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Biology Class 9 — Punjab Board (PECTAA)

CHAPTER 2

Biodiversity

Key Concepts · Definitions · Short & Long Questions · MCQs · Diagrams · Exam Tips

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Chapter 2: Biodiversity

Chapter 2 deals with the huge variety of life on Earth and the way biologists sort it into groups. It starts with what biodiversity means and why it matters, then explains classification: its aims, its advantages and the ladder of taxonomic ranks from domain down to species.

The middle of the chapter traces how classification grew from Aristotle's two groups to the modern three-domain system, and describes the main features of Archaea, Bacteria and the four eukaryotic kingdoms. It closes with two special topics: why viruses are left out of the classification system, and how binomial nomenclature gives every species one scientific name used across the world.

Learning Objectives

- Define biodiversity and classification and explain why classification is useful.
- List the taxonomic ranks in order and define species.
- Trace the history of classification from Aristotle to Carl Woese.
- Compare the two-kingdom, three-kingdom, five-kingdom and three-domain systems.
- Describe the main features of the three domains and the four eukaryotic kingdoms.
- Explain why viruses, viroids and prions are not placed in any kingdom.
- State the rules of binomial nomenclature and write scientific names correctly.

Key Concepts

2.1 Biodiversity and Its Importance

Biodiversity is the variety of living things in an area. It is judged by how many different kinds of organisms live there and how much variation exists within each kind. About two million kinds have been described so far, but the real number is thought to be far higher. Biodiversity is uneven: warm, wet tropical regions hold many more species than cold polar regions, because climate, altitude and soil all affect what can live in a place.

Biodiversity keeps ecosystems stable and drives cycles such as the carbon and nitrogen cycles; plants and algae absorb carbon dioxide and help regulate climate; it supplies food, medicines, timber and fuel; and it supports agriculture, tourism and the pharmaceutical industry. The United Nations marks 22 May as International Day for Biological Diversity.

2.2 Classification: Aims and Advantages

Classification is the arrangement of organisms into groups and subgroups according to their similarities and differences. Its two main aims are to make the study of so many organisms manageable and to reveal evolutionary relationships between them. Traditionally organisms were grouped by visible features; today genetic (DNA) similarities are also used.

Advantages: similar organisms can be studied together; species can be compared within a clear framework; relationships between groups become visible; newly discovered species can be placed

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quickly; and biologists everywhere share one common system, which also helps in conservation planning.

2.3 Taxonomic Ranks

The levels used in classification are called taxonomic ranks or taxa (singular taxon). Carl Linnaeus set up a system of seven ranks in 1735: kingdom, phylum (called division for plants and fungi), class, order, family, genus and species. Domain was later placed above kingdom, so the full ladder is domain, kingdom, phylum, class, order, family, genus, species.

Moving down the ladder, each group contains fewer kinds of organisms that are more similar to each other. Species is the basic unit: a group of similar organisms that can interbreed in nature and produce fertile offspring. For example, humans are Eukarya, Animalia, Chordata, Mammalia, Primates, Hominidae, Homo, Homo sapiens; the pea plant is Eukarya, Plantae, Magnoliophyta, Magnoliopsida, Fabales, Fabaceae, Pisum, Pisum sativum.

2.4 History of Classification

Aristotle (384-322 BC) divided living things into plants and animals. The Arab scholar Al-Jahiz described about 350 kinds of animals and wrote in detail on ants. Andrea Caesalpino grouped plants into fifteen genera, Tournefort introduced further groupings for plants, and Carl Linnaeus (1707-1778) built the seven-rank hierarchy still used today.

Two-kingdom system: organisms that make their own food went into Plantae and those that eat food into Animalia, which placed bacteria and fungi among plants. It failed for organisms like Euglena, which has chlorophyll yet can feed like an animal in darkness and has no cell wall, and it ignored the prokaryote-eukaryote difference.

Three-kingdom system (Ernst Haeckel, 1866): added kingdom Protista for Euglena-like organisms and bacteria, but fungi stayed in Plantae even though fungi absorb food and have chitin, not cellulose, in their walls. Five-kingdom system (Robert Whittaker, 1969): used cell organisation and mode of nutrition to create Monera, Protista, Fungi, Plantae and Animalia; Margulis and Schwartz (1988) kept the same five kingdoms but added genetic evidence. Three-domain system (Carl Woese): split prokaryotes into Archaea and Bacteria and put all eukaryotes in Eukarya.

2.5 The Three Domains

Archaea are prokaryotes whose cell walls lack peptidoglycan and whose membranes contain unusual lipids that let many of them live in extreme places such as hot springs, salt lakes and very acidic or alkaline water, though they also live in soil and oceans. Their ribosomal RNA is closer to that of eukaryotes than to bacteria. Examples include methanogens (release methane), halophiles (salt-loving), thermophiles (heat-loving) and acidophiles (acid-loving). They form kingdom Archaebacteria.

Bacteria are prokaryotes with peptidoglycan cell walls, found in soil, water, air and inside other organisms. Most are heterotrophs, but cyanobacteria photosynthesise. Some cause disease while many are useful, for example as decomposers that recycle nutrients. They form kingdom Eubacteria. Eukarya includes every organism whose cells have a true nucleus and membrane-bound organelles, divided into kingdoms Protista, Fungi, Plantae and Animalia.

2.6 Kingdoms of Domain Eukarya

Protista are unicellular, colonial or simple multicellular eukaryotes without multicellular sex organs. Algae are plant-like protists with cellulose walls and chlorophyll (Euglena, diatoms); protozoans are animal-like protists that ingest food and have no wall (Amoeba, Paramecium); fungus-like protists such as slime moulds and water moulds absorb food but have cellulose walls. Some protists cause disease, for example Plasmodium (malaria) and Entamoeba (amoebic dysentery).

Fungi are heterotrophs that absorb food from dead or decaying matter and have cell walls of chitin. Most are multicellular (mushrooms, rusts, smuts, moulds) while yeast is unicellular. Fungi are used in making bread and cheese, and the antibiotic penicillin comes from Penicillium. Plantae are multicellular autotrophs with cellulose walls and multicellular sex organs that form embryos (mosses, ferns, conifers, flowering plants). Animalia are multicellular heterotrophs without cell walls that ingest and internally digest food and develop from embryos (invertebrates and vertebrates).

2.7 Status of Viruses

Viruses sit on the border between living and non-living. They have no cells and no organelles: a virus is just DNA or RNA inside a protein coat. They cannot carry out metabolism or reproduce on their own; they must enter a host cell of a plant, animal or bacterium and use its machinery. Since they share none of the defining features of the three domains, they are not placed in the classification system. Examples are bacteriophages, the influenza virus and the coronavirus that caused COVID-19.

Viroids (small circles of RNA with no protein coat) and prions (infectious proteins with no nucleic acid) are even simpler disease-causing particles and are also left out of classification. COVID-19, first identified in late 2019, spreads through droplets and contaminated surfaces; masks, hand washing and vaccination reduce its spread.

2.8 Binomial Nomenclature

Binomial nomenclature, introduced by Carl Linnaeus, gives each species a two-part scientific name: the genus name first, then the species name, for example Homo sapiens (human), Allium cepa (onion), Solanum tuberosum (potato) and Panthera tigris (tiger).

Scientific names are needed because common names differ from region to region (onion is piyaz, ganda or bassal in different parts of Pakistan), one common name can be used for several organisms (bluebell, blackbird), and common names can be misleading (starfish and jellyfish are not fish). Rules: names are in Latin or Latinised form; the genus comes first and starts with a capital letter, the species comes second in small letters; each name is unique; printed names are written in italics; handwritten names have each word underlined separately.

Important Definitions

Biodiversity
The variety of living organisms in an area, including the number of kinds and the variation within each kind.

Classification
Arranging organisms into groups and subgroups on the basis of their similarities and differences.

Taxon (plural taxa)
Any group or rank used in classification, such as a genus or a family.

Species
A group of similar organisms that can interbreed and produce fertile offspring; the basic unit of classification.

Genus
A group of closely related species.

Domain
The highest taxonomic rank; all life is placed in three domains: Archaea, Bacteria and Eukarya.

Prokaryote
An organism whose cells lack a true nucleus and membrane-bound organelles, such as bacteria and archaea.

Eukaryote
An organism whose cells have a nucleus enclosed in a membrane and membrane-bound organelles.

Autotroph
An organism that makes its own food, usually by photosynthesis.

Heterotroph
An organism that obtains food from other organisms or organic matter.

Peptidoglycan
The material of the bacterial cell wall, made of sugars and amino acids.

Chitin
A tough polysaccharide that forms the cell walls of fungi.

Algae
Plant-like protists that contain chlorophyll and make their own food.

Protozoa
Animal-like protists that ingest food and have no cell wall.

Virus
An acellular particle made of DNA or RNA in a protein coat that can only multiply inside a host cell.

Viroid
An infectious particle made only of a small circle of RNA.

Prion
An infectious particle made only of protein.

Binomial nomenclature
The two-part system of scientific naming: genus name followed by species name.

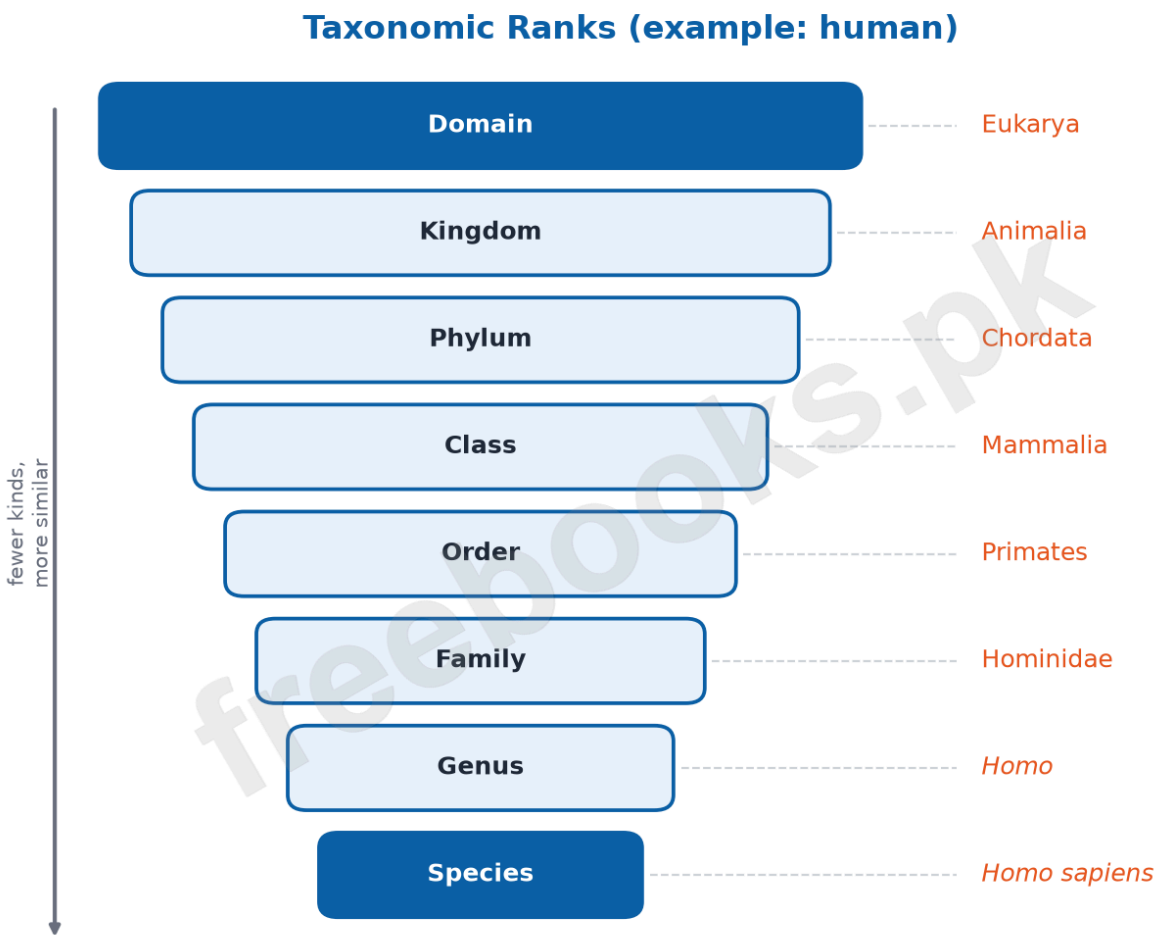
Key Facts at a Glance

Topic	Key point
Kinds of organisms described	About 2 million
International Biodiversity Day	22 May
Linnaeus' system	1735, seven ranks
Order of ranks	Domain → Kingdom → Phylum → Class → Order → Family → Genus → Species
Two-kingdom system	Aristotle's idea: Plantae and Animalia
Three-kingdom system	Ernst Haeckel, 1866 (added Protista)
Five-kingdom system	Robert Whittaker, 1969; revised by Margulis and Schwartz, 1988
Three-domain system	Carl Woese: Archaea, Bacteria, Eukarya
Cell wall: bacteria	Peptidoglycan
Cell wall: fungi	Chitin
Cell wall: plants and algae	Cellulose
Animal cells	No cell wall
Penicillin source	The fungus Penicillium
Human scientific name	Homo sapiens

Diagrams

Taxonomic ranks: The eight ranks from domain to species shown as a narrowing ladder, with the

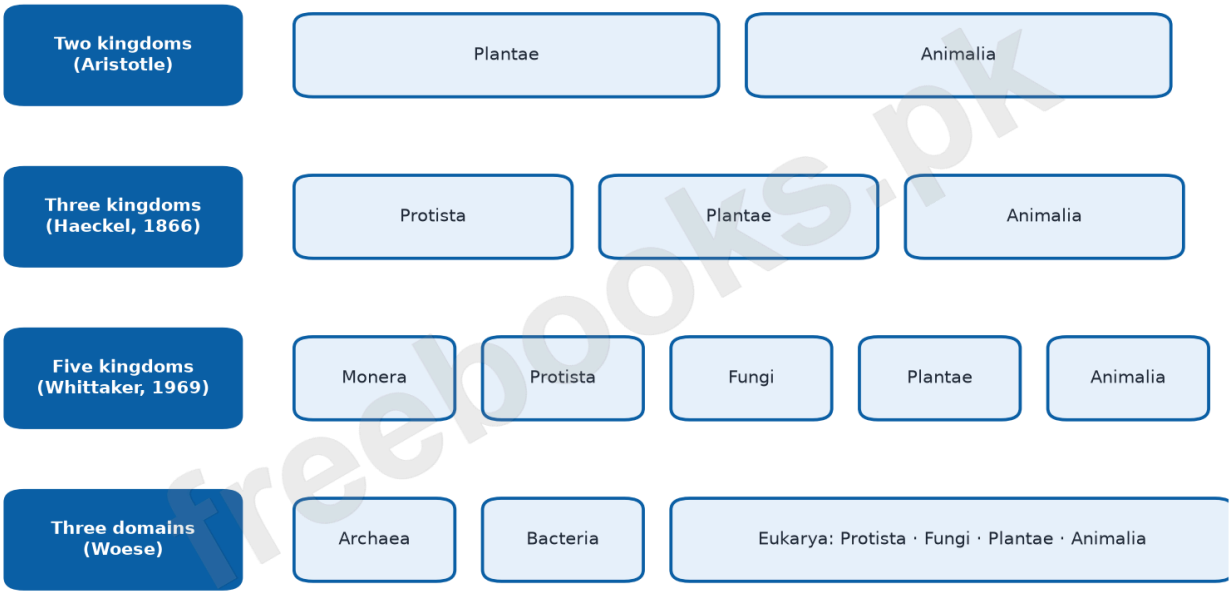
human classified at each level.



How classification systems developed: The two-kingdom, three-kingdom, five-kingdom and three-domain systems side by side, showing which groups were split off at each stage.

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Development of Classification Systems



Comparison of the six kingdoms: Cell type, cell wall material and mode of nutrition for Archaebacteria, Eubacteria, Protista, Fungi, Plantae and Animalia.

Six Kingdoms at a Glance

	Archaebacteria	Eubacteria	Protista	Fungi	Plantae	Animalia
Cell type	Prokaryotic	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	No peptidoglycan	Peptidoglycan	In some	Chitin	Cellulose	None
Nutrition	Auto/hetero	Auto/hetero	Auto/hetero	Absorb food	Photosynthesis	Ingest food
Body	Unicellular	Unicellular	Mostly unicellular	Mostly multicellular	Multicellular	Multicellular

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Short Questions and Answers

Why are tropical forests richer in biodiversity than polar regions?
Warm temperatures, high rainfall and long growing seasons in the tropics support more plant growth and more habitats, so many more species can live there than in cold, dry polar regions.

Give three ways in which biodiversity benefits humans.

It provides food, medicines and raw materials such as timber; plants and algae absorb carbon dioxide and help control climate; and it supports industries such as agriculture, tourism and pharmaceuticals.

What are the two main aims of classification?
To arrange organisms into groups so that their similarities and differences can be studied easily, and to show the evolutionary relationships among them.

Why is species called the basic unit of classification?
Because it is the smallest natural group: its members are alike and can interbreed to produce fertile offspring, while different species normally cannot.

Why did the two-kingdom system fail for Euglena?
Euglena has chlorophyll like a plant but no cell wall and it can feed on organic food in the dark like an animal, so it could not be placed cleanly in either kingdom.

Why were fungi finally separated from plants?
Fungi do not photosynthesise; they absorb food from organic matter, and their cell walls contain chitin rather than cellulose.

On what two bases did Whittaker build his five-kingdom system?
The level of cellular organisation (prokaryotic, unicellular eukaryotic or multicellular eukaryotic) and the mode of nutrition (photosynthesis, absorption or ingestion).

How do archaea differ from bacteria?
Archaea lack peptidoglycan in their walls, have unusual membrane lipids that suit extreme habitats, and have ribosomal RNA closer to that of eukaryotes.

Name the three types of protists with one example each.
Plant-like protists or algae (Euglena), animal-like protists or protozoa (Paramecium), and fungus-like protists (slime moulds).

Why are viruses not included in any kingdom?
They are not made of cells, have no organelles and no metabolism of their own, and can multiply only inside host cells, so they lack the features used to define the domains and kingdoms.

How are viroids different from prions?
A viroid is a small circle of RNA with no protein coat, while a prion is made only of protein and has no nucleic acid.

Why is the common name 'starfish' misleading?
A fish is a vertebrate with a backbone, fins and gills, but a starfish has none of these; it is an invertebrate, so its common name gives a wrong idea.

Write the scientific name of the potato correctly and name its genus and species.

Solanum tuberosum (italic when printed). Solanum is the genus and tuberosum is the species name.

How should a scientific name be written by hand?
The genus name starts with a capital letter, the species name with a small letter, and each of the two words is underlined separately.

Long Questions and Answers

What is classification? Explain its aims, advantages and the taxonomic ranks.

What is classification and what does it aim to do?

Classification is the grouping of organisms into categories based on similarities and differences. It aims to make the enormous number of organisms easier to study and to show how different groups are related through evolution. Modern classification uses both body features and genetic data.

What are the advantages of classification?

It lets similar organisms be studied together, gives a framework for comparing species, shows relationships among groups, helps place newly discovered species and gives biologists all over the world a common system and language, which also helps in conserving biodiversity.

What are the taxonomic ranks?

The ranks, from largest to smallest, are domain, kingdom, phylum (division), class, order, family, genus and species. Linnaeus introduced seven of them in 1735 and domain was added later above kingdom. Each lower rank holds fewer and more closely related organisms.

How is a human classified through these ranks?

Domain Eukarya, kingdom Animalia, phylum Chordata, class Mammalia, order Primates, family Hominidae, genus Homo and species Homo sapiens. This shows how the groups narrow from all eukaryotes down to one species.

Describe the history of classification systems from two kingdoms to three domains.

What was the two-kingdom system and why was it replaced?

It placed food-making organisms in Plantae and food-eating organisms in Animalia, putting bacteria and fungi with plants. Organisms like Euglena that show both plant and animal features could not be placed, and the system ignored the basic difference between prokaryotic and eukaryotic cells.

What did Haeckel's three-kingdom system add?

In 1866 Ernst Haeckel created kingdom Protista for Euglena-like organisms and also placed bacteria in it. Fungi still remained in Plantae, even though they absorb food and have chitin walls, so the system was still not satisfactory.

How did Whittaker's five-kingdom system work?

In 1969 Robert Whittaker grouped organisms by cell organisation and mode of nutrition into Monera, Protista, Fungi, Plantae and Animalia. In 1988 Margulis and Schwartz kept the five kingdoms but also used genetic evidence.

What is the three-domain system?

Carl Woese placed a new rank, domain, above kingdom and divided prokaryotes into Archaea and Bacteria because of major differences in their chemistry and genes. All eukaryotes were placed in the domain Eukarya, which contains Protista, Fungi, Plantae and Animalia.

Describe the main features of the domains and the kingdoms of domain Eukarya.

What are the features of domain Archaea?

Archaea are prokaryotes without peptidoglycan in their walls and with special membrane lipids. Many live in extreme habitats such as hot springs and salt lakes, and some produce methane. Their ribosomal RNA resembles that of eukaryotes.

What are the features of domain Bacteria?

Bacteria are unicellular prokaryotes with peptidoglycan walls that live almost everywhere. Most are heterotrophs, some like cyanobacteria photosynthesise; some cause disease while many act as decomposers that recycle nutrients.

How do Protista and Fungi differ?

Protists are unicellular or simple multicellular eukaryotes and may be plant-like, animal-like or fungus-like. Fungi are mostly multicellular heterotrophs that absorb food from organic matter and have chitin cell walls.

How do Plantae and Animalia differ?

Plants are multicellular autotrophs with cellulose walls and multicellular sex organs that form embryos. Animals are multicellular heterotrophs with no cell walls that ingest food and digest it inside the body.

What is binomial nomenclature? Explain its importance and rules.

What is binomial nomenclature?

It is the system of giving every species a two-part scientific name, introduced by Carl Linnaeus. The first part is the genus and the second part is the species, for example Panthera tigris for the tiger.

Why are scientific names better than common names?

Common names change from place to place, the same common name may be used for different organisms, and some common names are misleading. A scientific name is unique and is understood by biologists everywhere.

What are the rules for writing scientific names?

Names are Latin or Latinised. The genus is written first with a capital letter and the species second

with a small letter. Every name is unique; printed names are italicised and handwritten names have each part underlined separately.

Multiple Choice Questions (MCQs)

Which rank contains the largest number of different organisms? (A) Genus (B) Order (C) Kingdom (D) Domain
Correct answer: (D) Domain. Domain is the highest rank and includes the widest range of organisms.

Which pair of ranks lies directly between class and family? (A) Order only (B) Phylum only (C) Genus only (D) Domain only
Correct answer: (A) Order only. The sequence is class, order, family.

Organisms that interbreed in nature and produce fertile offspring belong to the same: (A) Family (B) Genus (C) Species (D) Class
Correct answer: (C) Species. This ability defines a species.

Euglena caused problems for the two-kingdom system because it: (A) Has a chitin wall (B) Shows both plant-like and animal-like features (C) Is a virus (D) Lives only in hot springs
Correct answer: (B) Shows both plant-like and animal-like features. It has chlorophyll yet can feed heterotrophically and lacks a cell wall.

Kingdom Protista was first proposed by: (A) Aristotle (B) Ernst Haeckel (C) Robert Whittaker (D) Carl Woese
Correct answer: (B) Ernst Haeckel. Haeckel proposed Protista in 1866.

The five-kingdom system is based mainly on: (A) Colour and size (B) Cell organisation and mode of nutrition (C) Habitat only (D) Number of legs
Correct answer: (B) Cell organisation and mode of nutrition. Whittaker used cell organisation and nutrition.

A microorganism lives in a boiling hot spring and has no peptidoglycan in its wall. It most likely belongs to: (A) Bacteria (B) Archaea (C) Fungi (D) Protista
Correct answer: (B) Archaea. Archaea lack peptidoglycan and many live in extreme habitats.

The cell wall of fungi is made of: (A) Cellulose (B) Peptidoglycan (C) Chitin (D) Lignin only
Correct answer: (C) Chitin. Fungal walls contain chitin.

Amoeba and Paramecium are examples of: (A) Algae (B) Protozoa (C) Fungi (D) Archaea
Correct answer: (B) Protozoa. They are animal-like protists.

Which kingdom contains multicellular autotrophs with multicellular sex organs? (A) Fungi (B) Protista (C) Plantae (D) Animalia

Correct answer: (C) Plantae. Only plants combine these features.

Viruses are not placed in any kingdom mainly because they: (A) Are too large (B) Are acellular and cannot reproduce on their own (C) Contain chlorophyll (D) Have chitin walls
Correct answer: (B) Are acellular and cannot reproduce on their own. They lack cells and independent metabolism.

An infectious particle made only of protein is a: (A) Viroid (B) Prion (C) Bacteriophage (D) Spore
Correct answer: (B) Prion. Prions consist only of protein.

Which is the correctly written scientific name? (A) homo sapiens (B) Homo Sapiens (C) Homo sapiens (D) HOMO sapiens
Correct answer: (C) Homo sapiens. Genus capitalised, species in small letters (and italic in print).

In Allium cepa, the word Allium is the: (A) Species name (B) Genus name (C) Family name (D) Common name
Correct answer: (B) Genus name. The first word is always the genus.

The antibiotic penicillin is obtained from a: (A) Bacterium (B) Fungus (C) Virus (D) Protozoan
Correct answer: (B) Fungus. It comes from the fungus Penicillium.

Quick Revision Summary

- Biodiversity = variety of life in an area; highest in the tropics; supports ecosystems, climate, resources and the economy.
- Classification groups organisms by similarities and differences; aims: easy study and evolutionary relationships.
- Ranks: Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species (Linnaeus 1735 gave seven; domain added later).
- Systems: 2 kingdoms (Aristotle) → 3 kingdoms (Haeckel 1866, Protista) → 5 kingdoms (Whittaker 1969) → 3 domains (Woese).
- Archaea: no peptidoglycan, extreme habitats. Bacteria: peptidoglycan walls. Eukarya: Protista, Fungi, Plantae, Animalia.
- Walls: bacteria = peptidoglycan, fungi = chitin, plants/algae = cellulose, animals = none.
- Viruses, viroids (RNA only) and prions (protein only) are not classified.
- Binomial name = Genus (capital) + species (small), italic when printed, underlined separately by hand.

Exam Tips

- Use a memory sentence for the ranks, for example: 'Dear King Philip Came Over For Good

Soup' = Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species.

- For each classification system, remember one name, one date and one reason it was replaced.
- In kingdom comparison questions, always mention cell type, cell wall and mode of nutrition; that covers most marks.
- Write scientific names carefully: one capital letter only, and underline the two words separately in handwriting.
- If asked why viruses are not classified, give at least two reasons: no cells and no independent metabolism or reproduction.

Note on Facts

The textbook dates the rank of domain to 1977. In 1977 Carl Woese and George Fox showed that archaea are a separate group; the three-domain system itself was formally proposed by Woese and colleagues in 1990. Use the date your teacher gives in the exam.

The textbook's table gives Solanum esculentum for tomato; the name used today is Solanum lycopersicum (older books use Lycopersicon esculentum).

The textbook says prions and viroids cause diseases in certain plants and cancer. In fact viroids infect plants, prions cause brain diseases in animals and humans (such as mad cow disease), and neither is known to cause cancer.