

**Marking Guide**

**BIOLOGY UNIT 3**

**2022**

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

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

**End of Section One**

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

This section has **five** questions. Answer **all** questions. Write your answers in the spaces provided.

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

Suggested working time: 90 minutes.

**Question 31 (21 marks)**

Shown below is a 2-dimensial model of DNA.

(a) On the diagram above, label the following

1. a nucleotide (1 mark)

***Preferable to circle. Most common mistake was circling a nitrogen base.***

1. a hydrogen bond (1 mark)
2. the sugar-phosphate backbone (1 mark)

DNA is the most important molecule in biology. Correct base pairing is essential for DNA to replicate correctly.

(b) Explain how **incorrect base pairing in DNA synthesis** would lead to the **daughter DNA molecules not being identical to the parent DNA molecule**. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Bases will only pair with complimentary bases  (DNA can be ) a template for a specific base sequence  Semiconservative replication / resulting in a gene/point mutation | 1 - 3 |
| **Total** | **3** |

***Many students missed the intent of the questions and spoke at length about the effect of mutations on protein production (not the question)***

Base analogues are molecules that can replace the normal DNA bases during DNA replication. These analogues can be used in the treatment of viral infections by inhibiting the complete replication of the viral DNA. The analogues have a modified base that stops other nucleotides bonding to it, thus ceasing DNA replication. The drug Acyclovir is used to treat herpes (a viral infection) in humans. Acyclovir contains a base analogue for guanine.

(c) Name a biotechnology technique that uses base analogues. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| DNA sequencing | 1 |
| **Total** | **1** |

(d) Which molecule used in this biotechnology technique (named in part (c)) contains a base analogue? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Sanger nucleotide/Sanger base/ chain terminating base/ ddNTPs | 1 |
| **Total** | **1** |

One kilo base pair (kbp) of DNA has a length of 0.00035 mm. The herpes virus DNA is 152 kbp in length.

(e) Calculate the length of herpes DNA. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 0.00035 mm x 152  = 0.0532 mm | 1 |
| **Total** | **1** |

The herpes genome possesses around 75 genes. Introns are present in only a few of these genes.  Scientists are currently trialling using “molecular scissors” that can enter human cells, search out the genes that are specific to herpes specific DNA and then cut these sequences in half.

(f) Define intron. **(more detail needed in definitions)**  (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Intron: non-coding DNA not involved in the production of a protein **(both parts needed in the definition)** | 1 |
| **Total** | **1** |

(g) Discuss the role of restriction enzymes in biotechnology. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Cut DNA at recognition sites/ restriction sites | 1 |
| To leave sticky or blunt ends ***(most often not included in student responses)*** | 1 |
| Allow target genes to be isolated/ allow scientists to join DNA from different sources/ allow scientists to create transgenic organisms | 1 |
| **Total** | **3** |

Many of the herpes genes code for the viral capsid (viral structure containing the DNA). The virus uses the humans cell to read its DNA and synthesis this protein capsid.

(h) Describe the role of mRNA in protein synthesis. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * Formed during transcription ***(can’t just say the term transcription – must say mRNA is formed during transcription)*** * mRNA takes a copy of the DNA code * from the nucleus to the ribosomes * where codons are read/translated | 1 - 4 |
| **Total** | **4** |

Use the codon table below to answer part (i) below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Second letter | | | | | | | |  |
|  |  | **U** | | **C** | | **A** | | **G** | |  |
| First Letter | **U** | UUU UUC UUA UUG | Phe Leu | UCU UCC UCA UCG | Ser | UAU Tyr UAC  **UAA Stop UAG Stop** | | UGU Cys UGC  **UGA Stop**  UGG Trp | | U C A G |
| **C** | CUU CUC CUA CUG | Leu | CCU CCC CCA CCG | Pro | CAU CAC CAA CAG | His Gln | CGU CGC CGA CGG | Arg | U C A G |
| **A** | AUU AUC AUA **AUG** | Ile  Start | ACU ACC ACA ACG | Thr | AAU AAC AAA AAG | Asn Lys | AGU AGC AGA AGG | Ser Arg | U C A G |
| **G** | GUU GUC GUA GUG | Val | GCU GCC GCA GCG | Ala | GAU GAC GAA GAG | Asp Glu | GGU GGC GGA GGG | Gly | U C A G |

(i) Complete the table below, using the portion of herpes DNA shown, and the codon table above, to determine the sequences of RNA and amino acids that the infected cell will produce. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Start and stop identified correctly on mRNA | 1 |
| All amino acids correct (2)  One error in amino acid sequence (1)  More than 1 error in amino acid sequence (0) | 1 - 2 |
| *Answer table shown below* | |
| **Total** | **3** |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Herpes DNA (template strand) | GCT | TAC | TAG | CGA | GGC | TTA | ACT | ACC |
| mRNA | CGA | AUG | AUC | GCU | CCG | AAU | UGA | UGG |
| Amino acids | Arg | start | Ile | Ala | Pro | Asn | stop | Trp |

(j) From the viral DNA sequence shown, how many amino acids will the protein contain?

(1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 4 amino acids / 5 amino acids ***(including methionine the start codon)***  *(Ile, Ala, Pro, Asn)* | 1 |
| **Total** | **1** |

***The stop codon doesn’t code for an amino acid but the start codon does. Given that the table doesn’t show AUG coding for Met, we accepted two possible answers (4 or 5 amino acids)***

**Question 32 (21 marks)**

Pest insects can have a devastating effect on crop production. Traditionally farmers have used pesticides that are sprayed over the crops to control many pests. These ***pesticides are effective against pests that eat foliage and live on the crops***. The European corn borer, *Ostrinia nubilalis,* is a pest thathas a very wide host range, attacking nearly all herbaceous plants and crops with stems large enough for the larvae to bore into. The European corn borer ***lays its eggs on the underside of the leaves*** and hatch four to nine days after being laid. The ***pupae bores into the stem where it feeds until it is ready to pupate***. After 7 to 10 days of being in the pupae the moth hatches. The adult moth lives for 2 weeks and the cycle starts again.

1. Why does the use of pesticides sprayed on crops have very little effect on the European corn borer? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * Sprayed insecticide sits on the exterior of the plant and may not reach the eggs on the underside of the leaves * The larva bores into the stalk and therefore isn’t affected. | 1 - 2 |
| **Total** | **2** |

***Many people spoke about natural selection and insecticide resistance (a fair link to the curriculum) however the information above provides a more detailed reason about the borer not coming into contact with the insecticide.***

1. How does the use of Bt corn, overcome the issue of sprayed pesticides not being effective against the European corn borer? (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * The corn plant produces the toxin/insecticide in its cells * The larva ingests the insecticide when consuming the corn plant * The larva does not need to come into contact with a sprayed pesticide ***(most often not included in student responses)*** | 1 - 3 |
| **Total** | **3** |

***Misconception: Bt Corn doesn’t stop the pest eating the crop. However, after eating it, the toxins in the plant kill the pest, preventing it from eating more***

1. Describe the biotechnological processes used to create Bt corn. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * Isolate the gene, that codes for the ***toxin***, from the donor DNA (from *Bacillus thuringiensis*) ***(must relate to Bt Corn)*** * insert this gene into a (Ti) plasmid * ***Recombinant*** plasmid taken up by bacteria (cannot just say plasmid) * Bacteria replicates creating many copies of the recombinant DNA/DNA containing the desired gene ***(most often not included in student responses)*** * Bacteria containing the recombinant Ti plasmid inserts plasmid into corn plant cells/inserts the gene that codes for the toxin into the plants DNA * Bt corn grown from modified cells (containing the gene that codes for the toxin) | 1 - 6 |
| **Total** | **6** |

Tumour inducing plasmids are found in the pathogenic bacteria, *Agrobacterium* *tumefaciens.* A simplified diagram of a Ti plasmid is shown below.

Shape

Description automatically generated

When using Ti-plasmids in plant biotechnology the Ti has to be modified.

1. ***Explain (what and why)*** two reasons why the Ti plasmid must be modified when used in plant biotechnology. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * The tumour inducing region must be removed * This is not beneficial to the host plant/This is detrimental to the host plant. * Desired/ target gene must be inserted * To produce desirable phenotype in GM plant | 1 - 4 |
| **Total** | **4** |

1. A neighbouring farmer has claimed that Bt corn could result in the formation of super weeds. He is very concerned about the long term implications for his farm as well as the surrounding native vegetation. Evaluate the neighbour’s claims. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * His claims are not justified/ false | 1 |
| * Super weeds form when herbicide resistant GM crops cross pollinate with closely related weed species * This gives weed species resistance to herbicide * Making them difficult to control/ They can dominate ecosystems | 1- 3 |
| * Bt corn GM to be pest resistant, not herbicide resistance * Bt corn cannot pass on herbicide resistance to nearby weeds because it does not possess the gene | 1 - 2 |
| **Total** | **6** |

**Question 33 (24 marks)**

The flower colour of hydrangea flowers (*Hydrangea macrophylla)* is determined by flavonoid pigments. The absorption spectra of flavonoid pigments are pH dependent. Cellular pH of the flower determines the wavelength of light absorbed and reflected, thus the colour of the flower. The wavelengths reflected by the flower is the colour we see. Some colours we see are a mixture of reflected wavelength and how our brain process this light, for example pink. For the purpose of this investigation, scientists recorded the wavelength of 650 as pink.

Scientist determined the wavelength reflected by the flowers when planted in soils with varying pH. The scientist ran three trials of 50 plants at each pH. The scientists data is shown in table 1. Table 2 shows the colour associated with light wavelength reflection.

Table 1: Soil pH and the Wavelength of Light Reflected by H*ydrangea macrophylla* Flowers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Soil pH | Mean Wavelength (λ) | | | |
| Trial 1 | Trial 2 | Trial 3 | Mean |
| 4.5 | 438 | 470 | 490 | 466 |
| 5 | 450 | 455 | 439 | 448 |
| 5.5 | 433 | 438 | 431 | 434 |
| 6 | 420 | 429 | 426 | 425 |
| 6.5 | 404 | 427 | 393 | 408 |
| 7 | 660 | 640 | 653 | 651 |

Table 2: The Visible Colour Reflected by wavelengths of Light.

|  |  |
| --- | --- |
| Light Wavelength (λ) Reflected | Colour Observed |
| 480 - 450 | deep blue |
| 451 - 440 | blue - purple |
| 441 -425 | light purple |
| 426 - 415 | purple |
| 416 - 400 | violet |
| 645 - 655 | pink |

(a) Construct a graph of the mean data in Table 1 on the grid below. (6 marks)

(A spare grid is available on page 38)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mean values correctly calculated in the table | 1 |
| Title must include both variables ***(copy the table heading word for word!)*** | 1 |
| Correct axis (X and Y) | 1 |
| Correct scale | 1 |
| Plotting - Data accurately plotted and joined (line) | 1 |
| Labelling - correct labelling on both axes including units | 1 |
| **Total** | **6** |

(b) Using the data from the investigation state mean wavelength of light recorded that produced light purple flower (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| 425 λ and 434 λ | 1 |
| ***Note: must have correct units and both values for mark to be awarded*** |  |
| **Total** | **1** |

(c) Using the data from the investigation state the pH that produced blue – purple flowers.

(1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| pH = 5 | 1 |
| **Total** | **1** |

(d) Would conducting the investigation using more than 50 plants in each of the trials improve the reliability or validity of the experiment? Give two reasons for your answer.

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| This would improve the reliability of the investigation | 1 |
| Any 2 of: | |
| * more data results in more confidence in the conclusion/ increased accuracy of results * increases the chances of representative sampling/reduces chance effects * reduces influence of outliers ***(doesn’t reduce the errors themselves but minimises the effect of them in the mean)*** * allows consistency of measure to be seen   OR   * not validity as this is the extent to which the investigation measures what it set out to measure * must control more variables to increases the validity of the results | 1 - 2 |
| **Total** | **3** |

Scientists have been investigating the possibility that the pH of the soil, affects gene expression and thus flower colour in hydrangeas.

(e) Describe how the environmental factor of pH could affect ***gene expression***. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * proteins are the product of gene expression/ phenotype is determined by both genotype and the environment * the affected genes may not produce proteins/ produce different protein/ produce more protein * soil pH may denature proteins involved in protein synthesis * this affects the phenotype/ colour of the hydrangeas | 1 - 3 |
| **Total** | **3** |

There are many examples in nature where gene products are influenced by the interaction of the gene and environmental factors.

(f) Using a named example (other than hydrangeas) describe the environmental influence on a gene and the resulting phenotype. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any correct example   * named example * states environmental influence on gene or gene product * states altered phenotype * explains the resulting effect on the phenotype | 1. - 4 |
| Example answer   * Himalayan rabbits * Only low temperatures allow enzyme function for black fur * Extremities have black fur (rest of body has white fur) * due to being more venerable to low temperatures | |
| **Total** | **4** |

Below is a possible DNA sequence that codes for coat colour in tigers.

Original DNA sequence

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| C | | A | | G | | T | | T | | A | | G | | C | | A | | C | | G | | T | | G | | A | | C | |

Mutated DNA sequence

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| C | | A | | G | | T | | T | | A | | G | | C | | A | | G | | G | | T | | G | | A | | C | |

(g) Categorise and name the type of mutation for white fur in tigers. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * gene or point mutation * substitution | 1 - 2 |
| **Total** | **2** |

(h) What is the effect of the mutation on the gene? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One of: | |
| * one different amino acid in protein/gene product * new DNA sequence and thus new allele | 1 |
| **Total** | **1** |

(i) How can scientists use biotechnology in monitor wild populations of tigers? (3 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One of: | |
| * Take DNA samples from tigers in wild populations | 1 |
| * Analyse DNA samples taken from tigers and make DNA profiles | 1 |
| * Assess genetic diversity of wild populations of tigers | 1 |
| * Use data to diagnose cause of pop decline/effectiveness of conservation Program/identify populations that should be conserved. (check in class) | 1 |
| **Total** | **3** |

**Question 34. (17 marks)**

A group of biology students were studying a population of beetles. They discovered that exoskeleton colour was determined by one gene and that two different alleles for the gene were present in the population. The population is made up of white and grey beetles. The beetles and their alleles are shown below.

A picture containing icon

Description automatically generated

(a) Calculate the frequency, for the genotype Gg, in the beetle population. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Frequency of Gg   * 5/18 * = 0.27 or 27% - Have to have answer not just fraction | 1 |
| **Total** | **1** |

(b) Calculate the allele frequencies for the beetle population. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Frequency of g   * 21/36 * = 0.58 or 58% - Have to have answer not just fraction | 1 |
| Frequency of G   * 15/36 * = 0.42 or 42% - Have to have answer not just fraction | 1 |
| **Total** | **2** |

Unfortunately, seven out of the eight white beetles died. The biology students wanted to increase the number of white beetles they had. They decided to mate two grey beetles in the hope that they would produce white offspring. The first mating produced all grey offspring. The students needed to determine the genotypes of the two grey beetles to see if it was possible they would have any white offspring. Unfortunately, they did not have access to any biological techniques to do this.

(c) Name a technique and explain how it could be used to determine the two grey beetle’s genotypes.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Perform many test cross mating  Mate each grey beetle with a white beetle  If the mating produces any white beetles, then the grey beetle is heterozygous  If no white beetles are produced it is likely (not certain) that the grey beetle is homozygous for the grey allele | 1 – 4 |
| *Students may use a punnet square to add to their explanation, however it is not required*   |  |  |  |  | | --- | --- | --- | --- | |  | G | g |  | | g | Gg | gg |  | | g | Gg | gg |  |   G = grey  G = white |  |
| **Total** | **4** |

Upon further inspection the students found that the beetles had different types of antennae.

A picture containing curlew, lamp

Description automatically generated

Non-feathery antennae

Feathery antennae

The mode of inheritance for having feathery antennae is sex-linked recessive. A female beetle with feathery antennae was mated with a male beetle with non-feathery antennae. The mating’s were continued and the pedigree below shows the inheritance of feathery antennae.

Diagram

Description automatically generated

(d) State the phenotype for the following individuals (2 marks)

1. (I, 2).
2. (III, 4).

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * (I, 2) = feathery antennae * (III, 4) = non- feathery antennae | 1 - 2 |
| **Total** | **2** |

(e) State the genotype for the following individuals (2 marks)

1. (II, 3).
2. (III, 4).

|  |  |
| --- | --- |
| **Description** | **Marks** |
| * (II, 3) = Xf Y * (III, 4) = XF Xf | 1 - 2 |
| **Total** | **2** |

(f) If individual (II,5) was mated with individual (III, 3) what is the probability of having an offspring with feathery antennae? Show all working. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Working must be shown. | |
| Individual (III, 3) = XF Xf **OR** XF XF  *Note: must have both genotypes to be awarded the mark* | 1 |
| Individual (II, 5) = Xf Y | 1 |
| *Student shows acceptable working.*   |  |  |  |  | | --- | --- | --- | --- | |  | XF | Xf |  | | Xf | XF Xf | Xf Xf |  | | Y | XF Y | Xf Y |  |   (III, 3) = XF Xf  (II, 5) = Xf Y | 1 |
| Probability feathery antennae = ½ **or** 0.5 **or** 50% | 1 |
| *Note: As individual (III, 3)’s genotype may also be XFXF  , a second cross is required.* | |
| *Student shows acceptable working.*   |  |  |  |  | | --- | --- | --- | --- | |  | XF | XF |  | | Xf | XF Xf | XF Xf |  | | Y | XF Y | XF Y |  | | 1 |
| Probability feathery antennae = 0 **or** 0% | 1 |
| **Total** | **6** |

**Question 35 (17 marks)**

Binary fission and mitosis are both forms of cell division.

1. What type of organisms replicate using binary fission? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Bacteria/prokaryotes | 1 |
| **Total** | **1** |

(b) Describe the process of binary fission. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any 5 of: |  |
| * Only one chromosome/DNA is circular * DNA/Chromosome is duplicated (do not accept chromosomes) * Duplicated chromosomes move to the opposite ends of the cell * Cell elongates * Each copy of the duplicated chromosome attaches to a different part of the cell membrane * New cell wall is laid down/ Cytoplasm splits also * Cell divides into two daughter cells * Daughter cells/DNA is a clone of the original cell | 1 - 5 |
| **Total** | **5** |

To produce offspring a female snake needs to mate with a male snake and fertilisation must occur.

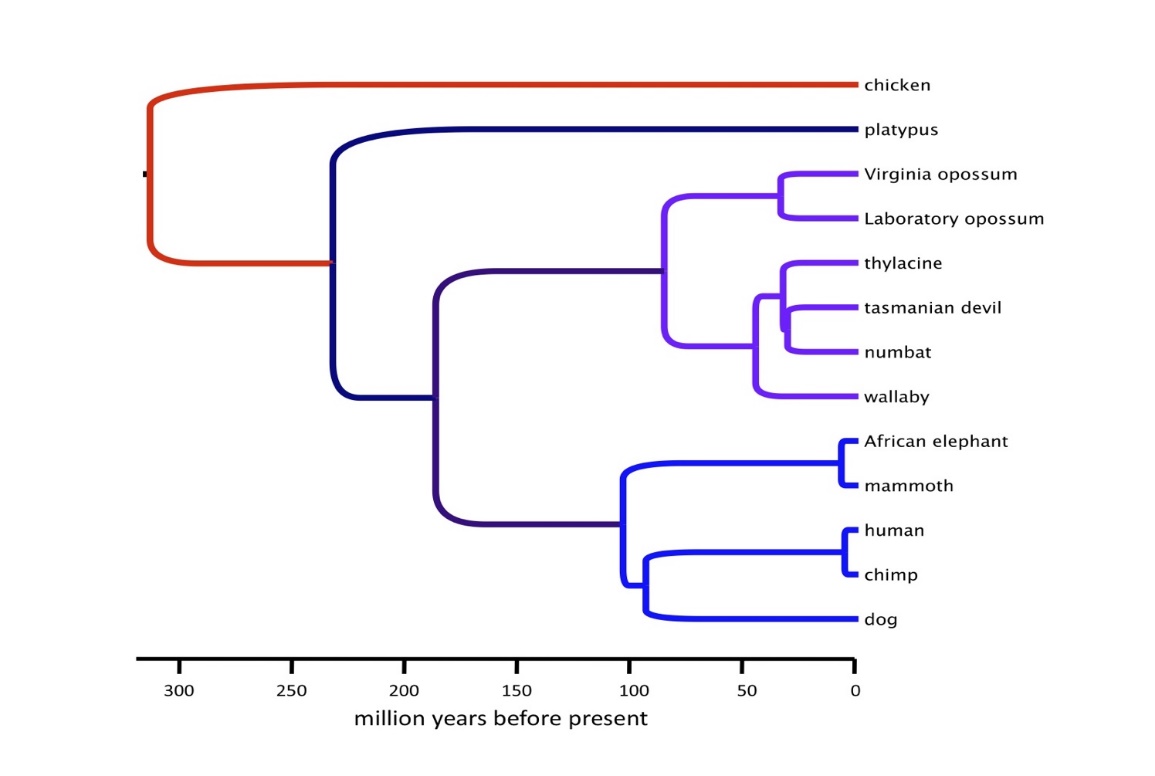
(c) What type of cell reproduction does this require? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| meiosis | 1 |
| **Total** | **1** |

(d) Explain the role of fertilisation in the reproduction of snakes and other sexually reproducing animals. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any four of: | |
| * Fusion of gametes/haploid cells * To create a diploid cell * Combines genetic material from two different parents/individuals * Meiosis produces haploid cells/gametes * Results in genetic variation | 1 - 4 |
| **Total** | **4** |

(e) The phylogenetic tree below shows the evolution of certain vertebrate groups.



(i) Which animal is most closely related to the Tasmanian devil and Numbat? (1 mark)

|  |  |
| --- | --- |
| Description | Marks |
| Thylacine | 1 |
| Total | 1 |

(ii) When did the common ancestor of the platypus and other mammals exists? (1 mark)

|  |  |
| --- | --- |
| Description | Marks |
| 240 million years ago/ before present (no range – use a ruler!) | 1 |
| Total | 1 |

(iii) List **four(4)** types of evidence that scientists may have used to create this phylogenetic tree. (4 marks)

|  |  |
| --- | --- |
| Description | Marks |
| fossils | 1 |
| embryological | 1 |
| Genetic/ Comparing DNA sequences | 1 |
| Biochemical / Comparing amino acid sequences of common proteins | 1 |
| Total | 4 |

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

**Question 36 (20 marks)**

(a) Compare artificial selection and natural selection. (10 marks)

|  |  |  |
| --- | --- | --- |
| **Description** | | **Marks** |
| Natural selection is the process of adaptation by an organism to its changing environment resulting in selective changes to its genotype | | 1 |
| Artificial selection is the process where humans choose a desirable phenotypic trait and breed these individuals to (try) produces offspring with these desirable phenotypic traits. | | **1** |
| Any six of: | | |
| Differences | | |
| Natural Selection | Artificial Selection | 1- 4 |
| Environmental selection pressure | Selection (pressure) by humans |
| Inbreeding is not common /Outbreeding is common/ fittest individuals select breeding partners (sexual selection) | Inbreeding is common/ humans select breeding partners with desirable traits |
| Usually slower/slow | Usually faster/fast |
| Promotes survival/evolution | Does not promote survival/evolution/ may increase the occurrence of deleterious alleles |
| Occurs in natural populations | Occurs in domesticated populations |
| Any two of: | | |
| Similarities | | |
| Genetic variation is required for both processes to occur  Both involve selection of a desirable trait  Both require reproduction by the organisms with desirable trait  Selected characteristics can be passed to the nest generation  Both result in changes to allele frequencies over time  Both micro evolutionary changes to a population  Both reduce genetic diversity | | 1 - 4 |
| **Total** |  | **10** |

***Most people choose this Qu since it was similar (but not identical) to the evolution test extended response. The test qu asked you to use well described examples. Most of you did that here even though the question did not ask for that. Mark allocation here was also different to the test (happens often in WACE), so ensure you give as many good similarities and differences rather than trying to predict the structure of the marking key.***

(b) Explain why the fossil record is incomplete and how fossils provide evidence for evolution. (10 marks)

|  |  |
| --- | --- |
| Description | Marks |
| * Fossils are preserved remains/impression/traces of an old/ancient/extinct organisms | 1 |
| The fossil record is incomplete due to   * Deceased organism must die in a location that has the ***right conditions for fossilisation to occur* or** fossils only form in areas with no oxygen/bacteria * (generally) soft parts of organisms are unlikely to form fossils * only organisms that avoid decomposition/scavengers/predators form fossils **or** * only organisms that are buried in sediment/mineral rich water form fossils **or** rapid burial * not all fossils have been discovered because they are difficult to find/access (under oceans/ buildings) * if fossils are discovered they have to be recognised as fossils * most fossils have been destroyed by human activities/ natural processes (erosion/ landslides/ earthquakes) | 1 - 6 |
| Fossils show evidence for evolution   * show past life/extinct organisms * show that ***life on Earth has changed over time*** **or** that life on earth has a long history * show how one type of organism/structure has transitioned to another | 1 - 3 |
| **Total** | **10** |

**Question 37 (20 marks)**

(a) Compare transcription and DNA replication. (10 marks)

|  |  |  |
| --- | --- | --- |
| **Description** |  | **Marks** |
| Any six of: | | |
| DNA Replication | Transcription | 1- 6 |
| Results in two identical copies of the DNA replicated/ Double stranded molecule is produced | Results in one complementary (to the DNA template strand) RNA strand/ single stranded molecule is produced |
| Both DNA strand acts a template | Only one DNA strand acts as a template |
| Uses DNA nucleotides | Uses RNA nucleotides |
| Complementary base to adenine (A) is thymine (T) | Complementary base to adenine (A) is uracil (U) |
| All of the DNA strand is copied | Only a gene of the DNA strand is transcribed |
| Required for cell division **or** mitosis, meiosis and binary fission | Required for protein synthesis |
| Produces both a continuous and discontinuous strand/Okazaki fragments | Produces a continuous strand |
| Uses DNA polymerase during synthesis | Uses RNA polymerase during synthesis |
| Helicase unzips and unwinds DNA | RNA polymerase unzips and unwinds DNA |
| Occurs in the S phase of the cell cycle | Occurs in the G phases of the cell cycle |
| RNA primers required | N RNA primers required |
| Any four of: | | |
| Similarities | | |
| DNA must be separated into two strands  Occurs in interphase of the cell cycle  DNA read 3’ to 5’  Both DNA and RNA synthesised 5’ to 3’  Both processes rely on the base pair rule  Both requires primers as a start point for polymerase  Both processes can lead to error in product of synthesis(DNA/RNA)  An error in either DNA replication or transcription can cause a change in the gene  Both processes occur in the nucleus (in eukaryotes) | | 1 - 4 |
| **Total** |  | **10** |

The New Zealand sea lion population declined significantly in the 1900s due to sealing. Seal lions were killed on mass for their fur skins. Boats from Europe brought “gangs” of seal hunters to New Zealand to collect the furs. Most boats would leave with a minimum of 10 000 seal furs. They were sold across the globe.

(b) Explain the effect of the significant decline in sea lion population on the viability of the sea lion gene pool and survival of the species. (10 marks)

|  |  |
| --- | --- |
| Description | Marks |
| * Loss of genetic diversity due to significant decrease in population numbers * The result of this event is (genetic drift) the bottle neck effect or random loss of genetic variation * The bottle neck effect is the sudden decrease in population size due to environmental effects * Allele frequencies do not reflect the original populations allele frequencies * The change in allele frequency is random/due to chance * The genetic diversity will not be quickly recovered (even if there is an increase in population number * Not all remaining individual may mate/successfully rear young to breeding age / increased effect of random genetic drift in smaller populations * Thus reducing genetic diversity further * Breeding within a small population results in inbreeding * The species is considered to have a loss of fitness/ vulnerable to changes in the environment * There could be a loss of alleles from the population * Reduced genetic diversity increases the likelihood of extinction of the sea lions | 1- 10 |
| **Total** | **10** |

**Part B**

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

Indicate the question you will answer by ticking the box next to the question. Write your answer on the pages provided.

**Question 38 (20 marks)**

(a) Explain how geographical isolation and microevolutionary changes can result in speciation. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any 10 of: | |
| **Division**   * The population is subdivided by a physical/geographical barrier * this barrier inhibits individuals moving between populations (into/out of) * there is not mating between populations as they are isolated from each other / no gene flow between populations | 1-3 |
| **Microevolution**   * populations evolve independently of each other due to different selection pressures acting on each population * Mutations, natural selection, RGD are microevolutionary changes * different mutations will occur resulting in different phenotypes in each of the populations * mutation result in genetic differences between the populations **or** populations have different genetic compositions * natural selection will favour different phenotypes/acts on phenotypes in the populations | 1 - 5 |
| **Speciation**   * over time /generations there will be an increase in genetic difference between the populations * this accumulation of microevolutionary changes results in macroevolution * resulting in speciation – individuals from each population are no longer able to interbreed to produce fertile offspring | 1 - 3 |
| *Answer must occur in a logical order to demonstrate an understanding of the process of allopatric speciation* |  |
| **Total** | **10** |

(b) Explain the process of sequencing DNA using Sanger sequencing. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Any 10 of: | |
| *Note Sanger nucleotides can be referred to as terminating nucleotides or* modified  *nucleotides or synthetic nucleotides* |  |
| * DNA to be sequenced is denatured into two single strands * By raising the temperature to approximately 95-98 ºC * Temperature dropped to approximately 55 ºC (40-60ºC) * A primer is annealed/attached to each single strand of the DNA sequence * Temperature raised to 72 ºC * DNA polymerase triggers the free floating nucleotides (dNTPs) to bind with complementary bases on the DNA sequence * Chain terminating nucleotides/ ddNTPs have each of the four bases labelled with a different colour fluorescence and lack a hydroxyl group on the sugar * When a chain terminating nucleotide is added, no more nucleotides can be added/ elongation is halted * Producing strands of DNA of various lengths are produced. * The DNA of various lengths (ending with fluorescing nucleotide) are separated based on size * Using capillary gel electrophoresis * As the DNA fragments pass a detector (laser) at the end of the gel * the fluoresced nucleotides are recognised/read creating a sequenced graph/base order of the DNA | 1 - 10 |
| *Note: Before using capillary gel electrophoresis, flat bed gel electrophoresis was used with either four wells for each terminating base and a southern blot used.*  *If this is the method taught, modify the answer to suit.* | |
| **Total** | **10** |

**Question 39 (20 marks)**

(a) Explain how homologous structures, analogous structures and vestigial structures provide evidence for the theory of evolution. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **Homologous structures**   * Structures across different species/groups have developed from the same plan but have adapted to different functions * Shows that different species have evolved from a common ancestor * Evidence of divergent evolution | 1 - 3 |
| **Analogous structures**   * Different structures in different species/groups that have the same function * The structures in the different species/groups evolved independently to the same selection pressures * Evidence of convergent evolution | 1 - 3 |
| **Vestigial structures**   * Structure that no longer have a function * Often reduced in size from when the structure had a function * Can be traced to functional structure in its ancestors * Evidence of divergent evolution | 1 - 4 |
| **Marks** | **10** |

(b) Explain how crossing over and independent assortment during meiosis can result in increased genetic diversity. (10 marks)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Crossing Over   * occurs during occurs during prophase 1 * occurs between a pair of homologous chromosomes (bivalents) * but not between non-sister chromatids of one bivalent * at the chiasmata * chromosomes exchange genetic material * resulting in new combinations of alleles on the chromosomes * suitable diagram | 1 - 5 |
| Independent Assortment   * alleles for different genes get sorted into gametes independently of each other * occurs during occurs during metaphase 1 * assortment of homologous chromosomes * each pair of homologous chromosomes line up along the cell equator * independently from other chromosome pairs * the chromosomes in the pair are equally likely to be found in either cell after division 1 * suitable diagram | 1 - 5 |
| **Marks** | **10** |

**End of questions**