Biochemistry Objectives and skills:

B.1

Understandings:

Shapes and structures of biomolecules define their functions.

Metabolic processes take place in aqueous solutions in a narrow range of pH and temperature.

Anabolism is the biosynthesis of complex molecules from simpler units that require energy.

Catabolism is the biological breakdown of complex molecules that provide energy for living organisms.

Condensation reactions produce biopolymers that can be hydrolyzed into monomers.

Photosynthesis transforms light energy into chemical energy of organic molecules synthesized from carbon dioxide and water.

Respiration is a set of catabolic processes that produce carbon dioxide and water from organic molecules.

Application and skills:

Deduce condensation and hydrolysis reactions and explain the difference between these processes.

Describe the balancing of carbon and oxygen in the atmosphere by summary equations of photosynthesis and respiration.

B.2

Understandings:

Proteins are polymers of 2-amino acids, joined by amide links (aka peptide bonds).

Amino acids are amphoteric and can exist as zwitterions, cations, and anions.

Protein structures are diverse and can be described at the primary, secondary, tertiary, and quaternary levels.

Three-dimensional shapes of proteins determine their roles in metabolic processes or as structural components.

Most enzymes are proteins that act as catalysts by binding specifically to a substrate at the active site.

As enzyme activity depends on the conformation, it is sensitive to pH, temperature, and the presence of heavy metal ions.

Chromatography separation is based on different physical and chemical principles.

Application and skills:

Deduction of the structural formulas of reactants and products in condensation reactions of amino acids, and hydrolysis reactions of peptides.

Explanation of the solubilities and melting points of amino acids in terms of zwitterions.

Application of the relationships between charge, pH, and isoelectric point for amino acids and proteins.

Descriptions of the four levels of protein structure, including the origin and types of bonds and interactions involved.

Deduce and interpret graphs of enzyme activity involving changes in substrate concentration, pH, and temperature.

Explain the processes of paper chromatography and gel electrophoresis in amino acid and protein separation and identification.

B.3

Understandings:

Fats are more reduced than carbohydrates and so yield more energy when oxidized.

Triglycerides are produced by condensation of glycerol with 3 fatty acids and contain ester links. Fatty acids can be saturated, monounsaturated, or polyunsaturated.

Phospholipids are derivatives of triglycerides.

Hydrolysis of triglycerides and phospholipids can occur using enzymes or in alkaline or acidic conditions.

Steroids have a characteristic fused ring structure, known as steroidal backbone.

Lipids act as structural components of cell membranes, in energy storage, thermal and electrical insulation, transport of lipid-soluble vitamins, and as hormones.

Application and skills:

Deduce the structural formulas of reactants and products in condensation and hydrolysis reactions between glycerol and fatty acids and/or phosphate.

Prediction of the relative melting points of fats and oils from their structures.

Compare the processes of hydrolytic and oxidative rancidity in fats with respect to the site of reactivity in the molecules and the conditions that favor the reaction.

Apply the concept of iodine number to determine the unsaturation of a fat.

Compare carbohydrates and lipids as energy-storage molecules with respect to their solubilty and energy density.

Discuss the impact of lipids on health, including the role of dietary HDL and LDL cholesterol, saturated, unsaturated, and trans-fat, and the use and abuse of steroids.

B.4

Understandings:

Carbohydrates general formula

Haworth projections represent the cyclic structures of monosaccharides.

Monosaccharides contain either an aldehyde group or a ketone group and several –OH groups.

Straight-chain forms of sugars undergo intramolecular nucleophilic addition reactions and form five- and six-membered ring structures.

Glycosidic bonds form between monosaccharides forming disaccharides and polysaccharides.

Carbohydrates are used as energy sources and energy reserves.

Application and skills:

Deduce the structural formulas of di- and polysaccharides from given monosaccharides.

Describe the relationship of the properties and functions of mono- and polysaccharides to their chemical structures.

B.5

Vitamins are organic micronutrients, which cannot be synthesized by the body and be obtained from food sources.

Solubility of a vitamin can be predicted from its structure.

Most vitamins are sensitive to heat.

Vitamin deficiencies in the diet cause particular diseases and affect millions of people worldwide.

Application and skills:

Compare the structures of vitamins A, C and D.

Discuss the causes and effects of vitamin deficiencies in different countries and suggestions of solutions.