Neap

Trial Examination 2023

Suggested Solutions

QCE Biology Units 3&4

Paper 2

SECTION 1

QUESTION 1 (3 marks)

Any three of:

- When the DNA is uncoiled from nucleosomes to bind to transcription factors (or at an epigenetic level).
- When the RNA is transcribed.
- When the RNA is processed and exported to the cytoplasm after it is transcribed (or at a post-transcriptional level).
- When RNA is translated into protein (translational level).
- After the protein has been made (post-translational level).

[3 marks]
1 mark for each correct stage identified.

QUESTION 2 (4 marks)

a) The introns are removed from the mRNA and the remaining exons are spliced (joined) back together before being translated.

[2 marks]
1 mark for describing the removal of introns.
1 mark for describing the splicing of exons before translation.

b) The exons can be spliced back together in a different order (or different groups of exons grouped together). This results in the production of different sequences of amino acids.

[2 marks]
1 mark for stating that exons can be spliced in a different order.
1 mark for explaining how splicing impacts amino acid sequence.

QUESTION 3 (5 marks)

a) point mutation

[1 mark]
1 mark for identifying point mutation.

b) One triplet is altered, which could change the amino acids produced that form haemoglobin.

[2 marks]
1 mark for identifying that the mutation alters the triplet.
1 mark for explaining how the mutation alters the amino acids produced.

c) If an additional nucleotide were inserted, this would lead to a frameshift mutation. The consequence of the frameshift mutation would be the production of a different amino acid or a codon that stops the protein from growing longer.

[2 marks]
1 mark for identifying frameshift mutation.
1 mark for describing the consequence.

QUESTION 4 (7 marks)

a) primary succession

[1 mark]
1 mark for identifying primary succession.

b) **Over the first 10 years**: The pioneer species initially had a high abundance, which then rapidly declined while the long-lived plants grew quickly. This is because pioneer species change the environment to make the conditions more favourable for long-lived plants. Pioneer species can rapidly germinate their seeds, tolerate extreme conditions, fix nitrogen and perform photosynthesis.

Between 20–50 years: The long-lived plants competed with each other, as the graph shows that their numbers remained relatively steady with a slight decline. In this period, the long-lived plants were more abundant than the pioneer species. This is because long-lived plants have a longer lifespan and more specific niches than pioneer species, and succession leads to a climax community.

[6 marks]
1 mark for identifying the initial high abundance of pioneer species and the rapid growth of long-lived plants over the first 10 years.
1 mark for explaining the impact of pioneer species on long-lived plants.
1 mark for providing a feature of pioneer species. Note: Features can include any one of germinate seeds, tolerate extreme conditions, fix nitrogen OR photosynthesis.
1 mark for identifying the slight decrease in the abundance of long-lived plants due to competition between 20–50 years.
1 mark for identifying that long-lived plants were more abundant than pioneer species between 20–50 years.
1 mark for explaining the difference between pioneer species and long-lived plants in terms of lifespan and/or niche.

QUESTION 5 (4 marks)

a) *Any one of:*

- In the cross with parents 3 and 4, both parents must be heterozygous (carriers) to produce an offspring with no white-haired patches (individual 8).
- In the cross between parents 1 and 2, horse 2 must be heterozygous to produce individual 6, which does not have the tobiano pattern.

[2 marks]
1 mark for identifying heterozygous parents.
1 mark for explaining the offspring phenotype.

b) The first punnet square is a cross between a homozygous dominant (parent 2) and a homozygous recessive parent. However, this cross is unlikely as individual 6 does not have a dominant allele.

	h	h
H	Hh	Hh
H	Hh	Hh

Parent 2 must be heterozygous as this would lead to a homozygous recessive child, as seen in individual 6.

	h	h
H	Hh	Hh
h	hh	hh

[2 marks]
1 mark for identifying that parent 2 is heterozygous.
1 mark for showing working.

QUESTION 6 (3 marks)

a) logistic growth

[1 mark]
1 mark for identifying logistic growth.

b) *Any two of:*

- supply of food
- lack of nesting sites
- disease
- amount of prey

[2 marks]
1 mark for each correct factor identified.

QUESTION 7 (6 marks)

a) Samples of DNA from both snake species could be cut with restriction enzymes and run through gel electrophoresis to compare the DNA profiles.

Similar patterns in the bands would indicate that they are the same species, so in this case, the presence of different patterns in the bands would indicate that the snakes are different species.

[2 marks]
1 mark for explaining the process of DNA profiling.
1 mark for explaining how DNA profiling could be used to identify the different species.

b) Mutation leads to variation within a population of snakes (for example, snakes with different colours or of different lengths). Natural selection leads to snakes that are better suited to the environment surviving to reproduce. This gives rise to two populations with different allele frequencies. Consequently, the two populations become reproductively isolated.

[4 marks]
1 mark for explaining that mutations lead to variations.
1 mark for explaining how natural selection chooses a particular characteristic.
1 mark for explaining the outcome of natural selection.
1 mark for referring to reproductive isolation.

QUESTION 8 (5 marks)

a) $$\text{ecological efficiency} = \frac{\text{average net primary productivity}}{\text{average value of solar energy striking Earth's atmosphere}} \times 100$$

$$= \left(\frac{36\,200}{4.4 \times 10^7} \right) \times 100$$

$$= 0.082\%$$

[2 marks]
1 mark for showing mathematical working.
1 mark for calculating the correct percentage.

b) A large amount of energy from the producer is not transferred to the primary consumer, as the producer has more tissue material (inedible/indigestible parts) that are not consumed by the primary consumer. Similarly, not all of the primary consumer is consumed by the secondary consumer.

Additionally, each time energy is transferred from one trophic level to the next, some energy is given out as heat, respiration, death or excretion.

[2 marks]
1 mark for explaining why there is less energy available for each trophic level.
1 mark for explaining that energy is lost at each trophic level.

c) $36\,300 - 20\,000 - 12\,900 = 3400$ kJ/m^2/year

[1 mark]
1 mark for providing the correct solution.

QUESTION 9 (3 marks)

The range in length shows continuous variation with seven different lengths. If the length of an ear of corn were controlled by only one gene, there would be discontinuous variation with only two length types. Hence, the length of an ear of corn must be controlled by several genes to produce continuous variation.

[3 marks]
1 mark for linking range in length to continuous variation.
1 mark for explaining how one gene would reflect discontinuous variation.
1 mark for explaining continuous variation.

QUESTION 10 (5 marks)

Since the area shown is not uniform (not homogenous), a stratified sampling process should be applied. Typically, the different strata would be assigned a proportional area of the ecosystem as a whole and a representative number of quadrats would be allocated to that strata. The quadrats would need to be an appropriate size (e.g. 10 m × 10 m) for the total area sampled. The quadrats would then be randomly positioned (using a random number generator) within each strata. A counting criteria for the sampling would be established to minimise bias.

[5 marks]
1 mark for identifying stratified sampling.
1 mark for explaining why stratified sampling is the most appropriate process.
1 mark for describing how the number of quadrats are determined in relation to strata.
2 marks for describing two characteristics of the process. Note: Characteristics may include positioning of quadrats, size of quadrats and/or minimising bias by using counting criteria.