Additional Assessment Materials Summer 2021

Pearson Edexcel GCE (Biology A)

Resource Set Topic 2: Genes and Health

Question Paper

(Public release version)

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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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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 Tay-Sachs disease is a genetic disorder.

(a) A couple without Tay-Sachs disease are expecting their second child. Their first child died from the disease.

Use a genetic diagram to determine the probability of their second child having Tay-Sachs disease.

(2)

Answer ....

(b) Tay-Sachs disease can be detected during pregnancy.

Name the prenatal test that could be used to detect Tay-Sachs disease at 11 weeks of pregnancy.

(1)

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(c) Explain why this couple may choose not to have this test.

(3)

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(Total for Question 1 = 6 marks)

1 The structure of the cell surface membrane can be described by the fluid mosaic model.

(a) The diagram shows the fluid mosaic model of the cell surface membrane.
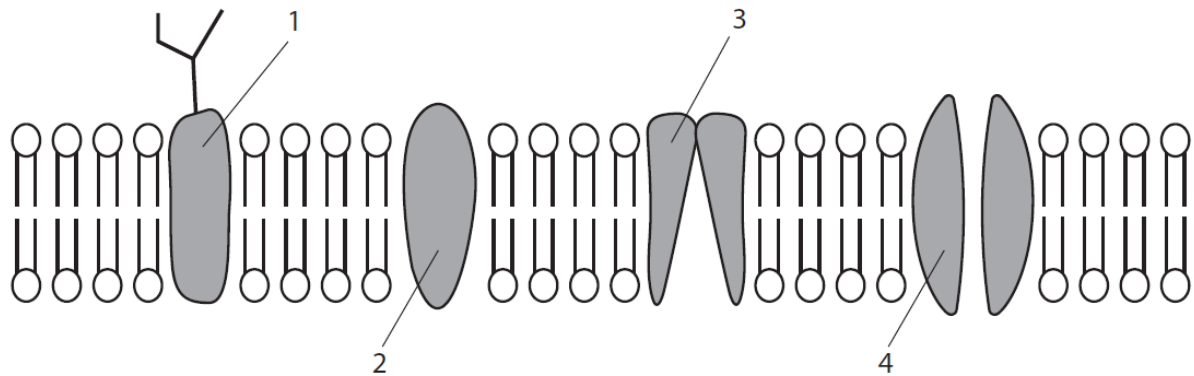
(i) Which of the shaded structures transport charged molecules or ions across the membrane?

(1)

☒ **A** 1 and 2 only

☒ **B** 3 and 4 only

☒ **C** 1, 2 and 3 only

☒ **D** 1, 2, 3 and 4

(ii) Which of the shaded structures contain both hydrophilic regions and hydrophobic regions?

(1)

☒ **A** 1 and 2 only

☒ **B** 3 and 4 only

☒ **C** 1, 2 and 3 only

☒ **D** 1, 2, 3 and 4

(iii) A student measured the width of the phospholipid bilayer shown on the diagram as 2.5 cm. The actual size of this bilayer is 5 nm.

What is the approximate magnification of the diagram?

(1)

☒ **A** × 5000

☒ **B** × 50 000

☒ **C** × 500 000

☒ **D** × 5 000 000

(b) Explain why the phospholipids are arranged in two layers in a cell surface membrane.

(3)

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(Total for Question 1 = 6 marks)

7 DNA is a double-stranded molecule. During transcription, the antisense and sense strands are separated.

Part of the antisense strand, with base sequence TACGCTGAC, is transcribed.

(a) (i) State where transcription occurs in an animal cell.

(1)

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(ii) Which row shows the correct sequence for the complementary sense strand and the mRNA produced in transcription?

(1)

		Sense strand	mRNA
☒	A	ATGCGACTG	ATGCGACTG
☒	B	TACGCTGAC	AUGCGACUG
☒	C	TACGCTGAC	ATGCGACTG
☒	D	ATGCGACTG	AUGCGACUG

(b) A human gene is 27 000 base pairs long. In this section of double-stranded DNA there are 4050 nucleotides containing the base cytosine.

(i) State what is meant by the term gene.

(1)

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(ii) How many nucleotides in this gene contain the base adenine?

(1)

☒ A 9000

☒ B 18000

☒ C 22950

☒ D 45900

(c) Mutations to DNA can affect the structure of proteins produced in the cell.

Removing one base from a DNA sequence will affect the primary structure of a protein.

Changing one base for another may not affect the primary structure of a protein.

Explain why these two types of mutation have different effects on protein structure.

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(Total for Question 7 = 8 marks)

2 All organisms exchange gases with their environment.

(a) Sailor's eyeball (*Valonia ventricosa*) is a single-celled, spherical organism.

One of these organisms can have a diameter of 1 cm to 4 cm.
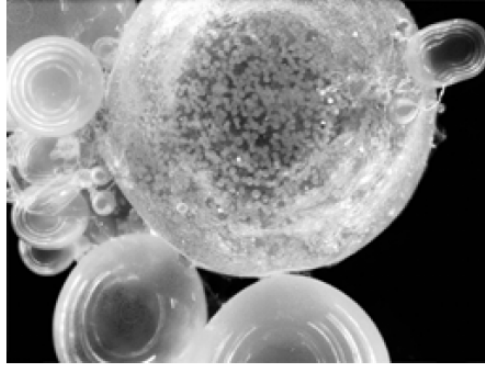
The table shows the diameter, surface area and volume of different *Valonia ventricosa* cells.

Diameter / cm	1	2	4
Surface area / cm²	3.14	12.57	50.27
Volume / cm³	0.52	4.19	

(i) The volume of a sphere can be calculated using the following equation.

$$V = \frac{4\pi r^3}{3}$$

What is the volume of a cell with a diameter of 4 cm?

(1)

☒ **A** 33.51 cm²

☒ **B** 33.51 cm³

☒ **C** 268.08 cm²

☒ **D** 268.08 cm³

(ii) Describe why single-celled organisms, such as *Valonia ventricosa*, do not need a specialised gas exchange surface.

(2)

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(b) Mammalian lungs are adapted for rapid gas exchange.

Explain how the structure of the human lungs enables rapid gas exchange.

(4)

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(c) The graph shows the death rates due to diseases of the respiratory system in some countries.
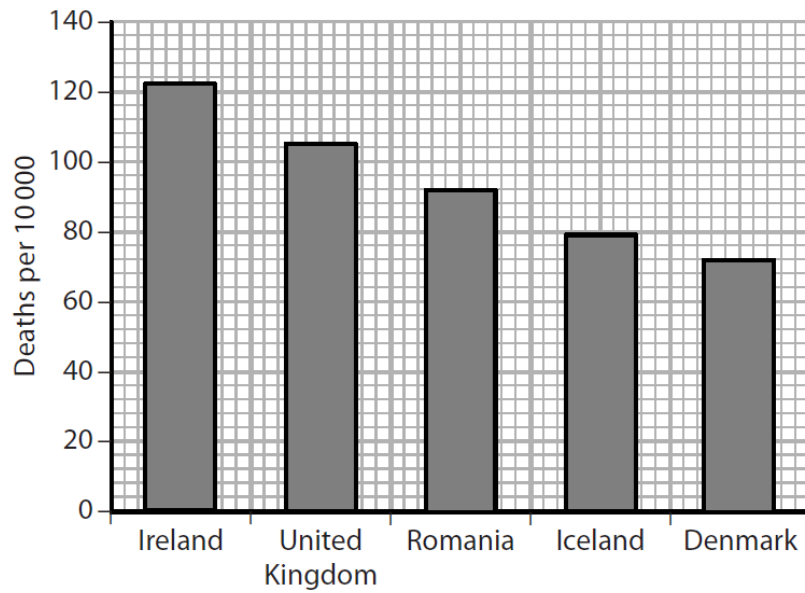
Calculate the probability of dying from a disease of the respiratory system in the United Kingdom.
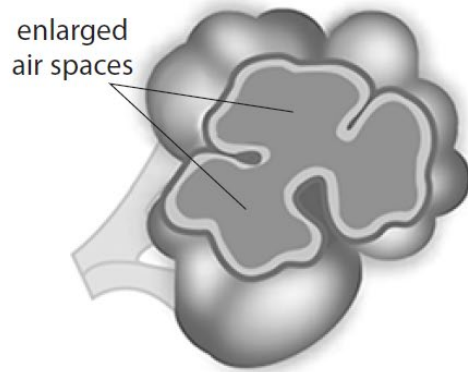
(2)

Answer ....

(d) Emphysema is a disease of the respiratory system that affects the structure of the lungs.

small air
spaces

enlarged
air spaces
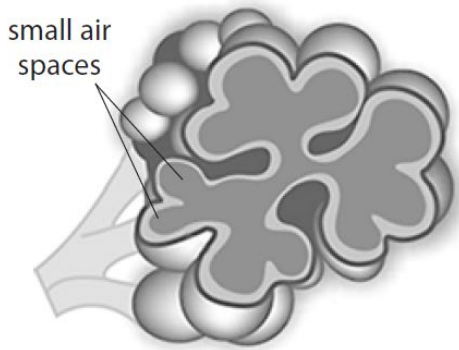
Lung without emphysema

Lung with emphysema

Explain why people with emphysema are given air with a higher concentration of oxygen than atmospheric air.

(2)

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(Total for Question 2 = 11 marks)

4 Blood plasma contains many different proteins. Prothrombin is a plasma protein that is involved in the blood clotting process.

(a) (i) The protein prothrombin is composed of monomers called amino acids.

Complete the diagram to show the structure of an amino acid.

(2)

$$\begin{array}{c} R \\ | \\ -C- \\ | \\ H \end{array}$$

(ii) Name the products formed when several amino acids are joined together.

(1)

*(b) Mutations in the gene coding for the prothrombin protein have been identified.

These mutations have resulted in different forms of prothrombin being produced.

The diagram shows the same part of the genetic sequence for prothrombin A and prothrombin B.

Prothrombin A:

TCC CAA TAA AAG TGA CTC TCA GCG AGC

Prothrombin B:

TCC CAA TAA AAG TGA CTC TCA GAG AGC

Prothrombin A and prothrombin B were used in an investigation into blood clotting.

A sample of blood had all of the prothrombin removed.

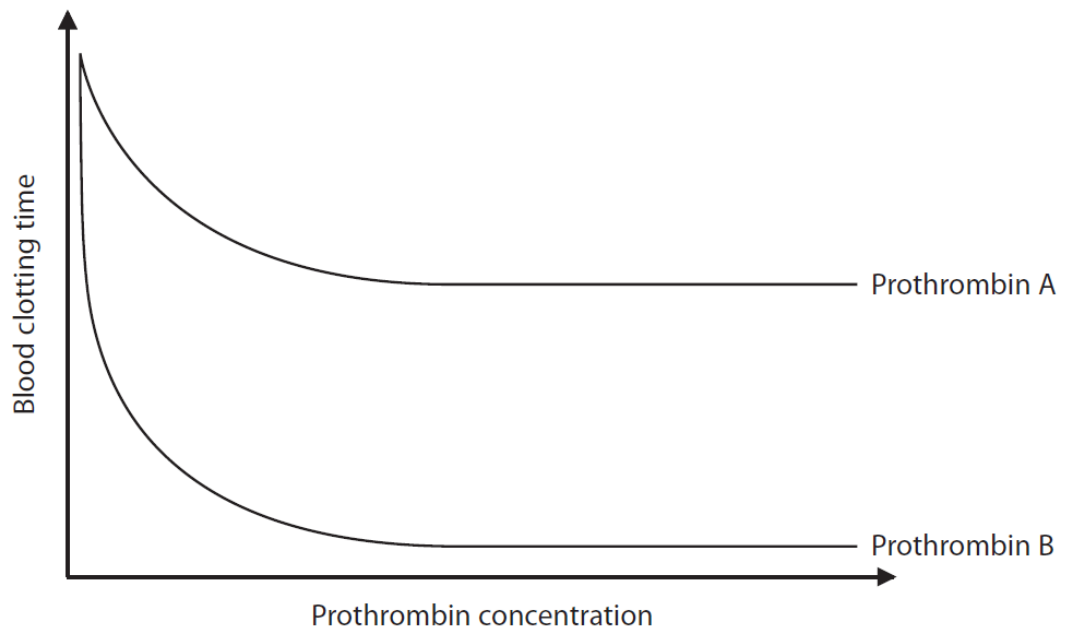Equal volumes of this blood were poured into test tubes.

Each test tube of blood received a different concentration of prothrombin A.

The volume of prothrombin A was the same in each tube.

The time taken for the blood to clot in each tube was measured.

The investigation was repeated with different concentrations of prothrombin B.

The results are shown in the graph.

Explain the results of this investigation.

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(Total for Question 4 = 9 marks)

5 Pickling is a technique used to preserve food. Onions can be pickled by immersing them in a solution of sodium chloride.

A student investigated the effects of changing the concentration of sodium chloride solution on the mass of onion tissue. Small onions were peeled, had their tops and bottoms cut off and were weighed. The onions were then placed into covered beakers containing different concentrations of sodium chloride solution.

Six beakers were set up as shown in the diagram.

| 0% sodium chloride solution | 2.5% sodium chloride solution | 5% sodium chloride solution | 10% sodium chloride solution | 15% sodium chloride solution | 20% sodium chloride solution |
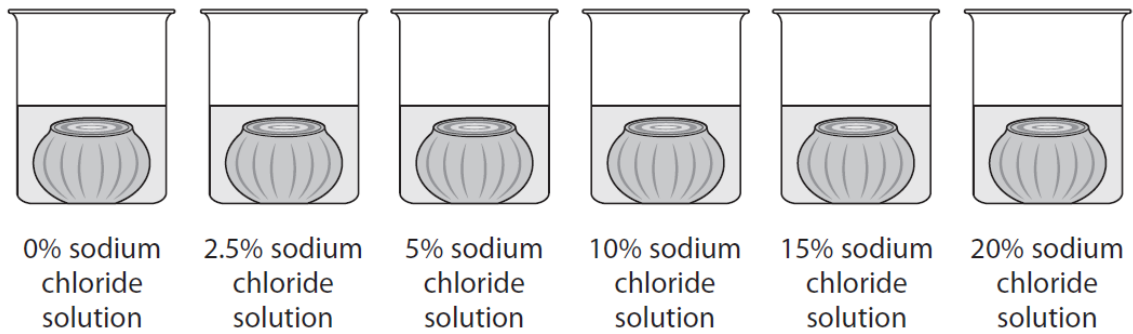
The beakers were left for two days. The onions were removed, blotted dry and reweighed. The investigation was repeated two more times.

The mean percentage change in mass was calculated.

The results of the investigation are shown in the table.

Sodium chloride solution (%)	Percentage change in mass (%)				SD
	1	2	3	Mean	
0.0	7.3	7.1	7.9	7.4	0.4
2.5	3.2	4.7	5.8	4.6	
5.0	−1.3	−0.9	−1.2	−1.1	0.2
10.0	0.6	−0.8	−1.9	−0.7	1.3
15.0	−2.1	−1.8	−2.9	−2.3	0.6
20.0	−2.2	−2.4	−1.9	−2.2	0.3

(a) (i) Explain **one** way in which this investigation could be improved.

(2)

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(ii) Standard deviation can be calculated using the formula shown.

$$S = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Calculate the standard deviation for the 2.5% sodium chloride solution.

(2)

Answer ....

(iii) Deduce the effect of increasing the concentration of sodium chloride on the change in mass of the onion tissue.

(3)

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(b) A method for pickling red onions is to immerse them in wine vinegar. This vinegar contains ethanoic acid. The vinegar causes anthocyanin pigments to leave the onion cells, entering the solution.

Explain why pickling in vinegar would result in anthocyanin pigments leaving the onion cells.

(3)

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(Total for Question 5 = 10 marks)

TOTAL FOR TEST = 50 MARKS