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| *Human Perspectives ATAR Units 3 & 4* |

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Answers: Chapter 12 Trends in hominid evolution

Questions 12.1

RECALL KNOWLEDGE

**1** Monkeys, humans and gorillas are all in which taxonomic order?

*Answer*: Primates.

**2** Define ‘arboreal’.

*Answer*: Arboreal means living in trees.

**3** List five characteristics of all primates.

*Answer*: Refer to Table 12.2 on page 324 of the student book for a summary of the characteristics.

APPLY KNOWLEDGE

**4** An unknown species is discovered. It has five fingers with claws, an opposable thumb and a small cerebrum that has limited convolutions. Would the species be classified as being a member of the family Hominidae? Explain your answer.

*Answer*: No. This species is unlikely to be a member of Hominidae due to the presence of claws and a small brain with limited convolutions.

Questions 12.2

RECALL KNOWLEDGE

**1** What family are humans in?

*Answer*: Hominidae

**2** List six characteristics of hominids.

*Answer*:

* A larger, more complex brain
* Five cusps in the molar teeth of the lower jaw
* Arms that can freely rotate at the shoulder
* Wide, shallow chest cavity
* No external tail
* An appendix
* Diurnal behaviour

**3** Describe the trend in the cerebral cortex that has occurred during evolution.

*Answer*: The cerebral cortex has become larger in size and increased in the depth and number of convolutions.

**4** Define ‘pentadactyl’ and ‘opposable’.

*Answer*: Pentadactyl refers to having five digits on each limb. Opposable means the first digit can be moved in such a way that it can touch each of the other digits.

**5** Use an example to describe:

**a** precision grip

*Answer*: The precision grip is formed by the thumb tip touching the other fingertips. It allows humans to grasp objects with precision life holding a pen when writing or using a needle when hand sewing.

**b** power grip.

The power grip is achieved when the thumb and fingers apply force against the palm. This is used when grasping a hammer to hit a nail into wood.

**6** What is meant by ‘bipedal with a striding gait’?

*Answer*: Bipedal with a striding gait refers to walking on two feet with the hip and knee being fully extended.

**7** List the features that allow humans to have a striding gait.

*Answer*:

* Centrally located foramen magnum
* Small, non-protruding jaw for skull balance
* ‘S’ shaped vertebral column
* Broad, shallow pelvis with wide attachments for femurs
* Large head of the femur to contribute the carrying angle
* Larger outer hinge joint on the knee
* Longer legs than arms to lower the centre of gravity
* Large heel bone, aligned big toe with a longitudinal and transverse arch in the foot
* Partial muscle tone to support the spine, hip, knee and ankle.

**8** Explain why a bowl-shaped pelvis in humans has an advantage for bipedalism over the longer pelvis of other apes.

*Answer*: The bowl shape allows for support of the abdominal organs, requiring less abdominal muscles to hold the organs in place. The bowl shape also provides greater stability for bipedal locomotion and the broad hip bones provides space for the attachment of the large buttock muscles to move the leg and keep the upper body erect.

**9** Define ‘carrying angle’ and explain why it allows a striding gait.

*Answer*: The carrying angle is generated by the wide apart hip bones and the convergence of the femurs towards the knees. This arrangement of the femurs forms an angle to the vertical which is called the carrying angle. It allows striding gait as the weight distribution remains close to the central axis of the body when walking. The body is able to be rotated about the lower leg and foot, so each footstep follows a more-or-less straight line.

**10** Which side of the knee is larger? Explain why.

*Answer*: The outer hinge (the lateral condyle) is larger and stronger than the inner hinge. This is due to the weight of the body being transmitted to the outer hinge.

**11** Describe the distribution of weight from the hip to the foot of a human.

*Answer*: The weight of the body is transmitted from the hip down the femur to the outer condyle of the knee. From there the weight is transmitted through the tibia to the ankle, through the talus (ankle bone) and then to the other tarsal bones, then to the metatarsals and phalanges via the arches of the foot.

**12** Draw the transverse and longitudinal arches on the diagram of a foot below.

*Answer*: See diagram below.



Longitudinal arch

Transverse arch

**13** Describe the trend in prognathism during evolution.

*Answer*: Prognathism has decreased due to the reduction in teeth size, the development of a chin and a prominent nose. A flatter face also helps the skull balance more evenly on top of the vertebral column during upright stance.

**14** State the dental formula of hominids.

*Answer*: 2:1:2:3.

APPLY KNOWLEDGE

**15** Explain the significance of an increase in the size of the frontal lobe.

*Answer*: The frontal lobe is where the higher functions of thinking – reasoning, planning and processing – take place. The increase in the frontal lobe will allow for greater thought into manipulating the environment for personal gain, for learning which tool is more effective and to overall effect the way humans live.

**16** Which animal would have a more convoluted cerebrum – an orangutan or a chimpanzee?

*Answer*: The chimpanzee will have more convolutions on their cerebrum.

**17** Explain the difference between the size of the brain and the cranial capacity.

*Answer*: The cranial capacity is the volume of the cranium that houses the brain. The volume is measured by endocasts taken from fossil finds as the brains of early hominins do not fossilise. We know the brain will fill the size of the cranium, so measuring the cranial capacity allows the determination of the size of the brain of early hominins.

**18** Explain how the length of the thumb of humans reflects a greater degree of evolution.

*Answer*: Humans have a longer thumb than the other primates. This arrangement gives the thumb a greater degree of freedom; it is readily opposable and has allowed humans to develop the precision grip to a greater degree than other primates.

**19** The spine of humans is described as ‘S’ shaped. Explain why this is necessary for bipedalism.

*Answer*: The ‘S’ shaped spine is generated from the cervical curve in the neck that brings the skull directly on top of the vertebral column and the lumbar curve generated by the large wedge-shaped vertebrae. This improves body balance in the upright position and enables the head to balance on top of the neck. Fewer muscles are required to hold the bones of the skull in place, increasing the efficiency of bipedalism.

**20** Explain why doctors are reluctant to amputate the big toe.

*Answer*: The big toe has lost its opposability as it has become a weight-bearing appendage. When striding, the whole weight of the body is propelled by the big toe. Doctors would be reluctant to amputate the big toe because the person’s gait would be affected.

**21** Gorillas have a diastema, but humans do not. State what a diastema is, and explain why it is present in the jaw of gorillas but not humans.

*Answer*: The diastema is the gap between the upper second incisor and the upper canine to accommodate the large lower canine. In gorillas the canines are large and sharply pointed, projecting beyond the level of the other teeth. The diastema is required to allow for the mouth to close and the teeth to interlock. Humans have smaller, more evenly sized teeth, without the projecting canines. The smaller teeth take up less room in the jaw, allowing the jaw to change into a more parabolic shape.

**22** Explain why bipedalism would have allowed ‘survival of the fittest’ during natural selection.

*Answer*: Bipedalism is a more efficient way of walking larger distances. It frees up the hands for carrying infants, reaching for food or making and holding stone tools. Bipedalism also allowed for better thermoregulation, a necessity as the forest was receding into grasslands. The ability to be bipedal would have been an advantage in the changing climate and changing environment about 8 million years ago. As such the individuals with the characteristics would have survived, reproduced, and passed the characteristics on to their offspring.

Chapter 12 activities

ACTIVITY 12.1 Comparing primate skulls

**What to do**

**5** Look carefully at the two skulls, noting the scale listed for each, and take this into consideration when answering the following questions. For some questions it may help to go back and select other views of the skulls for comparison.

**a** Using the scale provided, estimate the length of each skull.

*Answer*:

• Baboon – approximately 15 to 16 cm

• Orangutan – approximately 24 cm

**b** Which skull has a more rounded profile?

*Answer*: Orangutan is more rounded in lateral view.

**c** Estimate the length of the cranium of each skull. Which species would have the larger and more complex brain? Give reasons for your answer.

*Answer*:

• Baboon cranium – approximately 6 cm

• Orangutan cranium – approximately 11 cm

The orangutan has the larger and more complex brain, because the cranium is larger.

**d** Identify and count the teeth that are visible. What is the dental formula for each species?

*Answer*: Baboon 2:1:2:3. Orangutan 2:1:2:3

**6** Repeat steps 3 to 5 so that you can compare:

**a** an orangutan with a gorilla

**b** a gorilla with a chimpanzee

**c** a chimpanzee with a human.

*Answer*:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Characteristic observed** | **Baboon** | **Orangutan** | **Gorilla** | **Chimpanzee** | **Human** |
| Length of Skull | 16cm | 24cm | 26cm | 23cm | 16cm |
| Rounded profile | The flattest from all skulls compared | Sagittal crest present | Sagittal crest present | Rounded but no forehead | The most rounded or dome shaped |
| Length of cranium | 6cm | 11cm | 10cm | 15cm | 16cm |
| Dentition and dental formula | 2:1:2:3Diastema presentLarge canines | 2:1:2:3Diastema presentLarge canines | 2:1:2:3Diastema presentLarge canines | 2:1:2:3Diastema presentLarge canines | 2:1:2:3No diastemaSmaller, more even shaped teeth |

**Studying your observations**

Review your answers to the questions and use the information collected to describe evolutionary trends in the size and shape of the skull and teeth from baboons to humans.

*Answer*: The trend seen from baboons to humans is an increase in cranial capacity, and the development of the forehead to house the frontal lobe. The cranium has become more rounded and dome shaped. There is a significant reduction in prognathism and the dentition has reduced in size, coupled with a loss of diastema as the canines are smaller and non-projecting.

ACTIVITY 12.2 Observing the mobility of the human thumb

**Studying your observations**

**1** In relation to the palm of your hand, how is the position of the thumb different from the fingers? Give two reasons to explain the advantage of the thumb in this position.

*Answer*: The thumb is not in line with hand and other fingers. This improves fine motor skills – picking up and manipulating objects as in the precision grip.

The power grip is also stronger because the thumb can wrap around objects in the opposite direction to the fingers.

**2** What term is used to describe the movement of the thumb when it touches each fingertip in turn?

*Answer*: Opposability

**3 a** Describe the position of your thumb and fingers when picking up a pen.

*Answer:* This is the precision grip. The index finger and thumb are both used to pick up the pen. The thumb and fingers are both able to touch and hold the pen but they are on opposite sides of the pen.

**b** Which muscles were used to hold the pen in this precision grip?

*Answer*: The muscles in the hand itself

**4 a** List the differences in the position of the thumb and fingers when using the precision grip and the power grip.

*Answer*:

• Precision grip: Finger and thumb tips are together.

• Power grip: Hand clenched and thumb wraps around in the opposite direction to the fingers.

**b** How did your thumb assist in holding an object in the power grip? Describe how it did this.

*Answer*: It closed the grip so that thumb and fingers were wrapped right around the object, giving strength and power to the grip.

**c** Which muscles were employed in the power grip? Were these different from the ones used in the precision grip?

*Answer*: The muscles of the forearm were used in the power grip, not the muscles of the hand as in the precision grip. These large muscles gave the grip great strength.

**5** Which of the two grips would be the most efficient at holding an object against force?

*Answer*: The power grip

**6** List the features of the thumb that make both the power and precision grips possible.

*Answer*: Opposability; saddle joint of thumb; position on hand; the muscles of the hand and forearm; flexibility of the joints.

ACTIVITY 12.3 Investigating upright stance and the striding gait

**Studying your observations**

**1** Compare the skull of an ape with that of a human. List the differences in the size and shape of the crania (brain cases).

*Answer:*

|  |  |  |
| --- | --- | --- |
| **Gorilla skull** | **Human skull** | **Chimpanzee skull** |
| Small cranium | Very large cranium compared with chimp and gorilla | Small cranium |
| Large sagittal crest in male | No sagittal crest | No sagittal crest in either male or female |
| Absence of forehead | Presence of forehead | Absence of forehead |
| *Students may also mention:**Large eyebrow ridges**Prognathic jaw* | *Students may also mention:**Reduced eyebrow ridges**Reduced jaw* | *Students may also mention:**Large eyebrow ridges**Prognathic jaw* |

**2** Locate the position of the foramen magnum. Look at the base of each skull and compare the position of the foramen magnum in the ape and in the human. Where is the foramen magnum in the human skull? Where is the foramen magnum in the ape skull?

*Answer*: The foramen magnum is directly under the cranium in humans. In the ape it is towards the rear of the skull.

**3** Which skull is most easily balanced on the vertebral column: ape or human?

*Answer*: The human skull would balance easily on the vertebral column because the foramen magnum is centrally located under the skull. It allows the skull to balance on the vertebral column with little support.

**4** Look carefully at the model of the skeleton, and then refer to Figure 12.10. Describe the curves of the vertebral column of the ape and the human. What extra curve exists in the vertebral columns of humans?

*Answer*:

|  |  |  |
| --- | --- | --- |
| **Gorilla spine** | **Human spine** | **Chimpanzee spine** |
| C-shaped | S-shapedExtra curve in lumbar region of the spine | C-shaped |

**5** Look at Figure 12.11 and compare the shape of the human pelvis with that of the gorilla. Which pelvis is wider? Which is longer? Suggest reasons for the relatively wide pelvis in humans.

*Answer*: The human pelvis is wider and shorter than that of a gorilla. This is an adaptation for upright stance and bipedalism. The broad bowl-shape contributes to a lower centre of gravity and supports the abdominal organs. It also contributes to the carrying angle of the femurs because the sockets for the heads of the femurs are wide apart.

**6** The human pelvis is tilted forward and curves inward, creating a basin shape. List the advantages this arrangement has for upright stance.

*Answer*: This arrangement lowers the centre of gravity; it supports the abdominal organs when upright, and supports the foetus during pregnancy; it also allows the femurs to join at an angle that is advantageous for bipedalism (the carrying angle).

**7** Look carefully at the model of the skeleton again, and then refer to Figure 12.12. The narrow pelvis of the ape makes the legs hang vertically. This means the ape must keep its feet apart when standing and, when walking, sway from side to side to maintain balance. Describe how the breadth of the pelvis contributes to the carrying angle of the femurs.

*Answer*: The breadth of the pelvis allows the femurs to join the pelvis at an angle to the vertical that is advantageous for bipedalism. The femurs come together towards the knee, then the lower part of the legs are more vertical so that the feet are together when standing erect.

This arrangement allows for the striding gait, with one foot being placed in front of the other so that there is no swaying from side to side of the body. The body weight is directly over the foot during each stride; whereas an ape, when walking bipedally, would have to sway from side to side to keep the body weight over the foot that was on the ground.

**8** Explain the effect of the carrying angle on the arrangement of the knees, lower limb bones and the position of the feet in humans. What advantage does this arrangement have for a human walking?

*Answer*: The carrying angle allows the femur to be angled, so that the lower limb bones and feet are under the centre of gravity. When the leg is swung forward in walking, the knees lock in the fully extended position. This aids in the striding gait. The knee is hinged and only moves forward and backward to allow walking. The foot is weight-bearing in humans and the enlarged heel bone is able to take the weight of the body when taking a step forward. The carrying angle allows body weight to be directly over each foot while walking; the upper body remains relatively stationary. In contrast, an ape must sway from side to side when walking bipedally. This requires a lot more energy than the striding gait of humans.

**9** The vertebral column of humans acts as a weight-supporting column. How does the shape of the lumbar vertebrae contribute to the lumbar curve? Look closely at the angle between the lumbar curve and the pelvis. What effect does the lumbar curve have on the position of the trunk and legs in humans?

*Answer*: The lumbar vertebrae are thicker, wedge-shaped and have flattened processes. They are the largest vertebrae. These features contribute to the five lumbar vertebrae articulating in a way that produces the lumbar curvature. This curvature places the trunk over the centre of gravity and the legs directly beneath it. As a person walks, the centre of gravity moves from one side of the pelvis to the other so that it is always centred above the leg currently on the ground. These features give balance and stabilise the bipedal stance and the striding gait.

**10** Refer to Figure 12.15 and compare the position of the centre of gravity in humans and apes. Which animal has the lower centre of gravity relative to body size? What features of the skeleton contribute to this difference?

*Answer*: Humans have a lower centre of gravity compared to body size. This is due to the broad bowl-shaped pelvis, the S-shaped spine, the lumbar vertebrae position, and the legs being relatively long and directly beneath the body.

**11** Describe the pathway the body weight in humans follows from the pelvis down to the feet.

*Answer*: Pelvis → knee → ankle → foot

**12** Remove your shoe and run your fingers over the top of your foot from little toe side to big toe side. Can you feel the transverse arch? How is this arch different from the longitudinal arch? What is the main function of the two arches?

*Answer*: The longitudinal arch has a weight-bearing function; whereas the transverse arch is to aid in the transmission of thrust when walking (from heel strike to thrust from the big toe).

**13** Look at the model of the skeleton again, and then refer to Figure 12.14. Compare the toes of a gorilla and a human. What differences can you see?

*Answer:* The big toe of the gorilla is more like the human thumb. It is not in line with the other toes of the foot and is opposable. As such, it can be used for grasping. The human big toe is in line with the other toes of the foot and lacks opposability. It has a major function in the striding gait. The length of the toe bones and distance between joints are also different.

**14** When humans stride, the big toe provides the thrust. What features of the big toe assist this? Would an ape be able to use the big toe in a similar way? Explain your answer.

*Answer*: The big toe has a relatively large surface area in contact with the ground, is in line with the other toes of the foot, and is jointed to allow the push-off motion when walking. Gorillas have an opposable big toe. Because it is not in line with the other toes, it would not be able push off at the start of a stride in bipedal walking.

**15** Describe how the arches of the foot enable weight to be distributed from the heel to the big toe. Remove your shoes and try this for yourself.

*Answer*: The transverse arch distributes the body weight across the foot maintaining balance. When striding the longitudinal arch allows the weight to be moved from the heel down the outer part of the foot, across the transverse arch and to the big toe.

**16** Take a number of steps in your bare feet. Describe what occurs from the time your left heel hits the ground until your right heel hits the ground. Referring to Figures 12.16 and 2.17 may help you with your description.

*Answer*: Left heel strike → weight rolls down outside of the longitudinal arch → across the ball of the foot → thrust from ball of foot rolling onto big toe → thrust from big toe

This rolling motion happens on both feet, but not at the same time. As the left foot thrusts off from the big toe, the right foot is airborne. The right foot heel strikes the ground and transfers the weight and balance forward.

**17** Summarise the main features in the human skeleton that are adaptations for an upright stance and for walking bipedally with a striding gait.

*Answer*:

|  |  |
| --- | --- |
| **Characteristic** | **Adaptations** |
| Foramen magnum | Located centrally in the base of the craniumAllows skull to sit on top of the spine so that little muscular effort is needed to hold it in place |
| Jawbone | Small and non-protruding, so that it enables the skull to balance on the vertebral column Allows skull to sit on top of the spine so humans can stand upright and walk bipedally |
| Vertebral column | Lumbar vertebrae wedge-shaped producing an S-shaped curve that brings the vertebral column directly under centre of skullAllows spine to be in a position that allows humans to stand upright and walk bipedally |
| Pelvis | Broad – shallow from top to bottom Provides support for abdominal organsAllows an upright stance rather than carrying organs under the thorax when on all fours Attachment of femurs wide apart contributing to carrying angleAllows striding gait and upright stance |
| Femurs | Large head to femur that contributes to the carrying angle Allows the movement of the legs to walk bipedallyAngle in towards the knee |
| Knee joint | Outer ‘hinge’ larger and stronger to take weight of body, thus the ability to stand upright and walk bipedallyKnee able to be straightened as part of the striding gait |
| Legs | Longer than arms, contributing to a low centre of gravity so that humans do not fall over when uprightCarrying angle allows the weight of the body to be kept close to the central axis allowing a striding gait |
| Foot | Large heel bone and aligned big toe form a pedestal on which the body is supported; allows for a heel strike used in bipedal walkingThe large non-opposable big toe allows for a strong push offFoot has both longitudinal and transverse arches, again allowing for the striding gait |

Chapter 12 Review questions

Recall

**1** To which of the primate families do humans belong? Who shares this family with us?

*Answer*: Humans belong to the family Hominidae, and we share this family with the great apes, and the ancestors of apes and humans.

**2** Describe the evolutionary trend evident in primates concerning the mobility of the thumb and the other digits.

*Answer*: The evolutionary trend has been an increase in the mobility and opposability of the thumb. The other digits have become longer and more mobile.

**3 a** List the components of the skeleton that allow humans to adopt an erect posture.

*Answer*: Foramen magnum; skull and jawbone; vertebral column; pelvis; femurs; knee joint; legs; foot

**b** How do these components differ from the corresponding ones in a quadrupedal animal?

*Answer*:

• Foramen magnum – centrally located

• Skull and jawbone – reduced prognathism

• Vertebral column – S-shaped

• Pelvis – broad, shallow, bowl-shaped

• Femur – strengthened, at an angle to the vertical, ball and socket hip joint

• Knee joint – hinge joint can be fully straightened

• Legs – longer than arms

• Foot – transverse and longitudinal arches, inline (non-opposable) large toe

**c** What are the advantages and the disadvantages of an erect stance and bipedal locomotion?

*Answer*:

|  |  |
| --- | --- |
| **Advantages** | **Disadvantages** |
| For food hunting (can see further)For food gathering (pick fruit high in trees) Avoid predators; able to see further and run fasterBetter to walk longer distances (no longer arboreal) Mechanical advantages for travelling longer distances – reduces energy expenditureImproved cooling of the body, due to greater surface area and greater exposure to windHands free for carrying and/or tool use | Can no longer easily escape from predators into the treesSlow moving compared to some quadrupedal species Difficult to cover large distances quickly; therefore small, productive home range neededDifficult to maintain body temperature in cold climates |

**4** Describe carrying angle, and compare the carrying angle of an ape with that of a human.

*Answer*: The carrying angle is the angle of the femur bones to the vertical. The femurs angle in towards the knees so that, when walking, the weight of the body is over the feet at all times.

Humans have a wider carrying angle than apes; that is, the angle of the femur to the vertical in humans is greater. This allows for bipedalism in humans.

**5** How does the wide pelvis and carrying angle of the femur enable humans to walk without the body swaying from side to side?

*Answer*: The wide pelvis and carrying angle allow the body to rotate about the lower leg and foot, and centre the weight distribution over the foot so that the body does not sway from side to side when walking. Apes must sway from side to side so that the body weight is above the foot that is on the ground.

**6** What is an endocast? What can it tell us about the size and shape of the brain?

*Answer*: Endocasts are impressions of the inside of a skull made of rock or some other solid material. They occur naturally or can be made by scientists when a skull is found. They give a model of the brain, showing its size and the shape of the brain surface, including any convolutions if originally present.

**7** Describe the major anatomical and functional developments that have occurred in hominid brains over the past four million years or so.

*Answer*: Hominid brains have increased in cranial capacity; show an increase in the number and complexity of convolutions; show an increase in frontal lobe size with development of a forehead; have increased in cognitive and reasoning ability.

**8** Describe the change in the shape of the face of hominids over the past four million years or so.

*Answer*: Hominids have a flatter face that is less prognathic (a reduced jaw); a chin has developed along with a more prominent nose and a distinct forehead.

Explain

**9** Explain how muscle tone helps to support the body against the force of gravity.

*Answer*: It helps to keep the head erect and the body in the upright stance position, supporting the spine, abdomen, knees and ankles.

**10** When we walk, our arms move in a coordinated way. Explain how arm movement helps stabilise the body of a human while walking.

*Answer*: The arms move opposite to the leading leg, for example if the right leg is extended the left arm will be swung forward and vice versa. This allows the reduction in angular momentum of the body and balances the rotational motion produced during walking. The swinging of arms improves stability and efficiency in walking.

**11** Human dentition is said to be unique.

**a** List the differences between the teeth of a human and those of an ape, such as a gorilla.

*Answer*: Human canines look more like incisors – they are not longer than the other teeth. Ape canines are approximately twice as long as the incisors. Human molars are comparatively smaller than apes. Humans have a parabolic dental arcade, whereas in apes it is U-shaped.

**b** How has the dental arcade changed in hominins compared with that of an ape?

*Answer*: Hominins have a parabolic dental arcade, rather than a U-shaped arcade like an ape. In hominins there is no diastema to accommodate the long canines that protrude beyond the other teeth.

Apply

**12** Chimpanzees have been observed using a range of simple tools, mainly associated with feeding. Describe the structural characteristics of chimpanzees that enable them to make and use tools.

*Answer*: Chimpanzees possess prehensile digits; opposable first digits; have dexterity of the hands and feet; unspecialised limbs; stereoscopic vision; a large brain, especially the cerebral cortex; nails not claws; and a skeletal structure that allows them to sit with hands free.

**13** For humans to be able to stand upright, a number of adaptations have taken place. Changes have occurred to the skull, vertebral column, pelvis, legs and feet. Describe how each of these has contributed – and how they have interacted – to enable humans to adopt an erect stance.

*Answer*:

• Skull: Foramen magnum is centrally located to allow the skull to sit on top of the vertebral column. A flattened face ensures that there is about the same weight in front of, and behind, the foramen magnum so that the skull can balance on the spinal column.

• Vertebral column: S-shaped curve to allow the skull to sit on top of spine and allow upright stance with the torso held erect, instead of the continuous curve possessed by apes.

• Pelvis: A broad bowl-shape; supports the abdominal organs; a lower centre of gravity for upright stance; attached to a S-shaped spine; wide to contribute to the carrying angle.

• Legs: Carrying angle of femur requires broad pelvis with ball and socket hip joints; the knees are structured with a hinge joint so that the legs can carry the mass of the body upright and bend for walking; the knee can straighten as required in the walking process; the femur is also very strong. Legs are longer than arms.

• Feet: Connected to the legs with joints to allow the pivotal motion for walking, arched feet to stand upright and carry body mass; feet allow upright stance to be balanced; inline large toe and large, strong heel bone provides a pedestal when standing erect and takes the weight of the body at the start of each stride.

All the adaptations described above interact and contribute to the ability to stand erect.

**14** If you have seen chimpanzees or gorillas walking bipedally, you will have noticed that they sway from side to side as they walk. Explain why they cannot stride as humans do.

*Answer*: These primates do not have the adaptations for bipedalism that humans do. They are essentially quadrupedal animals walking upright for only short periods of time. The narrow pelvis and lower limb bones do not allow the striding gait to be used. This is mainly because there is no carrying angle and the ape must sway from side to side to keep the centre of gravity over the foot that is on the ground.

**15** What assumptions are made when scientists infer the degree of intelligence from the cranial capacity of a skull?

*Answer*: The cranial capacity of the skull gives an indication of brain size. It is assumed that the whole of the cranium is occupied by the brain and is not occupied by extra fluid or other matter. It is also assumed that increased brain size is proportional to increased intelligence.

**16** The human canine tooth is much smaller than that of the other hominids, especially in the males of the species. Describe the evolutionary processes that would have taken place in hominins to produce the current size of that tooth in humans today.

*Answer*: Natural selection would have caused the evolutionary trend toward smaller canine teeth. In early hominins there would have been natural variation in the size of the canine teeth. As the diet moved towards softer foods, the hominins with the smaller canines would have been more successful and have had an increased chance of survival. When these hominins reproduced they would have passed on the favourable allele for smaller canine teeth. This would have occurred over many generations – a period of time during which the diet became softer and contained an increasing amount of cooked meat. The ensuing trend was toward smaller canine teeth, resulting in the current canine size in modern humans.

**17** Briefly describe how the environment could have contributed to the first hominins evolving the free striding gait. How would this gait have increased the chance of survival in that environment?

*Answer*: Around 8 million years ago a significant change in climate resulted in the reduction of heavily forested areas and the emergence of sparse woodlands and long grasses. The free striding gait allowed the first hominins to walk along the ground with efficiency. The additional height allowed the hominins to see over the tall grasses to look for predators or other members of the tribe. Free hands allowed for carrying of infants and to reach into branches for different food. The striding gait also assists thermoregulation, as less skin is exposed to the sun, and standing upright allowed for better cooling of the body.

Extend

**18** As a result of various conditions, the normal curves of the vertebral column may become exaggerated. Use references to describe the conditions known as scoliosis, kyphosis and lordosis.

*Answer*:

**Scoliosis:**

• An abnormal sideways curve of the spine that makes the spine look tilted when viewed from the rear

• View from side usually shows a hump.

• May result from skeletal malformations present at birth, muscular problems, or in a great many cases the cause is unknown

• Pain, and in severe cases, breathing problems may result.

• It is likely that genetic factors are involved in many cases.

• Treatment can include physiotherapy, surgery, or if bone growth is not complete, bracing of the spine.

**Kyphosis:**

• Abnormal curvature of the spine in the thoracic region

• When the spine is viewed from side there is a front bending curve, in the cervical or thoracic area; appearance is hunchbacked.

• Most cases are mild, but very severe forms may be treated by spinal fusion therapy.

**Lordosis:**

• Abnormal inward curve in the small of the back

• When the spine is viewed from side there is a pronounced inward curve (sway back, hollow back or saddle back) in the lumbar region.

• Caused by uneven thicknesses in the intervertebral discs

• Usually treated by exercise to strengthen hip muscles

**19** The term ‘hominid’ used to have the same meaning that ‘hominin’ now has. ‘Hominid’ was used to refer to the various members of the human family tree. Scientists who study human origins have changed the classification scheme by introducing a new level, the tribe. ‘Hominid’ is now defined in a much broader way so that it refers to all great apes and their ancestors. ‘Hominin’ refers only to present-day humans and our extinct ancestors. Why would scientists make changes to the classification scheme for apes and humans? Suggest as many reasons as you can.

*Answer*: Modern biotechnological techniques, including molecular studies of DNA and proteins showed that humans, chimpanzees and gorillas are closer to each other than to orangutans. To fit this new evidence, two sub-families were created: the Ponginae, which includes the orangs; and the Homininae, which includes humans (and their ancestors), chimpanzees and gorillas. However, it was desirable to discuss humans and their ancestors as a separate group, so the tribes Gorillini (gorillas), Panini (chimpanzees) and Hominini (humans and their ancestors) were created.