FREE SAMPLE: THE FIRST QUESTION

Question One (16 marks)

(a) The table gives approximate values of the age and mean cranial capacity (brain volume) of fossils of several hominin species. (The values are rounded for this question.)

(i) Calculate the percentage increase in cranial capacity from Australopithecus afarensis to Australopithecus africanus.

(ii) Calculate the mean rate of increase in cranial capacity between the two species in cm^3 per million years.

(iii) Discuss how an increase in brain size could have given an advantage to the later hominins, and explain why the table alone does not prove that a larger brain caused the other changes seen in the fossil record.

Species	Approximate age of the fossils (million years ago)	Mean cranial capacity (cm
Australopithecus afarensis	3.2	450
Australopithecus africanus	2.8	460
Homo habilis	1.9	610
Homo rudolfensis	1.9	750
Homo ergaster	1.7	850
Homo erectus	1.0	930
Homo heidelbergensis	0.40	1200
Homo neanderthalensis	0.10	1450
Homo sapiens	0.050	1350

[8 marks]

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(b) Bipedalism (walking on two legs) is one of the earliest and most important trends in human evolution.

(i) For each of the following features, describe how it differs between a human and an ape such as a chimpanzee: the curvature of the spine; the knee joint.

(ii) Explain how each feature is evidence that a fossil hominin walked upright.

(iii) Discuss two possible selective advantages of bipedalism for early hominins living in open woodland and grassland.

[8 marks]

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (16 marks) [Brains and bipedalism]

(a) The table gives approximate values of the age and mean cranial capacity (brain volume) of fossils of several hominin species. (The values are rounded for this question.) (i) Calculate the percentage increase in cranial capacity from Australopithecus afarensis to Australopithecus africanus. (ii) Calculate the mean rate of increase in cranial capacity between the two species in cm^3 per million years. (iii) Discuss how an increase in brain size could have given an advantage to the later hominins, and explain why the table alone does not prove that a larger brain caused the other changes seen in the fossil record.

(a) Answer: (i) 2.22%; (ii) 25.0 cm^3 per million years; (iii) larger brain gave advantages but correlation does not prove cause

- Evidence level: Excellence (percentage increase = (new − old) ÷ old × 100; rate = change ÷ time between the species).
- (i) (460 − 450) ÷ 450 × 100 = 10 ÷ 450 × 100 = 2.22%.
- (ii) Time between = 3.2 − 2.8 = 0.400 million years; rate = 10 ÷ 0.400 = 25.0 cm^3 per million years.
- Achievement: (iii) States that a larger brain allows more complex behaviour.
- Merit: Links to survival: better planning, tool making and communication improve survival and reproduction.
- Excellence: Full discussion: a larger and more complex brain allows more advanced problem solving, toolmaking, social cooperation and communication (language), which improved access to food (hunting, scavenging, cooking), defence and care of offspring, so individuals with larger brains had higher fitness and the trait was selected for; however, the brain is energetically expensive (about 20% of the body's energy), so a larger brain also needed a better diet; the table shows a correlation only – other changes (bipedalism, diet, tool use, climate) happened at the same time, and cranial capacity also depends on body size, so cause and effect cannot be concluded from these data alone.

> **KEY TAKEAWAY**
> Trends in human evolution: cranial capacity increased roughly three-fold over about three million years; calculate percentage change and rate from the table; a correlation does not prove a cause.

(b) Bipedalism (walking on two legs) is one of the earliest and most important trends in human evolution. (i) For each of the following features, describe how it differs between a human and an ape such as a chimpanzee: the curvature of the spine; the knee joint. (ii) Explain how each feature is evidence that a fossil hominin walked upright. (iii) Discuss two possible selective advantages of bipedalism for early hominins living in open woodland and grassland.

(b) Answer: (i)–(ii) the curvature of the spine: an S-shaped spine supports an upright body; the knee joint: a large, angled knee joint copes with the weight of an upright body on one leg at a time; (iii) freed hands, energy efficiency, vigilance and thermoregulation

- Evidence level: Excellence (compare the human feature with the ape feature and then link the structure to the function of upright walking).
- (i) The curvature of the spine: A human spine has an S-shaped curve (including a lumbar curve) that absorbs shock and brings the centre of gravity over the hips; an ape's spine is C-shaped.
- The knee joint: In humans the knee joint is large and angled so that the weight of the body is carried through the joint when it is straight and each leg supports the body weight alone.

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• (ii) For the first feature, an S-shaped spine supports an upright body; for the second feature, a large, angled knee joint copes with the weight of an upright body on one leg at a time.

• Achievement: (iii) States one advantage of bipedalism.

• Merit: Gives two advantages linked to the environment.

• Excellence: Full discussion: walking on two legs frees the hands for carrying food, infants and tools, which increases survival of offspring and food gathering; it is more energy efficient than knuckle-walking over long distances in open habitats, allowing foraging over a larger area; it raises the head to see over tall grass and spot predators or food; it reduces the body surface exposed to the sun at midday (helping heat loss) and exposes more of the body to cooling air; each advantage increases survival and reproduction, so natural selection favoured the anatomical changes.

KEY TAKEAWAY

Bipedalism: forward-underneath foramen magnum, broad pelvis, angled femur, S-shaped spine, arched foot, long legs – each is evidence a fossil walked upright; selective advantages are carrying, energy efficiency, vigilance and heat balance.

LOS: Brains and bipedalism (91606)

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