Fossil Evidence for Evolution

Fossil Formation

Fossil Discovery

Fossil Dating

Date:	Human Biology Year 12 ATAR
Do Now Past Exam Question – sequencing and evidence for evolution **Lesson Agenda** 1: Do Now 2: Fossils and Absolute Dating Techniques 3: Lesson Summary and Wind Up **Suggested Study** • Read through today's notes and textbook section • Complete review worksheet, then mark and correct using the answer key on Connect (compulsory). **NEXT LESSON** Fossil Evidence and Relative Dating Techniques	**Learning Aims** • Describe the main processes of fossilisation • Explain the conditions required for fossilisation to occur. • Discuss how fossils are discovered and excavated • Define absolute dating and relative dating • Describe how K-Ar dating works and discuss its limitations • Describe how Radiocarbon dating works and discuss its limitations • Use given data to calculate the age of a sample using a graph **Key Vocabulary** Isotope Half-life Fossil

Overview/Intro

- Fossil record is one of the crucial pieces of evidence for evolution
- Fossil: a preserved trace left by an organism that lived long ago:
  - Footprints, Burrows, Faeces, Impressions (trace fossils)
  - Bones, Shells, Teeth, Soft tissues (body fossils)
- Not all remains and traces become fossilised. It happens rarely, so there are many extinct creatures where there is no fossil record.
- Materials associated with the fossils also helps to provide information:
  - Rock they were found in
  - Other fossils nearby
- Some fossil evidence can show an evolutionary sequence eg evolution of horse hoof.

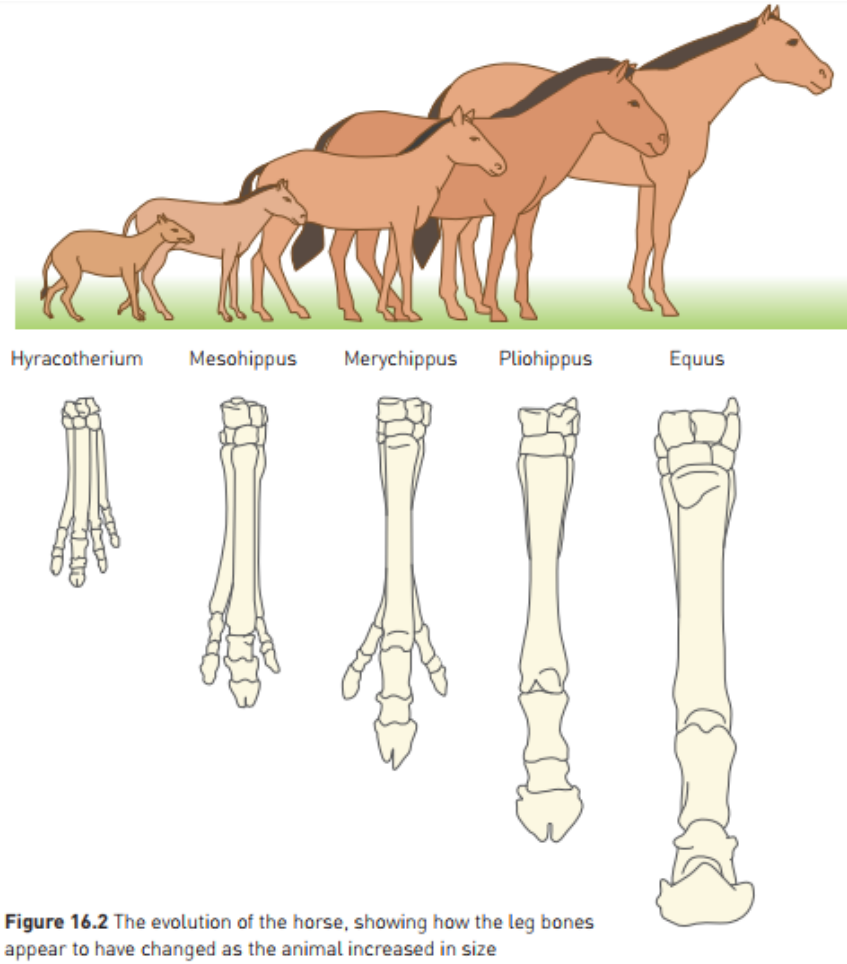


Figure 16.2 The evolution of the horse, showing how the leg bones appear to have changed as the animal increased in size

Processes of Fossilisation

- Fossils can form in different ways:

PERMINERALISATION

- After burial in sediment, minerals are deposited into the remains by water. This slowly replaces the remains with mineral, petrifying them.
- Many fossil bones and petrified wood are fossilised in this way.

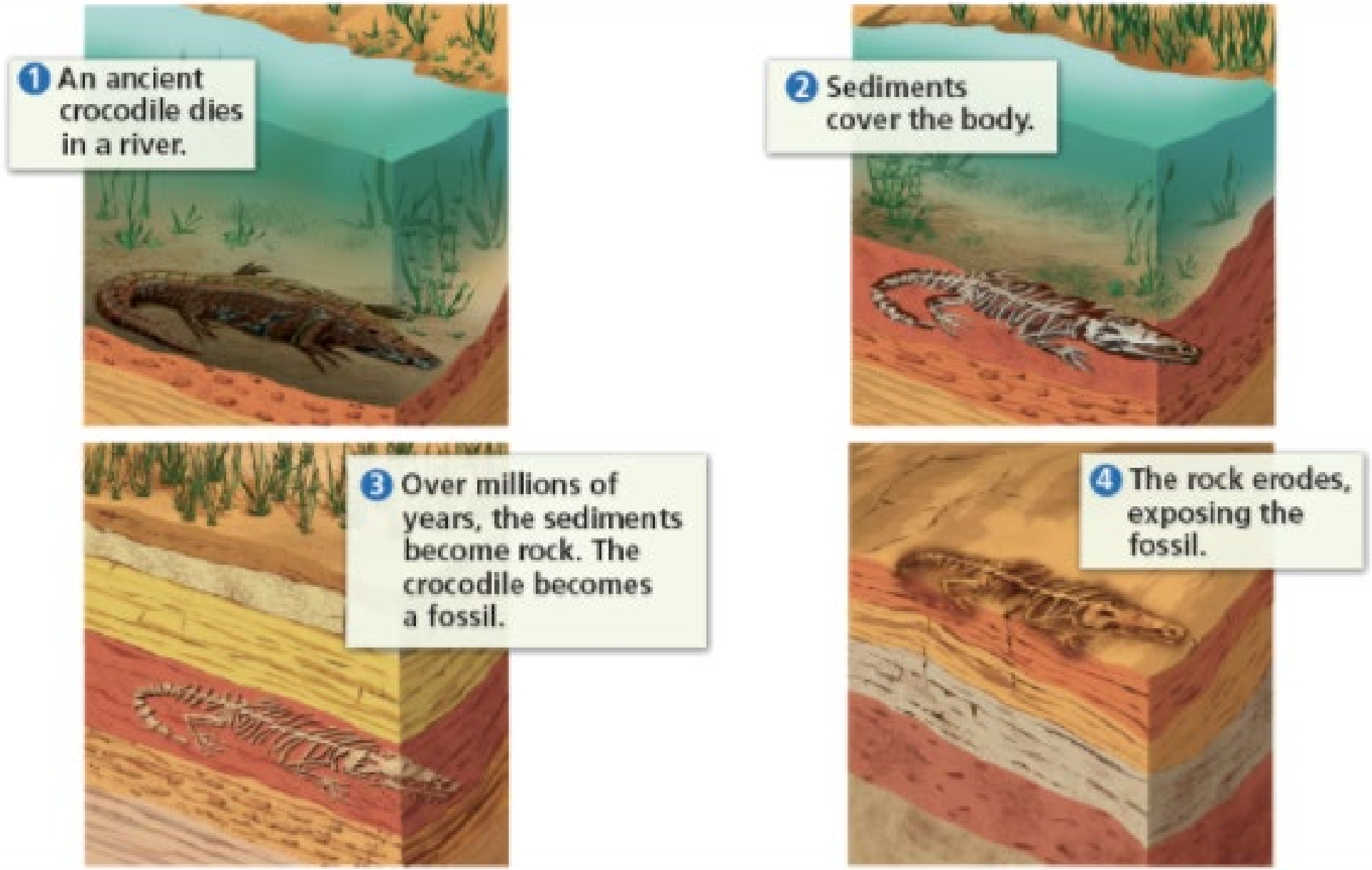
PRESERVED REMAINS

- The entire organism and its tissues are preserved
- Eg: insects in amber, mammoths in ice, Neolithic humans in peat bogs

MOLDS AND CASTS

- Original remains dissolve leaving a space “mold” that is later filled with other sediments “cast”.
- Eg: imprints of shells or other soft bodied creatures, footprints etc.

Learning Aim: Describe the main processes of fossilisation



Learning Aim: Describe the main processes of fossilisation

Conditions for Fossilisation

- Not all remains become fossils
- Fossilisation requires:

Rapid Burial

- Prevents decomposition or destruction of the remains
- Can be buried by:
  - Mud/Sediment deposits in riverbed
  - Drifting sand
  - Volcanic Ash
  - Deliberate burial (human funeral burials)

Favourable Soil Conditions

- Higher pH (alkaline soils) – mineral deposits replace tissues better in alkaline soils
- Low oxygen environment – slows decomposition of soft tissues
- Absence of decay organisms

Long Periods of Geological Stability

Learning Aim: Explain the conditions required for fossilisation to occur.

Fossil Discovery

- Geological processes such as erosion mean fossils eventually resurface
- Fossils can be found:
  - By chance, on surface: indication of good place to look for more: digging
  - By geological survey – looking at rock for indicators that it may have been favourable for fossil formation.
- Digging for fossils:
  - Area surveyed, marked into sections
  - Small hand tools remove soil
  - Soil is sieved to catch small fossil parts
  - Artefacts (carvings, tools) may also be found with human ancestral remains
  - Photos taken at each stage of dig
  - Labelled and catalogued
  - Final cleaning, repair and piecing together in the lab.

Learning Aim: Discuss how fossils are discovered and excavated.

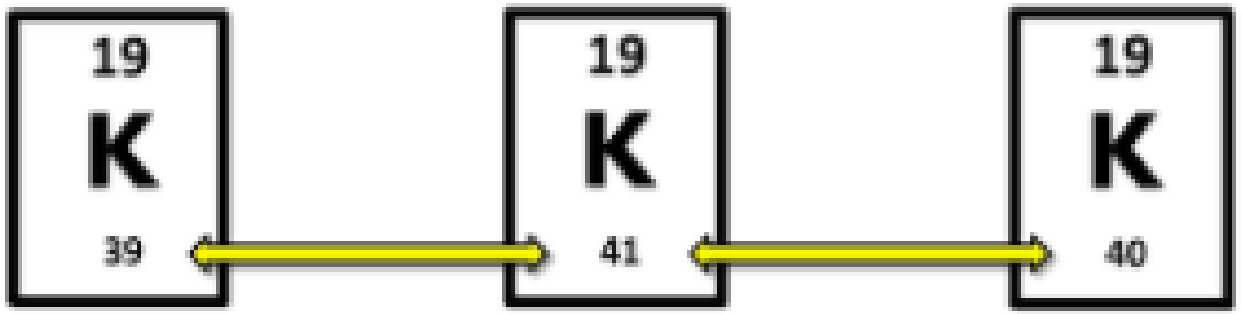
Dating of Fossils

- Dating: determining the age of material
- Many methods, may provide:
  - Absolute dates: approximate age in years
  - Relative dates: whether sample is older of younger than a comparison sample.
- Modern technology allows accurate estimates of absolute date.
- Absolute Date years given in years before present (BP)
- Eg: 45000 years BP = 45000 years old.

Learning Aim: Define absolute dating and relative dating.

Absolute Dating: Potassium – Argon Technique

- Method based on decay of radioactive potassium into calcium and argon.
- Potassium: 3 different forms (isotopes)



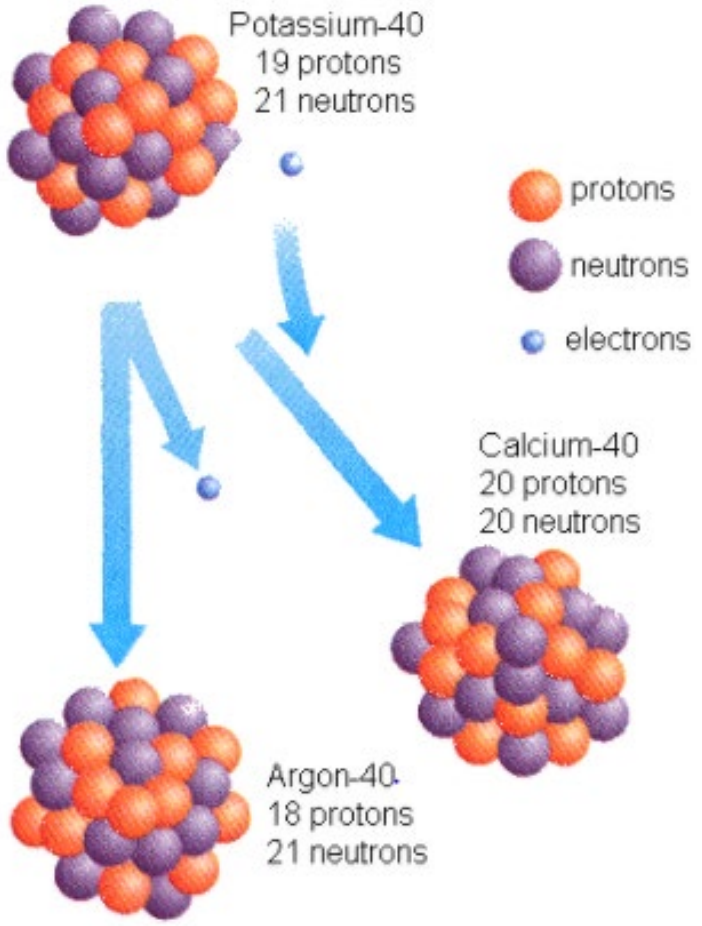
# protons	# neutrons	isotope	symbol	abundance	radioactivity
19	20	potassium-39	^{39}K	93.26%	stable
19	21	potassium-40	^{40}K	0.012%	decays to ^{40}Ar in 1,277,000,000 yrs'*'
19	22	potassium-41	^{41}K	6.73%	stable

Learning Aim: Describe how K-Ar dating works and discuss its limitations

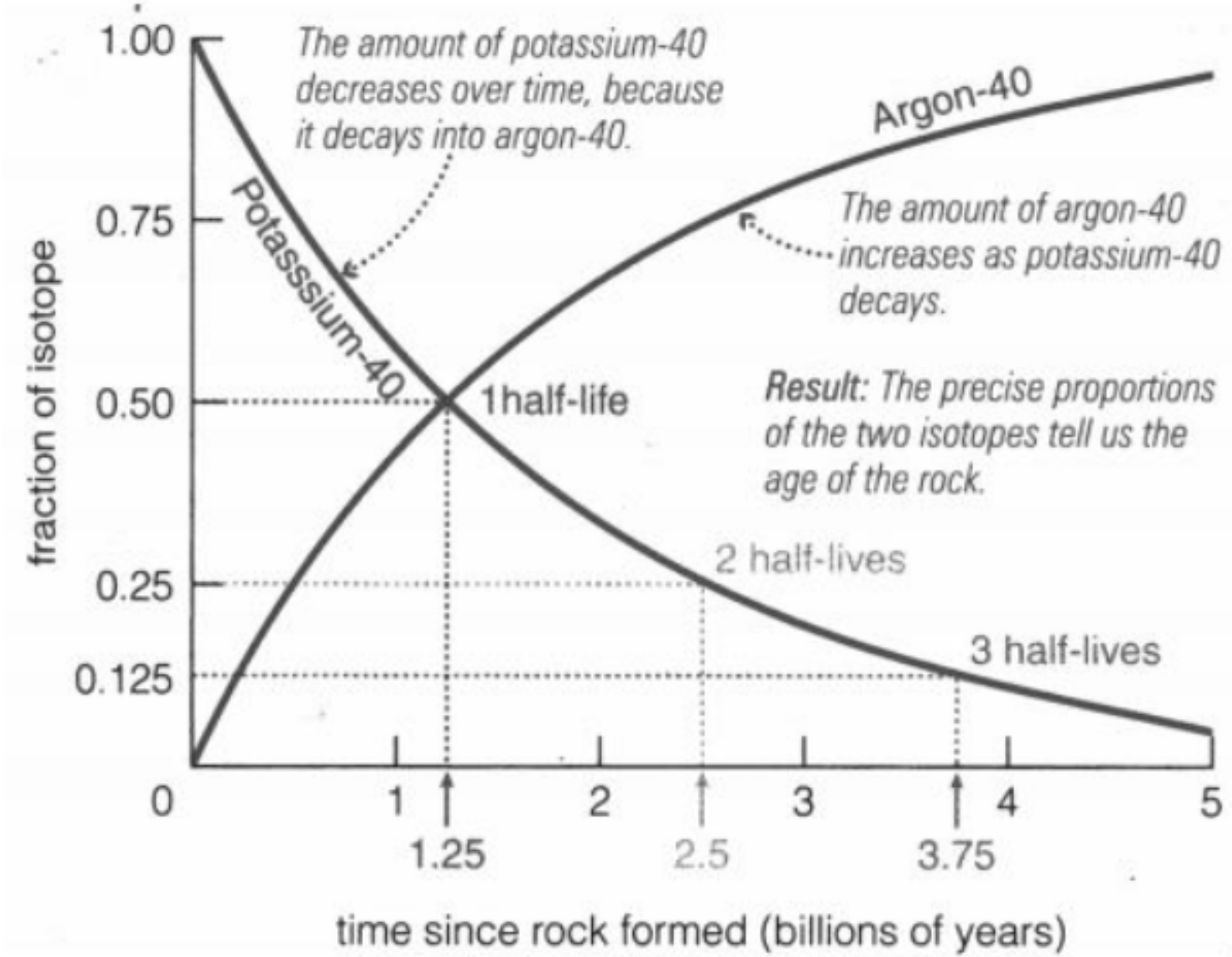
Absolute Dating: Potassium – Argon Technique

- Potassium-40:
  - Unstable potassium isotope - radioactive
  - Decays to form Calcium-40 and Argon-40
  - Decay happens at a very slow but constant rate
  - Determining relative proportions of K-40 and Ar-40 in a rock allows age of the rock to be calculated
  - “half life” is the time it takes for the amount of K-40 to halve
  - K-40 half life is 1.25 billion years

- Limitations of Potassium-Argon Dating
  - Limited usefulness
  - Not all rock types suitable
  - Can only date rocks older than 200 thousand years, as it takes so long to decay enough to measure.
  - Gives a precise date where it can be used.



Learning Aim: Describe how K-Ar dating works and discuss its limitations



Learning Aim: Describe how K-Ar dating works and discuss its limitations

Activity: Potassium- Argon Dating simulation

Learning Aim: Describe how K-Ar dating works and discuss its limitations

Absolute Dating: Carbon-14 / Radiocarbon dating

- Living things contain carbon. They get this carbon via the food chain. Plants get it from CO2 in the atmosphere, and animals get it via the rest of the food chain. Most of the carbon in the atmosphere, and therefore in living things is the Carbon-12 isotope, which is stable.

- A small amount of carbon in living things is the Carbon-14 isotope, which is unstable.
  - Carbon-14 exists in atmosphere in small amounts
  - Taken up by plants during photosynthesis, passes along food chain
  - Becomes part of living tissues
  - After death, intake ceases, and carbon-14 decays into nitrogen at a fixed rate

- We can work out how long a carbon based life form has been dead for by looking at the ratio of carbon-14 (radioactive) to carbon-12 (stable).

Learning Aim: Describe how Radiocarbon dating works and discuss its limitations

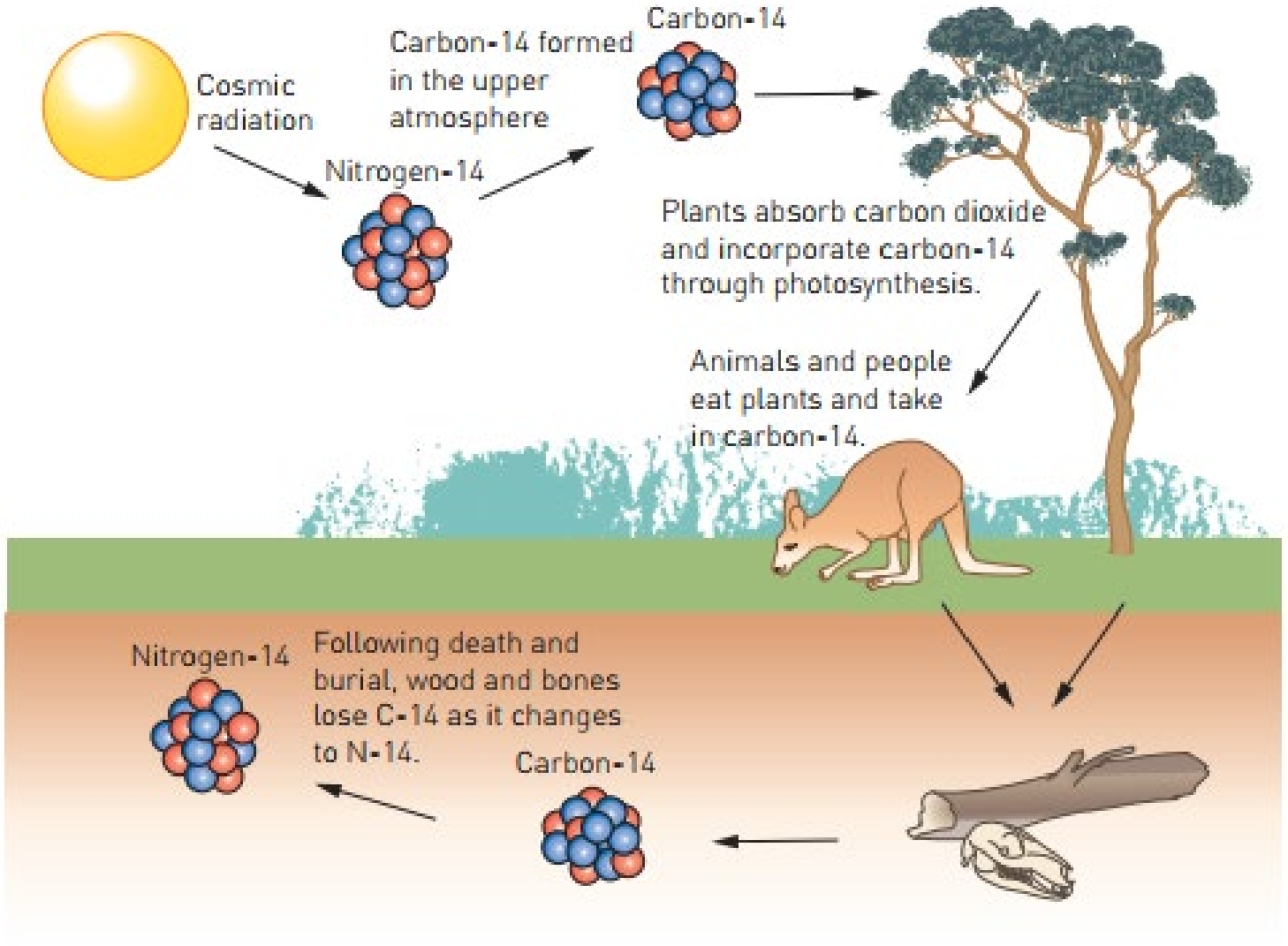


Figure 16.5 Summary showing how carbon-14 is formed, enters living things and decays

Learning Aim: Describe how Radiocarbon dating works and discuss its limitations

Absolute Dating: Carbon-14 / Radiocarbon dating

- In living organisms, the ratio is:

  1 carbon-14 : 10^{12} carbon-12

- The amount of Carbon-14 halves each 5730 years. This is the "Half Life" of Carbon 14.

- If we measure the ratio, we can use the graph to determine the age of the sample.

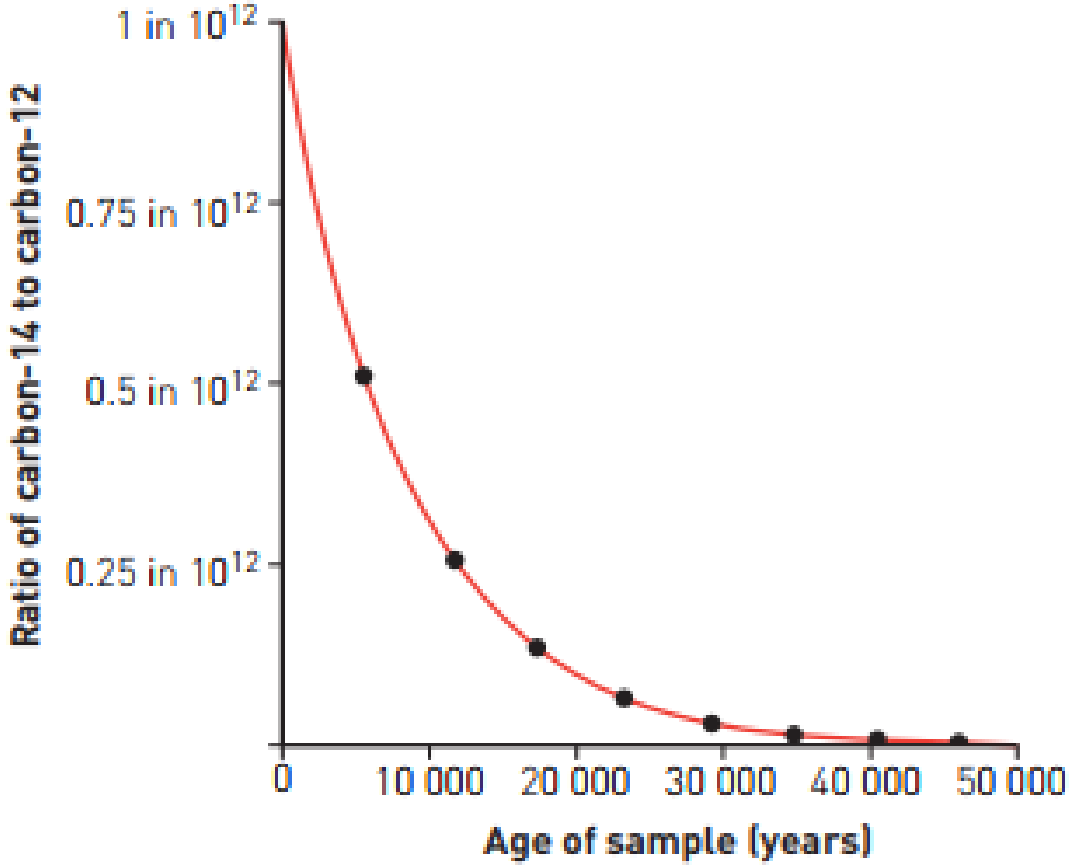


Figure 16.6 Rate of decay of carbon-14 to nitrogen. Each dot on the curve represents a period of 5730 years, the half-life of carbon-14.

Learning Aim: Describe how Radiocarbon dating works and discuss its limitations

Absolute Dating: Carbon-14 / Radiocarbon dating

- Normal method requires 3 grams of carbon
- Newer technique: Accelerator Mass Spectrometry (AMS) radiocarbon dating – can work with 100ug.
  - Can date using tiny samples
- Limitations of Radiocarbon dating:
  - After 70000 years, not much of sample left
  - Can only use for samples younger than this
  - Material tested must contain Carbon.
  - Some margin of error due to fluctuating Carbon-14 in the atmosphere

Learning Aim: Describe how Radiocarbon dating works and discuss its limitations