



BIOLOGY 2017

Unit 4

Key Topic Test 3 – Determining relatedness between species

Recommended writing time*: 45 minutes

Total number of marks available: 45 marks

SOLUTIONS

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

Question 1

Answer: B

Explanation:

Mitochondrial DNA mutates at a known rate, which makes it suitable to use as a molecular clock.

Question 2

Answer: C

Explanation:

Cladograms are used to show examples of divergent evolution; all organisms are descended from a common ancestor.

Question 3

Answer: A

Explanation:

Ursus arctos and *Ursus maritimus* are the most closely related as they have diverged from a common ancestor the most recently.

Question 4

Answer: B

Explanation:

The diagram indicates that this is the only correct option, there is only one Ailuropodinae species shown.

Question 5

Answer: B

Explanation:

Phylogeny is defined as the evolutionary relationships between different species that have a common ancestor.

Question 6

Answer: B

Explanation:

Mitochondrial DNA is passed from a mother to all of her offspring. Therefore, all of the offspring of a female with a specific mutation would also inherit that mutation as recombination doesn't occur.

Question 7

Answer: C

Explanation:

The migration of a small population to a new area where they experience new selection pressures leads to the formation of individuals with novel phenotypes.

Question 8

Answer: C

Explanation:

Molecular homology refers to the extent of similarity between molecules that carry out the same or similar functions in different species. If the species are closely related the degree of homology will be higher.

Question 9

Answer: A

Explanation:

The correct term for a gene that activates other genes is a master gene. There is no such thing as trigger or switch genes. Regulatory genes may only have an impact on the expression of one other gene rather than many.

Question 10

Answer: D

Explanation:

DNA, mtDNA and amino acids may all be analysed to determine the extent of relatedness between different species.

SECTION B - Short-answer questions

Question 1 (8 marks)

- a. Amino acid sequences are compared in order to determine the extent of relatedness between different species. Species that are closely related will have a greater similarity (homology) in their amino acid sequences than less related species.

1 mark

- b. Humans and Chimpanzees are very closely related.

1 mark

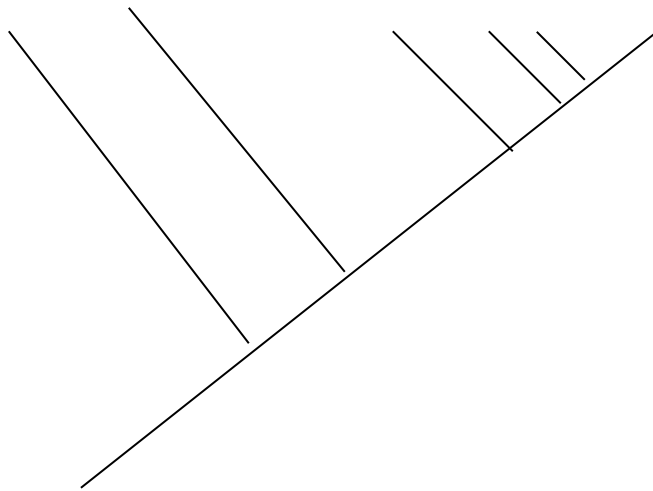
AND

There is no difference between the amino acid sequence of cytochrome c in chimpanzees compared to that of humans.

1 mark

- c. The diagram should resemble the one shown below.

The order of organisms from left to right is: Cow, Rabbit, Gorilla, Rhesus Monkey, Chimpanzee



1 mark for correct shape

1 mark for only including mammals

1 mark for correct order

- d. Highly conserved means that the gene for producing the protein is occurs in many different species.

1 mark

AND

Cytochrome c is highly conserved as it plays a role in aerobic respiration, a process that is essential for producing energy in most living organisms.

1 mark

Total 8 marks

Question 2 (11 marks)

- a. DNA hybridization.

1 mark

- b. The purpose of carrying out this process is to produce a DNA hybrid, which would then be exposed to heat to determine how much energy is required to denature the hybrid in order to determine the relatedness between two species.

1 mark

- c. Treatment 1 involves heating the two pieces of DNA.

1 mark

AND

This is done so that single strands of DNA are produced. A single strand from one piece of DNA is annealed to a single strand from the other, resulting in the production of a DNA hybrid.

1 mark

- d. A DNA hybrid.

1 mark

- e. In potential result A there is extensive binding between the two single strands of DNA

1 mark

AND

This result indicates that the organisms are closely related, as closely related organisms have similar DNA sequences.

1 mark

AND

In potential result B there is partial annealing between the two strands.

1 mark

AND

This indicates that there are some genetic similarities between the two species, but they are more distantly related than suggested by potential result A.

1 mark

AND

In potential result C there is no annealing between the two strands.

1 mark

AND

This indicates that the organisms are unrelated and they do not share any similarities in their DNA sequences.

1 mark

Total 11 marks

Question 3 (7 marks)

- a. The BMP4 gene codes for production of the protein that is responsible for determining the size and shape of finches beaks.

1 mark

- b. These finches would have had a larger or wider beak.

1 mark

AND

Finches that express the BMP4 gene early in development would begin to develop beaks earlier than their counterparts, which begin to develop beaks later in their development.

1 mark

- c. The large ground finch.

1 mark

AND

This finch has the largest beak and therefore would be the most likely to be producing large amounts of the protein produced by expression of the BMP4 gene.

1 mark

- d. The size and shape of a finches beak determines what it is capable of eating.

1 mark

AND

The differing food sources on each island resulted in different levels of expression of the BMP4 gene being favoured, resulting in different beak shapes and sizes that enabled the finches to take advantage of the food sources.

1 mark

Total 7 marks

Question 4 (5 marks)

- a. Adaptive radiation is the evolutionary diversification of a single ancestral species into a number of specialised descendent species in order to take advantage of a variety of ecological niches.

1 mark

- b. Fish with the pharyngeal jaw had a greater bite force enabling them to eat foods such as shellfish that other fish may be unable to eat.

1 mark

- c. The formation of the smaller lakes provided reproductive isolation for the fish in those lakes. Each lake had slightly different selection pressures resulting in the formation of different species of cichlid fish.

1 mark

- d. The cichlid fish and the introduced species would be in competition for the same resource, food.

1 mark

AND

The new species are able to swallow their food whole whilst the cichlid fish are limited to a bite at a time. Therefore, the new species can outcompete the cichlid fish for food sources leading to the extinction of the cichlid fish.

1 mark

Total 5 marks

Question 5 (4 marks)

- a. A genome is the complete set of DNA that is present in an individual organism.

1 mark

- b. The extent of genome similarity and protein similarity should be the same.

1 mark

- c. Test tube 6.

1 mark

AND

At 93.0% the degree of genome similarity between the rhesus monkey and humans is lower than that of any other primate. Therefore, there would be the least amount of recognition between the anti-human antibodies and the protein from the rhesus monkey resulting in the least amount of agglutination.

1 mark

Total 4 marks