A-Level Biology
Preparatory Work

Name : _____

Please complete the work and questions presented in this booklet and bring it with you to **your first A-Level Biology lesson** on the first day of college in September.

Welcome to A-Level Biology at Wyke Sixth Form College!

This booklet has been designed to help smooth your transition between the study of science at GCSE to the further study of biology at A-Level.

The study of biology begins with some of the smallest parts of the natural world by learning about the molecules that make up all living things. You will therefore find that this booklet begins by recapping some of the core concepts from the Chemistry parts of GCSE Science. Our first lessons in September will look at the structure and function of different carbohydrates, and so a brief introduction to the content of those lessons is also included as part of the booklet.

You must ensure that you bring your completed booklet with you to your first biology lesson in September – this could be on your first day of college, so ensure this work is completed and ready to hand in on this first day.

Take care, and enjoy your summer - we look forward to meeting all of you in September!

Lee, Sophie, Kim, Zoe, Sadie and Tom ☺

Resources needed for this work

- Instructions for completing this work on file paper
- A simple periodic table – we recommend the periodic table used for GCSE Science, which can be found on the AQA website: **https://filestore.aqa.org.uk/sample-papers-and-mark-schemes/2020/november/AQA-8462-PT-NOV20.PDF**

Instructions for completing this work on file paper

We know that many students do not have access to a printer, and therefore we will accept homework submissions on lined paper.

Please ensure you write your full name on each page of the work you complete.

Please ensure your answer to each question is clearly numbered in the left hand margin.

Please leave a line between each answer you provide to allow us to mark your work and provide any necessary feedback or corrections.

Atomic Structure

In GCSE Science, you will have learned that an **atom** is a single, **uncharged** unit of matter, composed of 3 things:

- **Protons** (positive charge)
- **Electrons** (negative charge)
- **Neutrons** (no charge)

The protons and neutrons make up the nucleus of the atom and are surrounded by shells / orbitals of electrons.

A periodic table can give you the proton number, or atomic number of an element. This is the smaller of the two numbers in each element's box in the periodic table. This tells you how many positive protons are found in the nucleus. This can also be used to work out the number of electrons in an atom of a particular element.

1. **Using the periodic table, identify the number of protons in an atom of Oxygen, O. Work out the number of electrons in a single atom of oxygen, explaining your answer.**

   Proton number:

   _____**(1)**

   Electron number:

   _____**(1)**

   Explanation:

   _____**(1)**

Electrons are allocated to electron shells that orbit the nucleus, starting at the shell with the lowest energy level first. You will have used the rule of electrons shell filling, where:

- The first shell at the lowest energy level holds up to 2 electrons
- The second shell at the next energy level holds up to 8 electrons
- At GCSE level, the third energy level holds up to 8 electrons
- At GCSE level, the fourth energy level holds 18 electrons (you may have been told 8.)

For the example of Boron, which has an atomic number of 5:

- There are 5 protons in the nucleus
- There are 5 electrons allocated to electron shells that orbit the nucleus. The first two electrons are added to the first energy level, with the remaining three allocated to second energy level or shell to give an electron arrangement for B = 2, 3

Elements are organised in the periodic table in order of increasing atomic number. The rows of the periodic table are referred to as 'periods' and the columns are referred to as 'groups,' with each group being labelled at the top of the periodic table with its group number. The group number is useful, as it is the same as the number of electrons found in the outer shell of a single atom of that element.

2. **Show that the group number corresponds to the number of electrons in the outer shell of an atom by writing the electron arrangement of an atom of carbon. Separate the number of electrons in each shell with a comma.**

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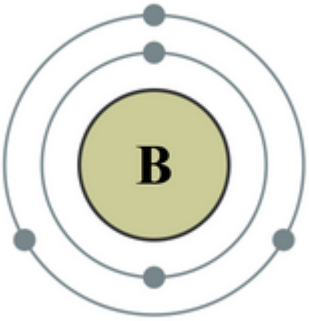
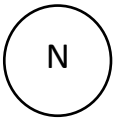
   _____**(1)**

You may have seen this represented as a diagram, with the nucleus in the centre surrounded by electron shells that surround the nucleus. The dots or crosses in each circle represent electrons within that electron shell:



3. **Using the periodic table, draw a diagram to show the electronic structure of an atom of Nitrogen, N. (2)**



Chemical Bonding

Atoms can react with other atoms to form **molecules**: two or more atoms chemically bonded together. These can be atoms of the same element (O_2) or atoms of different elements (H_2O), in which case the reaction results in the formation of a **compound.** But what determines if atoms react with each other?

The final column of the periodic table is Group 0 (or group 8 in some tables.) This group shows the noble gases, which are extremely stable and therefore very unreactive. The reason for this is that the outermost electron shell in each atom is full and cannot contain any more electrons. Atoms that don't have a full outer shell of electrons are able to react with each other, forming chemical bonds between the atoms. In these reactions, atoms share, gain, or lose electrons to ensure they have a full outer shell of electrons. This makes them take on the stable, unreactive properties of the noble gas atoms.

Ionic Bonding

Ionic bonds *typically* form between an atom of a metal element and an atom of a non-metal element.

As metal atoms have less than 4 electrons in the outer shell, the metal atom loses at least one negative electron in order to have a full outer shell of electrons. This leaves the metal atom as a positively-charged ion.

Non-metal atoms *usually* have 4 or more electrons in their outer shell. The non-metal atoms gain the negative electrons lost from the metal atom in order to fill their outer shell, becoming negatively-charged ions in the process.

This loss or gain of electrons makes each ion more stable than the original atom as they have complete outer shells of electrons. As the metal ions and non-metal ions have opposite charges, they are held together by strong electrostatic attractions between the positive ion and negative ion. This forms an ionic bond.

4. **Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl). Describe what happens in a reaction between a sodium atom and a chlorine atom, including the details of electron transfer in your answer.**

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_____**(4)**

Covalent Bonding

Covalent bonds typically form between atoms of non-metal elements. In this process, one atom shares an electron from their outer shell with another atom, while the second atom also shares an electron from its outer shell with the first atom. A covalent bond is defined 'a shared pair of electrons between two atoms.' The pair of electrons that are shared between the atoms 'belong' to the outer shells of both atoms. This forms a very strong bond as the shared pair(s) of negative electrons in the outer shells of the two atoms are attracted to the positive nuclei of both atoms. Covalent compounds can be joined by single covalent (1 shared pair of electrons), double covalent (2 shared pairs) or triple covalent (3 shared pairs) bonds.

5. **One of the most important covalent compounds for life on Earth is water. Use the electron arrangements of the atoms that make up a molecule of water to describe the chemical bonding in water.**

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_____ **(3)**

Carbohydrates

As part of the A-level course, you will also learn about *biological* molecules in more detail. These include carbohydrates, fats, proteins and DNA. The carbohydrates that you will learn about include glucose, starch, cellulose and glycogen. Carbohydrates are compounds made of three elements: carbon, hydrogen and oxygen. There are several types of carbohydrates.

Sugars

These are small, sweet, water-soluble molecules. The simplest sugars are **monosaccharides** (mon-o-sack-a-rides), **which literally means 'single sugar.'** The main example of a monosaccharide you have studied at GCSE level is the molecule glucose. Monosaccharides are single units from which larger carbohydrates are built. Monosaccharides contain atoms of the elements carbon, hydrogen and oxygen in the ratio of 2 hydrogen atoms and 1 oxygen atom for each carbon atom.

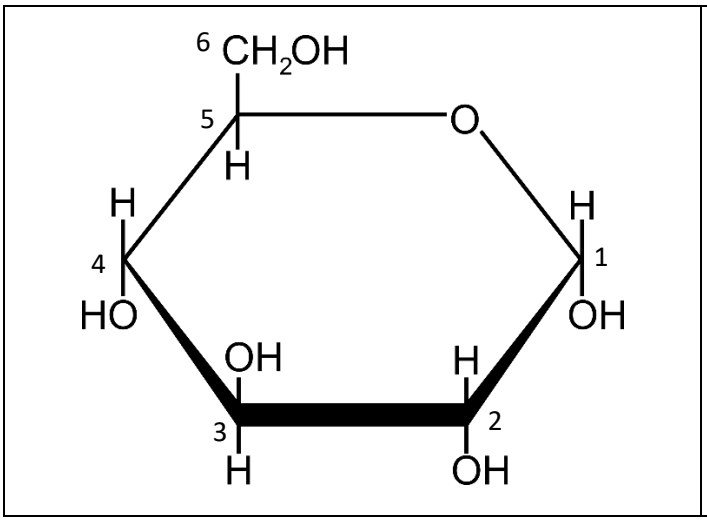
6. **From your studies at GCSE, state the chemical formula and function of glucose in biology.**

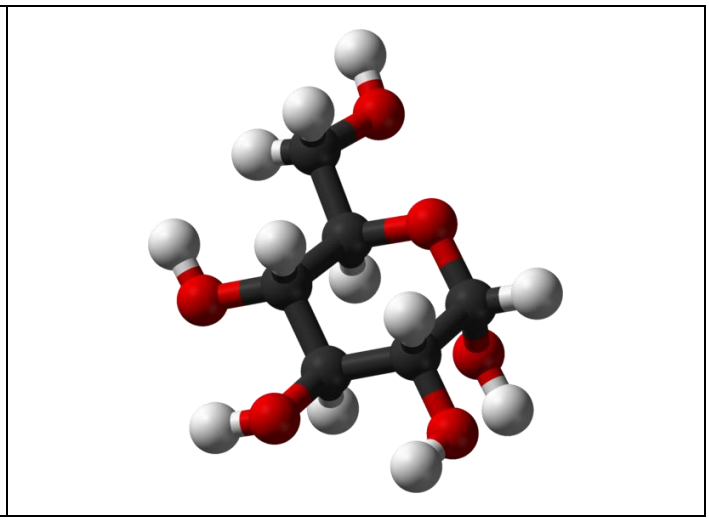
Formula_____**(1)**

Function_____

_____**(1)**

At A-level, we need to know a little more about this important molecule. We need to be able to draw the structural formula of glucose, which means drawing the position of each atom in the molecule and the position of the covalent bonds that join the individual atoms.





This image shows the structural formula of the ring form of a single molecule of alpha glucose. The five carbon atoms that form the 'ring' are not shown, but instead numbered to allow for ease of communication when discussing different parts of the molecule. On the right is a 'ball and stick' model of a molecule of alpha glucose, which clearly shows the central 'ring' structure of the molecule.

7. **From the structural formula given, identify the number of hydroxyl groups that are found in a molecule of alpha glucose.**

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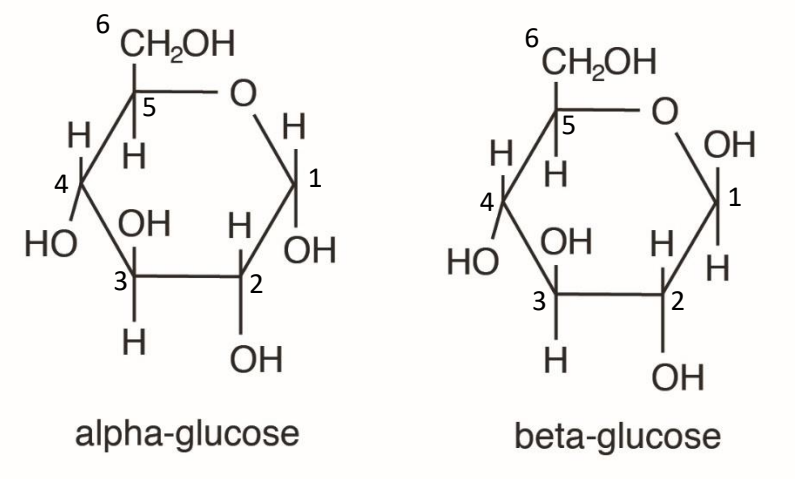
_____**(1)**

There are two forms of glucose: alpha and beta glucose. They are described as structural isomers of each other: this means they have the same chemical formulae, but a different arrangement of their atoms in three dimensional space. They are shown side by side in the image below:



8. **Describe the difference between the structure of alpha glucose and beta glucose. Use the numbering of the carbon atoms and the names of the chemical groups to add detail to your answer.**

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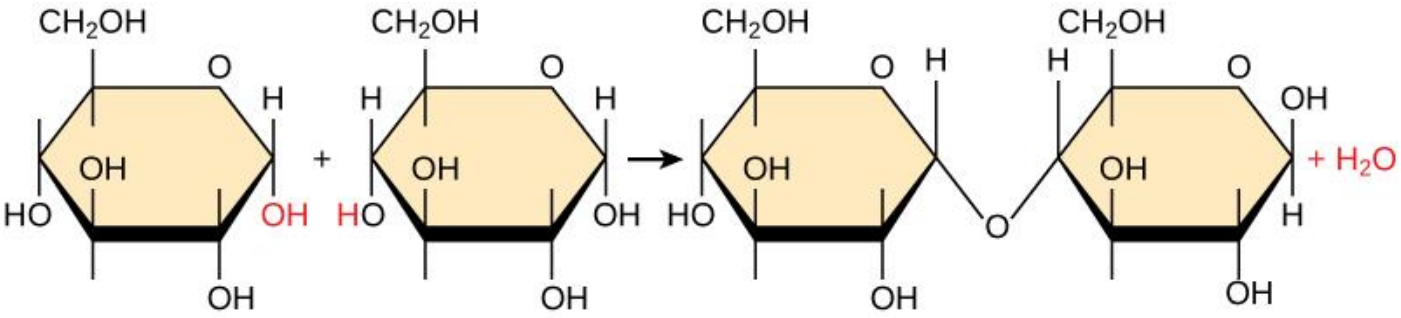
Disaccharides are also sugars, but these are made of two monosaccharides joined together. The disaccharide **maltose** is made from two alpha glucose monomers joined together.



The type of reaction that joins the two monosaccharides is a **condensation reaction.** A condensation reaction can be identified using the following definition: when a **bond forms** between the two monosaccharide molecules, a molecule of **water** is produced.

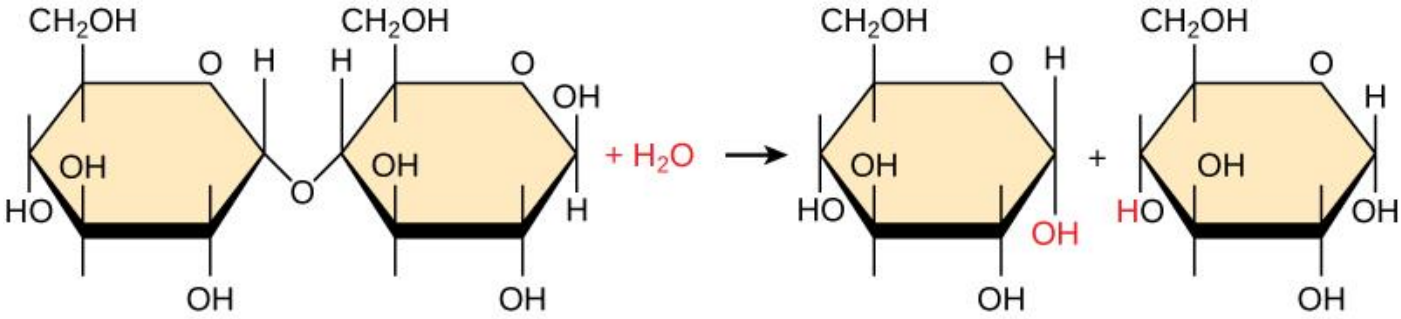
9. **The bond that forms between the two monosaccharides is referred to as an α-1,4 glycosidic bond. Explain why it is referred to in this way:**

Alpha_____

_____**(1)**

1,4_____

_____**(1)**



Maltose is broken back down to form two molecules of glucose in a **hydrolysis** reaction. The events of a hydrolysis reaction are simply the opposite of those that occur in a condensation reaction.

10. **Using the diagram and the information provided, give a definition of a hydrolysis reaction.**

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_____**(2)**

11. **The reaction that occurs to hydrolyse sucrose into glucose and fructose requires the specific enzyme sucrase, as this will allow the reaction to occur at typical biological temperatures. Explain why sucrose can only be hydrolysed by the enzyme sucrase and not any other enzymes.**

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_____**(3)**

12. **Which of these chemical formulae represents a disaccharide? Justify your answer.**
    a. **$C_6H_{12}O_6$**
    b. **$C_5H_{10}O_5$**
    c. **$C_{10}H_{18}O_9$**
    d. **$C_{12}H_{24}O_{12}$**

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_____**(3)**

Polysaccharides

Polysaccharides are large carbohydrate **polymers,** which are made from many monosaccharide monomers joined together by repeated condensation reactions.

Because **polysaccharides are so large,** they are completely insoluble in water – unlike the monosaccharides and disaccharides. Starch, cellulose and glycogen are three large polysaccharide molecules that you may be familiar with from GCSE Science.

13. **State the function of the three larger polysaccharides you have studied at GCSE.**

Starch_____

_____**(1)**

Cellulose_____

_____**(1)**

Glycogen_____

_____**(1)**

For this final question you may need to perform some additional research. You can present the information however you like: the minimum is to produce a short paragraph comparing the three different polysaccharides to each other, for which five marks are available. You may instead prefer to produce a short presentation, fact file, revision resource or series of classroom display posters to show the difference between the structure and function of these different molecules. 5 extra marks are available for presentation of your work if you choose to present your work in a different format.

14. **Describe why polysaccharides are much larger than monosaccharides and what the differences in structure are between starch, glycogen and cellulose. Try to link these differences in structure to the different properties of the molecules and their uses in biology.**

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