Pearson Edexcel

Additional Assessment Materials
Summer 2021

Pearson Edexcel GCE in AS Biology

Topic 1: Biological Molecules

(Public release version)

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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 Short sequences of nucleotides are being developed as potential drugs.

They act by binding to selected sites on DNA or RNA molecules and prevent the synthesis of a specific protein associated with a disease.

Two types of drug to treat genetic disorders are:

- antisense drugs, which are RNA nucleotides that bind to mRNA
- triplex drugs, which are DNA nucleotides that bind to DNA forming a three-stranded helix.

(a) (i) The type of bonds that hold the two strands of a DNA molecule together in a double helix are

(1)

☐ **A** glycosidic bonds

☒ **B** hydrogen bonds

☐ **C** phosphodiester bonds

☐ **D** peptide bonds

(ii) Antisense drugs inhibit protein synthesis by interfering with

(1)

☐ **A** protein folding

☐ **B** replication

☐ **C** transcription

☒ **D** translation

(iii) Triplex drugs inhibit protein synthesis by interfering with

(1)

☐ **A** protein folding

☐ **B** replication

☒ **C** transcription

☐ **D** translation

(b) The table shows the sequence of bases in part of an mRNA molecule.

Complete the table to show the base sequence of **each** of the following:

(i) the corresponding coding strand of DNA that produced this mRNA sequence

(1)

(ii) the base sequence of an antisense drug that will bind to this mRNA.

(1)

Base sequence on the DNA coding strand	G	T	A	C	G	T	A	T	A	G	C	C
Base sequence on mRNA	C	A	U	G	C	A	U	A	U	C	G	G
Base sequence of antisense drug	G	U	A	C	G	U	A	U	A	G	C	C

(iii) State the number of amino acids that would be coded for by the part of mRNA shown in this table.

(1)

4 amino acids

(c) Which of the following statements is true for the total number of bases in a double-stranded DNA molecule?

(1)

☐ **A** $\frac{A+T}{C+G}=1$

☒ **B** $\frac{A}{T}=\frac{C}{G}$

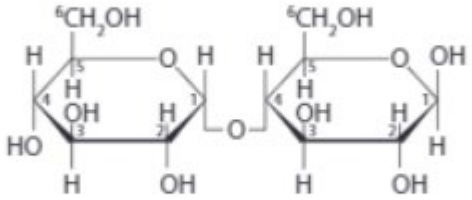
☐ **C** $A \times T = C \times G$

☐ **D** $\frac{A}{C}=\frac{G}{T}$

2

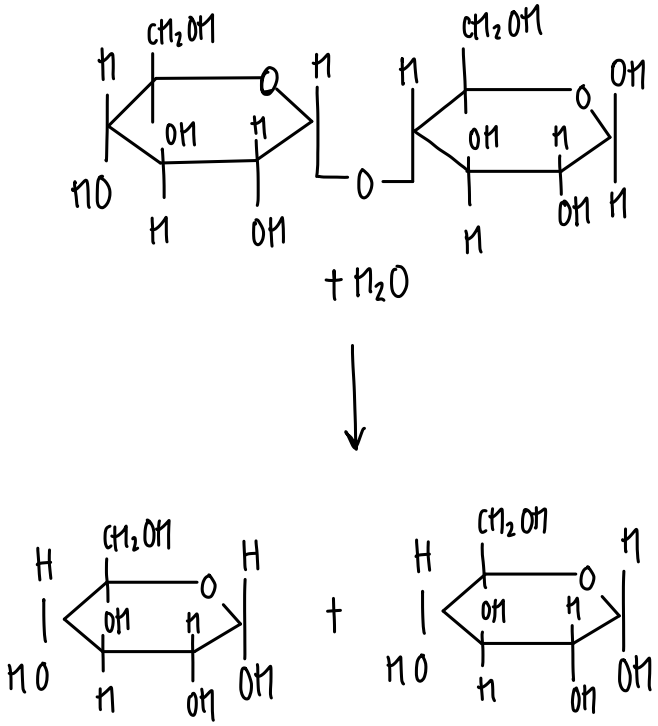
Enzymes are involved in a wide range of metabolic reactions.

(a) The diagram represents the structure of a maltose molecule.



Draw a diagram to show the hydrolysis of maltose.

(3)



(b) Catalase is an enzyme found in potato cells.

It catalyses the breakdown of hydrogen peroxide.

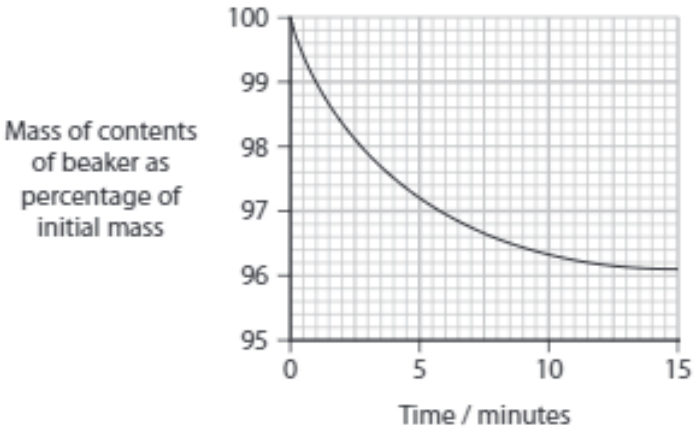
$$\text{hydrogen peroxide} \xrightarrow{\text{catalase}} \text{water} + \text{oxygen}$$

In an investigation, cylinders of potato were cut with a cork borer.

The cylinders were then sliced into discs with the same thickness and put into a small beaker containing 50 cm^3 of hydrogen peroxide.

The mass of the beaker and its contents was recorded over a period of 15 minutes.

The graph shows the results of the experiment.



Explain the relationship shown in the graph.

(4)

As the reaction between catalase and hydrogen peroxide proceeds, the mass of the contents of the beaker decreases between 0 and 14 minutes by 3.9% because the H_2O_2 is broken down into water and oxygen, which is a gas, and so it escapes from the beaker and so the mass of the contents in the beaker decreases. At 14 minutes the mass stops decreasing because the reaction has ended. This is because all of the H_2O_2 molecules (substrate) have been broken down by the catalase enzyme.

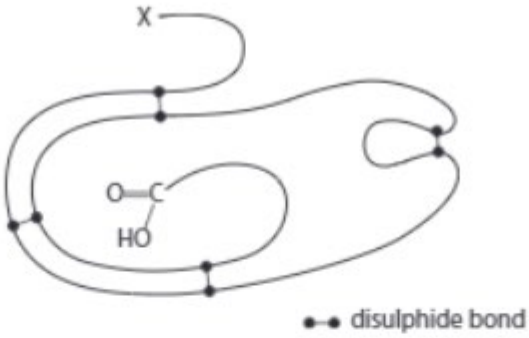
(c) Explain how a gene mutation can prevent the production of catalase in potato cells.

(3)

A gene mutation could be the deletion, insertion or substitution of a DNA base which would change the DNA triplets that code for proteins (i.e. catalase). This would result in a different mRNA molecule being made during transcription, which would result in a different amino acid sequence made during translation. This would change the hydrogen and disulphide bonds so the protein would have different 2° and 3° structures, changing the shape of the active site and leaving the enzyme infunctional.

The different base sequence could also result in a stop codon, therefore preventing translation.

3 The diagram shows the tertiary structure of a molecule of the enzyme RNase.



(a) (i) Which chemical group is found at position X?

(1)

- [X] **A** amino
- [ ] **B** carboxyl
- [ ] **C** hydroxyl
- [ ] **D** nitrate

(ii) Give the meaning of the term tertiary structure of a protein.

(2)

the 3D folding of the secondary structure of the protein, with new hydrogen, ionic and disulphide bonds formed between R groups

4

Polyphenol oxidase is an enzyme found in many plant cells.

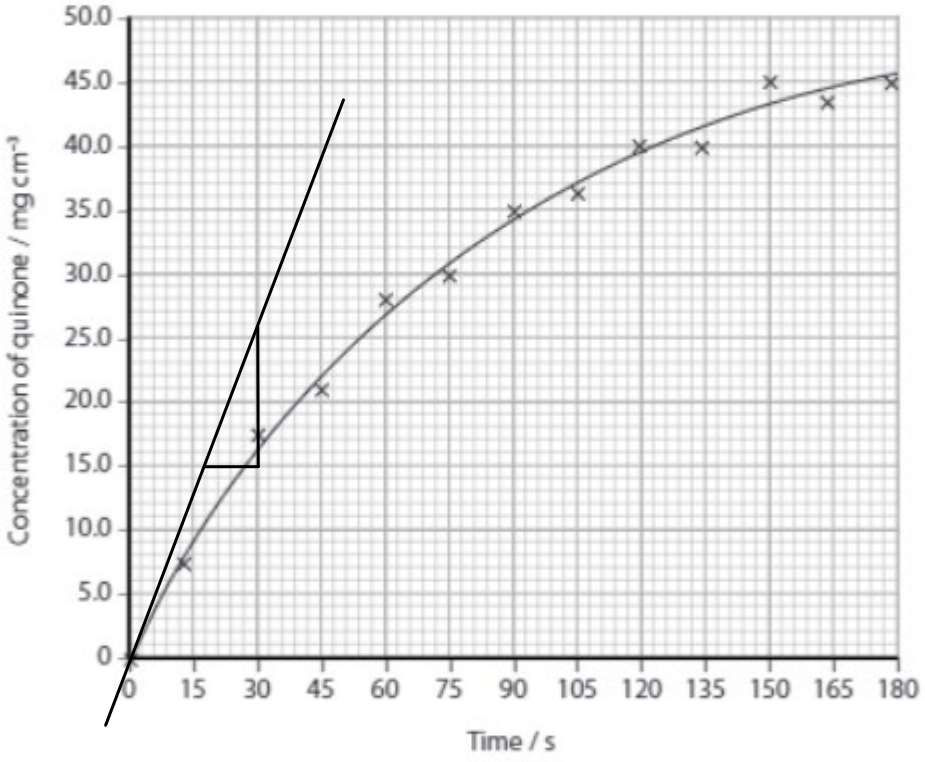
This enzyme catalyses the following reaction

monophenol (colourless) + oxygen ⟶ quinone (brown)

This reaction causes cut fruit to turn brown when exposed to air.

(a) A student carried out an investigation into the rate at which grape juice produced quinone.

The graph shows the results of this investigation.



(i) Calculate the initial rate of this reaction.

(3)

$$\frac{26-15}{30-16} = \frac{11}{14} = 0.786 \text{ mg cm}^{-3}\text{s}^{-1}$$

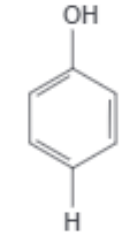
(ii) Explain why adding citric acid to cut fruit reduces the rate at which the fruit turns brown.

(2)

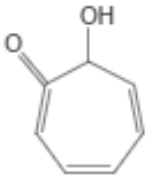
the citric acid lowers the pH which affects the hydrogen and ionic bonds in the enzyme, therefore changing the shape of the active site of the enzyme so the monophenol (substrate) no longer fits into the active site

(iii) The diagram shows the structures of monophenol and a molecule called tropolone.

Tropolone can be added to grape juice to slow the rate at which the juice turns brown.



monophenol



tropolone

Explain how tropolone affects the rate at which the grape juice turns brown.

(2)

tropolone has a similar structure to monophenol and so binds competitively to the active site of polyphenol oxidase, therefore inhibiting the binding of monophenol and decreasing the rate of production of quinone.

(b) Plant breeders have developed a grape variety that produces inactive polyphenol oxidase.

The bonding in this enzyme is changed and this prevents the juice from turning brown.

(i) Which of the following bonds are used to form the tertiary structure of enzymes?

(1)

- ☐ **A** hydrogen, glycosidic and ester
- ☒ **B** hydrogen, ionic and disulfide
- ☐ **C** ionic, glycosidic and disulfide
- ☐ **D** ionic, disulfide and ester

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety.

Explain how this leads to the production of inactive enzyme.

(3)

The change in the base sequence of the DNA leads to a change in the mRNA codons being made during transcription. This would result in a different amino acid sequence made during translation. This would change the hydrogen and disulphide bonds so the protein would have different 2° and 3° structures, changing the shape of the active site and leaving the enzyme infunctional as it can no longer bind to the substrate.

5

Pond skaters are insects. They can move on the surface of water due to the high surface tension of water.

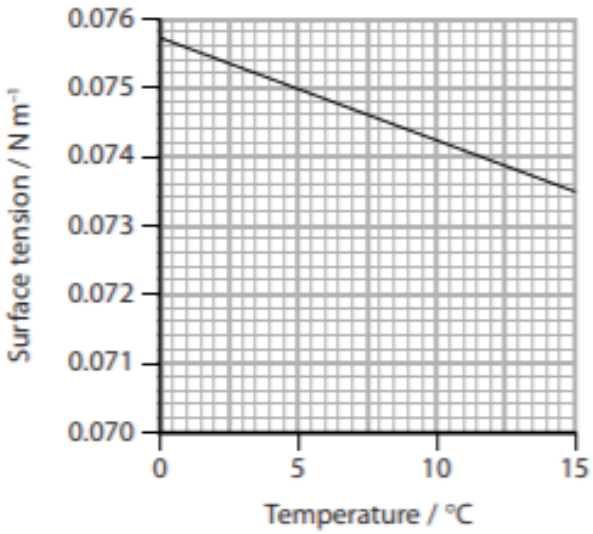
The photograph shows four pond skaters on the surface of water.

(a) Explain how the properties of water molecules result in surface tension.

(3)

Water molecules are polar because the electrons in the covalent bonds are closer to the oxygen than the hydrogens, making oxygen $\delta-$ and H $\delta+$. This allows water molecules to form hydrogen bonds between the molecules, making water cohesive, meaning the water molecules stick together. This causes a net inward force towards the liquid, which resists the breakage of the surface.

(b) The graph shows the effect of temperature on the surface tension of water.



A pond skater has a mass of 0.02 g and has a length of 20 mm in contact with the surface of the water.

The force that this pond skater exerts on the surface of the water can be calculated using the equation:

force in newtons = mass in kilograms × 9.8

(i) Calculate the force exerted by the pond skater for each millimetre length of contact with the surface of the water.

Give your answer in standard form.

(3)

$$F = \frac{0.02}{1000} \times 9.8 \div 20$$

$$F = 1.96 \times 10^{-4} \div 20$$

$$F = 9.8 \times 10^{-6} \text{ N mm}^{-1}$$

Answer 9.8×10^{-6} N mm^{-1}

(ii) This pond skater can stay on the surface of water even on a hot day in summer.

Use your calculated value and the graph to explain why this pond skater can stay on the surface of water.

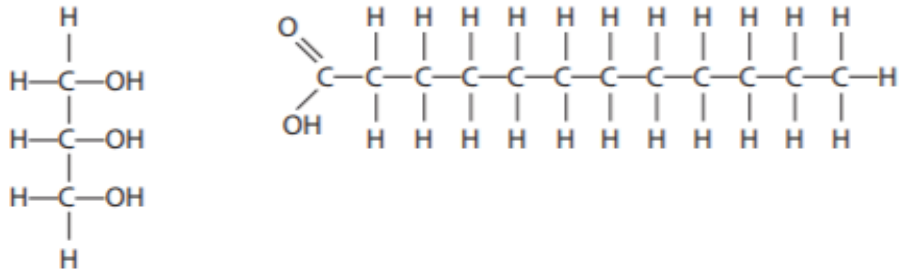
(3)

The surface tension is above 0.07 Nm^{-1} on a warm day, which is greater than the force exerted by the pond skater. Even if the temperature was greater than 15 °C, the surface tension of the water would still be greater than the force exerted by the pond skater.

6

Glycerol molecules and fatty acid molecules are used in the synthesis of cell membranes.

The diagram shows a molecule of glycerol and a molecule of a fatty acid.



(a) Which of the following describes the reaction when these two molecules are joined together?

(1)

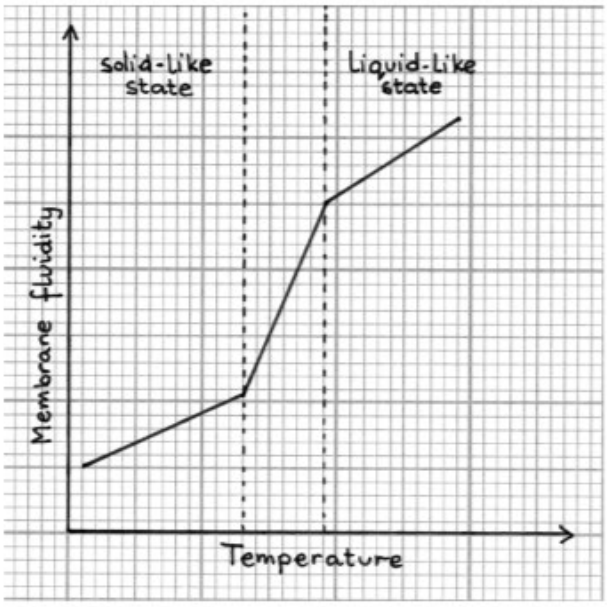
☒ **A** condensation reaction forming an ester bond

☒ **B** condensation reaction forming a glycosidic bond

☒ **C** hydrolysis reaction forming an ester bond

☒ **D** hydrolysis reaction forming a glycosidic bond

(b) This graph was sketched by a student to show how membrane fluidity changes with temperature.

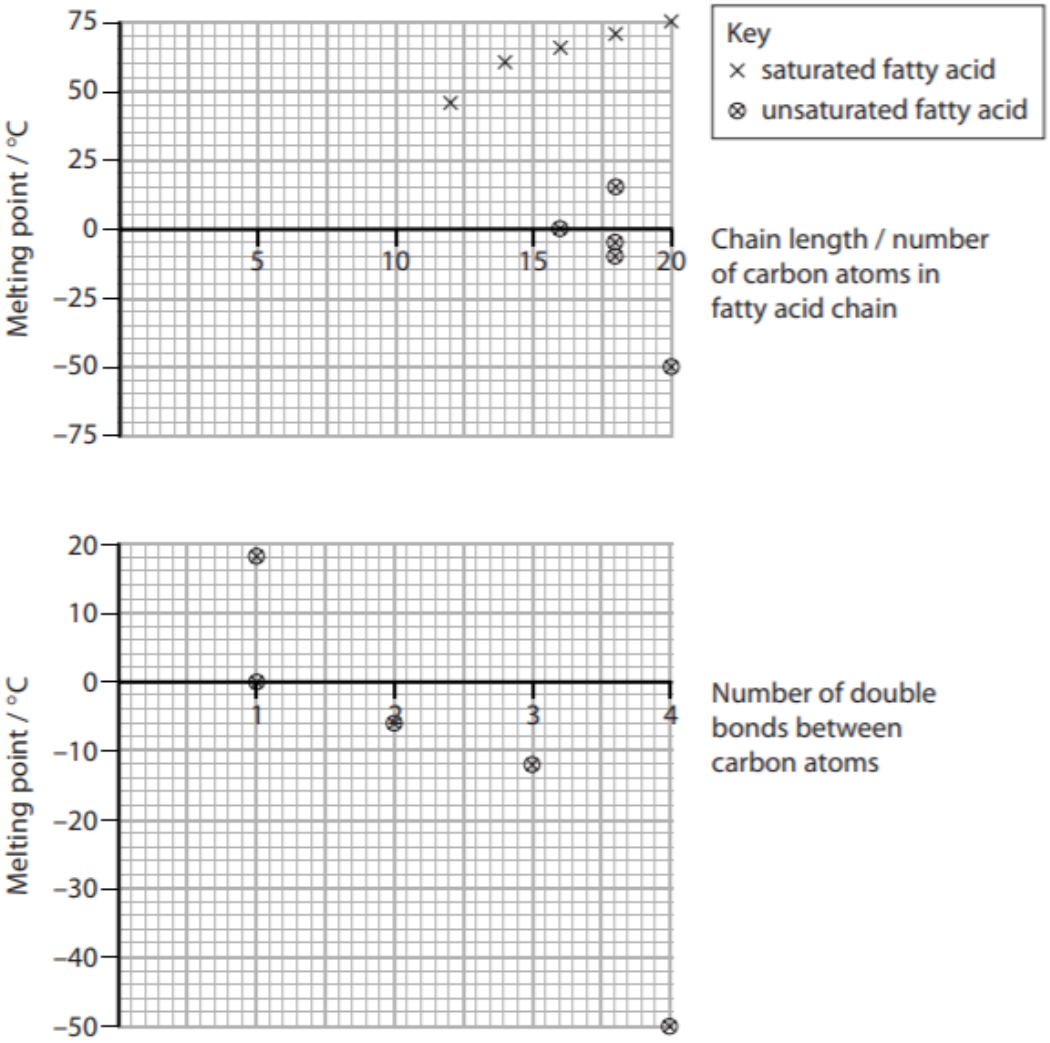


(i) Describe the relationship between membrane fluidity and temperature as shown by this graph.

(2)

as temperature increases, membrane fluidity also increases. The greatest increase in fluidity is seen during the change between a solid-like state and a liquid-like state.

(ii) The student found two graphs about the structure of lipids and their melting points.



The student stated that membrane fluidity depends on the fatty acids present.

Analyse the data in these two graphs and the sketched graph to comment on this statement.

(4)

Unsaturated fatty acids have a lower melting point than saturated fatty acids. For saturated fatty acids, the smaller the number of carbon atoms, the lower the melting point. An increase in the number of double bonds lowers the melting point in saturated fatty acids. Therefore, membranes with fewer saturated fatty acids and double bonds have a lower melting point and are more fluid at lower temperatures.

However, there are no temperature values on the fluidity graph, so no definite conclusions can be made.