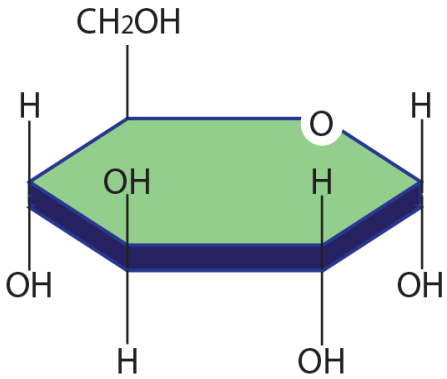
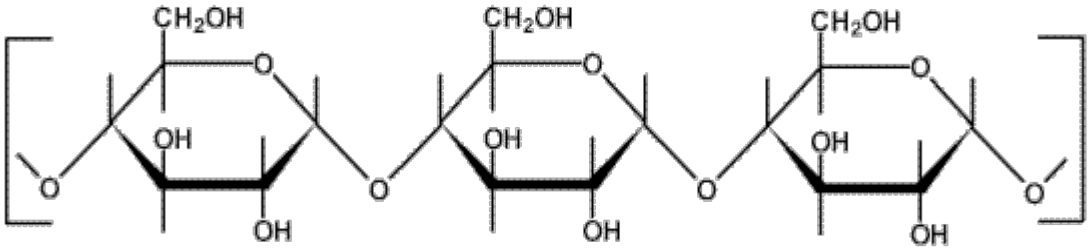
Macromolecule Structure and Function Reference Sheet

Macromolecule: Carbohydrate

This macromolecule is composed of three common elements (carbon, hydrogen, and oxygen) in a 1:2:1 ratio. The most basic carbohydrates are simple sugars, or monosaccharides. Simple sugars can combine to make larger carbohydrates, or polysaccharides. For example, the disaccharide sucrose, which is also known as table sugar, is made of two glucose molecules linked together. Many more glucose molecules can be linked together to make large polysaccharides, which are polymers of monosaccharides. Foods contain carbohydrate monomers, such as glucose and fructose, and carbohydrate polymers, such as starch. Plants and animals synthesize different polymers to store glucose for their cells to use when they need energy. Animals store glucose in glycogen polymers. Plants store glucose in starch and cellulose polymers. A starch polymer is composed of many glucose monomers. Scientists can identify various carbohydrates in breads, pastas, fruits, vegetables, and candies. The ingestion of carbohydrates supplies the body with its primary source of energy at a rate of 4 calories per gram of carbohydrate.



Monosaccharide- Glucose
($C_6H_{12}O_6$)



Polysaccharide – Starch
($(C_6H_{10}O_5)_n$)

Macromolecule Structure and Function Reference Sheet

Macromolecule: Carbohydrate, continued

Test for Monosaccharides – Procedure:

Benedict's solution is used to test for simple carbohydrates, or monosaccharides, like glucose. Benedict's solution is a blue liquid that contains copper sulfate. When Benedict's solution and glucose are combined and heated, the copper sulfate will react with glucose to create copper oxide, and change the color to an orange-red. If glucose is not present, then the reaction will not take place.

1. Put on safety goggles and a lab apron.
2. Using a separate pipette for each solution, add 1 mL of Sample A into test tube A1, and 1 mL of sample B into test tube B1. Add 1 mL of distilled water into one of the test tubes labeled Water.
3. Place the test tubes into the test tube rack and add 1 mL (20 drops) of Benedict's solution to each.
4. Carefully place each test tube in the hot water bath and heat for 2 to 3 minutes.
5. Remove the test tubes from the hot water bath using test tube tongs and place them back into the test tube rack.
6. Record your observations in your *Student Journal*.

Test for Starch – Procedure:

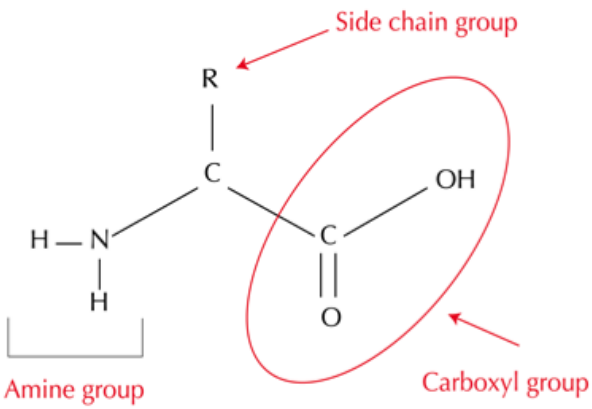
Iodine is a chemical element that undergoes a color change in the presence of starch. If starch is present in a solution or food, the drops of iodine will change to a dark purple or blackish color. A solution that changes color can be confirmed as a starch solution.

1. Using a separate pipette for each solution, add 1 mL of Sample A into test tube A2, and 1 mL of sample B into test tube B2. Add 1 mL of distilled water into the other test tube labeled Water. Be careful not to cross-contaminate the solutions.
2. Place test tubes into the test tube rack and add 2-3 drops of Lugol's iodine to each test tube.
3. Record your observations in your *Student Journal*.
4. Dispose of the materials in the test tubes according to your teacher's directions. Rinse, clean, and dry the test tubes.

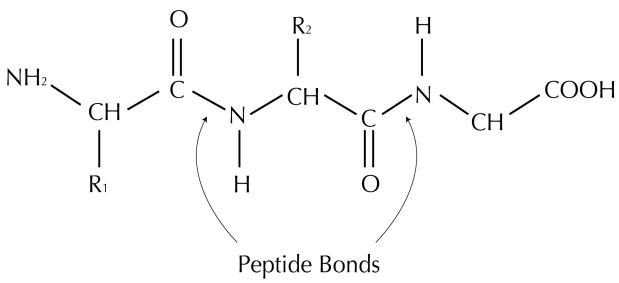
Macromolecule Structure and Function Reference Sheet

Macromolecule: Protein

A protein is a polymer made of monomers called amino acids. Proteins are composed of five basic elements: carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur. Amino acids are composed of an amine group, a carboxyl group, and a side chain group that varies among different types of amino acids. Amino acids link together via peptide bonds to create polymers that can fold into three-dimensional structures. Proteins derive their functions from the three-dimensional shapes and the chemical properties of the amino acid monomers that they contain. Small changes in the shape or the amino acid content of a protein can profoundly affect the function of the protein. Scientists can identify proteins in foods such as eggs, meat, poultry, and beans. The ingestion of proteins supplies the body with amino acids for protein synthesis and provides a potential energy source at a rate of 4 calories per gram of protein if the supply of glucose from carbohydrates is not providing enough energy.



Amino acid



Amino acids link by peptide bonds

Macromolecule Structure and Function Reference Sheet

Macromolecule: Protein, continued

Test for Proteins – Procedure:

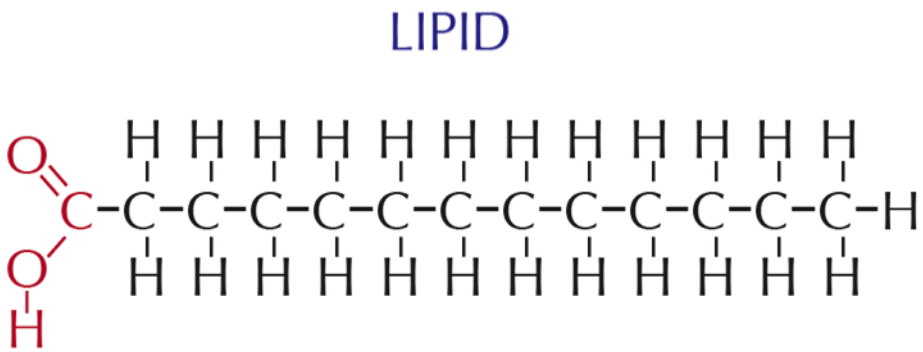
Biuret reagent is a chemical test used for detecting the presence of proteins. If proteins are present in a substance, then they will react with the Biuret solution and change its color from blue to purple. The intensity of the color change is directly proportional to the protein concentration.

1. Put on safety goggles, apron, and gloves when handling the Biuret solution. Be cautious! Your fingernails, hair, and skin all contain proteins, which means they can be stained by the Biuret!
2. Using a separate pipette for each solution, add 1 mL of Sample A into test tube A, 1 mL of Sample B into test tube B, 1 mL of Sample C into test tube C, and 1 mL of Sample D into test tube D. Add 1 mL of distilled water to the test tube labeled water. Be careful not to cross contaminate the samples.
3. Place the test tubes in the test tube rack.
4. Add 2 mL (40 drops) of Biuret solution into each of the test tubes.
5. Observe any color changes to determine the presence of proteins.
6. Record your observation in your *Student Journal*.
7. Dispose of the materials in the test tubes according to your teacher's directions. Rinse, clean, and dry the test tubes.

Macromolecule Structure and Function Reference Sheet

Macromolecule: Lipid

Lipids are large macromolecules that are nonpolar, which makes them insoluble in water. Lipids are made up of monomers of glycerol and fatty acids. Fats, oils, waxes, and cholesterols are common types of lipids. Lipids are composed of three basic elements: carbon, hydrogen, and oxygen. Fats and oils are large molecules made of a glycerol molecule attached to different fatty acids. There are two basic types of fatty acids: saturated and unsaturated. Most animal fats contain saturated fatty acids and are solid at room temperature. Saturated fatty acids contain the maximum number of hydrogen atoms that their carbon atoms can hold by chemical bonds, so each bond between their carbon atoms contains a single electron. Most plant fats, such as oils, contain unsaturated fatty acids and are liquid at room temperature. Unsaturated fatty acids have fewer hydrogen atoms than the maximum that could be held by their carbon atoms, so some of the bonds between their carbon atoms contain two electrons. Scientists can identify lipids in oils, butters, nuts, and fruits, such as avocados. The ingestion of lipids supplies the body with lubrication for joints, as well as the necessary components for the synthesis of cellular membranes. Lipids are also the body's secondary source of energy, providing 9 calories per gram of lipid.



Macromolecule Structure and Function Reference Sheet

Macromolecule: Lipid, continued

Test for Lipids – Procedure:

The chemical properties of lipids allow them to be easily absorbed into the cellulose fibers of paper. Lipids will saturate paper, causing it to become transparent. The higher the lipid content, the more transparent the paper will become.

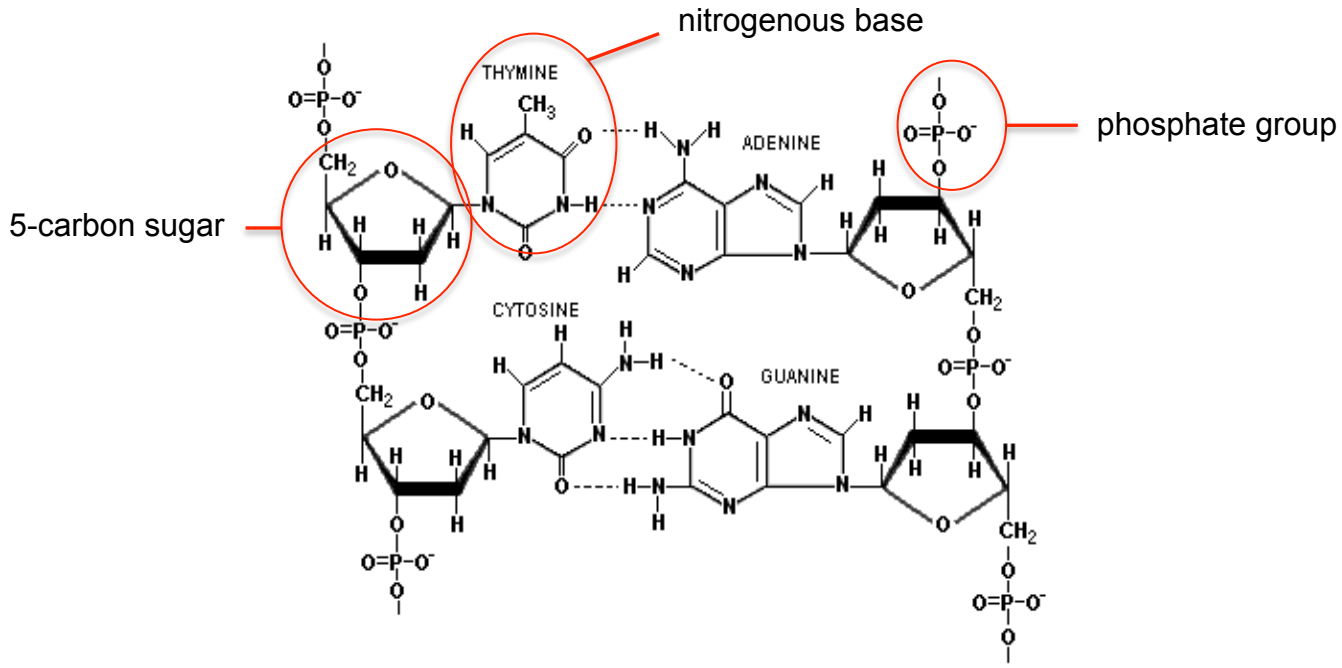
1. Label the brown paper towel in three sections, with A, B, C, and water.
2. Carefully transfer 1 drops of each solution into the sections of the towel with the corresponding label. (Ex. Solution A in section A) Us the tip of the dropper to spread the liquid on the brown paper towel.
3. Allow 5 full minutes for the solutions to dry on the paper towel.
4. Raise the paper towel toward the light and record the level of transparency in the chart in your *Student Journal*.
5. Dispose of the materials according to your teacher's directions. Clean your work area.

Macromolecule Structure and Function Reference Sheet

Macromolecule: Nucleic Acids

This macromolecule is composed of five basic elements: carbon, hydrogen, oxygen, nitrogen, and phosphorus. Nucleic acids are polymers composed of monomers called nucleotides. A nucleotide is a three-part unit that consists of a 5-carbon (pentose) sugar, a phosphate group, and a nitrogenous base. Nucleotides are found in most foods because they are part of all cells. There are two types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). The names are based on the 5-carbon sugars. DNA contains the sugar deoxyribose and is almost always a double-stranded molecule shaped like a double helix, or twisted ladder. There are four nitrogenous bases in DNA. Each base pairs with one other base; adenine pairs with thymine, and guanine pairs with cytosine.

On the other hand, RNA contains the sugar ribose and is often a single-stranded molecule. RNA contains three of the four bases contained in DNA; the fourth base in DNA, thymine, is replaced by uracil in RNA. Therefore, in RNA, adenine pairs with uracil, and guanine pairs with cytosine. Scientists can identify the same nucleic acids, with relatively little variation, in every living organism on Earth, and in viruses as well! The fundamental basis for all of modern biology is the discovery that nucleic acid sequences hold the information required to link different amino acids together in the proper order to make proteins. It is now clear that nucleic acids are responsible for storing and expressing the genetic information necessary for cells to carry out life processes.



Chemical structure of DNA