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**Marking Guide**

**Biology Unit 3**

**2019**

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

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

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

**Question 31 (20 marks)**

(a) Describe the components and structure of the following genetic material.

(i) Nucleotide (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Functional unit of DNA molecule with three chemical components - 5-carbon sugar (deoxyribose), a negatively charged phosphate group and a nitrogenous base. | 1 |
| Bases can be of four types - Adenine, Thymine, Cytosine and Guanine. | 1 |
| **TOTAL** | **2** |

(ii) Codon (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A series of three nucleotide bases in mRNA. E.g. ATT, GCT. | 1 |
| Each codon corresponds to an amino acid used in protein synthesis. | 1 |
| **TOTAL** | **2** |

(iii) DNA (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Large, double-stranded molecule comprised of nucleotides. | 1 |
| Strands are wound around each other to form a double helix. | 1 |
| **TOTAL** | **2** |

(iv) Chromatin (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Molecular complex for packaging DNA in eukaryotic cells as chromosomes. | 1 |
| DNA strands are wrapped around proteins called histones to form nucleosomes, the basic unit of chromatin. | 1 |
| **TOTAL** | **2** |

(b) Suggest why the information contained within genes is referred to as the 'universal genetic code'. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Almost every organism uses the four nitrogenous bases in DNA and RNA to translate genetic information into proteins. | 1 |
| The same codons code for the same amino acids in most organisms. | 1 |
| **TOTAL** | **2** |

The following strand of DNA is part of a gene that codes for a structural protein.

**3' CAATTGATAAGTCAGTCAATGGAT 5'**

**5' GTTAACTATTCAGTCAGTTACCTA 3'**

(c) Determine the mRNA sequence that would be synthesised from the DNA strand shown above. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Must be a transcription of the template strand - 3' to 5'. | 1 |
| Correct mRNA strand with uracil replacing thymine.  5' GUU AAC UAU UCA GUC AGU UAC CUA 3' | 1 |
| **TOTAL** | **2** |

(d) Using the genetic code table below, identify the amino acids that would be translated from the transcribed mRNA strand. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Correct order of amino acids, translated from 5' to 3' end. | 1 |
| *All amino acids must be correctly stated for full marks.*  Valine - Asparagine - Tyrosine - Serine - Valine - Serine - Tyrosine - Leucine. | 3 |
| **TOTAL** | **4** |

There are 64 three-letter codes in the genetic code table but only 20 amino acids.

(e) Explain how having many more codes than amino acids could be of benefit to the process of protein synthesis. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| If a mistake occurs there is a greater chance of translating for the same amino acid. | 1 |
| If this occurs, it will have no effect on the final protein or its function. | 1 |
| **TOTAL** | **2** |

Jessie and Rebecca are identical twins. Their parents, friends and teachers often find it difficult to tell them apart. However, Jessie was born with only four digits on her left hand.

(f) Explain how it is possible for Jessie to exhibit a difference in morphology to her identical twin. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| A mutation occurred within the uterus during foetal development. | 1 |
| Only one twin was exposed to a physical or chemical mutagen during the time when hands were forming. | 1 |
| **TOTAL** | **2** |

**Question 32 (20 marks)**

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

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Evolutionary process whereby a population of a single species can evolve and change over time to form two (or more) distinct species. | 1 - 2 |
| **TOTAL** | **2** |

(b) Describe the **four (4)** main factors that influence the process of speciation. (8 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 1.**Geographical Isolation**.  A population or populations are physically separated and exposed to different selection pressures. | 1 - 2 |
| 2. **Gene flow reduction**.  An isolated population cannot share/transfer genetic information, leading to genetic drift. | 1 - 2 |
| 3. **Hybridisation.**  Mating between individuals of very similar species produces a third, hybrid species, different from either parent, that is usually infertile. | 1 - 2 |
| 4. **Reproductive isolation.**  Gene pools are separated and prevented from mixing. This allows each population to evolve in isolation (due to genetic drift and alternate selection pressures). | 1 - 2 |
| **TOTAL** | **8** |

(c) Using specific examples, explain how analysis of each of the following can provide evidence for the 'theory of evolution'. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| (i) **Fossils**  Fossilised intermediate states of an organism can show change over time from its ancestral state to its descendants.  E.g. *Archaeopteryx,* bird-like dinosaur. | 1 - 2 |
| (ii) **Homologous structures**  Common physiological structures found on different organisms that share a common evolutionary ancestor.  E.g. Human hand, bat wing and dolphin pectoral fins show similar pentadactyl pattern. | 1 - 2 |
| (iii) **Analogous structures**  Features of unrelated organisms with the same function but different structure. Suggests separate lines of evolution.  E.g. Eyes - vertebrate and octopus eye have different position of optic nerve fibres. | 1 - 2 |
| **TOTAL** | **6** |

(d) Explain how microevolution differs from macroevolution. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Microevolution is the evolutionary change within a population due to changes in allele frequencies. | 1 |
| These changes are caused by mutations, gene flow, genetic drift and selection pressures. | 1 |
| Macroevolution describes evolutionary change above the species level. | 1 |
| Usually refers to speciation or adaptive radiation, when many new species evolve as a result of major environmental changes. | 1 |
| **TOTAL** | **4** |

**Question 33 (20 marks)**

(a) Explain why these genetically modified goats are considered 'transgenic' animals.

(2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The goats carry 'foreign' DNA from another species that has been deliberately inserted into their genome. | 1 |
| This foreign DNA can enable the goats to synthesise a protein that it does not normally code for/make. | 1 |
| **TOTAL** | **2** |

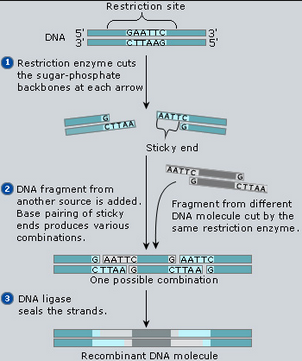
To ensure the spider silk gene is only expressed in the cells of the goat's mammary glands, the gene is inserted within the milk producing genes.

(b) Suggest the importance of inserting the gene at this location. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Easier to locate for subsequent experiments. | 1 |
| The gene is always linked to the milk-producing genes so will always be inherited together. | 1 |
| The spider silk protein will only be synthesised in the mammary gland cells and no other cells in the goat's body. | 1 |
| **TOTAL** | **3** |

(c) Construct an annotated diagram that reveals how a gene (segment of DNA) is inserted into a recipient genome. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Recipient DNA and gene of interest with complementary 'sticky ends'. | 1 |
| Correct enzymes included and labelled - restriction endonuclease and DNA ligase. | 1 |
| Diagram includes before, during and after images of the DNA being recombined correctly. | 1 - 2 |
| Diagram sequential and annotated correctly. | 1 - 2 |
| **TOTAL** | **6** |

E.g.

When the genetically modified goats are of reproductive age, they are mated with unmodified males. Not all of the subsequent offspring contain the spider silk gene.

(d) Explain why scientists would breed modified goats with the unmodified male stock.

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Maintain the genetic diversity of the goat population. | 1 |
| Avoid inbreeding which could cause other genetic problems. | 1 |
| Only the females carry the genes for spider-silk production so breeding with normal goats won't alter the outcome. | 1 |
| **TOTAL** | **3** |

Many news articles regarding the production of spider silk milk have referred to the genetically modified goats as 'spider goats'.

(e) Explain why the term 'spider goat' is scientifically incorrect. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The goat only contains one gene from the spider, out of the thousands in its genome. | 1 |
| The gene has no effect on any other function or structure in the goat's body. It is still a goat. | 1 |
| The goat does not possess any of the spider's characteristics such as making a web, having eight legs, external carapace, poison etc. | 1 |
| **TOTAL** | **3** |

(f) Suggest **three (3)** moral and/or ethical issues people may have with the use of mammals in genetic engineering. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Negative effects on the animal. E.g. turning it into a 'spider-goat'. | 1 |
| People may believe that geneticists are 'playing God' by changing an animal's genome for economic gain. | 1 |
| People tend to have a greater affiliation and emotional attachment to larger animals than insects. They don't want to think the animals are being harmed in any way. | 1 |
| **TOTAL** | **3** |

**\*** *Other reasonable examples are acceptable.*

**Question 34 (20 marks)**

(a) Identify **four (4)** main differences between mitosis and meiosis. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ***Four (4) points from below for a total of four (4) marks*** | |
| Mitosis produces 2 x 2n daughter cells; meiosis produces 4 x n daughter cells. | 1 |
| Mitosis occurs in somatic cells; meiosis occurs in reproductive/sex cells. | 1 |
| Mitosis gives rise to cells that are genetically identical; meiosis gives rise to cells that are not identical to the parent or each other. | 1 |
| Mitosis has one 'cycle' (IPMAT) while meiosis has a second, slightly modified cycle (IPMATPMAT). | 1 |
| Mitosis does not have any extra processes to increase genetic variation; meiosis includes crossing over and independent assortment. | 1 |
| Mutations in mitosis are not passed onto offspring; mutation in meiosis are usually passed onto offspring. | 1 |
| **TOTAL** | **4** |

A tumour is a group of abnormal cells, with no useful function, that grow and reproduce in an unrestrained manner. They can be either benign (non-cancerous) or malignant (cancerous).

(b) Describe the change that occurs within a normal somatic cell to allow a tumour to form. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mutation of the gene that controls normal cell growth and division. | 1 |
| Cells cannot carry out their normal functions and apotosis (cell death) does not occur. | 1 |
| Rate of cell division of abnormal (cancer) cells increases and tumours form. | 1 |
| **TOTAL** | **3** |

Meiosis plays an integral role in maintaining genetic diversity of a species' population.

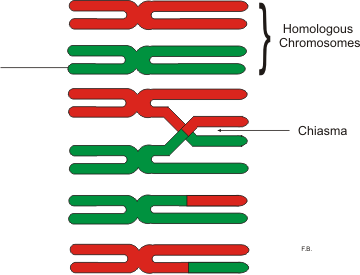
(c) Explain what is meant by 'independent assortment of alleles'. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Homologous chromosomes are replicated at the beginning of meiosis. Each homologue has a copy or sister chromatid. | 1 |
| Homologues line up in the centre of the cell separately. E.g. each copy of chromosome 15 with its sister chromatid are not joined to or located near one another. | 1 |
| When the cell undergoes the first cytokinesis, the homologous pairs are able to move independently of each other. | 1 |
| The homologous pairs and their alleles are able to move into separate cells (or sorted independently of each other). | 1 |
| **TOTAL** | **4** |

(d) Using a labelled diagram, describe the process of 'crossing over' that occurs during meiosis. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| After the homologous chromosomes are replicated in meiosis I, they pair up to form bivalents (in a process called synapsis). | 1 |
| While paired, the non-sister chromatids can move over one another and become tangled. A chiasmata forms between the chromatids where genetic material can be exchanged. | 1 |
| Sections of gene sequences 'cross over' between non-sister chromatids, producing chromosomes that are genetically different to the original. | 1 |
| Diagram must include both homologous chromosomes with sister chromatids, chiasmata, resultant chromatids with swapped genetic information. *See example below.* | 1 - 3 |
| **TOTAL** | **6** |

E.g.



*Wikimedia Commons*

(e) Explain the role of fertilisation in fostering genetic variation. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The union of gametes is random. | 1 |
| Huge number of gametes, each with variations from meiosis. | 1 |
| **TOTAL** | **2** |

(f) A fruit grower plants several different varieties of blueberry plants in close proximity to increase the likelihood of cross-pollination. Even though the flowers are fertilised with pollen from a different blueberry variety, they still produce fruit with the same genetic complement of the parent plant. Explain. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The pollen is fertilising the ovum of the flower only. | 1 |
| No genetic change has been made to the blueberry plant. | 1 |
| The fruit is produced by the plant to protect the growing seeds, so contains the same genome as the parent plant. | 1 |
| **TOTAL** | **3** |

**Question 35 (20 marks)**

(a) Identify the type of enzyme used to remove or 'cut' segments of DNA from a chromosome and explain how they work. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Restriction endonucleases or restriction enzymes. | 1 |
| These enzymes cleave the DNA at specific nucleotide sequences. | 1 |
| These sequences are known as restriction sites. | 1 |
| **TOTAL** | **3** |

In a normal frog, the cell membrane protein is coded for by the gene VPCM. In frogs carrying the mutation, the end of this gene sequence has been deleted.

(b) Suggest why this mutation prevents the virus from entering the frog's cells. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Cell cannot make the protein. | 1 |
| Cell makes a non-functional version of the protein. | 1 |
| **TOTAL** | **2** |

Multiple copies of the frog's DNA, required to carry out further analysis, were synthesised using PCR (Polymerase Chain Reaction). Two different DNA primers were added to the PCR so the correct gene sequence would be copied from the mutated and non-mutated DNA.

(c) Explain the function of a DNA primer and their importance in the PCR process.

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| DNA primers are segments of single-stranded DNA, about 20 nucleotides long. | 1 |
| The primers bind to the end of the DNA strand being amplified, in the 3' to 5' direction. | 1 |
| DNA polymerase adds new nucleotides to form a new strand but can only do this from an existing nucleotide. The primer provides this nucleotide. | 1 |
| **TOTAL** | **3** |

(d) Estimate the base-pair lengths for the gene segments of each test sample. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Sample 1 - 475 base pairs +- 5 | 1 |
| Sample 2 - 430 base pairs +- 5 | 1 |
| Sample 3 - 475 base pairs +- 5 | 1 |
| Sample 4 - 475 base pairs +- 5 and 430 base pairs +- 5 | 1 - 2 |
| **TOTAL** | **5** |

(e) Suggest a reason for the anomaly in the data for Sample 4. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| ***One (1) point from below for a total of one (1) mark.*** | |
| Sample was mixed up and contains DNA from mutated and non-mutated frogs. | 1 |
| Another mutation exists in the genome of the frogs that doesn't affect gene length. | 1 |
| The sample used in PCR was contaminated with the other species' DNA. | 1 |
| **TOTAL** | **1** |

*\*Other reasonable responses are acceptable*.

(f) Explain how this substitution mutation could allow the synthesis of the protein while offering resistance to the virus. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Substitution mutation involves the replacement of a nucleotide for a different one. | 1 |
| This replacement could cause the wrong amino acid to be added to the polypeptide chain during translation. | 1 |
| The wrong amino acid could cause a change in the shape or function of the protein. | 1 |
| These changes could prevent the protein from working properly and therefore the virus cannot enter the cell. | 1 |
| **TOTAL** | **4** |

(g) Propose how these findings could be used in the future conservation of frogs.

(2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Accurately test other species for the extra mutation. | 1 |
| Breed the resistant frogs to release into the environment. | 1 |
| **TOTAL** | **2** |

\**Other reasonable suggestions are acceptable*.

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

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

**Part A**

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

**Question 36 (20 marks)**

(a) Explain the concept of alleles in the inheritance and expression of genetic traits. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Different versions of a gene on homologous chromosomes are called alleles. Each allele only differs by a few bases. | 1 |
| The combination of alleles determines an organism's genotype for a particular trait. | 1 |
| A genotype is the information carried in the two alleles that results in the expression of some characteristic. | 1 |
| Genotypes can be homozygous (alleles are identical) and heterozygous (alleles are not identical). | 1 |
| The expression of the genotype is called the phenotype and is based on the interaction of alleles. | 1 |
| Phenotypes can be dominant, recessive, codominant or partially dominant. | 1 |
| Alleles can be dominant or recessive - the dominant allele usually masks the version of the characteristic carried in the recessive allele. | 1 |
| Dominant alleles are represented by a capital letter and recessive alleles by a lowercase letter - T and t. The letters reflect the genotype. | 1 |
| Dominant traits are expressed when the dominant allele is heterozygous (Tt) or homozygous (TT). Recessive traits are only expressed when the recessive allele is homozygous (tt). | 1 |
| Some alleles show codominance and both versions of the gene are expressed or they have partial dominance where the alleles combine to produce a mixed characteristic (red and white flowers = pink flowers). | 1 |
| **TOTAL** | **10** |

(b) Describe the type of mutations that result in a change in the structure of a chromosome. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Chromosome mutations result from two or more breaks in the DNA helix and rearrangement of the segments. | 1 |
| Breaks can occur naturally during meiotic division or from exposure to mutagens. | 1 |
| There are four main types of chromosomal mutations - deletions, inversions, translocations and duplication. |  |
| **Deletions** - usually fatal.  These occur when a strand is broken in two places and the segment is lost/removed. The resulting chromosome is shorter than before. | 1 - 2 |
| **Inversions** - gene disruption causing various disorders.  The chromosome breaks in two places and the segment is rotated 180o before re-joining. | 1 - 2 |
| **Translocations** - often result in cancer.  This occurs when a segment of one chromosome breaks off and attaches to another chromosome. | 1 - 2 |
| **Duplications** - usually harmful but can result in beneficial traits.  An extra copy of a section of a chromosome is made and then inserted into another region on the same chromosome or another chromosome. | 1 - 2 |
| **TOTAL** | **10** |

**Question 37 20 marks**

(a) Using specific examples, explain how environmental factors can influence phenotypic expression without causing change to the genotype. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The phenotype of any organism is the product of its genotype and the environment. Variation in phenotypic expression can occur within the same species due to environmental factors. | 1 |
| Sources of phenotypic variation include (but not restricted to);  Climate  Temperature  Altitude  Light availability  Water availability and condition  Food availability  Acidity  Soil (health and type)  Predation  Competition  Disease  Toxins  ***Must list at least eight (8) sources for full three (3) marks.*** | 1 - 3 |
| *Explanation of at least three sources of variation with examples.*  *Each source of variation with acceptable example is worth up to two (2) marks, for a total of six (6) marks.* | 6 |
| Examples include, but not restricted to;   * Climate - echidnas living in the warmer regions on mainland Australia produce a thinner coat of hair than their Tasmanian counterparts. Lower temperatures affect gene expression and stimulate growth of a thicker coat for extra warmth. * Food availability/water condition - *Daphnia carinata*, a tiny water invertebrate, will produce eggs that do not require fertilisation when water conditions are unfavourable, and food is scarce. This type of reproduction is called parthenogenesis and only produces female offspring. * Temperature - temperature of eggs during incubation can affect the sex of offspring in many reptiles. High temperatures during development can produce all females and vice versa. This can prevent inbreeding because all the offspring are the same sex. |
| **TOTAL** | **10** |

(b) Outline the processes involved in the synthesis of proteins, from DNA to ribosome.

(10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Region of DNA to be transcribed unwinds and unzips under the action of DNA helicase. Nitrogenous bases are exposed. | 1 |
| Messenger RNA (mRNA) is synthesised, using the template strand of DNA, from the promotor sequence to the stop codon (beginning and end of gene). | 1 |
| RNA polymerase makes mRNA by adding nucleotides under the base-pair rule. However, thymine is replaced by uracil in RNA. | 1 |
| mRNA is single-stranded and reflects the code carried by the non-template strand of the DNA. | 1 |
| DNA is zipped up and mRNA is released into the nucleus where it undergoes modification. | 1 |
| mRNA leaves the nucleus and attaches to a ribosome complex (on the endoplasmic reticulum) and begins to move through it. | 1 |
| Each codon (three nucleotide bases) on the mRNA code for an amino acid. Amino acids are carried to the ribosome by transfer RNA (tRNA) which has a complementary anticodon sequence. | 1 |
| tRNA joins to the complementary mRNA codon at the binding site. When a second tRNA joins, adjacent amino acids form a peptide bond. tRNA's detach and are reused. | 1 |
| The process continues until the stop codon is reached and a long polypeptide chain has formed. | 1 |
| The mRNA is released (can be reused) and the polypeptide is 'sent' to the ER and Golgi apparatus for folding and packaging into the 3-D protein structure. | 1 |
| **TOTAL** | **10** |

**Part B**

Choose **either** Question 38 **or** Question 39.

**Question 38 (20 marks)**

Analysing the similarities in homologous DNA sequences of organisms enables scientists to determine their relatedness.

(a) Describe the process of DNA (molecular) hybridisation and how it can reveal evolutionary relatedness and common ancestry. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| DNA hybridisation measures the degree of genetic similarity between complementary DNA sequences. Single strands of DNA from two different species are allowed to join together to form a hybrid DNA. | 1 |
| Closely related species have very few differences in their genome compared to distantly related species. The DNA sequences that are most closely related will have more bonds in complementary strands. | 1 |
| ***Hybridisation technique*** | |
| Complementary DNA strands of the species to be compared are heated (to 86oC) to break hydrogen bonds between base pairs. | 1 |
| Single-stranded DNA molecules from species being compared are mixed together and allowed to cool. | 1 |
| Similar strands of DNA from the different species will begin to re-anneal at complementary base pairs via hydrogen bonds. | 1 |
| The resulting hybrid DNA is then reheated. The temperature at which hybrid DNA separation occurs is related to the number of hydrogen bonds formed between complementary base pairs. | 1 |
| Closely related species will have temperature separation close to the temperature required to break hydrogen bonds initially (86oC) because most base pairs are complementary. | 1 |
| If the species are not closely related, less base pairing occurs. The temperature required to separate the hybrid molecule will be lower than the initial temperature (86oC). | 1 |
| The information gained from molecular hybridisation can be compared with known fossil dates and used as a molecular clock. | 1 |
| It is possible to estimate the approximate date (in evolutionary time) that certain species or taxa diverged, and the last time they shared a common ancestor. | 1 |
| **TOTAL** | **10** |

(b) Explain how adaptive radiation gave rise to Darwin's Galapagos Island finches through allopatric speciation. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Adaptive radiation is the divergence or diversification of the descendants of a single (ancestral) species to occupy different available niches. | 1 |
| Adaptive radiation is a type of divergent evolution where populations or small sections of a population move into a new area and a new species is formed through allopatric speciation. | 1 |
| Allopatric speciation refers to the divergence of a species into **geographically isolated** populations, such as the Galapagos islands. | 1 |
| Members of the original finch species population (of Darwin's finches) relocated onto various separate islands to access different sources of food. | 1 |
| Each new island population was then geographically isolated by distance and water; therefore gene flow was restricted. | 1 |
| The new populations on the different islands were subject to different selection pressures due to differences in climate, flora, fauna, predators and food availability. | 1 |
| The phenotypes best suited to the new food source were favoured. In the case of the finches, beak shape and size to best access food was favoured. | 1 |
| Subsequent generations of finches would more likely express the phenotype for the beak that was most effective at obtaining food. This eventually caused a change in allele frequencies in the gene pool. | 1 |
| Over time, the new island population develops a gene pool that is significantly different from the original population. The new population develops unique genetic and behavioural characteristics, so it is unlikely that they will/can mate with the original population. | 1 |
| Gene flow no longer occurs and the separated finch populations have become significantly different - reproductive isolation has been established and a new species formed. | 1 |
| **TOTAL** | **10** |

**Question 39 (20 marks)**

The European rabbit (*Oryctolagus cuniculus*) was introduced into Australia in 1859 by a wealthy farmer keen on hunting. Within a few years, the rabbits had spread uncontrollably throughout Australia despite hunting, poisoning and trapping. The Australian landscape was devastated as the rabbits fed on native plants and domestic stock feed.

In 1950, a highly virulent strain of the Myxoma virus (causing Myxomatosis) was released. Within five years it had spread throughout Australia, reducing the rabbit population by 99%. However, the effectiveness of the virus gradually declined and by 1995, the rabbit population had reached an estimated 300 million.

(a) Discuss how the mechanisms of natural selection and the Founder Effect led to the development of a rabbit population in Australia, resistant to the Myxoma virus. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The Founder Effect is a type of genetic drift that can occur after a catastrophic event that leaves a very small population. | 1 |
| The new, small population is very different from the original population with limited genetic variation. | 1 |
| The new population will only ever resemble the individuals that founded the small population. | 1 |
| Only a small selection of alleles of genes are present in the new population, therefore allele frequencies, genotypes and phenotypes will be different. Distinct gene pool arises. | 1 |
| The Founder Effect can cause higher frequencies of some traits. If a genetic resistance to the Myxoma virus had a low frequency in the large population, the frequency in the small population will seem much larger (due to low number of founders). | 1 |
| Natural selection will influence the allele frequency of the new population by favouring those rabbits resistant to the Myxoma virus. | 1 |
| The virus can still affect in the population, however, as the alleles (non-resistant) can stay in the gene pool if the rabbits are not exposed. (Silent alleles) | 1 |
| As natural selection acts on the rabbit populations to make them 'fitter', only the best adapted, healthiest and virus-resistant individuals will survive to reproduce. | 1 |
| This genetic resistance will be passed on to the offspring of healthy rabbits for many generations. | 1 |
| The result is a large population of rabbits with a very high frequency of alleles for virus-resistance in its gene pool. | 1 |
| **TOTAL** | **10** |

(b) Contrast the use of and processes involved in selective breeding and genetic modification in modern agricultural practice. (10 marks)

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| **Description** | **Marks** |
| Selective breeding has been used for centuries in agriculture to grow and develop the livestock, grains, vegetables and fruit that best suit the environment and needs (wants) of the wider community. | 1 |
| Selective breeding does not physically alter the genome of an organism as does genetic modification techniques. Allele frequencies are altered through artificial selection in breeding. | 1 |
| If an individual animal or plant shows a desired trait (phenotype), it will be selected to breed, or the seeds collected for sowing, etc. | 1 |
| This process continues through the generations until the trait has become common in the population; the allele frequency is very high. | 1 |
| Unlike modern genetic modification, selective breeding can change the phenotype and allele frequencies over time to suit the needs of the farmer/breeder. | 1 |
| Genetic modification practices in agriculture involve permanent changes to the genome of an organism by integrating foreign DNA. Selective breeding does not involve changing the organism's genome. | 1 |
| A gene from one organism (donor), that produces a desired protein or trait, can be cloned and inserted into the host organism. The use of a vector, such as bacteria, is often essential to this process. | 1 |
| Genetic modification in agriculture is more often carried out in plants. Crop plants can be modified to produce extra vitamins and proteins to increase/change the nutritional value of the product. | 1 |
| Genes for disease resistance and pesticide resistance can also be incorporated into the genome of many plants to improve yield and allow growers to better control weeds. | 1 |
| Changes that are brought about by genetic modification are very rapid and can occur in large numbers. Selective breeding is a much slower process and often requires a more 'trial and error' approach to get the required phenotype to be expressed. | 1 |
| **TOTAL** | **10** |