



HUMAN BIOLOGY

ATAR course examination 2018

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	A
3	B and D *
4	D
5	C
6	C
7	A
8	B
9	A
10	D
11	B
12	A
13	C
14	C
15	A
16	D
17	D
18	C
19	B
20	A
21	B
22	B
23	C
24	A
25	C
26	D
27	D
28	A
29	C
30	D

* Question 3 – both distractors B and D were deemed correct.

Section Two: Short answer

50% (109 Marks)

Question 31

(12 marks)

- (a) Using the information above, complete the following table.

(3 marks)

Description	Marks
A – dendrite	1
B – myelin sheath/Schwann cell	1
C – axon	1
Total	3

- (b) Describe why nerve transmission would be much faster in Neuron 1 than in Neuron 2.

(2 marks)

Description	Marks
Covered in myelin sheath/presence of nodes of Ranvier	1
Allows saltatory conduction/nerve impulse 'jumps' faster than unmyelinated fibre	1
Total	2

Neuron 1 can be found within the somatic division of the nervous system.

- (c) (i) To what structures in the body would these neurons take messages? (1 mark)

Description	Marks
Skeletal/voluntary/striated muscles	1
Total	1

- (ii) How does the pathway of a nerve impulse travelling through the neurons of the somatic division differ to that travelling within the autonomic division? (2 marks)

Description	Marks
Autonomic contains a synapse/somatic only has one (motor) neuron while autonomic has two motor neurons	1
Autonomic passes through (contains) a ganglion/has a preganglionic and a post ganglionic neuron	1
Total	2

Natasha walked into her Human Biology class a few moments late, only to find everyone putting their books and notes away. Her teacher was preparing to hand out a test. Natasha did not know the test was being done and started panicking. The teacher placed the test down on the desks and told the students to begin. Natasha suddenly felt like she was going to vomit.

- (d) (i) Identify the division of the nervous system activated in Natasha's body during this situation. (1 mark)

Description	Marks
Sympathetic	1
Total	1

Question 31 (continued)

- (ii) What was happening in Natasha's body to cause her to feel the way she did? (2 marks)

Description	Marks
Any two of the following	
(Vasoconstriction) blood has been diverted away from stomach/digestive system	1–2
Stomach movements/peristalsis slows	
(Vasodilation) rush of blood (oxygen) to the brain	
High levels of adrenalin/cortisol	
Total	2

- (iii) Identify another physiological response that could have been occurring in her body during this situation. (1 mark)

Description	Marks
Any one of the following	
Increased heart rate	1
Dilation of pupils	
Decrease saliva production/dry mouth	
Increase breathing rate/shallow rapid breathing/dilation of bronchioles	
Vasodilation of blood vessels to skeletal muscles	
Increases sweating/flushing of skin	
Pale face/vasoconstriction of blood vessels to skin	
Relaxation of bladder	
Increase uptake of glucose by liver	
Increase secretion of adrenalin	
Total	1

Question 32

(11 marks)

- (a) Complete the feedback loop by writing the appropriate word/s in the spaces provided. (5 marks)

Description	Marks
Receptors – skin	1
Modulator – hypothalamus	1
Effectors – skeletal/voluntary/striated muscles	1
Response – vasoconstriction	1
– (increase) heat production	1
Total	5

- (b) The people who found Jai in the snow gave him first aid. Identify **two** behavioural strategies the first aiders could have employed to help his body recover from hypothermia. (2 marks)

Description	Marks
Any two of the following	
Remove person from cold environment/place in warm environment/hugging	1–2
Remove wet clothes	
Cover in dry warm clothes/layers/blankets	
Provide warm liquids/foods	
Total	2

- (c) Several days after Jai was caught in the avalanche, he developed a cold, with a runny nose and sore throat. His friends said he must have become sick from being in the cold environment. Using your knowledge of infection and immune response, explain how this could not be the case and how, in fact, Jai would have become unwell. (4 marks)

Description	Marks
Any four of the following	
Sickness is caused by a virus/bacteria/pathogens	1–4
Cold weather alone does not expose body to pathogens	
He must have been exposed to pathogens in days/hours before symptoms	
Pathogens must have penetrated the body's external defences/example	
Pathogens could have been transmitted through various mechanisms/example	
Total	4

Question 33

(13 marks)

- (a) The graph above is missing some important information. Identify **two** pieces of information that should have been included when drawing the graph. (2 marks)

Description	Marks
Any two of the following	
No title	1–2
No name for x axis/time not stated	
No brackets on °C	
Y axis should have split axis	
no 0 on X axis	
Total	2

- (b) The stages in PCR are labelled 'A', 'B' and 'C' on the graph.

- (i) What name is given to stage 'C'? (1 mark)

Description	Marks
Extension/elongation	1
Total	1

- (ii) Describe what occurs at stage 'B'. (2 marks)

Description	Marks
TAQ polymerase and primers added	1
Primers bind (anneal) to the DNA	1
Total	2

- (c) Describe **two** situations in which PCR could be used and the information that would be gathered. (4 marks)

Description	Marks	
Any 2 situations – 1 mark for name, 1 mark for description		
Early detection of infectious disease Foreign DNA from viruses/bacteria	1–4	
Tiny samples of DNA from fossils of extinct species Information for phylogenetic studies/relatedness, migration information		
Shortens time to detect hereditary diseases Amplify DNA to recognise faulty DNA/DNA that causes genetic disease		
DNA profiling/DNA fingerprinting Comparing an individual's DNA to a library of DNA from known individuals		
DNA research Cloning/sequencing/patterns of gene expression/epigenetics		
Tissue typing DNA matches for transplant organs		
Total		4

- (d) Explain how the technique of gel electrophoresis separates DNA fragments of different sizes. (4 marks)

Description	Marks
Any four of the following	
DNA fragments are (able to move when) placed in a gel	1–4
A weak electric field is applied to the gel/positive and negative terminals	
This pulls the fragments to one end of the gel/fragments move to positive end	
Fragments move at different rates depending on size	
Smallest fragments move faster/further/offer less resistance	
Separates fragments into a unique pattern for that species	
Total	4

Question 34

(13 marks)

- (a) The study could be used to provide supporting data in the field of comparative biochemistry. Justify this statement. (2 marks)

Description	Marks
Comparative biochemistry studies evolutionary relationships between species.	1
This study looked at similarities (differences) of the neurotransmitters (chemistry) between species to establish relatedness	1
Total	2

- (b) State the role of neurotransmitters in the brain and nervous system. (1 mark)

Description	Marks
Transmission of a message across a synapse/between neurons	1
Total	1

- (c) Describe how the hominid brain differs from an ape brain. (2 marks)

Description	Marks
Any two of the following	
Increase in cranial capacity/average size of 1400cc compared to 500cc	1–2
More highly convoluted cerebral cortex	
Much larger frontal lobe	
Total	2

- (d) Complete the table below showing the hominid feature and the advantage that the hominid feature has for a hominid way of life. (2 marks)

Description	Marks
Hominid feature: opposable thumb	1
Advantage: allows for greater reliance on sight/better balance (in bipedalism)/development of speech/change in diet	1
Total	2

Question 34 (continued)

- (e) Features of the fossil remains of the *Australopithecus afarensis* species include a broad, shallow pelvis, long, curved fingers, a carrying angle of the femur present and a highly mobile shoulder joint. On the basis of these anatomical features, suggest how *Australopithecus afarensis* may have lived. (3 marks)

Description	Marks
Indicates life both in the trees and on the ground	1
Pelvis and carrying angle suggest bipedalism	1
Fingers and shoulder joint support that it was arboreal lifestyle/brachiating/climbing	1
Total	3

- (f) Complete the table below on the basis of the information presented in the phylogenetic tree above. (3 marks)

Description	Marks
<i>Homo neanderthalensis</i> – 'R'	1
<i>Paranthropus robustus</i> – 'Q'	1
<i>Australopithecus africanus</i> – 'O'	1
Total	3

Question 35

(12 marks)

- (a) (i) In the diagram above, what would structure A be? (1 mark)

Description	Marks
Pancreas/islets/alpha cells	1
Total	1

- (ii) In this scenario, structure A releases a hormone that acts on the liver. What name is given to this hormone? (1 mark)

Description	Marks
Glucagon	1
Total	1

- (iii) Adrenalin acts on many structures to help increase blood sugar levels. What process is occurring at B that would contribute to the raising of blood sugar levels? (1 mark)

Description	Marks
Breakdown of fats/lipolysis/break down of amino acids/gluconeogenesis	1
Total	1

- (iv) What other endocrine gland not shown in the diagram above could possibly be involved in maintaining blood sugar levels? (1 mark)

Description	Marks
Thyroid/adrenal cortex	1
Total	1

- (b) To help lower blood sugar levels, a series of processes occurs in various effectors. Define each of the following terms and name the structures in which each process occurs. (4 marks)

Description			Marks
One mark for definition and one mark for structure			
Process	Definition	Structure/s	
<i>Glycogenesis</i>	Converts glucose into glycogen	Liver/muscle cells	1–2
<i>Lipogenesis</i>	Glucose converted to fat/fatty acid synthesis from glucose	Fat cells/adipose tissue	1–2
Total			4

- (c) Explain why a person with diabetes would feel the effects of high blood sugar, such as tiredness and excessive thirst. (4 marks)

Description	Marks
Any four of the following	
Lack of insulin in blood/lack of effective insulin	1–4
Cells are starved of glucose	
Cells cannot respire to produce energy/tiredness	
High glucose level increases osmotic pressure	
Hypothalamus triggers a thirst reflex	
Total	4

Question 36

(12 marks)

Evolution of a species can occur through either genetic drift or natural selection.

The evolution of hominids probably occurred through the process of natural selection as the environment around them changed.

- (a) Describe mechanisms underpinning the theory of natural selection that produce changes in a gene pool, leading to speciation. (5 marks)

Description	Marks
Variation: any one of the following	
• variation is present in individuals	1
• wide variety of genes/large gene pool present	
Isolation	
• isolation of gene pool/barriers to gene flow	1
Struggle: any one of the following	
• characteristics that are more suitable for the environment are present	1
• individuals that possess the suitable genes are more likely to survive and produce offspring	
• overproduction of offspring meaning more are produced that can survive	
Selection: any one of the following	
• suitable genes are passed onto offspring	1
• individuals that do not possess suitable genes die off	
• over time individuals change from original characteristic to having the more suited characteristics	
Speciation	
• no longer able to reproduce with others/new species	1
Total	5

- (b) What is random genetic drift? (2 marks)

Description	Marks
Is the change in the allele frequency in a population	1
Due to chance events/non-directional/due to small sample size	1
Total	2

- (c) Explain, using the most likely scenario (random genetic drift or natural selection), how sickle-cell anaemia became common in Nigeria. (5 marks)

Description	Marks
Sickle-cell has become prominent due to natural selection	1
Sickle-cell anaemia trait provides immunity against malaria	1
Malaria causes more mortality than sickle-cell anaemia	1
Sickle-cell trait is an advantage	1
Genes passed onto next generation from heterozygous individuals	1
Total	5

Question 37

(13 marks)

- (a) (i) Is the diagram above a representation of the mode of action of a lipid-soluble or a water-soluble hormone? (1 mark)

Description	Marks
Water-soluble	1
Total	1

- (ii) In the outline below, draw an annotated diagram of the mode of action of the other type of hormone than the one shown in the diagram above. (4 marks)

Description	Marks
Diagram shows the following points: one mark for each	
Diffuses across the cell membrane	1
Hormone attaches to receptor in cytoplasm/hormone-receptor complex formed in cytoplasm	1
Complex enters the nucleus	1
Complex binds to DNA activation of genes/transcription of mRNA/protein synthesis occurs	1
Total	4

- (b) Using the information in the diagram, identify the appropriate gland using letters 'A'–'I' in the table below. (3 marks)

Description	Marks
The pineal gland is – 'A'	1
Aldosterone is released from – 'F'	1
Hormones released from this gland target the bones – 'D'/'E'	1
Total	3

- (c) (i) State the type and the location of the receptors that detect changes which stimulate the production and release of antidiuretic hormone (ADH). (2 marks)

Description	Marks
Osmoreceptors	1
Found in hypothalamus/B	1
Total	2

- (ii) Explain how the structures labelled 'B' and 'C' in the diagram on the previous page are involved in the production and release of ADH. (3 marks)

Description	Marks
Produced in B/hypothalamus	1
Stored in C/posterior pituitary	1
Nerve impulse from B/hypothalamus triggers release	1
Total	3

Question 38

(12 marks)

- (a) Suggest a hypothesis that this experiment was designed to test. (1 mark)

Description	Marks
Statement linking independent and dependent variable	1
Total	1
Sample hypothesis: Use of the new asthma bronchodilator will increase blood oxygen concentration.	

- (b) Name the independent and dependent variables (2 marks)

Description	Marks
Independent – asthma bronchodilator	1
Dependent – blood oxygen concentration	1
Total	2

- (c) Why was a placebo used for group 2 participants? (1 mark)

Description	Marks
Comparison/control group	1
Total	1

- (d) State
- three**
- variables that would need to be controlled to ensure that the experiment was a fair trial. (3 marks)

Description	Marks
Any three of the following	1–3
Age/gender	
Same general health/previous health history	
Similar effects of asthma on blood oxygen concentration	
Similar daily exercise	
Same time of day for measuring blood oxygen concentrations	
Same method/volume/frequency of administration of bronchodilator	
Total	3

- (e) Explain how, under normal conditions, a change in gas concentrations in the blood brings about a response that returns the concentrations to acceptable homeostatic levels. (5 marks)

Description	Marks
Any five of the following	1–5
Chemoreceptors (in aorta, carotid artery and medulla oblongata) detect change (\downarrow pH/ \uparrow CO ₂)	
Send message to (respiratory control centre) the medulla	
Message sent along nerves	
Intercostal muscles and diaphragm stimulated to increase rate of contraction/respiratory muscles stimulated to increase rate of contraction	
Increases depth and rate of breathing	
Increase O ₂ concentration/ \downarrow CO ₂ / \uparrow pH	
Total	5

Question 39

(11 marks)

- (a) What name is given to this type of evidence for evolution? Describe how it provides evidence for evolution. (3 marks)

Description	Marks
Comparative anatomy/comparison of homologous structures	1
Structures show a high degree of structural similarity but perform different functions	1
Indicates shared common ancestry	1
Total	3

- (b) According to the theory of evolution, why are these six limbs similar and why are they different? (2 marks)

Description	Marks
Similar – at one point they all shared an ancestor who had the basic structure	1
Different – different selection pressures modified the structures to suit the environment	1
Total	2

- (c) (i) State **one** condition under which it would be suitable to date the vertebrate specimen using radiocarbon dating, and **one** condition under which it would be unsuitable. (2 marks)

Description	Marks
Suitable – useable organic material was found	1
Unsuitable – specimen older than 60 000 – 70 000 years	1
Total	2

- (ii) Describe the process of radiocarbon dating. (4 marks)

Description	Marks
Based on the decay of carbon-14 into nitrogen	1
Amount of carbon-14 is fixed at death	1
The ratio of carbon-14 to carbon-12 determines the age	1
Carbon-14 has a half-life of 5730 years	1
Total	4

Section Three: Extended answer

20% (40 Marks)

Question 40

(20 marks)

- (a) Describe the process involved in the body developing immunity to a certain bacteria or virus. (16 marks)

Description	Marks
Any 16 of the following	
Pathogen invades body	1–16
Macrophages engulf pathogens	
Macrophages present the non-self antigen/pathogen fragment (can also say B cells/antigen presenting cell or dendritic cells)	
Cytokines stimulate T cells/B cells	
B cells are sensitized and enlarged	
B cells divide producing clones/mitosis occurs	
Most B cells will develop into plasma cells	
Plasma cells produce antibodies	
Antibodies travel in the bloodstream	
Antibodies combine with specific antigens	
Antibodies inactivate or destroy non-self antigens	
Some B cells form memory cells	
Memory cells remain to increase immune response when reinfection occurs	
Intercellular pathogen infection will stimulate the T cells to become activated by non-self antigen	
T cells divide producing clones/mitosis occurs	
Killer T cells produced	
Killer T cells target and destroy infected cells/ engulf pathogenic cells via phagocytosis	
Macrophage will help to activate Helper T cells	
Helper T cells secrete cytokines	
Helper T cells attract B cells (to attach to) and activate	
Total	16

- (b) Provide the logical reasoning that led scientists to develop the 'hygiene hypothesis'. (4 marks)

Description	Marks
Any four of the following	
Less exposure to bacteria and viruses	1
No immune responses to pathogens have been triggered	1
Decrease immunity for wide range of infections/no natural immunity/no memory cells present	1
Increased chance of being infected	1
Over-production of histamine leads to allergies	1
Total	4

Question 41

(20 marks)

(a) Errors in DNA replication

(7 marks)

Description	Marks
Any five of the following	
DNA replication is the process where new strands of DNA are made	1–5
During replication (the DNA unzips and) complementary strands are formed	
Can cause substitutions/the wrong bases pair up during the process	
Can cause deletions/DNA can be removed	
Can cause insertions/DNA can be duplicated/extra DNA added	
Can cause frameshifts/incomplete DNA code/unreadable DNA code	
DNA that is formed undergoes cell division to create a new cell	
New cells have the wrong DNA code	
Any one of the following	
Results in gene or chromosome mutations/can affect one gene or a whole part of a chromosome	1
Results in somatic or germline mutations/mutations can affect individual or can be passed on	
Example – cancerous cells/sickle-cell anaemia/silent mutations/Huntington's disease/cystic fibrosis	1
Total	7

(b) During cell division

(7 marks)

Description	Marks
Any five of the following	
During cell division homologous chromosomes line up	1–5
Genetic material is swapped during cross over	
Can cause inversions/chromosomes segment reversed	
Can cause translocations/section of chromosome attaches to another	
Extra chromosomes can be added to cells/cells can lose chromosomes/aneuploidy/non-disjunction	
Gametes produced have faulty chromosomes/incorrect chromosome number	
Any one of the following	
Results in chromosomal mutations/affects whole parts of chromosomes	1
Results in germline mutations/mutations can be passed on	
Example – Down syndrome/XXY male/XO female	1
Total	7

Question 41 (continued)

- (c) From damage caused by mutagens (6 marks)

Description	Marks
Any five of the following	
Can resemble proteins and be incorporated into DNA	1–4
Can trigger DNA replication errors	
Can cause DNA breakages/lengthening	
Can block DNA replication/damage DNA structure	
Can chemically react and modify DNA	
Cells with damaged DNA multiply	
Any one of the following	
Results in gene and chromosomal mutations/can affect one gene or a whole part of a chromosome	1
Results in somatic or germline mutations/mutations can affect individual or can be passed on	
Examples – UV, mustard gas/ionising radiation/bromouracil	1
Total	6

Question 42**(20 marks)**

- (a) Much of the fossil record is incomplete. Explain why this is so and why it cannot represent the entire biodiversity of a time. (8 marks)

Description	Marks
Any eight of the following	
Most fossils formed from solid body parts such as bones and teeth/many organisms do not have hard structures	1–8
Need to be buried rapidly at time of death	
Specific sediment features are required for fossilisation such as low pH (acidic) and no oxygen/alkaline soils/lack of oxygen	
Bodies often scavenged before fossilisation could occur	
Organisms often decayed by micro-organisms	
Need to be left undisturbed for a long time/long time must pass for fossilisation to occur	
Fossils can be destroyed due to volcanic eruption/earthquakes/faulting and folding	
Weathering and erosion can destroy fossil remains	
Human activity/animal activity may disturb fossil remains	
Fossils may not be recognised	
May not be looking in the right place	
Layers of rock containing fossils may not be exposed at the surface - difficult to find deeply buried fossils	
Total	

- (b) Mitochondrial DNA (mtDNA) samples have been extracted from *Homo neanderthalensis* fossils and compared with those of modern humans. The focus was on differences in mtDNA to determine whether speciation had in fact taken place. Describe how the study of mtDNA can be used to support the theory of evolution and the relationship between *Homo neanderthalensis* and modern humans. (4 marks)

Description	Marks
Any four of the following	1–4
mtDNA only inherited from the mother	
Mutations occur more readily in mtDNA than in nuclear DNA	
The number of mutations that have occurred within a DNA molecule can be correlated with time elapsed.	
The greater the diversity in mtDNA the less closely related they are/less diversity more closely related species are	
Phylogenetic trees can be constructed to determine when divergence of <i>Homo neanderthalensis</i> occurred from modern humans	
Total	4

While fossil and artefact finds are limited, they can be used to show changes in both anatomy and culture.

- (c) (i) Name and describe what tools found near *Homo neanderthalensis* bones would have looked like. (4 marks)

Description	Marks
Mousterian tools/flake tools	1
Any three of the following	1–3
Flakes with reworked edges/sharpened edges	
Blade tools	
Core/scrapper tools	
Hand axe	
Some had handles/hafting	
Spear points	
Made of bone/ivory/antler	
Total	4

- (ii) State how the tools would have been manufactured and what they would imply about the way in which *Homo neanderthalensis* lived. (4 marks)

Description	Marks
Levallois method/large flake removed from stone core and then reworked/prepared stone and then flaked/pressure flaking	1
Any three of the following	1–3
Spears used to hunt large animals/meat eaters	
Scrapers could have been used to create clothing	
Hand axes may have been used for chopping animal meat	
Hand axes may have been used to create other tools	
Tools were used to make other tools	
Total	4

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