The evidence for evolution

How does palaeontology support the theory of evolution?

- Palaeontology is the study of ancient life.
- Fossils form the basis of palaentology as they are the main direct evidence about past life.
  - Fossils are the remains or traces of animals, plants and other organisms from the remote past.
  - We can group fossils into two categories:

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Category 1: The remains of the dead animal or plant or the imprint left from the remains, including :

- Bones and teeth
- Skin impressions and hair
- The hardened shell of an ancient invertebrate such as a trilobite or an ammonite
- An impression of an animal or plant, even if the actual parts are missing.

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Category 2: Something that was made by the animal while it was living that has since hardened into stone; these are called trace fossils and include:

- footprints
- burrows
- coprolite (animal faeces)

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How do fossils form?

There are four main stages:

1. Death without decomposition

- The organism must die in or so close to water.
- The water insulates the remain.

2. Sedimentation

- As time passes, sediments bury the remaining hard parts of the organism.
- Sedimentation further insulates the organism from complete decay.

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3. Permineralisation

- As the sediments accumulate, the lower layers become compacted. Over time, this pressure turns the sediments into rock.
- If water rich in minerals percolates through the sediments, the mineral particles stick to the particles of sediment.
  - The mineral particles dissolve away the original hard parts of the organism, replacing the molecules of exoskeleton with molecules of calcium carbonate or another mineral.

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4. Uplift

- Movements of continental plates
  - Rock that contains fossils becomes lifted to the Earth's surface.
- Rain, wind, earthquakes, freeze and thaw erode rock and may expose a fossil.

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How can we date fossils?

1. Relative dating

- Use the sequence of the strata and the fossils that occur in them to deduce how the organisms have changed over time.
- The oldest strata, and therefore the oldest fossils, will be in the lowest layers.

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- It takes approximately1000 years to form 30 cm of sedimentary rock.
  - ➢ When the thickness of a rock layer is determined, its age can be estimated.

2. Radiometric dating

- The use of radioactive isotopes and their half-lives to give absolute dates to rock formations, artifacts, and fossils.

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- This technique rely on the principle that radioactive atoms decay into other atoms over time.
- The half-life of a radioactive isotope describes the amount of time that it takes half of the isotope in a sample to decay.

A. Radiocarbon Dating

- Radioactive carbon is used to date organic remains.

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- Measuring the amount of radiocarbon remaining in an organic sample provides an estimate of its age.
- The approximate half-life of carbon 14 is 5,730 years and is good for dating up to about 60,000 years.
- The ratio of carbon 14 to carbon 12 in living things is about 1 to 1 trillion.

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- A formula to calculate how old a sample is by carbon-14 dating is:

$$t = [\ \ln (Nf/No) / (-0.693)\ ] \times t_{1/2}$$

- ♥ **ln** = The natural logarithm
- ♥ **Nf/No** = Percent of carbon-14 in the sample compared to the amount in living tissue
- ♥ $t_{1/2}$ = The half-life of carbon-14 (5,730 years).
  - ln0.5 = -0.693
  - ln0.25 = -1.386
  - ln0.125 = -2.079
  - ln0.0625 = -2.773

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Example

1. If you had a fossil that had 25 percent carbon-14 compared to a living sample, what would be the age of the fossil?

2. Say a fossil is found that has 35% carbon 14 compared to the living sample. How old is the fossil? (ln 0.35 = -1.04982)

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B. Potassium-Argon Dating

- Used to date rocks as old as 4 billion years and is a popular dating technique for archeological material.
- Potassium-40, with a half-life of 1.3 billion years, decays into argon-40 at a known rate.
- Dates are determined by measuring the amount of argon-40 in a sample.

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Evidence from comparative anatomy

•Organisms with similar anatomical features are closely related evolutionarily.

- ➢ Probably share a common ancestor.

•Homologous structures – very similar in form but very different in function.

E.g. Forelimb of mammals (pentadactyl limb)

- Arm for manipulation in humans
- Leg for running in cats
- Flipper for swimming in whales
- Wing for flying in bats

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- Analogous structures – function in very similar ways but very different morphologically and developmentally.
  - ➢ Does not indicate common ancestry

E.g. Wings of a bird and a mosquito

Evidence from comparative embryology

- Embryonic development shows similarities which supports a common ancestry

E.g. Gill slits and tails in vertebrates embryo

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Evidence from comparative biochemistry

- If organisms share very similar molecules and biochemical pathways, then they must be closely related evolutionarily.

E.g. DNA, Cytochrome C, haemoglobin

- Species that closely related have the most similar DNA & proteins.
- Chimpanzees are humans' closest relatives

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DNA hybridization

a. dsDNA into ssDNA by heating
b. ssDNA from both species is mixed and cooled
c. Regions of mismatch
d. Measuring the percentage of mismatch

Evidence from animal breeding

- If new varieties can be produced by selective breeding then natural selection should be able to produce new varieties and eventually, new species.

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