

QCE Biology Units 3&4

Paper 1

SECTION 1 – MULTIPLE-CHOICE QUESTIONS

	A	B	C	D
1.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
2.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
3.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
4.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
7.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
8.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9.	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
10.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
11.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
12.	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
13.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
15.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

	A	B	C	D
16.	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
17.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
18.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
19.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
21.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
22.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
24.	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
25.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

QUESTION 1 B

B is correct, as each segment is a chain of nucleotides bonded together. As the base pairs are bonded with weak hydrogen bonds, this is a small segment of one molecule of DNA. DNA replicates from the 3' to the 5' end of the strand, which is X to Y on the diagram. The number of purines and pyrimidines should be equal. Six base pairs form three triplets coding for two amino acids.

QUESTION 2 B

The most abundant species is *Banksia*, so that would be the first word for the dominant species. The *Banksia* plants are only 7–10 m tall, so they are classified as shrubs to small trees in terms of plant structural features, and so woodland is a more appropriate term than forest.

QUESTION 3 D

D. pulicaria is better adapted to the conditions, as it can survive and reproduce steadily until it reaches maximum population size; **D** is correct. If *D. pulicaria* ate *D. magna*, it would starve after 40 days as no *D. magna* would remain. *D. magna* reproduces more rapidly than *D. pulicaria* in the first 20 days as its growth curve is steeper.

QUESTION 4 A

D. magna has a more rapid rate of reproduction and increases to a greater population size when fed yeast instead of algae. The population of *D. magna* also survives for a longer number of days when fed yeast. These differences indicate yeast is a more favourable food than algae.

QUESTION 5 B

By plotting the abundance of the five species of shrubs along the belt transect, their distribution indicates they are in habitat zones. This does not mean they are in the process of succession to reach a climax community, and the estimates could change if they were measured during another season or in a different time period.

QUESTION 6 D

DNA polymerase is an important enzyme in DNA replication in the cell and in PCR, as it leads to the formation of the new complementary strands of DNA by helping guide the complementary bases into place on the template strand and bond in base pairs. Restriction enzymes cut, not join, plasmids. In PCR, high temperature is used to separate the double helix, not helicase. Ligase enzymes are used in joining, not cutting, DNA.

QUESTION 7 D

Today, many species are becoming extinct due to clearing of the land and pollution, and so the present is the sixth period of mass extinction. The most devastating extinction did happen 222 million years ago, but only 90% of species died. The Megafaunal extinction happened 10 000 years ago, but not all marsupials in Australia died, as there are many left today. In the Cretaceous extinction 65 million years ago, about 500 families died out, not 200.

QUESTION 8 A

A is the required incorrect answer, as only plant cells have chloroplasts that will contain DNA. In eukaryotic cells, the chromosomes are linear DNA bound with histone proteins, and in prokaryotes the chromosomes are found in the nucleus and mitochondria of every living cell. **D** is incorrect, as in prokaryotic cells the one singular chromosome and several plasmids are circular DNA and are found in the cytosol.

QUESTION 9 C

The *Eucalyptus* trees only grow on granite-loam soil, not sandstone soil, so their distribution is affected by soil type. The *Eucalyptus* trees only grow on drier soil, not in the creek area, so their distribution is also affected by soil moisture content. The fern plants grow on both granite-loam and sandstone soil, so their distribution is not affected by soil type. The fern plants only grow in the creek area, so their distribution is affected by soil moisture content.

QUESTION 10 D

Octopuses are in a different major classification group (phylum *Mollusca*) compared to humans (phylum *Chordata*) and they did not have a recent common ancestor. The fact that the eyes in the two groups are similar in structure and function is due to similar selective pressures: to be able to change focus rapidly and have good stereoscopic vision at all distances to see food and predators. The eyes in the two different groups are called analogous structures and evolved due to convergent evolution.

QUESTION 11 D

Mules are sterile as the two sets of chromosomes, $n = 32$ and $n = 31$, inherited from their horse and donkey parents are not homologous. They cannot pair up during meiosis Prophase I, so meiosis cannot occur and no gametes are produced by the mule. Mules are therefore infertile. They are called interspecific, as two different species interbred to produce them; and hybrids, as they have a mixture of characteristics of the two parent species. Mules are found frequently together in groups on farms or in the wild.

QUESTION 12 C

Widespread use of pesticide chemicals acts as an environmental selective pressure, killing off non-resistant ticks and allowing resistant ticks to survive and reproduce, passing on the alleles for resistance to their offspring. Over generations, the percentage of resistant ticks in the population increases to almost 100% in this process of natural selection.

QUESTION 13 A

The genotype of Grace must be $I^A I^O$ as she is blood group A, but must have inherited one I^O allele from her mother. Likewise, the genotype of Robert must be $I^B I^O$.

Parents $I^A I^O \times I^B I^O$:

	I^B	I^O
I^A	$I^A I^B$	$I^A I^O$
I^O	$I^B I^O$	$I^O I^O$

The chance of their child having genotype $I^O I^O$ like their grandmother is 25%.

QUESTION 14 B

The orchid gains nutrients from the broom honeymyrtle to help it grow, so it benefits; the broom honeymyrtle does not benefit from the orchid and loses some of the nutrients it has synthesised. The orchid is the parasite and the broom honeymyrtle is, indirectly via the threads from the fungus, the host. The broom honeymyrtle gains extra water from the fungus that grows on its roots; the fungus gains sugars and a place to live from the broom honeymyrtle. This relationship is a type of symbiosis called mutualism.

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.

QUESTION 23 D

At each step in the food chain, energy is lost in movement and heat. It would, therefore, be more efficient to consume producers, as energy available from consumers higher up in energy pyramids will be considerably less than the initial input from the sun's radiant energy.

QUESTION 24 C

The ecological niche of an organism is not just its habitat; it includes the requirements of the species, the physical conditions in which it lives, and the resources it requires. A platypus' niche therefore includes the stream or river bank, the grubs it eats for food, and its interactions with members of its own and other species.

QUESTION 25 B

With the many significant medical advances made in the last 100 years, the death rate of children at birth and up to adolescence has been reduced dramatically. Although death at an older age has also decreased due to medical advances, it has not had the enormous impact on human population growth that the increased survival of children has had.

SECTION 2**QUESTION 26 (5 marks)**

Non-disjunction can occur in mitosis or meiosis. It is the failure to separate of the homologous chromosome pairs in Metaphase I of meiosis, or the failure of the sister chromatids to separate in Metaphase II of meiosis or in mitosis. [1 mark]

If the homologous chromosomes or sister chromatids do not separate, the resulting gametes will have more or fewer chromosomes than the haploid number, which will result in offspring with chromosome numbers more or less than the normal diploid number. This is called aneuploidy. [1 mark]

In the case of Down's syndrome, the most common scenario is when non-disjunction of chromosome 21 occurs at Metaphase I or II of meiosis, producing an egg with a haploid number of $n = 24$, as it has two copies of chromosome 21. When this egg fuses with a normal sperm, $n = 23$, a zygote will be formed, $2n = 47$, that will develop into a person with Down's syndrome. [1 mark]



[2 marks]

Award one mark for male showing one X and one Y chromosome.

Award one mark for showing three of chromosome 21.

QUESTION 27 (6 marks)

a) The binomial system of nomenclature is useful for international communication between scientists and all people as the two-word Latin names are consistent universally, despite the language of the country in which they are used. [1 mark]

This reduces confusion and inconsistencies in communication about organisms that cause disease, are useful for food, interact and aid in the environment and have many other purposes. [1 mark]

b) Site A:

$$\begin{aligned} SDI &= 1 - \frac{(110 + 30 + 182 + 110)}{1722} \\ &= 1 - \frac{432}{1722} \\ &= 1 - 0.25 \end{aligned}$$

Therefore SDI at site A = 0.75. [1 mark]

Site B:

$$\begin{aligned} SDI &= 1 - \frac{(420 + 110 + 42 + 2)}{1640} \\ &= 1 - \frac{574}{1640} \\ &= 1 - 0.35 \end{aligned}$$

Therefore, SDI at site B = 0.65. [1 mark]

- 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]