**BIOLOGY**

**Insert School Logo**

**UNIT 3**

**2023**

**Name**:

**Teacher**:

**Time allowed for this paper**

Reading time before commencing work: ten minutes

Working time: three hours

**Materials required/recommended for this paper**

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

This Question/Answer booklet

Multiple-choice answer sheet

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

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

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

**Important note to candidates**

No other items may be taken into the examination room. It is **your** responsibility to ensure that

you do not have any unauthorised material. If you have any unauthorised material with you, hand

it to the supervisor **before** reading any further.

**Structure of this paper**

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

**Instructions to candidates**

1. The rules for the conduct of the Western Australian external examinations are detailed In the *Year 12 Information Handbook 2023*. Sitting this examination implies that you agree to abide by these rules.

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

3. Answer the questions according to the following instructions.

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

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

Section Three: Consists of two parts each with two questions. You must answer one question from each part. Tick the box next to the question you are answering. Write your answers in this Question/Answer booklet.

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

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

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

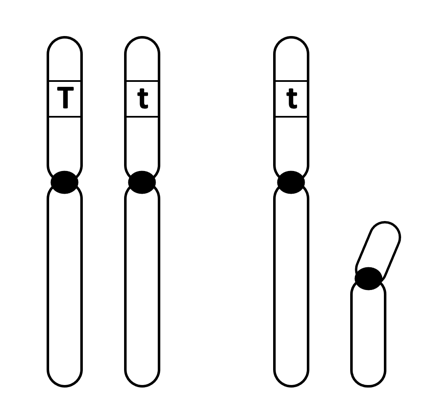
This section has **30** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question, shade a box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 40 minutes.

1. A nucleotide consists of
   1. a sugar, a base and a phosphate.
   2. a sugar and a phosphate.
   3. paired bases.
   4. a sugar, a phosphate and three bases.
2. Which of the following characteristics is/are the result of continuous variation?
3. sex
4. leg length in mammals
5. all Y linked characteristics
6. tongue rolling
7. cpDNA and mtDNA are
   1. circular and code for the functions of the organelles in which they are found.
   2. linear and code for the functions of the organelles in which they are found.
   3. circular and code for all characteristics of the organism in which they are found.
   4. linear and code for all characteristics of the organism in which they are found.
8. In pea plants, the allele for wrinkled peas, d, is recessive to the allele for smooth peas, D. Which of the following parental crosses would produce offspring in the ratio of 1:3 for wrinkled and smooth peas.
   1. DD x Dd
   2. dd x DD
   3. Dd x dd
   4. Dd x Dd
9. Which statement is true of both chromosomes and genes in gametes?
10. both are only composed of DNA
11. both contain histones
12. both only contain introns
13. both occur in pairs

Use the information below to answer question 6.

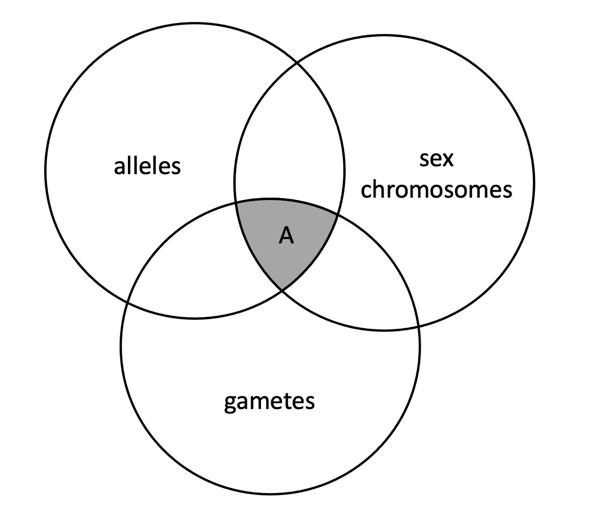
The diagram below shows a parental cross for a recessive sex-linked condition.



x

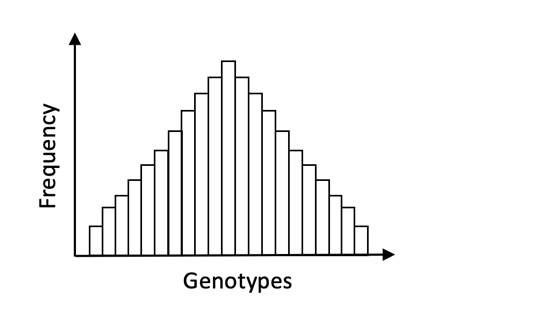
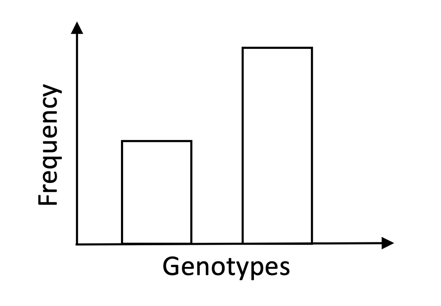
1. What is the probability that a daughter, from this parental cross, will show the sex-linked condition?
2. 0%
3. 25%
4. 50%
5. 75%
6. Which of the following is an example of a characteristic that shows discontinuous variation?
7. height
8. skin colour
9. sex
10. tail length
11. Bacteria are often used in genetic engineering as they
12. they share their genetic code with all other organisms.
13. they can become resistant to antibiotics.
14. reproduce slowly.
15. are eukaryotic cells.
16. Which of the following situations is an example of artificial selection?
17. a population of magpies increasing in size over many generations
18. a bird breeder pairs a male and female macaw to mate
19. snakes developing narrow mouth openings, as not to be able to eat cane toads
20. lily plants having stomata only on the top surface of their leaves
21. Taq polymerase is used in the process of polymerase chain reaction (PCR) as it is
22. stable at high temperatures.
23. stable at a high pH.
24. able to be reused.
25. is inexpensive.

Use the following Venn diagram to answer question 11.



1. What mode of inheritance does A, represent in the Venn diagram?
2. codominant
3. dominant/recessive autosomal
4. y linked
5. sex linked

Use the following graphs of the frequency of genotypes in a population to answer question 12.



Graph X Graph Y

1. Which of the following statements best describes the frequency of genotypes in a population, shown in graphs X and Y?
2. The inheritance of the trait in graph X is autosomal co-dominance and the inheritance of the trait in graph Y is X linked recessive.
3. The trait in graph X has a continuous genotype and a continuous phenotype.
4. The phenotypes of the traits in both graphs X and Y are polygenic.
5. The phenotype of the trait in graph X is discrete and the genotypes of the trait in graph Y are coded for by more than one gene.
6. Restriction enzymes can cut DNA to leave unpaired bases at the end of the DNA molecule. These ends are known as
7. uneven ends.
8. blunt ends.
9. sticky ends.
10. tacky ends.

Use the following information to answer questions 14 and 15.

The beetle shown measures 3.4 cm in length.

Chart

Description automatically generated

The table below shows the measurements taken by four different students.

|  |  |
| --- | --- |
| Student | Beetle Length (cm) |
| Amy | 3.3 |
| Tom | 3.5 |
| Neha | 3.7 |
| Divit | 3.5 |

1. The students’ measurements of the beetle’s length are an example of a
   1. systematic error.
   2. instrumental error.
   3. environmental error.
   4. measurement error.
2. The average percentage error, for the students’ beetle measurements is
3. 2.8 %.
4. 3.8 %.
5. -2.8 %
6. -3.8%.
7. Which of the following is true of human skin colour?

|  |  |  |  |
| --- | --- | --- | --- |
|  | Affected by the environment | Shows discontinuous variation | Is a polygenic trait |
| (a) | ✔︎ | ✔︎ | ✔︎ |
| (b) | ✗ | ✔︎ | ✗ |
| (c) | ✔︎ | ✗ | ✔︎ |
| (d) | ✗ | ✗ | ✗ |

1. Which of the following statements are **not** true of small inbreeding populations?

I There is a decreased occurrence of recessive gene expression.

II Alleles may become fixed with in the population.

III They have a decrease in genetic diversity over time.

IV There is an increased rate of mutations within the population.

V There is a decreased chance of extinction.

1. II and III only
2. I, IV and V only
3. I, II and III only
4. II, IV and V only
5. To determine whether an animal showing an autosomal dominant trait is homozygous or heterozygous, it must be crossed with an animal which is
6. heterozygous for the trait.
7. homozygous dominant for the trait.
8. homozygous recessive for the trait.
9. either homozygous dominant or heterozygous for the trait.

Use the following diagrams to answer questions 19 and 20.

Rectangle

Description automatically generated

1. The process shown above is
2. mitosis in prokaryotic cells.
3. binary fission in prokaryotic cells.
4. replication of mtDNA in prokaryotic cells.
5. meiosis in eukaryotic cells.
6. The correct order for the process shown is
7. A, C, E, D, F, B and G.
8. B, F, D, E, C, A and G.
9. G, B, F, E, D, C and A.
10. C, A, E, D, G, F and B.

Use the diagram below, showing a number of different fossils found at one site , to answer question 21.

Ground surface

Graphical user interface

Description automatically generated

1. Which of the following is the oldest fossil?

|  |  |
| --- | --- |
| (a) | Conch outline |
| (b) | Shell outline |
| (c) | Dead Fish Skeleton with solid fill |
| (d) | Fossil with solid fill |

1. DNA contains both introns and exons. Which of the following is a correct comparison between introns and exons?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Introns | | Exons | |
| (a) | Coding sequences  of a gene | Are not found in mature mRNA | Transcribed in translation | Do not code for proteins |
| (b) | Found in both eukaryotes and prokaryotes | Translated in transcription | Noncoding sequences of a gene | Not translated in transcription |
| (c) | Translated in transcription | Code for proteins | Not translated in transcription | Found in eukaryotes only |
| (d) | Found in eukaryotes only | Found in the nucleus | Only makes up a small percentage of a genome | Many exons make up mature mRNA |

1. Which of the following statements explain why the fossil record is incomplete?

I All organisms that die are preserved.

II Some deceased organisms are consumed by animals.

III Not all fossils have been discovered.

IV Not all organisms that die are preserved.

V There are less and less species over time.

VI All organism that die are fossilised.

VII All deceased organisms decompose.

VIII Not all deceased organisms are buried quickly.

1. I, V, VI and VII only
2. III, V, and VII only
3. II, III, IV and VIII only
4. IV, V and VII only
5. Comparative embryology can be used as evidence for evolution. Traits that can be used in comparative embryology are similar in the early stages of embryo formation
6. and are never seen in the adult phenotype.
7. and may be lost or modified in the adult phenotype.
8. are only found in mammals.
9. and become more similar across species as the embryo develops.

Use the following information to answer question 25.

Abiologist set up four large saltwater aquariums, to investigate the claim that rising global warming is resulting in coral bleaching. The natural water temperature for the coral being used in the investigation is 24 C. A water heater was placed into each aquarium with the coral and all four aquariums were supplied with oxygen and nutrients. Aquarium one’s water temperature was 22 C, aquarium two’s water temperature was 24 C, aquarium three’s water temperature was 26 C and aquarium four’s water temperature was 28 C. The colour of the coral was recorded at 8 am daily over a four-week period.

1. The control in the investigation was aquarium
2. one.
3. two.
4. three.
5. four.
6. Gene guns transfer DNA into plants cells by
7. bombarding the plant cells with metal particles coated in DNA containing the desired gene.
8. firing radio waves at a culture of plant bacterial cells, thus allowing the bacteria to transfer plasmids to the plant cells/
9. bombarding bacterial cells, to be used as a vector, with DNA containing the desired gene.
10. firing pieces of DNA directly at seedlings.
11. A selective advantage is
12. the ability of an organism to out compete other organisms in a given population, at a particular point in time.
13. a characteristic of an organism that facilitates mutation, to enable survival in adverse environments over time.
14. the ability of organisms in a population to adapt to many abiotic pressures and survive.
15. a characteristic of an organism, enabling it to survive and reproduce more successfully than other organisms in a given population, in a given environment.
16. The Australian code of ethics for the use of animals for scientific purposes is underpinned by the 3Rs project. Which of the following best describes the 3Rs?
17. using different methods of research in place of animals, using less animals where possible and using practices that minimise distress to the animal
18. where possible using animal simulations in place of animals in research, only using captive bred animals using practices that maximise animal wellbeing
19. using practices that minimise distress to the animal, using animal practices that maximise animal wellbeing and humanly euthanising all animals after the research has concluded
20. where possible using different methods of research in place of animals, using animal practices that maximise animal wellbeing and humanly euthanising all animals after the research has concluded
21. Which of the following comparisons of mRNA and tRNA is correct?

|  |  |  |
| --- | --- | --- |
|  | mRNA | tRNA |
| (a) | contains ribose sugars | contains deoxyribose sugars |
| (b) | has the four bases: guanine, thymine, uracil and cytosine | has the four bases: guanine, thymine, adenine and cytosine |
| (c) | has codons | has anti-codons |
| (d) | has an association with ribosomes | has no association with ribosomes |

Use the following information to answer question 30.

Lake Maracaibo is a region of Venezuela that has a high incidence of Huntington’s Disease. In the 19th century, a woman who carried the allele responsible for Huntington’s Disease moved into Lake Maracaibo. She had 10 children. Many of the people who now reside in this region are her descendants.

1. The high incidence of Huntington’s Disease in Lake Maracaibo is most likely a result of
2. natural selection.
3. the Founder Effect.
4. a genetic bottleneck.
5. selective breeding.

**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 (20 marks)**

The white spot grouper fish (*Epinephelus coeruleopunctatus*) occur in tropical marine waters of the Indo-west-central-Pacific. Currently the white spot grouper is not endangered. However, a conservation group in Indonesia, have decided to breed the species in captivity, so they have a backup population, in case the species becomes threatened. To do this, the captive population must have a viable gene pool.

1. Describe the characteristics of a viable gene pool. (3 marks)

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1. State why captive populations, bred for conservation, must have a viable gene pool?

(1 mark)

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Establishing the captive breeding population of white spot grouper required wild caught fish to be caught. Before these fish were released into the main breeding tank, they were quarantined. Some of the fish in quarantine were found to have a white fungus growing on their scales. To effectively treat this fungus, the species of the fungus had to be determined. A sample of the fungus was sent to a scientific laboratory, where the sample was analysed by scientists. The first step in identifying specie of the fungus was to create a genetic profile from the sample. DNA was extracted from the fungal sample. To have enough DNA to create a genetic profile, the scientists needed to amplify the quantity of DNA using the Polymerase Chain Reaction (PCR).

1. Using the table below explain the main events in the three stages in a PCR cycle. (3 marks)

|  |  |
| --- | --- |
| Stages in PCR | Description |
| 1 |  |
| 2 |  |
| 3 |  |

The scientist took the DNA and cut it with restriction enzymes at specific base sequences. To create the genetic profile the used a flatbed gel and electrophoresis.

1. Explain the process and principles of gel electrophoresis. (4 marks)

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The scientists had genetic profiles for many different marine fungi species. They used the genetic profile of the fungus and comparative genomics to determine the species of fungus.

1. Define the term the comparative genomics. (1 mark)

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Below is one section of DNA code from the genetic profiles of the fungi.

A picture containing diagram

Description automatically generated

1. Name the feature labelled X in the table. (1 mark)

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1. Identify the fungus that was found on the fish. (1 mark)

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Sequential hermaphroditism is when the sex of an organism changes from one sex to the other sex during the organisms lifetime. Sequential hermaphroditism occurs in the white spot grouper fish (*Epinephelus coeruleopunctatus*). Fish sampling was carried out in the waters of Indonesia. The following results were obtained.

|  |  |  |
| --- | --- | --- |
| The Sex and Length of White Spot Grouper | | |
|  | |  |
| Length (mm) | Sex |  |
| 10 - 184 | unable to be determined |  |
| 185 - 290 | female |  |
| 291 - 310 | males and females |  |
| 311 - 500 | males |  |

1. In what direction is the sequential hermaphrodism? (1 mark)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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The conservation group must choose100 male and 100 female white spot groupers to start the captive breeding population.

1. What lengths of fish should be chosen for the captive population? Justify your choices. (5 marks)

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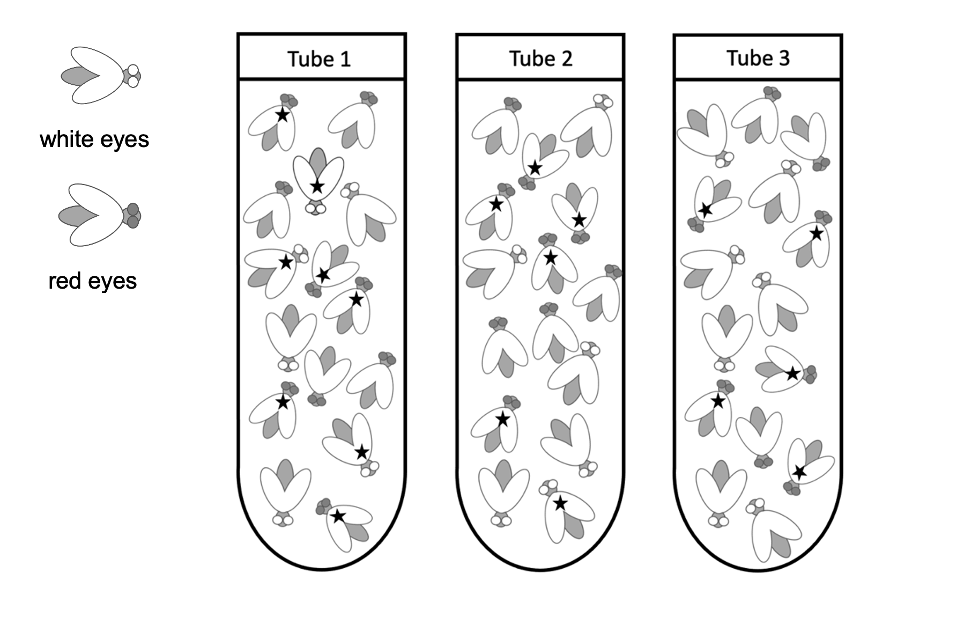
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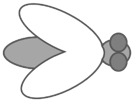
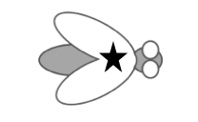
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**Question 32 (21 marks)**

The eye colour gene for fruit flies (*Drosophila melanogaster*), is located on the X chromosome. For this question assume males are XY and females are XX. Fruit flies can have white or red eyes. White (W) is recessive to red (W+). A class of biology students wanted to study the inheritance of eye colour in fruit flies. They ordered fruit flies and received the tubes shown below.



female



male

The following information came with the fruit flies.

|  |  |  |  |
| --- | --- | --- | --- |
| **Biological Supplies** | | | |
| Date: | 1 January 2023 | | |
| **Customer Information** | | | |
| School: | Western Australian College of Biology | | |
| Email: | wacb@education.com | | |
| Phone: | --------------------- | | |
| **Species:** | *Drosophila melanogaster* | | |
| **Tube** | **Number** | **Sex** | **Details** |
| **1** | 8 | Female | 4 homozygous red eyes |
| 7 | Male | 4 red eyes, 3 white eyes |
| **2** | 6 | Female | 2 homozygous red eyes |
| 9 | Male | 4 red eyes |
| **3** | 5 | Female | 5 homozygous red eyes |
| 10 | Male | 7 white eyes |

* 1. Define the term allele frequency. (1 mark)

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* 1. Use the table below to determine the number of W and W+ alleles in the fruit fly population.

(2 marks)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tube** | **Sex** | **Number Of Individuals** | **Phenotype** | **Genotype** | **Number of Alleles** | |
| **W+** | **W** |
| **1** | Female | 1 | red eyes |  |  |  |
| 4 | red eyes |  |  |  |
| 3 | white eyes |  |  |  |
| Male | 4 | red eyes |  |  |  |
| 3 | white eyes |  |  |  |
| **2** | Female | 1 | white eyes |  |  |  |
| 2 | red eyes |  |  |  |
| 3 | red eyes |  |  |  |
| Male | 4 | red eyes |  |  |  |
| 5 | white eyes |  |  |  |
| **3** | Female | 5 | red eyes |  |  |  |
| Male | 3 | red eyes |  |  |  |
| 7 | white eyes |  |  |  |
| **Totals** | | 45 |  |  |  |  |

* 1. Determine the allele frequencies, for the W and W+ alleles, for the population of fruit flies. Show your working and then write your final answer in the table below. (3 marks)

|  |  |
| --- | --- |
| Allele | Allele Frequency |
| W |  |
| W+ |  |

The tubes were left in a storage cupboard over the weekend. When the students returned to school, they found that all the fruit flies in tubes 2 and 3 had died.

* 1. Determine the allele frequencies for the population of fruit flies that remain and write your answer in the table below. Show all of your working out. (3 marks)

|  |  |
| --- | --- |
| Allele | Allele Frequency |
| W |  |
| W+ |  |

The students’ thought, that this loss of individuals, modelled the evolutionary mechanism of genetic drift.

* 1. State the type of genetic drift this event models. (1 mark)

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* 1. Describe how genetic drift would affect a natural population of fruit flies. (3 marks)

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Many populations of fruit flies are located within flying distance from each other, this allows gene flow to occur between the populations.

* 1. Explain how gene flow can change the allele frequencies in the gene pools of the fruit fly populations. (4 marks)

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Microevolutionary changes can be the result of mutation, genetic drift, gene flow and selection.

* 1. State the two main types of selection. (1 marks)

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* 1. Explain the biological concept of selection. (3 marks)

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**Question 33 (19 marks)**

Green sea turtles (Chelonia mydas) are found around the world in warm subtropical and tropical ocean waters. They come ashore to nest. In southern Queensland, nesting occurs between late November and January. Most females return to the same beach every nesting season. Scientists are concerned that global warming will affect the survival of the green sea turtles. One aspect that is being investigated is the effect of rising temperatures on population structure.

Scientists have been using artificial nests, at specific temperatures, to hatch green sea turtle eggs. The results of the investigation are shown below.

|  |  |  |  |
| --- | --- | --- | --- |
| Temperature of Nest (ºC) | No of Eggs | No of Male Hatchlings | % Female Hatchlings |
| 27.6 | 500 | 500 |  |
| 28.2 | 550 | 456 |  |
| 28.4 | 489 | 399 |  |
| 28.7 | 753 | 489 |  |
| 29.4 | 544 | 294 |  |
| 30.0 | 598 | 299 |  |
| 30.6 | 532 | 0 |  |

* 1. Propose an hypothesis for the investigation. (2 marks)

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* 1. Calculate the percentage of female hatchlings per nest and add these calculations to the results table . (2 marks)
  2. State an assumption that you have made when calculating the percentage of female hatchlings for each nest temperature. (1 mark)

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* 1. Construct a graph showing the percentage of female hatchlings for each nest temperature. (6 marks)

A picture containing chart

Description automatically generated

A spare grid is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare grid

* 1. Would increasing the number of eggs, in each nest, at each temperature, improve the reliability or validity of the results? Give two reasons for your answer. (3 marks)

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* 1. What could the results of the investigation suggest about the determination of sex in green sea turtles? (5 marks)

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**Question 34 (19 marks)**

During interphase of the cell cycle of eukaryotic cells, DNA replication takes place. This process is said to be semi-conservative.

1. In the space below, draw and label a diagram of the cell cycle. (3 marks)
2. Explain why some cells never enter the S phase of the cell cycle. (2 marks)

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1. Explain what is meant by semi conservative DNA replication. (1 mark)

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During DNA replication, one strand is synthesized continuously, and the other strand is synthesised discontinuously.

1. Explain how both continuous and discontinuous replication of DNA occurs. (4 marks)

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Part of the cell cycle is interphase. Interphase is when protein synthesis occurs. The processes of DNA replication and protein synthesis both require enzymes. Ligases are a group of enzymes required in both processes.

1. State one similarity and one difference in the role of ligases in DNA replication and protein synthesis. (2 marks)

Difference:

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Similarity:

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Similarities between biological molecules across different organisms can be evidence of evolution. DNA is one such molecule. All organisms have the same basic DNA.

1. Explain how organisms having the same basic DNA, suggests that there is a common origin for all life on earth. (3 marks)

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1. Explain how comparing DNA between species is evidence for the theory of evolution. (4 marks)

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**Question 35 (21 marks)**

A new herbicide resistant crop, Glyphosate Tolerant Crop (GT)’, was genetically engineered to be glyphosate tolerant. GTC plants are transgenic plants with recombinant DNA.

1. Define the term ‘recombinant DNA’. (1 mark)

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1. Explain a possible adverse effect, that the farmer may encounter, when growing a ‘GTC’ crop. (2 marks)

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1. Explain possible adverse effects on non-target species when ‘GTC’ crop is grown. (2 marks)

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Having had success using the ‘GTC’ crop, the same farmer decided to plant another transgenic crop. The farm had recently had an invasion of grasshoppers, so the farmer planted a crop of ‘GRO’, that was genetically engineered to be pesticide resistant. Once the crop was planted, the field was sprayed with pesticide, to kill the grasshoppers. As the crop grew, the field was sprayed with pesticide every 4 weeks. Initially, the farmer noticed a significant decrease in the number of grasshoppers, in and around the crop. However, over time, the grasshopper population increased. The farmer continued to spray the ‘GRO’ crops with pesticide but found that the grasshopper population still continued to increase.

1. Suggest a reason for the increase in grasshoppers, after there had been a significant decrease in the grasshopper population. (1 mark)

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1. Name the evolutionary mechanism that allowed the grasshopper population to survive and increase, after being sprayed with pesticide. (1 mark)

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1. Explain how the grasshopper population was able to survive and increase, after being sprayed with pesticide. (6 marks)

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Prior to the development of biotechnology that has allowed transgenic crops to be created, crops were artificially selected to have characteristics such as increased protein and increased yield.

1. Explain the impact ‘artificial selection’ has on the genetics of the crops. (2 marks)

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1. State two similarities between ‘artificial selection’ and the genetic engineering of transgenic organisms . (2 marks)

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1. Describe four differences between ‘artificial selection’ and the genetic engineering of transgenic organisms .

(4 marks)

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

Section Three consists of **four** questions.

Answer **one** question from Part A and **one** question from Part B

Use black or blue pen for this section. Do not use erasable or gel pens. Only graphs and diagrams may be drawn in pencil. Responses can include; labelled diagrams with explanatory notes; lists of points with linking sentences; labelled tables and/or graphs; and/or annotated flow diagrams with introductory notes.

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: 50 minutes

**Part A**

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

Indicate the question you will answer by ticking the box next to the question. Write your answer on pages 29 - 33. When you have answered your first question, turn to page 34 and indicate on that page the second question you will answer.

**Question 36 (20 marks)**

1. Describe chromosomal mutations and gene mutations that result in a frame shift and gene mutations that do not result in a frame shift. Explain their impact on gene expression.
2. Compare mitosis and meiosis. (10 marks)

**OR**

**Question 37 (20 marks)**

Convergent evolution is when two species evolve similar features for the same function, but do not have a common ancestor. Convergent evolution results in analogous structures. Wings of birds and bats are one example of analogous structures. The wings of birds and bats perform the same function, however they have different evolutionary origins. Divergent evolution leads to different species having homologous structures.

1. Using a named example, explain why the pentadactyl limb structure is considered a homologous structure and why it is considered evidence for divergent evolution. (10 marks)
2. Explain how phenotypes are the result of genotypes. (10 marks)

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**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)**

Atrazine is one of the most widely used herbicides in Australian agriculture. It that is used both before and after the emergence of grass and weeds in crops such as sugarcane, lupins and eucalypt plantations. The broad use of this herbicide has resulted in significant pollution of Australian waterways.

Scientists have genetically engineered bacteria to break down atrazine pollution in the soil, thus preventing it reaching and polluting waterways. The gene atzA, found in the *Pseudomonas* bacteria, produces the enzyme, atrazine chlorohydrolase, that breaks down atrazine. Scientists inserted the gene atzA, found in *Pseudomonas*, into *Escherichia coli*  bacteria.

1. Explain the process, that scientists would use, to create transgenic *Escherichia coli*  containing the gene atzA. (10 marks)
2. Compare the inheritance patterns of complete dominance, co-dominance, incomplete dominance in terms of allele interaction, phenotypes and phenotypic ratios in the F1 and F2 generations. (10 marks)

**OR**

**Question 39 (20 marks)**

Perth Zoo is involved in the conservation of the critically endangered Sumatran Orangutan. As part of the Australasian breeding program, they have successfully breed over 25 Orangutans. Part of the program is the release of some of the offspring into the protected Bukit Tigapuluh ecosystem in Sumatra, Indonesia.

1. Explain how DNA biotechnology could be used in the monitoring of Sumatran Orangutan populations, the breeding program and the reintroduction of animals into Sumatra, Indonesia.

(10 marks)

Phylogenetic trees can be constructed using a variety of information. With the emergence of bioinformatics, they are now mostly constructed from the comparison of DNA or proteins. The table below, shows sequences of DNA, form five different species.

Table 1: Homologous Chromosomes Sequences Compared Across Five Species

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Species** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| **A** | T | G | A | C | G | G | C | T | A | G | C | G | T | T | G | C | A | T | C | G |
| **B** | T | G | A | C | G | G | C | A | A | G | C | G | T | T | G | C | A | T | C | G |
| **C** | T | G | A | C | G | C | C | T | T | C | C | C | T | T | G | C | T | T | C | G |
| **D** | T | G | A | C | C | G | C | T | A | G | C | G | A | T | G | C | A | A | C | G |
| **E** | T | G | T | C | G | G | C | - | A | G | C | G | T | T | G | C | A | T | C | G |

1. Using the DNA sequences provided, construct a phylogenetic tree **and** explain how you constructed the tree from the information given. (10 marks)

**End of questions**

Question number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Spare grid

A picture containing chart

Description automatically generated