Classification of living organisms

4.6.4 · Inheritance, variation and evolution · revision notes

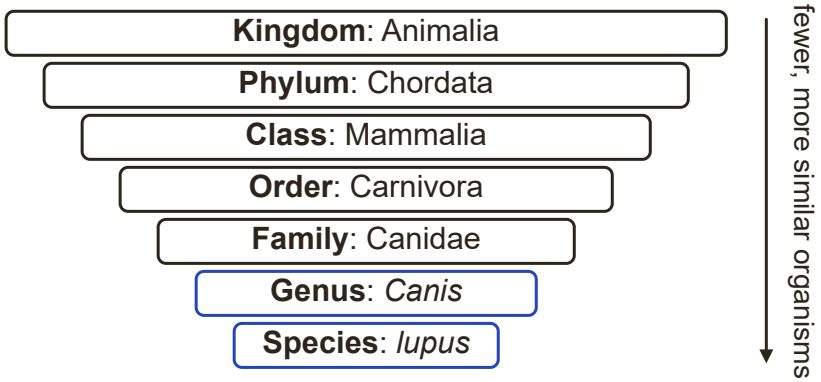
How living things are classified: the Linnaean system (kingdom down to species), the binomial naming system, Carl Woese's three-domain system and evolutionary trees. Expect recall of the order of groups, questions using scientific names, and interpreting evolutionary trees.

Key facts

- Linnaeus: kingdom, phylum, class, order, family, genus, species
- Binomial name = genus + species, e.g. *Homo sapiens*
- Archaea = primitive bacteria, usually in extreme environments
- Evolutionary tree: branch point = common ancestor; most recent common ancestor = most closely related
- Classified by structure and characteristics
- Carl Woese's three domains (from chemical analysis): archaea, bacteria, eukaryota; domain is the group above kingdom
- Eukaryota = protists, fungi, plants and animals
- Classification changed because of better microscopes and better understanding of biochemical processes

The Linnaean system

- Traditionally, living things have been classified into groups depending on their **structure and characteristics**, in a system developed by **Carl Linnaeus**.
- Linnaeus classified living things into **kingdom, phylum, class, order, family, genus and species**.
- Going down from kingdom to species, each group contains fewer organisms, which are more similar to each other.
- Organisms are named by the **binomial system** of **genus** and **species**, e.g. *Homo sapiens* for humans. The genus starts with a capital letter; the species name does not.
- Two organisms in the same genus are more closely related than two organisms that are only in the same family.

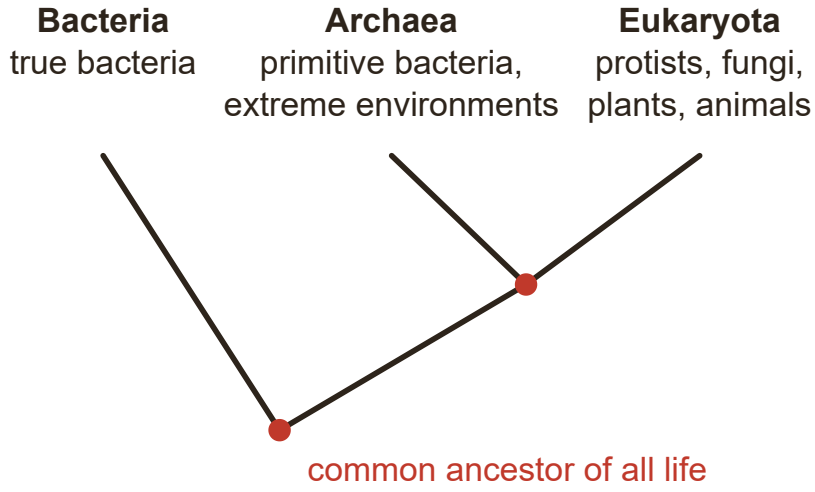


Grey wolf: Canis lupus (genus + species)

The Linnaean system, using the grey wolf as an example.

The three-domain system

- As **microscopes improved**, scientists could see internal structures in more detail, and understanding of **biochemical processes** progressed (e.g. DNA analysis). New models of classification were proposed.
- Evidence from **chemical analysis** led **Carl Woese** to develop the **three-domain system**.
- **Archaea**: primitive bacteria, usually living in extreme environments (e.g. hot springs or very salty lakes).
- **Bacteria**: true bacteria.
- **Eukaryota**: includes protists, fungi, plants and animals.
  A **domain** is the group above kingdom, e.g. a polar bear is in domain Eukaryota, kingdom Animalia.



The three domains. Archaea and eukaryota share a more recent common ancestor.

Evolutionary trees

- **Evolutionary trees** are a method used by scientists to show how they believe organisms are **related**.
- They use current classification data for living organisms and **fossil data** for extinct organisms.
- Each branch point is a **common ancestor**. The more recent the common ancestor, the more closely related the organisms are.

How to answer each type of question

Use the Linnaean system and binomial names

1 to 3 marks | **Grade 4**

1. Learn the order from kingdom (largest group) to species (smallest).
2. In a binomial name, the first word is the genus and the second is the species.

Example. The scientific name of the grey wolf is *Canis lupus*. The scientific name of the coyote is *Canis latrans*.
(a) Give the genus of the grey wolf.
(b) What do the names show about how closely related the grey wolf and the coyote are? [2 marks]

Model answer.

(a) *Canis* (1)
(b) They are in the same genus, so they are closely related, but they are different species (1)

Recall the three-domain system

2 to 3 marks | **Grade 5**

1. Name Carl Woese and chemical analysis as the evidence.
2. Name the three domains: archaea, bacteria, eukaryota.
3. Say what each contains.

Example. In the three-domain system, organisms are divided into archaea, bacteria and eukaryota.
(a) Which scientist developed this system?
(b) What type of evidence led to this system?
(c) Name two groups of organisms in the eukaryota. [3 marks]

Model answer.

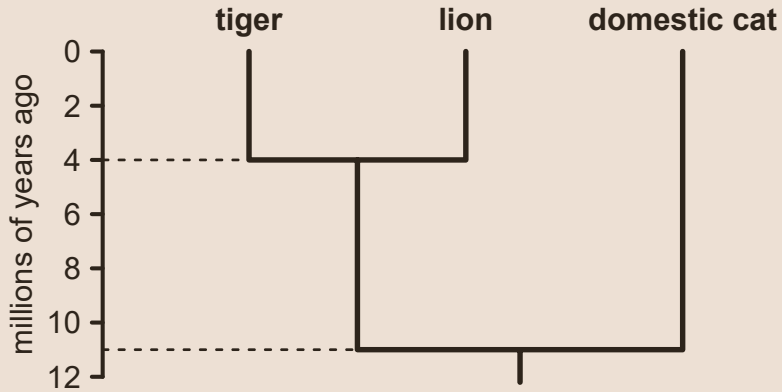
(a) Carl Woese (1)
(b) Chemical analysis (1)
(c) Any two of: protists, fungi, plants, animals (1)

Interpret an evolutionary tree

2 marks | Grade 4

1. Find where each pair of branches joins (their common ancestor).
2. The more recent the common ancestor, the closer the relationship.
3. Use the time scale if there is one.

Example. The evolutionary tree shows that lions and tigers share a common ancestor that lived 4 million years ago, and that lions and domestic cats share a common ancestor that lived 11 million years ago.



Are lions more closely related to tigers or to domestic cats? Explain your answer. [2 marks]

Model answer. Tigers (1). Lions and tigers share a more recent common ancestor (4 million years ago, compared with 11 million years ago) (1).

Explain why classification systems have changed

2 marks | Grade 7

1. Better microscopes showed internal structures in more detail.
2. Chemical analysis and a better understanding of biochemical processes showed relationships that outward structure missed.

Example. Explain why scientists have changed the way living organisms are classified since the time of Linnaeus. [2 marks]

Model answer. Improvements in microscopes let scientists see internal structures in more detail (1). Chemical analysis / a better understanding of biochemical processes showed that some organisms are more or less closely related than they appear (1).

Don't lose marks

- Putting the groups in the wrong order, especially swapping class and order, or family and genus.
- Writing the species name first, or giving the genus a small letter.

- Saying archaea are true bacteria. Archaea are primitive bacteria usually found in extreme environments; true bacteria are a separate domain.
- Saying that one living organism on an evolutionary tree evolved from another, when they share a common ancestor.

More tips

Memory tricks

- 'King Philip Came Over For Good Soup': kingdom, phylum, class, order, family, genus, species.
- Binomial = two names: Genus (capital letter) then species (small letter).
- Three domains, 'ABE': Archaea, Bacteria, Eukaryota.

Exam technique

- In evolutionary tree questions, identify the common ancestor and give its time from the tree.
- Learn who did what: Linnaeus (kingdom to species, binomial names) and Woese (three domains).
- Use the phrase 'chemical analysis' for the evidence behind the three-domain system.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **List the Linnaean groups in order**
Kingdom, phylum, class, order, family, genus, species.

Grade 4 — **Use binomial names**
An organism's scientific name is its genus followed by its species, e.g. Homo sapiens.

Grade 4 — **Interpret evolutionary trees**
Organisms that share the most recent common ancestor are the most closely related.

Grade 5 — **Describe how Linnaeus classified organisms**
Into groups depending on their structure and characteristics.

Grade 5 — **Name the three domains**
Archaea, bacteria and eukaryota.

Grade 6 — **Explain why the three-domain system was introduced**
Evidence from chemical analysis showed that some organisms are more different than their structure suggests.

Grade 7 — **Explain how new evidence changed classification**
Better microscopes revealed internal structures, and biochemistry revealed chemical differences, leading to new models.

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