Additional Assessment Materials
Summer 2021

Pearson Edexcel GCE in AS Biology

Topic 3: Classification and Biodiversity

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1

Natural selection can lead to adaptations in organisms.

(a) Explain how evolution can occur through natural selection.

(3)

A variety of phenotypes exist in a population as a result of mutations. An environmental change occurs and as a result the selection pressure changes. The individuals that possess advantageous characteristics are more likely to survive and reproduce, passing on the advantageous alleles to their offspring. Over time, the frequency of alleles in the population changes, since the offspring which inherit the advantageous alleles will be more likely to survive than others.

(b) (i) Which of the following is an example of a behavioural adaptation?

(1)

- [x] **A** courtship display in sticklebacks
- [ ] **B** litter size in pigs
- [ ] **C** number of *Drosophila* eggs that hatch
- [ ] **D** pollen production in sycamore trees

(ii) Which of the following is an example of anatomical adaptation?

(1)

- [ ] **A** an alarm call by a song thrush
- [ ] **B** dominance behaviour in dairy cattle
- [x] **C** limb structure in primates
- [ ] **D** water potential in root hair cells

(iii) Which of the following is an example of physiological adaptation?

(1)

- ☐ **A** increased number of stomata on leaf upper surface in a water lily
- ☒ **B** production of venom by a snake
- ☐ **C** reduction of leaves to spines in a cactus
- ☐ **D** salmon swimming upstream to mate

(c) Natural selection can lead to speciation.

(i) Which information about a new organism would to lead to it being classified as a new species?

(1)

- ☐ **A** anatomical differences
- ☐ **B** behavioural differences
- ☐ **C** genetic differences
- ☒ **D** inability to produce fertile offspring with similar species

(ii) Give one method that a scientist might use to inform the scientific community about the discovery of a new species.

(1)

publish the information in a scientific journal

(d) Compare and contrast allopatric and sympatric speciation.

(4)

Allopatric speciation occurs between populations of organisms living in different geographical locations whereas sympatric speciation occurs in the same area. Allopatric speciation is a result of geographical isolation i.e. when a population becomes separated by a physical barrier such as a river or mountain range, whereas sympatric speciation occurs due to behavioural, ecological or temporal isolation. In both cases, there is no gene flow between organisms and so over time, genetic differences accummulate in the populations. In both types of speciation reproductive isolation occurs.

2 Minke whales, killer whales and dolphins are all cetaceans.

These animals are different species that all belong to the order Cetacea.

(a) The five-kingdom model of classification is hierarchical.

Part of this hierarchy is: kingdom

phylum

class

family

genus

Where in this hierarchy should the order Cetacea appear?

(1)

☐ **A** between kingdom and phylum

☐ **B** between phylum and class

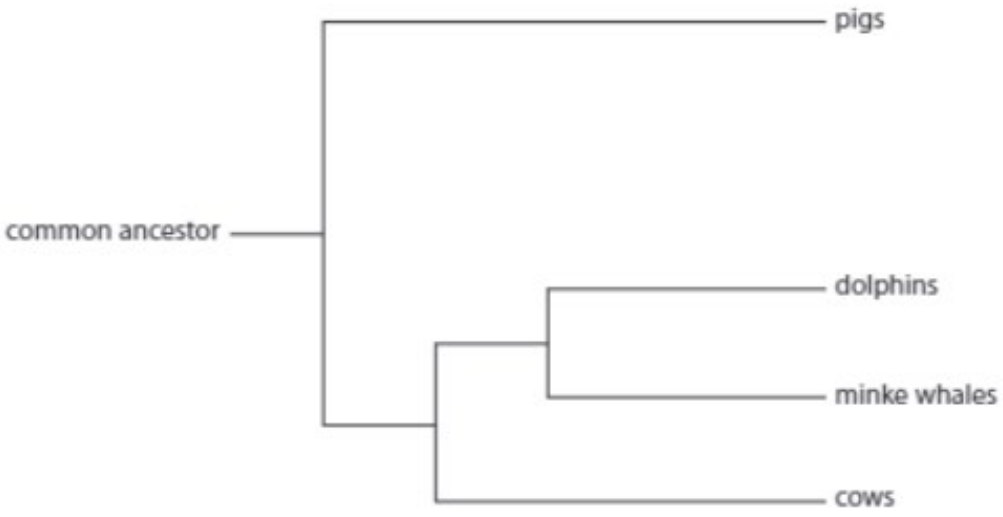
☒ **C** between class and family

☐ **D** between family and genus

(b) Cetaceans evolved between 55 and 60 million years ago.

Their closest living relatives are thought to be pigs and cows.

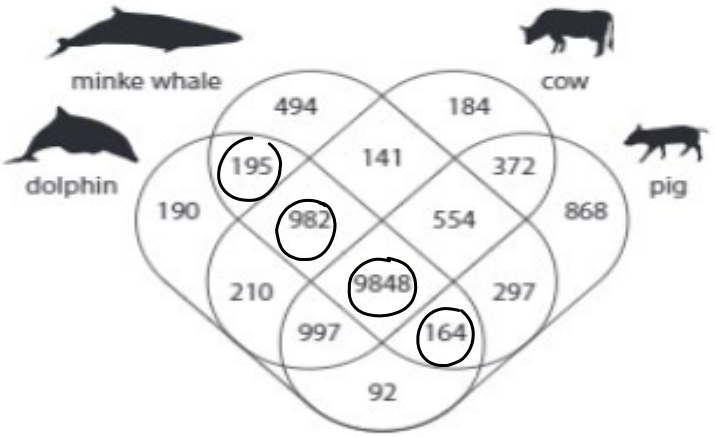
The diagram shows the evolutionary relationship between minke whales, dolphins, pigs and cows.



Analyse the diagram to explain the evolutionary relationship between these four animals.
(3)

Dolphins and Minke whales are the most closely related as they evolved from the most recent common ancestor. Cows are more closely related to dolphins and whales than pigs, as they share a common ancestor with the Cetaceans. All four animals come from one common ancestor but have become separate species due to reproductive isolation and speciation, so have accummulated different alleles over time. Dolphins and Minke whales are the most closely related because they are both marine mammals

(c) The Venn diagram shows unique and shared gene families in the genomes of minke whales, dolphins, pigs and cows.



Calculate the percentage of a dolphin's gene families that are shared with the minke whale.
(2)

$$\left(\frac{11189}{12678}\right) \times 100 = 88.25524\ldots$$

Answer 88.3 %

(d) A wholphin is an extremely rare hybrid animal born from the mating of a female dolphin and a male killer whale.

Kekaimalu was a wholphin born in the United States in 1985. Kekaimalu was mated with a dolphin and on three occasions gave birth to live offspring.

Explain how this case study illustrates the limitations of the definition of a species.

(2)

A species is defined as a group of organisms with similar characteristics that can interbreed to produce fertile offspring. Even though dolphins and whales are different species, they can still interbreed to produce fertile offspring (a wholphin, which can give birth to live offspring as seen with Kekaimalu).

3

(a) Explain the difference between biodiversity within a habitat and biodiversity within a species.

(2)

Biodiversity within a habitat involves different species with different characteristics living in the same area, but can also include differences between organisms of the same species, whereas biodiversity within a species involves genetic, structural and behavioural differences between organisms which can interbreed to produce fertile offspring, but which don't have to be living in the same habitat.

(b) Biodiversity can be measured by calculating an index of diversity.

The following data were collected from a freshwater pond in England.

Species	Number of individuals (n)	n(n-1)
Mayfly nymph	80	6320
Freshwater shrimp	23	506
Freshwater hoglouse	14	182
Beetle larvae	9	72
	total =	7080

(i) Calculate the index of diversity (D) for this pond. Use the formula

(3)

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

$$D = \frac{126(125)}{7080} = 2.22$$

Answer 2.22

(ii) A pond in a different area had a lower index of diversity.

Explain how the composition of this second community could have resulted in this lower index of diversity.

(2)

There are more similarities between the organisms in this second community which could be due to a fewer number of different species and/or a lower number of different niches which can be exploited.

*(c) Discuss the use of *in-situ* and *ex-situ* methods in the conservation of endangered species. (6)

In-situ conservation means the conservation of ecosystems and recovery of populations of species in their natural habitats.
Ex-situ conservation is the conservation of species outside their natural habitats.
In-situ methods involve the designation, management, and monitoring of species where they are encountered. For example, protected areas (where endangered species exist naturally.
Ex-situ methods involve sampling, transfer and storage of species from the target area. For example, botanic gardens, zoo/livestock parks, seed storage.
In-situ methods (e.g. national parks, wildlife sanctuaries) allow animals to flourish in their natural habitat/food chain and gives them more mobility.
Ex-situ methods, on the other hand, offer animals less mobility as it is smaller in area. However, it provides protection to endangered species against predators, unfavourable climate conditions and proper supervision and food is provided.

4

Gel electrophoresis is used to separate biological molecules such as proteins.

(a) Explain how gel electrophoresis separates molecules.

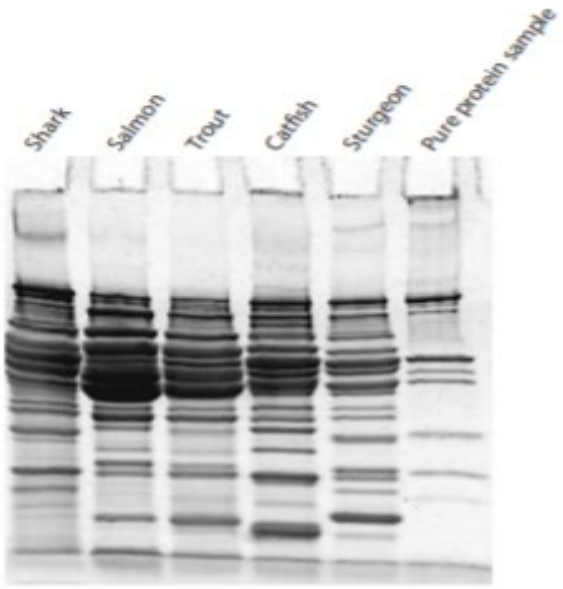
(2)

Wells are made in the agarose gel and the different molecules are put in each well. A current is turned on and negatively charged molecules e.g. DNA move towards the anode. A UV light is turned on and current turned off and different bands show up on the gel as different molecules travel different distances along the gel. Larger molecules move a shorter distance.

(b) Proteomics is the study of proteins that are produced in different species.

Scientists used gel electrophoresis to separate muscle proteins from five species of fish and from a pure protein sample.

The photograph shows the results of a gel separation of proteins from these fish and from the pure protein sample.



(i) Protein molecules in solution do not separate as easily as DNA fragments.

Explain how protein molecules in solution must be treated so that they can be separated by gel electrophoresis.

(2)

the protein molecules must be mixed with protease enzymes to digest / break down the proteins into smaller components which can be separated on the agarose gel.

(ii) Analyse the information shown in the photograph to explain how this banding pattern can be used to confirm that these are separate species of fish.

(4)

Each species has a different banding pattern meaning they all have different muscle proteins. The greatest number of similarities in banding patterns are between trout and salmon as the protein molecules in both moved similar distances along the gel. The greater the number of bands that moved the same length along the gel of two different species, the more closely related they are and so have a more recent common ancestor. salmon and trout have 8 bands in common and all the bands are also similar thickness (very thick) so many of the muscle proteins are the same.

(iii) Give a reason why pure protein samples were included in the gel.

(1)

To compare the pure protein sample with fish protein.

(iv) The bands in the photograph vary in thickness.

State what the thickness of the bands indicates.

(1)

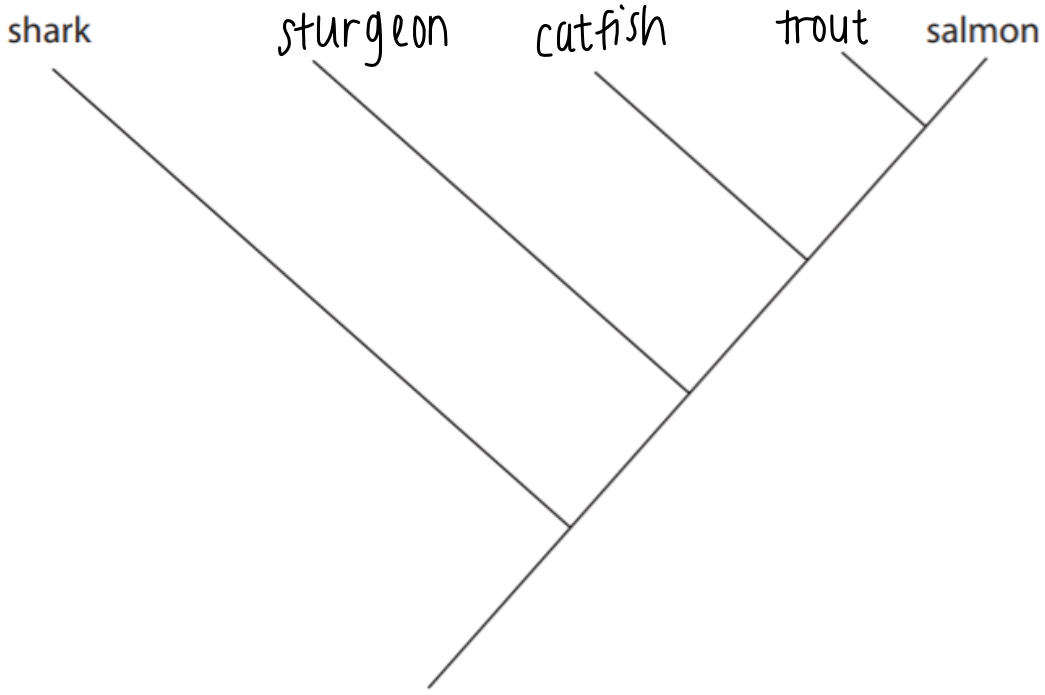
the thickness shows the number of molecules of that particular muscle protein (the amount of protein.)

(c) The table shows the number of bands each fish has in common with the other species.

Species	Shark	Salmon	Trout	Catfish	Sturgeon
Shark	8	2	2	2	2
Salmon		10	10	5	3
Trout			13	5	4
Catfish				10	2
Sturgeon					12

Analyse the data to complete the diagram showing the evolutionary relationships between these species of fish.

(2)



TOTAL FOR TEST = 45 MARKS