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

HUMAN BIOLOGY

ATAR course examination 2020

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.

2021/2620
Web version of 2020/67089

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

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

Section Two: Short answer **50% (110 Marks)**

Question 31 **(10 marks)**

(a) Hormones differ from nerves in their mode of action. In relation to the mode of transmission and response time, state how a hormonal response is different from a nervous response. (2 marks)

Description	Marks
Mode of transmission – bloodstream	1
Response time – slower	1
Total	**2**

(b) (i) The dotted lines on the diagram indicate negative feedback. Outline what is meant by the term negative feedback. (1 mark)

Description	Marks
response reduces stimulus/response works in opposition to stimulus	1
Total	**1**

(ii) Describe the role of the receptor in a feedback loop. (2 marks)

Description	Marks
detects stimulus/change	1
sends signal to coordinating centre/modulator/control centre	1
Total	**2**

(c) Identify the following components shown in the diagram on page 16. (2 marks)

Description	Marks
Control centre – hypothalamus	1
Effector – testes	1
Total	**2**

(d) If a tumour began to affect the functioning of the anterior pituitary by inhibiting the production of LH and FSH, explain the impact this would have on the fertility of the affected male. (3 marks)

Description	Marks
decreased fertility	1
tumour reduces the secretion of testosterone	1
which will reduce the production/maturation of sperm	1
Total	**3**

Question 32 **(12 marks)**

(a) Botulism is classified as a bacterium. List **three** structural characteristics of a bacterium. (3 marks)

Description	Marks
cell wall	1–3
microscopic/single-celled organism	
prokaryote/have no nucleus	
no membrane bound organelles	
plasmid/rings of DNA	
can be rod, spiral, spherical shape	
(many) flagellum present/slime layer	
Total	**3**

(b) Botulism can be transferred in many ways. For each of the mechanisms listed below outline how it can spread the pathogen. (3 marks)

Description	Marks
Droplet transmission – when droplets containing microorganisms are sneezed/coughed into air and inhaled by another person	1
Direct contact with infected bodily fluid – Infected blood/bodily fluids/ faecal matter enters the blood stream (through an open cut or the mucous membranes of a bodily opening)	1
Contamination of food or water – Microorganisms present in unclean food or water supplies consumed/enter through digestive tract.	1
Total	**3**

(c) (i) Acetylcholine is a neurotransmitter. State its role in nervous transmission. (1 mark)

Description	Marks
enables an impulse (message) to cross the neuromuscular junction/synapse	1
Total	**1**

(ii) Explain how transmission across a synapse normally occurs. (5 marks)

Description	Marks
action potential arrives at pre-synaptic knob/axon endings	1
calcium ions flow into pre-synaptic knob/exocytosis of vesicles containing neurotransmitter	1
neurotransmitter diffuses across gap/synapse	1
neurotransmitter binds to receptors on post-synaptic membrane/ dendrite of next neuron	1
ion channels on the post synaptic membrane open/causes an influx of sodium ions/triggering depolarisation/triggering action potential	1
Total	**5**

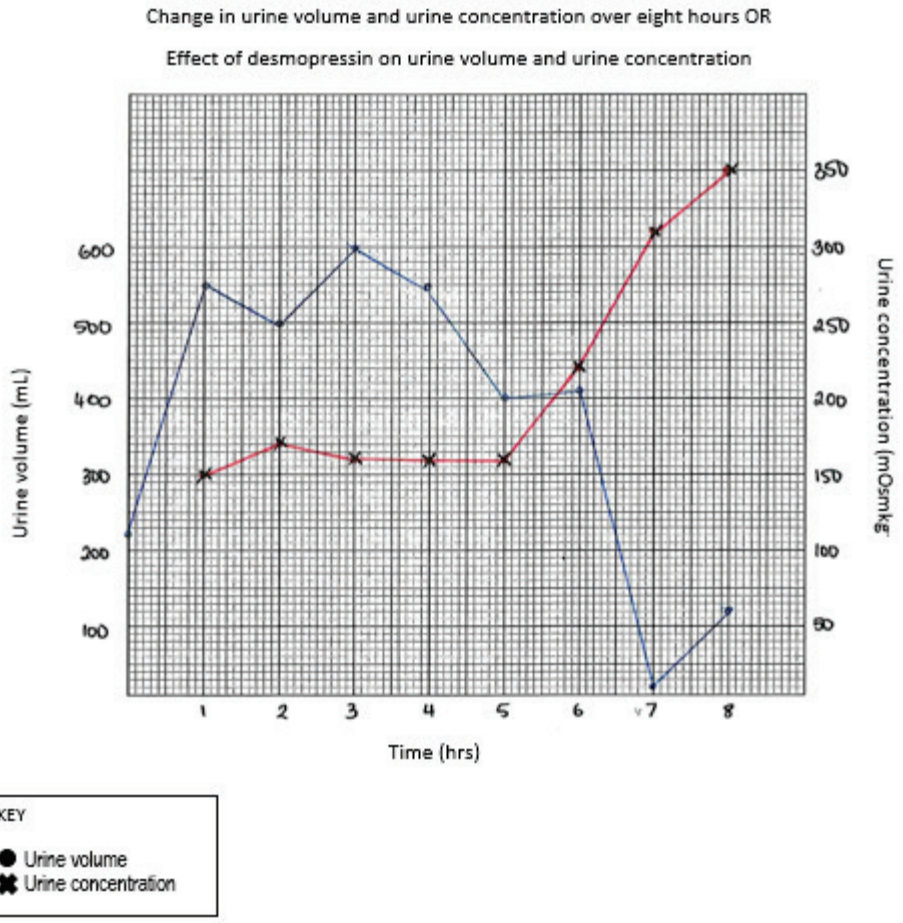
Question 33 **(16 marks)**

(a) Graph these results on the grid provided below. (5 marks)

Description	Marks
correctly constructs axes using appropriate scale (urine volume and urine osmolality on Y axes, Time on X axis)	1
correctly plots points and joins points to form a line (ruler)	1
labelling of axes with correct name and unit	1
identifies lines using key/labels	1
title appropriate with both independent and dependent variables included 'Effect of Desmopressin on Urine Volume and Urine Concentration' or 'Urine Volume and Urine Concentration changes over eight hours'	1
Total	**5**

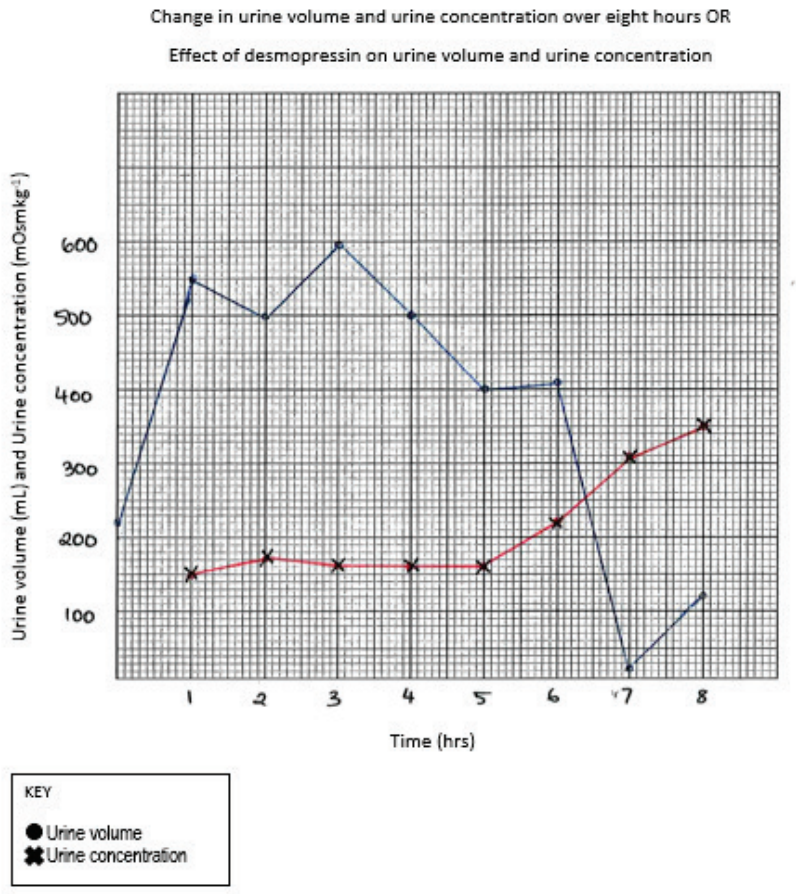
Answers could include:

Example one



Question 33 (continued)

Example two



(b) When was the desmopressin administered? Justify your response. (2 marks)

Description	Marks
at six hours	1
desmopressin will reduce urine volume (like ADH does, this occurs when urine volume is reduced from 410 mL to 10 mL)	1
urine concentration increases (decreasing water volume in urine)	
Total	**2**

(c) Does this patient have CDI? Justify your response. (2 marks)

Description	Marks
yes	1
high urine production despite having had no fluids to drink	1
drop of urine volume to 10 after desmopressin administered indicating no ADH in blood to reduce urine volume previously	
Total	**2**

(d) (i) Identify the gland that secretes ADH. (1 mark)

Description	Marks
posterior pituitary gland	1
Total	**1**

(ii) Explain the role of ADH in the maintenance of water balance in the body.

(6 marks)

Description	Marks
water concentration of blood plasma decreases/osmotic pressure of the blood increases	1
osmoreceptors (in hypothalamus) detect decrease in water concentration/increase in osmotic pressure	1
hypothalamus stimulates posterior pituitary gland	1
to release ADH	1
permeability of the distal convoluted tubule and collecting tubule (of the nephron) to water is increased	1
Increased amount of water is reabsorbed into the blood/water concentration of blood plasma increases/osmotic pressure of the blood decreases	1
Total	**6**

Question 34 **(15 marks)**

(a) (i) List **three** structures that would normally assist in protecting the brain against injury. (3 marks)

Description	Marks
Cranium/skull/bone	1
meninges	1
cerebrospinal fluid/CSF	1
Total	**3**

(ii) Suggest **two** symptoms a boxer might display if the cerebellum was damaged. (2 marks)

Description	Marks
slurred speech	1–2
loss of balance	
lack of coordination/clumsy movements/reduce fine motor control	
involuntary shaking	
Total	**2**

(b) (i) Describe the cause of Parkinson's disease. (2 marks)

Description	Marks
damage/degeneration to nerve cells in the brain (substantia nigra/basal ganglia)	1–2
reduced dopamine levels	
dopamine is required for smooth control of muscles and movement	
Total	**2**

(ii) Describe how cell replacement therapy is being used to treat Parkinson's disease. (2 marks)

Description	Marks
For copyright reasons this text cannot be reproduced in the online version of this document, but may be viewed at the link listed on the acknowledgements page.	1
For copyright reasons this text cannot be reproduced in the online version of this document, but may be viewed at the link listed on the acknowledgements page.	1
Total	**2**

(c) (i) If X is injured, it can lead to paralysis of part/s of the body and loss of sensation, depending on how high up the spinal cord the injury is. Why does this occur? (2 marks)

Description	Marks
X is a spinal nerve/mixed nerve/it contains both sensory and motor neurons	1
damage effects both neurons/both pathways to and from the brain	1
Total	**2**

(ii) If Y is damaged, there will be a loss of feeling, but movement can still occur. Injury to Z leads to paralysis, but there will still be a sense of feeling. Explain why this difference occurs. (4 marks)

Description	Marks
if Y is damaged it effects the sensory neuron	1
impulses will not travel into the spinal cord but messages can still be sent out	1
if Z is damaged it effects the motor neuron	1
impulses still travel into the spinal cord but messages cannot be sent out	1
Total	**4**

Question 35 **(12 marks)**

(a) In relation to the following, describe the effect on the gene pools each time a small group of people settle onto a new Polynesian island.

(i) Gene flow: (2 marks)

Description	Marks
gene flow is reduced due to geographical barriers (ocean)/isolation/inhibiting interbreeding between populations	1
traits (alleles) that are not frequent in the original population can become more frequent	1
Total	**2**

(ii) Impact of selection pressures on alleles: (3 marks)

Description	Marks
different environmental pressures result in different alleles being selected for	1–3
over time (generations) allele frequencies in the gene pools will change	
populations become less like each other depending on which alleles are selected for	
Total	**3**

(b) (i) Identify **two** reasons why radiocarbon dating was an appropriate method for determining the age of the Polynesian skeletons. (2 marks)

Description	Marks
because it can date fossils up to the age of 60 000–70 000 years old/the skeletons found were at the correct age range for dating technique	1
skeleton is organic material	1
Total	**2**

(ii) Describe how radiocarbon dating works to determine the age of a fossil. (3 marks)

Description	Marks
based on the decay of carbon-14 to nitrogen	1
the ratio of carbon-14 to carbon-12 determines the age	1
carbon-14 has a half-life of 5730 years	1
Total	**3**

(c) A fossil of a human skeleton was found in Australia. Can the Polynesian fossil be used to provide a relative date for the Australian skeleton? Provide a reason for your answer. (2 marks)

Description	Marks
no	1
the fossils are from different locations so cannot be correlated	1
or	
Yes	1
if index fossils are present that allow correlation	1
Total	**2**

Question 36 **(16 marks)**

(a) Propose an hypothesis for the study described above. (1 mark)

Description	Marks
testable, predictive statement E.g. injectable drugs will be more effective in treating thalassemia symptoms than orally ingested drugs	1
Total	**1**

(b) Why were both groups B and D required for this study? (3 marks)

Description	Marks
control groups of the study to compare results with	1
they both administer the placebo treatment (to minimise any psychological effects)	1
needs both as there is two different modes of delivery that need to be equally controlled	1
Total	**3**

(c) Identify a variable that was controlled in the study. (1 mark)

Description	Marks
treatment schedule/daily treatments for a month **or**, all participants have same type of thalassemia	1
Total	**1**

(d) Describe the data the researchers would need to collect and when they should collect the data. (3 marks)

Description	Marks
test for the levels of iron found in the blood	1
testing should be done before treatment	1
testing should be done at the end of the one-month treatment	1
Total	**3**

(e) Outline the cause of alpha (α) and beta (β) thalassemia and identify what makes each type of thalassemia different. (3 marks)

Description	Marks
mutation of the gene responsible for red blood cells/haemoglobin production	1
alpha (α) – effects genes on chromosome 16/reduces the formation of alpha polypeptide chains/the alpha globin of red blood cells	1
beta (β) – effects genes on chromosome 11/reduces the formation of beta polypeptide chains/the beta globin of red blood cells	1
Total	**3**

(f) Alpha (α) and beta (β) thalassemia display the same inheritance pattern but can have differing effects on the gene pool of a population. Justify this statement. (5 marks)

Description	Marks
both are recessive traits	1
heterozygotes are mildly affected with the disease/heterozygous carrier parents pass the traits on to their children	1
homozygous condition in alpha thalassemia is fatal	1
homozygous condition in beta thalassemia is severe but not fatal	1
no homozygote alpha sufferers present in a population but there will be beta sufferers	1
Total	**5**

Question 37 **(12 marks)**

(a) (i) What type of immunity would the measles vaccine provide? (1 mark)

Description	Marks
artificial active/active artificial	1
Total	**1**

(ii) Suggest why a vaccine containing B would provide immunity to microorganism A. (4 marks)

Description	Marks
immune system responds to antigen (even in damaged/weakened state)/same surface antigen present	1
B cells produce antibodies	1
also produce memory cells	1
allowing a rapid/stronger response to antigen if virus invades in the future	1
Total	**4**

(b) (i) State the term given to the type of immunity described above. (1 mark)

Description	Marks
natural passive/passive natural	1
Total	**1**

(ii) Describe how antibodies to measles are present in babies at birth. (2 marks)

Description	Marks
antibodies that mother has produced in response to measles vaccine/or prior exposure to the disease	1
can be passed across the placenta	1
Total	**2**

(c) If a child under the age of 12 months contracted measles, would it be necessary for them to still be immunised with the MMR vaccine? Provide a reason for your answer. (4 marks)

Description	Marks
yes	1
they would only have memory cells against measles	1
each pathogen has a different antigen/there would be no memory cells formed in the body for mumps or rubella	1
vaccine would also help to increase the immunity of the child further to measles	1
Total	**4**

Question 38 **(17 marks)**

(a) (i) Identify the organism that **most** recently shared a common ancestor with *Australopithecus anamensis*. (1 mark)

Description	Marks
Orrorin tugenesis	1
Total	**1**

(ii) Select which of the following hominins is **most** distantly related to modern humans: *Australopithecus afarensis* or *Paranthropus boisei.* (1 mark)

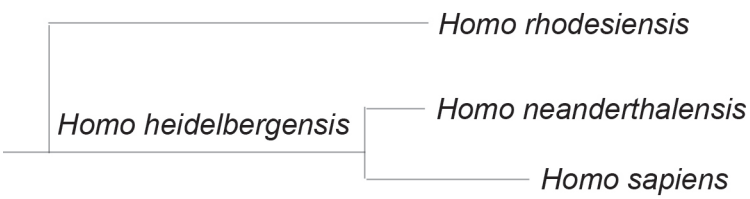
Description	Marks
Australopithecus afarensis	1
Total	**1**

(b) Explain how evidence from DNA sequencing can be used to construct a phylogenetic tree. (3 marks)

Description	Marks
the sequence of nucleotides of the DNA of organisms is compared	1
the more similar the sequence the more closely related organisms are/less time since common ancestor/less time since divergence	1
organisms appear closer together on the phylogenetic tree	1
Total	**3**

Question 38 (continued)

(c) In the space below, redraw the phylogenetic tree on page 30 showing *Homo heidelbergensis* as the common ancestor to modern humans and *Homo neanderthalensis* and *Homo rhodesiensis* as more distantly related to the other three *Homo* species on the same branch. (3 marks)

Description	Marks
	1–3
Answer – must have • *Homo rhodesiensis* on different branch above other two • *Homo heidelbergensis* on common ancestor branch • *Homo neanderthalensis* and *Homo sapiens* both from same common ancestor	
Total	**3**

(d) State **two** features of a typical *Homo neanderthalensis* skull that distinguish it from modern humans. (2 marks)

Description	Marks
Any **two** of:	
large cranial capacity around 1400 cc	1–2
lack of chin	
occipital bun	
lack of forehead	
elongated skull	
depression (the suprainiac fossa) at back of skull	
flared zygomatic arch	
Larger brow ridges	
Total	**2**

(e) (i) Rearrange the tools I to IV in order from oldest to youngest. (1 mark)

Description	Marks
IV – I – II – III	1
Total	**1**

(ii) The tools display a trend in the tool manufacture. State this trend and what it implies about the changes to hominin lifestyle. (2 marks)

Description	Marks
greater workmanship/greater number of blows made in construction/greater design complexity	1
hominids completed more specialised tasks/did finer work/had more time to create	1
Total	**2**

(iii) Identify which tool was **most** likely to be made first by *Homo erectus*. (1 mark)

Description	Marks
I	1
Total	**1**

(iv) How would hominins have manufactured tool III? (3 marks)

Description	Marks
Levallois method/large flake removed from stone core	1
flakes reworked edges/edges sharpened	1
pressure flaking	1
Total	**3**

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

Unit 3

Question 39 **(20 marks)**

(a) Describe the physiological mechanisms that cause fever. (8 marks)

Description	Marks
hypothalamus increases thermostat setting of body (person feels cold)	1–8
pyrogens released	
Produced by white cells or pathogens	
muscles begin to shiver	
blood vessels constrict	
both processes help to drive up body temperature	
macrophage engulfed pathogen	
macrophage stimulated to release interleukins/cytokines	
interleukins/cytokines enhance the pyrogens	
Total	**8**

(b) Explain how different antibiotics can be used to treat infections. (8 marks)

Description	Marks
antibiotics target disease causing bacteria	1–8
can be broad spectrum/affect a wide range of bacteria	
or can narrow spectrum/effective only against specific types of bacteria	
(bacteriostatic) antibiotics inhibit growth of bacteria	
by interfering with protein synthesis	
(bactericidal) antibiotics destroy bacterial pathogens	
by targeting cell walls, cell membranes or	
metabolic pathways/action of enzymes found inside bacteria	
Total	**8**

(c) Explain why the doctor stressed that the full course of antibiotics needed to be taken. (4 marks)

Description	Marks
antibiotics gradually reduce the numbers of bacteria	1–4
will still be a small population of bacteria that remain	
if antibiotics are then stopped the bacteria that persist will increase in number/surviving bacteria reproduce	
reinfection occurs/become sick again	
eeduce likelihood of resistance developing	
Total	**4**

Question 40 **(20 marks)**

(a) hGH is released from the pituitary gland. State from which lobe of the pituitary this hormone is secreted and explain the relationship between this section of the pituitary gland and the hypothalamus. (6 marks)

Description	Marks
secreted from the anterior lobe	1
communication between the hypothalamus and the anterior pituitary occurs through chemicals/hormones	1–5
through the infundibulum/blood vessels	
hypothalamus stimulates the anterior pituitary to release hormones	
via releasing factors/hormones	
the hormones are released into a capillary network and transported through veins	
also produces inhibiting factors to inhibit activity of the pituitary	
Total	**6**

(b) hGH is a water-soluble hormone. Explain how hGH enters and affects the functioning of its target cell. (6 marks)

Description	Marks
Enters target cell	
dissolve in water (not fats) so cannot pass through cell membrane	1–3
hormone molecule attaches to receptor molecule	
receptor molecule found on surface of target cell	
receptor molecule must match shape of signalling molecule	
Subtotal	**3**
Affects target cell	
binding of hormone to receptor triggers a secondary messenger/response inside the cell	1–3
secondary messenger activates enzymes inside the cytoplasm	
enzymes adjust chemical activity of the cell	
speed of reactions will either increase or decrease	
Subtotal	**3**
Total	**6**

(c) Dwarfism can be treated using synthetically produced hGH. Explain how hGH could be produced using recombinant DNA technology. (8 marks)

Description	Marks
gene for hGH located (on human chromosome)	1–8
gene cut out using endonuclease/treated with restriction enzyme	
cuts DNA at specific sites/produces sticky ends	
plasmid cut with same restriction enzyme	
gene inserted into plasmid using ligase	
acts as a vector/produces a transgenic organism	
recombinant plasmid enters into host bacterial cell	
which propagates/replicates/clone	
bacteria express gene to synthesize human protein/hormone	
produces large scale amounts of hGH	
Total	**8**

Unit 4

Question 41 **(20 marks)**

(a) If in the future a group of 50 humans was selected to colonise Mars, over time this group could be at risk of becoming an example of the Founder Effect and, potentially, speciation. Justify this statement by explaining how the evolutionary mechanisms of both the Founder Effect and speciation could apply to this scenario. (13 marks)

Description	Marks
Founder effect	
50 people represents a small original population	1–4
geographic barrier to gene flow present	
random genetic drift more likely to occur/gene pool may not be reflective of original population	
allele frequencies change over time	
Subtotal	**4**
Speciation	
genetic variation exists in the 50 people	1–9
new environmental conditions on Mars	
there could be a struggle for survival/limited resources	
isolated gene pool/restricted breeding	
an allele in the gene pool could be selected for/survival advantage present	
frequency of alleles change over time from original	
over many generations changes become greater	
changes can become so great that the new group can no longer reproduce with the original population	
new/distinct species has been formed	
Subtotal	**9**
Total	**13**

(b) If this hypothetical group of 50 humans was to colonise Mars, it would be advisable to obtain DNA sequences of the individuals as part of the selection process. Define the term 'DNA sequencing' and name and explain the method by which a DNA sequence is obtained today. (7 marks)

Description	Marks
Define and name	
process of determining the order of nucleotides in the DNA	1
gel electrophoresis/sanger sequencing	1
Subtotal	**2**
Process – One to five of the following:	
DNA sample undergoes PCR	1–5
DNA polymerase added to primer	
Fluorescents dideoxynucleotides (ddNTPs = ddATP + ddCTP + ddTTP + ddGTP) added to four reaction mixtures	
DNA terminated at different lengths	
Four mixtures run separate lines	
DNA pieces are placed at one end of a bed of gel into wells	
an electric current is passed through the gel/a voltage is applied across the gel	
DNA is negatively charged so moves through the gel to the positive electrode	
DNA pieces move through the gel at different speeds/smaller DNA pieces move faster than large ones	
bands form which represent different segments/sizes of DNA	
Subtotal	**5**
Total	**7**

Question 42 **(20 marks)**

(a) Describe the various types of mutations, identify the causes and describe how they can occur. (15 marks)

Description	Marks
Define	
a mutation is a change in a gene or a chromosome (leading to new characteristics in an organism or their offspring)	1
Types of mutations	
can be gene mutation or chromosomal mutations	1–3
Gene – changes in a single gene (which occurs during DNA replication)	
Chromosomal – all or part of a chromosome is affected	
can be somatic or germline	1–3
Somatic – mutations that occur in the body cells (reproductive cells are not affected) therefore mutation is not passed on to offspring	
Germline – mutations that occur in the reproductive cells/gametes therefore can be passed on to offspring	
Causes	
Mutagens	
caused by mutagens/mutagenic agents	1
substances that are known to increase the rate at which mutations occur	1
e.g. ionising radiation (e.g. X-rays), mustard gas, formaldehyde, some antibiotics	
DNA replication	
caused by errors in DNA replication	1
deletion – part of a chromosome is lost	1–2
Duplication – section of chromosome is repeated/occurs twice	
Insertions – DNA can be duplicated/extra DNA added	
Frameshifts – incomplete DNA code/unreadable DNA code	
Cell division	
cause by errors in cell division/meiosis	1
Inversion – broken part of chromosome joins back but in the wrong way	1–2
Translocation – part of chromosome breaks off and re-joins to the wrong chromosome	
Non-disjunction – during meiosis, a chromosome pair does not separate so one daughter cell has an extra chromosome and one daughter cell has one less (aneuploidy)	
Total	**15**

(b) Explain how the example of the evolution of the unique hominin jaw illustrates the importance of mutations to evolution. (5 marks)

Description	Marks
mutations introduce new alleles into population	1–5
hominin jaw mutations must have been favourable/an advantage to survival	
organisms are better suited to bipedal locomotion/balance of head in bipedal locomotion/better for stereoscopic vision/helped to enable increases in cranial capacity	
favourable alleles passed onto offspring	
mutation maintained in population/future generations	
Total	**5**

ACKNOWLEDGEMENTS

Question 34(b)(ii) Adapted from: Science Daily. (2018). *Improving cell replacement therapy for Parkinson's disease: New cell surface markers*. Retrieved July, 2020, from https://www.sciencedaily.com/releases/2018/08/180823171027.htm

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