K 1

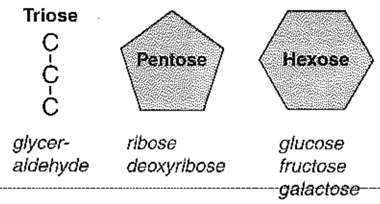
Carbohydrates

Carbohydrates are a family of organic molecules made up of carbon, hydrogen, and oxygen atoms with the general formula **$(CH_2O)x$**. Simple sugars are known a monosaccharides. Monosaccharides may join together to form compound sugars (disaccharides and polysaccharides), releasing water in the process (condensation). Compound sugars can be broken down into their constituent monosaccharides by the opposite reaction (hydrolysis). Carbohydrates are the major constituents of most plants. Plants use carbohydrates (made via photosynthesis) as an energy source, for storing energy, and for forming supporting material. Animals consume carbohydrates in the diet, gaining both energy and a source of fibre.

Monosaccharides

Monosaccharides are **single-sugar** molecules and include glucose (grape sugar and blood sugar) and fructose (honey and fruit juices). The commonly occurring monosaccharides have between 3 and 7 carbon atoms. Five and six carbon sugars tend to exist as ring structures: pentose or hexose sugars.

Single sugar (monosaccharide)



Biological Functions

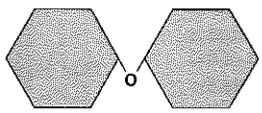
- Hexoses are the primary energy source for cellular respiration.
- Ribose occurs in coenzymes, ATP, and in RNA.
- Deoxyribose occurs in DNA.
- Trioses play an important part in carbohydrate metabolism in plants and animals.

Disaccharides

Disaccharides, or **double sugars**, formed by two monosaccharide units combining together with the elimination of a water molecule. Examples of disaccharides include sucrose (simple sugar) and lactose (milk sugar).

Sucrose = glucose + fructose
Maltose = glucose + glucose
Lactose = glucose + galactose

Double sugar (disaccharide)



Examples: *sucrose, maltose, lactose, cellobiose*

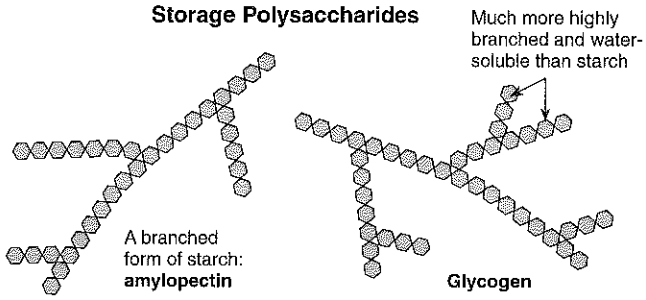
Biological Functions

- Hydrolysed to release sugar as an energy source for cells.
- Used as building blocks for making other molecules.
- Sucrose is the form of sugar transported in plants.
- Lactose is the sugar in milk.

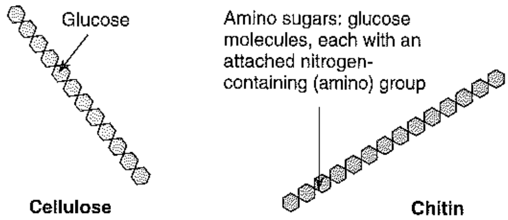
Polysaccharides

Polysaccharides are **macromolecules**: polymers made from many repeating monosaccharide units linked together. Like disaccharides, polysaccharides are formed by reactions in which water is removed (condensation). The way in which the monosaccharides are linked together gives the polysaccharide its particular properties. Some polysaccharides are storage molecules which can be hydrolysed to produce sugar for cells. Others form structural components of cells or organisms. Examples of commonly occurring polysaccharides are:

Storage Polysaccharides



Structural Polysaccharides



Starch is a polymer made entirely of glucose. It is an important energy storage molecule in plants, found concentrated in **starch granules** within plant cell. Unbranched and branched forms exist.

Glycogen is the form in which glucose is stored in animal tissues. It is a very branched polysaccharide comprising 2,000 to 60,000 glucose molecules. Glycogen is found mainly in **liver** and **muscle** cells.

Cellulose: Cellulose is a structural material in plants. It is made up of long, unbranched chains of glucose molecules. It is a major component of plants, forming their **cell walls**, **xylem vessels**, and **wood**.

Chitin: Chitin is a tough, modified polysaccharide made up of chains of amino-sugars. It is the main component of the **exoskeletons** of insects and other arthropods, and a constituent in the cell walls of **fungi**.

1. Name one biological function of monosaccharides, providing a example: ______

______

2. Briefly state the structure and biological role of each of the following polysaccharides:

(a) Starch: ______

(b) Glycogen: ______

(c) Cellulose: ______

(d) Chitin: ______

3 (a) Name the reaction that produces polysaccharides from monosaccharides: ______

(b) Name the reaction that breaks down polysaccharides into simple sugars: ______

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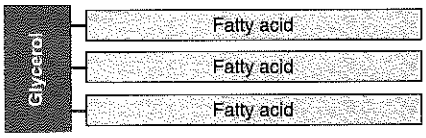
Lipids

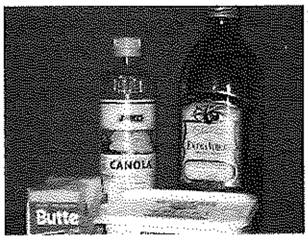
Lipids are a group of organic compounds that have an oily, greasy, or waxy consistency. They are relatively insoluble in water and tend to be water-repelling (eg. waxy cuticle on leaf surfaces). Lipids are important biological fuels, some are hormones, and some serve as the structural components of cell membranes. Proteins and carbohydrates can be converted into fats by enzymes and stored within cells of adipose (fat) tissue. During times of plenty, this store is increased, to be used during times of food shortage.

Neutral Fats and Oils

The most abundant lipids in living things are neutral fats. They make up the fats and oils found in plants and animals. They are an economical way to store fuel reserves, since they yield more than twice as much energy as the same quantity of carbohydrate. Neutral fats are composed of a glycerol molecule attached to one (monoglyceride), two (diglyceride) or three (triglyceride) fatty acids. The fatty acid chains may be saturated or unsaturated (see below). **Waxes** are similar in structure to fats and oils, but they are formed with a complex alcohol instead of glycerol.



Neutral Fat



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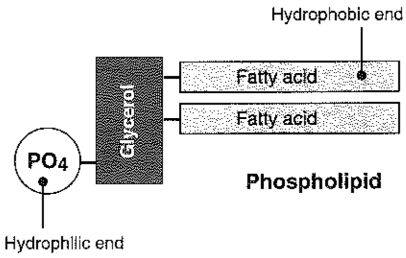
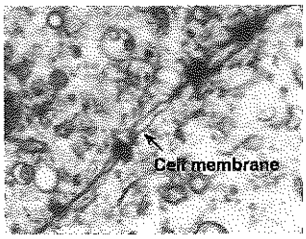
Phospholipids

Phospholipids are important lipids which form cell membranes. A phospholipid consists of a glycerol molecule attached to two fatty acid chains and a phosphate (PO_4) group. The phosphate end of the molecule is attracted to water (hydrophilic) while the fatty acid end is repelled (hydrophobic). The hydrophobic ends turn inwards in the membrane to form a double lipid layer.



Phospholipid



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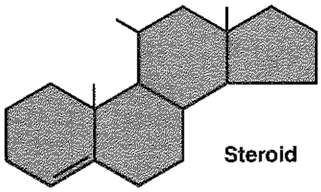
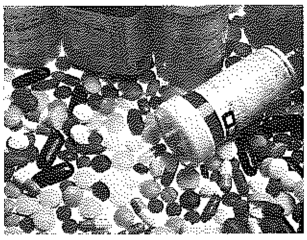
Steroids

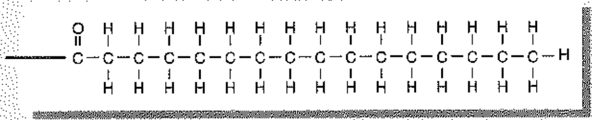
Although steroids are classified as lipids, their structure is quite different from that of other lipids. Steroids have a basic structure of three rings made of 6 carbon atoms each and a fourth ring containing 5 carbon atoms. Examples of steroids include cholesterol, testosterone and oestrogen (the male and female sex hormones), and the hormones cortisol and aldosterone.



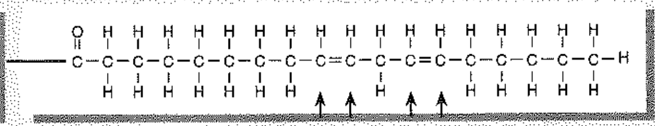
Steroid



Saturated and Unsaturated Fatty Acids



Palmitic acid (saturated fatty acid)



Linoleic acid (unsaturated fatty acid)

Fatty Acids Fatty acids are a major component of neutral fats and phospholipids. About 30 different kinds are found in animal lipids. Saturated fatty acids contain the maximum number of hydrogen atoms. Unsaturated fatty acids contain some carbon atoms that are double-bonded with another and are not fully saturated with hydrogens. Lipids containing a high proportion of saturated fatty acids tend to be solids at room temperature (e.g. butter). Lipids with a high proportion of unsaturated fatty acids are oils and tend to be liquid at room temperature. Regardless of their degree of saturation, fatty acids yield a large amount of energy when oxidised.

1. Name the type of fatty acids found in lipids that form the following at room temperature:

   (a) Fats: ______________________ (b) Oils: ______________________

2. Briefly explain how fats differ from oils: ______________________

3. Name three examples of a steroid: ______________________

4. Describe the primary role of waxes in plants: ______________________

5. Describe the importance of phospholipids in cell structure: ______________________

6. Describe three roles of lipids in our bodies: ______________________

