Bridging Activity for September 2017

A level Biology

Why do I need to complete a bridging activity?
The purpose of this activity is to aid your preparation for advanced level study and make the transition from GCSE study as smooth as possible. Some activities are written pieces of work, some are research-based and some are practical. They should be completed to the best of your ability and they will give you the opportunity to start to showcase your talent for your chosen subjects. As these are compulsory activities, it is vital that you put in the time and effort to ensure they are completed to the highest standard.
When should I hand this in?
You should complete this activity for the start of your first lesson in September.
How will I be given feedback?
Feedback appropriate to the task will be given to you by your teacher.
Summary of the activity
There are two elements to your pre-course activity, the first assesses your understanding of biological molecules beyond GCSE level and the second your ability to plot and interpret graphs. It is essential that you attempt all questions as your marks will be taken into consideration when assessing your suitability for the course.

Student Name

Task 1 - Biological molecules

Learning objectives

After completing this worksheet you should be able to:

- understand the meaning of the terms: monomer, polymer, condensation, and hydrolysis
- recall the structures of glucose and amino acids
- understand the structure and properties of carbohydrates, lipids, and proteins
- know that enzymes are a type of protein and understand how they work
- recall the chemical test for each type of molecule.

Introduction

Questions on this topic will assess your knowledge of three different types of biological molecules. You will be expected to understand their structures, their properties and how to chemically test for them.

This support information will take you through all of these points and help you to answer the exam-style questions that follow, so please read it carefully.

Background

Many biological molecules are polymers. A polymer is a large molecule made from many smaller units called monomers.

Monomers join together in a chemical reaction called condensation. When two monomers join by condensation, one molecule of water is eliminated.

The opposite of condensation is hydrolysis where a molecule of water is added to separate two monomers.

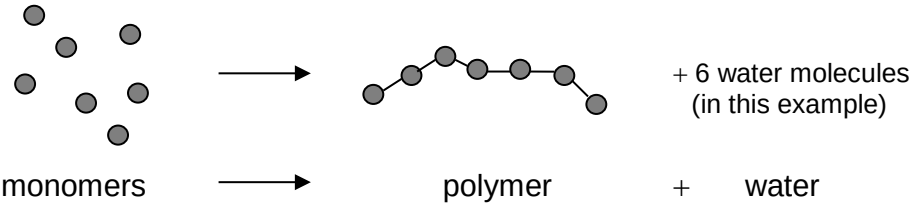

Figure 1 *The formation of a polymer*

You could reverse the reaction in Figure 1 by adding (in this example) six water molecules to the polymer and hydrolysing it into separate monomers.

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Carbohydrates

The simplest carbohydrate is called a monosaccharide. Monosaccharide means one sugar (molecule). You can think of them as just the monomers on their own. They are also called reducing sugars. Examples of monosaccharides include glucose, fructose, and galactose. Glucose is the most common, and you need to know the chemical structures of its two forms, or isomers.

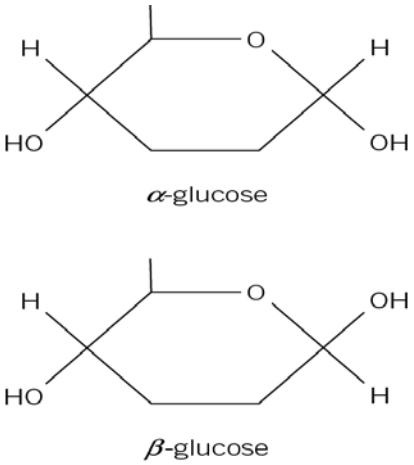

Figure 1 *The structures of α and β (alpha and beta) glucose*

Disaccharides are formed by condensation of two monosaccharides. You also need to be familiar with some disaccharides:

- maltose is formed from two glucose molecules
- sucrose is formed from one glucose and one fructose molecule
- lactose is formed from one glucose and one galactose molecule.

Maltose and lactose are reducing sugars. Mono- and disaccharides are sugars that are used as energy sources for cells.

You also need to know about polysaccharides, these are long polymers.

Some examples include:

- starch and glycogen are both polymers of α-glucose
- cellulose is a polymer of β-glucose.

Starch and glycogen are used for energy storage in plants (starch) and animals (glycogen). Cellulose is used by plants for making cell walls. There is a special name for the covalent bond between monosaccharides in both di- and polysaccharides. It is called a glycosidic bond.

You can test for carbohydrates in two ways:

- Benedict's solution goes from blue to brick-red when heated with reducing sugars
- iodine in potassium iodide goes from orange to blue / black when starch is present.

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Lipids

You need to know about two chemical groups of lipids. The first group is the triglycerides. The triglycerides are fats, oils, and waxes. They are used for energy storage, thermal and electrical insulation, and waterproofing.

Triglycerides are formed from the condensation of one molecule of glycerol and three fatty acid molecules. The fatty acid has two parts to its structure: an acid part (COOH) and an R-group, which is a long chain of carbon and hydrogen atoms bonded together.

The R-group can be saturated or unsaturated:

- a saturated fatty acid contains no carbon-carbon double bonds
- an unsaturated fatty acid contains one or more carbon-carbon double bonds.

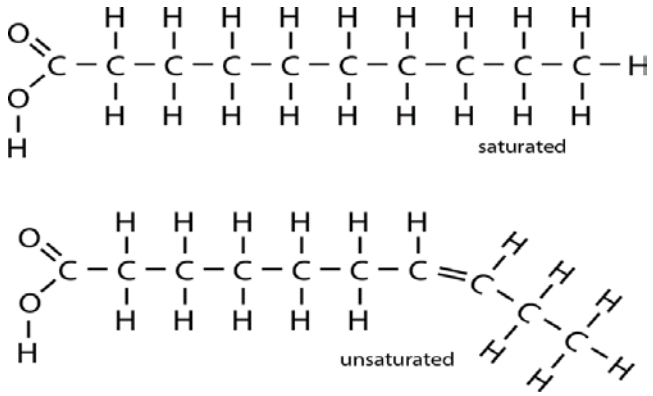

Figure 2 *Saturated and unsaturated fatty acids*

You do not have to learn the structures shown in Figure 2, but you must be able to recognise the difference between saturated and unsaturated fatty acids.

The other group of lipids is the phospholipids, which are found in cell membranes. A phospholipid is like a triglyceride, except that there are two fatty acids and one phosphate group joined to glycerol by condensation instead of three fatty acids.

The phosphate group makes the “head” of the phospholipid polar, or hydrophilic, so will easily mix with water. The fatty acids make the “tail” of the phospholipid non-polar, or hydrophobic, so will be repelled away from water.

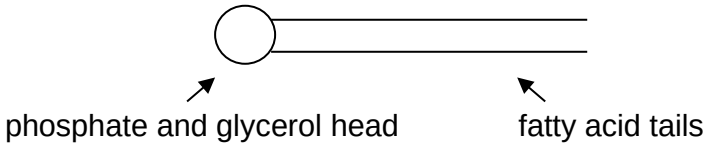

Figure 3 *Diagram of a phospholipid*

Phospholipids form a bilayer in water because of these two properties. This makes them suitable for cell membranes.

The test for a lipid is called the emulsion test. A sample is shaken with ethanol, allowed to settle and the liquid part poured into water. If a lipid is present, there will be a milky emulsion. If not, the liquid mixture will be clear.

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Proteins

Proteins are polymers of amino acids. There are 20 different amino acids, but they all have the same general structure that you should learn.

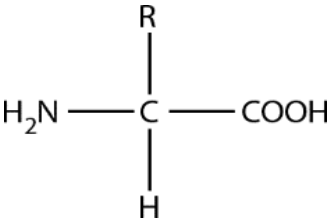

Figure 4 *The general structure of an amino acid*

There are three chemically important parts to an amino acid:

- the NH_2 part is called the amine group
- the COOH part is called the acid group
- the R part is called the side group, or R group, and there are 20 of these.

A polymer is formed by condensation between the NH_2 of one amino acid and the COOH of the next one. A dipeptide consists of two amino acids, and a polypeptide consists of many amino acids. The word protein is used to describe a polypeptide that is capable of carrying out a function.

One particular amino acid has sulfur in the side group. Two of these in the same protein can form covalent disulfide bonds between their side groups. Other bonds that hold the protein structure together are hydrogen bonds and ionic bonds.

Proteins have many functions, and their structure varies according to their function. Protein structure can be very complex, and so the structure is described on four levels:

- primary structure is the sequence of amino acids in the polypeptide and the location of any disulfide bonds
- secondary structure describes folding patterns within the protein, for example the α-helix is common, where part of the polypeptide forms a helix
- tertiary structure describes the overall three dimensional shape – how the whole molecule is folded
- quaternary structure occurs where there is more than one polypeptide in the structure of the protein.

Examples of proteins include the hormone insulin, the blood pigment haemoglobin, the structural protein collagen, and all enzymes.

The test for proteins is the Biuret test. Biuret reagent is added to the sample and will turn from pale blue to purple if protein is present.

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Enzymes

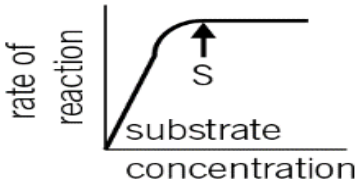
Enzymes are a special class of proteins that act as biological catalysts. They make reactions happen easier and faster by lowering the activation energy. All enzymes have a complex tertiary structure, which makes them rounded in shape and gives them a special part called an active site.

The active site has a specific three-dimensional shape for binding with one substrate. When the substrate binds, the shape of the active site alters to make the substrate fit perfectly; this is called induced fit.

Intracellular enzymes work inside cells and include those that catalyse respiration. Extracellular enzymes, such as digestive enzymes in the gut, work outside cells.

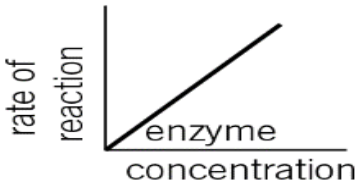
You need to know about the effects of some variables on the rate of enzyme reactions. These are most easily summarised in graph form.

(a)



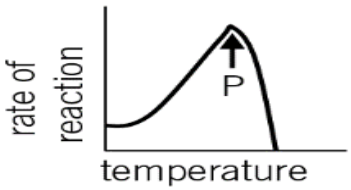
(a) The rate will get faster as there is more substrate but will reach a point, S, where all the active sites are full and cannot go any faster.

(b)



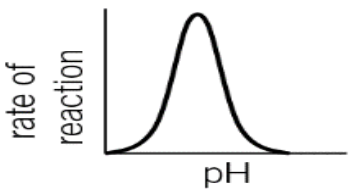
(b) The rate will get faster as there is more enzyme and will keep getting faster as long as the substrate does not run out.

(c)



(c) The rate will get faster as the temperature rises up to the optimum, P. At higher temperature the enzyme is denatured and stops working. Hint: the enzyme is not alive, so never say that it has been killed!

(d)



(d) Most enzymes have an optimum pH of about 7 (neutral) but others can have different optimum pH values. The optimum for stomach enzymes will be around pH2.

Figure 5 *The effects of (a) substrate concentration, (b) enzyme concentration, (c) temperature, and (d) pH on the rate of enzyme reactions*

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Enzyme inhibitors are substances which bind to enzymes and reduce their rate of reaction. Many drugs and poisons work this way.

A competitive inhibitor has a very similar structure to the substrate and competes for the active site. This type of inhibitor binds only temporarily in the active site.

A non-competitive inhibitor binds permanently, not usually at the active site, but it still causes distortion the shape of the active site.

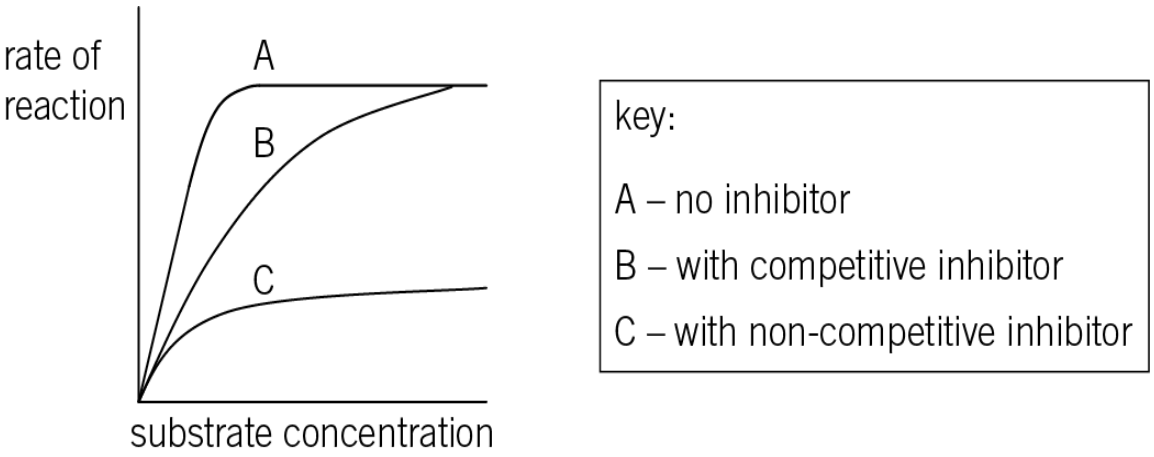

Figure 6 *The effect of inhibitors on the rate of an enzyme reaction*

Figure 6 shows how inhibitors affect the rate of an enzyme reaction. If the concentration of the inhibitors is increased there will be changes to lines B and C in Figure 6. The line B would slope less steeply with a more concentrated competitive inhibitor. Line C would move downward and slope less steeply with a more concentrated non-competitive inhibitor.

You may be asked to sketch these graphs, points to remember are:

- the line (B in this example) with the competitive inhibitor will always meet the line with no inhibitor
- the line (C in this example) with non-competitive inhibitor will always remain below the line with no inhibitor.

Bridging Activity for September 2017

A level Biology

Student Name

Task 1 – Questions /27

1 a Name the type of reaction that would occur when:

i monomers join to form a biological polymer

…… (1)

ii a biological polymer is separated into monomers.

…… (1)

b Two monosaccharides can join to form a disaccharide.

i Complete the word equation.

glucose + fructose → …… + ……(*2*)

ii Name the type of bond formed between glucose and fructose.

…… (1)

iii Describe how you would test for the presence of glucose in a food sample.

……

……

…… (2)

c **i** Describe the chemical difference between saturated and unsaturated fatty acids.

……

……

…… (2)

ii Name one part of the cell where phospholipids are found.

…… (1)

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2 The enzyme amylase catalyses the following reaction:

starch + water → maltose

a A student carries out this reaction and adds a few drops of iodine in potassium iodide to the reaction mixture.

i State what colour would be seen if all the starch had been digested

…… (1)

ii The student carried out the same reaction using amylase that had been boiled beforehand. State and explain what colour would be seen after adding iodine to this reaction mixture.

……

……

……

……

…… (3)

b Amylase has tertiary structure but no quaternary structure.

i State the number of polypeptide chains in amylase.

…… (1)

ii Covalent bonds can be found in amylase. Suggest two other types of bond that could be present in amylase.

……

…… (2)

3a The table below shows some features present in biological molecules.

Complete the table by using a tick (✓) to show if a feature is present.

	amino acid	**starch**	**fatty acid**
can be saturated or unsaturated			
contains glucose monomers			
contains the chemical group COOH			

(*3*)

b A student designs an investigation to determine the effect of substrate concentration on the rate of an enzyme reaction.

They decide to carry out the investigation at 35 ºC.

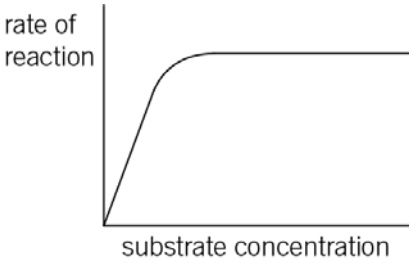
i State two other variables that must be kept constant during the investigation.

……

…… (2)

The results of the investigation are shown in the sketch graph below.

The student repeats the same investigation, but in the presence of a competitive inhibitor of the enzyme.



ii Copy the graph and sketch another line to show the results in the presence of the competitive inhibitor.

(2)

c Explain how the structure of phospholipids enables them to form cell membranes.

……

……

……

……

……

…… (3)

A level Biology

Task 2 - Finding rates of reaction using tangents

Learning objectives

After completing the worksheet you should be able to:

- plot two variables from experimental data
- draw and use the slope of a tangent to a curve as a measure of rate of change.

Introduction

When biological experiments give trends in which the rate of reaction changes, tangents can be used to allow calculation of the rate of reaction at any given point on the curve, for example, the fastest rate.

Worked example

Question

The graph in Figure 1 shows data collected during the reaction between catalase and hydrogen peroxide. The volume of gas collected is plotted against time. What is the maximum reaction rate?

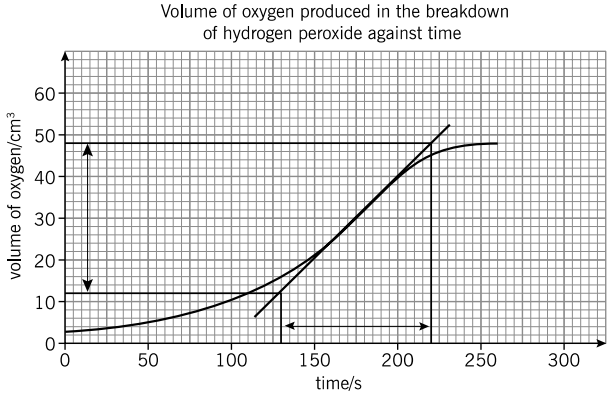


Figure 1 *Graph of volume of oxygen produced in the breakdown of hydrogen peroxide*

Answer

Step 1

First construct a tangent line by drawing a line using a ruler as shown in Figure 1. The tangent line touches the curve at its steepest point. The exact position of a tangent is achieved by estimation, so the trend line curve is symmetrically diverging from the point at which the tangent line touches it. (refer to diagrams on next page)

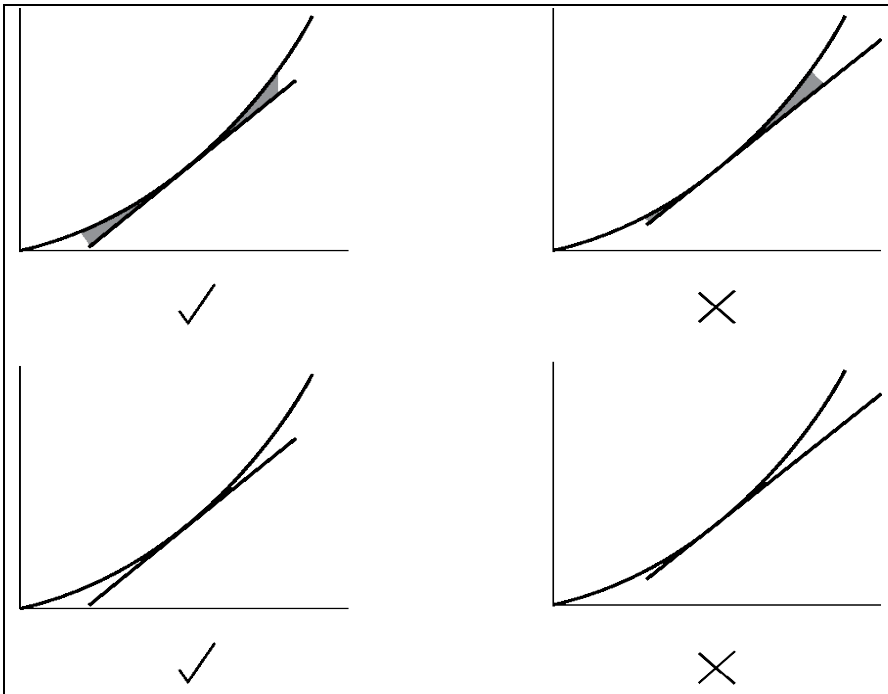


Figure 2 *Finding a tangent*

Step 2

Next use construction lines to find the values of *x* and *y* at any two selected points on the tangent, as shown.

Find the change in *y* and the change in *x* between the two selected points. In the example, *y* goes from 12 to 48 cm^3, a change of 36 cm^3 oxygen while *x* changes from 128 to 220 s, a change of 92 s.

Step 3

Calculate the rate by dividing the change in y by the change in x (dy/dx). In the example:

$$\frac{dy}{dx} = \frac{36}{92} = 0.39 \text{ cm}^3 \text{ s}^{-1}$$

Student Name

Activity 2 Question / 8

1 The table below shows data collected from an experiment in which glucose was being produced by the digestion of starch.

Time (minutes)	Glucose produced (mmol dm^{-3})
5	2
10	6
15	12
20	22
25	25
30	28
35	29

a Plot the data on a suitable graph using the graph paper provided.

Make sure that you choose a suitable scale that allows you to use more than 50% of the graph paper. (4 marks)

b Use a tangent to calculate the maximum rate of reaction.

Remember to include units and show your working

…… (2)

c Find the rates of reaction at 8 minutes and at 32 minutes.
Remember to include units and show your working

…… (2)