

Characteristics and classification of living organisms revision notes

All living things share seven characteristics, and biologists use shared features to sort organisms into groups. This topic covers how those groups are defined and named, how a dichotomous key identifies an organism, and the features used to place organisms into kingdoms and smaller groups.

For Cambridge IGCSE Biology 0610 (and 0970, which has the same content). **Supplement** is Extended content, only examined on Papers 2 and 4.

1 Characteristics and classification Spec 1.1, 1.2

The seven characteristics of living organisms Spec 1.1.1

Every living organism, from a bacterium to a blue whale, shows **seven characteristics**. A non-living thing, such as a car or a flame, may appear to show some of them, but never all seven.

Movement	an action by an organism or part of an organism causing a change of position or place
Respiration	the chemical reactions in cells that break down nutrient molecules and release energy for metabolism
Sensitivity	the ability to detect and respond to changes in the internal or external environment
Growth	a permanent increase in size and dry mass
Reproduction	the processes that make more of the same kind of organism
Excretion	the removal of the waste products of metabolism and substances in excess of requirements
Nutrition	the taking in of materials for energy, growth and development

The first letters spell **MRS GREN**: Movement, Respiration, Sensitivity, Growth, Reproduction, Excretion, Nutrition. Learn each definition word for word, because Cambridge mark schemes follow the syllabus wording.

Points that are often marked

- Plants move too. A plant moves when its leaves or flowers change position, even though the whole plant stays in one place.
- Growth means a permanent increase in size and **dry mass**. A balloon gets bigger when inflated but does not grow.
- Excretion is not the same as egestion. Faeces are undigested food that never entered the body's cells, so they are not metabolic waste.
- Examples of excretion: carbon dioxide from respiration, urea from the breakdown of excess amino acids, and oxygen from photosynthesis in plants.

Common mistake: Respiration is not breathing. Respiration is a set of chemical reactions in cells that release energy. Breathing only moves air in and out of the lungs.

Classification, species and binomial names Spec 1.2.1, 1.2.2, 1.2.3

Scientists use classification to sort living organisms into groups. Organisms can be classified into groups by the **features that they share**. Organisms in the same group are more alike than organisms in different groups.

Species

A **species** is a group of organisms that can reproduce to produce fertile offspring. 'Fertile' means that the offspring can themselves reproduce.

A horse and a donkey can mate and produce a mule. The mule is sterile, so it cannot produce offspring of its own. This is why horses and donkeys are two different species, even though they look similar.

The binomial system

The **binomial system** is an internationally agreed system for naming species. Because it is agreed worldwide, scientists in every country use the same name for the same organism, whatever language they speak.

The scientific name has two parts. The first part is the **genus** and the second part is the **species**. A genus is a group of closely related species.

Examples of binomial names			
Organism	Binomial name	Genus	Species
Human	<i>Homo sapiens</i>	<i>Homo</i>	<i>sapiens</i>
Lion	<i>Panthera leo</i>	<i>Panthera</i>	<i>leo</i>
Tiger	<i>Panthera tigris</i>	<i>Panthera</i>	<i>tigris</i>

The genus name starts with a capital letter and the species name starts with a lower-case letter. In print the name is in italics. When you write it by hand, underline each word separately. The lion and the tiger share a genus, so they are closely related, but they are different species.

Exam tip: A question that asks for a definition of species needs both ideas: can reproduce, and produce fertile offspring. 'Can interbreed' on its own is not enough.

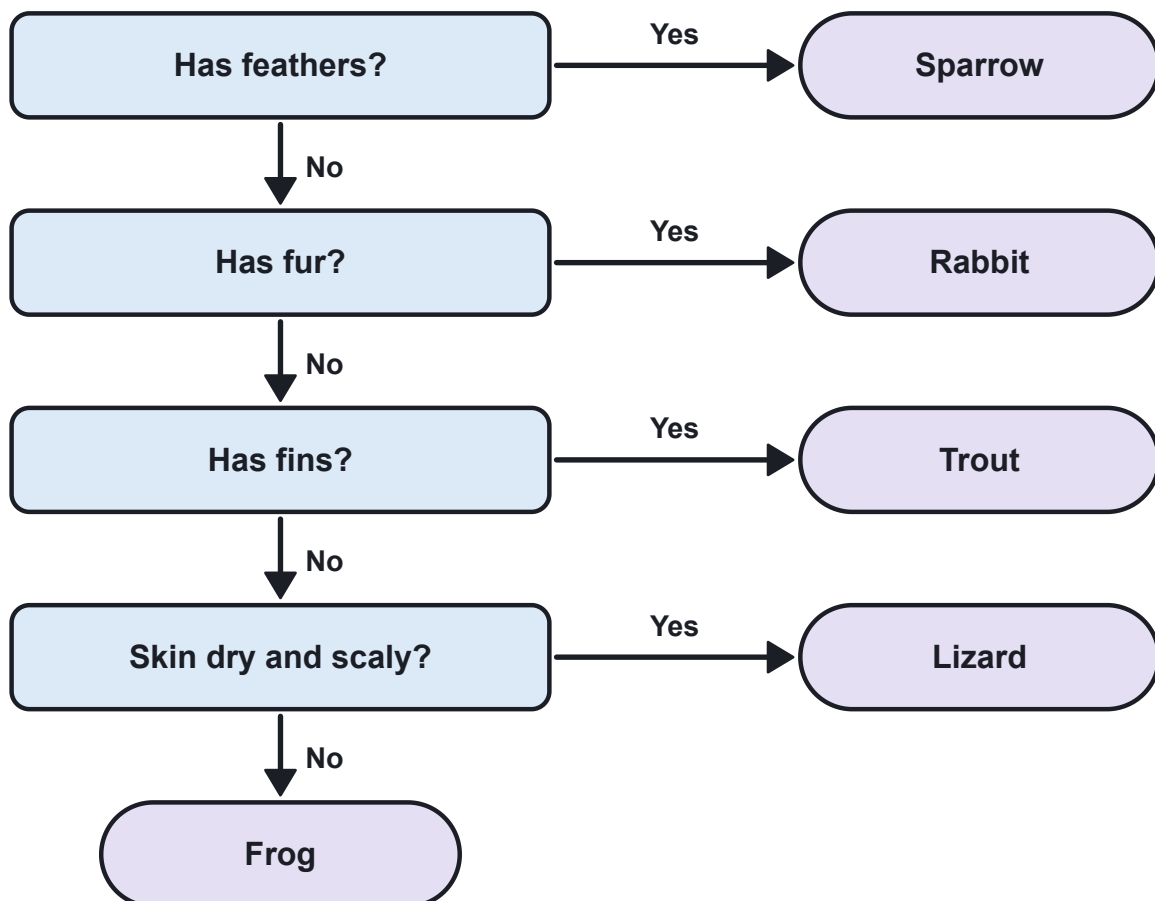
Constructing and using dichotomous keys Spec 1.2.4

A **dichotomous key** is a series of **paired statements** that identifies an organism. 'Dichotomous' means 'divides into two'. At each step you choose between two descriptions, and each choice sends you to another step or to the name of an organism.

Using a key

A key to five animals		
Step	Feature	Result
1a	Has feathers	Sparrow
1b	Does not have feathers	Go to step 2
2a	Has fur	Rabbit
2b	Does not have fur	Go to step 3
3a	Has fins	Trout
3b	Does not have fins	Go to step 4
4a	Skin is dry and scaly	Lizard
4b	Skin is moist and smooth	Frog

To identify a frog, start at 1. It has no feathers (1b), so go to step 2. It has no fur (2b), so go to step 3. It has no fins (3b), so go to step 4. Its skin is moist and smooth (4b), so it is a frog.



The same key as a flow chart. Each question has **two exits**, and every organism ends in its own box.

Constructing a key

1. List the organisms and choose features that you can see and that are clearly different, such as feathers, fins or number of legs.
2. Pick one feature that splits the organisms into two groups, so that some have it and some do not.

3. Write the two statements as a pair. Each statement must be a clear contrast, for example 'has fur' and 'does not have fur'.
4. Repeat with each group until every organism is on its own.
5. Test the key by using it on each organism.

Exam tip: Use features that can be observed and do not change, such as the number of legs. Avoid size, because it varies with age. Do not use two features in one statement.

Classification, evolution and DNA Spec 1.2.5, 1.2.6, 1.2.7 Supplement

Supplement

Classification systems aim to **reflect evolutionary relationships**. Organisms are grouped together because they are believed to have evolved from a common ancestor, not just because they look alike.

Supplement

DNA and classification

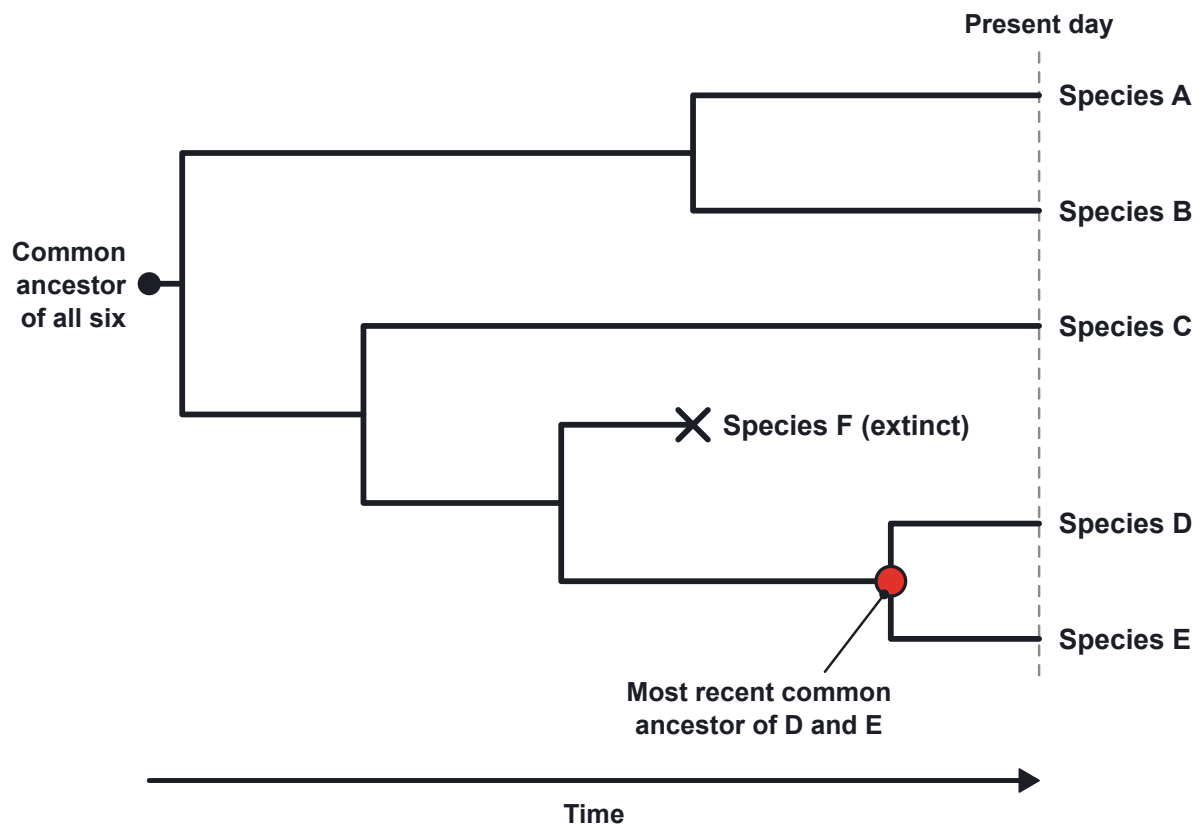
Supplement

The **sequences of bases in DNA** are used as a means of classification. Scientists compare the base sequence of the same gene in different organisms. DNA is inherited from ancestors, so the more similar the sequences are, the more recently the organisms shared an ancestor.

Supplement

Groups of organisms which share a more recent ancestor (are more closely related) have base sequences in DNA that are **more similar** than those that share only a distant ancestor. Over time, mutations change the sequence, so organisms that separated long ago have gathered more differences.

Supplement



D and E share the **most recent common ancestor**, so they are the most closely related species on this tree and their DNA base sequences are the most similar.

Supplement

Example: similarity of one gene to the human sequence

Species	Similarity to human gene / %
Chimpanzee	99
Mouse	85
Chicken	75

Supplement

The values are for practice. The chimpanzee sequence is the most similar, so the chimpanzee shares the most recent common ancestor with humans and is the most closely related.

Supplement

Exam tip: Link the three ideas in your answer: similar DNA base sequences, a more recent common ancestor, and closer relationship.

Quick check

1. Define a species.
2. Which two parts make up a binomial name?
3. What is excretion?
4. What does 'dichotomous' mean?
5. **Supplement** How does DNA show that two species are closely related?

2 Features of organisms Spec 1.3

Features of the animal and plant kingdoms Spec 1.3.1

The two kingdoms you meet most often are the **animal kingdom** and the **plant kingdom**. Each kingdom has main features that are used to place an organism in it.

Main features of animals and plants		
Feature	Animals	Plants
Number of cells	Multicellular	Multicellular
Cell walls	No cell walls	Cell walls made of cellulose
Chloroplasts	No chloroplasts	Contain chloroplasts, so they can carry out photosynthesis
Nutrition	Feed on other organisms (they take in organic substances)	Make their own food by photosynthesis
Carbohydrate store	Glycogen	Starch
Coordination	Usually have a nervous system	No nervous system
Movement	Most can move from place to place	Cannot move from place to place

Use these features to place an unknown organism. An organism that is multicellular, has cellulose cell walls and has chloroplasts is a plant. A multicellular organism with no cell walls that eats other organisms is an animal.

Exam tip: Mention at least two features and always compare the same feature in both kingdoms. 'Plants have chloroplasts' scores better as 'plants have chloroplasts; animals do not'.

Vertebrate and arthropod groups Spec 1.3.2, 1.3.3

The animal kingdom is split into smaller groups. You need the five groups of **vertebrates** (animals with a backbone) and four groups of **arthropods** (animals with jointed legs).

Vertebrates

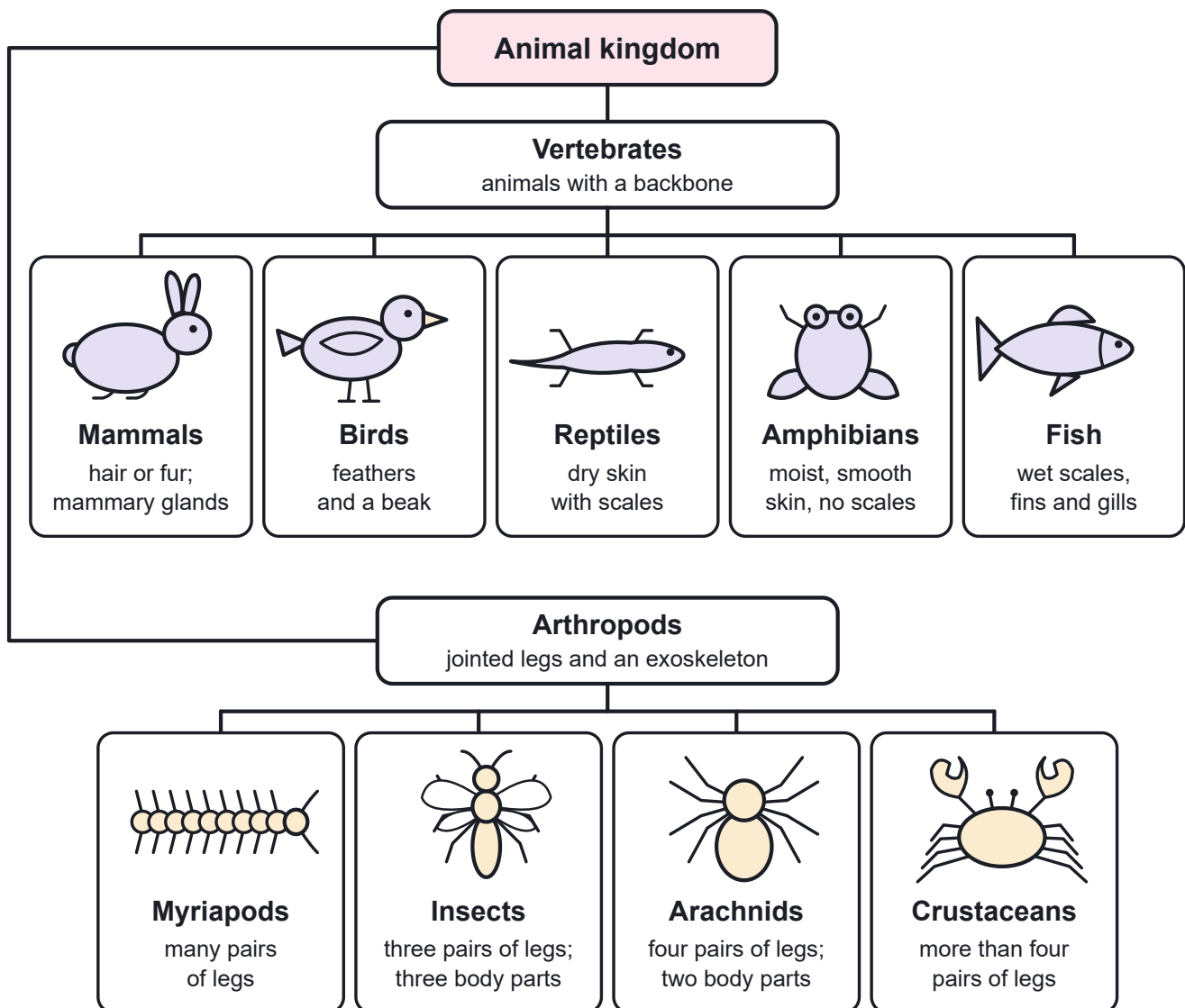
Main features of the vertebrate groups	
Group	Main features
Mammals	Body covered with hair or fur; young develop in the mother and are fed on milk from mammary glands; external ears (pinnae)
Birds	Body covered with feathers; two wings and two scaly legs; a beak; lay eggs with hard shells
Reptiles	Dry skin covered with scales; lay eggs with soft, leathery shells; most live on land
Amphibians	Moist, smooth skin without scales; lay jelly-covered eggs in water; larvae (tadpoles) live in water; adults often live on land
Fish	Body covered with wet scales; fins; gills for gas exchange; lay soft eggs in water

Arthropods

All arthropods have a hard **exoskeleton**, a body made of segments, and **jointed legs**. They are split into four groups by the number of legs and body parts.

Main features of the arthropod groups

Group	Main features	Example
Myriapods	Long body made of many similar segments; many pairs of legs, one or two pairs on each segment; one pair of antennae	Centipede
Insects	Body in three parts (head, thorax, abdomen); three pairs of legs; one pair of antennae; usually two pairs of wings	Housefly
Arachnids	Body in two parts (cephalothorax and abdomen); four pairs of legs; no antennae and no wings	Spider
Crustaceans	More than four pairs of legs; two pairs of antennae; breathe using gills; most live in water	Crab



The five vertebrate groups and four arthropod groups, with a key feature of each.

Classifying an organism

To classify an organism, first decide its kingdom using the animal and plant features. Then match its features to the group descriptions. An animal with a backbone, feathers and a beak is a bird. An animal with a hard exoskeleton, eight legs and two body parts is an arachnid.

Exam tip: Do not name a group from one feature alone. Many groups lay eggs, but only birds have feathers and only mammals have fur and mammary glands.

The five kingdoms Spec 1.3.4, 1.3.6 Supplement

Supplement

All organisms can be placed in one of **five kingdoms**: animal, plant, fungus, prokaryote and protocist. The animal and plant features are in the table in the previous section. The other three kingdoms have these main features.

Supplement

Main features of fungi, prokaryotes and protocists

Kingdom	Main features	Example
Fungus	Cell walls made of chitin; no chloroplasts, so they cannot photosynthesise; feed by absorbing nutrients from dead or living organisms; body usually made of threads called hyphae (yeast is single-celled); store glycogen; reproduce with spores	<i>Mucor</i> , yeast
Prokaryote	Single-celled; no nucleus (a circular DNA molecule lies free in the cytoplasm, and there may be plasmids); cell wall that is not made of cellulose	Bacteria
Protocist	Mostly single-celled microscopic organisms with a nucleus; some have chloroplasts like plants, others feed like animals	<i>Amoeba</i> , <i>Chlorella</i>

	Animal	Plant	Fungus	Prokaryote	Protocist
Cells	Multicellular	Multicellular	Usually multicellular (yeast is single-celled)	Single-celled	Mostly single-celled
Nucleus	Present	Present	Present	Absent (DNA free in the cytoplasm)	Present
Cell wall	None	Cellulose	Chitin	Present, not cellulose	Some have one
Chloroplasts	Absent	Present	Absent	Absent	Some have chloroplasts
How it feeds	Feeds on other organisms	Makes its own food by photosynthesis	Absorbs nutrients from dead or living organisms	Most absorb nutrients	Some photosynthesise; others feed like animals

The five kingdoms compared. Check **nucleus** and **cell wall** first.

Supplement

Classify an organism by working through the features. Single-celled with no nucleus means prokaryote. Chitin cell walls and no chloroplasts means **fungus**, even when single-celled like yeast. Single-celled with a nucleus but without chitin walls means protocist.

Supplement

Common mistake: Fungi are not plants. They have chitin walls, no chloroplasts, and they absorb nutrients from their surroundings instead of making food by photosynthesis.

Ferns, monocots and dicots Spec 1.3.5 Supplement

Supplement

The plant kingdom contains two groups that you need to know: **ferns** and **flowering plants**. Flowering plants are split again into **monocotyledons** (monocots) and **dicotyledons** (dicots).

Supplement

Main features of the plant groups

Group	Main features
Ferns	Leaves called fronds; have roots, stems and leaves; no flowers; reproduce using spores, made on the underside of the fronds, not seeds
Flowering plants	Produce flowers; reproduce using seeds, which form inside the ovary of the flower

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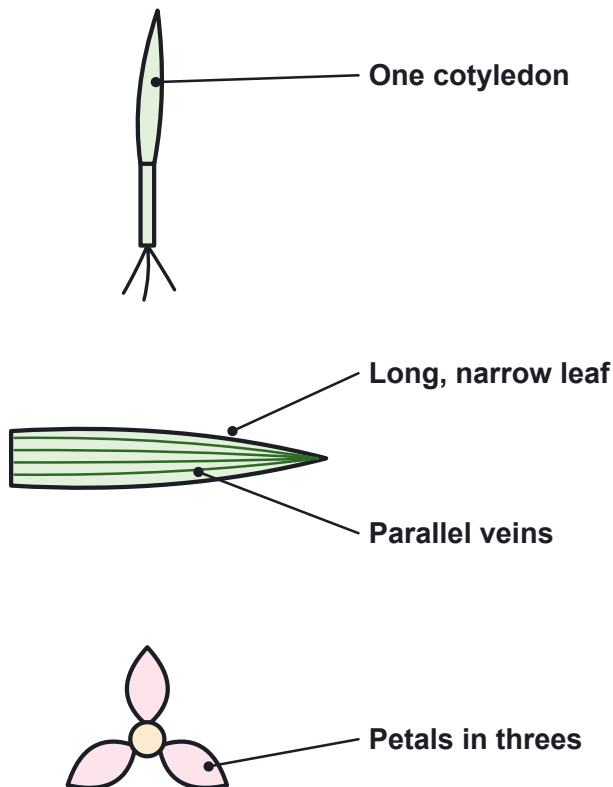
Monocotyledons and dicotyledons

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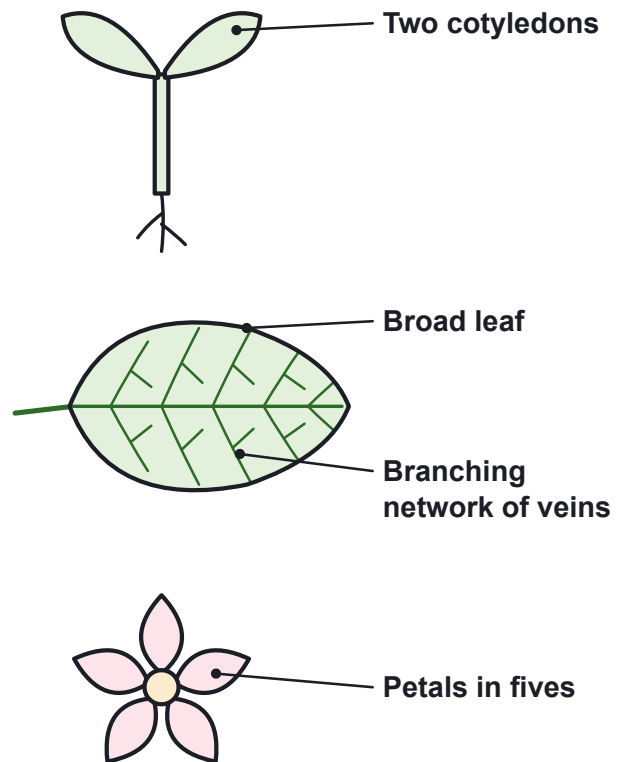
Comparing monocots and dicots

Feature	Monocotyledons	Dicotyledons
Cotyledons (seed leaves)	One	Two
Leaf veins	Parallel	Branching network
Leaf shape	Usually long and narrow	Usually broad
Flower parts	In threes or multiples of three	In fours or fives, or multiples of four or five
Examples	Grasses, wheat, maize	Beans, sunflower, oak

Monocotyledons



Dicotyledons



Monocots have **one cotyledon** and parallel veins; dicots have **two cotyledons** and a branching network of veins.

Supplement

Exam tip: Count the cotyledons first, because that gives the group its name. Leaf vein pattern is the quickest feature to use when you are shown a leaf.

Viruses Spec 1.3.7 Supplement

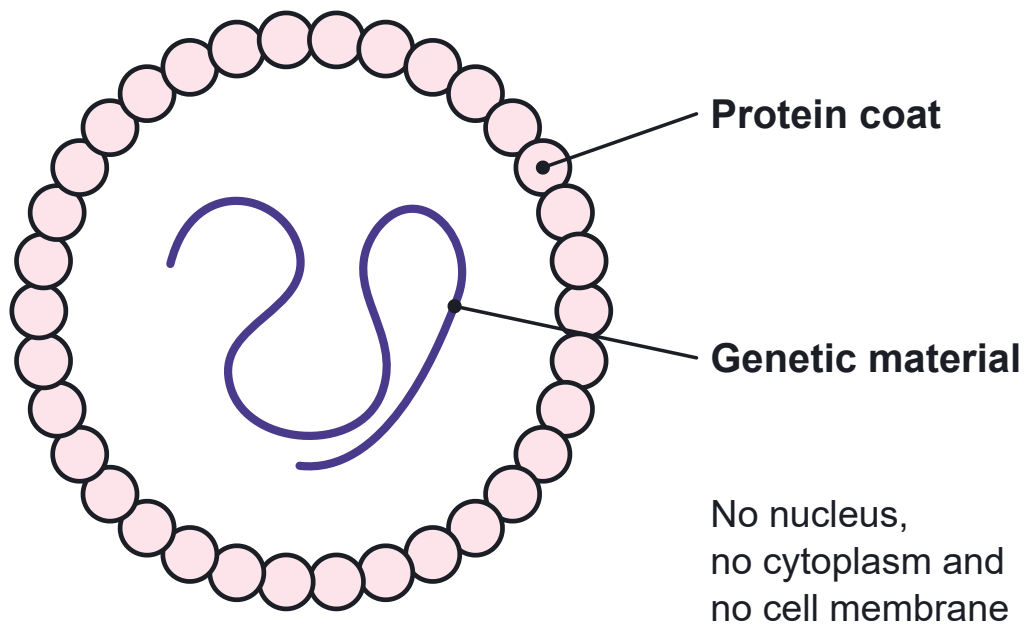
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A **virus** is much smaller than a bacterium. Viruses are not made of cells, so they do not fit into the five kingdoms. The features of a virus are limited to two: a **protein coat** and **genetic material**.

Supplement

Features of a virus

Part	Description
Protein coat	Surrounds and protects the genetic material
Genetic material	Carries the instructions for making new viruses; inside the protein coat



A virus has only a **protein coat** and **genetic material**.

Supplement

Exam tip: Do not describe a virus as having a nucleus, cytoplasm or cell membrane. State protein coat and genetic material, and nothing else.

Quick check

1. State two features of plants that animals do not have.
2. Name the four groups of arthropods.
3. Name the five groups of vertebrates.
4. **Supplement** Name the five kingdoms.
5. **Supplement** State the two features of a virus.

Quick check answers

Characteristics and classification

1. A group of organisms that can reproduce to produce fertile offspring.
2. The genus and the species.
3. The removal of the waste products of metabolism and substances in excess of requirements.
4. Divides into two: each step of the key offers a choice between two statements.
5. Their DNA base sequences are more similar, because they share a more recent common ancestor.

Features of organisms

1. Cell walls made of cellulose; chloroplasts (so they photosynthesise).
2. Myriapods, insects, arachnids and crustaceans.
3. Mammals, birds, reptiles, amphibians and fish.
4. Animal, plant, fungus, prokaryote and protist.
5. A protein coat and genetic material.