

QUESTION 30 (5 marks)

- a) Waterlogging of the soil due to flooding or poor water drainage can impact on the nitrogen cycle. With less oxygen in waterlogged soil, the denitrification process by *Pseudomonas* bacteria is favoured instead of nitrogen fixation by nitrogen-fixing bacteria.

Discuss the effect on the soil and the impact on the ecosystem of this change in the nitrogen cycle.

[2 marks]

- b) In wetland ecosystems, such as swamps that are permanently waterlogged, some plant species have specific adaptations to be able to obtain nitrogen from extracellular digestion of insects and other small animals.

Explain how these adaptations have arisen in these species.

[2 marks]

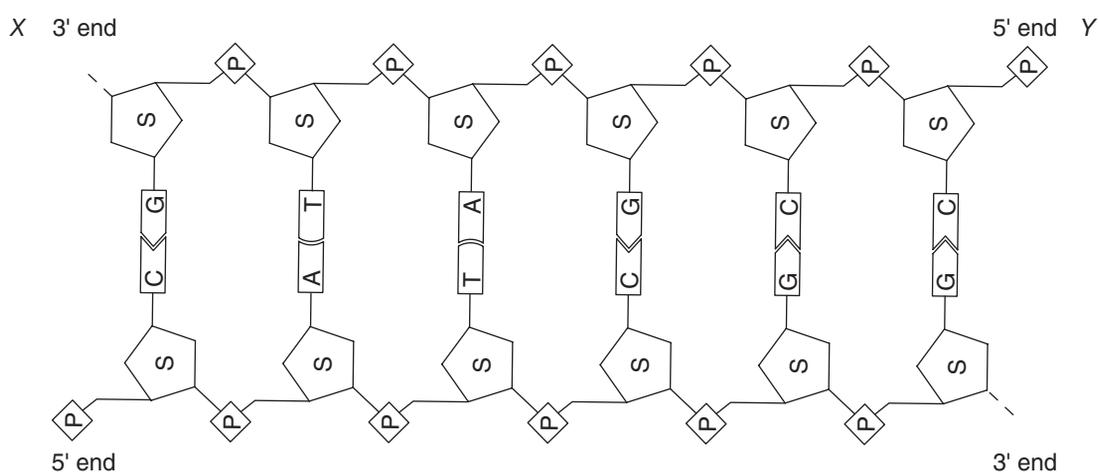
END OF PAPER

SECTION 1**Instructions**

- Answer all questions in the question and response booklet.
- This booklet will not be marked.

QUESTION 1

This figure shows a segment of DNA.



Which of the following statements is correct when referring to this segment?

- (A) If the strand labelled X–Y is the template strand, DNA replication would occur in the direction from Y towards X.
- (B) This DNA segment consists of one molecule made up of two nucleotide strands.
- (C) This DNA segment contains four purines and eight pyrimidines.
- (D) This DNA segment could code for six amino acids.

QUESTION 2

The table below was compiled from a student survey of vegetation in a natural community in an area south-east of Perth.

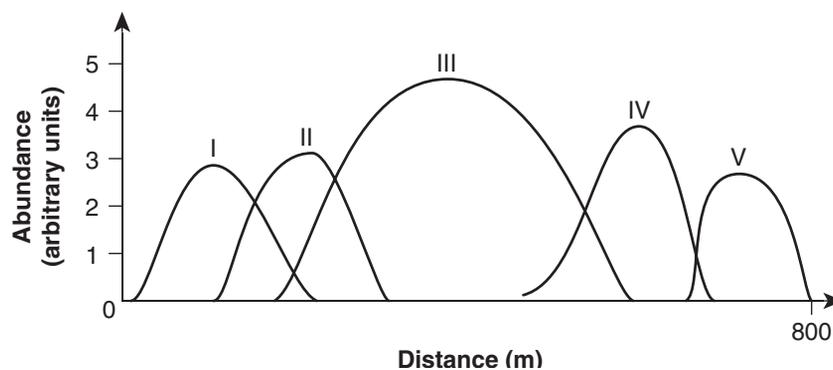
Name of plant	Height (m)	Population density (plants/km ²)
Jarrah	40–60	20
<i>Banksia</i>	7–10	100
<i>Acacia</i>	2–3	50

The most suitable name for this community would be

- (A) jarrah forest.
- (B) *Banksia* woodland.
- (C) jarrah–*Banksia* woodland.
- (D) jarrah–*Banksia*–*Acacia* community.

QUESTION 5

A group of students established a belt transect 800 m long and recorded the distribution and abundance of five species of shrubs (I–V) along it, as shown in the graph below.



Analysis of these graph patterns suggests that

- (A) adaptive radiation is occurring in the area.
- (B) community zonation is apparent in the area.
- (C) the physical microenvironment is uniform throughout the area.
- (D) the estimates would be stable, and similar counts would be measured annually.

QUESTION 6

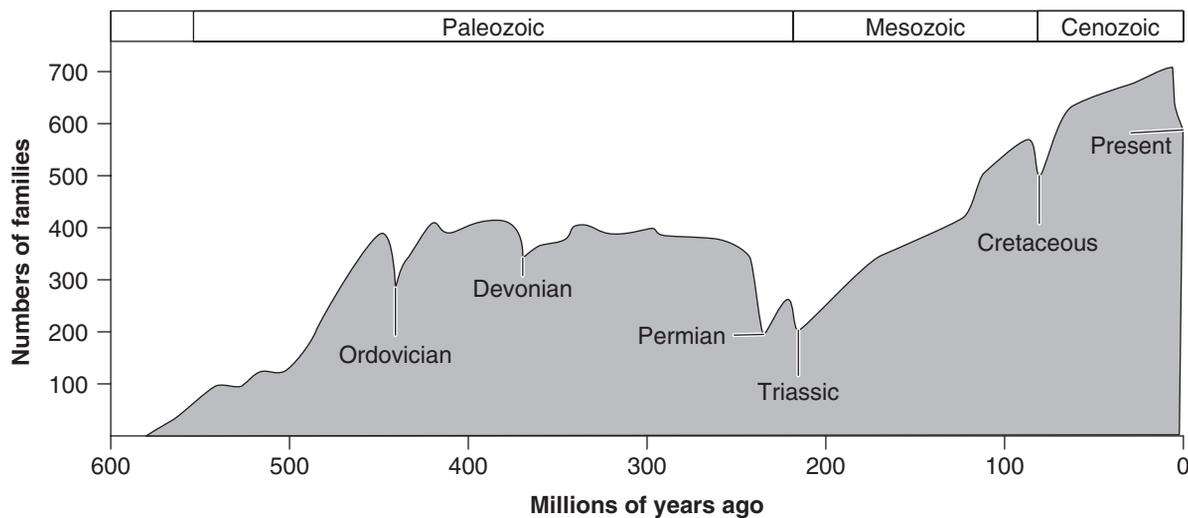
Enzymes play important roles in the intracellular and extracellular environments of cells, as well as in biotechnology processes.

Which of the following statements is correct?

- (A) Restriction enzymes are used in recombinant DNA technology to join cut plasmids and host DNA.
- (B) Helicase enzymes are used in PCR to unzip two strands of double-helix DNA.
- (C) Ligase enzymes are used in recombinant DNA technology to cut plasmid vectors.
- (D) DNA polymerase is used in PCR to form new complementary DNA strands.

QUESTION 7

There have been five major mass extinctions events throughout the past 600 million years of life on Earth, as shown in the graph below.



From your knowledge and examination of the graph, the

- (A) most devastating mass extinction was approximately 225 million years ago and all species disappeared from the fossil record.
- (B) Megafaunal extinction, approximately 10 000 years ago, happened when giant mammalian species died out, including all the marsupials and placentals in Australia.
- (C) Cretaceous extinction, approximately 65 million years ago, resulted in around 200 families of marine species, many terrestrial animals and plants, and most of the dinosaurs becoming extinct.
- (D) sixth period of extinction is happening now due to the destruction of habitats and pollution, resulting in many species becoming extinct.

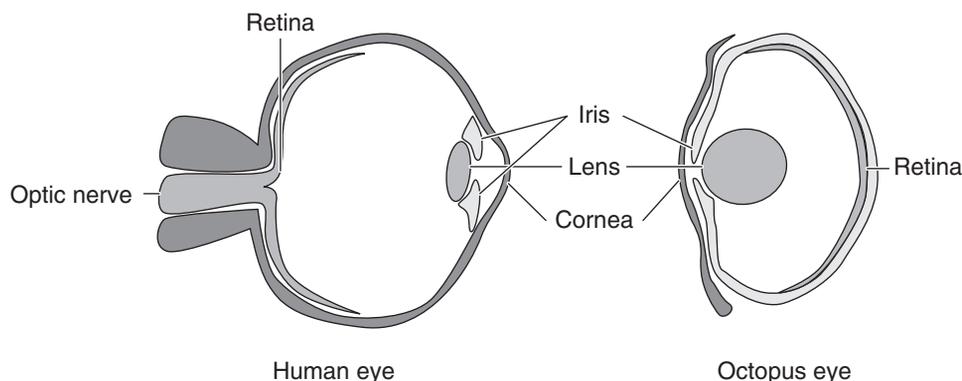
QUESTION 8

Which of the following is **not** a correct statement about DNA structure and location?

- (A) DNA is found in all the cells of every eukaryotic organism: in their nucleus, mitochondria and chloroplasts.
- (B) DNA is only present in prokaryotic cells in the cytosol.
- (C) Eukaryotic DNA is linear in form and is bound to histone proteins.
- (D) Both the single chromosome and the plasmids of prokaryotic DNA are circular.

QUESTION 10

The figure below shows the human eye and the octopus eye in cross section. Although humans are terrestrial and octopuses are aquatic, their ancestors would have both needed good stereoscopic vision for judging distance in order to catch food and avoid predators. These ancestors inherited the following similar eye structure independently of each other to cope with the demands in their environments.



A comparison of the human and octopus eyes suggests that

- (A) the structures have the same basic structure and function and so are homologous.
- (B) humans and octopuses had a recent common ancestor and evolved by divergent evolution.
- (C) humans and octopuses have a recent common ancestor and the structures resulted from convergent evolution.
- (D) humans and octopuses have evolved in environments with similar selective pressures.

QUESTION 11

Mules have a chromosome number of 63; 32 chromosomes come from a female horse (the mule's mother) and 31 come from a male donkey (the mule's father).

Mules are called infertile interspecific hybrids because they

- (A) cannot mate under natural conditions, as mules are kept in separate paddocks from each other.
- (B) produce eggs and sperm but these fail to fuse in fertilisation.
- (C) are produced from interbreeding of horses and donkeys, which are both in the same species but are in different families.
- (D) do not undergo successful meiosis due to differences in their chromosome structure and numbers.

QUESTION 12

Cattle ticks were introduced into Australia in the 1800s by infected animals transported into the country. Their effects on cattle are severe and cost farmers millions of dollars yearly. Until recently, the main method of control was spraying affected animals with pesticide chemicals. There have been serious cases of cattle ticks developing resistance to pesticide chemicals, and the best solution appears to be the development of naturally tick-resistant cattle.

The increase in cattle ticks becoming resistant to pesticide chemicals would have been due to

- (A) the migration of ticks from other areas.
- (B) individual ticks developing resistance and passing it on to their offspring.
- (C) widespread use of the pesticide chemicals.
- (D) a change in tick behaviour that reduced their contact with the pesticides.

QUESTION 15 B

Since a similar sequence of amino acids appears in animals from frogs to humans, it would appear this molecule is important for organism functioning. In these vertebrates, it can be seen that as their genetic relatedness decreases, the number of amino acid differences increases; that is, it is inversely proportional.

QUESTION 16 C

The vertical bar lines for the distribution of larvae of both species are far longer and overlap more than does the distribution of the adults of the two species shown growing on the rock. The main cause of death above the mean high neap tide for *Chthamalus* is desiccation, not predation. There is only one adult *Balanus* growing above mean high neap tide. The larvae do not choose where they settle, but larvae that happen to settle in locations that are good for their future growth are more likely to survive.

QUESTION 17 D

Chthamalus can tolerate desiccation and grow above mean high neap tide, but it cannot grow well below it as it is not a good competitor. In comparison, *Balanus* cannot tolerate the harsh conditions of mean high neap tide, nor compete successfully with *Chthamalus*.

QUESTION 18 B

There are a variety of shapes for biomass pyramids that show the amount of living matter transferred through a food chain. Both of those shown are possible, and the pyramid in ecosystem II could be correct if the producers had very high growth rates.

QUESTION 19 A

The sperm formation is complete in the testes; egg formation is not complete until after fertilisation of the egg. All the other alternatives are wrong, so the answer could be determined by elimination: for **B**, there is only one egg and three polar bodies formed in the female; for **C**, oogenesis does not include mitosis; for **D**, female egg development begins in the foetal stage.

QUESTION 20 D

Hox genes code for Hox proteins, which act as transcription factors that control the identity of the body segments and what type of appendages will form on the segments. They do this by switching certain genes on and off – that is, by gene regulation. Hox genes are master genes that control gene expression.

QUESTION 21 D

It is most likely that the enzyme coded for will be dysfunctional or reduced in function. Frameshift mutations do not result from point substitution mutations in the DNA. Frameshift mutations alter all the codons past the point of the mutation, not just one. All or most of the amino acids past the point of the frameshift mutation will be altered.

QUESTION 22 A

Sympatric speciation occurs when populations of a species become reproductively isolated from each other; that is, they stop successfully interbreeding even though they are living in the same habitat. Both species of palm would have had a common ancestor, but due to a mutation that altered their flowering times they no longer flowered at the same time, so no cross-pollination could occur and they evolved into different species.

- c) Site A shows greater species diversity, as the SDI value is closer to 1. For Site A there is a 75% chance that two individuals chosen at random will belong to different species, whereas for Site B there is a 65% chance that two individuals chosen at random will belong to different species. [1 mark]

This is probably because sites A and B are relatively similar environments in the forest and have similar abiotic factors (amount of sunlight and water, type of soil) and biotic factors (other organisms competing for resources, predators). [1 mark]

QUESTION 28 (4 marks)

- a) As the gene is sex or X-linked, the allele symbol should show it linked to the X chromosome:

X^H = unaffected (non-haemophiliac) X^h = haemophiliac

Females can have three genotypes:

- $X^h X^h$ – unaffected female
- $X^H X^h$ – unaffected (carrier) female
- $X^H X^H$ – haemophilic female

Males can only have two genotypes:

- $X^H Y$ – unaffected male
- $X^h Y$ – haemophilic male

[1 mark]

Note: Accept responses that use consistent and appropriate allele symbols.

Therefore, there is more chance of a male being a haemophiliac than a female, as a male cannot be heterozygous and so he does not have a second allele to mask the haemophilia allele as in a female carrier.

[1 mark]

- b) parents: mother – $X^H X^h$; father – $X^H Y$

	X^H	X^h
X^h	$X^H X^h$	$X^h X^h$
Y	$X^H Y$	$X^h Y$

[1 mark]

The chances of this mother and father having a haemophilic boy is 25% or one quarter.

[1 mark]

QUESTION 29 (6 marks)

This S-curve is a typical growth pattern when a population colonises a new habitat:

- Exponential phase: Initially, with a low level of resistance and adequate resources, the population will grow exponentially, in which birth rate exceeds death rate.
- Transitional phase: As the population density begins to increase, various density-dependent factors begin to limit population growth. Death rate begins to increase but is still less than birth rate, and the population is still growing at this stage.
- Plateau phase: begins when death rate equals birth rate and the graph levels out or fluctuates a little about the line.

[3 marks]

Award 1 mark for each phase adequately discussed.

K is the letter used for maximum-carrying capacity: at this point, the population will stop growing, birth rate equals death rate, and an equilibrium population is often maintained.

[1 mark]

Density dependent factors are factors that limit growth of the bird population on the island and could include:

- Biotic (or living) factors: competition with same or other species, predators, and disease. Birth, death, immigration and emigration of the birds would also limit the growth of the bird population.
- Abiotic (or non-living) factors: food and water, nesting sites, suitable places to live such as rocky outcrops or hollow trees.

[2 marks]

Award 1 mark for each factor correctly described.

Note: Students need give only one example for each factor.

QUESTION 30 (5 marks)

- a) If the soil is waterlogged and denitrification is favoured, more of the nitrates in the soil will be converted back into nitrogen in the air by the *Pseudomonas* bacteria. The soil will not be as fertile and this will affect the community of living organisms, both in the soil and on the surface of the ground.

[1 mark]

This will reduce the amount of nitrates to be taken up as mineral ions by plants and used to make plant proteins and other important substances. Through the food chain, this lack of nitrogen in plant protein will mean there is less for the consumers and decomposers.

[1 mark]

- b) Plants living in nitrogen-deprived soils in wetland ecosystems often have specific adaptations for trapping and digesting insects and other small animals (such as sticky leaves, water pitchers or curled or scented leaves) to supplement their nitrogen intake. They have been selected for these specific features, as they have a greater chance of survival and reproduction when there is the selective pressure of low soil nitrogen.

[1 mark]

They pass on the genes for their trait to their offspring, and, over generations, the percentage of plants with the special feature increases. This is the process of natural selection.

[1 mark]