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DIVERSITY: HUMAN EVOLUTION AND TRENDS IN HUMAN EVOLUTION – APELIKE BEINGS THROUGH TO *homo sapiens*

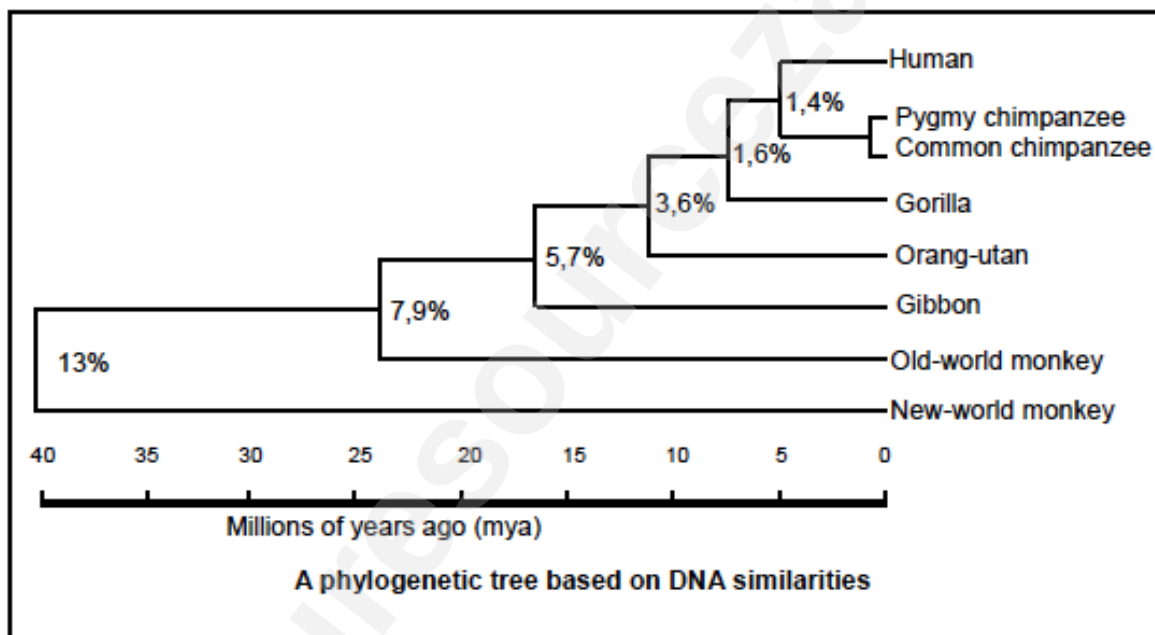
Learner Note: Please review terms like **Anthropology, Palaeontology and Archaeology**. The Chemical and Homonid evolution theories are important. Questions on this section of work are often comparative questions.

SECTION A: TYPICAL EXAM QUESTIONS

Question 1: 5 minutes

(Taken from DoE Feb/March 2010 Paper 2)

The diagram below shows a phylogenetic tree based on DNA similarities. The percentage next to each branch shows the amount of difference in the genome (DNA nucleotide sequence) of the two relevant groups.



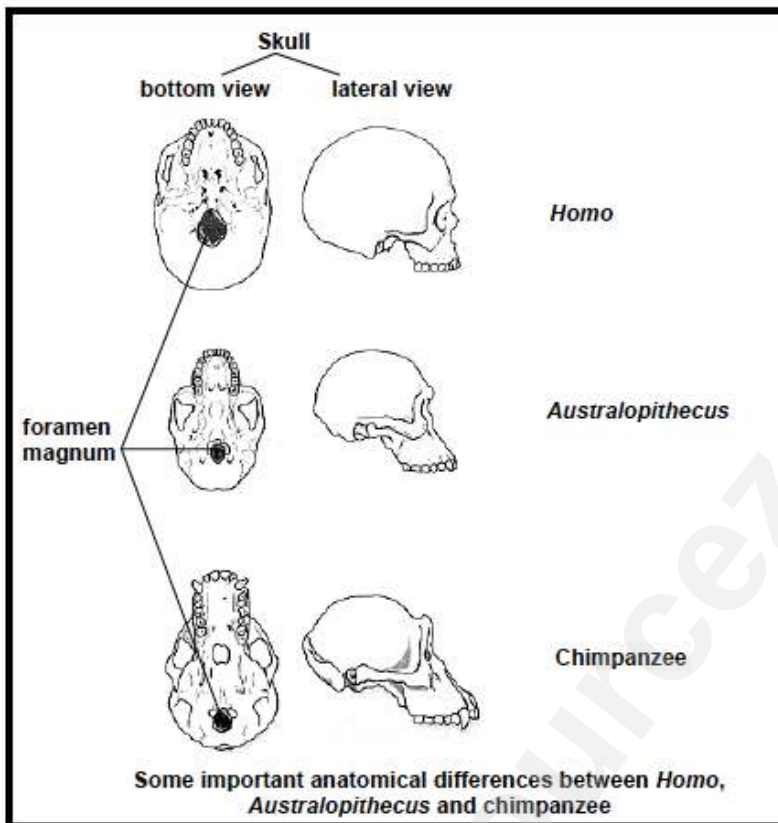
[Adapted from: Senior Biology 2]

- 1.1. From the diagram, determine how long ago the chimpanzees split from the line to humans. (**HINT: Use a ruler so that you are accurate in your readings**) (2)
- 1.2. Which organism is most closely related to humans? (1)
- 1.3. Calculate the DNA similarity between the genome of the chimpanzee and the human. (2)

Question 2: 9 minutes

(Taken from DoE Feb/March 2009 Paper 2)

A comparison of the anatomical features of organisms has helped scientists to propose evolutionary relationships. Please study the following diagram and answer the questions that follow:



- 2.1. Tabulate THREE observable differences between the side view of the skulls of *Homo* and the chimpanzee.
(Hint: When you are asked to tabulate, you must draw a table. You get marks for this. Always compare the same things in each point) (7)
- 2.2. Which ONE of the organisms (*Australopithecus* or chimpanzee) is/was a quadruped? (Quad means 4) (1)
- 2.3. Give ONE observable reason for your answer to QUESTION 2.2. (1)

Question 3: 8 minutes

(Taken from DoE Preparatory Examination 2008 Paper 2)

In an investigation a biotechnologist injected chimpanzee blood into a rabbit. The immune system of the rabbit recognised the chimpanzee blood protein as foreign and produced antibodies. The rabbit's antibodies were then extracted and developed as a serum.

When the serum is added to blood samples in different test tubes removed from of a variety of different animals, a precipitate forms. The more precipitate forms, the more closely related the animal is to the chimpanzee.

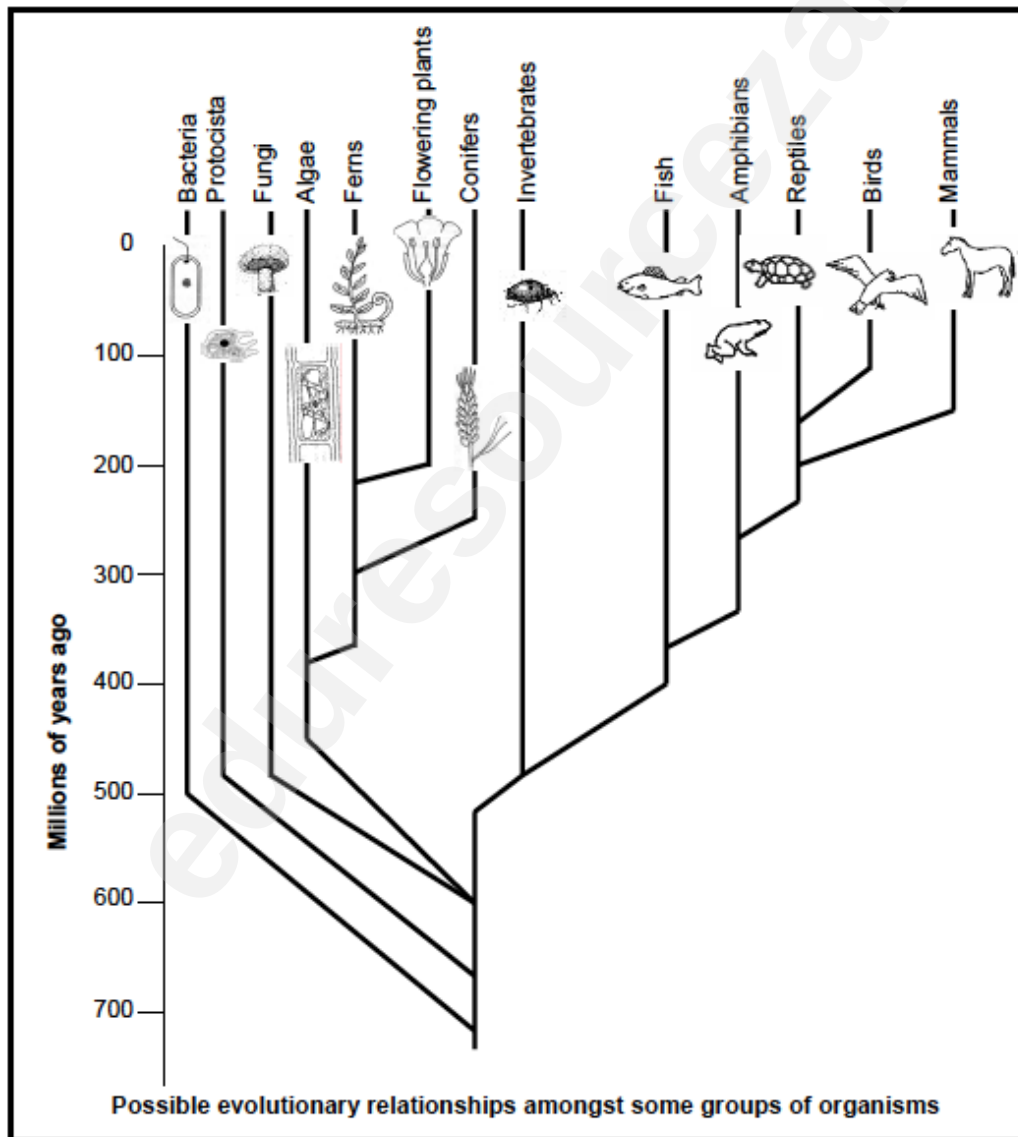
Study the table below that shows the percentage precipitate formed in this investigation, and answer the questions that follow.

Animal species	Percentage precipitate formed
Gorilla	Very high
Baboon	High
Monkey	Moderate
Pig	Very low

- 3.1. What is the composition of the serum? (2)
- 3.2. According to the above information, which animal is least closely related to chimpanzees? Give a reason for your answer. (2)
- 3.3. Formulate a hypothesis for the investigation above. (2)
- 3.4. Name TWO variables that had to be kept constant in this investigation. (2)

Question 4: 8 minutes*(Taken from DoE Feb/March 2009 Paper 2)*

Study the diagram showing possible evolutionary relationships amongst some groups of organisms.



- 4.1. According to the diagram:
- How many million years ago did the conifers evolve? (1)
 - Which were the first organisms that lived on Earth? (1)
 - From which group of animals did the reptiles evolve? (1)
 - Which is the most recent group of animals to evolve? (1)
- 4.2. Name TWO fields of study, other than embryology and biochemistry, that scientists may have used to propose the evolutionary relationships shown in the diagram. (2)
- 4.3. Explain why we cannot be sure that the evolutionary relationships displayed in the diagram are absolutely correct. (2)

SECTION B: SOLUTIONS AND HINTS

Question 1:

- 1.1 5P mya ✓ (1)
 1.2 Chimpanzee ✓ (1)
 1.3 98,6 ✓ % ✓ (2)

Question 2:

2.1.

Homo	Chimpanzee
1. Canines not well developed ✓	1. Canines well developed ✓ /form fangs
2. Less protruding jaws ✓ /not prognathus	2. Protruding jaws/prognathus ✓
3. Brow-ridge less pronounced ✓	3. Heavily pronounced brow- ridge ✓
4. Proportionally large cranium ✓	4. Proportionally smaller cranium ✓
5. Proportionally shorter cheek bone ✓	5. Proportionally larger cheek bone ✓
6. No ridge at base/back of skull ✓	6. Ridge at base/back of skull ✓

(Mark first **THREE** only) (any 3 x 2) 1 mark for table (7)

- 2.2 Chimpanzee ✓ (1)
 2.3 The foramen magnum is towards the posterior/back of the skull ✓ (1)

Question 3:

- 3.1 The serum contains antibodies ✓ against chimpanzee protein ✓ (2)
 3.2 Pig, ✓ it only forms an very low % ✓ precipitate when the blood is exposed to serum. (2)
 3.3 A high percentage ✓ of precipitate formed indicates a close relationship ✓ with chimpanzees
OR
 A low percentage ✓ of precipitate formed indicates a no ✓ relationship with chimpanzees
OR
 A high percentage ✓ of precipitate formed indicates a weak ✓ relationship with chimpanzees
OR
 A low percentage ✓ of precipitate formed indicates a strong ✓ relationship with chimpanzees (2)
 3.4 Temperature ✓, pH ✓, concentration of serum ✓ amount of serum and blood the same ✓

Any 2 (2)



Question 4:

- 4.1. a) 300 ✓ million years ago (1)
 b) Bacteria ✓ (1)
 c) Amphibians ✓ (1)
 d) Birds ✓ (1)
- 4.2 Studying fossils ✓ /paleontology Anatomy ✓
 Taxonomy ✓
 Biogeography ✓ **any (2)**
- 4.3 We cannot observe these changes ✓ because they took place millions of years ago ✓
 Gaps ✓ in the fossil records ✓ /comparative anatomy, biochemistry embryology ✓ (**any 1 x 2**)

SECTION C: ADDITIONAL CONTENT NOTES**Anthropology, Palaeontology and Archaeology**

Please learn the following definitions:

- **Anthropology** is the study of the human race, including the different belief systems, customs and social habits.
- **Palaeontology** is the study of the earliest known periods of human existence, for example the Stone Age.
- **Archaeology** is the study of ancient times by examining the buried remains of buildings, tool and animal and plant fossils.

An **Archaeologist** studies and traces fossil remains to determine when the animals and plants lived by carbon dating. **Palaeontologists and Anthropologists** use the information to determine what lead to extinction or evolutionary changes. **Fossils** found laid down in one stratum of rock are compared to strata from later periods where progression can be seen. Organisms without a backbone show development into organisms that have a backbone. The Archaeologists have also recorded fish that have modified into amphibians, amphibians that have modified into reptiles and in later strata, the reptiles into mammals. Fossil evidence supports these **progressions**.

Origin of humankind

Scientists estimate that the earth is more than **5 billion years old**. Geological evidence indicates that simple forms of life on earth appeared 3,5 billion years ago. There are many hypotheses but none have been irrefutably proven.

Chemical evolution:

In the 1920s, a Russian scientist named **A.I. Oparin** suggested that the earth was very different three billion years ago, with an atmosphere made up of ammonia (NH_3), methane (CH_4) and water vapour (H_2O). Energy from lightning and radiation caused these molecules to split resulting in carbon, hydrogen, oxygen and nitrogen forming different combinations to make organic compounds. When the correct combination formed, life began. Remember, carbon, hydrogen and oxygen are elements that form organic molecules like carbohydrates (C, H, O) and fats (C, H, O). If we add nitrogen, proteins (C, H, O, N) result. This process is called **chemical evolution**.

In 1953, two American scientists, **Stanley Miller and Harold Urey**, tested Oparin's hypothesis in a laboratory. Charges of electricity were sent through gas mixtures similar to that believed to have made up the atmosphere billions of years ago. **Organic molecules** were produced. In later years, amino acids, carbohydrates and DNA have been produced using the same process. However, no experiments have produced a living organism.

Hominid evolution:

Substantial fossil proof exists to explain **hominid evolution** although it is not enough to make specific conclusions. The hominid line separated from the ape line approximately four million years ago. Many people make the assumption that because fossils have been shown to prove that the hominid and ape line were once joined – that humans are related to apes. Should this be the case, then one could argue that humans are all related to the HIV virus since humans and the HIV both have DNA. So, based on the above logic, we are related to HIV. We can expand this 'theory' to state that humans are related to a chicken or a lizard as both groups belong to Vertebrates.

Further, it should be noted that apes have 48 chromosomes and **humans have 46**. Humans are in no form or manner related to apes and this is not what the evolution theories are all about. Since none of the present human population lived 3 million years ago, no-one can be sure and this is why scientists hypothesize about the origins of man and base their findings and theories on scientific evidence.

Characteristics hominids share with other hominoids

1. The upper limbs

- Primates have very long upper arms, which they can move freely because of the shallow socket (glenoid cavity) into which the head of the humerus fits and also because the scapulae (shoulder blades) are not attached to the vertebral column. The long arms are useful in plucking fruit from the tips of tree branches.
- Primates can also rotate the hands at least 180° by simply turning the wrist.
- Primates have flat nails instead of claws. The bare finger tips are rich in nerve endings which make them very sensitive, allowing for precision work such as in making and using tools.
- All primates have thumbs which work in the opposite direction to their fingers. We say that primates have **opposable thumbs**. The thumb can be pressed against the fingers, and the hands form a **power grip** for grasping tree branches and climbing. Apes and humans can also use their fingers and thumbs in a **precision grip** such as holding a pair of tweezers.

2. The brain

- Primates have larger brains compared to their body masses. This allows them to make sense of the large amount of information they obtain as they move from tree to tree.
- The parts of the brain that interpret information coming from the hands and eyes are enlarged. The part of the brain responsible for interpreting the sense of smell (the olfactory centre) is reduced since the sense of smell is less useful to primates.

3 Vision

- Primates have stereoscopic vision (observing the solid nature of an object) and the eyes have cones (as well as rods) for colour vision and greater clarity of vision.

4 Number of offspring produced

- Primates have fewer offspring than many other mammals, and their young are dependent on their parents for much longer. The long period of interaction between adults and offspring allows the adults to teach the young essential survival skills.

5 Upright posture

- Primates have the ability to sit or stand upright with the head held high. Upright posture allows a better view of the surroundings and allows the animal to walk on two legs, which in turn frees the upper limbs for carrying things such as food, tools and babies.

Characteristics that make hominids different from other hominoids1_ Bipedalism

Humans walk on two feet all the time. (other primates do this occasionally).

Bipedalism offers the animal the following advantages:

- the hands became free for carrying food, tools and babies.
- a better view of the surroundings in search for food and predators.
- movement from place to place become more efficient.
- faster cooling of the body, which was essential in their original hot tropical environments.
- Display of the male sex organs (phallic displays) as part of courtship behaviour.

Because the position of the vertebral column change in relation to the skull, the opening that allows the spinal cord to leave the skull (the **foramen magnum**) must change from the back of the skull in animals that walk on all 4 legs to a forward position at the bottom of the skull in bipedal animals.

2 A flat face

All human faces appear flat, because

- human foreheads do not slope backwards as much as those of ape men
- human lower jaws have a well-developed chin
- the bones of the nose and jaws do not stick out as much as those of ape men i.e. humans are not prognathous.

Human brow ridges are not as pronounced as those of ape men.

3 Shape of jaws

The jaws of apes are U-shaped with parallel sides and a slightly rounded front. The incisors are in front while the canines, premolars and molars are on the sides.

The sides and front of humans jaws are gently curved, with the position of the different teeth more or less the same as in apes.

4 Detinition

The general dental formula of mammals is

3.1.4.3

3.1.4.3

The oldest primates have the dental formula

2.1.3.3

2.1.3.3

Humans have the same dental formula as apes which is

2.1.3.2

2.1.3.2

Humans also have very small canines

5 An enlarged brain

Modern humans have the largest brain size of all primates. Human brain sizes range from 1 200ml to 1 800ml, with average brain size being 1 400ml.

6 Language

Many of the apes existing today are able to communicate by means of sounds. These sounds may be the natural languages of these apes.

Only humans can learn to communicate in artificial languages such as English.

Fossil evidence to support the hominid evolution theory

Hominid type	Date of appearance (millions of years)	Average brain cavity size (cc)	Identifying characteristics
<i>Australopithecus afarensis</i>	3,8	450	- About 3 feet tall - Upright posture on two legs - Long canines - Skeleton found called 'Lucy'
<i>Australopithecus africanus</i>	3,0	495	- About 5 feet tall - Upright posture on two legs - Definite hands - Teeth show that it ate plants and animals
<i>Australopithecus robustus</i>	2,0	500	- About 5 feet tall - Upright posture on two legs - Larger and not a direct line to humans
<i>Homo habilis</i>	1,8	650	- Placed in same genus as humans - Fossils found in Africa - Sites contain first primitive stone tools

Hominid type	Date of appearance (millions of years)	Average brain cavity size (cc)	Identifying characteristics
<i>Homo erectus</i>	1,5	950	- Numerous fossils found - Evolved in Africa but migrated to Europe and Asia – based on fossil dating - Peking man and Java man discovered in Asia <i>Homo erectus</i> was taller than <i>Homo habilis</i> - Heavy supra-orbital ridges and looked more ape-like - More advanced stone tools like hand axes, choppers and scrapers - Wore clothing to keep warm, built fires and lived in caves and shelters
<i>Homo sapiens</i>	0,2	1 400	- Features can be compared to modern man - Earliest groups were Neanderthals - Short sturdy build - Face had less pronounced chin but still had a heavy brow ridge - Tools included spear points - Sites showed evidence of hunting - Sites show that they cared for their elderly which shows social co-operation - They buried their dead and left food and flowers at the graves – shows basic concept of afterlife - Later <i>Homo sapiens</i> showed distinct features, lacked heavy brow ridges and showed a more pronounced chin - Tools and weapons were complex and made of materials other than stone; they made stone blades - They created art in the form of cave paintings, engravings and sculptures

(From Vivlia: Grade 12 Viva Life Science, 2008)

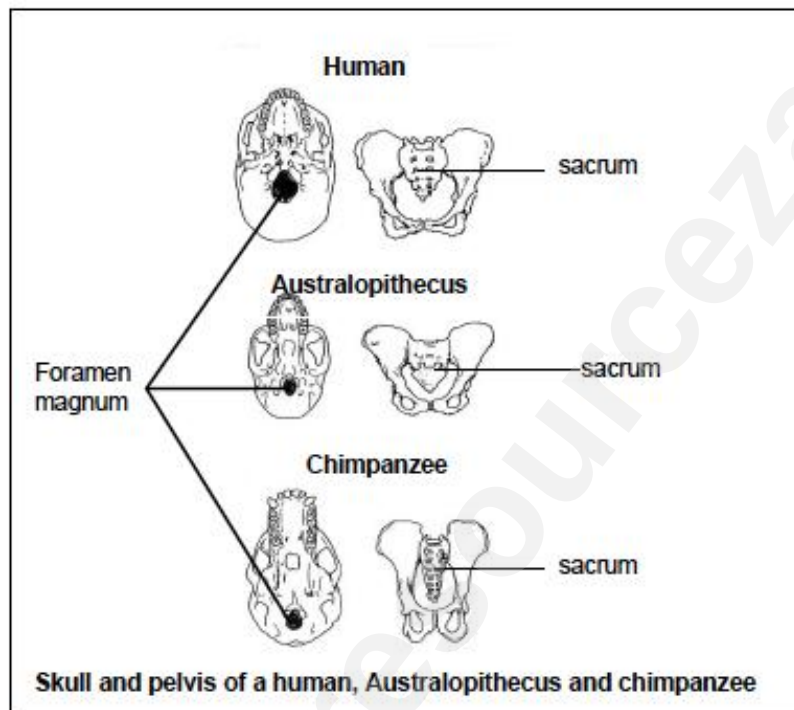
SECTION D: HOMEWORK

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: 15 Minutes (Taken from DoE Preparatory Examination 2008 Paper 2)

(HINT: This question is very similar to the question in Section A. Please note how a similar question can be asked around the same topic.)

The diagram below shows the skull and pelvis of three mammals. Study the diagram and answer the questions that follow.



- 1.1. Tabulate FOUR observable differences of the skull and pelvis of a human and a chimpanzee. (9)
- 1.2. Which organism(s) is/are bipedal? (2)
- 1.3. Give ONE reason, observed from the diagram, for your answer to QUESTION 1.2.(2)
- 1.4. State ONE visible difference between the skull of Australopithecus and a human. (2)
2. In table form show the differences between anthropology, palaeontology and archaeology. (6)
3. List the SIX main hominid types that form part of Hominid Evolution and discuss the variation in the formation and development of the skulls. (7)
4. Bipedal locomotion and upright posture is a distinctive trait of human beings. Describe FIVE advantages of bipedalism to humans today. (5)

SECTION E: SOLUTIONS TO SESSION 24 HOMEWORK**Question 1:**

- 1.1 Birds flew into the unaffected areas from the affected areas □. (1)
- 1.2 Remaining patches may not have had the habitat/food resources needed for some of the bird species □/competition
These species may have become extinct □ in that area/left the area. (2)
- 1.3 Bird species that would have been made extinct □ in that area are preserved □ .
The larger the area, the more useful the preservation □. (3)

Question 2:

2.1.

	Sympatric speciation	Allopatric speciation
The most common type of speciation in animals	X	✓
Hybrids may result	X	X
Occurs in populations living in the same geographical area	✓	X
Breeding is between members of the same species	✓	✓

(4)

- 2.2. 1. Disruptive □ 2. Stabilizing □ 3. Directional □ (3)

Question 3:

- 3.1 Equal✓ number of light and dark-banded snails✓ will be eaten✓
OR
More✓light-banded snails✓ will be eaten✓
OR
Less✓light-banded snails✓ will be eaten✓
OR
More✓dark-banded snails✓ will be eaten✓
OR
Less✓ dark-banded snails✓ will be eaten✓ (3)
- 3.2 Natural selection✓/camouflage/predation/survival of the fittest/
micro-evolution (1)

- 3.3 Light-banded✓ (1)
- 3.4
- | | |
|---|---|
| Lower number✓ of light-banded shells found, indicating that they are not easily detected ✓ by the birds | Dark-banded✓ |
| | Higher number✓ of dark-banded shells found, indicating that they are not easily detected ✓/camouflaged by the birds |
- 3.5 Started with equal numbers✓ of light and dark-banded snails in the environment (1)

Question 4:

- 4.1 - Random assortment □/segregation/recombination of chromosomes during meiosis in the formation of gametes
- Crossing over □
 - Chance/random fertilisation of gametes □/sexual reproduction
 - Mutation □
 - Outbreeding □/Gene flow
- (**Mark first FOUR answers only in learner's script**) (4)
- 4.2 - Within each of the two groups there is variation □
- Each group undergoes natural selection □
 - as a result of varying environmental conditions □
 - and develops differently □
 - genotypically □ and phenotypically □
 - since the geographical barrier prevents gene flow □/reproduction between the two populations
 - The differences that develop between the two populations prevent them from interbreeding □even if they were to mix
 - such that one or both of the groups becomes a new species □ **any 6 (6)**