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Cambridge IGCSE® & O Level **Biology**



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Characteristics and classification of living organisms

1.1 Characteristics of living organisms

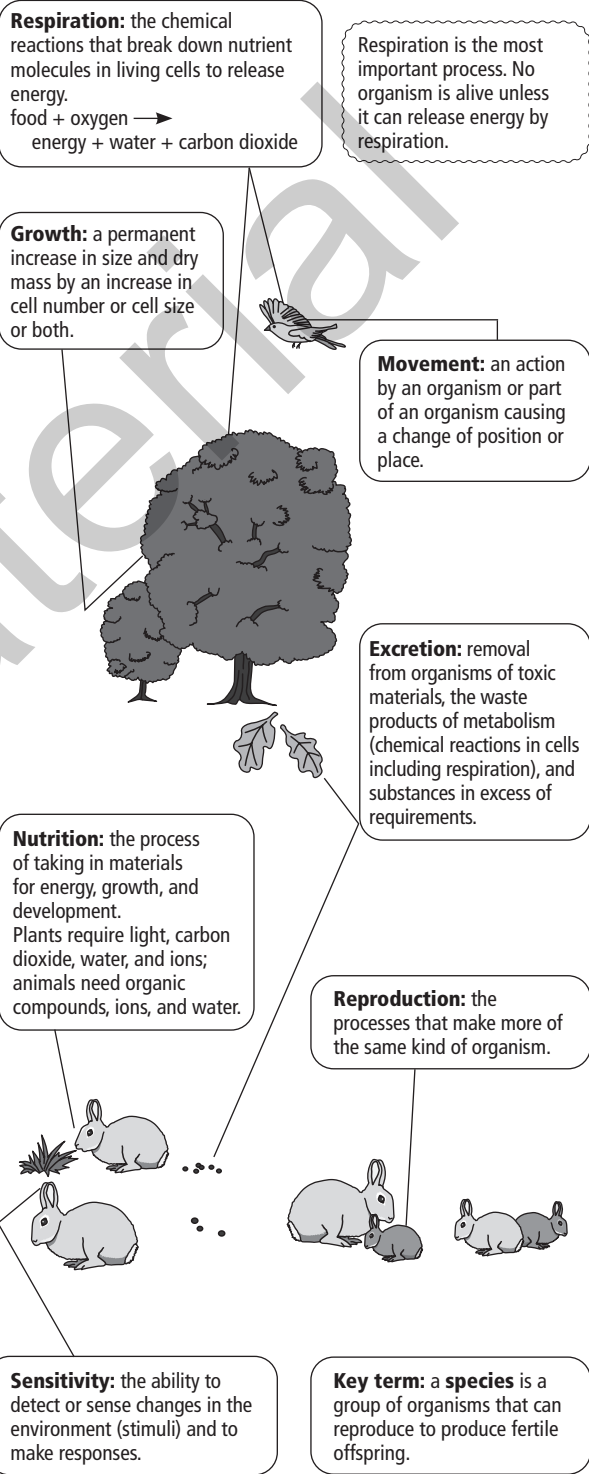
Your revision checklist

Core/Extended curriculum syllabus content		1	2	3
1.14	Describe the characteristics of living organisms by defining the terms:			
	movement respiration sensitivity growth			
	reproduction excretion nutrition			

Recap

Living organisms show seven characteristics.

The biosphere is made up of living and non-living things. Plants and animals are living things because they have these characteristics:



▲ Characteristics of living things.

Exam tip

Use a single word to help you to remember these life processes. For example, the word RINGER is made up from the first letters of each of them: **R**espiration, **I**rritability and **M**ovement, **N**utrition, **G**rowth, **E**xcretion, and **R**eproduction.

Exam tip

Don't confuse excretion and egestion. **Excretion** is the removal of the waste products of metabolism and **egestion** is the removal of food that has passed through the gut without being digested.

1.2 Concept and use of a classification system

Your revision checklist

Core/Extended curriculum syllabus content		1	2	3
1.2	State that organisms can be classified into groups by the features that they share			
	Define <i>species</i> as a group of organisms that can reproduce to produce fertile offspring			
	Define and describe the <i>binomial system</i> of naming species as an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species			
	Explain that classification systems aim to reflect evolutionary relationships Explain that the sequences of bases in DNA and amino acids in proteins are used as a more accurate means of classification Explain that 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			

Classification is the science of putting organisms into groups based on features that they have in common.

Classification was traditionally based on the *external features of organisms*, such as the type of skin.

Classification is now based on similarities in the *sequence of bases in DNA* or on the *sequence of amino acids* in a particular protein.

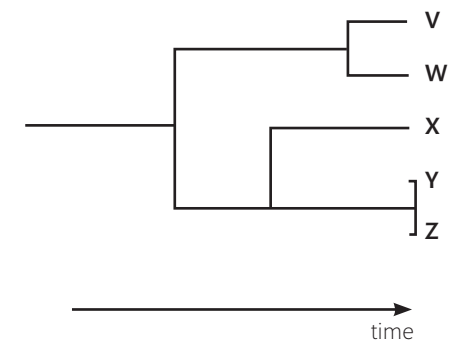
Apply

1. The evolutionary relationships between five species are shown in the diagram.

An analysis of base sequences from the DNA of these five species was carried out.

Which two species will have the most similar sequences?

- A. V and W
B. W and X
C. X and Z
D. Y and Z



(1)



Recap

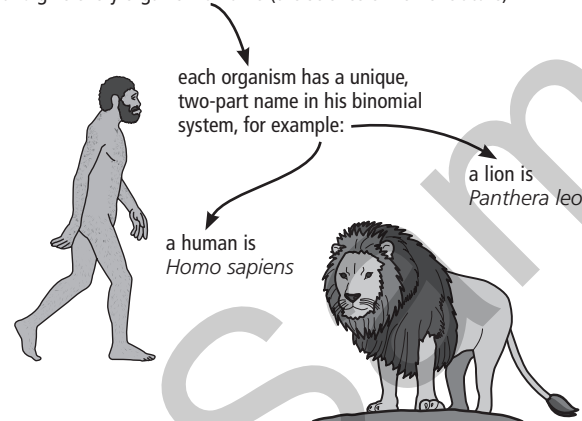
Scientists classify living organisms into groups. This is useful since it enables humans to sort out the millions of different species according to their similarities, and makes communication between scientists more straightforward.

Exam tip

Classification

The full name for a species is both names. The name should be written in italics, and the genus – such as *Homo* – begins with a capital letter.

Linnaeus was a scientist who believed he could put every organism into a group (the science of taxonomy) and give every organism a name (the science of nomenclature).



▲ Naming the organisms.

The **binomial system** uses two names for each species: the genus name, with a capital letter, and the species name, with a small letter, for example, *Panthera leo* – the lion.

A **species** is a group of organisms that can interbreed and produce fertile offspring.

1.3 Features of organisms

Your revision checklist

Core/Extended curriculum syllabus content		1	2	3
1.3	List the features in the cells of all living organisms, limited to cytoplasm, cell membrane, and DNA as genetic material			
	List the main features used to place animals and plants into the appropriate kingdoms			
	List the main features used to place organisms into groups within the Animal Kingdom, limited to: - the main groups of vertebrates: mammals, birds, reptiles, amphibians, fish - the main groups of arthropods: myriapods, insects, arachnids, crustaceans			
	Classify organisms using the features identified in 1.3.1 and 1.3.2			
	State the main features used to place all organisms into one of the five kingdoms: Animal, Plant, Fungus, Prokaryote, Protocist			
	State the main features used to place organisms into groups within the Plant Kingdom, limited to ferns and flowering plants (dicotyledons and monocotyledons)			
	Classify organisms using the features identified in 1.3.4 and 1.3.5			
	State the features of viruses, limited to protein coat and genetic material			

Features of organisms

The cells of all living organisms have cytoplasm, a cell membrane, and a nucleus.

There are five kingdoms of living organisms: Animal, Plant, Fungi, Protocist, and Prokaryote.

We can identify the group to which a particular organism belongs by asking a series of questions.

1. Is the organism made of a single cell? YES go to question 2
NO go to question 3
2. Does the cell have DNA inside a clear nucleus? YES it is a **protocistan**
NO it is a **prokaryote**
3. Are the cells surrounded by a cell wall? YES go to question 4
NO it is an **animal**
4. Is the cell wall made of cellulose? YES it is a **plant**
NO it is a **fungus**

Prokaryotes (for example bacteria) have cells with a cell wall and DNA that is not contained in a nucleus.

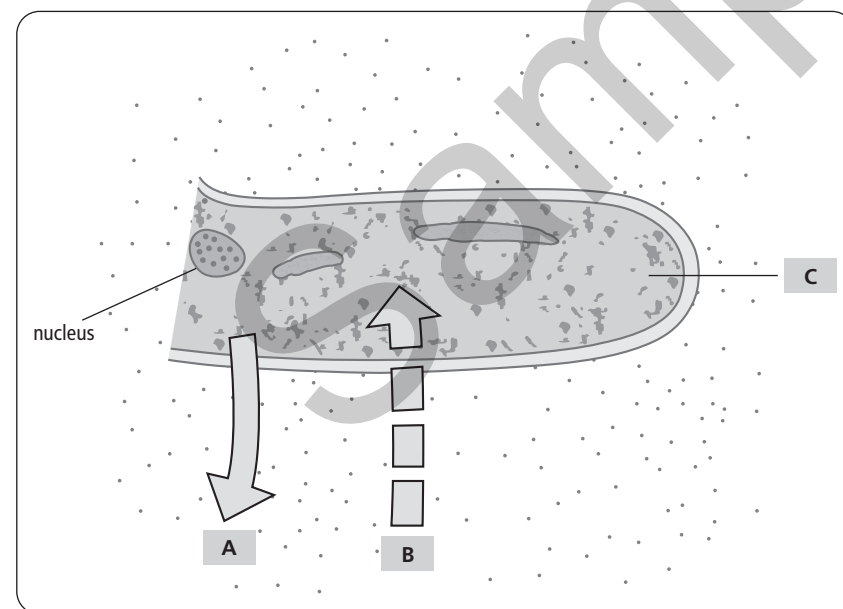
Protocistans (for example *Amoeba*) have some features of typical animal or plant cells, such as a nucleus and simple chloroplasts, but usually are made up of one or just a few cells.

Fungi have cells with a cell wall (not made of cellulose) which are arranged in threads called hyphae. The hyphae feed by releasing enzymes onto their food and then absorbing the digested products.

Viruses do not fit into any of the five kingdoms. They are made up of a few genes inside a protein coat and cannot reproduce outside a living cell.

Apply

2. The following diagram shows the feeding process in a small organism.



▲ Feeding hypha.

The organism is feeding on some waste protein—the skin of a dead animal.

- a. Which class of enzyme must be secreted at **A**? (1)
- b. Which type of compound will be absorbed at **B**? (1)
- c. Which Kingdom does this organism belong to? (1)
- d. What is the name given to the feeding structure labelled **C**? (1)

A biologist was interested in the uptake of the compounds at **B**. The biologist carried out an experiment to investigate the effect of oxygen concentration on this process. The results are shown in the following table.

Oxygen concentration in %	0	4	8	12	16	20
Rate of uptake in arbitrary units	2	10	18	25	32	32

- e. Draw a graph to represent this information. (5)
- f. What does the graph tell you about the uptake of compounds at **B**? (3)
- g. Suggest another factor that might affect the rate of uptake of these compounds. (1)
- h. How could this information be useful to an organic farmer? (2)
3. Indicate which of the following statements is true (T) and which is false (F).
 - a. Bacteria always cause disease.
 - b. A typical bacterium is about one thousandth of a metre long.
 - c. Viruses can only reproduce inside other living cells.
 - d. Bacteria are smaller than viruses.
 - e. Viruses do not have their own genes.
 - f. All viruses are the same shape.
 - g. Viruses are simpler in structure than bacteria.
 - h. Viruses always cause disease.
 - i. Viruses can only be seen using an electron microscope.
 - j. Bacteria can infect animals and plants. (10)

Plants: Ferns and flowering plants

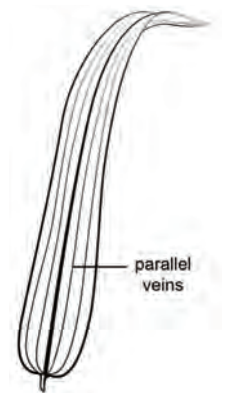
Ferns reproduce by means of spores, not seeds. They have xylem for water transport, but no true roots.

Flowering plants are made of cells that are surrounded by a cellulose cell wall and often contain chloroplasts.

Flowering plants produce flowers. Part of the flower may become a seed.

Dicotyledons have two cotyledons (seed leaves) in their seeds and have leaves with branching veins.

Monocotyledons have one cotyledon (seed leaf) in their seeds and have leaves with parallel veins.



▲ Monocot and dicot leaves.

Invertebrates

Invertebrates are animals that do not have a vertebral column or any internal skeleton made of bone.

Arthropods are the most abundant invertebrates. Arthropods are segmented animals with an exoskeleton and jointed legs.

Arthropods are classified into different groups, including insects, arachnids, crustaceans and myriapods.

Arthropods are invertebrates (animals without backbones). They have a hard exoskeleton and jointed limbs.	
Class	Features
Insects	- three body parts – head, thorax, and abdomen - three pairs of legs - usually one or two pairs of wings
Crustaceans	- many segments, usually each with legs, claws, or feelers - breathe via gills, as live in water - exoskeleton particularly hard for protection
Arachnids	- two body parts, eight legs, and no wings - all have piercing jaws since all are predators
Myriapods	- long, thin body with many segments for moving easily through soil and leaf litter - have 1 or 2 pairs of legs per body segment - antennae as sense organs in dark habitats

Vertebrates

Vertebrates are animals that have a vertebral column made of bone.

There are five groups of vertebrates: fish, amphibians, reptiles, birds, and mammals.

Vertebrates (animals with backbones)		
Class	External features	Other features
fish (all aquatic)	- scales - fins - eyes and lateral line	- jelly-covered eggs; usually use external fertilisation - ectothermic - gills for gas exchange
amphibians (always breed in water)	- moist skin - four limbs - eyes and ears	- jelly-covered eggs; external fertilisation - ectothermic - lungs/skin for gas exchange
reptiles (lay eggs on land)	- dry, scaly skin - four limbs (not in snakes) - eyes and ears	- soft-shelled eggs; internal fertilisation - ectothermic - lungs for gas exchange
birds (very few are aquatic)	- feathers (scales on legs) - two wings, two legs - eyes and ears	- hard-shelled eggs; internal fertilisation - endothermic - lungs for gas exchange
mammals (very few are aquatic)	- fur or hair - four limbs - eyes and ears - nipples	- live young (a few lay eggs) - endothermic - lungs for gas exchange - feed young with milk from mammary glands

You could be asked to directly describe these in exam questions.

You could use these features in questions on other topics.

Apply

4. a. A biology student working in a museum mixed up a series of specimens. The specimens are named in this list:

amphibian, earthworm, bacterium, bird, mammal, fish, reptile, fungus, moss, fern, protist, virus, flowering plant, insect, parasite

Choose organisms from this list to match the following descriptions:

- body covered with fur; has mammary glands
- cells with cell wall but no chlorophyll; reproduce by spores
- body covered with dry scales
- body has three regions – head, thorax, and abdomen
- single cell, without a defined nucleus
- can only reproduce within another living cell; few genes inside protein coat
- has feathers and a beak; maintains constant body temperature (7)

- b. All living organisms display certain characteristics.

Complete the following sentences about these characteristics.

- The release of energy in cells is called _____. (1)
- The removal of the waste products of the chemical processes in the body is called _____. (1)
- The ability to respond to changes in the environment is called _____. (1)

Exam tip

Invertebrates

The most common mistake in classifying invertebrates concerns spiders. Spiders are arachnids – they have two body parts, eight legs, and no wings – and are *not* insects.

1.4 Dichotomous keys

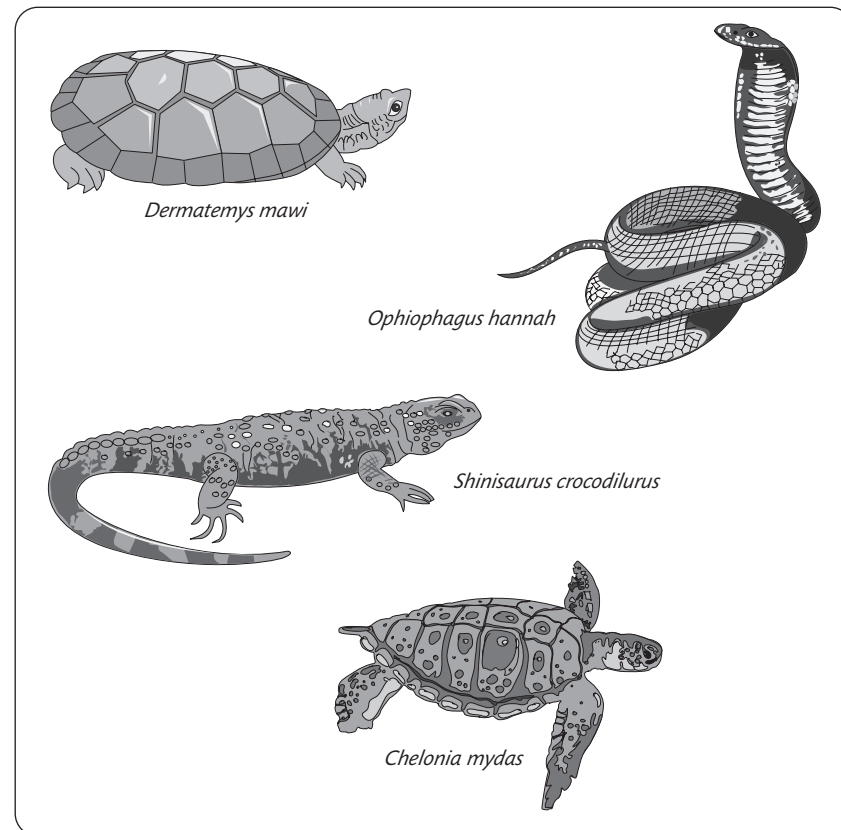
Your revision checklist

Core/Extended curriculum syllabus content		1	2	3
1.4	Construct and use simple dichotomous keys based on easily identifiable features			

Most questions on classification and the variety of life involve the use of a key. A key used in an examination will concentrate on easily visible external features of organisms. It is likely to be a numbered key rather than a branched key (for reasons of space).

Apply

5. The figure shows drawings of four reptiles.



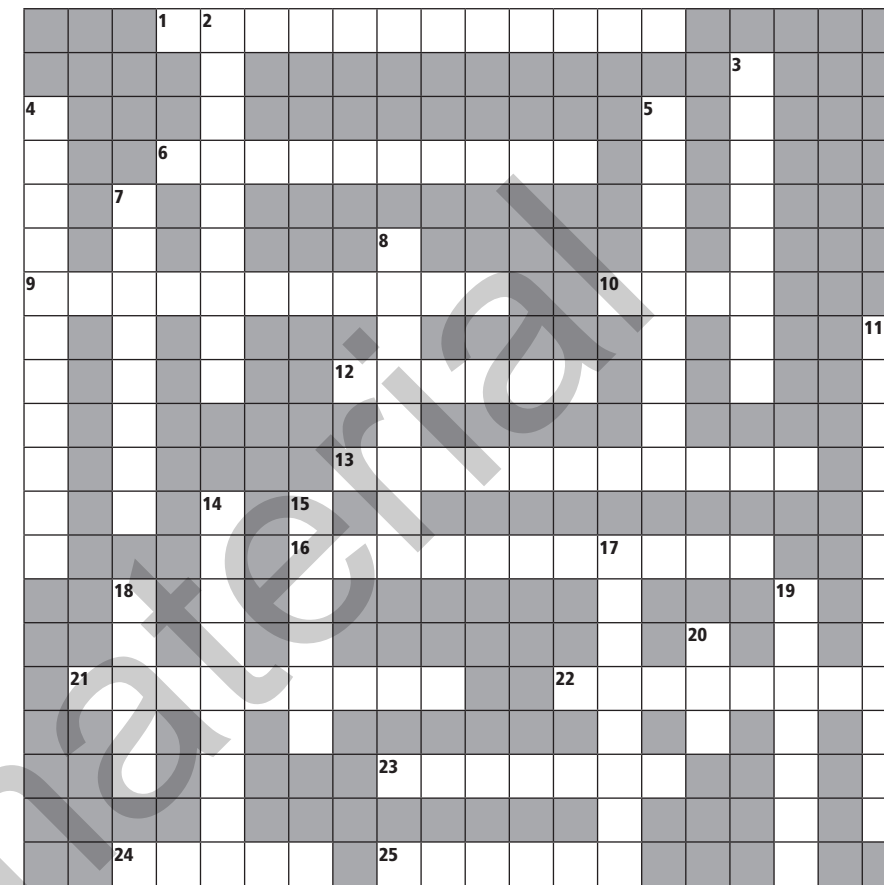
▲ **Four reptiles.**

- a. Complete the following key so that it can be used to identify each of the four reptiles. (4)

Key:

- 1 Has legs go to 2
No legs
2 Most of body covered by a shell go to 3
Body not covered by shell *Shinisaurus crocodilurus*
3 Front legs have claws *Dermatemys mawii*
4 Front legs are flippers *Chelonia mydas*

- b. Describe **one** feature, which you can see in the drawings, that all four reptiles have in common but which is not present in a human. (1)

**ACROSS:**

- 1 The generation of new individuals of the same species
6 Single-celled organism with a definite nucleus
9 The ability to detect changes in the environment
10 A sequence of DNA – may be used in classification
12 This kingdom includes humans and other chordates
13 A change in the form or function of an organism
16 Oxidation of food to release energy
21 Measurable differences between organisms
22 A change in position of an organism
23 The peak of the hierarchy of taxonomic groups
24 Kingdom whose members feed by external digestion
25 Essential to drive the processes of life and to maintain organisation

DOWN:

- 2 Removal of the waste products of metabolism
3 Genus that includes all the big cats
4 The 'proper' name for a human – means a 'wise man'
5 Single cell without a definite nucleus
7 The two-part system of naming living organisms
8 The father of naming organisms
11 The arrangement of molecules and cells into a working pattern
14 Supply of raw materials for metabolism, growth, and reproduction
15 A permanent increase in size
17 Another name for 'classification' – the science of putting living organisms into groups
18 Kingdom with members capable of photosynthesis
19 Members of this taxonomic group can mate and produce fertile offspring
20 A set of questions that can be used to 'unlock' the name of an organism

Use the following words to complete the crossword grid.

ANIMAL	FUNGI	KINGDOM	PANTHERA	RESPIRATION
BINOMIAL	GENE	LINNAEUS	PLANT	SENSITIVITY
DEVELOPMENT	GROWTH	MOVEMENT	PROKARYOTE	SPECIES
ENERGY	HOMO SAPIENS	NUTRITION	PROTOCTIST	TAXONOMY
EXCRETION	KEY	ORGANISATION	REPRODUCTION	VARIATION

Exam tip

You may be asked to produce a key to identify individual organisms from a group.

- A branching key is usually much easier to construct.
- Choose questions that have only two answers – there are only two branches from one point.
- 'Size' is not a good feature to use in keys – remember that living organisms grow.

**Review**

The words all relate to the sections on Living Organisms and their Characteristics.