2025/8322
Web version of 2024/81800

Government of **Western Australia**
School Curriculum and Standards Authority

HUMAN BIOLOGY

ATAR course examination 2024

Marking key

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

Section One: Multiple-choice **30% (30 Marks)**

Question	Answer
1	d
2	c
3	a
4	b
5	d
6	c
7	c
8	c
9	b
10	d
11	a
12	c
13	d
14	d
15	a
16	b
17	d
18	c
19	c
20	a
21	b
22	a
23	d
24	a
25	b
26	a
27	b
28	b
29	a
30	c

Section Two: Short answer **50% (106 Marks)**

Question 31 **(18 marks)**

(a) Identify the structures labelled A, B and C and justify your choice. (6 marks)

Description			Marks
	Structure name	**Justification**	
A	connector neuron/ interneuron/ intermediate neuron	found within spinal cord/found in between two other neurons	1–2
B	sensory/afferent neuron	contains a ganglion/is found in the dorsal root/is connected to a receptor/cell body in a ganglion/cell body in the middle of the neuron	1–2
C	motor/efferent neuron	is located in the ventral root/is connected to an effector/muscle/cell body at the end of the neuron	1–2
		Total	**6**

(b) (i) On the diagram on page 14, sketch and shade the location of the grey matter. (1 mark)

Description	Marks
For copyright reasons this illustration cannot be reproduced in the online version of this document	1
Total	**1**

Note:
- shading must in the centre and not touching the edges
- must be butterfly/H shape.

(ii) Outline **one** similarity and **one** difference between the grey matter found in the brain and the spinal cord. (2 marks)

Description	Marks
Similarity: both contain unmyelinated neurons/cell bodies	1
Difference: in the brain grey matter is external whereas in the spinal cord the grey matter is internal	1
Total	**2**

Question 31 (continued)

(c) Describe an advantage provided by a reflex arc in detecting and responding to a change in the environment. (2 marks)

Description	Marks
it allows the body to respond quickly without waiting for the brain to interpret the information	1
this minimises damage/harm to the body	1
Total	**2**

(d) Explain how the role of the reflex arc would be impacted by damage occurring to Structure C. (3 marks)

Description	Marks
message from the receptor/sensory neuron would still be sent into the spinal cord	1
message to the effector would not be able to be transmitted	1
response would not occur/would not occur rapidly	1
Total	**3**

(e) Contrast how each of the two actions of the anaesthetic described above would stop a person from feeling pain during surgery. (4 marks)

Description	Marks
Stopping the release of neurotransmitters	
pre-synaptic neuron fails to respond to action potential/no calcium ions released/no message conveyed across the synapse	1
the action potential would not be initiated in the post-synaptic neuron/next neuron	1
Blocking receptors any one of (1 x 2 marks)	
• the neurotransmitter would still be released from the sensory neuron but it could not bind to the post-synaptic neuron • pain receptor not responsive to trigger the action potential/does not allow sodium channels to open on the sensory neuron no message conducted to next neuron/the rest of the neural pathway inhibited	1–2
Total	**4**

Question 32 **(14 marks)**

(a) (i) State the type of dating that carbon-14 dating is classed as. (1 mark)

Description	Marks
absolute	1
Total	**1**

(ii) Identify **two** features of the remains of King Richard III that would make them suitable for carbon-14 dating. (2 marks)

Description	Marks
his remains are organic/contain carbon	1
remains are younger than 70 000 years old	1
Total	**2**
Accept other relevant answers.	

(iii) Explain why variations in atmospheric carbon can impact carbon-14 dating. (3 marks)

Description	Marks
comparing ratio of C12 to C14 establishes the date of fossil	1
if amounts of carbon isotope vary at different times	1
then the ratio will be affected	1
Total	**3**

(b) Explain how DNA is used to establish genetic relationships. (3 marks)

Description	Marks
DNA samples of individuals are sequenced	1
comparison of sequences	1
the more similar the DNA is the more closely related the individuals are	1
Total	**3**

(c) (i) Identify **two** characteristics of a typical human spine that allow for an upright stance and bipedal locomotion. (2 marks)

Description	Marks
Any two of	
• s-shaped spine/double curve spine • wedge shaped lumbar vertebrae • flexible structure/movement between vertebrae • large thickness to vertebrae • intervertebral discs between vertebrae	1–2
Total	**2**

Question 32 (continued)

(ii) Given that King Richard III's spine did not possess all the typical human features, deduce the negative impact this could have had on his ability to move using bipedal locomotion. (3 marks)

Description	Marks
his head may not have correctly balanced on the top of the spine	1
had difficulty maintaining balance/centre of gravity affected	1
Any one of	
• stability issues when standing on two legs/walking • create difficultly weight bearing when on one leg • lack of shock absorption when walking	1
Total	**3**

Question 33 **(19 marks)**

(a) Define the term 'point mutation'. (1 mark)

Description	Marks
change in one base/nucleotide in the DNA sequence	1
Total	**1**

(b) (i) Select which **one** of the above mutations, labelled O, P, Q and R, is the same as the sickle-cell mutation. Justify your answer. (2 marks)

Description	Marks
O	1
is a substitution of a single base	1
Total	**2**

(ii) Select which **one** of the mutations on page 20 labelled O, P, Q and R, could be classified as an inversion mutation. Justify your answer. (2 marks)

Description	Marks
P	1
broken piece of DNA joins back in a different orientation	1
Total	**2**

(iii) Explain how a mutation may occur during DNA replication. (3 marks)

Description	Marks
during DNA replication the DNA is copied	1
complementary pairs of nucleotides are matched together	1
a mismatching occurs during the process/nucleotides incorrectly added or removed	1
Total	**3**

(iv) List **two** other processes that can lead to mutations occurring. (2 marks)

Description	Marks
exposure to mutagens/mutagenic agents	1
during cell division/translocation/nondisjunction	1
Total	**2**

Question 33 (continued)

(c) Complete the table below, contrasting the **two** conditions. (4 marks)

Description			Marks
	Sickle-cell anaemia	**Sickle-cell trait**	
Genetic makeup of individual	two copies of the sickle-cell allele/homozygous (recessive) for sickle-cell	one copy of sickle-cell allele/heterozygote	1–2
Effect on haemoglobin of individual	rigid/inflexible/ sickle-cell shaped/ poor oxygen carrying ability	normal shape/concave shape/normal functioning/some sickling/ sickling present at low concentrations	1–2
		Total	**4**

(d) Explain why the sickle-cell mutation persists in some populations. (5 marks)

Description	Marks
in populations where malaria is present it provides a survival advantage	1
those with sickle-cell trait/heterozygotes have resistance to malaria	1
they also are not severely unwell (with sickle-cell anaemia)	1
they are more likely to survive	1
passing mutated sickle-cell alleles onto offspring	1
Total	**5**

Question 34 **(18 marks)**

(a) State a hypothesis for the investigation. (1 mark)

Description	Marks
Statement that contrasts the independent and dependent variable and has a directional relationship	1
Total	**1**
Answers could include: A decrease in ADH levels in the blood increases urine output (or vice versa).	
Accept other relevant answers.	

(b) (i) Calculate the difference between the mean urine volumes for the different time periods. (1 mark)

Description	Marks
36.8 mL h^{-1}	1
Total	**1**

(ii) Outline the purpose of having a large sample size and calculating a mean ADH level or mean urine volume for this investigation. (2 marks)

Description	Marks
reduces the effect of biological variation/random errors/outlier results	1
improves reliability of results	1
Total	**2**

(c) Explain the relationship between the levels of ADH at 2 am and the amount of urine produced between the hours of 8 pm and 8 am. (4 marks)

Description	Marks
higher volumes of ADH in blood	1
ADH increases permeability of kidney tubules/collecting ducts and distal convoluted tubules to water	1
increased amount of water is reabsorbed into the blood/plasma	1
lower volumes of urine produced	1
Total	**4**

(d) Explain why this could indicate damage to the hypothalamus.

(5 marks)

Description	Marks
hypothalamus contains osmoreceptors	1
they will not detect changes in water levels/osmotic pressure	1
hypothalamus won't make ADH	1
it would then not be able to stimulate the posterior lobe of the pituitary	1
to secrete ADH	1
Total	**5**

Question 34 (continued)

(e) (i) Name the endocrine gland that secretes aldosterone. (1 mark)

Description	Marks
adrenal cortex/adrenal gland	1
Total	**1**

(ii) Explain the mechanism by which aldosterone helps to regulate water balance. (4 marks)

Description	Marks
tubules increase amount of sodium reabsorbed	1
increase amount of potassium excreted in urine	1
water is reabsorbed along with sodium ions	1
increases water volume in the blood/plasma	1
Total	**4**

Question 35 **(16 marks)**

(a) Given the evidence outlined above, identify the most likely mode of transmission for the typhoid fever pathogen. (1 mark)

Description	Marks
ingestion of contaminated food/drink	1
Total	**1**

(b) Identify the location of the most important external body defence mechanism in preventing the spread of *Salmonella typhi* and outline **two** ways in which it prevents pathogens entering the internal environment. (3 marks)

Description	Marks
stomach/digestive tract/mouth	1
Any two of	
• vomiting to expel bacteria • high acidic environment in stomach to kill bacteria • mucous lining of mouth/digestive tract to trap bacteria • lysozyme enzymes in saliva to destroy bacteria • beneficial gut bacteria to compete with bacteria • constant flushing of materials/peristalsis to prevent stagnation • antimicrobial peptides/immunoglobulins are found in tract to eliminate bacteria	1–2
Total	**3**

(c) (i) List **two** ways in which a fever can help the body fight an invading pathogen. (2 marks)

Description	Marks
Any two of	
• inhibit pathogen growth/replication/reproduction • stimulates tissue repair/increase rate of chemical reactions • enhances white blood cell function • enhances presentation of antigens to macrophages • increases the production of antibodies	1–2
Total	**2**

(ii) Explain the physiological mechanisms that produce a fever. (4 marks)

Description	Marks
pyrogens/interleukin-1 produced	1
hypothalamus increases the body's set point temperature	1
body generates heat through shivering	1
decreases heat loss from skin/vasoconstriction of blood vessels to the skin	1
Total	**4**

Question 35 (continued)

(d) (i) Describe the key difference between when a person should be treated with antibiotics and when they should be treated with a vaccine. (2 marks)

Description	Marks
antibiotics are taken after a person is already infected	1
vaccines are administered before infection	1
Total	**2**

(ii) Present **two** separate arguments for whether antibiotics and/or a vaccine is the best method of treating a population exposed to, or at risk of, exposure to a disease such as typhoid fever. (4 marks)

Description	Marks
Any two of (2 x 2 marks)	
• vaccines create memory cells while antibiotics don't therefore, vaccines provide long-term immunity/protection • vaccines establish herd immunity while antibiotics don't therefore, vaccines help protect the population/protect those who cannot be vaccinated • vaccines reduce severe forms of illness while antibiotics can't therefore, vaccines can reduce complications/likelihood of deaths • vaccines require fewer repeat treatments than antibiotics therefore, vaccines are more cost effective • antibiotics can treat infected people where a vaccine can't therefore, an antibiotic is the only thing that can help the people who are ill • antibiotics can quickly treat illness where it takes months/years for a vaccine to protect a population therefore, an antibiotic can reduce disease spread more quickly • antibiotics can be broad spectrum, while a vaccine must be specific therefore, many different antibiotics might work/one specific vaccine must be developed for the disease	1–4
Total	**4**

Question 36 **(21 marks)**

(a) Considering only the lower jaw, identify the letters of the skulls in evolutionary order. (1 mark)

Description	Marks
C, A, D, B	1
Total	**1**

(b) State **three** separate features apparent in the diagrams that led you to choose the order identified in part (a). (3 marks)

Description	Marks
Any three of	
• jaw size • amount of prognathism • presence of chin • size of teeth	1–3
Total	**3**

(c) (i) State the numbers of the **three** sets of tools associated with early *Homo Sapiens* or Cro-Magnon man. (1 mark)

Description	Marks
2, 4, 5	1
Total	**1**

(ii) Outline **two** features evident in the tools of Set 6 above that indicate they are examples of Acheulean tool culture. (2 marks)

Description	Marks
Any two of	
• shows bifacial flaking/flaked on both sides • symmetrical cutting tools • tools are handaxes/teardrop shape • larger/more robust tools	1–2
Total	**2**

(iii) Explain how this conclusion could be made from these tools. (3 marks)

Description	Marks
Set 3 more primitive while Set 2 is advanced	1
Set 3 tools are generic while Set 2 show variety/many different types of tools	1
variety of tools suggests different roles/uses	1
Total	**3**

Question 36 (continued)

(d) (i) Identify the organisms most closely related to *P. boisei.* (1 mark)

Description	Marks
P. robustus	1
Total	**1**

(ii) Describe **one** feature of the skull of *A. africanus* that can be used to justify the positioning of *A. africanus* in the phylogenetic tree in relation to the other Homo specimens. (2 marks)

Description	Marks
more similar to *H. habilis* (early Homo) than other (non Homo) specimens	1
Any one of	
• more rounded • parabolic lower jaw • teeth more even in size • smaller canines • position of foramen magnum	1
Total	**2**

(iii) State where *H. neanderthalensis* would most likely be placed on the tree diagram. Justify your answer. (2 marks)

Description	Marks
must state a position that would fall after *H. erectus* but before *H. sapiens*	1
considered more modern than *H. erectus* but less modern than *H. sapiens*	1
Total	**2**
Accept other relevant answers.	
Note: must reference comparison between both species.	

(e) Using the concept of natural selection, explain how bipedalism evolved in early hominins. (6 marks)

Description	Marks
variation exists within the population with some quadrupedal/semi-erect and some bipedal organisms	1
overpopulation more individuals living in the population than the resources can sustain	1
can see further/can use arms to carry things/see predators/see danger	1
bipedal individuals have a survival advantage/bipedal individuals better suited to the environment and live to sexual maturity	1
bipedal individuals have better reproductive success than quadrupedal individuals/more bipedal offspring produced	1
over many generations increased frequency of alleles producing bipedal organisms	1
Total	**6**

Section Three: Extended answer **20% (40 Marks)**

Unit 3

Question 37 **(20 marks)**

(a) Explain how the nervous system and endocrine system work together to prevent body temperature from falling below optimum levels in the short-term. (10 marks)

Description	Marks
thermoreceptors in hypothalamus detect a decrease in blood temperature	1
peripheral thermoreceptors/cold receptors in skin send nerve impulses to hypothalamus	1
hypothalamus sends nerve impulses/messages via the autonomic division of the nervous system	1
to the skin which stimulate arterioles to constrict/vasoconstriction	1
to skeletal muscles that contract and relax rapidly/shiver	1
to sweat glands to reduce production of sweat	1
hypothalamus also stimulates adrenal medulla	1
via sympathetic nerves	1
adrenal medulla secretes adrenalin and noradrenaline into blood	1
(these hormones) increase cell respiration/metabolism/heat production	1
Total	**10**

(b) Describe how normal breathing rate is maintained and describe how a change in blood gas concentrations in a person with sleep apnoea would cause them to wake. (10 marks)

Description	Marks
Normal breathing	
breathing rate controlled by respiratory centre	1
in the medulla oblongata	1
messages are sent (from the respiratory centre) via nerves (phrenic and intercostal)	1
to stimulate contraction of the diaphragm and intercostal muscles	1
Subtotal	**4**
Sleep apnoea	
carbon dioxide (and hydrogen ions) would start to rise in blood	1
decrease in pH/increase in H^+ detected by chemoreceptors	1
in the aortic and carotid bodies	1
stimulate (respiratory centre in the) medulla oblongata	1
resulting in a sudden large breath	1
detected by the cerebral cortex causing them to wake up	1
Subtotal	**6**
Total	**10**

Question 38 **(20 marks)**

(a) While the nervous and endocrine systems work together to co-ordinate the functions of the body systems, they differ in several ways. Contrast **three** ways in which these systems operate. (6 marks)

Description		Marks
Any three of (3 x 2 marks)		
Nervous	**Endocrine**	1–6
rapid/within milliseconds	slower/from seconds to days	
brief/stops quickly when the stimulus stops	longer lasting/response may continue long after the stimulus has stopped	
electrochemical/electrical impulses and neurotransmitters	chemical/hormones	
along neurons	via the blood stream	
usually local and specific to one effector	may be very general and widespread	
	Total	**6**

(b) Outline the neural pathway of the autonomic nervous system activated in the athlete and explain the reasons for these symptoms. (14 marks)

Description	Marks
Pathway	
sympathetic pathway	1
Any three of	
• neurons originate in the middle region of the spinal cord (thoracic and lumbar) • neurons leave spinal cord via ventral root • synapse close to spinal cord with next neuron (postganglionic fibre) • release noradrenaline to effect target organ • two motor neurons and one synapse	1–3
Subtotal	**4**
Reasons	
to prepare the body for physical work	1
activation of fight or flight responses/protect the body from harm/ lifesaving mechanisms	1
sweating was because of the activation of sweat glands	1
to keep the body cool during physical activity	1
stomach feeling was due to decreased movement of digestive organs/ intestinal arterioles constricted	1
to divert blood/energy to other parts of the body that need it more	1
light changes due to the dilation of the pupil	1
to allow for more precise vision/ability to interpret visual stimuli	1
heart racing due to increased rate/strength of heart contractions	1
to ensure enough blood/energy is being pumped to vital organs/muscles	1
Subtotal	**10**
Total	**14**

Unit 4

Question 39 **(20 marks)**

(a) Identify **six** anatomical features of the skeleton that could have been present in the shoulders, arms, and hands to support brachiation as a means of locomotion, and explain how the shoulders, arms and hands allow for brachiation. (10 marks)

Description	Marks
Brachiation any six features (must have at least one from each of shoulders, arms and hands)	
Shoulders • short/reduced clavicle • high shoulder blades • mobile shoulder joint/backwards facing socket of scapula Arms • longer arms/smaller arm to leg ratio/long, robust humerus/long, slender radius and ulna • flexible elbow joint Hands • long, curved fingers • short thumbs • robust but flexible wrist joint	1–6
Subtotal	**6**
Explanation	
adapted for swinging in trees/circular arm movements/flexibility of arms to rotate	1
hands adapted to grasp branches/hang from branches	1
provide strength to support the weight of the hominin in trees	1
creates energy efficient pattern of movement	1
Subtotal	**4**
Total	**10**

Question 39 (continued)

(b) Identify **two** anatomical features of the skeleton that could have been present in the pelvis to support bipedalism as a means of locomotion, and outline how these features would allow for bipedalism. (4 marks)

Description	Marks
Pelvis any two of	
• wide pelvis/short and broad pelvis • bowl-shaped pelvis • forward facing acetabulum • robust sacroiliac joint/sacrum to ilium joint • reduced iliac crest	1–2
Subtotal	**2**
Outline any two of	
• ensures weight-bearing/support of body organs • help propel the body forward during locomotion • creates energy efficient pattern of movement • large area for muscle attachment • creates balance/stability • creating the striding gait motion	1–2
Subtotal	**2**
Total	**4**

(c) Name and describe **two** ways in which stratigraphy is employed to date a fossil. (6 marks)

Description	Marks
principle of superposition	1
youngest rock are at the top, while oldest are underneath	1
fossils higher in the layers are younger	1
Subtotal	**3**
correlation of rock strata	1
rock strata from one location are matched with another location	1
fossils in matching rock strata are the same age/matching index fossils to determine age	1
Subtotal	**3**
Total	**6**

Question 40 **(20 marks)**

(a) Contrast PCR and gel electrophoresis in terms of the purpose, processes and end products formed. (10 marks)

Description		Marks
Purpose		
PCR is used to amplify/create more copies of a DNA sequence		1
gel electrophoresis is used to separate DNA strands based on size		1
	Subtotal	**2**
Process (2 x 3 marks)		
PCR	**Gel electrophoresis**	
uses thermal cycle/repeated cycles/thermocycler	uses electric current (in agarose gel)	1–2
starts with a small amount of DNA	starts with a large amount of DNA	1–2
enzymes used to copy DNA	enzymes used to break DNA into fragments	1–2
	Subtotal	**6**
End products		
PCR creates large amounts of copied DNA		1
gel electrophoresis provides DNA bands/visual representation of DNA fragments		1
	Subtotal	**2**
	Total	**10**

(b) Define the term 'DNA sequencing' and identify **five** ways in which DNA sequencing can be used to provide evidence for evolution. (6 marks)

Description	Marks
DNA sequencing determines the order of nucleic acids in the DNA	1
How DNA sequencing is used any five of	
• identifies the degree of genetic variations in a population • identifies the degree of genetic similarity between species • quantifies the degree of genetic diversity between species • establishes molecular clocks/determine the time since organisms shared a common ancestor • helps construct phylogenetic trees • identifies how genes derived from common ancestors have changed over time • uses comparative genomics to help understand the process of evolutionary changes over time	1–5
Total	**6**

(c) Explain how the process of bioinformatics can be applied to help determine the relatedness of species. (4 marks)

Description	Marks
allows for large scale computerised/mathematical analysis of biological/genetic data	1
allows the determination of the degree of similarity	1
the higher the degree of similarity the more recent the separation from a common ancestor	1
helps determine where species are placed in phylogenetic trees/evolutionary models of relationships between species	1
Total	**4**

ACKNOWLEDGEMENTS

Question 31(b) Adapted from: PurposeGames. (n.d.). *Reflex ArcMJ* [Illustration]. Retrieved April, 2024, from https://www.purposegames.com/game/4eb928bc4c

Published by the School Curriculum and Standards Authority of Western Australia
303 Sevenoaks Street
CANNINGTON WA 6107