



eduresourceza.com

DIVERSITY: EVIDENCE OF EVOLUTION

Learner Note: Make sure that you know and understand geological and anatomical evidence. You must also know what a fossil is and how fossils are dated. Refer to the Additional Content Notes if you get stuck.

SECTION A: TYPICAL EXAM QUESTIONS**Question 1: 8 Minutes***(Taken from Additional Exemplar 2008 Paper 2)*

Study the passage below and answer the questions that follow.

CHARLES DARWIN

In 1831 Charles Darwin set out on a trip around the world in the HMS Beagle. At the Cape Verde Islands, he saw the fossil remains of sea creatures in the cliffs, many metres above sea level.

The unique forms of life he found on the Galapagos Islands, such as the giant tortoises, convinced him that living organisms had evolved over many millions of years. He noticed that these tortoises were quite different from those found elsewhere in the world. Each island also had a distinct type of tortoise, differing in the shape of the shell and mating behaviour.

- 1.1. Explain how Darwin would have used the example of the tortoises to explain speciation. (4)
- 1.2. How do fossils provide evidence for evolution? (2)
- 1.3. Give ONE reason why there are gaps in the fossil records. (2)

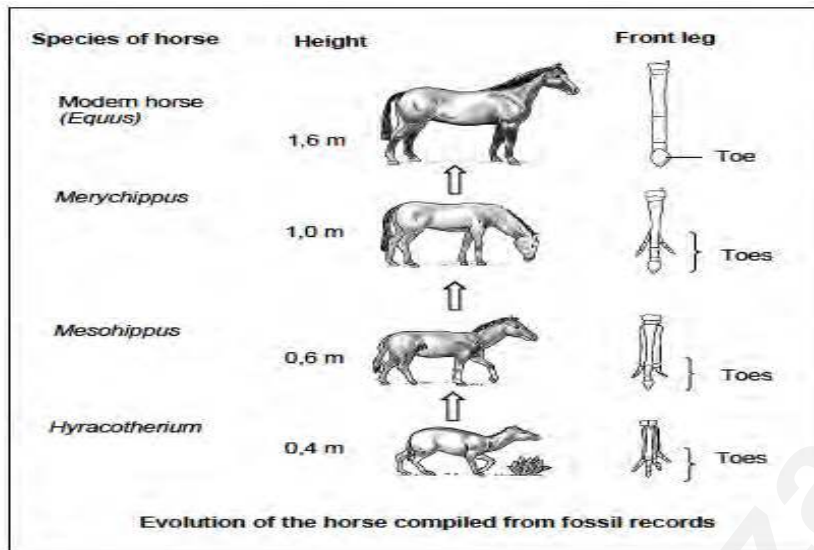
Question 2: 6 Minutes*(Taken from DoE Preparatory Examination 2008 Paper 2)*

Describe how the following aspects provide evidence for evolution:

- (a) Comparative embryology (3)
- (b) Comparative anatomy (3)

Question 3: 7 Minutes*(Taken from DoE November 2008 Paper 2)*

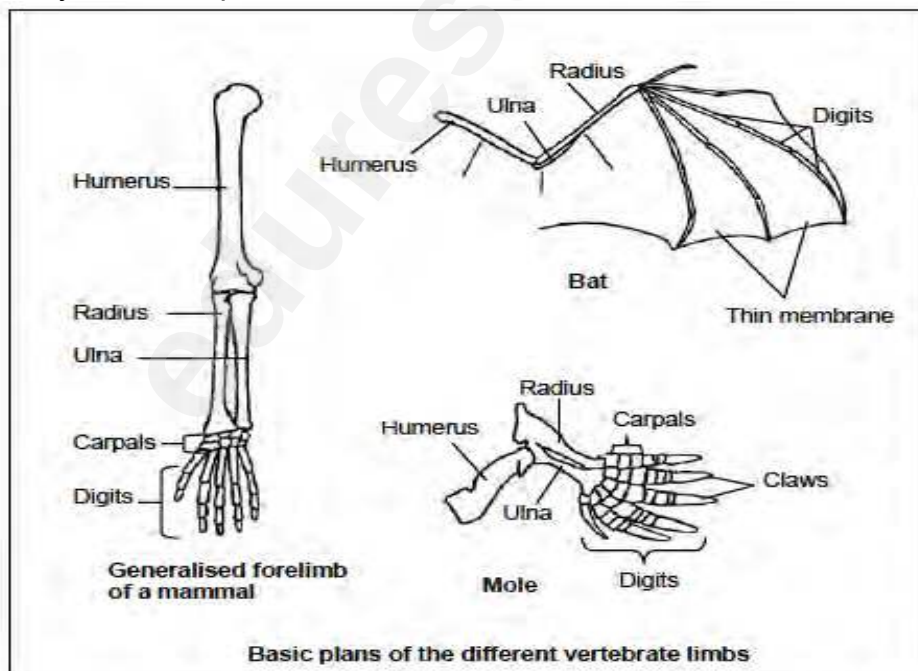
The diagrams below represent the evolution of the horse, compiled from fossil records.



- 3.1. How many times is the modern horse taller than its earliest ancestor? Show your working. (3)
- 3.2. What happened to the appearance of the feet of the horse over time? (2)
- 3.3. Palaeontologists suggest that ancient horses lived in forests, but modern horses live in open grassland. Explain ONE way in which the modern horse is adapted to open grassland. (2)

Question 4: 5 Minutes*(Taken from DoE November 2008 Paper 2)*

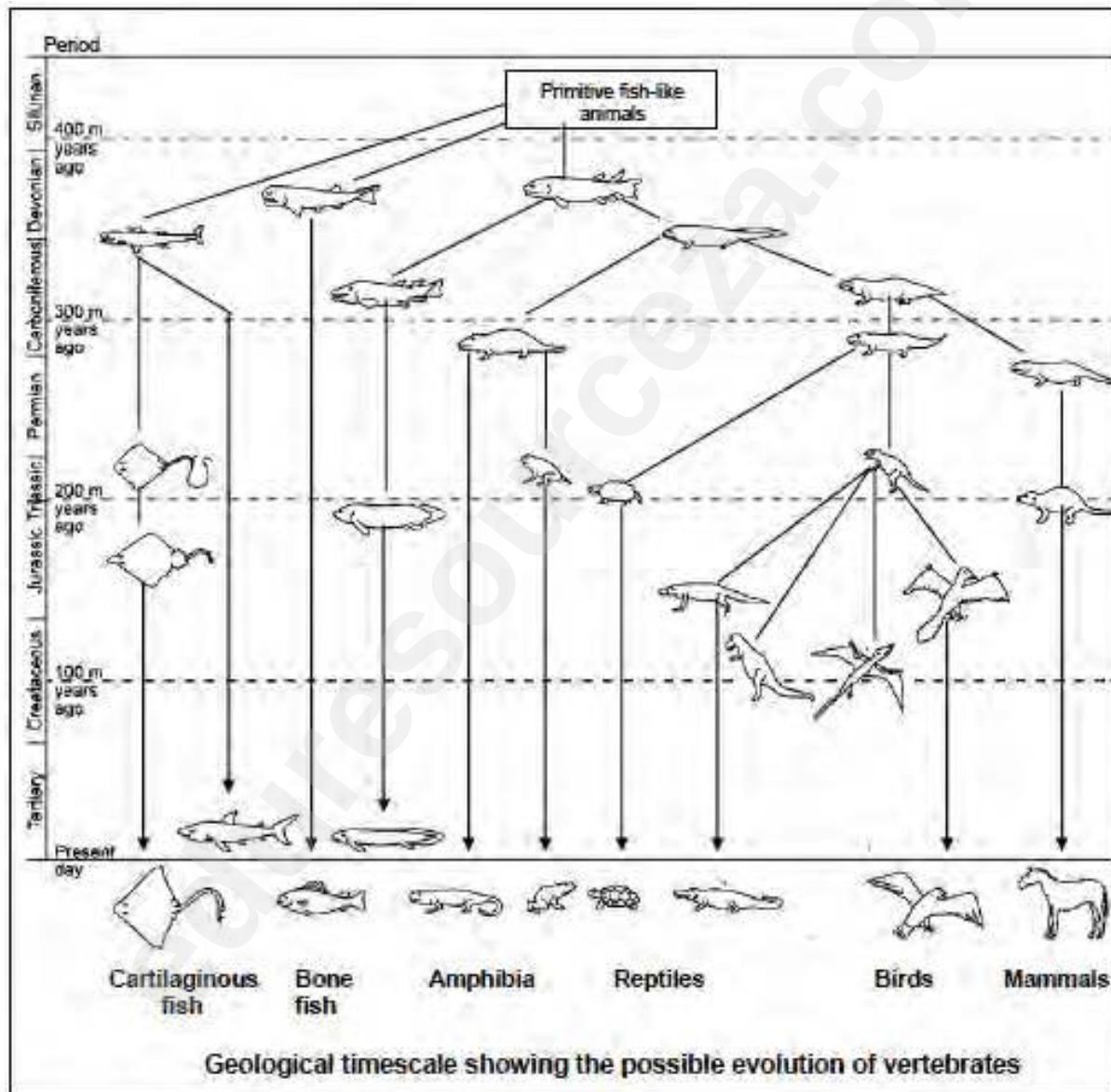
Study the basic plans of three different vertebrate limbs shown below:



- 4.1. Are the above examples of homologous or analogous structures? (1)
- 4.2. Explain your answer to QUESTION 4.1. (2)
- 4.3. State ONE way in which the forelimbs of the:
- Bat are adapted for flying (1)
 - Mole are adapted for digging holes (1)

Question 5: 13 Minutes (Taken from DoE Preparatory Examination 2008 Paper 2)

The geological timescale below shows the possible evolution of vertebrates. Study the timescale and answer the questions that follow.



- 5.1. In which period did the first terrestrial (land) vertebrate appear? (2)
- 5.2. According to the time scale, would it be acceptable to say that amphibia are primitive reptiles? Give a reason for your answer. (2)
- 5.3. According to the timescale, which group of animals went extinct in the Cretaceous period? (1)

- 5.4. Explain how scientists can determine that these animals mentioned in QUESTION 5.3 became extinct 100 millions years ago. (4)
- 5.5. Discuss any TWO theories on how these animals in QUESTION 5.3 became extinct. (4)

SECTION B: SOLUTIONS AND HINTS

Question 1:

- 1.1. During continental drift ✓ the tortoise populations were isolated/separated ✓ from the original population on different islands ✓ living under different environmental conditions ✓ and through natural selection developed into new species ✓ not able to interbreed after a period of time ✓ (any 4) (4)
- 1.2. Fossils provide evidence of life forms that existed in the past/that are now extinct ✓ Intermediate forms of organisms ✓ have been discovered that illustrate the changing forms of plants/animals ✓ (any 2) (2)
- 1.3. Only a few of the ancient organisms are preserved as fossils ✓ because they need to be covered soon after death otherwise they will be decomposed by bacteria ✓ Only organisms with a solid and resistant skeleton ✓ are easily preserved ✓ We have not found all the fossils □ that exist in the earth ✓ (any 1 x 2) (2)
- (Mark first ONE only)**

Question 2

(a) Comparative anatomy

The arm of a human and the flipper of a dolphin perform different functions ✓, yet the type and arrangement of bones are similar ✓ called homologous structures ✓ reveal that they may have evolved from a common ancestor ✓ Closely related species have more common structures like horses and zebras ✓

Any 3 (3)

(b) Comparative embryology

Embryology is the study of stages of organism's development before birth. The embryos of all vertebrate groups are amazingly similar ✓ They all have gill slits ✓/ fish like kidneys / two chambered heart / a nerve cord and a tail ✓ All these features stay in tact in fish ✓, but the other develop in stages further and loses the ancestral (fish like) features ✓ In mammals the nerve cord develops into a closed spinal cord, lungs developed and the human embryo develops a 4 chambered heart and loses the tail ✓ The embryo passes through all the stages of its ancestor during its development ✓

Any 3 (3)

Question 3:

- 31 $1,6 \text{ m} / 0,4 \text{ m} \checkmark$ **OR** $0,4 \text{ m} \times 4 = 1,6 \text{ m} \checkmark$
 $= 1:4$ $= 4 \text{ times} \checkmark \checkmark$
OR
 $35 \text{ mm} / 25 \text{ mm} \checkmark = 1,4 \text{ times} \checkmark \checkmark$ (due to translation error) (3)

- 3.2 - Over time the number of toes appeared to decrease in number ✓/ digits are now fused - but increased in size ✓/ elongated (2)

- 3.3 - The taller body ✓/legs of the modern horse enables it to look over grasses and have a wider view ✓
 - The single/fused toe ✓ of the modern horse enables it to run faster ✓ over open ground
(Mark FIRST answer only in learner's script) (any 1 x 2) (2)

Question 4:

- 4.1 Homologous ✓ (1)
 4.2 - Because the structures may have different functions ✓
 - but are similar in structure ✓ suggesting a similar/common origin/ancestor (2)
 4.3 (a) - There is a wing ✓/web of skin/membrane
 - Forelimb and digits are thin ✓ /light/long
(Mark FIRST answer only in learner's script) any (1)
 (b) - The bones are short ✓/thick and therefore strong
 - and the digits (fingers) ends in long claws ✓
(Mark FIRST answer only in learner's script) any (1)

Question 5:

- 5.1 Carboniferous period ✓✓ (2)
 5.2 Yes, ✓ they evolved from a common ancestor ✓
OR
 No, ✓ they evolved separately from common ancestor ✓ (2)

- 5.3 Dinosaurs ✓ (1)

5.4

Relative dating: ✓ Fossil age is estimated relative to other layers ✓ / bottom layer is older than top layer

Radiometric dating: ✓ Carbon-14 or Uranium-238 is used ✓ know how long it takes for these unstable elements to decay ✓ into other products ✓ calculate the number of atoms of a radioactive element and their product in a sample ✓ can calculate how old that rock/ sample is ✓ Any 4 (4)

5.5

- Ice ages ✓ caused by changed orbit of earth or continental drift ✓
- Climates changed and animals could not survive or adapt/
- Melting ice caused massive floods, tsunamis/
- Mid Atlantic ocean current stopped and no nutrients, energy, heat or food distributed to world oceans
- Asteroid ✓ comet, star collided with earth caused rock falls, earth quakes, tsunamis killed many and dust clouds covered the sun ✓ No photosynthesis / plants died and all after that
- Volcanic activity ✓ massive rock falls, dust covered earth, also dust blocked out sun ✓ / no photosynthesis / cold no survival
- Disease ✓ Flu or other bacterial, virus outbreaks ✓ / could have caused mass extinction of several species

Any 2 x 2 (4)

SECTION C: ADDITIONAL CONTENT NOTES**Evidence of Evolution**

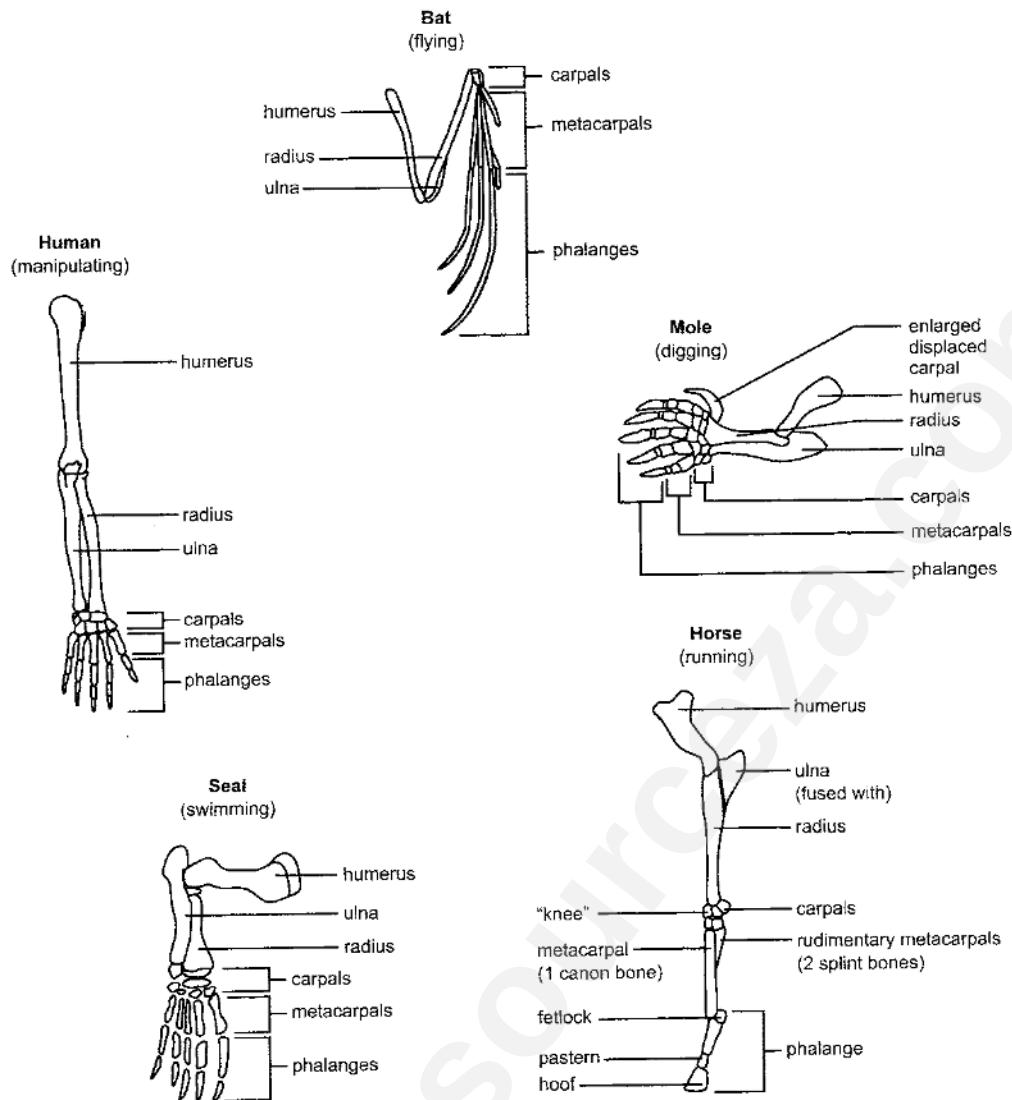
Information and research to support the concept of continual change has come from sources like geology, anatomy, embryology, genetics and physiology.

Geological evidence shows that the earth is about five thousand million years old. The first record of living material that was preserved as a fossil is from the Palaeozoic era (540 million years ago).

The word fossil is derived from Latin and is defined as the imprint, traces or preserved remains of an organism that once lived. Fossilisation is the process that took place to produce the fossil.

Archaeologists study and trace the fossil remains in rock strata. The study of fossils is called palaeoecology. Fossils found laid down in one stratum are compared to strata from later periods. A progression of forms can be clearly seen. Organisms without a backbone show modifications and development into organisms that have a backbone. Archaeologists have also recorded fish that have modified into amphibians. Amphibians modified into reptiles and the reptiles modified into mammals. Fossil evidence supports these progressions.

Anatomical evidence is derived from the study of the details of the **structures of body parts** and systems of organisms that belong to a phylum. There is a **similarity in the structure** of the pentadactyl limb for example the flipper of a dolphin, the wing of a bird and the human arm. The bones, muscles and nerves are arranged in a similar way. When there is a **similarity of the formation** of a body part or organ due to a common evolutionary origin, it is termed a **homologous organ**.

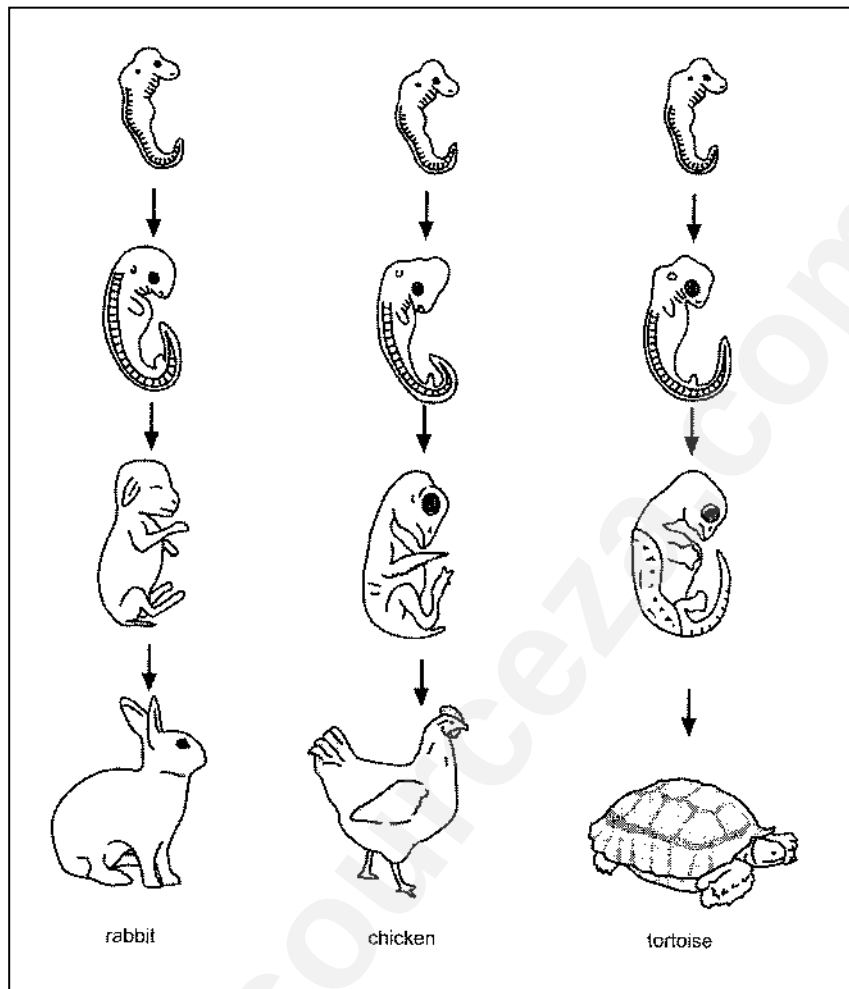


Adaptation of the pentadactyl limbs of mammals (Vivlia publishers – Viva Grade 12 Life Science 2008)

When the organ or body part is not homologous, but has a **similar function** in **different organisms**, it is termed an **analogous organ**, e.g.: lungs of mammals, trachea or air tubes of insects and gills of fish. These organs have evolved in different ways to meet a common need to obtain oxygen.

Physiological evidence shows that the chemicals found in the cytoplasm of plant and animal cells are similar. When studying the nucleus, the DNA and RNA are similar in plants and animals.

Reproductive evidence shows that the **embryonic development** of the vertebrate groups has very similar structures from cleavage, gastrulation and the early stages of differentiation. Haeckel (1834–1919) suggested that the developmental stages of the embryo are a repeat of the evolutionary history of the group to which the organism belongs.



Stages of embryonic development in three classes of vertebrates
(Vivlia publishers – Viva Grade 12 Life Science 2008)

Age of Fossils

Two methods that are used to determine the age of a fossil:

- **Relative age:** sedimentary rocks are formed over a long period of time and each layer will contain the organisms that lived at a certain period of time. Each layer is covered over with a new layer of sedimentary rock and soil. Fossils found in the **upper layers** **will be newer** than those found lower down so the depth of the fossils will determine their relative age.

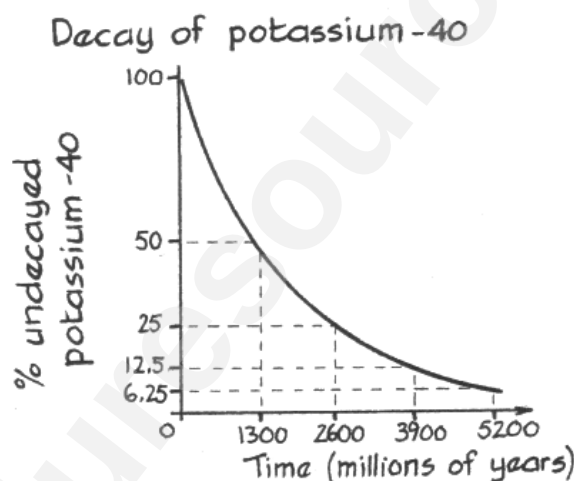
- **Absolute age:** is accurate and is measured in years. Two techniques are used by Archaeologists to deter the absolute age of a fossil:
 - **Radio-active dating:** there are radioactive elements like uranium in rocks and as these rocks age, **the uranium converts into lead**. Scientists measure the uranium and lead levels to determine the age of the fossils embedded in the rocks. This method can only be used for fossils believed to be older than 100 million years because the process of the uranium to lead conversion takes a long time.
 - **Carbon dating:** all living organisms contain a radioactive atom called Carbon-14. When the organism dies, the **Carbon-14 atom is converted into nitrogen** over time. Scientists know the rate of the conversion and the period of time this takes. Once the level of Carbon-14 is determined in the fossil, the age can be calculated. This method will only be used for fossils believed to be less than 50 000 years old.

SECTION D: HOMEWORK

Learner Note: As you attempt attempt the homework, you **MUST** stick to the time frames. If you get stuck refer to either the additional notes or your class teacher.

Question 1: 8 Minutes

(Taken from St Mary's DSG September 2009 Paper 2)



The graph above shows the decay of potassium-40 which is used to radiometrically date fossils.

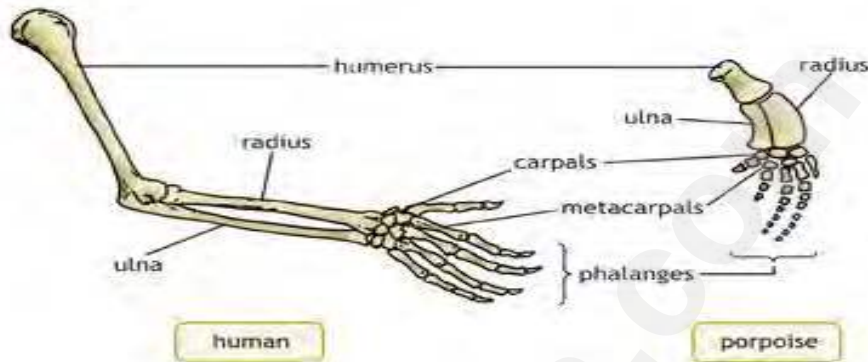
1.1 Assume a paleontologist found a fossil and determined that the ground in which it was found contained 12.5% undecayed potassium-40. How old would that fossil be? (2)

1.2 If another fossil was found in the same area but was determined to contain 25% undecayed potassium-40, which fossil (this one or the one from the previous question) would be found at a greater depth? Explain your answer. (3)

1.3 If scientists dated a fossil bone and determined that it was 10 000 years old, but there is a 1% error in the method. How old might this fossil really be? (3)

Question 2: 5 Minutes*(Taken from St Mary's DSG September 2009 Paper 2)*

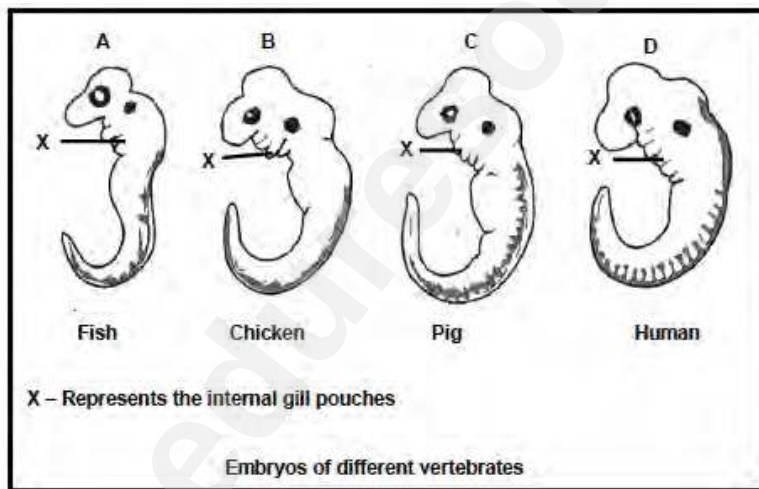
Below are the forelimbs of a human and a porpoise. Study the diagrams carefully and answer the questions that follow.



How would you use the diagram to provide evidence for evolution as a possible explanation for diversity? (5)

Question 3: 5 minutes *(Taken from DoE Exemplar 2008 Paper 2)*

Study the diagrams below that show embryos of different vertebrates and answer the questions that follow.



- 3.1. Explain what biologists concluded about the similarities in the structures of the embryos of the four vertebrates shown in the above diagram. (2)
- 3.2. Most scientists believe that all vertebrates share a common ancestor. Which of the embryos (A, B, C or D) would scientists identify as being closely related to this ancestor?(1)
- 3.3. Explain your answer to QUESTION 1.2. (2)

Question 4: 5 minutes

Various possible options are provided as answers to the following questions. Choose the correct answer and write only the letter next to the number on your answer sheet.

- 4.1 Which ONE of the following is an example of a pair of analogous structures?
- A A whale's flipper and a bat's wing
 - B A bird's wing and an insect's wing
 - C A hawk's wing and a sparrow's wing
 - D A dog's leg and a horse's leg
- 4.2 The following is needed for new species to form....
- A an extinction event
 - B an homologous structure
 - C an analogous structure
 - D reproductive isolation
- 4.3 Macroevolution is a term that describes ...
- A an increase in the size of individuals of a population over a long period of time.
 - B the process by which new genera and families of organisms are formed.
 - C a gradual change in the number of species found in the fossil record.
 - D changes that can be seen without the need for a microscope.
- 4.4 Which of the following is NOT a fossil?
- A *Tyrannosaurus rex* skull, 65 million years old
 - B Oil formed from microorganisms, 150 million years old
 - C Stone tool made by ancestors of human, 2,6 million years ago
 - D 195 million-year-old dinosaur footprint imprinted in rock
- 4.5 The theory of evolution based on the principle of use and disuse was proposed by ...
- A Darwin.
 - B Mendel.
 - C Lamarck.
 - D Wallace.

SECTION E: SOLUTIONS TO SESSION 22 HOMEWORK**Question 1:**

1. A
2. B
3. B
4. B
5. D
6. C
7. A
8. C
9. B
10. A

Question 2:

- 2.1. Paleozoic Era ✓ (1)
- 2.2. (a) Paleozoic Era ✓ (1)
 - (b) Permian ✓ (1)
- 2.3. Cenozoic ✓ (1)
- 2.4. (a) 65 ✓ mya (1)
 - (b) Comet ✓ / star/meteorite/asteroid (1)
 - (c) Extraterrestrial object hit the earth Climate change occurred – due to dust clouds ✓
 Sunlight was blocked ✓ Ice age occurred ✓ Reduction of CO₂ in the atmosphere ✓
 Photosynthesis decreased ✓ Many plants died ✓ Many animals died ✓ /dinosaurs
 become extinct max. (4)
- 2.5. Uranium ✓ will be used, because dinosaurs lived approximately 65 million ✓ years ago
 and C-14 can only measure up to 5 730 ✓ years ago (3)