



Trial Examination 2020

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**Suggested solutions**

# **QCE Biology Units 3&4**

Paper 2

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**SECTION 1****QUESTION 1 (6 marks)**

- a) Transcription is the copying of the DNA template strand onto a complementary strand of messenger RNA (mRNA) that takes place during gene expression. [1 mark]  
It starts with the unzipping of the double helix of the DNA. RNA polymerase attaches to a specific recognition site on the template strand of the gene. As it moves along the strand, complementary RNA nucleotides attach and bind to the DNA nucleotides. The RNA nucleotides then join to form a strand of pre-mRNA. [1 mark]
- b) The pre-mRNA strand contains coding segments called exons and non-coding regions called introns. [1 mark]  
Before the mRNA leaves the nucleus, the introns are spliced out and the exons join. The segment of mature mRNA that moves out to a ribosome is therefore shorter. [1 mark]
- c) Proteins called transcription factors determine which segments are copied in eukaryotic cells. These proteins are coded for by regulatory genes that are associated with the functional genes. [1 mark]  
These factors can attach to the start of a functional gene to dictate which gene is expressed, and the rate at which it is expressed. [1 mark]

**QUESTION 2 (6 marks)**

- a) Cassowaries are called a keystone species as they have a disproportionately large impact on their rainforest environment relative to their abundance. [1 mark]  
They are a specific species in the rainforest ecosystem that aids in the balance of organisms within the ecosystem. If the cassowaries were lost from the rainforest or their numbers markedly decreased, this could result in a breakdown of the ecosystem or a complete collapse. [1 mark]
- b) Cassowaries are one of only a few frugivores that can disperse large rainforest fruits and the only disperser of large fruit seeds over large areas of rainforest. This is important for many other species which feed on these fruits and their seeds. [1 mark]  
They play an important role in spreading the plants to many areas instead of the seeds being concentrated near their parent plant, and in maintaining diversity in the rainforest. [1 mark]
- c) The habitat of the cassowaries of Northern Queensland has been markedly reduced to a much smaller area that is divided into three populations. Their habitat has been seriously reduced by humanity's land clearing for farms and urban development. This is habitat fragmentation, which has broken up their habitat into smaller pockets of rainforest. [1 mark]  
In a fragmented area, the cassowaries cannot move further away to find mates, disperse seeds, or seek out fruits to eat. They are more vulnerable to being killed by cars, dogs and disease. [1 mark]

**QUESTION 3 (3 marks)**

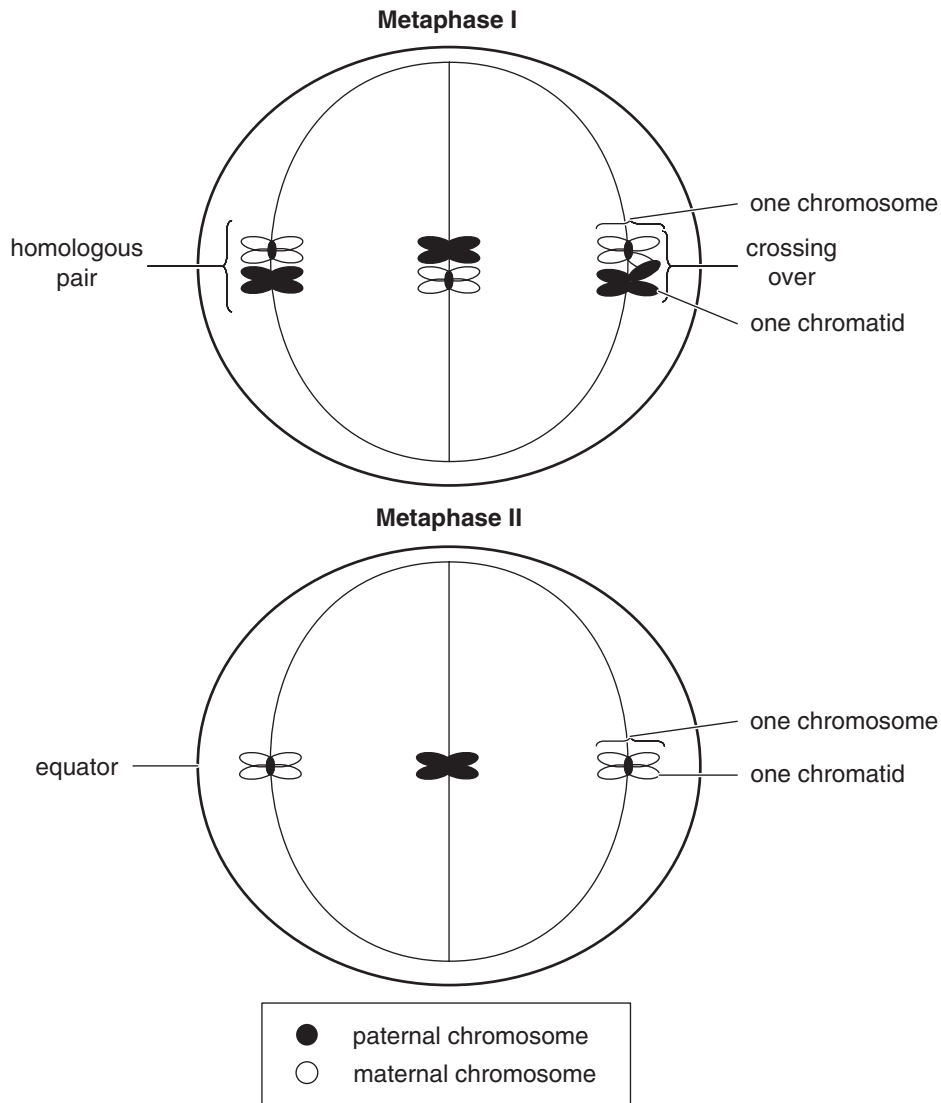
In the food web, acacia seeds and shoots come from producers and provide food, and therefore energy, for the first-order consumers pigeons and parrots. In 2014, the unusually large number of parrots would have eaten much of the available seeds and shoots, especially from the acacias. [1 mark]

Beetles and ants are first-order consumers that provide food for the malleefowl, a second-order consumer. With fewer available acacia seeds and shoots for the malleefowl, they would have eaten more ants and their numbers would have decreased. [1 mark]

The malleefowl would have then started to eat more beetles, causing the observed significant decrease in the beetle numbers. [1 mark]

**QUESTION 4 (6 marks)**

a)



[4 marks]

Award 1 mark for drawing the two cells.

Award 1 mark for appropriate labels.

Award 1 mark for showing independent assortment.

Award 1 mark for showing crossing over.

- b) Crossing over produces new combinations of alleles of the genes, and independent assortment results in a greater variety of combinations of the alleles. Both processes, therefore, produce greater variation in the gametes and ultimately the offspring produced in sexual reproduction. [1 mark]

The greater the genetic diversity of the offspring, the greater the chance that some will survive if there is a change in the environment, and thus the species will continue. [1 mark]

*Note: While crossing over begins in Prophase I, it is ongoing in Metaphase I.*

### OR

During metaphase I, homologous chromosomes line up at the equator as bivalents in one of two arrangements. Due to random assortment, the orientation of pairs of homologous chromosomes is random, which results in greater possible differences in the final gametes. [1 mark]

These processes are important for the survival of the species, as independent assortment results in a greater variety of combination of alleles and therefore greater variation in gametes and offspring. [1 mark]

### QUESTION 5 (5 marks)

- a) Using the formula for the Lincoln index,  $N = \frac{M \times n}{m}$ , the estimated number of salmon in the migrating population at the beginning of the migration =  $\frac{400 \times 400}{50} = 3200$  salmon. [2 marks]

*Award 1 mark for the correct answer.*

*Award 1 mark for the correct use of the Lincoln index.*

- b) A range of factors affect the salmon's survival and these factors must remain within the salmon's tolerance range if they are going to survive and reproduce. These are called limiting factors and include both biotic and abiotic factors. [1 mark]

In their migration from their birth stream to the estuary and then the sea, salmon may be exposed to changes in salinity, water temperature, current speed, water clarity and type of stream bed material. These are all abiotic or nonliving factors that will affect the salmon's survival. [1 mark]

Biotic or living factors may include food availability, predators, competition with other salmon, and disease-causing microorganisms. [1 mark]

### QUESTION 6 (5 marks)

- a) Ecological succession is the process of gradual evolution of an ecosystem. The type of succession shown in the glacial retreat area of Glacier Bay is called primary succession, as it starts with bare rock and then, through a series of changes, a stable ecosystem becomes established. [1 mark]

The environment, when the glaciers retreated, was bare rock and was first colonised by lichens, moss and bacteria. They began the breakdown of the rock into soil, which would have allowed herbs and small shrubs to grow. As a deeper soil developed, taller shrubs and eventually trees were able to grow. [1 mark]

The final stable ecosystem in the glacial area was a spruce and hemlock forest. At this climax stage, changes still occur but they are much slower and the ecosystem is less likely to change; it is here referred to as a stable ecosystem. [1 mark]

- b) Species richness is a measure of the number of species compared to the number of individuals found in a sample. In the glacial area, species richness increased as the soil became deeper and the conditions were more suitable for a variety of different species; that is, there has been an increase in species richness with an increase in terrain age as shown in the graph. [1 mark]
- Species evenness, the relative abundance of each species compared to each other, shows that some species, such as mosses and liverworts, increased in species numbers over the 200-year period; other species, such as herbs and small shrubs, maintained relatively consistent numbers. [1 mark] (5 marks)
- a) PCR (polymerase chain reaction) is carried out to amplify the DNA sample, producing millions of copies of the target DNA segment from a very small amount of DNA from the cheek cells collected. Further testing can then be carried out. [1 mark]
- b) DNA is negatively charged and the segments of DNA will therefore move from the wells at the negative electrode end towards the positive electrode end. [1 mark]
- The DNA segments placed in the wells are of different lengths and have different molecular weights. As they move through the gel, sometimes called a ‘molecular sieve’, the smaller segments move faster, and therefore further, than the longer segments. This results in separation of the bands at different positions in the gel. [1 mark]
- c) In the DNA profile, as the CF allele has a 3-base deletion, it will be a slightly shorter segment and will therefore move faster and further in the gel. The DNA sample of person B, known to have CF, will have only one band further towards the positive pole, where all the DNA segments of the shorter length will be deposited. The DNA sample of person D will contain all slightly longer DNA segments which will all be deposited in one band closer to the negative pole. [1 mark]
- The DNA of person C has two bands which indicates the sample contained DNA of both lengths, so this person has both alleles of the gene and is called a carrier. Since the DNA of the person being tested produced the same result as for C, it can be concluded that they are a carrier of CF. [1 mark]

**QUESTION 7 (6 marks)**

- a) A phylogenetic tree represents possible evolutionary relationships between organisms and is useful for determining common ancestry, how recently species evolved from their common ancestor, and how closely related two groups are to each other. [1 mark]
- Any example from the ratite phylogenetic trees, for example:*
- the divergence from a common ancestor, which was a flying bird, over 60 million years ago
  - the divergence into eight major groups of ratites, all having certain features similar to each other
  - the most recent to evolve, determined by the most recent divergence in the pathway, being between the two species of spotted kiwi
  - rhea being the least closely related to all other ratites, as they diverged the earliest
- [1 mark]
- mtDNA is preferred over nuclear DNA as the rate of mutation in it is faster and therefore it can be used as a ‘molecular clock’ in relatively closely related species, such as ratites. mtDNA also has some highly conserved DNA sequences, which is useful as any change in them is likely to indicate an important evolutionary divergence. [1 mark]

- b) Allopatric speciation would have been the main process in the formation of these closely related ratite species from a common ancestor. [1 mark]

Initially there would have been inheritable variation in the characteristics of the common ancestor living on the large supercontinent of Gondwana. When the land masses separated by continental drift into the major continents of the southern oceans, the geographically isolated groups could no longer interbreed, so gene flow was prevented. [1 mark]

On each continent and in different regions of each continent, there were different selective pressures, which selected the better suited to survive and reproduce. Their offspring inherited the genes for the favourable traits. Over millions of years, the separated populations evolved into new species. [1 mark]

**QUESTION 8 (3 marks)**

In a population of Crimson rosellas in the Springbrook Mountain rainforest, there is variation in size, colour and tail feather length. Rare, random changes occur in the birds' DNA, called mutations. Those better adapted rosellas survive and reproduce, resulting in a better adapted species. This is microevolution. [1 mark]

The rosellas can interbreed to produce viable fertile offspring, so there is one gene pool with gene flow from one area of the rainforest to another. [1 mark]

If there was a drastic environmental event that wiped out a large percentage of the species at random, such as a bushfire or if the area was fragmented by habitat removal or some other factor, the genetic make-up of the remaining group may not be representative of the original population. This random change in the allele frequencies in the gene pool, especially in a small population, is called genetic drift. [1 mark]