSWER

Stamps can be classified in the same way as organisms, by choosing criteria.

Criterion	Groups
Kingdom	Plants, animals, fungi, microorganisms
Animals	Vertebrates (fish, amphibians, reptiles, birds, mammals) and invertebrates
Plants	Flowering and non-flowering plants
Habitat	Forest, desert, mountain, water
Region and status	Endemic species of India; endangered species

For the exhibition: place the stamps on charts under the groups, label them with their common and scientific names, and write the criterion used.

Therefore, stamps can be sorted by chosen criteria and displayed in a school exhibition.

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QUESTION 6 *The Journey Beyond · p. 251*

Investigate an extinct species and analyse how its disappearance impacted the organisms that depend on it, and how this affected the ecological balance of the ecosystem.

ANSWER

This is a research project. Use the format below with the species of your choice.

Step	What to write
Species and place	Name, habitat and when it became extinct
Reasons	Habitat loss, pollution, overuse of resources, climate change
Organisms that depended on it	Animals that fed on it, plants it pollinated or dispersed, organisms it fed on
Effect on ecosystem	Decline of dependent species, change in the food web

The chapter explains that when one species disappears, others that depend on it may also decline in number and eventually disappear. The Sangai deer, once declared extinct and later rediscovered, shows how fragile a species with a small habitat can be.

Therefore, the loss of one species can disturb the whole ecosystem, which is why biodiversity conservation is important.

QUESTION 7 *The Journey Beyond · p. 251*

Study the diversity of farm animals used in different types of farming practices in various parts of the country.

ANSWER

Different farming practices use different animals suited to the climate of the region. Model examples are given; add those from your region.

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Region / farming	Animals used
Mountains and cold regions	Yak, sheep and goats
Deserts and dry regions	Camel, sheep and goats
Plains (crop and dairy farming)	Cattle, buffalo, poultry
North East hill farming	Mithun, pigs and poultry
Wet and coastal regions	Ducks, poultry and fish

Therefore, the farm animals differ from region to region according to the climate and the type of farming.

QUESTION 8 *The Quest Continues... · p. 251*

What knowledge do you think scientists would come up with further and how would it affect the classification system?

ANSWER

This asks for your own thinking. A model answer is given.

- With more advanced microscopes and genetic studies, more organisms may be compared at the DNA level, and new species will be discovered, especially microscopic ones.
- New knowledge, such as about viruses and the groups of microscopic life, may need new groups or changes in the existing ones, as the three domain system did after the five kingdom system.
- Science is an ongoing process of reasoning and change, so the classification system will keep being modified.

Therefore, new discoveries will keep refining the classification system.

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