

**Marking Guide**

**Biology Unit 3 & 4**

**2019**

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

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

**Section Two: Short answer 50% (100 Marks)**

**Question 31 (20 marks)**

A market gardener planted 400 blueberry plants derived from a single mature bush. These new plants were established using plant tissue culture techniques. Before they were planted in the ground, the blueberry plants were kept in a greenhouse and exposed to the same environmental conditions. The blueberries were planted in the ground using the same fertiliser, soil conditioner, compost and sowing techniques. The plants are water daily for one hour via a drip irrigation system and receive the same amount of sunlight.

After five months, the market gardener was quite surprised to find that the plants were growing at different rates and were of different shapes and sizes. Given that the 400 blueberry plants were grown from tissue derived from one single plant, he assumed they would be identical.

(a) Discuss the mechanisms influencing phenotypic expression of the blueberry plants. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mechanisms are environmental only / no meiosis involved. | 1 |
| Microenvironments - exposure to slightly different conditions such as wind, insects, animals, rainfall, parasites and variations in soil.*\*Students must give at least two (2) examples.*  | 1 - 2 |
| Variations in these conditions could switch genes on or off, changing the growth patterns of the plants. | 1 |
| **TOTAL** | **4** |

After the first fruiting season, the market gardener collected and processed the blueberry seeds from each plant. He was hoping to increase the genetic variation of his crop by germinating and planting the seeds he collected.

(b) Explain whether the plants that germinate from the seeds he collected will be genetically different to the original 'parent' blueberry bush. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Diversity is possible due to heterozygous traits. | 1 |
| Crossing over in meiosis I increases genetic variation of gametes. | 1 |
| Independent assortment of alleles in meiosis II increases genetic variation of gametes. | 1 |
| Fertilisation of these gametes will produce plants that are not identical to the parent.  | 1 |
| **TOTAL** | **4** |

(c) Suggest an alternate method the market gardener could employ, using only the plants he has, to increase the genetic diversity of his crop in the future. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * Collect pollen from the F2 generation and
* fertilise the flowers of the original plants.
 | 1 - 2 |
| **TOTAL** | **2** |

(d) Propose **two (2)** problems that could arise from growing genetically identical plants.

 (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * If disease is introduced, then all the plants will be affected
* as they are identical.
 | 1 - 2 |
| * Plant response to unusual weather events (drought, flooding, frost or heatwave)
* will be the same and the plants will respond in the same way.
 | 1 - 2 |
| **TOTAL** | **4** |

(e) Suggest how the phrase "Survival of the Fittest", as coined by Charles Darwin, relates to the market gardener's situation. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Individuals that exhibit traits/phenotypes best suited to the environment will survive to reproduce. | 1 |
| Without genetic diversity in the blueberry population, the 'fittest' individuals will not be selected to pass on favourable traits. | 1 |
| **TOTAL** | **2** |

Polyploidy is a common phenomenon in plants and often utilised by flower and fruit growers due to some of the advantageous effects.

(f) Explain how polyploidy occurs in plants and identify a resulting trait that would be beneficial to fruit growers. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Polyploidy is a chromosome mutation resulting in cells containing more than their 2*n* complement of chromosomes. | 1 |
| Polyploidy occurs during meiosis through non-disjunction, mutation, replication errors or unequal crossing over of chromosomes.  | 1 |
| Resulting gametes can have more than the two copies of a chromosome; triploid (3*n*) or tetraploid (4*n*) are three and four copies of a homologous chromosome. | 1 |
| Large fruit OR seedless fruit (as the plant is infertile). | 1 |
| **TOTAL** | **4** |

**Question 32 (20 marks)**

Dieback is caused by infection with the pathogenic 'water mold' *Phytophthora cinnamomi*. Dieback has become widespread throughout Western Australia, with particular effect on species within the Jarrah forest and Banksia woodlands.

(a) Define the term 'pathogen'. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A microorganism or infectious agent, | 1 |
| that can cause disease to its host. | 1 |
| **TOTAL** | **2** |

(b) Describe the effect of a *P. cinnamomi* infection on a susceptible species such as the Jarrah tree (*Eucalyptus marginata*). (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Feeds on the roots of plants, causing them to rot. | 1 |
| Plants cannot absorb water or nutrients from the soil. | 1 |
| Plants 'die back' from the shoot tips to the trunk as they are deprived of water. | 1 |
| **TOTAL** | **3** |

(c) Explain why *P. cinnamomi* is also referred to as a parasite. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *P. cinnamomi* infects the host and feeds from it. | 1 |
| It causes harm to the host whilst benefiting itself. | 1 |
| **TOTAL** | **2** |

(d) Explain the importance of establishing 'boot cleaning' stations, such as the one pictured above, along public walking trails through native bushland. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| It is a microscopic soil-borne pathogen that is spread via moist infected soil. | 1 |
| Infection is spread via zoospores. | 1 |
| Shoes could contain infected soil from another location. | 1 |
| If the soil isn't removed, it could be distributed throughout other 'dieback' free locations. | 1 |
| **TOTAL** | **4** |

(e) Identify **three (3)** quarantine procedures used in Australia to prevent the spread of plant pathogens or disease. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *\*Any three (3) from below for three (3) marks.* |
| * Certification of produce for export.
* Confiscation of infected or prohibited items.
* Public awareness campaigns/public education.
* Inspection or confiscation of produce at state borders.
* Supervision or check at first port of call for ship arrivals and aircraft.
 | 1-3 |
| **TOTAL** | **3** |

Microorganisms are recognised for their ability to reproduce rapidly, thereby increasing the potential to infect and spread throughout a host population. Rapid reproduction also supports rapid evolution which, in the case of bacteria and viruses, can lead to resistance to common pharmaceutical treatments.

(f) Explain how bacteria can evolve to express antibiotic resistance, through natural selection. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Large numbers of bacterium, rapid reproduction and mutation increase phenotypes present in the population. | 1 |
| Increased/excessive exposure to antibiotics provides a selection pressure to the bacteria. | 1 |
| Bacteria with genetic resistance to the antibiotic will survive and reproduce (rapidly).  | 1 |
| Resistant bacteria can also share alleles for resistance through exchange of genetic information - conjugation and plasmids. | 1 |
| Bacteria with no resistance will not survive to reproduce and pass on genetic information so their alleles are lost from the gene pool. | 1 |
| Resultant populations are all resistant to the antibiotic, so it is no longer effective for treating infection.  | 1 |
| **TOTAL** | **6** |

**Question 33 (20 marks)**

(a) Define 'homeostasis'. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Maintenance of a constant internal environment, | 1 |
| despite changes in the external environment. | 1 |
| **TOTAL** | **2** |

(b) Identify the body systems involved in homeostatic processes. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Endocrine | 1 |
| Nervous | 1 |
| **TOTAL** | **2** |

In the film 'The Hunger Games - Mockingjay Part 1', President Coin requests a reduction in the oxygen levels to 14% during a bombing attack on District 13.

(c) Describe the physiological response of an individual confined to an area with a reduced oxygen content. Use the stimulus-response model to support your answer. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Stimulus - an increase in blood CO2. | 1 |
| Receptor - chemoreceptors in arteries. | 1 |
| Control centre - Medulla oblongata (breathing centre) receives information from receptors. | 1 |
| Effector - intercostal muscles and diaphragm (lungs and thoracic cavity) are stimulated to increase depth and frequency of breathing rate. | 1 |
| Response - Blood O2 levels increase and CO2 decreases. | 1 |
| The information above should be shown in a diagram with arrows in the direction of stimulus to response. | 1 |
| **TOTAL** | **6** |

(d) Explain why most stimulus-response models involve negative feedback. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Organisms are stimulated by conditions that are outside the normal range, high or low. | 1 |
| Homeostasis works to keep a constant internal environment, so conditions need to be brought back to the 'normal'. | 1 |
| A negative feedback is usually required because the required response is opposite to the stimulus. | 1 |
| Positive feedback amplifies the stimulus, moving conditions further from the 'normal'. | 1 |
| **TOTAL** | **4** |

Different organisms control their internal body temperature in different ways.

(e) Explain the difference between an ectotherm and an endotherm in terms of internal temperature control. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| An endotherm uses heat produced from metabolic processes. | 1 |
| An ectotherm obtains heat from the external environment (via specialised adaptations). | 1 |
| **TOTAL** | **2** |

(f) Describe **two (2)** behavioural responses of an ectotherm, such as a lizard, trapped in the hot sun for an extended period of time. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Hold body off the ground - reduces heat transfer via conduction. | 1 - 2 |
| Change shape or orientation of body - reduces surface area to reduce heat transfer via radiation (from the sun). | 1 - 2 |
| **TOTAL** | **4** |

**Question 34 (20 marks)**

Due to the provision of nationwide immunisation programs many incurable diseases (poliomyelitis, Diphtheria and smallpox), that have been around for hundreds of years, have been eradicated from the Australian population. However, there is an increasing trend in the wider Australian community to not vaccinate children against these preventable diseases. Some anti-immunisation supporters believe that "vaccines can cause autism and Down syndrome" and that "the diseases are old-fashioned and don't exist anymore".

(a) Formulate a response to both anti-immunisation claims. In your responses, explain why each statement is both incorrect and harmful to the community.

 (i) "Vaccines can cause autism and Down syndrome". (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Diseases requiring vaccines are caused by viruses and/or bacteria.  | 1 |
| A virus/bacterium is a pathogen that can be transmitted between individuals. | 1 |
| Autism and down syndrome are conditions/diseases a person is born with and/or caused by genetic mutations (anomalies). | 1 |
| Not vaccinating children based on these ideas will decrease herd immunity and put others at risk of infection. | 1 |
| **TOTAL** | **4** |

 (ii) "They are old-fashioned diseases that don't exist anymore". (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The introduction of vaccination/immunisation programs has eliminated the diseases from our population.  | 1 |
| If most people are immunised, the pathogen/virus cannot spread between individuals and won't 'exist' in the population. | 1 |
| However, herd immunity will decrease through lack of vaccination. | 1 |
| This will allow diseases to reappear and spread to other individuals who have not been immunised. | 1 |
| **TOTAL** | **4** |

Influenza, or the 'flu', is a common illness that is most prevalent during the winter months. There are three main types of influenza - A, B and C, with type A being the most virulent.

(b) Explain the term 'virulent' in the context of disease. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A virulent disease spreads very rapidly, | 1 |
| and causes severe damage or illness to the host. | 1 |
| **TOTAL** | **2** |

Type A Influenza includes a number of strains such as swine flu (H1N1) and avian flu. These strains of influenza A can be transmitted between humans and animals.

(c) Identify the term used to describe a disease that can be transmitted between different species and explain why these particular diseases can be problematic to human populations. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Zoonotic diseases / Zoonoses  | 1 |
| * Can spread rapidly between people and between animals and people.
* A host may not know they have been in contact with an infected individual or animal.
* Can cause pandemics due to rapid spread between species.
 | 1-3 |
| **TOTAL** | **4** |

(d) A new vaccine for Influenza A is developed every year. Explain why this is necessary.

 (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Viruses mutate rapidly as they move through a population leading to the development/evolution of new strains. | 1 |
| The current vaccine may no longer be effective against the new strains. | 1 |
| A new or altered vaccine needs to be produced to protect individuals from the new strain (now prevalent in the population). | 1 |
| **TOTAL** | **3** |

(e) Explain why diseases such as influenza and measles cannot be treated with antibiotics.

 (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Viruses are not considered to be living cells as they cannot reproduce outside a host cell. | 1 |
| Antibiotics work by breaking down bacterial cell membranes or damaging cellular processes. | 1 |
| As viruses are not cells with functional processes, antibiotics are not effective.  | 1 |
| **TOTAL** | **3** |

**Question 35 (20 marks)**

Recent studies in China have discovered alarming levels of bacteria in the thick smog that often blankets many cities. Vehicle exhaust and burning of coal for power are the main contributors of the toxic smog. The airborne bacteria have been traced back to wastewater treatment plants where they use bacteria to break down organic matter, and from pharmaceutical companies that use genetically engineered bacteria in the production of medicines.

A group of PhD students investigated the effect of smog levels on the airborne bacterial load in Beijing over time. The data presented below are their results that were collected from various different sites a number of times during the year.

**Table 1** - Mean smog and bacteria levels throughout Beijing.

|  |  |
| --- | --- |
| **Mean smog levels (μg/m3)** | **Mean bacterial load x 103 (m3)** |
| 91.3 | 65 |
| 82.9 | 58 |
| 64.3 | 42 |
| 21.4 | 6 |
| 38.1 | 10 |
| 52.7 | 25 |
| 68.9 | 40 |
| 49.4 | 21 |
| 42.3 | 18 |
| 50.6 | 27 |
| 72.8 | 49 |
| 88.7 | 61 |

(a) Identify the independent and dependent variable in this investigation. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Independent - Smog levels (μg/m3) | 1  |
| Dependent - Bacterial load x 103 (m3)\*Units are required to gain the full mark | 1 |
| **TOTAL** | **2** |

(b) Propose an appropriate hypothesis for this investigation, based on the variables identified in part (a). (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Hypothesis must include both the independent and dependent variables for full marks.* |
| Example;Bacterial load in the air will increase in response to increasing levels of smog. | 1 - 2 |
| **TOTAL** | **2** |

(c) Construct an appropriate graph of the data, represented by the independent and dependent variables, in the space provided below. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Accurately plotted scattergraph. | 1 |
| Correct variables plotted - smog (independent) vs bacteria (dependent).  | 1 |
| Correct axes with appropriate scale. | 1 |
| Labelled axes with units.  | 1 |
| Appropriate title with independent and dependent variables. | 1 |
| Line of best fit. | 1 |
| **TOTAL** | **6** |

Example;

(d) Explain any patterns in the data presented in the graph. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Positive relationship between smog and bacterial load. | 1 |
| The worse the smog the more bacteria there is in the air. | 1 |
| **TOTAL** | **2** |

(e) Identify **two (2)** variables that need to be controlled in this investigation. Explain why controlling these variables is important for data validity. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Students must identify a controlled variable for* ***one (1)*** *mark and explain why it should be controlled for* ***one (1)*** *mark.*  |
| * Place where smog and bacteria are collected/tested must be consistent throughout the investigation.
* If the location changes the data could change based on proximity to roads, power plants, wastewater treatment plants, pharmaceutical companies.
 | 1 - 2 |
| * Method of collecting data should stay the same throughout the investigation.
* If methodology is altered, then the data cannot be compared accurately.
 | 1 - 2 |
| * The time of day when the data is collected should remain consistent.
* If data collection is not kept the same, data analysis could be affected and not give a true representation of actual events.
 | 1 - 2  |
| *\*Other reasonable variables and explanations are acceptable.* | 1 - 2 |
| **TOTAL** | **4** |

(f) Suggest **two (2)** ways in which the scientists could improve or expand their investigation to provide more comprehensive data. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Students must provide* ***two (2)*** *points from below worth* ***one (1)*** *mark each. Other suggestions are acceptable at the teacher's discretion.* |
| * Identification of the types of bacteria present in their samples.
* Collect weather/climate data to see if it affects smog levels.
* Collect data for a longer period of time to increase data validity.
* Run the investigation in other cities for a comparison.
 | 1-2 |
| **TOTAL** | **2** |

(g) Explain why the release of genetically modified (GM) bacteria into the atmosphere could pose a problem for the wider community. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Students need to suggest a problem and give a possible effect for full marks.* |
| * The pharmaceutical company does not know the effect of GM bacteria on people's health
* it could make them sick or worsen pre-existing conditions.
 | 1 - 2 |
| * GM bacteria released into the atmosphere could share DNA with other similar species,
* creating new, pathogenic strains.
 | 1 - 2 |
| *\*Other responses are acceptable at the teacher's discretion.* | 1 - 2 |
| **TOTAL** | **2** |

**End of Section Two**

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

This section contains **four (4)** questions. You must answer **two (2)** questions; **one (1)** from Unit 3 and **one (1)** from Unit 4.

**Unit 3**

Choose **either** Question 36 **or** Question 37.

**Question 36 (20 marks)**

Sickle-cell anaemia is an inherited disease caused by point mutations, resulting in crescent-shaped red blood cells and free-floating haem molecules in the blood plasma.

(a) Explain how a point mutation within a gene can result in the development of a genetic disease like sickle-cell anaemia. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Students must include any 10 points from below.* |  |
| A point mutation involves one base (or nucleotide) being replaced by a different base in a gene. | 1 - 10 |
| A point mutation is the simplest form of mutation that can occur within a DNA molecule. |
| If a point mutation occurs within the exon/coding region of the DNA, a change in the base will alter the triplet sequence copied for mRNA in transcription. |
| mRNA carries the altered codon/s out of the nucleus and to a ribosome for translation into a polypeptide. |
| If the altered (or mutated) codon codes for a different amino acid, the complementary tRNA (anticodon) will deliver the 'incorrect' amino acid to the growing polypeptide chain. |
| The presence of a different amino acid may not have any effect on the structure or function of the resulting protein. It therefore does not cause any harm to the individual. |
| A different amino acid can sometimes change the final structure of the protein and therefore affect its function.  |
| If the structure is severely affected by the presence of an incorrect amino acid, the protein will not be able to carry out its normal role in the cell. |
| A non-functional protein can have a dramatic effect on an organism's metabolic functions and therefore survival.  |
| Sickle-cell anaemia is caused by a substitution of one base for another in the gene that codes for a functional protein (β-chain) in haemoglobin.  |
| Deformed haemoglobin causes the production of sickle-shaped red blood cells that do not carry oxygen. A simple mutation has resulted in the development of a lethal disease. |
| **TOTAL** | **10** |

The world's smallest reptile, a dwarf leaf chameleon (*Brookesia micra*), is endemic to a small islet on the northern tip of Madagascar. This species was only discovered in 2012, likely due to its diminutive stature - the male measures 16 millimetres and the female up to 30 millimetres. Mitochondrial DNA comparisons show that *B. micra* diverged as a single species around 20 million years ago. The tiny chameleon survives within the leaf litter of the islet's forest, feeding on small invertebrates.

(b) Discuss the mechanisms involved in the evolution of the dwarf leaf chameleon, *Brookesia micra*. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Genetic drift** is responsible for chameleon evolution. | 1 |
| No selecting force/environmental conditions for natural selection. | 1 |
| **Founder effect** - isolation of a small population of the ancestral species on the islet.  | 1 |
| Genetic composition of the isolated population is not representative of the original population.  | 1 |
| Alleles can be lost. In the case of the chameleon, the genes (alleles) for longer body length were lost from the gene pool. | 1 |
| The allele for shorter length in the new founder population is at a high frequency so 'dwarfism' becomes the dominant phenotype. | 1 |
| Not all of the individuals in the new population contribute their genes to the next generations, making the impact of isolation and changes in allele frequency more pronounced. | 1 |
| The isolation and change in allelic frequency persist over time until the 'dwarf' chameleon population becomes reproductively isolated and cannot breed with the original population.  | 1 |
| A new species is formed - **allopatric speciation** has occurred as a result of geographical isolation of gene pools.  | 1 |
| Changes to each species' habitat over time will lead to further changes in their gene pools due to **natural selection**. | 1 |
| **TOTAL** | **10** |

**Question 37 (20 marks)**

(a) Discuss the function of restriction enzymes and their importance to the development of genetic engineering techniques. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Restriction enzymes were discovered in bacteria (e.g. *E. coli*) and found to have a role in cellular defence.  | 1 |
| Restriction enzymes (endonucleases) are enzymes that cleave (cut) the DNA molecule at or near specific recognition sites called restriction sites. | 1 |
| Restriction sites are specific nucleotide sequences (between 4 and 8 bases long) where the enzyme cuts through the double-stranded DNA. | 1 |
| Restriction sites are often palindromic - the base sequence reads the same forwards and backwards.  | 1 |
| Different restriction enzymes recognise different restriction sites and produce either 'sticky ends' or 'blunt ends'. | 1  |
| Blunt ends are produced when the restriction enzyme cuts straight through the DNA strand, creating fragments with a flat or blunt end. | 1 |
| Sticky ends are produced when the enzyme cuts through the strands at mismatching nucleotides. This results in fragments with one strand of the DNA overhanging at the end. | 1 |
| Sticky ends are useful in genetic recombination because they readily recombine or attach to complementary base sequences on the desired DNA strand. | 1 |
| Restriction enzymes are the basic tool for geneticists and biotechnology research. Without these enzymes, most modern techniques could not be performed. | 1 |
| Restriction enzymes are used in cloning, DNA profiling, production of transgenic organisms, genetic modification, gel electrophoresis, genome sequencing and the production of pharmaceuticals using recombinant bacteria. *(Students must give at least* ***two*** *examples for one mark*) | 1 |
| **TOTAL** | **10** |

(b) Discuss why homologous structures support the concept of adaptive radiation. Use specific examples to support your response. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Homologous structures are common physiological structures that are found in different organisms, originating from a common ancestor. | 1 |
| Structures have been modified over time (adapted) to meet the needs of the different organisms, so similar structures have different functions. | 1 |
| Adaptive radiation is the rapid evolutionary diversification of descendants of a single ancestor (or ancestral group).  | 1 |
| This occurs in response to environmental change, geographical isolation, resource availability and occupation of different niches. | 1 |
| Adaptive radiation results in the phenotypic adaptation and speciation of a single ancestor to an array of species showing different morphologies (explains similarity in structure when there are differences in function). | 1  |
| New niches are filled over time due to variation in selection pressures.  | 1 |
| Homologous structures adapt (phenotypic selection) in response to these new pressures/meet niche requirements. | 1 |
| *Students must provide an example of a homologous structure to provide evidence of adaptive radiation and give* ***two (2)*** *specific examples of differing function.****Example;*** |
| Pentadactyl limb structure (five digits on hands and feet) has shown specialisation over evolutionary time through adaptive radiation.ORAll mammals exhibit some form of pentadactyl limb structure based on the organism's requirements for survival and reproduction. | 1 |
| * Whales, dolphins and seals possess an adapted form of this structure in pectoral fins which are used for swimming.
* Rabbits, wallabies and kangaroos have an adapted form of the pentadactyl limb structure in hind feet that allows for hopping.
* Birds and bats use their front limbs for flight, but both have different forms of the structure.
* Humans and other primates possess hands that can be used to grasp objects and aid balance. Humans have further evolved an opposable thumb for fine motor skills.
 | 1 - 2 |
| **TOTAL** | **10** |

**Unit 4**

**Question 38 (20 marks)**

Living in a freshwater environment has enabled the evolution of specialised homeostatic mechanisms to regulate osmotic potential and excretion of wastes.

(a) Discuss the mechanisms by which freshwater fish maintain their internal solute and water balance. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Students must include any 10 points from below.* |
| Freshwater fish are osmoregulators. They must maintain their internal osmolarity (which is very different to their surroundings) through physiological processes. | 1-10 |
| Freshwater fish are hypertonic to the water in which they live. The concentration of ions (salts etc.) in their tissues is greater than the surrounding water.  |
| Water is taken up osmotically through the gills and other body surfaces. Some water is consumed through their food. |
| Salts are lost to their surroundings by diffusion in their gills and in urine. |
| Freshwater fish produce copious amounts of dilute urine and do not actively drink water.  |
| The functional unit of their kidneys, the nephron, is much simpler than terrestrial animals as it does not need to reabsorb water. (Loop of Henle is reduced) |
| The kidneys of freshwater fish have an increased filtration rate to ensure rapid water loss. (Large glomerulus) |
| The kidney cells (surrounding the nephron) also actively reabsorb salts back into the bloodstream. |
| Specialised cells in the gills absorb ions/salts from the water through active transport.  |
| Active transport mechanisms in the kidney and gills require extra energy in the form of ATP. |
| Production of very dilute urine allows freshwater fish to produce ammonia as their nitrogenous waste. Ammonia is toxic but can be safely excreted in dilute urine (into the surrounding water). |
| **TOTAL** | **10** |

(b) Compare the transmission of pathogens through direct and indirect contact and identify the types of infection associated with each. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Direct contact** involves actual physical contact or touching. The infected host can transmit the pathogen to another individual by touching them with an infected area.  | 1  |
| Skin touching and handshaking often involves the transmission of externally visible diseases like warts, ringworm, lice, conjunctivitis, golden *Staph*, etc. *(Students must give* ***two*** *examples*) | 1 |
| Kissing and sexual contact often involve transmission of body fluids and skin touching. Infections include STI's such as HIV, gonorrhoea, chlamydia, cold sores (*Herpes*), genital warts, etc.(*Students must give* ***two*** *examples*) | 1 |
| Some diseases that are spread readily through indirect contact can also be spread via direct contact. Airborne diseases, and infections involving contaminated food and surfaces can be transmitted via direct contact of dirty/contaminated hands. | 1 |
| **Indirect contact** can transmit a large variety of pathogens through many different ways. Some pathogens require more than one host to complete their lifecycle. | 1 |
| *Students must include at least* ***two (2)*** *different forms of indirect contact in their comparison, in addition to* ***Airborne diseases*** *and* ***Vectors****. At least* ***one (1)*** *example of a specific disease must be included with each form of indirect contact.*  |
| **Airborne diseases** - inhalation of bacteria, spores, virus particles or droplets containing pathogens. These are spread by an infected individual sneezing, coughing or speaking. E.g. colds, flu, measles, diphtheria, whooping cough, mumps, rubella. | 1 |
| **Vectors** - * The pathogen is transmitted via another organism (vector). The vector carries the pathogen from an infected individual to a new host. E.g. Malaria (*Plasmodium*), Ross River virus, Lyme disease, Dengue fever, plague.
* Some vectors (e.g. mosquitoes) are **intermediate** hosts that play an integral part in completing the pathogen's lifecycle.
 | 1 - 2 |
| *Other examples of indirect contact include;* |
| **Contaminated food and water** - consumption of contaminated food or water resulting from poor hygiene practices or exposure to sewage.E.g. Hepatitis A, cholera, *Giardia*, viral meningitis, *Salmonella*, typhoid. | 1 |
| **Animals and Zoonotic diseases** - birds and mammals such as bats, dogs, cats and pigs can carry pathogens that are zoonotic; they can be transmitted to humans.E.g. Rabies, swine flu, tapeworm, bird flu, bat lyssavirus. | 1 |
| \**Other forms of indirect contact are acceptable at the teacher's discretion.* |
| **TOTAL** | **10** |

**Question 39 (20 marks)**

(a) Describe the structural, physiological (functional) and behavioural adaptations of endotherms that inhabit cold environments. Use specific examples to support your answer. (10 marks)

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| **Description** | **Marks** |
| Endotherms in cold environments possess adaptations that help to maintain their core body temperature. Adaptations are not mutually exclusive. | 1 |
| *Students must describe at least* ***one (1)*** *structural, physiological (functional) and behavioural adaptation to obtain full marks. For each adaptation students must identify the adaptation, explain how it works and give at least* ***one (1)*** *example of an organism with the adaptation. Examples include;* |
| **Structural adaptations** |
| * Waterproof outer fur or feather layer.
* Prevents cold water coming into contact with the animal's skin and heat loss through conduction.
* Penguins, platypus, otters etc. have waterproof coats.
 | 1 - 3 |
| * Thick 'fluffy' undercoat.
* A thick layer of fine fur or feathers, usually under a waterproof layer, insulates the animal by trapping warm air next to its body.
* Penguins, water rats, otters, platypus, etc. have a thick layer under waterproof covering.
 | 1 - 3  |
| * Thick layer of 'blubber' under the surface of the skin.
* A thick layer of blubber acts as an insulator against cold water. It prevents heat loss from the body core through conduction.
* Penguins, seals, polar bears, whales, etc, possess these fat layers.
 | 1 - 3 |
| **Physiological (Functional) adaptations** |
| * Counter-current heat exchange. (\**Could be accepted as structural*)
* Extremities possess arteries and veins lying adjacent to each other. Heat from core blood is transferred to the cold venous blood by conduction, preventing the cooling of the body's core.
* Penguin feet, dorsal fin of dolphins, platypus tail.
 | 1 - 3 |
| * Vasoconstriction in extremities.
* The capillaries in small external structures are constricted to reduce blood flow. This enables the animal to maintain warm blood in its core, protecting vital organs.
* Humans in sub-zero climates.
 | 1 - 3 |
| * Shivering.
* Shivering in response to the cold is an autonomic nervous response to increase body temperature. It increases heat production through increased metabolism of muscle cells.
* Dogs, cats, birds, humans shiver in response to the cold.
 | 1 - 3 |
| **Behavioural adaptations** |
| * Hibernation. *(\*Can be accepted in functional adaptations*)
* Hibernation involves the complete avoidance of cold/freezing conditions. The animal 'sleeps' for long periods in a burrow or den with a reduced metabolic rate and core body temperature (to reduce weight loss).
* Polar bears and wombats hibernate over winter.
 | 1 - 3 |
| * Huddling.
* Animals in freezing conditions will huddle closely together to share body warmth and reduce loss of heat to the environment through conduction. Huddling can be within burrows or on land.
* Most species of penguin huddle in large groups.
 | 1 - 3 |
| * Burrowing.
* Endotherms seek warmth by digging burrows. Burrows underground maintain constant temperatures and protect animals from the elements. Small spaces trap heat.
* Wombats, foxes, rabbits, etc.
 | 1 - 3 |
| **TOTAL** | **10** |

(b) Compare the disease-causing agents that cause malaria and Ross River virus. Suggest how climate change could affect the transmission and distribution of these diseases in the future. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| *Comparison and description should include pathogen, host, transmission and lifecycle for eight (8) marks.*  |
| Malaria and Ross River Virus (RRV) or Ross River fever are caused by pathogens carried by a mosquito vector. Transmission is via a bite by the female mosquito. | 1 |
| Malaria is caused by infection with the parasitic protozoan, *Plasmodium*. RRV is caused by a virus (Alphavirus) that is comprised of an encapsulated single strand of RNA.  | 1 |
| Both pathogens complete their lifecycles within two hosts - mosquito and human. RRV can also be carried by other vertebrates like horses and kangaroos (enzootic). | 1 |
| RRV can be carried by around 40 different species of mosquito and is Endemic to Australian, Papua New Guinea and islands in the South Pacific. Malaria is transmitted via female mosquitoes from 50 species of the genus *Anopheles,* found in tropical regions of the world. | 1 |
| Ross River virus is non-lethal but causes debilitating joint pain (polyarthritis). There are around 5,000 report cases per year. Malarial infections can cause severe illness and death. Of the five different species of *Plasmodium* that cause malaria *P. falciparum* is most virulent. Around 700,000 deaths are reported annually. | 1 |
| RRV infects skeletal muscle cells where it replicates. New viral particles enter the blood stream, spreading to other parts of the body.Incubation period is usually between 5 and 15 days. Infected blood is transmitted by the mosquito to other humans/animals.  | 1 |
| *Plasmodium* sporozoites are transmitted into the blood via mosquito saliva and infect liver cells. Liver cells rupture and release merozoites. These infect red blood cells and produce gametocytes. Gametocytes are taken up by another mosquito where they develop into new sporozoites. Incubation period is 10 - 15 days.*\*Students can use a labelled diagram to illustrate this cycle for two (2) marks.* | 1 - 2 |
| *Suggestions for effects of climate change are allocated three (3) marks. Examples include;* |
| Both diseases are affected by local conditions that influence mosquito breeding. This includes rainfall, temperature, tides and presence of inland waterbodies. | 1 |
| Climate change is responsible for increases in global temperatures, changes to rainfall patterns and extreme weather events. These factors can influence mosquito populations and distribution. | 1 |
| Changes to the climate and weather will increase the geographical range of mosquito vectors for malaria and RRV, allowing for increased infection rates.  | 1 |
| **TOTAL** | **10** |

**End of Exam**