

Student Name: _____



BIOLOGY 2017

Unit 4

Key Topic Test 3 – Determining relatedness between species

Recommended writing time*: 45 minutes

Total number of marks available: 45 marks

QUESTION BOOK

* 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 14 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

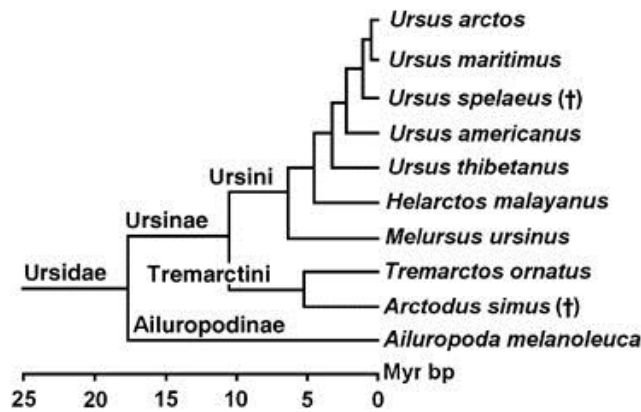
Select the response that is most correct for the question. A correct answer scores 1, an incorrect answer scores 0. Marks are not deducted for incorrect answers. If more than 1 answer is completed for any question, no mark will be given.

Question 1

Mitochondrial DNA (mtDNA) is used as a molecular clock because:

- A. It is abundant in all cells.
- B. It mutates at a known rate.
- C. It doesn't undergo mutation.
- D. It recombines at a regular rate.

Use the following diagram to assist you to answer questions 2 to 4



Question 2

What type of evolutionary pattern is shown in the diagram shown above?

- A. Parallel
- B. Adaptive
- C. Divergent
- D. Convergent

Question 3

Which of the following species would be the most closely related?

- A. *Ursus arctos* and *Ursus maritimus*
- B. *Ursus thibetanus* and *Ursus americanus*
- C. *Helarctos malayanus* and *Melursus ursinus*
- D. *Ailuropoda melanoleuca* and *Arctodus simus*

Question 4

Which of the following statements is most correct?

- A. All *Ursidae* organisms are also classed as *Ailuropodinae*
- B. *Ailuropod melanoleuca* is the only current species of *Ailuropodinae*
- C. All organisms referred to in the diagram are members of the same species.
- D. All of the organisms who have *Tremarctini* as an ancestor also have *Ursini* as a common ancestor

Question 5

Phylogeny is best defined as:

- A. The extent of phenotypic variation within a species
- B. The evolutionary relationships between different species
- C. The genetic variation within members of the same species
- D. The number of differences between DNA sequences in different species.

Question 6

A researcher was investigating the transmission pattern of a specific mutation in a mitochondrial gene. Which of the following would be the most accurate?

- A. All of the offspring of a male with the mutation would also have the mutation.
- B. All of the offspring of a female with the mutation would also have the mutation.
- C. Only the male offspring of a male with the mutation would also have the mutation.
- D. Only the female offspring of a female with the mutation would also have the mutation.

Question 7

Some members of a species of bird flew from the mainland and established a colony on an isolated island. Over time the birds adapted to the conditions on the island. This would lead to the establishment of:

- A. A mutation in the island population.
- B. A mutation in the mainland population.
- C. A novel phenotype in the island population.
- D. A novel phenotype in the mainland population.

Question 8

Molecular homology refers to:

- A. The number of different molecules found in one species.
- B. The number of similar molecules found in related species.
- C. The degree of similarity between specific molecules in different species.
- D. The degree of similarity of the functioning of DNA molecules in different species.

Question 9

One of the important genetic concepts in evolutionary biology is the single gene that activates other genes, leading to the development of specific tissues or organs. This type of gene is known as:

- A. A master gene
- B. A switch gene
- C. A trigger gene
- D. A regulatory gene

Question 10

Which of the following molecules are analysed in order to determine the degree of relatedness between different species?

- A. DNA only
- B. DNA and mtDNA
- C. mtDNA and rRNA
- D. DNA, mtDNA and amino acids

SECTION B - Short-answer questions

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

Question 1 (8 marks)

Cytochrome c is a large protein found in the mitochondria of eukaryotic organisms. It plays a role in aerobic respiration.

A comparison was made between the amino acid sequence of cytochrome c in a range of species compared to human cytochrome c. The number of differences between the organism being tested and cytochrome c in humans is shown in the following table.

Chimpanzee	0	Rhesus Monkey	1	Gorilla	3
Rabbit	9	Cow	10	Pigeon	12
Frog	20	Fruit fly	24	Yeast	42

- a.** Explain the reason for comparing amino acid sequences in varied organisms.

1 mark

- b.** Identify a conclusion that could be made regarding humans and chimpanzees. Use the data supplied to support your answer.

2 marks

- c. Use the data supplied to produce a phylogenetic tree (cladogram) containing information only relating to the mammals that were tested.

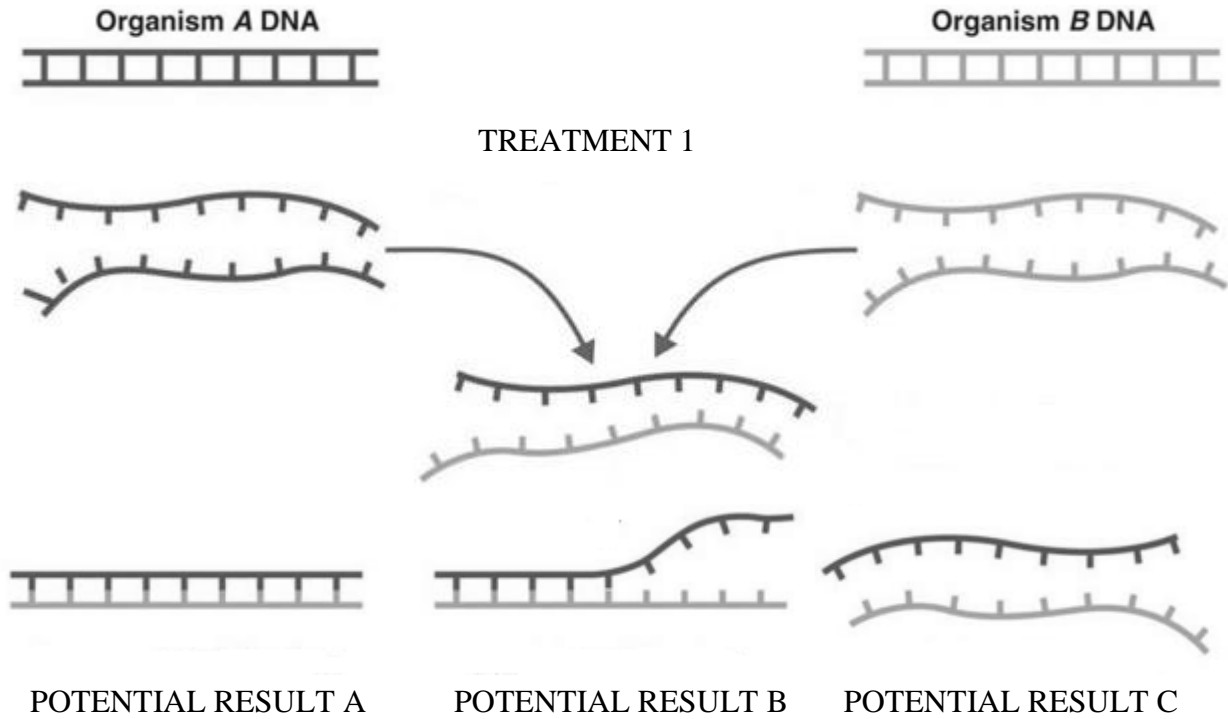
3 marks

- d. Comparing the amino acid sequence in cytochrome c is commonly performed in evolutionary studies because it is highly conserved. What does this term mean? Explain why cytochrome c would be highly conserved.

2 marks

Question 2 (11 marks)

The diagram below shows an overview of a process.



a. Identify the process that is being shown in the diagrams above.

1 mark

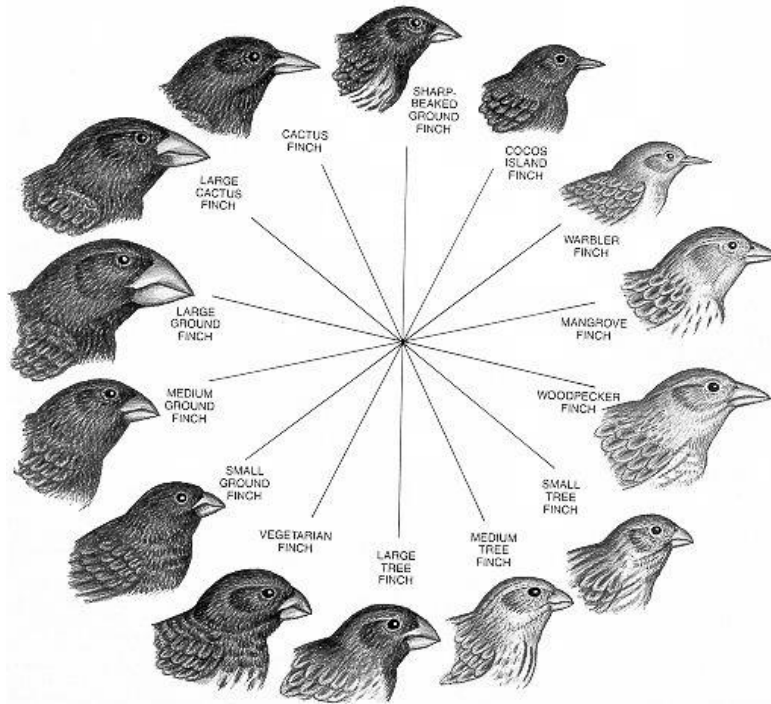
b. Explain the purpose of carrying out this process.

1 mark

Question 3 (7 marks)

The BMP4 gene has been found to act as a factor that stimulates beak growth in Darwin's finches. Greater expression of the BMP4 gene leads to the production of beaks of high depth and width.

The impact of this gene was determined as the result of research carried out in 2004. The team concerned examined the activity of the BMP 4 in the embryos of a range of different species of finch.



- a. Explain why the BMP4 gene is considered to be the genetic cause for determining beak shape in finches.

1 mark

- b. Some embryonic finches were found to begin expressing the BMP4 gene earlier than others. What effect would this have on their beak size? Provide a reason to support your answer.

2 marks

- c. The diagram above shows a range of finches. Which of the finches shown would be most likely to produce the largest amount of the bone growth protein? Provide a reason to support your answer.

2 marks

- d. All of the finches share a common ancestral species from mainland South America, however, the ancestral birds migrated to different islands with differing conditions on each island. Explain how and why the finches have benefitted from the different expression rates of the BMP4 gene.

2 marks

Question 4 (5 marks)

The cichlid fish is one of the best examples of adaptive radiation. Lake Victoria in Africa used to be the home of over six hundred different species. This large diversification of species occurred because there have been several occasions where the lake dried up into several smaller lakes and isolated smaller populations of fish. The diet of the different species alive today varies from eating other fish to snails, shellfish, insects and detritus. Some cichlid fish have developed a pharyngeal jaw. This is a second set of jaws that are located in the throat of the fish. The bite force of these fish is greater, however, their jaws do not open as wide as those of other fish.

- a.** Explain what the term adaptive radiation means.

1 mark

- b.** Explain how the formation of the pharyngeal jaw could provide an advantage to those fish that possess it.

1 mark

- c.** Explain how the circumstances described could have led to the production of a large range of related species.

1 mark

- d.** Many cichlid species are now extinct due to the introduction of other species of carnivorous fish that can swallow their prey whole. Explain how the introduction of these fish lead to the extinction of cichlid fish that possess the pharyngeal jaw.

2 marks

Question 5 (4 marks)

The similarity of proteins may be determined by the application of immunology. If a researcher wished to test for the similarity between human proteins and those of related hominins they may use the following procedure:

- 1) Inject human serum into a rabbit.
- 2) The rabbit will then produce anti-human protein antibodies.
- 3) These antibodies are harvested and placed into test tubes.
- 4) Blood samples are taken from the species being compared and a sample for each species is placed into a separate test tube already containing the antibodies.
- 5) If the antibodies recognize the protein then they will bind to it and agglutination (clumping) will be observed.

Information about the genome similarity of several different species is shown below along with the tube into which each sample was placed.

ORGANISM	GENOME SIMILARITY	TEST TUBE
Chimpanzee	98.6%	1
Gibbon	93.5%	2
Gorilla	98.2%	3
Macaque	94.1%	4
Orang utan	97.0%	5
Rhesus Monkey	93.0%	6

a. Briefly explain what the term genome means.

1 mark

b. This technique involves making a link between genome similarity and protein similarity. What link between these two pieces of information is being made?

1 mark

- c. In which tube would the least amount of agglutination be expected to occur? Provide a reason to support your answer.

2 marks

END OF KEY TOPIC TEST