Carbohydrates, Lipids, and Proteins

3.2

Organic vs. Inorganic compounds

- Organic compounds:
  - contain carbon and are found in living organisms.
  - Exceptions: hydrocarbonates, carbonates, oxides of carbon.
- Inorganic compounds:
  - Do not contain carbon

Carbon atoms can form four covalent bonds allowing a diversity of stable compounds to exist.

There are four major groups of carbon compounds that are the basis of living things:
- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids
Basic types of organic biological molecules:

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>Example Molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbohydrates</td>
<td>monosaccharides</td>
<td>glucose, galactose, fructose</td>
</tr>
<tr>
<td></td>
<td>disaccharides</td>
<td>maltose, lactose, sucrose</td>
</tr>
<tr>
<td></td>
<td>polysaccharides</td>
<td>starch, glycogen, cellulose</td>
</tr>
<tr>
<td>proteins</td>
<td></td>
<td>enzymes, antibodies, hormones</td>
</tr>
<tr>
<td>lipids</td>
<td></td>
<td>triglycerides, phospholipids</td>
</tr>
<tr>
<td>nucleic acids</td>
<td></td>
<td>DNA, RNA</td>
</tr>
</tbody>
</table>

Structure of common organic molecules:

Glucose (6 carbon monosaccharide)
- Sugar (simple carbohydrate)
- Product of photosynthesis
- Broken down during cellular respiration
- 6 carbon ring structure

Amino acids
- Subunits of proteins
- 20 different types
- Contain an amino group, a carboxylic acid group and a variable \( R \) group
Fatty acids

• basis of the phospholipid bilayer of the cell membrane (phospholipids = fatty acids + phosphate group)
• Triglycerides, a very common organic molecule consist of fatty acids + glycerol

If there are no double bonds between carbon atoms on the fatty acid (as many hydrogens as possible are attached) it is called a saturated fatty acid
• If there are double bonds the fatty acid is considered unsaturated
Ribose
- Sugar found in RNA (type of nucleic acid)
- One of the most important molecules in photosynthesis (ribulose biphosphate binds carbon dioxide in the Calvin Cycle)
- 5 carbon ring structure

Carbohydrates can be divided into three groups based on their structure:
Monosaccharides
- Simple sugars
- e.g. glucose, galactose, and fructose

Disaccharides
- Two simple sugars put together
- e.g. maltose, lactose, and sucrose
Polysaccharides
- More complex; composed of multiple types of sugars
- e.g. starch, glycogen, and cellulose

Functions of common organic carbohydrates:

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>glucose</td>
<td>monosaccharide</td>
<td>Chemical fuel for cell respiration; short term energy storage</td>
</tr>
<tr>
<td>lactose</td>
<td>disaccharide</td>
<td>Makes up some of the solutes in milk; short term energy storage</td>
</tr>
<tr>
<td>glycogen</td>
<td>polysaccharide</td>
<td>Stores glucose in liver and muscles; long term energy storage</td>
</tr>
</tbody>
</table>
### Importance of carbohydrates in PLANTS:

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>monosaccharide</td>
<td>found in many fruits (makes them sweet)</td>
</tr>
<tr>
<td>Sucrose</td>
<td>disaccharide</td>
<td>often transported from leaves of plants to other locations in plants by vascular tissue; mix with water to form plant sap</td>
</tr>
<tr>
<td>Cellulose</td>
<td>polysaccharide</td>
<td>one of the primary components of cell walls</td>
</tr>
</tbody>
</table>

### Metabolism - Complex web of enzyme catalyzed reactions within a cell or organism

### Condensation and Hydrolysis
- **Condensation** = the removal of water from monomers during the synthesis of polymers
  - e.g., removing water so that amino acids may bond together to form proteins
- **Catabolism**

\[ + \text{H}_2\text{O} \]
Hydrolysis = the addition of water to polymers to break them down into monomers
• e.g: breaking triglycerides down into glycerol and 3 fatty acids.
• Anabolism
Functions of lipids
• Energy Storage (long term)
  - solid triglycerides = fat (animals)
  - liquid triglycerides = oil (plants)

Thermal insulation
• A layer of fat beneath the skin (called subcutaneous fat) insulates against heat loss
• blubber is essential for many cold weather animals.

Buoyancy
• Lipids are less dense than water and therefore help animals to float
Carbohydrates vs. lipids for energy storage

Carbohydrates
- Store less energy per mass
- More accessible (easier to break down)
- More soluble in water and therefore easier to transport in the blood stream

Lipids
- More energy per unit of mass (2x)
- Insoluble in water

Homework:

Read p 47-55 and add information to notes