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

HUMAN BIOLOGY

ATAR course examination 2021

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

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

Question 31 **(12 marks)**

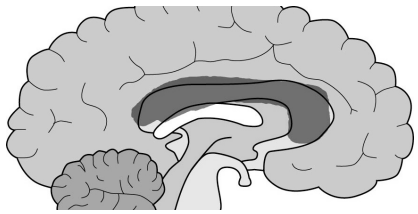
(a) (i) Identify structure 'Z'. (1 mark)

Description	Marks
Hypothalamus	1
Total	**1**

(ii) State **one** function of structure 'Y'. (1 mark)

Description	Marks
Control breathing rate/heart rate/blood pressure/diameter of blood vessels/expulsion reflex	1
Total	**1**

(iii) Indicate on the diagram, with a line and label, where the corpus callosum would be located. (1 mark)

Description	Marks
Indicates with a line and label in any of the region highlighted below 	1
Total	**1**

(b) (i) Which region, A or B, shows structures that would be found in the outer layer of structure 'X'? (1 mark)

Description	Marks
B	1
Total	**1**

(ii) Justify your decision in part (b)(i). (2 marks)

Description	Marks
Grey matter is made up of unmyelinated nerve fibres/cell bodies	1
The outer region of the cerebrum contains only grey matter	1
Total	**2**

(c) (i) What other sensation would be experienced by the man? (1 mark)

Description	Marks
Pressure/touch	1
Total	**1**

Question 31 (continued)

(ii) Describe how this sensation would be detected and registered by the man. (2 marks)

Description	Marks
Pressure/mechanoreceptors/touch receptors detect stimuli	1
Send (impulse) along sensory neurons to CNS/brain	1
Total	**2**

(d) Suggest what this information could tell the doctors about the damage to the man's spinal cord. Explain your answer. (3 marks)

Description	Marks
Damage must be between arms and legs/below arms/below waist/lower region of spinal cord	1
Information from nerves in arms still reaches the brain/ascending tracts from the arms are still functioning	1
Information from the legs doesn't reach the brain/ascending tracts from the legs are damaged	1
Total	**3**

Question 32 **(17 marks)**

(a) DEC2 is a gene mutation. How do gene and chromosomal mutations differ? (2 marks)

Description	Marks
Gene mutations only affect one gene (loci)/small section of DNA	1
Chromosomal mutations affect more than one gene/part of a chromosome/whole chromosome	1
Total	**2**

(b) In the study, the mutation was found in several family members. What does this tell you about where the original mutation occurred? Justify your response. (2 marks)

Description	Marks
It occurred in the cells that produce the gamete (germline)/germline cell	1
Only mutations produced in these cells can be inherited/passed on	1
Total	**2**

(c) Mutations can be caused in several ways. For each of the three ways stated below, describe how they may produce new mutations. (6 marks)

Description	Marks
Mutagens	
Substances that are known to increase the (rate of) changes to DNA	1
Includes ionising radiation/mustard gas/some antibiotics/formaldehyde	1
DNA replication	
Errors during the process that alter DNA code	1
Can be deleting/duplicating/insertions/frameshifts of DNA	1
Cell division	
Errors during the process that alter the genes or chromosomes in daughter cells formed	1
Can be non-disjunction/translocation/inversions of DNA	1
Total	**6**

Question 32 (continued)

(d) If researchers wanted to further investigate the link between the DEC2 gene and sleep, they would need to set up an experimental study.

(i) Propose a possible hypothesis for the study. (1 mark)

Description	Marks
A statement that contrasts the presence/absence of the DEC2 gene and amount of sleep required e.g. individuals with the DEC2 gene will sleep less hours a night	1
Total	**1**

(ii) In the study, what would the control group consist of, and what purpose would it have? (2 marks)

Description	Marks
Individuals without the DEC2 gene	1
Act as a comparison to the experimental group	1
Total	**2**

(e) A mutation, such as the DEC2 gene, could be favourable to the human population. Explain how a favourable gene like this could lead to changes in allele frequencies of a gene pool. (4 marks)

Description	Marks
Mutations introduce new alleles into the population/mutations create variation	1
Alleles may produce traits favourable to survival	1
Favourable alleles are passed to offspring	1
Favourable traits will increase in number within the gene pool/natural selection will produce changes to gene pool	1
Total	**4**

Question 33 **(11 marks)**

(a) Is the jaw pictured from a great ape or a human? Justify your answer by identifying **one** feature that supports your conclusion. (2 marks)

Description	Marks
Great ape	1
Any **one** of the following:	
It is 'U' shaped as opposed to parabolic	1
Range of teeth sizes as opposed to teeth of similar size	
Large teeth as opposed to small teeth	
Large molars as opposed to molars of similar size to other teeth	
Prominent canines as opposed to canines same size as other teeth	
The jaw has gaps (diastema) between some of the teeth	
Total	**2**

(b) The evolution from great ape to human has involved several changes to the cranium. For the following cranial features, contrast great ape and human craniums. (3 marks)

Description	Marks
Brow ridges	
Great ape – prominent brow ridge; Humans – reduced/absent brow ridge	1
Facial profile	
Great ape – prognathic/sloping face; Humans – flatter/vertical face	1
Foramen magnum	
Great ape – foramen magnum to rear of base of skull; Humans – foramen magnum more central/underneath skull	1
Total	**3**

Question 33 (continued)

(c) With hominins becoming bipedal there were several changes to their hands and feet. Describe what these changes were and how they contributed to bipedalism and mobility of their digits. (6 marks)

Description	Marks
Evolutionary changes to the feet	
Any **two** of the following:	
Longitudinal and transverse arches	1–2
Big toe aligned with other toes/non-prehensile big toe/parallel toes	
Robust calcaneus	
How the changes to the feet contributed to bipedalism	
Any **one** of the following:	
Allowed feet to carry more load	1
Allows for striding gait	
Acts as a shock absorber	
Better balance when upright	
Evolutionary changes to the hands	
Any **two** of the following:	
Thumb relatively longer to fingers	1–2
Opposability of thumb	
Short broad palm	
Relocation of muscles for fingers to forearm	
How the changes to the hands contributed to mobility of digits	
Any **one** of the following:	
Allowed for the precision grip	1
Allowed hands to be more manoeuvrable/manipulate objects	
Total	**6**

Question 34 **(12 marks)**

(a) State what is Tay-Sachs. (1 mark)

Description	Marks
Any **one** of the following:	
Degenerative neurological disease	1
Caused by deficiency of the HexA enzyme	
Disorder of lipid metabolism	
Autosomal recessive disease	
Total	**1**

(b) Explain how the high incidence of Tay-Sachs within the Ashkenazi Jewish community in Australia is an example of the founder effect. (4 marks)

Description	Marks
Small original population/migration of small group to Australia	1
With some (or one) individuals carrying the allele for Tay-Sachs disease	1
Restricted breeding with gene pool/cultural isolation	1
Frequency of allele increases over time	1
Total	**4**

(c) Outline what occurs in each stage of the PCR process. (3 marks)

Description	Marks
Denaturing	
Separates complimentary base pairs/DNA strands separate/heating separates the DNA	1
Annealing	
Adding a primer (small single strand of DNA) to bind to complementary base sequences	1
Extension	
(DNA polymerase) makes a copy of DNA strands through repeated series/ elongation/replication	1
Total	**3**

(d) Using the theory of natural selection, explain why Tay-Sachs disease still exists in the Ashkenazi Jewish populations today. (4 marks)

Description	Marks
Variation is present in individuals/individual are heterozygous for Tay-Sachs	1
Isolation of gene pool/barriers to gene flow	1
Individuals that are heterozygous are more likely to survive/not contract TB and produce offspring	1
Suitable genes are passed onto offspring/individuals that do not possess suitable genes die off	1
Total	**4**

Question 35 **(21 marks)**

(a) For each part, outline **one** mechanism that functions to prevent the entry of a pathogen into the internal environment. (2 marks)

Description	Marks
X: Eye	
Any **one** of the following:	
Lysozyme/chemical in tears to kill bacteria	1
Eyelashes catch debris/cleanse by tears	
Blinking action washes away debris	
Y: Urethra	
Any **one** of the following:	
Regular flushing of urine to wash away pathogens/maintain sterile environment	1
Acidic urine inhibits/prevents bacterial growth	
Total	**2**

(b) The bacterium that causes Lyme disease is known to be transmitted to humans through the bite of infected blacklegged ticks.

(i) Identify the type of disease transmission that Lyme disease displays. (1 mark)

Description	Marks
Vector	1
Total	**1**

(ii) Lyme disease is not believed to be transmitted from person to person but, if it was, describe how a mode of direct person to person transmission could occur. (2 marks)

Description	Marks
• infected blood/bodily fluids/faecal matter from one person • enters the blood stream of another through open cut or mucous membranes, **or**	1–2
• when droplets containing microorganisms are sneezed/ coughed/breathed into air by one person • and inhaled by another person	
Total	**2**

(c) Many of the symptoms associated with Lyme disease are caused by inflammation triggered in response to the bacterium.

(i) What is the role of inflammation in the prevention of disease? (2 marks)

Description	Marks
Localised non-specific response to infection	1
To increase speed of healing/reduce the spread of pathogen	1
Total	**2**

(ii) Explain the process of inflammation that causes an area to become red, swollen and hot. (4 marks)

Description	Marks
When tissue damage occurs mast cells are triggered	1
Histamine is released	1
Vasodilation/increased blood flow/increased permeability of capillaries	1
Macrophages/leucocytes/phagocytes are attracted to the area	1
Total	**4**

(d) Lyme disease is treated by antibiotics. However due to the nature of the disease it could also be potentially treated with a vaccine. Complete the table below, outlining the differences in how an antibiotic and a vaccine provide protection against infection. (8 marks)

Description			Marks
	Antibiotics	Vaccines	1–8
Time when the treatment should be administered	When infected with a pathogen (1)	Before exposure to pathogen (1)	
How the treatment fights the pathogen	Inhibit bacterial growth/directly destroy the bacterium (1) by interfering with protein synthesis of the bacteria to prevent reduction/kill bacteria by destroying cell walls or cell membranes of bacteria/block metabolic pathways of bacteria/inhibit enzyme activity (1)	Triggers own immune response/ produces antibodies to fight pathogen (1) Memory cells produced (1)	
Length of duration of defence against the pathogen	Short-lived/only while taking the antibiotic (1)	Long-lived/years/ permanently (1)	
		Total	**8**

(e) Provide **one** social/cultural and **one** economic argument to justify the decision to participate in immunisation programs. (2 marks)

Description	Marks
Social/cultural	
Any **one** of the following:	
Helping to create herd immunity/social responsibility to protect everyone from communicable disease	1
Following the health advice of government/health professionals	
Negative side effects considered very rare	
Historically always done in families/cultural groups	
Economic	
Any **one** of the following:	
Reduced health care cost for treating the sick	1
No loss of family tax benefits/immunisation bonus paid to participants	
Businesses can fully function when disease spread is limited	
Total	**2**

Question 36 **(19 marks)**

(a) Identify chemical 'X'. (1 mark)

Description	Marks
Neurotransmitter	1
Total	**1**

(b) Describe how chemicals 'X' and 'Y' differ in the way in which they reach their target cell/s. (2 marks)

Description	Marks
Chemical X/neurotransmitter diffuses across the synapse	1
Chemical Y travels through the bloodstream	1
Total	**2**

(c) (i) Identify which pathway has the quicker response time. (1 mark)

Description	Marks
Pathway 1/nervous	1
Total	**1**

(ii) Describe **one** characteristic of the pathway you chose in part (c)(i) that is significant in making the difference in response time. (2 marks)

Description	Marks
Nervous signal is an electrochemical/electrical impulse	1
The nervous signal travels faster than blood (carrying hormones in the bloodstream)	1
Total	**2**

(d) (i) State the name of this hormone. (1 mark)

Description	Marks
Glucagon	1
Total	**1**

(ii) Describe how this hormone causes an increase in blood glucose concentration. (3 marks)

Description	Marks
Glucagon (acts on liver) to convert glycogen to glucose/ glycogenolysis	1
Amino acids converted to glucose/gluconeogenesis	1
Fatty acids are converted to glucose/lipolysis	1
Total	**3**

(e) Explain how Type 1 diabetes can affect the control of blood sugar levels. (4 marks)

Description	Marks
Any **four** of the following:	
Pancreas (beta cells) produces little/no insulin	1–4
Glucose not taken into cells	
Glucose also not able to be stored as glycogen/fat	
Blood glucose levels remain high	
Glucagon secretion is not inhibited	
Total	**4**

(f) Synthetic insulin can be used to treat Type 1 diabetes. Describe the steps involved in producing the functioning bacterial cell that can be used to make synthetic insulin. (5 marks)

Description	Marks
Cut out required gene using restriction enzyme	1
Bacterial plasmid/DNA removed from bacterial cell	1
Bacterial plasmid/DNA cut with the same restriction enzyme	1
Gene (for human insulin) inserted into bacterial plasmid/DNA	1
Recombinant plasmid is inserted into a bacterial cell	1
Total	**5**

Question 37 **(14 marks)**

(a) Read the following paragraph and fill in the missing information. (3 marks)

The first hominins were the australopithecines. They had a gracile body; the two known species are called *Australopithecus* _____ and *Australopithecus* _____. A robust hominin called _____ *robustus* existed around the same time.

Description	Marks
afarensis	1
africanus	1
Paranthropus	1
Note – must have correct use of lower and upper case	
Note – *afarensis* and *africanus* can be written in any order	
Total	**3**

(b) It is thought that the earliest use of tools would have been by australopithecines using sticks and stones picked up from the local environment, whereas *Homo habilis* is the first hominin known to have produced tools.

(i) What is the name given to the tools made by *Homo habilis*? (1 mark)

Description	Marks
Oldowan/pebble tools	1
Total	**1**

(ii) Describe how the tools identified in part (b)(i) were made. (2 marks)

Description	Marks
Stones/pebbles/rocks	1
with one or two pieces chipped off by striking/flaking rocks together/striking one stone with another	1
Total	**2**

(c) Dated fossils of *Homo habilis* and *Homo erectus* indicate that they were both present on Earth at the same time. List **two** anatomical differences between the two species. (2 marks)

Description	Marks
Any **two** of the following:	
H erectus had a larger brain/*H erectus* (1000 cm^3) cranial capacity compared to (600 cm^3) for *H habilis*	1–2
H erectus had a taller/larger body	
H erectus had a relatively flatter face with less prominent cheekbones and large brow-ridges	
H erectus had a more sloping forehead	
H erectus had a flatter face	
H erectus dental arcade was shorter and more rounded	
H erectus had a shorter more rounded jaw	
H erectus had smaller teeth/molars/modern style teeth	
H erectus had more human-like proportions e.g. longer legs/shorter arms	
Total	**2**

(d) The graph below shows the average cranial capacity for several hominin fossils graphed against the fossils' age.

(i) Calculate the difference in cranial capacity between fossils B and E. (1 mark)

Description	Marks
Answer including correct unit – 800 cm^3	1
Total	**1**

(ii) What percentage of fossil D's cranial capacity would be taken up by that of fossil F? Show your working. (3 marks)

Description	Marks
Read data from graph e.g. F – 400 cm^3 and D – 900 cm^3	1
Calculation e.g. (400 x 100)/900	1
Answer – 44/44.4 %	1
Total	**3**
Note: Do not penalise for consequential errors	

(iii) State what hominin species fossil B is most likely from, and propose why, although older, it has a greater cranial capacity than fossil A. (2 marks)

Description	Marks
Fossil B – *Homo neanderthalensis/Homo neandethal*	1
Any **one** of the following for one mark:	
• larger brain needed for control of larger leg/arm muscles • larger brain volume needed to control larger body • larger brain associated with larger visual cortex needed for better vison • larger brain a result of a longer growing period	1
Total	**2**

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

Unit 3

Question 38 **(20 marks)**

During a trip to the Australian bush, a young man was lost for over six hours. The day on which he was lost was particularly hot, with temperatures peaking at 42°C. After a day's rest, the young man recovered from his experience with no lasting ill-effects.

(a) Describe the physiological mechanisms that would have been operating to maintain his internal body temperature during the six hours he was lost in the bush. (10 marks)

Description	Marks
Any **ten** of the following:	
Internal body temperature increase	1–10
Thermoreceptors detect increased temperature	
Central thermoreceptors located in hypothalamus/peripheral thermoreceptors located in the skin	
Hypothalamus activates cooling mechanisms/acts as modulator	
Peripheral blood vessels/skin arterioles	
Vasodilation occurs	
Heat loss by radiation/conduction	
Heat loss by evaporation	
Sweat glands activated	
(Increases) sweating occurs	
Decrease metabolic rate	
Occurs because of decrease thyroxine	
To decrease heat production	
Total	**10**

(b) Explain how the mechanisms required to maintain homeostasis of the man's internal body temperature would have also triggered the homeostatic processes involved in the maintenance of his body fluid concentration. (10 marks)

Description	Marks
Increase sweating results in greater water loss from body	1
Water must be conserved/replaced	1
Any **eight** of the following:	
Water concentration of blood plasma decreases/osmotic pressure of the blood increases	1–8
Osmoreceptors detect decrease in water concentration/increase in osmotic pressure	
Osmoreceptors in hypothalamus	
Hypothalamus stimulates posterior pituitary gland	
Increased ADH released	
Permeability of the distal convoluted tubule/collecting tubule (of the nephron) to water is increased	
Increased amount of water is reabsorbed into the blood/water concentration of blood plasma increases/osmotic pressure of the blood decreases	
Thirst reflex also triggered	
Nerve impulse to cerebrum/cerebral cortex/conscious desire to drink/ skeletal muscle effectors carry out response	
Total	**10**

Question 39 **(20 marks)**

Flynn was standing at second base during a game of baseball. The batter hit the ball straight at him. Without thinking, Flynn put his baseball glove up to stop the ball from hitting his face and his face flinched (involuntarily moved) away from the incoming ball.

(a) Describe the components of the mechanism that produced the flinching response. (8 marks)

Description	Marks
Any **eight** of the following:	
Reflex action (so only involves the spinal cord)	1–8
Impulse travels from receptor to spinal cord	
via a sensory/afferent neuron	
through the dorsal root	
Synapse between a sensory/afferent neuron and an interneuron	
In the grey matter of the spinal cord	
Synapse between interneuron and motor/efferent neuron	
Impulse sent to effector through ventral root	
Motor/efferent neuron stimulates muscle movement	
via a neuromuscular junction/across a motor end plate	
Total	**8**

(b) Explain how a nerve impulse travels along an axon and between neurons. (12 marks)

Description	Marks
Along the axon	
Any **seven** of the following:	
Depolarisation occurs	1–7
Reaches threshold/-55 mV	
Cell membrane becomes permeable to sodium ions/sodium channels open	
Sodium ions diffuse into the cell (across the cell membrane)	
Inside the cell/membrane becomes positive relative to the outside	
Potassium ions diffuse out of the cell (across the membrane)/potassium channels open	
Inside the membrane becomes negative relative to the outside	
A sodium–potassium pump transports sodium ions out of the cell transports potassium ions into the cell	
Returns to a polarised/resting state/neuron repolarised	
Subtotal	**7**
Between neurons	
Any **five** of the following:	
Action potential reaches axon terminal	1–5
Calcium channels open	
Calcium causes vesicles to release neurotransmitter (via exocytosis)	
Neurotransmitter diffuses across synaptic cleft	
Neurotransmitters binds to (neuro)receptors on post synaptic dendrite	
Action potential triggered in post synaptic neuron	
Subtotal	**5**
Total	**12**

Question 40 **(20 marks)**

Excavations of the sediments at an Aboriginal rock shelter in Juukan Gorge found flaked stone artefacts and a 4000 year-old belt made of plaited hair. A survey of the sediments provided a pollen record charting thousands of years of environmental changes.

(a) Name and describe **two** techniques that could be used to date the stone artefacts and **one** technique that could be used to date the hair belt. (12 marks)

Description	Marks
Indicates an understanding there are relative and absolute dating methods	1
Subtotal	**1**
Stone Artefacts	
Name and describe **two** of the following techniques (3 marks each)	
• stratigraphy • study the rock strata/layers • match similar strata to other strata already dated/artefacts in the same strata are the same age. • principle of superposition • assume lower rock layers are older • deeper artefacts are older. • index fossils • fossils widely found but only present for a limited time on Earth • match index fossils from various locations with known dates.	1–6
Subtotal	**6**
Hair belt	
Radiocarbon/carbon-14/C14 dating	1
Based on the decay of carbon-14/C14 to nitrogen	1
Amount of carbon-14/C14 fixed at death	1
Carbon-14/C14 half-life 5730 years	1
The ratio of carbon-14/C14 to carbon-12/C12 determines the age (years)	1
Subtotal	**5**
Total	**12**

(b) The mitochondrial DNA (mtDNA) in the plaited hair belt was associated with the DNA of today's traditional owners. Describe what mitochondrial DNA is and explain how it can be used to demonstrate a genetic relationship. (8 marks)

Description	Marks
Definition	
Genetic material found within mitochondria	1
mtDNA is found in small circular molecules/plasmids	1
mtDNA is inherited only from the mother/via the mitochondria in the mother's ova	1
Subtotal	**3**
Use	
Mutations occur more readily in mtDNA (than in nuclear DNA)/higher rate	1
Similarities in MtDNA between traditional owner and hair sample can be used to identify relatedness	1
Number of mutations in mDNA of traditional owner and hair sample assessed	1
The less the diversity in their mtDNA	1
The more closely related they are	1
Subtotal	**5**
Total	**8**

Question 41 **(20 marks)**

It is estimated that millions of hominins pre-dating the modern *Homo sapiens* have populated the Earth and yet only 6000 individuals are represented in the hominin fossil record.

(a) Explain why there are so few fossils in the fossil record. (10 marks)

Description	Marks
Any **ten** of the following:	
Generally only hard/solid parts e.g. bones/teeth are fossilised	1–10
Organisms need to 'die' in area suitable to fossilisation	
The sediments/soils needs to be of the right conditions/alkaline/low oxygen levels	
Organisms need to be protected from decay from microorganisms	
The body/remains need to be undisturbed by scavengers	
The body/remains need to be quickly covered by sediments/rapid burial	
The soil/sediments need to be undisturbed by geological processes	
Many fossils are buried too deep to be found/not exposed to the surface	
Many fossils are destroyed by geological processes/human activity	
Many fossils are not recognised as being so/people don't recognise them	
Many fossils once exposed are eroded/weathered	
Total	**10**

(b) Explain, using examples, how the comparative studies of anatomy can be used for the construction of phylogenetic trees. (10 marks)

Description	Marks
Any **two** of the following examples:	
Comparative embryology	
Compare anatomical structure during embryo development/stages of embryo development from different species	1
Organisms share similar anatomical structures during early development	1
Indicates shared common ancestry/at one point they all shared an ancestor who had the basic structure	1
More similar the structures are for longer in the embryonic stage = more closely placed together on phylogenetic trees	1
Example – gill silts and tail found in vertebrate embryos	1
Subtotal	**5**
or Homologous structures	
Compare anatomical structure from different species	1
Structures show a high degree of structural similarity but perform different functions	1
Indicates shared common ancestry/at one point they all shared an ancestor who had the basic structure	1
More similar the structures are = more closely placed together on phylogenetic trees	1
Example – bone structure in the vertebrate limbs	1
Subtotal	**5**
or Vestigial organs	
Homologous structures that have a benefit/normal function in some species	1
Present but not functional in other species	1
Indicates shared common ancestry/at one point they all shared an ancestor who had the structure	1
More shared features = more closely placed together on phylogenetic trees	1
Example – appendix/nictitating membrane/muscles to move ears/ body hair/wisdom teeth in humans	1
Subtotal	**5**
Total	**10**

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