

# Evidence for evolution and classification

Revision notes · Fossil and stone tool evidence for human evolution, the pentadactyl limb, and how genetic analysis led to the three domains.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

## Evidence for evolution and classification Spec 4.4-4.7

### Fossil evidence for human evolution Spec 4.4

Fossils are the preserved remains or traces of organisms that lived long ago. By comparing fossils of different ages, scientists can see how early human ancestors changed over time. You need to know three important discoveries.

| Fossil evidence for human evolution                 |                       |                                                                                                                                  |
|-----------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Fossil                                              | Age                   | What it shows                                                                                                                    |
| <b>Ardi</b>                                         | 4.4 million years ago | Partial skeleton. A small brain and long arms. Could walk upright, but had a grasping big toe so could still climb trees.        |
| <b>Lucy</b>                                         | 3.2 million years ago | Partial skeleton. Walked upright on two legs, with feet more like a human's, but still a small brain and some ape-like features. |
| <b>Fossils found by Richard Leakey and his team</b> | 1.6 million years ago | Many fossils, including a nearly complete skeleton. A larger brain, longer legs and a body shape much more like a modern human.  |

Taken together, the fossils show a gradual change from ape-like ancestors towards modern humans. Walking upright came first, and larger brains came later.

The evidence has limits. Fossils are rare because most dead organisms decay before fossilising, and many fossils are incomplete. This is why scientists sometimes disagree, and why new discoveries can change ideas about human evolution.

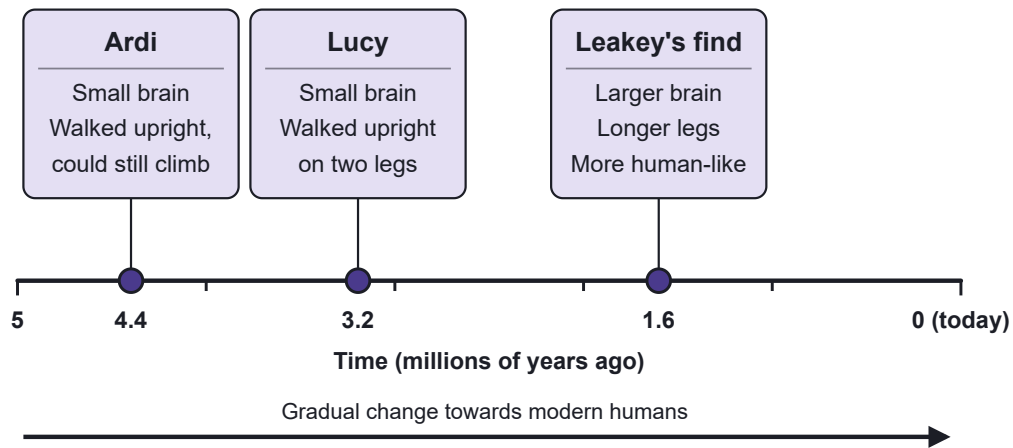
#### Working with large time spans

Ardi lived 4.4 million years ago and Lucy lived 3.2 million years ago. Write 4.4 million in standard form, and find how many years separate the two fossils.

1. 4.4 million = 4 400 000 =  $4.4 \times 10^6$  years
2. Difference =  $4.4 - 3.2 = 1.2$  million years
3. 1.2 million =  $1.2 \times 10^6$  years

**Answer:**  $4.4 \times 10^6$  years; the fossils are  $1.2 \times 10^6$  years apart.

*Exam tip: Learn the order, oldest first: Ardi (4.4), Lucy (3.2), Leakey's discovery (1.6). Questions often ask which is oldest or most like a modern human.*



Oldest first: Ardi, Lucy, then Leakey's find. Walking upright came first; larger brains came later.

## Stone tools Spec 4.5

Early humans made tools from stone. Stone tools survive for a very long time, so they give evidence about how early humans lived and how their skills developed.

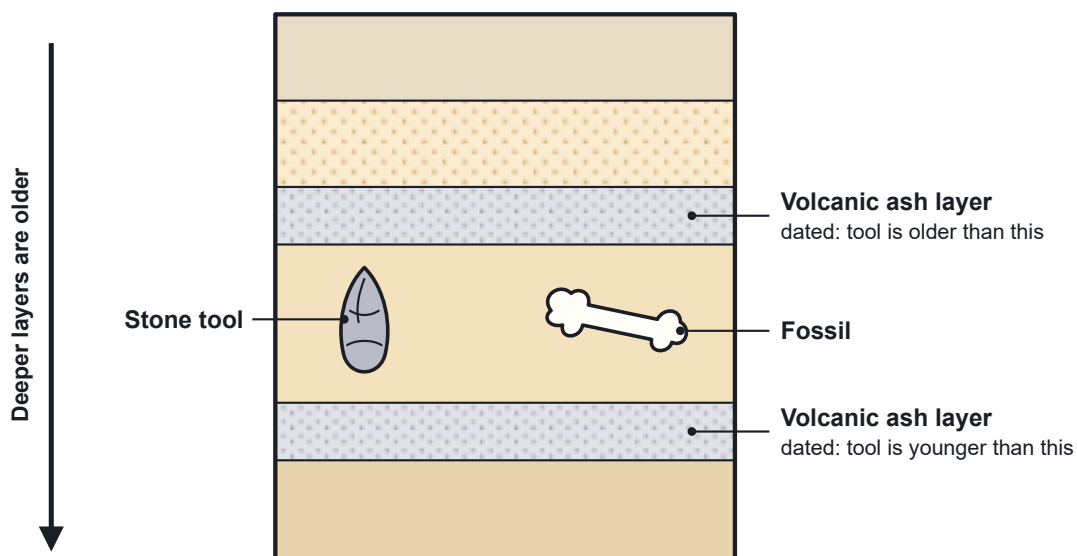
### Development of stone tools over time

- The oldest tools are very simple, such as stones with a few chips knocked off to make a sharp edge.
- Over time tools became more complex and better made: more carefully shaped and more specialised for different jobs.
- This suggests that early humans developed greater skill and intelligence, which fits with fossil evidence of larger brains.

### Dating stone tools

Scientists can date stone tools from their environment. A tool is found in a layer of rock or sediment. The age of that layer, or of materials found with the tool such as volcanic ash, can be worked out. The tool is then taken to be about the same age as the layer it was found in. Layers are laid down one on top of another, so deeper layers are usually older.

*Exam tip: For 'how are tools dated', refer to the layer or materials around the tool, not to the tool itself.*



The tool is dated from its environment: it must be younger than the ash below it and older than the ash above it.

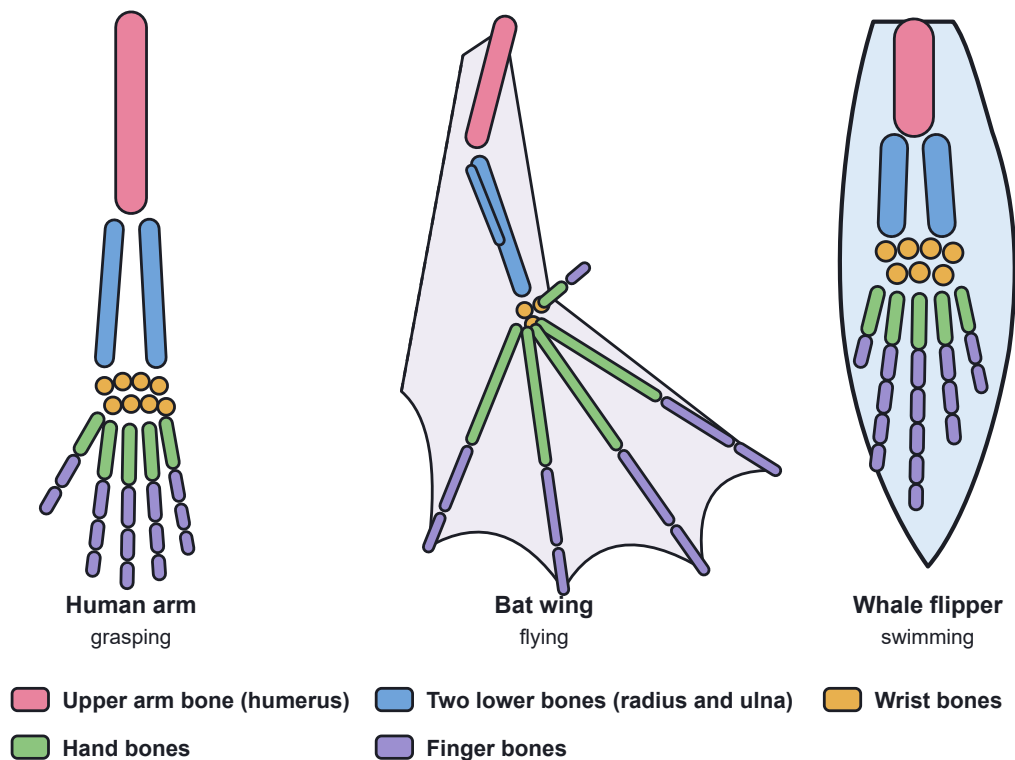
## The pentadactyl limb Spec 4.6B Triple only

The **pentadactyl limb** is a limb with five digits. The same basic pattern of bones is found in the limbs of many vertebrates, including humans, bats, whales and frogs.

Although these limbs do different jobs (grasping, flying, swimming, jumping), they have the **same basic arrangement of bones**: one upper bone, two lower bones, then wrist, hand and finger bones. The size and shape of the bones differ to suit each function.

This provides evidence for evolution. The similar bone structure suggests the animals share a **common ancestor**, and natural selection has adapted the limb to different ways of life over time. If each animal had evolved separately, there would be no reason for the same bone pattern.

*Exam tip: Use the two ideas together: same structure suggests a common ancestor; different functions are due to adaptation by natural selection.*



Same **basic arrangement of bones**, different shapes for grasping, flying and swimming: evidence of a common ancestor.

## Five kingdoms and three domains Spec 4.7

Living things were traditionally sorted into **five kingdoms**: animals, plants, fungi, protists and prokaryotes. This was based on the structure and features of organisms that could be observed.

Improved methods of **genetic analysis** (comparing the genetic material of different organisms) showed that the prokaryotes are not all closely related. This led to a new system of **three domains**, which sits above the kingdoms.

| The three domains |                                                               |
|-------------------|---------------------------------------------------------------|
| Domain            | Organisms                                                     |
| <b>Archaea</b>    | Prokaryotes that are genetically very different from bacteria |
| <b>Bacteria</b>   | 'True' bacteria (prokaryotes)                                 |
| <b>Eukarya</b>    | Organisms with a nucleus: protists, fungi, plants and animals |

*Exam tip: Explain the change using the key idea: genetic analysis revealed differences that observation of structure could not, so the prokaryotes were split into two domains.*

#### **Quick check**

- 1 . Which is older, Ardi or Lucy?
- 2 . How are stone tools dated from their environment?
- 3 . Name the five kingdoms.
- 4 . What are the three domains?

## Quick check answers

### Evidence for evolution and classification

1. Ardi (4.4 million years ago; Lucy is 3.2 million years ago).
2. By finding the age of the rock layer, or materials found with them, in which they were buried.
3. Animals, plants, fungi, protists and prokaryotes.
4. Archaea, Bacteria and Eukarya.