10

AS Module 1
CORE PRINCIPLES

Introduction

This module lays emphasis on concepts which are essential for more advanced understanding of living organisms. All organisms are composed of compounds whose molecules are based on a small number of chemical elements. These biologically important compounds frequently consist of monomers combined into polymers. Organisms are organised on a cellular basis, and cells are differentiated according to function. Cells, and whole organisms, exchange materials with their environment. The biological processes that are essential for the functioning of organisms are regulated by the action of enzymes. The study of enzymes is extended to include digestion. The gas exchange and the digestive systems are explored in the context of adaptation to function. It is expected that the emphasis in this module will be on these fundamental principles, and that there will also be adequate opportunity for candidates to undertake work related to the development of experimental and investigative skills.
This module includes part of the knowledge and understanding specified in the mandatory subject criteria for Advanced Subsidiary Biology, as set out in the document issued by QCA in June 1999. It covers sections 3.5, 3.6, 3.7, 3.9 and 3.11 of that document.

10.1 Biological molecules

Carbohydrates

The elements which make up carbohydrates. Monosaccharides are the basic molecular units (monomers) of which other carbohydrates are composed; they include the reducing sugars glucose and fructose.

The condensation of glucose to form the disaccharide, maltose, and of glucose and fructose to form the disaccharide, sucrose (a non-reducing sugar).

The formation of the polysaccharides starch, glycogen and cellulose.

Hydrolysis of disaccharides and polysaccharides.

Relationship of structure to function in starch, glycogen and cellulose molecules.

Proteins

The elements which make up proteins. Amino acids are the monomers of which proteins are composed.

The condensation of amino acids to form dipeptides, polypeptides and proteins. Hydrolysis of proteins.

The primary, secondary and tertiary structures of proteins. The relationship of structure to function in fibrous and globular proteins.

Lipids

The elements which make up lipids (fats and oils).

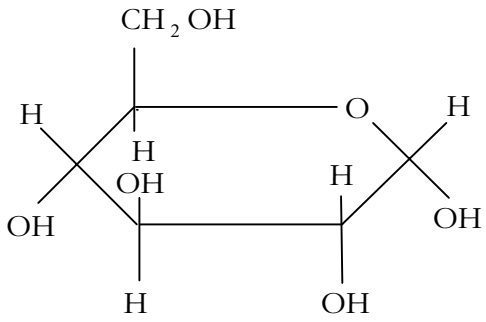
Glycerol and fatty acids combine by condensation to produce triglycerides.

The R group of a fatty acid may be saturated or unsaturated.

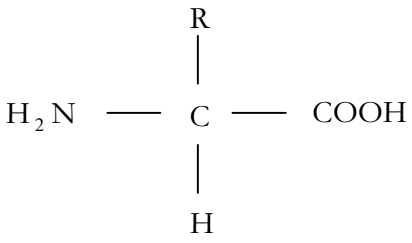
In phospholipids, one of the fatty acids of a triglyceride is substituted by a phosphate group.

Structural formulae

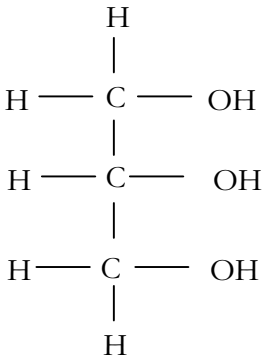
The structural formula of glucose is:



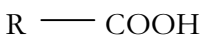
The structural formula of an amino acid is:



The structural formula of glycerol is:



The structural formula of a fatty acid is:



Candidates should be able to use the above structural formulae, and others that may be given, to explain the processes of condensation and hydrolysis.

Biochemical tests

The identification of reducing and non-reducing sugars, starch, proteins and lipids by means of simple biochemical tests, using Benedict's solution, iodine solution, the biuret test and the emulsion test.

Chromatography	The separation and identification of compounds by means of chromatography, including Rf values and two-way chromatography.
Water	The biological importance of water as a solvent and as a medium for living organisms, including change of state and specific heat capacity.

10.2 Cells

Cell structure	The structure of an epithelial cell from the small intestine and a palisade mesophyll cell from a plant, as seen with a light microscope. The ultrastructure of eukaryotic cells and their organelles, to include cell wall, cell membrane, nucleus, mitochondrion, chloroplast, rough and smooth endoplasmic reticulum, Golgi body and ribosome. Functions of these organelles.
Prokaryotic and eukaryotic cells	The ultrastructure of a typical bacterial cell, to include cell wall, cell membrane, genetic material, ribosomes, flagellum, plasmid, capsule. Comparison of prokaryotic and eukaryotic cells.
Electron microscopy and differential centrifugation	The use of electron microscopy and differential centrifugation as means of investigating cell structure and function. **Candidates should be able to** recognise the organelles in cells in electron micrographs.
Cell differentiation	The cells of multicellular organisms may differentiate and become adapted for specific functions. Tissues as aggregations of similar cells, and organs as structures performing specific physiological functions. **Candidates should be able to** describe and explain the adaptations of epithelial cells from the small intestine and of palisade mesophyll cells, and to use examples from the human digestive system to illustrate the features of tissues and organs.

10.3 Cell transport

Plasma membranes	The entry and exit of substances is controlled by the cell surface membrane and by other plasma membranes within cells. The fluid-mosaic model of plasma membrane structure. The function of proteins in membranes as receptors and carriers. The relationship between membrane structure and the ability of membranes to control the movement of substances through them.
Diffusion	Diffusion as the passive movement of substances in the direction of a concentration gradient. The effect of surface area and distance on the rate of diffusion. The role of carrier and channel proteins in facilitated diffusion.
Osmosis	Osmosis as a special case of diffusion across a partially permeable membrane, net movement of water depending on difference in water potentials. Hypotonic, hypertonic and isotonic solutions, and the importance of ion concentrations in maintaining cell turgor.

Active transport	Active transport as the movement of molecules or ions through a membrane by carrier proteins against a concentration gradient, and as a process requiring the transfer of energy.

10.4 Organisms exchange materials with their environment

Surface area: volume ratio	The relationship between the size of an organism or structure and the surface area: volume ratio, and the significance of this for the exchange of substances and of heat. Changes to body shape and the development of systems in larger organisms as adaptations to facilitate exchanges as the ratio reduces.
Gaseous exchange	The development of internal gas exchange surfaces in larger organisms to maintain adequate rates of exchange. The structure, location and adaptation for function of the gas exchange surfaces and related structures in: dicotyledonous plant leaves (mesophyll and stomata); bony fish (gill lamellae and filaments, including the countercurrent principle); mammals (alveoli, bronchioles, bronchi, trachea, lungs).
Ventilation	Organisms with internal gas exchange surfaces need mechanisms for conveying gases between the environment and these surfaces. The ventilation systems, related to the environment in which they live, in bony fish and mammals.

10.5 Enzymes

Action of enzymes	Biological processes are regulated by the action of enzymes. Enzymes as proteins which act as catalysts. The importance of enzymes in lowering activation energy so that the chemical reactions necessary to support life can proceed sufficiently quickly and within an acceptable temperature range. The mode of action of enzymes in terms of the formation of an enzyme-substrate complex.
Enzyme properties	The properties of enzymes related to their tertiary structure. The effects of change in temperature, pH, substrate concentration, and competitive and non-competitive inhibition on the rate of enzyme action.

10.6 Digestion

Extracellular digestion	Extracellular digestion exemplified by a saprophytic fungus. The principles of the use of starch-agar plates for assaying carbohydrase activity.
Digestion in humans	The generalised structure of the human gut wall. **Candidates should be able to** relate the generalised structure of the gut wall in the oesophagus, stomach, duodenum and ileum to the functions of these organs.

The sites of production and action of:

- amylases;
- endopeptidases;
- exopeptidases;
- lipase;
- maltase;
- bile.

Mechanisms for the absorption of food by the ileum, including the roles of diffusion, facilitated diffusion and active transport.