

# Characteristics and classification

Revision notes · The seven characteristics of living organisms, species, binomial names, dichotomous keys and how classification reflects evolution.

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

## 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.

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

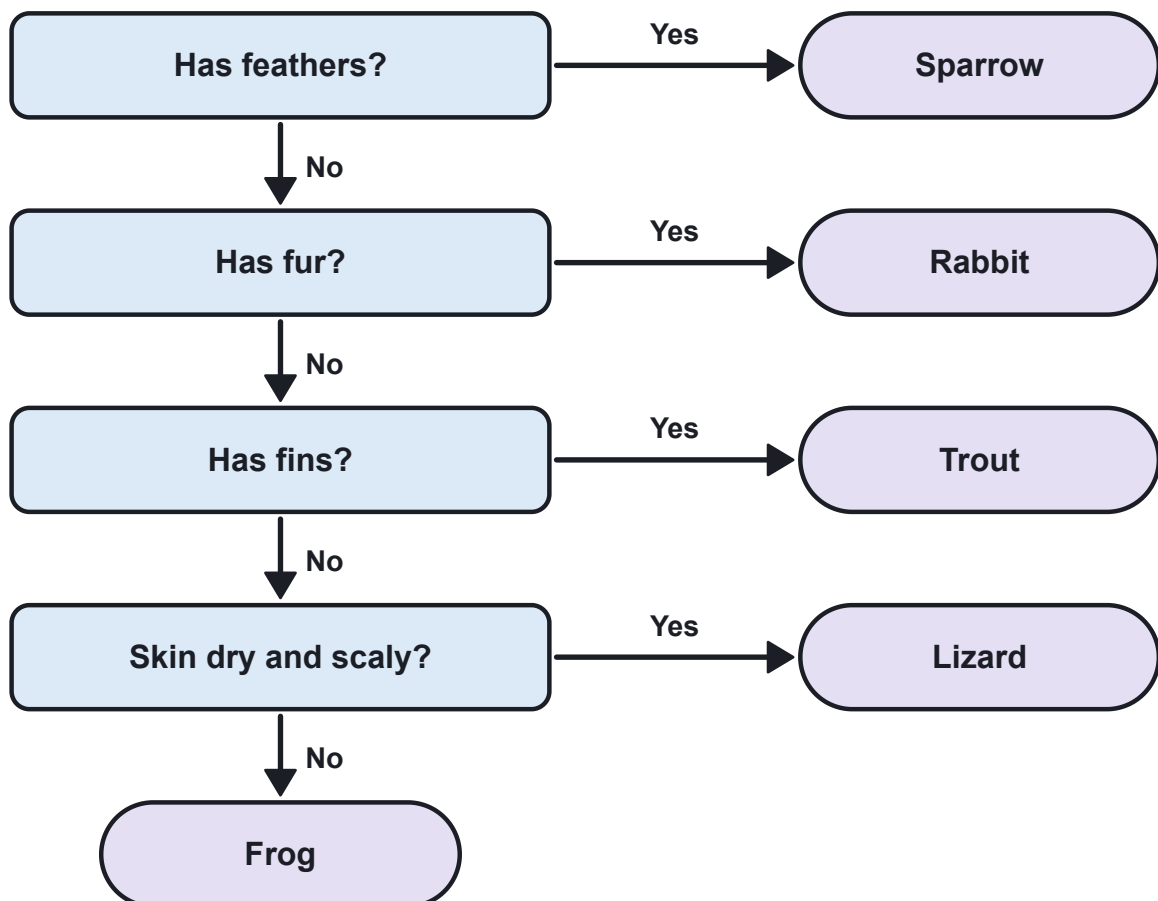
## Constructing and using dichotomous keys Spec 1.2.4

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

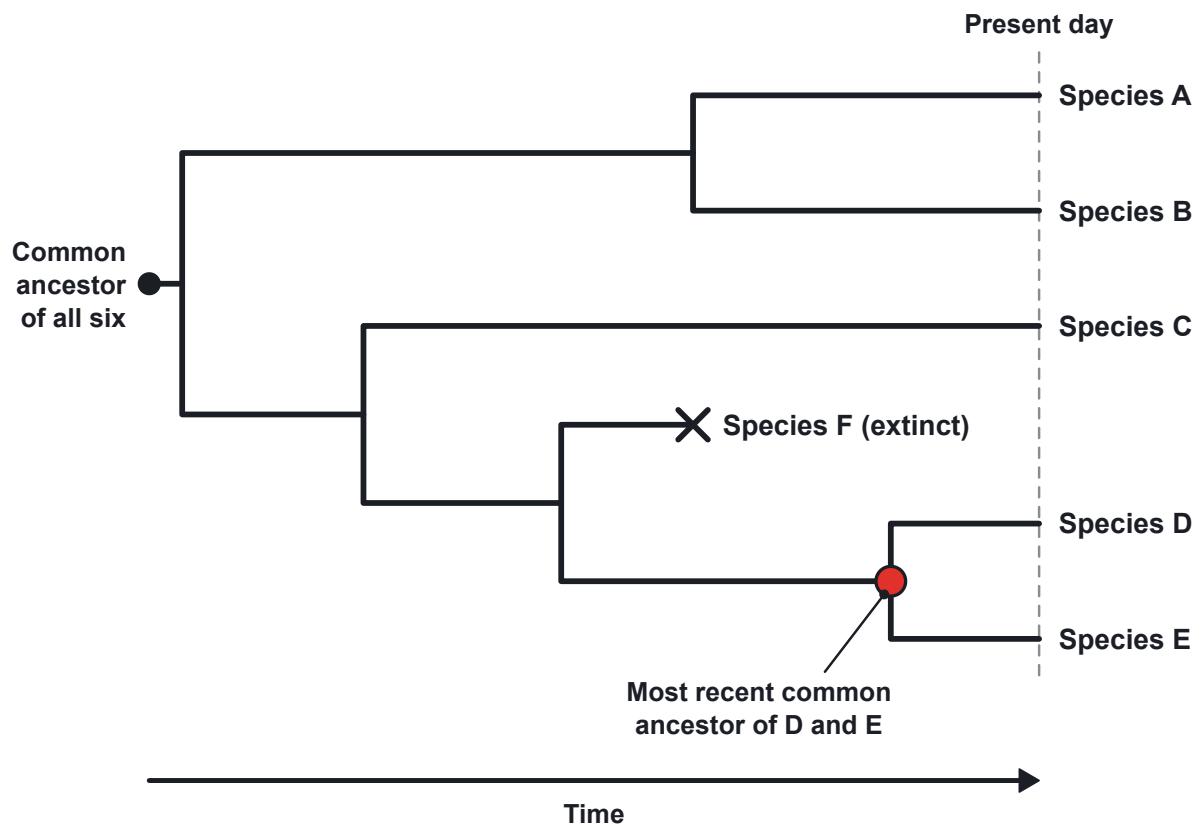
### Supplement

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?

## 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.