**HUMAN BIOLOGY**

**Unit 3 and 4**

**2020**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_SOLUTIONS\_\_\_\_\_\_\_\_\_\_\_\_\_

Teacher: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Time allowed for this paper**

Reading time before commencing work: ten minutes

Working time: three hours

**Materials required/recommended for this paper**

***To be provided by the supervisor***

This Question/Answer booklet

Multiple-choice answer sheet

***To be provided by the candidate***

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

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

**Important note to candidates**

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of questions available | Number of questions to be answered | Suggested working time (minutes) | Marks available | Percentage of examination |
| Section One Multiple-choice | 30 | 30 | 40 | 30 | 30 |
| Section Two Short answer | 5 | 5 | 90 | 102 | 50 |
| Section Three Extended answer  Unit 3 | 2 | 1 | 50 | 40 | 20 |
| Unit 4 | 2 | 1 |  |  |  |
|  |  |  |  | **Total** | 100 |

**Instructions to candidates**

1. The rules for the conduct of the Western Australian examinations are detailed in the *Year 12 Information Handbook 2020*. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.

3. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Only use a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Section Two: Write your answers in this Question/Answer booklet. Wherever possible, confine your answers to the line spaces provided.

Section Three: Consists of two parts each with two questions. You must answer one question from each part. Tick the box next to the question you are answering.

Write your answers in this Question/Answer booklet

4. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

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

|  |  |
| --- | --- |
| 1 | D |
| 2 | C |
| 3 | B |
| 4 | A |
| 5 | A |
| 6 | C |
| 7 | C |
| 8 | B |
| 9 | B |
| 10 | B |
| 11 | C |
| 12 | C |
| 13 | D |
| 14 | A |
| 15 | D |
| 16 | A |
| 17 | D |
| 18 | A |
| 19 | D |
| 20 | B |
| 21 | C |
| 22 | D |
| 23 | D |
| 24 | C |
| 25 | A |
| 26 | A |
| 27 | B |
| 28 | B |
| 29 | D |
| 30 | A |

**Section Two: Short answer 50% (102 Marks)**

**Question 31 (14 marks)**

The genetic condition thalassemia is caused by a mutation that occurs in roughly 3% of the global population. It has been found that there are two main types of thalassemia: alpha thalassemia and beta thalassemia.

(a) (i) Define the term mutation. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A permanent change in the DNA of a cell | 1 |
| **Total** | **1** |

(ii) Two main types of mutations are somatic and germ line. Explain which type of mutation thalassemia is. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Germline | 1 |
| As it can be passed on to offspring | 1 |
| Occurs in gametes |
| **Total** | **2** |

(b) Name a population typically affected by thalassemia. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mediterranean / Greek / Italian / African / Middle East | 1 |
| **Total** | **1** |

(c) State three symptoms people with the intermediate form of alpha thalassemia and beta thalassemia would have in common. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ***Any three of the following:*** |  |
| Fatigue / weakness | 1-3 |
| Shortness of breath |
| Pale skin |
| Irritability |
| Deformities of the facial bones / skeletal abnormalities |
| Slow growth |
| Anaemia / less red blood cells |
| **Total** | **3** |

(d) Thalassemia is a condition that provides a heterozygote advantage to malaria.

(i) What is the term given to how malaria is transferred? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Vector | 1 |
| **Total** | **1** |

(ii) Explain the term heterozygote advantage using the example of thalassemia. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Individuals who are heterozygous for thalassemia do not suffer from malaria / are resistant to malaria | 1 |
| And have reduced symptoms of thalassemia compared to homozygous recessive individuals | 1 |
| **Total** | **2** |

(iii) Name one other condition that provides a similar advantage to malaria. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Sickle cell | 1 |
| **Total** | **1** |

(e) People who suffer repeated infection by malaria show reduced symptoms with each subsequent infection, which is commonly referred to as “seasoning.” Explain how seasoning would reduce the symptoms shown by people with repeated infections by malaria. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| As a result of the first infection, memory cells / memory T / memory B cells would be produced | 1 |
| Memory cells produce a stronger response for secondary infections, so symptoms are less | 1-2 |
| Memory cells produce a faster response for secondary infections, so symptoms are less |
| Memory cells produce a longer lasting response for secondary infections, so symptoms are less |
| **Total** | **3** |

**Question 32 (20 marks)**

Since the beginning of January until the end of March, an outbreak of coronavirus (COVID-19) saw more than 700,000 infected and more than 33,000 die from the disease globally. Originating in Wuhan city in China, the coronavirus was believed to have first infected people in a seafood wholesale market, causing sufferers to experience breathing difficulties, fever, coughing and shortness of breath. Current estimates are that the incubation period is up to 14 days, with most asymptomatic (showing no symptoms) until 5-6 days after infection.

(a) A person with coronavirus experiences most symptoms in their respiratory system. Describe the external defence mechanisms of the respiratory system and suggest how they are believed to assist the body to defend itself against disease. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Hairs at the entrance of the nostrils | 1-2 |
| prevent the entry of large particles into the nasal cavity |
| Sticky mucous lines the nasal cavity / trachea | 1-2 |
| which traps smaller particles and prevent them moving deeper into the respiratory system |
| Cilia are small finger-like projections of cells | 1-2 |
| that move in unison to take mucous and trapped particles up and out of the respiratory system |
| **Total** | **6** |

(b) (i) Given a person is asymptomatic for up to 5-6 days after infection, explain how this could have affected the incidence of the disease. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Increased the incidence | 1 |
| as people would have not taken precautions to prevent spreading it / quarantined themselves / not done a named preventative measure | 1 |
| **Total** | **2** |

(ii) What measures could an individual put in place in order to reduce their chance of catching the disease? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Washed their hands regularly | 1-2 |
| Worn a face mask / gloves |
| Reduced their contact with other people / worked from home |
| Maintain 1.5m distance from others |
| **Total** | **2** |

(iii) A number of mechanisms were put into place by governments as a result of the increasing numbers of infections. China restricted all movements in or out of Wuhan, cruise liners held their passengers on board in their rooms and people who had travelled internationally were asked to not attend school or work for 14 days after their return home.

Explain how it is believed these measures will affect the number of people with the disease. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Reduce numbers affected | 1 |
| As isolation will prevent transmission between individuals | 1 |
| **Total** | **2** |

(c) Researchers in Queensland have been working on a vaccine for the coronavirus since its outbreak.

(i) Why could this not be a toxoid vaccine? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| This disease is caused by a virus, not a bacterium | 1 |
| **Total** | **1** |

(ii) Explain why a sub-unit vaccine could be used as a potential vaccine against coronavirus. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The subunit is a small section of a viral coat, which this disease has | 1 |
| It would prevent the recipient from developing the disease | 1 |
| Our immune systems can work against the protein / don’t require the whole organism to develop immunity | 1 |
| **Total** | **3** |

(iii) What type of immunity would be provided by a vaccine against coronavirus? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Artificial | 1 |
| Active | 1 |
| **Total** | **2** |

(iv) State one economic and one sociocultural reason why some people may not want their child vaccinated against coronavirus. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Economic: can’t afford vaccine / can’t afford visit to doctor | 1 |
| Sociocultural: religious views / already been infected / don’t believe in vaccination / concerned about negative side effects / had negative effects against other vaccines / | 1 |
| **Total** | **2** |

**Question 33 (32 marks)**

A fossil specimen of a young woman was found in a cave in China that showed characteristics of both Neanderthals and Denisovans (another fossil group). A small amount of DNA was retrieved from her bones and analysed using DNA electrophoresis.

(a) Describe the conditions required for the young woman to be fossilised. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Sandy / sedimentary soils | 1-4 |
| Alkaline environment |
| Low humus levels |
| Rapid burial |
| No scavengers / low bacteria |
| Hard body parts |
| Long period of stability / undisturbed for long period |
| **Total** | **4** |

(b) Name the process that would have multiplied the amount of DNA found in her bones and briefly explain what would occur in each stage. (7 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| PCR / polymerase chain reaction (compulsory mark) | 1 |
| Temperature is increased / heating to 96oC | 1-6 |
| Which causes the DNA to denature into single strands |
| Temperature is cooled / is reduced 50-65 oC |
| Causes annealing of primers to the DNA strands |
| Temperature is raised / is increased to 72 oC |
| When DNA polymerase / Taq polymerase builds copies of the DNA strands |
| **Total** | **7** |

(c) DNA electrophoresis was conducted in order to compare her DNA to a sample of pure Neanderthal DNA and a sample of pure Denisovan DNA from other sites.

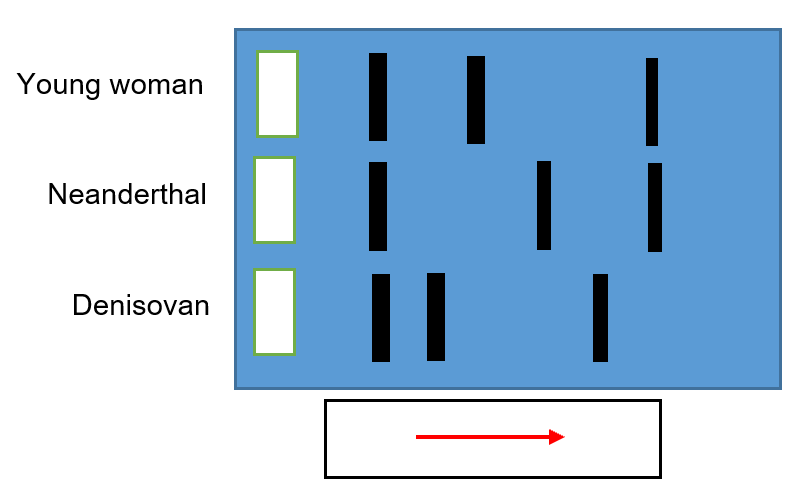
(i) What would all three DNA samples have been treated with prior to being placed in the agarose gel? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Restriction enzymes | 1 |
| **Total** | **1** |

(ii) Explain why and how the DNA moves across the gel during the electrophoresis process. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| DNA is negatively charged | 1 |
| So is pushed away from the negative terminal / towards the positive terminal | 1 |
| DNA moves according to size with smaller lengths moving further / larger pieces not moving as far from the well | 1 |
| **Total** | **3** |

The results of the DNA electrophoresis are shown below:



(iii) Draw an arrow in the box on the diagram above to show the direction that DNA would move during the process of gel electrophoresis. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| To the right / | 1 |
| **Total** | **1** |

(iv) Draw a circle around one lane of DNA on the image above. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Only Denisovan / young woman / Neanderthal DNA circled | 1 |
| **Total** | **1** |

(v) Explain what the results on the agarose gel shows about the young woman. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| She is more closely related to Neanderthals than Denisovans / less closely related to Denisovans than to Neanderthals | 1 |
| as she shares 2 bands with Neanderthals and only 1 with Denisovans | 1 |
| **Total** | **2** |

(d) These three specimens as well as *Homo sapiens* were studied in order to determine the evolutionary relationships between the specimens. The table below shows a portion of the amino acid sequence for the same gene from each specimen.

Table 1: Amino acid sequence for one gene

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Amino acid sequence in one gene** | | | |
| Young woman | ile | trp | cys | his |
| Neanderthal | glu | val | iso | ser |
| Denisovan | ile | asn | ala | his |
| *Homo sapiens* | ile | trp | cys | phe |

(i) Name one gene on which this comparison could have been made. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Cytochrome C | 1 |
| Haemoglobin |
| **Total** | **1** |

(ii) According to the table of amino acid sequence data above, who is most closely related to the young woman? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Homo sapiens* | 1 |
| **Total** | **1** |

(iii) The scientists also studied the DNA of this amino acid sequence. Would comparative DNA or comparative proteins provide more accurate data about their relationship? Justify your answer. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Comparative DNA | 1 |
| Comparative proteins may not show null mutations in nitrogen base sequence which do not affect the amino acid produced | 1 |
| Comparative DNA will show mutations in nitrogen base sequence that do not affect the amino acid determined by that codon |
| **Total** | **2** |

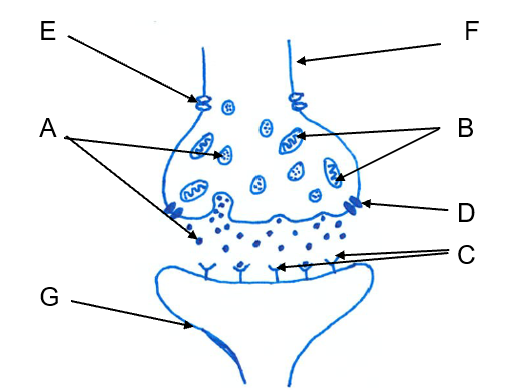
(iv) Construct a phylogenetic tree using the amino acid sequence data in the table above. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Woman most closely related to *Homo sapiens* | 1 |
| Woman least closely related to Neanderthal | 1 |
| Woman medium closely related to Denisovan | 1 |
|  |  |
| **Total** | **3** |

(e) Describe the differences between aspects of the culture and tools associated with Neanderthals and *Homo erectus*. (6 marks)

|  |  |  |
| --- | --- | --- |
| **Description** | | **Marks** |
| ***1 mark for Neanderthal and 1 mark for contrasted Homo erectus.***  ***Any 3 of the following:*** | |  |
| ***Neanderthals*** | ***Homo erectus*** |
| Hafting / hand axes attached to handles | No hafting | 1-6 |
| Flakes with reworked / sharpened edges | Cores only / no flakes used |
| Spear points | No spear points |
| Evidence of burial of the dead / spiritual belief system | No burial of the dead / no spiritual beliefs |
| Care of elderly | No care of elderly |  |
| **Total** | | **6** |

**Question 34 (14 marks)**



(a) Name the structures labelled: (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A – neurotransmitter | 1 |
| B – mitochondria | 1 |
| C – receptors | 1 |
| **Total** | **3** |

(b) What is the stimulus for an action potential to cross the synapse? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Calcium ions entering the axon terminal | 1 |
| **Total** | **1** |

(c) Dopamine is a neurotransmitter in the efferent nerve pathways of the central nervous system. It is involved in many body functions, including: alertness, a “feel good” mood and motor control. When a person takes cocaine, dopamine cannot be taken out of the synapse to be transported back into the presynaptic neuron.

(i) Which way are messages transmitted in efferent nerve pathways? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Away from the CNS / towards the body / towards an effector | 1 |
| **Total** | **1** |

(ii) State one effect of dopamine not being removed from the synapse. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Heightened alertness / feeling very good / greater motor control | 1 |
| **Total** | **1** |

(iii) Parkinson’s is a neurodegenerative condition characterised by a lack of dopamine. Briefly describe how cell replacement therapy could be utilised to

treat Parkinson’s. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Stem / totipotent / pluripotent cells that produce dopamine could be placed in the brain | 1 |
| In order for them to release the dopamine that the existing cells cannot produce in people with Parkinson’s | 1 |
| **Total** | **2** |

(d) The brain uses approximately 20% of all the glucose available in the body. By referring to the labels used in the image shown previously, explain why this is the case. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Any 3 of the following:** |  |
| A - Moving vesicles (containing neurotransmitters) to the surface of the axon terminal | 1-3 |
| A- Producing neurotransmitters |
| Exocytosis to release neurotransmitters into synapse |
| D - Using active transport to bring neurotransmitters back into the presynaptic neuron |
| E – actively bringing calcium ions into the cell |
| **Total** | **3** |

(e) Complete the table showing the effect of an injury to different brain structures. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| |  |  | | --- | --- | | **Structure** | **Effect of an injury** | | Cerebellum | Inability to control fine motor movements | | Hypothalamus | Body temperature unable to be regulated | | Cerebrum | Decreased ability to think / reason / analyse / problem solve / remember / altered personality | | 1-3 |
| **Total** | **3** |

**Question 35 (22 marks)**

In 2001, Pat Rafter suffered from extreme cramps and lost the semi-final in the Australian

Tennis Open to Andre Agassi. After testing, it was found Rafter sweats twice as much as other

people in the same conditions.

(a) (i) What hormone, produced by the hypothalamus, would be released as a result of the volume of sweat lost? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ADH / antidiuretic hormone | 1 |
| **Total** | **1** |

(ii) Describe and explain the effect of this hormone on its target cells. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Makes the distal collecting tubule and collecting tubule more permeable to water | 1 |
| Which allows more water to return from the filtrate into the blood | 1 |
| **Total** | **2** |

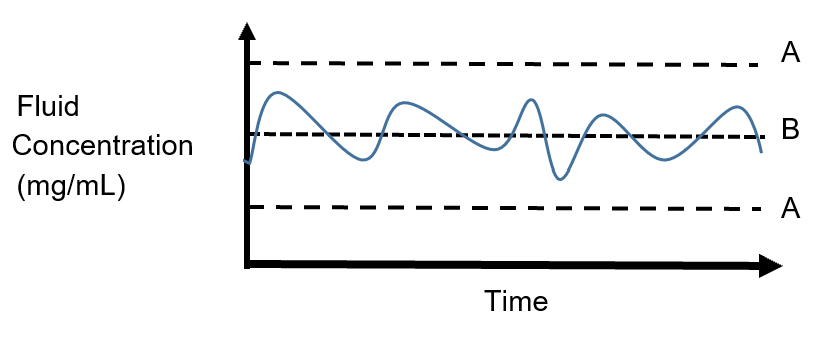
(b) (i) Pat Rafter was initially told to drink more water during his tennis matches in order to prevent dehydration. Explain why drinking more water would have made his problem worse. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Drinking water would only have replaced the water he lost in sweat | 1 |
| It would not have replaced the salts he lost in his sweat | 1 |
| So he / his body fluid would have become even more hypotonic | 1 |
| **Total** | **3** |

(ii) Name the hormone that would be produced after consuming large amounts of water and state one behavioural mechanism Pat Rafter could take in order to minimise the effect of his heavy sweating. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Aldosterone | 1 |
| Consume sports drink / eat salty food / consume drink with salt ions | 1 |
| **Total** | **2** |

(c) A graph of Pat Rafter’s fluid concentration during normal activity is shown below.



(i) What type of feedback model is shown in the graph above? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Negative | 1 |
| **Total** | **1** |

(ii) During normal activity, Pat Rafter stays between the lines marked A on the graph. What do these lines represent? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Threshold limits (upper and lower) / tolerance limits | 1 |
| **Total** | **1** |

(iii) What does the line marked B on the graph represent? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Optimal functioning / levels | 1 |
| **Total** | **1** |

(d) Thermoregulation relies on both hormonal and nervous control. Describe how

temperature can be regulated using both hormonal and nervous controls. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ***Hormonal – Any 4 points*** |  |
| TSH rf from the hypothalamus | 1-4 |
| Causes the release of TSH from the anterior pituitary |
| Which causes thyroxine to be released from the thyroid gland |
| Which increases rate of metabolism / cell respiration |
| Which increases core body temperature |
| ***Nervous – Any 2 points*** |  |
| Nerve impulses cause sweat glands to release sweat | 1-2 |
| Nerve impulses from vasomotor centre cause vasodilation of arterioles |
| Which reduces core body temperature |
| **Total** | **6** |

(e) The scientists investigating Pat Rafter’s problem chose three other tennis players to compare Pat against. Pat and the other players were weighed before and after their games in one tournament. Games were timed so that they could calculate the water loss per hour. The tournament ran over 5 days and the players had varying levels of success, with one making it to the grand-final.

(i) Name one variable the scientists controlled. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Tennis players used | 1 |
| Games were timed |
| Weighing before and after games |
| **Total** | **1** |

(ii) Name one potentially uncontrolled variable and explain the effect of this on the experiment. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Any 1 of the following with its associated explanation:** |  |
| Time to complete a game could vary | 1-2 |
| Might lose sweat at different rates so validity is reduced |
| Temperature / humidity during the game | 1-2 |
| Might cause different rates of sweating so validity is reduced |
| How many games each player played in the competition | 1-2 |
| May affect sweating rate of subsequent games which reduces validity |
| **Total** | **2** |

A lab assistant was asked to create the table of results for the experiment, which is shown below.

Title: Weight loss

|  |  |  |  |
| --- | --- | --- | --- |
|  | Body weight | | |
| Subject | Before game | After game | Average |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |

(iii) Identify two errors the lab assistant has made in constructing the table. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Title does not include both variables | 1-2 |
| Body weight does not show the units used |
| Average is placed incorrectly / does not average all the players |
| **Total** | **2** |

**End of Section Two**

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

**Unit 3**

**Question 36 (20 marks)**

1. Cortisol and ADH have different effects on cells due to the fact they belong to different categories of hormones. Compare and contrast the action of water soluble and lipid soluble hormones and describe how cortisol and ADH affect their target cells. (14 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ***Cortisol (Any 7 points)*** |  |
| Lipid soluble hormones enter the cell | 1 |
| Attaches to receptors in the cytoplasm / on organelles / on mitochondria / on nucleus / on DNA | 1 |
| Causes genes to be activated to produce a particular enzyme / protein / changes the rate of production of enzymes / alters rate of transcription or translation | 1 |
| Which are permanent / have much longer lasting effects | 1 |
| Cortisol has receptors on all body cells | 1 |
| Is produced during times of stress | 1 |
| Converts fat to glucose / assists in repair | 1 |
| ***ADH (Any 7 points)*** |  |
| Water-soluble hormones cannot enter the cell | 1 |
| Attach to receptors on / in the cell membrane | 1 |
| Which releases a secondary messenger inside the cell | 1 |
| Which alters enzyme activity / changes the concentration of enzymes | 1 |
| Which is much shorter acting | 1 |
| ADH has receptors on the distal convoluted tubule and collecting tubule of the nephron | 1 |
| causing the distal convoluted tubule and collecting tubules to become more permeable to water | 1 |
| So more water is reabsorbed from the filtrate back into the blood / less urine is produced | 1 |
| **Total** | **14** |

1. Explain how bioinformatics and gene therapy could be used to combat diabetes mellitus. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Bioinformatics would be used to analyse the DNA code of a number of individuals | 1 |
| Both with diabetes and without | 1 |
| In order to determine the genes that contribute to the disease | 1 |
| Gene therapy would replace the defective diabetes gene/s | 1 |
| With a healthy gene/s | 1 |
| So that beta cells could continue to produce insulin | 1 |
| **Total** | **6** |

**Question 37 (20 marks)**

1. Describe how the resting potential of the neuron membrane is maintained and use the all or none response to explain how stimulation of the same nerve cell could result in two different outcomes. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ***Any 10 of the following points:*** |  |
| The resting membrane is maintained by sodium potassium pumps | 1 |
| Which pump 3 sodium out and 2 potassium into the cell | 1 |
| Potassium moves out very easily, sodium move in less easily | 1 |
| Nerve cell membrane has a resting potential of -70mV | 1 |
| If a stimulus of less than 15mV is received | 1 |
| It is too small to cross threshold | 1 |
| So no change in the resting potential occurs / no action potential occurs / depolarisation does not occur | 1 |
| If the stimulus is greater than 15mV / crosses threshold of -55mV | 1 |
| Depolarisation occurs | 1 |
| And due to the all or none response, an action potential occurs | 1 |
| **Total** | **10** |

1. The body undertakes two specific immune responses once an antigen has breached its external defences and entered blood or other extracellular fluids. Compare and contrast the two specific responses of the body. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Compare: (Any 2 points)** |  |
| Respond to only one type of antigen | 1-2 |
| Produce memory cells |
| Uses lymphocytes |
| Lymphocytes originate in bone marrow |
| Mature cells found in all lymphoid tissue |
| Become activated, sensitised, enlarge and divide on recognition of an antigen |
| **Contrast: (Any 4 points but must match on concept)** |  |
| Humoral: Involves B cells | 1-2 |
| Cell mediated: involves T cells |
| Humoral: produces antibodies | 1-2 |
| Cell mediated: does not produce antibodies |
| Humoral: forms into two types of cells / plasma and memory cells | 1-2 |
| Cell mediated: forms four types of cells / Killer T, suppressor, helper and memory cells |
| Humoral: matured in bone marrow and spleen | 1-2 |
| Cell mediated: matured in thymus |
| Humoral: provides resistance to viruses, bacteria and toxins before they enter the cell | 1-2 |
| Cell mediated: provides resistance to intracellular phases of bacteria and viruses, cancer cells, transplanted tissue, parasites, fungi |
| Humoral: no presentation of antigen required / meets antigen randomly | 1-2 |
| Cell mediated: requires a B cell / macrophage to present the antigen |
| **Total** | **10** |

**Unit 4**

**Question 38 (20 marks)**

People who have red blood cell Duffy antigen negativity lack the antigen receptor on the haemoglobin molecule that normally allows malaria to invade our red blood cells. 97% of West and Central Africans have this mutation for Duffy negativity, making them resistant to malarial infection. African Pygmies are 100% Duffy negative.

(a) Discuss how this mutation may have come about. (7 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mutations are inheritable changes in DNA | 1 |
| That occur during cell division | 1 |
| DNA replication | 1 |
| or from damage due to mutagens | 1 |
| Mutagens are substances that increase the rate at which mutations occur | 1 |
| Mutagens could include: UV light / X-rays / cosmic rays / mustard gas / formaldehyde / nuclear explosions / radioactive waste / sulfur dioxide / antibiotics | 1-2 |
| The mutations could include: point mutation / substitution / insertion / deletion / gene mutation / inversion | 1-2 |
| **Total** | **7** |

(b) Explain how, over an extended period of time, the West and Central African populations came to be resistant to malaria. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **If only natural selection process discussed without reference to Duffy negativity, max 5 marks** |  |
| All individuals with the West and Central African populations showed variation in whether they had the receptor or not | 1 |
| More individuals in the population are born than survive to maturity | 1 |
| The numbers of people in the population is maintained over time | 1 |
| The lack of receptor for malaria is adaptive / aids survival | 1 |
| There is a struggle for existence in the population due to infection by malaria | 1 |
| Those individuals who lack the receptor do not get malaria and will survive and reproduce | 1 |
| Those with the receptor will be affected by malaria and will die or have reduced fertility | 1 |
| The lack of receptor is then passed on to the next generation | 1 |
| Lack of receptor increases in frequency from one generation to the next | 1 |
| Over time the population increases its percentage of individuals lacking the receptor for malaria | 1 |
| **Total** | **10** |

(c) Using the concept of gene flow, explain why the African Pygmies are 100% Duffy negative. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| African Pygmies are an isolated population | 1 |
| They have no gene flow with other population groups / only breed within their own population | 1 |
| Therefore have no allele for the receptor to pass on | 1 |
| **Total** | **3** |

**Question 39 (20 marks)**

Earlier this year, scientists uncovered the remains of a new human species, *Homo luzonensis* in the Philippines. It shared features of its hands and feet with *Australopithecus africanus*, although other features such as its dentition and degree of prognathism were more closely aligned with modern hominins.

(a) Describe the features *Homo luzonensis* would have shared with *Australopithecus africanus* and those it would have shared with more modern hominins and suggest why these features might have been an advantage to *Homo luzonensis*. (11 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Features shared with *Australopithecus africanus*** |  |
| Hands: short thumb / long finger / curved fingers / less mobile thumb / fingers more heavily built | 1-2 |
| Foot: robust big toe / longitudinal arch / parallel toes / non-opposable big toe | 1-2 |
| **Advantage these features offer (Any 2 points)** |  |
| Erect stance / bipedal method of locomotion | 1-2 |
| Allowed faster movement / better vision of predators when upright / better vision of prey when upright / reduction in heat gain when upright |
| Fingers adapted for power grip |
| Allowed better grasping ability for climbing trees |
| **Features shared with modern hominins** |  |
| Dentition: smaller teeth / teeth more similar in size and shape / no projecting canines / Y5 molar pattern / | 1-2 |
| Prognathism: reduced / flatter face | 1 |
| **Advantage these features offer (Any 1 point)** |  |
| Reduced prognathism means skull is more balanced on spine | 1-2 |
| Less teeth / smaller teeth reduces the size of the jaw |
| Which reduces energy requirement / muscles required to maintain position |
| **Total** | **11** |

(b) In a cave nearby, a number of stone tools were found which were dated at 700,000 years. Name and describe the specific dating technique that would have been used in this instance, giving reasons why this method would have been appropriate. (9 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Name (compulsory point)** |  |
| Potassium – Argon dating | 1 |
| **Description:** |  |
| Based on the decay of Potassium 40 / K40 | 1 |
| to form Argon 40 / Ar40 and Calcium 40 /Ca40 | 1 |
| The half-life of K40 is 1300 million years | 1 |
| So relative amount of K40 decreases and Ar40 increases over time | 1 |
| Must be buried in volcanic ash as it doesn’t contain argon | 1 |
| Requires a rock of the same age for comparison | 1 |
| **Reasons for using this method** |  |
| Dates fossils older than 100,000-200,000 years of age | 1 |
| 700,000 is a specific age in years / not a relative date | 1 |
| **Total** | **9** |

**End of Questions.**