TSSM
Creating VCE Success

BIOLOGY 2017

Unit 4
Key Topic Test 1 – Changes in the genetic makeup of a population

Recommended writing time*: 45 minutes
Total number of marks available: 45 marks

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1
Answer: D

Explanation:
If the allele is selectively neutral then the expression of the allele will not have any impact on the biological fitness of any organism that expresses it. Therefore, there is no selective advantage or disadvantage associated with the expression of the gene.

Question 2
Answer: D

Explanation:
Not all mutations have a harmful effect and therefore an individual that expresses the mutation will not always be selected against. Not all mutations are inherited, some will occur spontaneously due to environmental factors. However, some mutations, referred to as silent mutations, will have no effect on an organism's phenotype.

Question 3
Answer: A

Explanation:
Although it is possible that speciation will eventually occur if the two populations remain reproductively isolated from each other, speciation is a process that takes many generations, it will not occur immediately.

Question 4
Answer: C

Explanation:
One of the events that occurs to cause allopatric speciation is the geographical separation of a single population into two or more smaller populations that are then subjected to different selection pressures.

Question 5
Answer: B

Explanation:
This diagram represents stabilising selection. The extremes are being selected against and the average phenotype is being selected for.

Question 6
Answer: A

Explanation:
Genetic drift is defined as random changes in the allele frequency of a population over time.

Question 7
Answer: B

Explanation:
An individual's percentage contribution to a gene pool increases as the size of the gene pool decreases, so all individuals in a small population make a comparatively high contribution to the gene pool of that population. As a result, the population is significantly affected by any alteration to the population number, which contributes to genetic drift.

Question 8
Answer: D

Explanation:
The decimation of the elephant seal population was a non-selective event, so therefore it is an example of genetic drift. However, the specific type of genetic drift was a population bottleneck.

Question 9
Answer: C

Explanation:
The fact that a new strain of bacteria exist indicates that evolution has occurred. All bacteria have a very short generation time, some as short as twenty minutes. Forty years would have provided sufficient generational time for the new strain to have evolved.

Question 10
Answer: A

Explanation:
A gene pool is described as the sum total of genetic information in a population.

SECTION B - Short-answer questions

Instructions for Section B
Answer all questions in the spaces provided.

Question 1 (5 marks)

a. In this context, the individual wheat plants that had traits considered to be desirable by farmers where chosen to develop the variety "Mitch".

1 mark

b. Artificial selection OR selective breeding.

1 mark

c. Organisms with traits that are seen as desirable are selected and bred with each other. The offspring with the greatest extent of the desired trait are chosen and bred with each other. This process continues reinforcing the prevalence of that trait.

1 mark

d. Selective breeding or artificial selection results in the production of organisms with specific traits. However, these organisms are the natural offspring of their parents and do not contain any foreign DNA.

1 mark

AND

Genetic engineering is the process where DNA is artificially changed. This can also include adding foreign DNA into the genome of an organism.

1 mark

Total 5 marks

Question 2 (6 marks)

a. The process is natural selection.

1 mark

AND

Initially the weaver birds produced eggs that were all similar in colour, pattern and size, although there were slight variations between eggs.

1 mark

AND

The cuckoos remove eggs from the weaver bird's nest and replace them with their own. Weaver birds would not remove these as they could not detect that they were cuckoo eggs. However, increasing the differences between the eggs enabled recognition to increase and the weaver birds were more likely to remove the cuckoo eggs.

1 mark

AND

The eggs with a marked difference were more likely to hatch, so therefore there would be more adults eventuating from these clutches. As a result, the incidence of birds producing eggs that were different to cuckoo eggs increased.

1 mark

b. The weaver birds were more able to recognize the difference between their own eggs and those of the cuckoos, so they could dispose of the cuckoo eggs and not waste energy on hatching them and raising young cuckoos.

1 mark

c. The removal of a selection agent, such as the cuckoos, meant that there was no selective agent to favour the production of similar eggs.

1 mark

Total 6 marks

Question 3 (8 marks)

a. The original mRNA sequence is: AUG CGC ACU GGU CGA UGU CCA

1 mark

AND

The original amino acid sequence is: Met Arg Thr Gly Arg Cys Pro

1 mark

b. A point mutation (or substitution mutation)

1 mark

c. The change to the codon has caused the production of Alanine (Ala) instead of threonine (Thr).

1 mark

AND

As a result, the primary structure of the polypeptide has been slightly altered, which will cause a slight alteration to the tertiary structure of the protein.

1 mark

AND

The function of a protein is largely determined by tertiary three-dimensional structure, so altering the structure will mean that the protein will be less likely to carry out its function.

1 mark

d. If the protein is functional then it means that a new allele has been produced which may be selected for or retained in the population.

1 mark

The presence of an additional allele will increase the genetic diversity of the population as there is now an additional allele in the gene pool.

1 mark

Total 8 marks

Question 4 (5 marks)

a. The weather is consistently cooler in Tasmania compared to the mainland, so the platypuses that live in Tasmania gain an advantage from additional insulation in the form of additional fat and thicker fur.

1 mark

b. The ability for platypuses from these different geographic locations to produce viable offspring indicates that speciation in platypuses has not occurred (or they are still all members of the same species).

1 mark

c. Speciation would be expected to occur eventually.

1 mark

AND

This would occur as the populations are reproductively isolated from each other preventing gene flow from occurring. Each sub-population would be subjected to different selection pressures and develop accordingly.

1 mark

Eventually the extent of genetic changes in the populations would have accumulated to the point where the populations are so genetically different that they cannot produce viable offspring if interbred with each other.

1 mark

Total 5 marks

Question 5 (5 marks)

a. Strict endogamy prevents gene flow between populations.

1 mark

b. Strict endogamy has reduced the genetic diversity of the Amish population. If new individuals do not enter then population then there will be no new genetic material added to the gene pool.

1 mark

c. The founder effect.

1 mark

AND

The fact that this trait can be traced back to a single couple in the original population, means that these people were part of the small founding population and the trait has subsequently spread in the population over many generations.

1 mark

d. It would be correct to state that the high incidence of EVC in the Amish population is an example of genetic drift. This is due to the small initial population size and inbreeding.

1 mark

Total 5 marks

Question 6 (6 marks)

a. Polyploid.

1 mark

b. The tetraploid offspring are a new species.

1 mark

c. The presence of the tetraploid plants could potentially decrease the genetic diversity of the cabbage and radish species as they are descended from those species, but cannot reproduce with them.

1 mark

d. The haploid number of the ancestor was 11 chromosomes.

1 mark

AND

The diploid number of each of the descendent species is a multiple of 11.

1 mark

e. The extent of genetic variation within a species decreases due to the formation of new species which cannot successfully interbreed with each other.

1 mark

Total 6 marks