BIOLOGY

UNIT 3 Semester One 2019

Marking Key

Marking keys outline the expectations of examination responses. They help to ensure a consistent interpretation of the criteria that guide the awarding of marks.

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|  |  |
| --- | --- |
| Section One: Multiple–choice | 30% (30 Marks) |

Suggested working time: 40 minutes.

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

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

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|  |  |
| --- | --- |
| **Question 31** | **(20 marks)** |

The domestication of livestock dates back over 10,000 years. Selective breeding, also known as artificial selection, has produced most of todays domesticated breeds.

1. Briefly explain the purpose of selective breeding. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Enhance/improve certain traits of an original ‘wild’ type through a controlled breeding program. – Some people gave a good clear example of this & received a mark | 1 |
| Useful/Desirable features or characteristics have been selected for and improved upon though intentional reproduction. | 1 |
| **Total** | **2** |

Selective breeding has increased the efﬁciency of domesticated plants and animals; however, there are some disadvantages.

(b) Discuss **two** long-term disadvantages to a plant species, as caused by selective breeding, that need to be considered. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Two** long-term |
| Loss of variety (genetic diversity) means that:  | 1 |
| Plants are more susceptible to disease and pests  | 1 |
| **Total** | **2** |

(c) How might these disadvantages be reduced or prevented? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any **two** of:* Preserve variety genetic variety by maintaining the original ‘wild’ stock
* Seed banks to store original/wild stock
* Keep records to reduce intensive/close inbreeding
* Some people stated could breed plants with plants from another region (I only accepted this answer if they clearly stated that they know the genetics of both plants – did not accept breeding different species)
 | 1-2 |
| **Total** | **2** |

**Question 31** (continued)

(d) From your knowledge of genetics and using a named example, brieﬂy describe how the process of selective breeding operates. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Undesirable characters are culled or removed from a breeding program/Only individuals with desirable traits are used to breed  | 1 |
| Examples: bulls (male calves) and low-yield milking cows. | 1 |
| **Total** | **2** |

(e) Biotechnology applications include recombinant DNA technology and DNA hybridization. DNA hybridization is a technique used for comparing the DNA of one species with the DNA of another species.

What is recombinant DNA? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Recombinant DNA is DNA that has had a gene added (combined) to it from another source. | 1 |
| Recombinant DNA technology is used to produce transgenic organisms. | 1 |
| **Total** | **2** |

Briefly describe how recombinant DNA is produced? (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| DNA containing the required gene from a particular organism is isolated [restriction enzyme].  | 1 |
| Plasmid is cut with same restriction enzyme | 1 |
| The DNA segment combines with/inserted into Plasmid DNA using ligase. | 1 |
| Recombinant DNA is created – when 2 organisms DNA combined | 1 |
| **Total** | **4** |

Briefly explain how DNA hybridization can indicate genetic relationships between species. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The degree of similarity between the two species is based on the number of mismatched/matched nitrogenous bases.  | 1 |
| Two species that are very similar would have very few mismatched nitrogenous bases/or many matched nitrogenous bases | 1 |
| **Total** | **2** |

The percentage similarity in the DNA sequence among four species are shown in the table below. Many people did not read this table correctly & so did not draw the phylogenetic tree correctly

|  |  |
| --- | --- |
| **Species** | **Percentage similarity with species 1** |
| 1 | - |
| 2 | 90 |
| 3 | 95 |
| 4 | 80 |
|  |  |

(f) Use the information from the table above to create a phylogenetic tree in the space below.

 (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| See drawing options for phylogenetic trees below |
| Branching placing species 1 and 3 together  | 1 |
| Branch/section placing species 2 on the outside of species 1 and 3  | 1 |
| Branch/section placing species 4 on the outside of species 2 | 1 |
| Title: Phylogenetic Tree of species 1-4 (or similar) | 1 |
| **Total** | **4** |

**Phylogenetic Tree of species 1-4**

species 2

species 3

species 1

species 4

**or**

species 1

species 3

species 2

species 4

**Phylogenetic tree showing the evolutionary relationships
among four related species.**

|  |  |
| --- | --- |
| **Question 32** | **(20 marks)** |

The pattern of inheritance for albinism in rabbits produces white hair and pink eyes.

1. In a cross between two non-albino rabbits the offspring included some albino and some non-albino kittens. Explain how the non-albino parents could produce albino offspring. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Albinism is a recessive [autosomal] trait.  | 1 |
| Both parents would have to be heterozygous for the condition. Carrier not accepted | 1 |
| **Total** | **2** |

Use the symbols 'A' for the dominant allele and 'a’ for the recessive allele to answer the questions for part (b) and part (c). Draw a punnett square to show your working.

1. A non-albino female, whose mother was albino, was bred with an albino male and their first two offspring were albino males. What is the probability that their third offspring will also be an albino male? (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Parents: Aa x aa.  | 1 |
| Offspring: 50% male x 50% albino = 25% probability  | 1 |
| Punnett square:

|  |  |  |
| --- | --- | --- |
|  | **A** | **a** |
| **a** | Aa | aa |
| a | Aa | aa |

 | 1 |
| **Total** | **3** |

1. A breeder crossed two rabbits which were heterozygous for albinism. In what ratio would you expect normal and albino rabbits in the offspring? Indicate clearly the genotypes and phenotypes of the offspring. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Parents: Aa x Aa | 1 |
| F1 genotype: 1:2:1 | 1 |
| F1 phenotype: 3:1  | 1 |
| Punnett square

|  |  |  |
| --- | --- | --- |
|  | **A** | **a** |
| **A** | AA | Aa |
| a | Aa | aa |

 | 1 |
| **Total** | **4** |

(d) Explain why, albino rabbits are quite common in domestic populations but rare in natural populations. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any **three** of:* Albino selectively bred/artificial selection
* Albino allele increases in frequency
* Colour favoured by natural selection
* Albino preyed upon [selected against] in natural populations
 | 1-3 |
| **Total** | **3** |

The Andalusian fowl has three varieties of feather colour: blue, black or splashed white. Using appropriate symbols to represent the alleles that produce feather colour, explain the pattern of inheritance that would produce the F1 below.

(e) In a cross between a blue chicken and a splashed white the offspring were either blue or black in the ratio of 1:1. Show all working. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Incomplete dominance (blending): where neither allele completely dominates. | 1 |
| Appropriate symbols: BOTH upper case, eg B and W | 1 |
| Parent genotypes stated: blue [BW] x splashed white [WW] | 1 |
| Punnet square (working)

|  |  |  |
| --- | --- | --- |
|  | B | **W** |
| **W** | BW | WW |
| W | BW | WW |

 | 1 |
| F1 phenotype stated: 1 blue : 1 black  | 1 |
|  |  |
| F1 genotype stated: 1 BW : 1 BB 1  | 1 |
| **Total** | **6** |

(f) Of the three varieties of feather colour shown in Andalusian fowl, which one(s) would be heterozygous and which one(s) would be homozygous? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Heterozygous: blue BW  | 1 |
| Homozygous: white WW and black BB  | 1 |
| **Total** | **2** |

|  |  |
| --- | --- |
| **Question 33** | **(20 marks)** |

Grasses form a major part of agricultural pastures around the world. In drier parts of the world these grasses are annuals, meaning that they complete their life cycle in one season, produce seeds and die. The seeds germinate in wet seasons of following years to renew the pasture. Some seeds germinate the very next year but others remain dormant for up to several years before germinating.

A scientist investigated the dormancy rates for seeds of three different species of annual grass. Two grams (2 g) of seed of each species were planted in separate square metre plots. No other plant species was present in the plots. Each year for six years the number of seed that germinated in each plot was counted. The seedlings were then removed so that no new seeds were produced in the plots.

The results of this experiment are shown in the table below.

Examine the data presented below and answer the questions that follow.

|  |  |  |
| --- | --- | --- |
|  | **Grass species** | **Time (years)** |
| Number of seeds germinated (No. per sq m) | 1 | 2 | 3 | 4 | 5 | 6 |
| A | 610 | 320 | no reading | 140 | 20 | 5 |
| B | 415 | 35 | 0 | 0 | 0 | 0 |
| C | 380 | 100 | 35 | 15 | 10 | no reading |

(a) For the experiment described, name

the dependent variable. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Number of seeds germinated/m2 or number of seeds germinated | 1 |
| **Total** | **1** |

the independent variable. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Grass species | 1 |
| **Total** | **1** |

**two** variables that would have to be controlled to ensure the differences observed were only due to seed dormancy. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any **two** of:* Environment: temperature/light/rainfall/water
* Soil type nutrients/fertilizers
* Seed age/sown
* Animal pest control
 | 1-2 |
| **Total** | **2** |

1. On the grid provided, draw a line graph for the data obtained for each of the 3 grass species. (6 marks)



|  |  |
| --- | --- |
| **Description** | **Marks** |
| Heading | 1 |
| Accurate plotting | 1 |
| Appropriate scale | 1 |
| Correct axis – dependent on vertical & independent on horizontal | 1 |
| Axis Title with Units | 1 |
| Key | 1 |
| **Total** | **6** |

For species ‘A’ in year 3 and species ‘C’ in year 6 valid measurements were not available.

(c) Use the graph that you have drawn to predict likely values for these readings had it been possible to measure them.

1. Species ‘A’ year 3 (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 230 seeds/m2: accept 225-235 | 1 |
| **Total** | **1** |

1. Species ‘C’ year 6 (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 5 seeds/m2: accept 4-6 | 1 |
| **Total** | **1** |

**Question 33** (Continued)

1. In which prediction do you have the greatest confidence? Explain why. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Species A | 1 |
| Interpolation [data between plots more accurate] | 1 |
| **Total** | **2** |

All plots were planted with equal amounts of seed (2 g per m2), yet very different numbers of plants grew in each plot.

1. Give **two** possible reasons to explain this. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any **two** of:* Variation in viability of seeds
* Less actual seed numbers [sown by weight/mass]
* Seeds eaten by pest animals before germination
 | 1-2 |
| **Total** | **2** |

In severe drought years grass seeds germinate when it rains but fail to mature, dying before they produce seed. In the year following a severe drought year pasture growth depends largely on dormant seeds in the soil that are at least two years old.

1. (i) In a period of extended drought (two or more years) which of the three

species of grass would suffer the greatest reduction? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Species B | 1 |
| **Total** | **1** |

(ii) Give an explanation for your answer above. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Germination rate declines to 0 (zero) after 2-3 years so no seeds left to regenerate. | 1 |
| **Total** | **1** |

1. Suggest two ways in which the experiment could be improved. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any **two** of:* Seeds planted by equal numbers not mass.
* Repeat the experiment.
* Use a larger sample size (more than 2gm).
 | 1-2 |
| **Total** | **2** |

|  |  |
| --- | --- |
| **Question 34** | **(20 marks)** |

Charles Darwin (1809-1882) suggested that all organisms on Earth arose through a process called natural selection. This is the basis of the theory of evolution. Evidence supporting Darwin's theory has been substantial.

1. Briefly explain Darwin’s Theory of Evolution. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Evolution is the slow and gradual change in the genetic makeup of a population in successive generations over time  | 1 |
| Variation exists within species including variation in their phenotype and genotype..  | 1 |
| Some variations offer an advantage | 1 |
| As a result of natural selection these favoured traits are selected for.  | 1 |
| Gradually over many generations there will be a change in the allele frequency in the population with an increase in the frequency of the favoured traits  | 1 |
| **Total** | **4** |

1. Explain how the following areas of study provide evidence for the theory of evolution.
2. Fossils and the fossil record (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Fossils: any trace of a previously existing organism  | 1 |
| Fossils provide direct evidence of change/evolution  | 1 |
| Fossil record shows a steady increase in the variety of life on earth with time.  | 1 |
| Fossil record shows a steady increase in the complexity of life on earth with time.  | 1 |
| **Total** | **4** |

1. Homologous structures (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Similarities in structures (homologous) indicate a close evolutionary relationship.  | 1 |
| Limbs of vertebrates/pentadactyl limb (or insect mouthparts) are built on the same basic plan.  | 1 |
| This suggests a common ancestor for vertebrates (or insects).  | 1 |
| **Total** | **3** |

* + - * 1. (iii) Embryology (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| At some stage in its development an individual resembles the embryos of its ancestors.  | 1 |
| All vertebrate embryos including terrestrial vertebrates go through a stage with gill slits (visceral clefts)  | 1 |
| All vertebrate embryos go through a stage with a post-anal tail.  | 1 |
| Suggests that they have a number of similar genes and supports the idea of a common ancestor. | 1 |
| **Total** | **4** |

**Question 34** (continued)

1. Give an example of a selective pressure in nature and briefly explain how selective pressures may contribute to evolutionary change. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Selective pressures are environmental factors that may reduce reproductive success in a population.  | 1 |
| Example  |
| Any **one** of:* competition for resources (light, food, space, water)
* predation
* pollution
 | 1 |
| Selective pressures contribute to evolutionary change or extinction through the process of natural selection. | 1 |
| **Total** | **3** |

1. The percentage difference between Human and Chimpanzee DNA and Human and Gibbon DNA is 2% and 5%, respectively. What can be inferred from these results?

 (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| The difference between the DNA (base sequences) of chimpanzees and humans is about two per cent which indicates only a few unmatched base pairs and a close evolutionary relationship.  | 1 |
| The difference between the DNA (base sequences) of human and gibbon is about five per cent which indicates more unmatched base pairs and a more distant evolutionary relationship.  | 1 |
| **Total** | **2** |

|  |  |
| --- | --- |
| **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/cut 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)** |

Unit 3

**Question 36 (20 marks)**

1. Meiosis is a process known to produce genetic variation in offspring produced by sexual reproduction. Describe the process of meiosis and explain how this process produces genetic variation. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Describe the process of meiosis |
| Any **five** of: |
| First stage* replication of chromosomes: become double stranded
* homologous chromosomes pair up
* homologous chromosomes line up at equator
* homologous chromosomes move to poles
* daughter/intermediate cells produced

Second stage* chromosomes line up on equator
* chromosomes split at centromere/chromatids move to poles
* results in four gametes
* number of chromosomes halved: haploid
 | 1-5 |
| **Subtotal** | **5** |
| Explain how this process produces genetic variation ecosystem |
| Any **five** of: |
| * crossing over
* involves exchange of DNA segments/alleles/sections of chromatid between homologous chromosomes
* crossing over produces new combinations of alleles
* homologous chromosomes exchange matching (homologous) segment
* each chromosome is now a blend of maternal and paternal DNA
* independent assortment/random alignment of chromosomes
* chromosomes align randomly/ independently on each side of equator
* Produces a very large range of variation in
* maternal and paternal chromosomes move independently to poles at random
* crossing over and independent assortment produces a very large range of variation in gametes
 | 1-5 |
| **Subtotal** | **5** |
| **Total** | **10** |

**Question 36** (continued)

1. Recombinant DNA technology is used to produce transgenic organisms that have been genetically modified for a specific purpose. The process has been applied to agriculture and environmental conservation. Using specific examples, briefly discuss the advantages and disadvantages for introducing transgenic organisms. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Definition |
| * A transgenic organism is one that has been genetically modified by incorporating a gene from another species into its genome.
* Transgenic organisms have been engineered for desirable traits, including resistance, faster growth rate, greater product quality and yield, and tolerance to adverse environmental conditions.
* Transgenic organisms [GMO’s] have been engineered to reduce the pressure on farming industries and environmental conservation.
 | 1-2 |
| **Subtotal** | **2** |
| Advantages |
| Any **four** of: |
| * The ability to design and manipulate organisms
* Modify and selective breeding through Biotechnology – techniques and processes
* Faster production of desirable traits for human consumption and use
* GMO technology more predictable than traditional selective breeding
* Traditional selective breeding can be slow and undesirable traits can be expressed
* Increased food supply/greater crop yields
* Longer shelf life
* Better quality: flavour/nutritional value
* Sustainability; i.e. edible plant vaccines
* Environmental: salt tolerant plants/crops, GM bacteria are able to feed on pollutants/oil spills
* Any reasonable answer

*Examples** *Tomato long shelf live, Growth hormones, Bacteria [biofactories], Insulin, Salt resistant crops, Bt cotton*
 | 1-4 |
| **Subtotal** | **4** |

**Question 36 cont**

|  |
| --- |
| Disadvantages |
| Any **four** of: |
| * Optimistic predictions, no true understanding of what determines form and function
* No long term monitoring and balances for nature
* Traditional biotechnology uses natural organisms in context; GE creates new genetic make-up that would never come about by natural processes
* Lack of testing
* GE unnatural
* Biotechnology God role
* Effects GMO’s will have on the natural world (non-target organisms) not fully understood.
* Allergic reactions/causes harm to humans when ingested
* Modify genes can escape into wild species (cross pollination)
* Increase of pesticide/insecticide resistant insects
* rapid evolution of pesticide-resistant species
* Any reasonable answer

*Examples** *Superweeds resistant to herbicides through repeated spraying or through gene flow*
 | 1-4 |
| **Subtotal** | **4** |
| **Total** | **10** |

**Question 37 (20 marks)**

1. “PCR and DNA Profiling are an ecologist’s best friend”

Justify this statement in relation to conservation ecology. Describe how PCR and DNA profiling can be used in studying genetic diversity of a single species over a broad range of geographic and environmental conditions

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Prior to PCR large samples of DNA were required from organisms to compare genomes | 1 |
| Invasive & time-consuming techniques used to collect samples | 1 |
| PCR involves the amplification of DNA sequences (taken from small samples) | 1 |
| Large-scale studies can be conducted to compare gene pools of species’ populations & gene flow between populations | 1 |
| Small samples can be taken from ‘the field’, extracted from animal products (such as hair, urine, faeces) | 1 |
| Ecologists can now use techniques that do not require constant monitoring or animal handling/where the animal is not harmed | 1 |
| Rare or endangered species can be sampled without trapping, giving a better indication of genetic diversity of remaining population | 1 |
| Samples of the same species collected from different areas can be amplified using the PCR process | 1 |
| The resultant large samples of DNA can be profiled for comparison using gel electrophoresis | 1 |
| Determine the relatedness between species | 1 |
| Determine the genetic compatibility of different populations | 1 |
| Give ecologists information regarding translocating animals | 1 |
| Information for breeding program requirements | 1 |
| Genetic diversity within populations of a species can be established | 1 |
| Provide data on inbreeding, gene flow, threat of extinction | 1 |
| Data can be used in conservation strategies | 1 |
|  | 10 |

**Question 37 cont. (20 marks)**

1. Protein synthesis involves two stages, transcription and translation. Describe the main steps in each of these processes. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Transcription |
| Any **five** of: |
| * DNA unwinds/unzips
* DNA code is used as a template
* mRNA is synthesized/transcribed from DNA
* mRNA forms complementary strand to DNA
* uracil instead of thymine attached to adenine [C - G, A - U not T]
* RNA polymerase involved
* only one strand of DNA is transcribed
* free nucleotides used to form mRNA (not RNA nucleotides)
* pre-mRNA is modified to produce mature mRNA or introns are removed from mRNA
* difference is transcription stops at terminator sequence on DNA strand
* RNA polymerase/enzyme then detaches from DNA/releases mRNA
* mRNA transported/moves (from nucleus) to cytoplasm
 | 1-5 |
| **Subtotal** | **5** |
| Translation |
| Any **five** of: |
| * mRNA transported/moves (from nucleus) to cytoplasm (only if not awarded above)
* mRNA binds to ribosome
* start codon (mRNA)
* tRNA contains an anti-codon
* tRNA recognizes complementary codon [set of 3 nucleotides] on mRNA
* tRNA binds to site on ribosome/P site and brings an amino acid
* a peptide bond forms between the amino acids
* tRNA is released to continue the process
* amino acid chain forms a polypeptide/ protein
 | 1-5 |
| **Subtotal** | **5** |
| **Total** | **10** |

**Question 38 (20 marks)**

1. Evolution occurs over a time frame that makes it difficult to observe, however examples of natural selection in action can be found.

Using an example of natural selection in action, such as industrial melanism in peppered moths (*Biston betularia*) or bacterial resistance to antibiotics, explain how selective forces in the environment contribute to evolutionary change at the species level. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Natural selection is the process of the survival and reproduction of organisms that are better suited to their environment. | 1 |
| It results in those better suited individuals contributing proportionally more offspring/alleles to subsequent generations. | 1 |
| Variation must already be present in the population. | 1 |
| If the environment changes [selective forces act] the population needs to adapt to the changes in order to survive. | 1 |
| An existing variation that offers a survival advantage will be selected for. | 1 |
| This will result in changes in allele frequency. | 1 |
| **Subtotal** | **6** |
| Example  |
| **Either**This can be observed in the peppered moth (Biston betularia):* industrial melanism in peppered moths
* two varieties [alleles]: dark and light
* selective forces are industrial pollution (soot) and predation (birds)
* dark variety has advantage in polluted area and light variety preyed on.
* increase/shift in allele frequency over several generations
* light variety has advantage in unpolluted area and dark variety preyed on. Increase/shift in allele frequency over several generations

**or**eg bacterial resistance to antibiotics.* resistant variation (mutation)
* survival advantage
* increase of resistant allele frequency over several generations in population
* strain/species immune to antibiotic exposure

**or**eg snail shell colour variation for camouflage.* shell colour variation (mutation) in snail population
* survival advantage of specific colour (camouflage)
* colour variation offers advantage against predation
* increase of allele frequency over several generations in population
 | 1-4 |
| **Subtotal** | **4** |
| **Total** | **10** |
| **Note:** Students may elect to choose any other suitable example. |

1. Many plant and animal species are under threat of extinction. Briefly describe examples of external factors and factors within a species that are likely to increase its chances of extinction. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Extinction  |
| Any **five** of: |
| External factors * Selection pressures/forces can become so great that species become extinct.
* Selection pressures can become so great that species loss of biodiversity/variation.
* habitat destruction
* fragmentation of ecosystem

Examples of environmental changes or disturbance include: * a reduction in suitable shelter
* a reduction in suitable breeding sites
* a reduction in food supply
* an increase in predators
* competition
* unpredictable events such as ﬁres, ﬂoods, disease and droughts
 | 1-5 |
| **Subtotal** | **5** |
| Factors within a species that are likely to increase extinction rate include: |
| Any **five** of: |
| * A specialised life style
* Small population size
* Restricted distribution
* Exist in a rapidly changing habitat
* Limited genetic variability/biodiversity
* Long time to reach reproductive age
* Low numbers of offspring produced.
 | 1-5 |
| **Subtotal** | **5** |
| **Total** | **10** |

**Question 39 (20 marks)**

1. Several unrelated mammals, such as the giant anteater and the aardvark, have a specialized diet of ants and termites. Giant Anteaters (*Myrmecophaga tridactyla*) are found in Central and South America. The aardvark (*Orycteropus afer*) shares many features with the giant anteater but is found only in Africa.



These two mammals which are unrelated, yet share similar structures with similar functions is an example of an analogous structure or convergent evolution, showing the evolution of similar structures without any common ancestry.

Explain how these unrelated mammals have evolved to have similar structural specialisations for obtaining food and give examples of the common structures they share. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
|  |  |
| Any **eight** of:* Convergent evolution/analogous structures due to environmental/selection pressures which are similar for each species.
* Example of selection pressure: Competition for resources/food
* Structural similarities due to a similar lifestyle/specialized diet.
* Over many generations, natural selection may act.
* Variation in each population
* Successful/Advantageous features increase in the population.
* As individuals with advantageous features have increased opportunity to reproduce
* Common adaptations/analogous structures for digging out ants/termite nests.
 | 1-7 |
| Any **two** of: |
| * Claws for digging
* a long, sticky tongue
* elongated snout.
 | 1-2 |
| **Total** | **10** |

1. Over several generations, natural selection and genetic drift may act to bring a change in the allele frequencies of a gene pool. Explain how genetic drift may result in changes in allele frequency in a population and how this differs from changes in allele frequency as a result of natural selection. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Genetic Drift**  |
| Gene pool changes due to chance/random/non-selective | 1 |
| In a small population | 1 |
| Change in allele frequency from one generation to another due to chance fluctuations. | 1 |
| The founder effect: small group from large population migrate/isolated (isolated population not genetically representative of original population) | 1 |
| Bottlenecks: non-selective events [climate, ice-age) causes population/species to be reduced.(only a small sample of the total gene pool of the species survives and genetic diversity is reduced even if numbers increase) | 1 |
| **Subtotal** | **5** |
| **Natural Selection** |
| Gene pool changes due to selection | 1 |
| An existing variation that offers a survival advantage will be selected for/favoured. | 1 |
| An existing variation that offers no survival advantage will be selected against/non-favoured. | 1 |
| Results in positive changes that offer a survival/adaptive advantage  | 1 |
| This will result in changes in allele frequency over several generations | 1 |
| **Subtotal** | **5** |
| **Total** | **10** |