



HUMAN BIOLOGICAL SCIENCE

Stage 3

WACE Examination 2014

Marking Key

Marking keys are an explicit statement about what the examiner expects of candidates when they respond to a question. They are essential to fair assessment because their proper construction underpins reliability and validity.

Section One: Multiple-choice

(30 Marks)

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

Section Two: Short answer

(100 Marks)

Question 31

(9 marks)

- (a) (i) What collective name is given to the structures shown in the diagram? (1 mark)

Description	Marks
Vestigial (organs)	1
Total	1

- (ii) Provide another example of a structure in the human body that could be classified in the same category as those shown in the diagram. (1 mark)

Description	Marks
Coccyx/body hair/tonsils/nictitating membrane of the eye/pointed canine teeth/segmented abdomen muscles/pyramidalis muscle/piloerector muscles	1
Total	1

- (iii) Explain how the structures shown in the diagram could provide evidence for evolution. (3 marks)

Description	Marks
Any three of:	1-3
<ul style="list-style-type: none"> • The structures are remains of organs that were required in ancestral forms • Natural selection pressures have reduced the organs/natural selection pressures have made them non-functional • No longer essential/body does not waste energy on maintaining structures • Suggests ancestral relationship with organisms that have functional forms of the same organs 	
Total	3

- (b) (i) What name is given to the type of evidence for evolution represented in the diagram? (1 mark)

Description	Marks
Comparative embryology/developmental anatomy	1
Total	1

- (ii) Describe how the evidence shown in the diagram provides support for the theory of evolution. (1 mark)

Description	Marks
Any one of:	1
<ul style="list-style-type: none"> • Closely related organisms show more similar anatomical development in the embryonic/early stages of life • More distantly related organisms show greater differences anatomy/earlier differences in embryonic development 	
Total	

- (iii) Could a similar diagram be drawn to include humans as an example in the same category as the three organisms shown in the diagram above? Justify your answer. (2 marks)

Description	Marks
Yes	1
It is a vertebrates/ show similar embryonic stages/stages of early life/embryos of organisms (vertebrates) are easy to compare at an early stage	1
Total	2

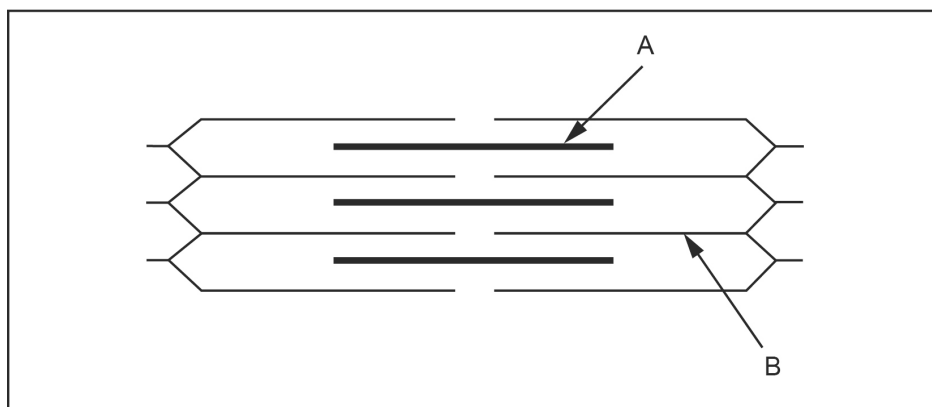
Question 32

(14 marks)

- (a) (i) Identify the proteins labelled as A and B in the diagram. (2 marks)

Description	Marks
A – Myosin	1
B - Actin	1
Total	2

- (ii) In the box below, accurately draw the same sarcomere as it would appear when the muscle is contracted. (2 marks)



Description	Marks
Diagram same length and width of myosin and actin as in first diagram	1
Diagram shows shortening of sarcomere/filaments closer together/Z lines closer together	1
Total	2

- (iii) Explain what has happened to cause the change you have shown in the diagram between the relaxed and contracted positions of the sarcomere. (2 marks)

Description	Marks
Any two of:	
<ul style="list-style-type: none"> • Calcium exposes binding sites on actin • Myosin cross bridges form/myosin attaches to actin/A attaches to B • Actin filaments slide over the myosin filaments/B slides over A/cross bridges cycling 	1–2
Total	2

- (b) Name **one** other muscle type and state **one** way in which the structure of this type of muscle differs from skeletal muscle. (2 marks)

Description	Marks
One mark for naming muscle type, one mark for characteristic	1-2
Smooth/involuntary	
Any one of :	
<ul style="list-style-type: none"> • Lacks striations • Mononucleate/single nucleus • Cells smaller than in skeletal • Cell shape has tapered ends • Long shape 	
Cardiac	
Any one of :	
<ul style="list-style-type: none"> • Mononucleate/single nucleus/double nuclei • Contains intercalated discs • T tubules are larger/broader than in skeletal • Branched fibres/not parallel • Short shape 	
Total	2

- (c) (i) Describe the role of each of these enzymes in the production of the gene that would have been injected into the laboratory mice. (4 marks)

Description	Marks
Restriction enzyme Isolates the gene (DNA) by cutting it at a recognition (selected) site	1-2
A plasmid is cut with the same type of restriction enzyme	
Produce sticky ends	
DNA ligase Joins the isolated gene and plasmid together	1
Joins at the sticky ends (of each)	1
Total	4

- (ii) Large numbers of the gene are needed for the experiment. Describe how they are produced using recombinant DNA technology. (2 marks)

Description	Marks
Combined gene and plasmid are inserted into a vector/bacterial cell	1-2
Vector is cloned/reproduces to produce copies of the gene	
or Gene is inserted into a virus which acts as a vector	
When virus enters the mice it multiplies to produce more copies of the gene	
Total	2

Question 33

(10 marks)

- (a) Describe the past and present conditions required in the Linha São Pedro population to enable the founder effect to occur. (3 marks)

Description	Marks
Small original population	1
With at least one (or more) individuals carrying the alleles/genes	1
Restricted breeding/inbreeding within the population/isolation from other populations	1
Total	3

- (b) The Linha São Pedro population could also be a useful group to study for a better understanding of epigenetics. Explain why the scientists would be interested in the Linha São Pedro population for a study in epigenetics. (2 marks)

Description	Marks
Identical twins are the best subjects for epigenetic studies/high frequency of twins in population	1
Twins have the same genotype/non-genetic effects can be shown in their phenotype	1
Total	2

- (c) Tay-Sachs disease is genetically inherited. It is a lethal recessive disease that is relatively common in certain populations.

Identify a population that has a high incidence of Tay-Sachs disease. (1 mark)

Description	Marks
Ashkenazi/Jewish population/Eastern European descent/Cajun population of Louisiana/French Canadians	1
Total	1

- (d) The high incidence of Tay-Sachs disease in certain populations can also be accounted for by the founder effect. However, some scientists also support the theory of heterozygous advantage. This means that the Tay-Sachs disease allele continues in the population due to natural selection. If this theory is accepted, what benefit must people carrying the affected Tay-Sachs disease allele have compared with non-carriers? (1 mark)

Description	Marks
Survival advantage/are positively selected for/increased protection from T.B.	1
Total	1

- (e) List **three** features required for natural selection to occur in a population. (3 marks)

Description	Marks
Variation/genetic difference	1
Competition/struggle to survive/selective pressures	1
High birth rate/large number of offspring/reproduction	1
Total	3

Question 34

(13 marks)

- (a) Name and describe the structure of the part of the cell membrane labelled A. (3 marks)

Description	Marks
Phospholipid bilayer	1
Hydrophilic heads	1
Hydrophobic tails	1
Total	3

- (b) Identify the type of protein labelled as B in the diagram. (1 mark)

Description	Marks
Carrier	1
Total	1

- (c) Explain how Substance X is able to move from the outside to the inside of the cell. (2 marks)

Description	Marks
Any two of:	1-2
<ul style="list-style-type: none"> Substance X is lipid soluble/steriod Diffuses across cell membrane/does not require energy to move across membrane Higher concentration outside the cell/lower concentration inside cell 	
Total	2

- (d) Explain how Substance Y is able to move from the inside to the outside of the cell. (2 marks)

Description	Marks
Any two of:	1-2
<ul style="list-style-type: none"> Binds to the (carrier) protein Requires energy/ATP/against concentration gradient/low-high concentration Molecule moves through protein and is released on the outside 	
Total	2

- (e) The protein labelled Structure B is produced in a step by step process, known as protein synthesis, commencing in the nucleus. Explain how parts within the cytoplasm are involved in the production of proteins. (5 marks)

Description	Marks
Any five of:	1-5
<ul style="list-style-type: none"> (One end of the) mRNA attaches to a ribosome Ribosome reads a codon/3 mRNA bases at a time A codon determines one amino acid tRNA brings amino acids to the ribosome tRNA contains anticodons/bases complementary to mRNA Ribosome joins amino acids together to form a polypeptide chain/Molecule B 	
Total	5

Question 35

(15 marks)

- (a) (i) Propose a hypothesis for the experiment. (1 mark)

Description	Marks
Statement including independent and dependent variable/nil hypothesis/null hypothesis (eg. Consumption of saline solution will decrease urine production)	1
Total	1

- (ii) List **two** variables that were controlled in the experiment. (2 marks)

Description	Marks
Any two of:	1-2
<ul style="list-style-type: none"> • Volume/amount of fluid consumed • Length of time of recording urine production • Length of time to consume fluid • Temperature for duration of experiment • Temperature for both groups • Amount of/minimal physical activity for both groups 	
Total	2

- (b) Suggest how researchers could increase the

- (i) validity of the experiment. (1 mark)

Description	Marks
Establish more controlled variables/improve experimental design/specific answer referring to the experiment	1
Total	1

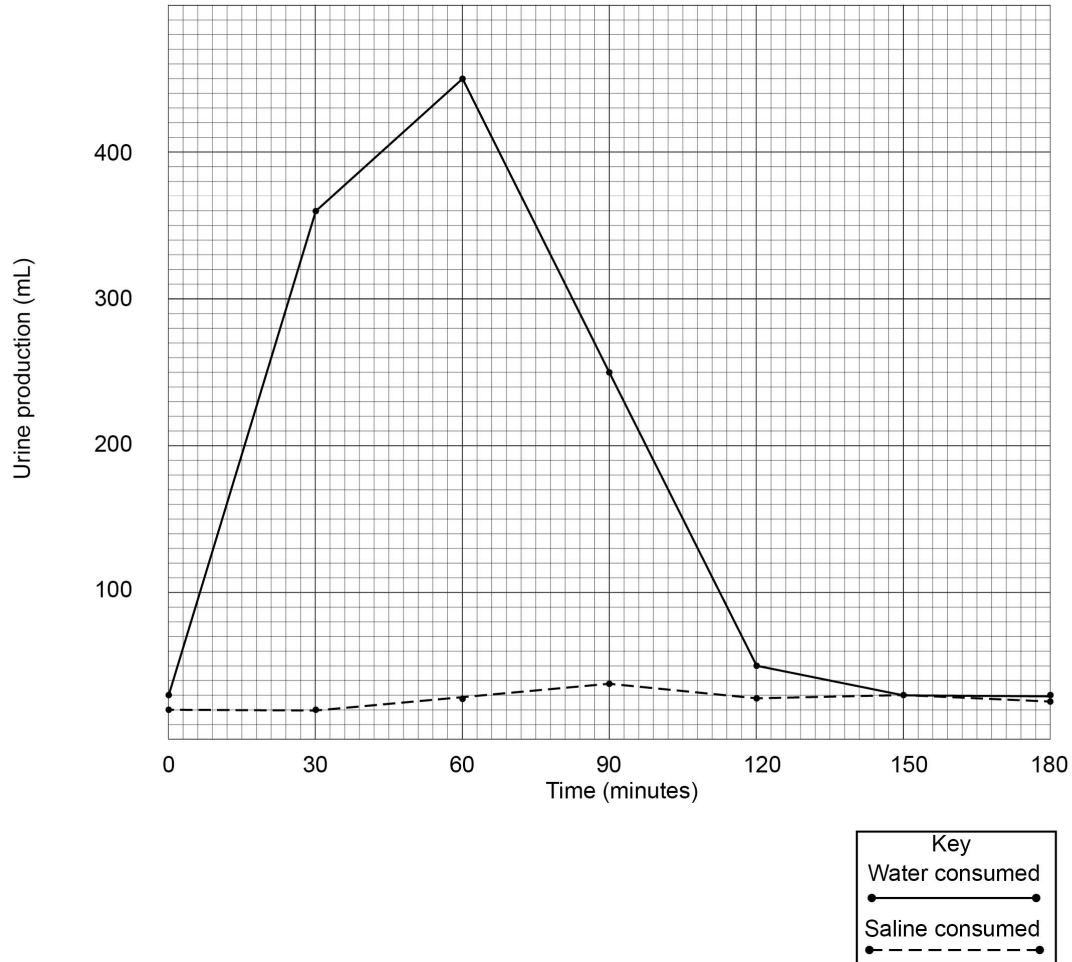
- (ii) reliability of the results. (1 mark)

Description	Marks
Repeat experiment again/replicate/increase sample size/specific answer referring to the experiment	1
Total	1

(c) Graph the data in the table on the grid below.

(5 marks)

(e.g.) Relationship between water and saline solution consumption and urine output over time



Description	Marks
Correctly plots points and joins points to form a line/curve	1
Labelling of axes with correct name and unit	1
Uses a suitable scale	1
Title appropriate with both variables included	1
Key for lines/identify lines	1
Total	5

- (d) (i) Identify the hormone directly involved in the maintenance of water balance in the body and state the specific part of its target organ that it influences. (2 marks)

Description	Marks
Antidiuretic hormone/ADH	1-2
Distal convoluted tubule/collecting duct of nephron	
or	
Aldosterone	
Loop of Henle/distal convoluted tubule/collecting duct	
Total	2

- (ii) On the basis of the results of the experiment, the consumption of which fluid, water or saline, would have triggered the release of the hormone identified in part (d)(i)? (1 mark)

Description	Marks
Saline	1
Total	1

- (iii) Explain why people suffering dehydration are given either a saline solution to drink or a saline intravenous drip rather than only water. (2 marks)

Description	Marks
Saline solution increases osmotic pressure/saline solution does not lower osmotic pressure/drinking saline solution triggers ADH production/saline solution increases water reabsorption/saline solution triggers osmoreceptors	1
Allows fluid to be added back to the body without increasing urine production/allows the consumed fluid to not be lost through urine/body is rehydrated faster	1
Total	2

Question 36

(10 marks)

- (a) Identify structures A, B and C indicated by arrows on the diagram. (3 marks)

Description	Marks
A - Hypothalamus	1
B - Cerebrum/cerebral cortex/sulci/parietal lobe	1
C - Cerebellum	1
Total	3

- (b) (i) In which part of the brain would damage have occurred to cause this form of ataxia? (1 mark)

Description	Marks
Cerebellum/C	1
Total	1

- (ii) Name **two** other symptoms, apart from shaking or tremor, that a person would have if the area in part (b)(i) was damaged. (2 marks)

Description	Marks
Any two of:	1-2
• Lack of balance	
• Lack of muscle tone/hypotonia/floppiness	
• Reduced speed of movements	
• Inability to estimate how much time has passed	
• Inability to compare actual and intended movement	
Total	2

- (iii) Explain why a person with this form of ataxia can still move their muscles even though this movement cannot be coordinated. (2 marks)

Description	Marks
Conscious control of movement is in the cerebrum (so not affected)	1
Cerebrum doesn't need to receive sensory information from outside the brain/the cerebellum needs to receive sensory information from outside the brain.	1
Total	2

- (c) The brain is a very delicate organ and needs to be protected from damage by other structures that surround it. Name **one** of these structures and explain how it protects the brain. (2 marks)

Description	Marks
Cranium/skull	1-2
Hardness of the cranium/shape of the skull is rounded to glance off blows/encases brain	
or	
Meninges	
Outer layer is tough/inflexible – prevents the brain moving/inner layer is sealed so protects against infection	
or	
Cerebrospinal fluid	
Cushions/shock absorbs	
Total	2

Question 37

(11 marks)

- (a) The feedback loop below is incomplete, as information is missing from the receptors, modulator and effectors boxes. Complete the feedback loop by writing the appropriate word/s in the spaces provided. (3 marks)

Description	Marks
Carotid/aortic bodies	1
Respiratory	1
Respiratory muscles or Diaphragm and intercostals/rib muscles	1
Total	3

- (b) There are two main modes of transmission of messages in the body. These are carried out either by hormones or nerves. Which of these is stimulating the effectors in the diagram above? (1 mark)

Description	Marks
Nerves/nervous	1
Total	1

- (c) As the carbon dioxide in the blood increases, there is also a change in hydrogen ion concentration and the pH of the blood. Describe these changes. (2 marks)

Description	Marks
Increase in hydrogen ion concentration	1
Decrease in pH//higher acidity	1
Total	2

- (d) Explain how an increase in blood pressure is brought about in this situation. (5 marks)

Description	Marks
Any five of:	1-5
<ul style="list-style-type: none"> • Low blood pressure • Detected by baroreceptors/pressure receptors • (Nerve impulses are sent to the) cardiovascular centre/medulla oblongata • Sympathetic nerve impulses stimulate • The SA node • Increase heart rate and stroke volume/cardiac output • Vaso/veno constriction 	
Total	5

Question 38

(8 marks)

- (a) Place the skulls A, B, C, and D in the correct evolutionary sequence, from oldest to most recent.

(1 mark)

Description	Marks
D-B-C-A	1
Total	1

- (b) Describe the evolutionary trend that can be seen in hominin fossils associated with the jaw. Explain why this trend is believed to have occurred.

(2 marks)

Description	Marks
Reduction in jaw/progressively flatter face/more parabolic	1
Increase size of cranium/skull better balanced for bipedalism	1
Total	2

- (c) The hunter-gatherer way of life was gradually replaced by the agricultural way of life in various regions of the world. Give **three** reasons for the lifestyle change from a hunter-gatherer to an agricultural way of life.

(3 marks)

Description	Marks	
Any three of:	1-3	
<ul style="list-style-type: none"> • Need for more food to support larger populations • Desire for more permanent settlements/began staying in one place for longer periods of time • Reduction in big game animals for hunting • Warm climate with adequate rainfall for growing crops • Water supplies/rivers nearby • Animals available for domestication/available crops • Fertile soils 		
Total		3

- (d) Outline **two** cultural developments that accompanied the change from a hunter-gatherer to an agricultural way of life.

(2 marks)

Description	Marks	
Any two of:	1-2	
<ul style="list-style-type: none"> • Settling down to form larger villages • Development of social hierarchy • Trade between communities • Occupational specialisation • Development of new tools • More time to spend on other cultural aspects (such as pottery, art) • Production of metals 		
Total		2

Question 39

(10 marks)

- (a) Identify the region of the axon labelled as structure 'X'. (1 mark)

Description	Marks
Node of Ranvier	1
Total	1

- (b) State **one** function of the structure labelled 'Y'. (1 mark)

Description	Marks	
Any one of:	1	
<ul style="list-style-type: none"> • Insulate axon/fibre • Protect axon/fibre from damage • Faster nervous transmission • Saltatory conduction/propagation • Produce myelin 		
Total		1

- (c) The arrows drawn along the axon show the direction of a nervous impulse. The impulse in this neuron would travel via saltatory conduction. Describe how a nervous impulse is propagated along this type of fibre. (4 marks)

Description	Marks	
(Depolarisation) occurs at Nodes of Ranvier along fibre/occurs at X/jumps from node to node	1	
Any three of:	1-3	
<ul style="list-style-type: none"> • (Sodium channels open for) sodium ions to diffuse in across membrane • Inside membrane becomes positive in relation to outside • (following depolarisation sodium channels close and potassium channels open for) potassium ions to diffuse out across membrane • Inside membrane becomes negative in relation to outside • A sodium-potassium pump transports sodium ions out of the cell and potassium ions in to return to a polarised/resting state 		
Total		4

- (d) Calcium plays an important role in the functioning of the nervous system. Explain how the thyroid and parathyroid glands ensure calcium supplies are balanced.

- (i) Thyroid (2 marks)

Description	Marks
Calcitonin released (from thyroid gland) in to blood	1
Osteoclasts inhibited/osteoblasts stimulated/deposit calcium into the skeleton/less calcium in blood	1
Total	2

- (ii) Parathyroid (2 marks)

Description	Marks
Parathormone released (from parathyroids) into blood	1
Osteoclasts stimulated/release calcium from skeleton/increases calcium absorption from gut/increase activation of vitamin D/more calcium in blood	1
Total	2

Section Three: Extended answer

(40 Marks)

Question 40

(20 marks)

An elderly man visited the doctor and was diagnosed with osteoarthritis in his left hip joint. The doctor needed to inform the man about the disease and how it could be treated.

- (a) Summarise the information about osteoarthritis that the doctor would have provided to the man. Include in your answer the possible causes and risk factors that could lead to developing the disease, its effects on the body and the treatment options for osteoarthritis sufferers. (11 marks)

Description	Marks
Causes and risk factors	
Any three of:	
<ul style="list-style-type: none"> • Aging/over 45 • Joint injury/overuse • Hereditary factors • More common in females • Obesity • Joint alignment issues/dislocating joints/bow legged/double-jointedness • Exact causes unknown 	1–3
Effects	
Any five of:	
<ul style="list-style-type: none"> • (Articular) cartilage softens/degenerates/roughens/wears away • Bone tissue is exposed • Ends of the bones rub together • Bone spurs develop/joint deformity/ends of bones thicken/joint may lose its normal shape/bone wears away • Restricting movement/causing pain with movement • Inflammation of the joint /swelling of joint 	1–5
Treatments	
Any three of:	
<ul style="list-style-type: none"> • Pain medication • Anti-inflammatory drugs • Physiotherapy • Injections (cortisol/lubrication) • Joint replacement surgery • Joint realignment surgery • Maintaining a healthy lifestyle/physical activity/maintaining healthy weight 	1–3
Total	11

- (b) The hip joint is classified as a synovial joint. Name and describe **four** different types of synovial joints and identify to which one of these types the man's affected hip joint belonged. (9 marks)

Description	Marks
Affected hip joint Ball and socket joint	1
Any 4 synovial joints: (1 mark for name and 1 mark for description)	1-8
Hinge joint	
Convex surface of one bone fits into concave surface of another/allows movement in one plane/allow flexion and extension movements	
or	
Ball and socket joint	
Spherical head of one bone fits into cup cavity of another/allows movement in all directions	
or	
Pivot joint	
Pointed end of one bone fits into ring of another/allows rotational movement/one bone rotates around another	
or	
Gliding joint	
Irregular shaped bones held together by ligaments/allows bones to slide past one another/movements side to side or back and forth	
or	
Saddle joint	
Two bones both saddle shaped fit together to form joint/allows side to side or back and forth movement/allows flexion, extension, abduction and adduction movements (circumduction)	
or	
Condyloid joint	
One convex surface of a bone fits into a concave surface of another bone/allows movement in two directions/allows flexion, extension, abduction and adduction movements (circumduction)	
Total	9

Question 41

(20 marks)

Tuberculosis is an infectious disease that is caused by a bacterium called *Mycobacterium tuberculosis*.

- (a) If a person is infected with *Mycobacterium tuberculosis*, antibodies are produced to fight the infection.

Describe the immune response that produces antibodies and explain how the antibodies act to fight the bacterial infection. (8 marks)

Description	Marks
Production of antibodies	
Any five of:	
<ul style="list-style-type: none"> • Antigen/pathogen (for tuberculosis) enters the body • Macrophage engulfs the pathogen • Displays the antigen on its surface/displays the antigen presenting cells (dendritic cells) • Specific B lymphocytes/B cells recognize the antigen • Sensitized and enlarged • Mitosis/cloning/dividing occurs • B lymphocytes/B cells produce plasma cells • Plasma cells produce antibodies (release into the bloodstream) 	1–5
Action of antibodies	
Any three of:	
<ul style="list-style-type: none"> • Inactivate antigens/neutralise antigens/form an antigen-antibody complex • Combine with foreign bacterial toxins • Coat bacteria/opsonisation • Enhanced phagocytosis/make them more easily consumed by phagocytes (macrophages) • Cause leakage of contents/make cell membranes permeable of bacteria/make cell membrane permeable of foreign cell • dissolve organisms • Make soluble substances insoluble/form a precipitate/agglutination 	1–3
Total	8

- (b) It is difficult to gain a sample of the *Mycobacterium tuberculosis* bacteria from patients and the bacterial cultures grow very slowly in the laboratory. Polymerase Chain Reaction (PCR) based tests have enabled more rapid detection of small numbers of the bacteria.

Name and describe the **three** steps involved in the PCR process. (12 marks)

Description	Marks
Step 1 - Denaturation	1
<ul style="list-style-type: none"> • Heating of double stranded DNA (94 – 98 °C) • Disrupts hydrogen bonds between complementary bases • Separation of the strands/single strand of DNA produced 	1–3
Step 2 – Annealing/Hybridization	1
Any three of:	1–3
<ul style="list-style-type: none"> • Temperature is lowered (50-65°C) • Primer is a small single strand of DNA • DNA strand binds to complementary base sequences • DNA is annealed to a primer • Starts the replication 	
Step 3 – Extension/Elongation/Synthesis	1
Any three of:	1–3
<ul style="list-style-type: none"> • Taq/DNA polymerase binds to the primer (DNA template hybrid/combined primer and single DNA strand) • Polymerase synthesizes a new DNA strand • Complementary to the DNA template strand • Segments of single stranded DNA are replicated • Through a repeated series of cycles/this process is repeated many times/a series of cycles of heating and cooling. 	
Total	12

Question 42

(20 marks)

- (a) Describe the roles of the hypothalamus and pituitary gland and explain how they work together. (12 marks)

Description	Marks
Hypothalamus controls release of hormones from the pituitary	1
Pituitary releases hormones that control many other endocrine glands/pituitary is the master gland	1
Any two of:	1-2
<ul style="list-style-type: none"> Hypothalamus regulates many basic bodily functions/regulates body temperature/water balance/heart rate/named example with function 	
<ul style="list-style-type: none"> Pituitary hormones regulate many bodily activities/regulates growth/regulate metabolism/regulate reproductive cycles/named example with function 	
<ul style="list-style-type: none"> Infundibulum connects hypothalamus to pituitary Hypothalamus works differently for the two lobes of pituitary 	
Posterior	1
Hormones are produced in cell bodies located in the hypothalamus/not produced by pituitary	
Hormones are transported down the axons (neurosecretory cells) of the cells to the posterior lobe	
Hormones stored in posterior lobe	
Released via nervous stimulation	
Anterior	1
Hormones produced in anterior lobe	
Blood vessels (hypothalamic-hypophyseal portal system) connects hypothalamus with the anterior lobe	
Released via chemical/hormonal stimulation	
Inhibiting and releasing factors secreted by hypothalamus	
Total	12

(b) Contrast the modes of action of steroid and amine hormones.

(8 marks)

Description	Marks
Steroid	
Any four of:	
<ul style="list-style-type: none"> • Receptor inside cytoplasm/receptor on nucleus • Moves through cell membrane • Hormone receptor complex forms inside cytoplasm • Enzymes activated inside nucleus/organelles • Genes activated to form a particular protein • Slower acting/effects in hours or days 	1–4
Amine	
Any four of:	
<ul style="list-style-type: none"> • Receptor on the surface/cell membrane • Stays outside of cell • Hormone receptor complex forms on the cell membrane/surface • Enzymes activated within the cytoplasm • Secondary messenger within cytoplasm is activated • Faster acting/effects in seconds or minutes 	1–4
Total	8

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