Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

BIOLOGY

BIOLOGICAL MOLECULES

LEVEL & BOARD:	AQA (A - LEVEL)
TOPIC:	Inorganic ions
PAPER TYPE:	Solution
TOTAL QUESTIONS:	03
TOTAL MARKS:	25

Inorganic ions

I. The importance of ions in metabolic process

Photosynthesis

Photosynthesis generally takes place in the leaves of plants. It is a multi-step process that requires sunlight, carbon dioxide (CO_2, found in the air), and water (H_2O, from the soil). After the process is complete, the plant releases oxygen into the air (O_2, essential for many living organisms) and produces the simple carbohydrate molecule of glucose, which can be used as an energy source by the plant, converted to starch and stored for a later energy source, or converted into other organic molecules such as fats, proteins and vitamins. This glucose contains the energy that all living organisms need to survive.

The basic formula for photosynthesis is as follows:

$6CO_2 + 6H_2O + \text{sun's energy} = C_6H_{12}O_6 + 6O_2$

Starch is the storage form of glucose in plants, stored in seeds, roots, and tubers for later use as an energy source for the plant to reproduce. When a seed is buried deep in the soil, this starch can be broken down into glucose to be used for energy for the seed to sprout. As the seed sprouts, and shoots go above the ground and leaves start to form, the new plant can then photosynthesize glucose for an energy source. When we eat foods that contain starch, we must digest that starch down into single sugars (glucose) in order for the glucose to be absorbed into the intestinal cells, where it will enter the bloodstream to be carried to all cells of the body to use as an energy source.

Cellular Respiration

Cellular respiration is a set of metabolic reactions occurring inside the cells to convert biochemical energy obtained from the food into a chemical compound called adenosine triphosphate (ATP). Metabolism refers to a set of chemical reactions carried out for maintaining the living state of the cells in an organism. These can be divided into two categories:

- **Catabolism** – the process of breaking molecules to obtain energy.
- **Anabolism** – the process of synthesizing all compounds required by the cells.

Therefore, respiration is a catabolic process, which breaks large molecules into smaller ones, releasing energy to fuel cellular activities.

While breathing, we breathe in air that contains oxygen and we breathe out air rich in carbon dioxide. As we breathe in, the oxygen-rich air is transported to all parts of our body and ultimately to each cell. Inside the cell, the food, present in the form of glucose, is broken down into carbon dioxide and water with the help

of oxygen. The process of breakdown of glucose to release energy, which can be utilized by our body to perform daily chores like walking, sitting or even thinking, is known as respiration.

Digestion

Digestion is the process of breaking large, insoluble food molecules into smaller molecules for absorption into the bloodstream. This process involves the use of many digestive fluids and enzymes such as saliva, mucus, bile and hydrochloric acid, among others.

There are four primary stages of food digestion in the human body that include:

- After the intake of food through the mouth, it makes its way through the stomach into the small intestine, where it is digested.
- The nutrients from the digested food get absorbed into the bloodstream through small pores in the small intestine.
- The remaining undigested food is sent to the large intestine, where any unprocessed water or nutrients are reabsorbed into the body.
- The remaining waste food product is passed out of the body in the form of stools.

Absorption is the process of the absorbing or assimilating substances into the cells or across the tissues and organs through the process of diffusion or osmosis.

Carbohydrates are one of the essential nutrients in the human diet. There are two types of carbohydrates that can be digested by the human digestive system sugar and starch.

Sugar is broken down in the gastrointestinal tract by the small intestine and three enzymes present in the mouth, namely, Lactase, Sucrase, and Maltase. In the same way, starch is broken down with the help of the Amylase enzymes which are present in the mouth and the stomach. After digestion, carbohydrates are absorbed in the small intestine with the help of minute finger-shaped projections known as Villi.

Protein

Proteins play a vital role in the growth and replenishment of body cells and tissues. The digestion of proteins takes place in the stomach with the help of protease and pepsin enzymes, which breaks down the proteins into amino acids. The process is facilitated by the hydrochloric acid present in the stomach. Amino acids are tiny elements which get absorbed into the blood system through the wall of the small intestine.

Digestion and Absorption of Lipids

Lipids are organic compounds comprising fatty acids, which are insoluble in water. Fats are the most common examples of lipids. The insoluble property of lipids makes the digestion and absorption of fats a complicated process.

Since they are hydrophobic, fats stick together as a large glob of insoluble mass after reaching the stomach. It is broken down with the help of bile juice, which contains bile salts. These broken molecules are then acted upon by pancreatic lipase, the major fat-absorbing enzymes in the body

Pancreatic lipase breaks down fats into tiny molecules of free fatty acids and monoglycerides, which are small enough for the small intestine to push through into the bloodstream.

Transport across cell membrane

The cell membranes serve two important functions:

1. It must retain the dissolved materials of the cell so that they do not simply leak out into the environment.
2. It should also allow the necessary exchange of materials into and out of the cell.

There are two major methods for moving molecules across a membrane, and it is related to whether or not cell energy is used. Passive mechanisms, such as diffusion, require no energy to function, whereas active transport does. In passive transport, an ion or molecule crosses the membrane and moves down its concentration or electrochemical gradient. The different types of transport mechanisms across cell membranes are as follows:

1. Simple diffusion
2. Facilitated diffusion
3. Osmosis

Diffusion

Diffusion is a spontaneous process in which a substance moves from a region of high concentration to a region of low concentration, eventually eliminating the concentration difference between the two regions.

Simple Diffusion

Transport across the plasma membrane occurs unaided in simple diffusion, i.e., molecules of gases such as carbon dioxide and oxygen, as well as small molecules like ethanol, enter the cell by crossing the cell membrane without the assistance of any permease. A small molecule in an aqueous solution dissolves into the phospholipid bilayer, crosses it, and then dissolves into the aqueous solution on the opposite side during simple diffusion. The relative rate of molecule diffusion across the phospholipid bilayer is proportional to the concentration gradient across the membrane.

Facilitated Diffusion

This is a type of passive transport in which molecules that cross the cell membrane move quickly due to the presence of specific permeases in the membrane. Facilitated diffusion occurs only in the direction of a concentration gradient and does not require metabolic energy. It is distinguished by the following characteristics:

- The rate of molecule transport across the membrane is much faster than would be expected from simple diffusion.
- This is a specific process; each facilitated diffusion protein transports only one type of molecule.
- There is a maximum rate of transport, which means that when the concentration gradient of molecules across the membrane is low, increasing the concentration gradient results in an increase in the rate of transport.

Osmosis

Water molecules can transport through the cell membrane. The movement of water molecules through the cell membrane is caused by differences in the concentration of the solute on its two sides. Osmosis is the process by which water molecules pass through a membrane from a region of higher water concentration to a region of lower water concentration

(a)

No for aspirin = 1.8 g

Yes for paracetamol = 3.44 g

(b) Same factor 1: BMI

Same factor 2: Age

Different Factor: No sodium in the (same) medicine

(c) 8514

(d)

- Sodium ions lower the water potential of blood
- Water would move into the blood by osmosis from cells
- Increasing the blood volume

3.

(a)

Iron ions

Haemoglobin transports/loads oxygen

Sodium ions

Its co-transport of glucose/amino acids into cells because sodium moved out by active transport/Na – K pump creates a sodium concentration/diffusion gradient affects water potential.

Phosphate ions

- It affects water potential
- It joins nucleotides in phosphodiester bond/in backbone of DNA in nucleotides;
- It is used to produce ATP
- Phosphorylates other compounds (usually) making them more reactive;
- Hydrophilic part of phospholipid bilayer membrane

- Founder & CEO of Chemistry Online Tuition Ltd.
- Completed Medicine (M.B.B.S) in 2007
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
- Chemistry, Physics, Math's and Biology Tutor