

HUMAN BIOLOGY

Student Name: _____

Time allowed for this paper

Reading Time: 10 minutes

Working Time: 105 minutes

Materials required/recommended for this paper

To be provided by the candidate

Standard Items: Blue/black pen ONLY, pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighter

Special Items: non-programmable calculators approved for use in this examination

Structure of this paper

Section	Number of questions available	Suggested working time (minutes)	Marks available	Percentage of examination
Section Two: Mixed Response		105	114	100
Total				100

Question 1

Bacteriophages are responsible for the conversion of harmless strains of *Vibrio Cholerae* into highly virulent strains that result in Cholera. This disease is most common in places with poor sanitation as it is usually found in food or water contaminated by faeces from an infected individual. When a person consumes the contaminated food or water, the bacteria release toxins in the intestines that produce severe diarrhoea. (15 marks)

a. Define what a bacteriophage is and explain how it is capable of infecting bacteria cells like *Vibrio Cholerae*. (3 marks)

b. Name the protective reflex initiated by this bacterium and explain how it can lead to dehydration. (3 marks)

c. Although there is a vaccine against Cholera, the World Health Organisation doesn't normally recommend it because it only lasts up to a few months. Describe what type of vaccine the Cholera vaccine is. (2 marks)

d. Name one type of antibiotic and what effect it would have on Cholera. (2 marks)

e. Malaria is another common infection carried in contaminated water. In countries where malaria is prevalent, those who have the allele for Sickle-Cell Trait but also have a normal allele, are immune to the infection. Hence, this is an example of: (1 mark)

f. Explain why the Sickle-Cell allele frequency is much higher in countries where malaria is prevalent compared to Australia. (4 marks)

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Question 2

Jonathan has the influenza virus. Due to the nature of this virus he developed a fever and began to shiver and notice an increase in body temperature. (14 marks)

- a. Using your knowledge of how a fever occurs, explain using a specific hormone cascade/feedback loop how the regulation of metabolism can contribute to the symptoms of a fever. (5 marks)

- b. Using your answer from part a, state whether this model in relation to fever is an example of positive or negative feedback and why. (2 marks)

- c. There is another endocrine gland that is capable of increasing metabolism. Name and describe the organ and how it is capable of increasing core body temperature (3 marks)

d. Explain how the influenza virus, acted on the hypothalamus to cause Jonathan to develop a fever (4 marks)

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Question 4

In the body, corticosteroid hormones are responsible for the regulation of blood sugar, the inflammatory response and metabolism. Artificial Corticosteroids can be produced as topical treatments to reduce common rashes or eczema. Topical corticosteroids are absorbed into skin cells, inhibiting the production of prostaglandins which are lipid compounds responsible for the acute symptoms of inflammation. (13 marks)

a. Discuss how topical corticosteroids are absorbed by skin cells to regulate the production of prostaglandins. (4 marks)

b. Prostacyclin is a specific type of prostaglandin. It acts on cells by inducing vasodilation, bronchodilation and by inhibiting platelet aggregation. Explain how two hormones involved in the inflammatory response work in similar ways to prostacyclin. (2 marks)

c. One of the acute symptoms of inflammation is swelling. State which effector is responsible for this symptom and how it's response leads to swelling. (2 marks)

Question 5

Simon accidentally stood on a nail and immediately pulled his foot away in pain.

(8 marks)

a. Illustrate the reflex action that allowed Simon to instantly pull his foot away. Ensure you label the diagram with the specific neurons and nervous devisions. (4 marks)

b. State the neurotransmitter involved in this response. (1 mark)

c. After Simon stood on the nail he was unable to feel his foot. Gradually over three weeks Simon regained sensation in his foot. Discuss which type of neuron fibre in the afferent division was damaged and why he was able to regain feeling. (3 marks)

b. Even though both digests were sourced from the same bacterium they produced a large discrepancy in the banded patterns produced. State why this was the case. (3 marks)

c. The 5' recognition sequence for EcoRI is 5'GAATTC. Write the 3' recognition sequence and contrast between 5' and 3' DNA ends. (2 marks)

D. Using the results above, state which suspect was present at the crime scene. (1 mark)

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Question 8

A scientist was investigating CIPA to determine how environment influences the occurrence and severity of the condition. CIPA is a hereditary sensory and autonomic disorder which is passed down as an autosomal recessive trait. It prevents the formation of nerve cells which respond to pain and heat. Before beginning research he developed the following hypothesis: (10 marks)

'Hyperthermia kills more than half of all children with CIPA before the age of three.'

a. State the type of neuron that is prevented from forming as a result of CIPA. (1 mark)

b. Justify the scientists hypothesis by outlining how CIPA may result in hypothermia and why it can become fatal. (5 marks)

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c. The scientist examined a Japanese family line that had a high occurrence of CIPA. He found that the inheritance could be traced back to a small group of individuals who were closely related. State and describe the process that enabled the allele frequency of CIPA to increase in this family (4 marks).

Question 9

A team of archeologists were excavating a site in remote Northern Russia, a common site for the discovery of fossils between the ages of 1.4 to 2 million years old. After days of searching they finally uncovered a skull fossilised in sedimentary rock believed to belong to a Hominid species. A digital scan of the skull they found is shown below: (11 marks)



a. With reference to the age range of fossils discovered at the site and the image, name the hominid the skull belongs to and describe the tool culture of this species. (2 marks)

b. Describe how the location of the fossils discovery aided in its preservation (2 marks)

c. (i) Outline why both absolute dating techniques may not be suitable for the dating of this skull. (2 marks)

(ii) Name and describe one relative dating technique that would be most suitable for the approximation of the skulls age (3 marks)

b. Describe two distinguishing features which prove this skull belongs to a species more modern than the Australopithecines (2 marks)

Marking Key for Exam

Question 1

a. Define what a bacteriophage is and explain how it is capable of infecting bacteria cells like *Vibrio Cholerae*. (3 marks)

Bacteriophages are viruses that attack bacterial cells (1)

They attach themselves to a host cell and inject their DNA/RNA (1)

Inside the cell genetic material is replicated and the new viruses are released by rupturing the cell (1)

b. Name the protective reflex initiated by this disease and explain how it can lead to dehydration. (3 marks)

- Diarrhoea (1)

- Walls of the large intestine/colon become inflamed and contract more readily (1)

- Water passes through the large intestine at a faster rate (1)

- Less water is absorbed leading to a lower volume of water in blood/Dehydration (1)

c. Although there is a vaccine against Cholera, the World Health Organisation doesn't normally recommend it because it only lasts up to a few months. Describe what type of vaccine the Cholera vaccine is. (2 marks)

- Dead Micro-Organism (1) Patient injected with dead pathogen (1)

- OR

- Toxoid (1) Toxins produced by bacteria are injected (1)

d. Name one type of antibiotic and what effect it would have on Cholera. (2 marks)

- Bactericidal (1) kill cholera directly, altering cell wall/ disrupting production of cholera's essential enzymes (1)

- OR

- Bacteriostatic (1) prevents cholera cells from growing/prevent protein synthesis (1)

e. Malaria is another common infection carried in contaminated water. In countries where malaria is prevalent, those who have the allele for Sickle-Cell Trait but also have a normal allele, are immune to the infection. Hence, this is an example of (1 mark)

- co-dominance (1)

f. Explain why the Sickle-Cell allele frequency is much higher in countries where malaria is prevalent compared to Australia. (4 marks)

- those exhibiting sickle-cell trait co-dominance have a survival advantage/ immunity to malaria (1)

- These individuals are more likely to reproduce and survive. (1)

- Thus sickle-cell Anaemia allele frequency is higher in countries affected by malaria (1)

- Sickle-Cell allele frequency is lower in Australia because there is no advantage in having sickle-cell trait/ Malaria is not prevalent (1)

Question 2

a. Using your knowledge of how a fever occurs, explain using a specific hormone cascade/feedback loop how the regulation of metabolism can contribute to the symptoms of a fever. (5 marks)

- Hypothalamus releases TSHrF in response to over-cooling (1)

- TSHrF travel through blood capillaries (1)

- stimulates the anterior lobe of the Pituitary gland to increase production AND release of TSH (1)

- TSH stimulates the thyroid to increase production AND release of thyroxine (1)

- Thyroxine increases Basal Metabolic Rate (BMR) which in turn generates more heat (1)

b. Using your answer from part a, state whether this model in relation to fever is an example of positive or negative feedback and why. (2 marks)

- Positive feedback (1)

- Original stimulus is increased/amplified (1)

c. There is another endocrine gland that is capable of increasing metabolism. Name and describe the organ and how it is capable of increasing core body temperature (3 marks)

- adrenal medulla is stimulates when core body temperature drops (1)

- This results in the release of Noradrenaline and Adrenaline (1)

- Adrenaline causes an increase in cellular metabolism which produces heat (1)

d. Explain how the influenza virus, acted on the hypothalamus to cause Jonathan to develop a fever (4 marks)

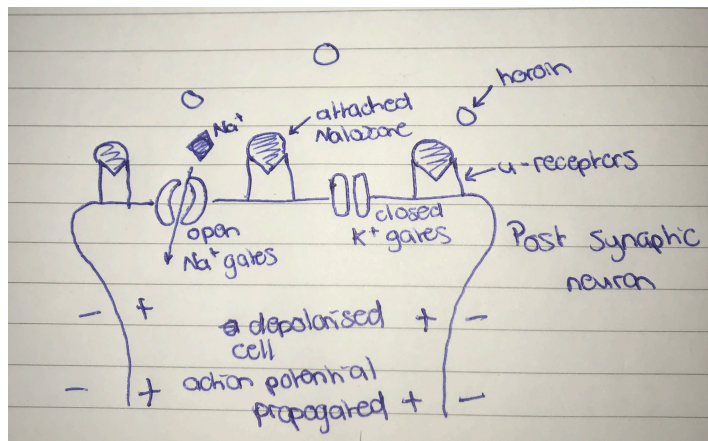
- Pathogen releases endotoxins/toxins/pyrogens OR Cytokines produce pyrogens (1)
- Pyrogens/Interleukin-1 released into blood (1)
- Pyrogens alter body's temperature sensors (making the body think it is cooler than it actually is) (1)
- Hypothalamus responds to pyrogens resetting internal thermostat (1)

(PAY ATTENTION TO THIS QUESTION, WAS THE MOST POORLY DONE IN 2017 WACE EXAM)

Question 3

a. Discuss with the aid of a diagram how *Naloxone* is capable of suppressing the effects of Heroin. (5 marks)

- Due to Naloxone's similar shape to heroin it is specific to μ -receptor sites and binds to those located on post-synaptic neuron (1)
- μ -receptors become saturated with naloxone, therefore leaving no places for heroin to bind (1)
- Naloxone stimulates opening of sodium ion (Na^+) channels which causes the inside of the cell to become positively charged on the inside relative to the outside (1)
- An action potential is propagated and effects of heroin reduced (1)
- Diagram (1)



B. Using your knowledge of the brain, explain how Heroin is capable of decreasing breathing rate to the point where an individual may lose consciousness. (5 marks)

- Heroin binds to μ -receptors that exist in respiratory centre of medulla oblongata (1)
- Potassium ion (K^+) gates are stimulated to open, causing inside of cell to become negatively charged (1)
- If there is a negative charge inside the cell and a positive charge outside, the cell remains polarised/becomes hyper polarised (1)
- Action potential is prohibited and respiratory centre does not respond to stimulate breathing (1)

Question 4

a. Discuss how topical corticosteroids are absorbed by skin cells to regulate the production of prostaglandins. (4 marks)

- lipid soluble hormone diffuses across cell membrane (1)
- Binds to receptor inside the cell to form the hormone-receptor complex (1)
- Hormone receptor complex enters nucleus (1)
- Activates genes controlling protein synthesis/regulation of prostaglandins (1)

b. Prostacyclin is a specific type of prostaglandin. It acts on cells by inducing vasodilation, bronchodilation and by inhibiting platelet aggregation. Explain how two hormones involved in the inflammatory response work in similar ways to prostacyclin. (2 marks)

- Histamine: Increases blood flow to the affected site through vasodilation (1)
- Heparin: prevents blood clotting in the localised area (ie. platelet aggregation) (1)

c. One of the acute symptoms of inflammation is swelling. State which effector is responsible for this symptom and how it leads to swelling. (2 marks)

- Blood vessels/capillaries (1)
- Vasodilation increases permeability of blood vessels (1)
- Increased permeability increases volume of fluids and therefore phagocytes in the area, contributing to swelling (1)

d. Corticosteroids have many other functions other than assisting the inflammatory response. Name the naturally occurring source of this hormone in the body and describe how it is capable of increasing blood glucose levels. (5 marks)

- cortisol from adrenal cortex (1)
- In stressful situations, cortisol increases blood glucose to combat stress (1)
- This is achieved by inhibiting insulin/gluconeogenesis/increasing glycogen formation in the liver (1)

Question 5

Thermoregulation can also be assisted by behavioural mechanisms. Identify four behaviours that lower internal temperature when it is in danger of rising above tolerance limits and outline how each of these assist in maintaining internal temperature. (8 marks)

- **2 marks each for any 4 of the following:**

- e.g 1

- Move into the shade

- Reduces sun's heat radiation falling on the body and increases conduction to cooler air

- e.g 2

- Take a cool shower/swim

- Increases heat conduction from the skin

- E.g 3

- Remove some clothing

- Reduces insulation allowing heat loss by conduction

- E.g 4

- Drink cooler water

- Lowers body temperature and provides more water for perspiration

- E.g 5

- Reduced physical activity

- Lowers metabolic rate and decreases heat production by body cells and muscle

- E.g 6

- Use a fan to increase air flow over body

- Increases rate of sweat evaporation leading to heat loss

b. Explain how the nervous and endocrine systems maintain the body's internal temperature when it is in danger of falling below the tolerance limits. Ensure your answer include two nervous and one endocrine mechanisms. (14 marks)

- The nervous and endocrine systems are both influenced by the hypothalamus/are both complementary. Hypothalamus contains thermoreceptors that detect increase/decrease in body temperature (1)

- **NERVOUS SYSTEM 1 mark for each of any 7. (7)**

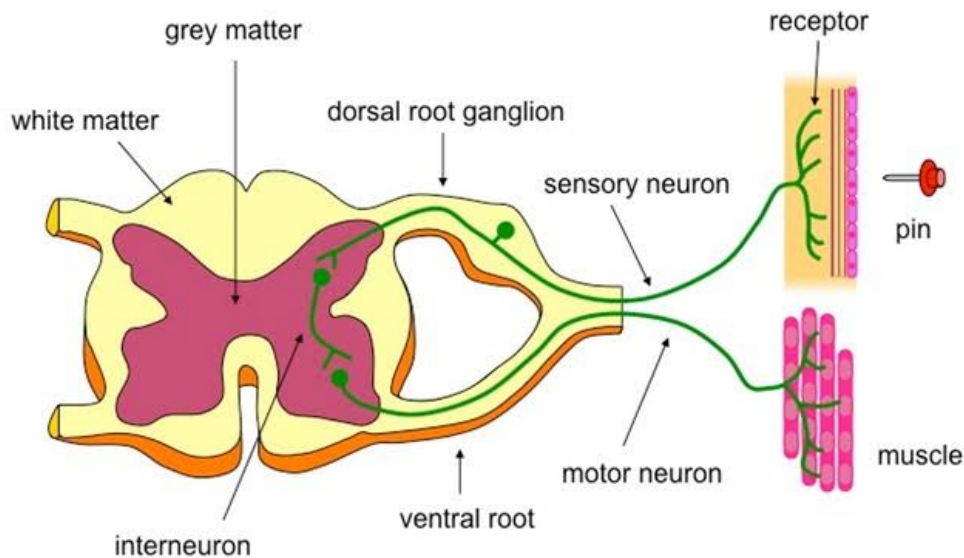
- VASODILATION OF BLOOD VESSELS

- If hypothalamus detects a fall in body temperature nerve impulses are sent via the sympathetic nervous system to the precapillary sphincter in the skin (1)

- Vasoconstriction occurs which reduces the volume of blood flow to the surface of the skin (1)
- Less heat is lost by conduction and radiation to the atmosphere from the blood in the skin. (1)
- Reduced heat loss- body temp rises (1)
- SHIVERING
- If thermoreceptors detect a fall in body temp nerve impulses are sent via the sympathetic pathway to skeletal muscles
- Series of involuntary contractions and relaxations occur in the muscles
- Muscle contractions generate heat
- Body temp increases
- **ENDOCRINE SYSTEM- 1 mark each for any 6 dot points**
- ADRENAL MEDULLA
- Thermoreceptors in hypothalamus detect a fall in body temp causing nerve impulses to be sent via sympathetic nervous system
- Impulses target the adrenal medulla
- Adrenal medulla releases adrenaline/noradrenaline
- The hormones enter the blood
- Hormones increase cellular metabolism
- Metabolism produces heat (exothermic)- temperature of body increases
- THYROID
- If thermoreceptors detect a fall in body temp TSHrF is released
- TSHrF stimulates anterior pituitary lobe to release TSH into the blood
- TSH targets the thyroid
- Thyroid produces and releases thyroxine
- Thyroxine increases metabolic rate in the body cells
- This produces more heat and increases body temperature

Question 6

a. Illustrate the reflex action that allowed Simon to instantly pull his foot away. Ensure you label the diagram with the specific neurons and direction of transmission. (4 marks)



- diagram has correctly labelled neurons (1)
- Correctly labelled dorsal/ventral root (1)
- Correctly indicates direction with an arrow from receptor to sensory neuron to muscle (1)
- Interneuron shown IN the grey matter (1)

b. State the neurotransmitter involved in this response. (1 mark)

Acetylcholine (this response involves the somatic division)

c. After Simon stood on the nail he was unable to feel his foot. Gradually over three weeks Simon regained sensation in his foot. Discuss which type of neuron fibre in the afferent division was damaged and why he was able to regain feeling. (3 marks)

- myelinated fibre (1)
- Myelinated nerve fibres contain Schwann cells (1)
- Schwann cells produce the neurolemma which helps repair damaged fibres (1)

Question 7

a. Due to the blood sample being so small, suggest what procedure and steps would have been taken before the sample could have been used in Gel Electrophoresis.

(5 marks)

- Polymerase Chain reaction (1)
- Denaturing: solution of DNA, primers and Taq polymerase are heated to approx 96°C which allows the hydrogen bonds to break between DNA strands. (1)
- Annealing: solution cooled between 55-65°C allowing primers to attach to the single stranded DNA (1)
- Elongation: primers act as a starting point to allow Taq polymerase to replicate strands at approx 73 °C (1)
- Process is repeated over several cycles in order to produce sufficient quantities of DNA for gel electrophoresis (1)

b. Even though both digests were sourced from the same bacterium they produced a large discrepancy in the banded patterns produced. State why this was the case. (3 marks)

- The bacterium/digests contains different restriction enzymes (1)
- Restriction enzymes cut DNA at different locations respective to the sequence of bases (1)
- This varies the length of the DNA strands causing them to travel through the gel at different rates (1)

c. The 5' recognition sequence for EcoRI is 5'GAATTC. Write the 3' recognition sequence and contrast between 5' and 3' DNA ends. (2 marks)

- 3'CTTAAG (1)
- 5' DNA end contains a phosphate group while the 3' end contains a hydroxyl group (1)

Using the results above, state which suspect was present at the crime scene. (1 mark)

- Suspect 2 (1)

Question 8

a. State the type of neuron that is prevented from forming as a result of CIPA. (1 mark)

Sensory/Unipolar neuron (1)

b. Justify the scientists hypothesis by outlining how CIPA may result in hypothermia and why it can become fatal. (5 marks)

- heat receptors in the skin detect increase in temperature but sensory neurons don't respond to the stimulus (1)
- The hypothalamus isn't stimulated and a reduction in nervous conduction via the parasympathetic pathway does NOT occur/ sympathetic pathway is NOT stimulated (1)
- The effectors are therefore not stimulated by the sympathetic pathway which inhibits vasodilation, production of sweat and behavioural changes (1)
- body temperature is not decreased resulting in hyperthermia which is fatal when not regulated (1)
- This means the scientists hypothesis is correct as patients with CIPA cant regulate body temperature from a young age (clear justification whether hypothesis is correct with evidence) (1)

c. The scientist examined a Japanese family line that had a high occurrence of CIPA. He found that the inheritance could be traced back to a small group of individuals who were closely related. State and describe the process that enabled the allele frequency of CIPA to increase in this family (4 marks).

- Random Genetic Drift (1)
- In small population there can be random/non-directional differences in the allele frequency (1)
- The differences are not representative of the population as a whole (1)
- This means the occurrence of CIPA becomes more prevalent in this family line resulting in an increase in the allele frequency (1)

Question 9

a. With reference to the age range of fossils discovered at the site and the image, name the hominid the skull belongs to and describe the tool culture of this species. (2 marks)

- homo habilis (existed around 1.7-2 million years ago) (1)
- Used Oldowan pebble tools which included choppers, scrapers, flakes and chisels (1)

b. Describe how the location of the fossils discovery aided in its preservation (2 marks)

- Northern Russia is cold/arctic climate which helps slow the rate of decay/preserves fossil (1)
- Remote locations reduce the occurrence of scavenging/ human activity that may disrupt fossilisation/destroy the fossils (1)
- Any other relevant point for 2 marks

c. (i) Outline why both absolute dating techniques may not be suitable for the dating of this skull. (2 marks)

- The use of potassium-argon dating relies on suitable material such as volcanic rock/ igneous rock being present/ rocks covered in lava. This fossil was found in sedimentary rock (1)
- Carbon-14 dating is only appropriate for fossils of ages up to 60,000 years old, this fossil is much larger (1)

(ii) Name and describe one relative dating technique which would be most suitable for the approximation of the skulls age (3 marks)

- Stratigraphy (1) as fossils with known ages have been discovered in the area.
- This technique assumes that fossils found above others/in higher strata layers are younger and those found in lower rock Strata are older (1)
- Correlations between the fossils in rock strata are determined by comparing fossils in the same layers to approximate age (1)

b. Describe two distinguishing features which prove this skull belongs to a species more modern than the Australopithecines (4 marks)

Any 2 of the following for 1 mark each:

- Absence of sagittal crest (1) compared to Australopithecine's such as Paranthropus Robustus who has a sagittal crest
- Reduced brow ridges compared to Australopithecines. (1)
- Reduced prognathism (1)
- No diastema (1)
- Larger cranial capacity (1)
- Skull retains less juvenile features/not neotenized (1)