Identification of Biological Compounds

Introduction

Living organisms are primarily composed of four main types of organic molecules: carbohydrates, lipids, proteins and nucleic acids. A variety of chemical tests may be used to confirm the presence of these compounds. The tests can be conducted by grinding up a sample of tissue to extract its juices or by sectioning the tissue and staining with the appropriate reagent to determine the region where the biomolecule is in use.

Nutrients are the substances present in food that are used by an organism to sustain its metabolic processes. An essential nutrient is a biomolecule that cannot be synthesised by the body and must be consumed in the diet. Different food types have different proportions of nutrients and hence are required by the body in different amounts. The estimated amount of a nutrient needed to meet the nutritional requirements of an organism is called the recommended daily intake (RDI).

Materials

Chemicals	Foods	Equipment
• Iodine solution • Benedict's reagent • Sudan III solution • Sodium hydroxide solution • Copper sulphate solution	• Potato • Apple • Full-cream milk • Egg	• Corer • Tongs • Mortar and pestle • Bunsen burner, heat proof mat • Test tubes and test tube rack

Methodology

The following activities should help you to understand the different types of molecules (nutrients) found in foods. For each activity, in the space provided, provide a qualitative description of the outcome of the specific chemical test.

TEST 1: Starch

Starch is a carbohydrate composed of repeating glucose monomers (it is a polysaccharide). It functions as a short-term energy storage molecule in plants. Potato plants will often store starch in underground tubers (potatoes). The presence of starch can be detected by testing with iodine.

- Cut out a section of potato that is 2 cm in length using an apple corer
- Grind it up with a mortar, transfer to a test tube and add water to create a liquid mixture
- Add two drops of iodine solution and record any changes

TEST 2: Reducing Sugars

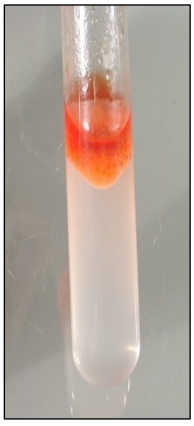
Carbohydrates are composed of repeating subunits (monomers) called monosaccharides. All monosaccharides contain a free carbonyl group which can react to form a ringed structure. If the carbonyl group is not involved in polymerisation, it can interact with Benedict's reagent (these are *reducing* sugars). If the carbonyl group is involved in the formation of a glycosidic linkage, then the Benedict's reagent will remain unreactive in the presence of the sugar (non-reducing). Glucose is a monosaccharide used by organisms as a source of chemical energy and it is a reducing sugar.

- Cut out a section of apple that is 2 cm in length using an apple corer
- Grind it up with a mortar, transfer to a test tube and add water to create a liquid mixture
- Add an equal volume of Benedict's reagent and heat to boiling over a Bunsen burner
- Record any changes

TEST 3: Lipids

Lipids are not made up of monomers but all share the common property of being *non-polar* and *hydrophobic* (although some may be amphipathic and have additional hydrophilic components). Lipids can be composed of long fatty acid chains (e.g. phospholipids and triglycerides) or can be organised into a fused ring structure (e.g. steroids – such as cholesterol). Phospholipids serve as a major component of cell membranes. Triglycerides are found in foods and function as a long-term energy source. Triglycerides can exist as either *fats* (solid) in animals or as *oils* (liquid) in plants. The presence of lipids in foods can be determined by testing with Sudan III solution.

- Pour 2 ml of full cream milk into a test tube, then add a small volume of water and mix together
- Add a few drops of Sudan III solution and shake again, before recording any changes



TEST 4: Proteins

Proteins are a diverse class of molecules that make up over 50% of the dry weight of a cell. They are composed of recurring monomers called amino acids. Some amino acids can be synthesised by the body (non-essential), while others must be ingested as part of the diet (essential). Amino acids are joined together by peptide bonds – these bonds can be visualised using a Biuret test.

- Add 2 ml of egg white to a test tube followed by an equal amount of sodium hydroxide solution
- When the solution clears, add copper sulphate solution via dropwise (shaking between drops)
- Record any changes (if a blue precipitate forms, too much copper sulphate has been added)

EXTENSION: Organic Compounds

- Complete the table below comparing the four main types of organic compounds found in cells

	Monomer / Subunits	Polymer	Bond Involved	Cell Function
Carbohydrate				
Triglyceride		Not applicable		
Protein				
Nucleic Acid				

The different types of biomolecules were detected via tests that triggered a change in colour. This type of assessment (qualitative) is not very accurate. Quantitative data is considered more exact.

- Outline how colour changes can be quantitatively measured using a colourimeter

METHODOLOGY: Experimental Design

Design an experiment to test the levels of a biological compound in food. Include a rationale (introduction), hypothesis and basic methodology. Possible experiments may include:

- A comparative study (*t*-test) of the levels of a compound in two food variants (e.g. milk brands)
- An experimental study on a factor affecting food (e.g. chemicals involved in food preparation)

Be sure to include appropriate controls and a sufficient number of repetitions to promote reliability.