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

QUESTION BOOK

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* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions
- Students are permitted to bring into the room for this test: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.
- No calculator is permitted in this test.

Materials supplied
- Question and answer book of 13 pages.

Instructions
- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

SECTION A – Multiple-choice questions

Instructions for Section A
Select the response that is most correct for the question. A correct answer scores 1, an incorrect answer scores 0. Marks are not deducted for incorrect answers. If more than 1 answer is completed for any question, no mark will be given.

Question 1

A mutant allele was located in a species of fruit fly. It was subsequently determined that the allele was selectively neutral. The significance of this was that:

    A. The frequency of the allele will increase in subsequent generations.
    B. Inheritance of this allele will neutralize the impact of the normal allele.
    C. The impact of the mutated allele will be neutralized by the expression of the normal allele.
    D. There is no selective advantage or disadvantage caused by the inheritance of the mutated allele.

Question 2

Which of the following statements relating to mutations is the most correct?

    A. New mutations arising will always be selected against.
    B. All mutations in offspring had to be inherited from their parents
    C. All mutations will have a harmful effect on an individual's phenotype.
    D. Some mutations will have no effect on the phenotype of an affected individual

Question 3

A population of snakes was separated into two smaller populations by a river. The separation of the two smaller populations became permanent. Which of the following is least likely to occur in the two populations?

    A. Speciation will immediately occur in one of the populations
    B. Phenotypic variations begin to occur between the two populations
    C. The breeding times for members of the two populations begins to differ.
    D. Members of the two populations will be exposed to different selection pressures.

Question 4

Which of the following events occurs during allopatric speciation?

    A. A beneficial mutation occurs in a species.
    B. A population experiences a high rate of mutations.
    C. A geographic barrier divides a single population into two.
    D. Individuals continually migrate between two different populations.

Question 5

A researcher was studying the variation of a trait in a species of pea plants for a period of 10 years. Graph 1 shows the distribution of phenotypes at the beginning of the study. Graph 2 shows the distribution of phenotypes at the end of the study.

Graph 1   Graph 2
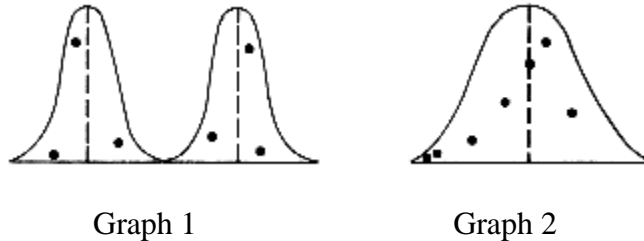
Which of the following conclusions could be made based on this data?

    A. This is an example of unifying selection.
    B. The plants with the average trait have been selected for.
    C. The plants with the extreme traits have been selected for.
    D. Two species have evolved in a similar manner and both now have the same trait as each other.

Use the following information to answer questions 6 and 7

Small populations are particularly vulnerable to genetic drift.

Question 6

Which of the following is the best explanation of genetic drift? It occurs as a result of:

    A. Random changes occurring in the allele frequencies of a specific population.
    B. Gradual changes in an organism's phenotype due to changes in environmental conditions.
    C. Organisms leaving one population and interbreeding with other populations of the same species.
    D. A small section of a population becoming isolated from the main population and only interbreeding with each other.

Question 7

Which of the following is the best explanation of the reason why small populations are particularly susceptible to genetic drift?

    A. They have a higher chance of being killed by predators.
    B. All individuals make a comparatively high contribution to the gene pool.
    C. Interbreeding occurs more frequently between small populations than larger ones.
    D. All individuals in a small population are equally likely to be affected by environmental changes

Question 8

The population of Northern elephant seals was believed to be reduced to as few as twenty individuals in the 1890s. Consequently, the extent of genetic variation in the modern population of elephant seals remains low. The most correct term used to describe this is:

    A. Genetic drift
    B. The founder effect
    C. Artificial selection
    D. A population bottleneck

Question 9

Nylon is a synthetic substance which was developed in the 1930s. In the 1970s a strain of bacteria that could use nylon as a food source was identified. It is believed that this occurred as a result of the bacteria responding to changes in the environment. Which of the following statements is most likely to be correct?

    A. This cannot be an example of evolution because insufficient time elapsed.
    B. The ability to metabolise nylon must have occurred as a result of being transformed.
    C. The short generational time of bacteria enabled them to evolve rapidly enough to take advantage of the new food source.
    D. This is an example of genetic drift which resulted in the allele enabling the ability to metabolise nylon to increase in frequency.

Question 10

Which of the following is the best definition of a gene pool?

    A. The sum total of genetic information in a population.
    B. The number of different alleles present in a population.
    C. The number of different sub-species which can still successfully interbreed.
    D. The number of individuals in a population who are capable of producing offspring.

SECTION B - Short-answer questions

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

Question 1 (5 marks)
A variety of wheat known as "Mitch" was released in Australia in 2014. It is advertised as having an improved yield and increased resistance to a condition known as crown rot. Advertising also states that "Mitch was selected for high yield and excellent agronomic performance".

    a. Explain what is meant by using the term "selected for".

                                                                 1 mark

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_____

    b. Identify the term used to describe the production of varieties such as "Mitch".

                                                                  1 mark

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    c. Explain how new varieties of a species are produced in the manner identified in part b.

                                                                  1 mark

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    d. This variety of wheat is not genetically engineered. Briefly explain the difference between the process identified in part b and genetic engineering.

                                                                  2 marks

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Question 2 (6 marks)

Some species of bird push eggs out of other bird's nests and then lay their own eggs, called mimic or mimetic eggs in that nest. This is known as brood parasitism. One such example is the Diedrik cuckoo (*Chrysococcyx caprius*) which lays its eggs in the nests of the African Weaver bird (*Ploceus cucullatus*). It has been determined that over time that the colour and degree of spotting on the eggs of individual weaver birds became more consistent, but eggs from different individuals became more widely varied. If recognition of the mimic cuckoo eggs is possible then the weaver birds are more likely to dispose of them.

    a. Identify and explain the process that lead to the weaver birds producing clutches of eggs that increased in similarity to each other in terms of colour, pattern and size.

4 marks

    b. Explain how the weaver birds benefit by producing eggs of increased similarity to each other.

1 mark

A population of weaver birds was introduced to Hispaniola over 200 years ago and another population was introduced to Mauritius about 100 years ago. Neither of these islands have any populations of brood parasites. It was subsequently found that the consistency in appearance of eggs in the same clutch decreased, with clutches commonly containing eggs of different colours, shapes and patterns.

  c. Identify a plausible conclusion that could be based upon this information.

1 mark

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Question 3 (8 marks)

The diagram below is an example of a codon table.

	Second Letter			
	U	**C**	**A**	**G**

Second Letter

1st letter		U		C		A		G		3rd letter
	U	UUU UUC — Phe / UUA UUG — Leu	UCU UCC UCA UCG — Ser	UAU UAC — Tyr / UAA UAG — Stop Stop	UGU UGC — Cys / UGA — Stop / UGG — Trp	U C A G
	C	CUU CUC CUA CUG — Leu	CCU CCC CCA CCG — Pro	CAU CAC — His / CAA CAG — Gln	CGU CGC CGA CGG — Arg	U C A G
	A	AUU AUC AUA — Ile / AUG — Met	ACU ACC ACA ACG — Thr	AAU AAC — Asn / AAA AAG — Lys	AGU AGC — Ser / AGA AGG — Arg	U C A G
	G	GUU GUC GUA GUG — Val	GCU GCC GCA GCG — Ala	GAU GAC — Asp / GAA GAG — Glu	GGU GGC GGA GGG — Gly	U C A G

The original sequence of a segment of DNA was as follows:

TAC GCG TGA CCA GCT ACA GGT

  a. Identify the original mRNA and amino acid sequences.

2 marks

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_____

A mutation occurs in which the 7th base in the DNA sequence, thymine was replaced by a cytosine base.

b. What type of mutation has occurred in this example?

1 mark

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c. Explain the effect that this mutation will have on the structure and function of the polypeptide.

3 marks

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d. Assuming that the protein produced as a result of the mutation is functional, discuss the effect that the mutation will have on the genetic diversity of the population. Explain why this effect will occur.

2 marks

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_____

Question 4 (5 marks)

The diagram below shows the distribution of the Australian platypus (*Ornithorhynchus anatinus*). Tasmania is believed to have separated from the mainland approximately ten thousand years ago. A study of the Australian platypus has taken place over many years in which the Tasmanian animals were compared to those living on the mainland. The two most significant differences found were that the Tasmanian platypuses had higher amount of fat storage in their bodies and thicker fur.

a. Discuss why the Tasmanian platypuses have developed larger fat storage and thicker fur than their mainland counterparts.

1 mark

b. Currently it is possible to interbreed a platypus from Tasmania with another platypus from Queensland resulting in the production of viable offspring. Explain the significance of this information.

1 mark

c. The mainland and Tasmanian populations are geographically isolated. Discuss what would be eventually expected to occur in these two populations and explain why this event would be expected to occur.

3 marks

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Question 5 (5 marks)

Ellis-van Creveld (EVC) syndrome is an autosomal recessive trait in humans which affects bone growth. Individuals with this condition are short (exhibit dwarfism), have short limbs, narrow chests and frequently have extra fingers and toes (polydactyly). The incidence of EVC in most populations is approximately 1 per 100 000 or 0.00001. However, in one group of the Amish population in the United States, the incidence is 0.066). All of the current members of that population trace their ancestry back to a small initial population, with all members of the population committed to strict endogamy (they only marry within their community).

a. Discuss the effect that strict endogamy has upon gene flow.

1 mark

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b. Discuss the biological consequences that strict endogamy has on the genetic diversity of the Amish population.

1 mark

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c. All of the individuals in the Amish population who have EVC can trace their ancestry back to a single couple who were members of the small initial population in 1744. What term is used to identify this type of scenario? Provide a reason to support your answer.

2 marks

d. Would it be correct to state that the high incidence of EVC in the Amish population is an example of genetic drift? Provide a reason to support your answer.

1 mark

Question 6 (6 marks)

An experiment was conducted in which a cabbage (*Brassica oleracea*) was crossed with a radish (*Raphinus raphanistrum*). Both parents were diploid and most of their offspring were also diploid, but sterile. However, a few tetraploid offspring were produced which could be successfully bred with each other, but could not be bred with either cabbages or radishes.

a. Identify another term used to describe the tetraploid offspring.

1 mark

b. Identify a plausible conclusion relating to the production of the tetraploid offspring.

1 mark

c. Discuss the impact that the presence of these tetraploid plants would have on the genetic diversity of the cabbage and radish species.

1 mark

d. In a species of coffee plants there are several different varieties. Some have 22 chromosomes, some have 44 chromosomes and some have 66 chromosomes. What does this information suggest about the haploid number of chromosomes of the ancestor of these plants? Provide a reason to support your answer.

2 marks

e. Discuss a possible reason to explain why the differences identified above decreases the extent of genetic variation in a species.

1 mark

END OF KEY TOPIC TEST