

Chemical Constituents of Cells

1. Inorganic substances

-dissolve water or react with water to release ions

-these are electrolytes

a. water is the most abundant compound in living material

-2/3 of body weight in human adult

-formula is H_2O

-major component of blood and other fluids

-plays role in carrying chemicals to all parts of the body

-water can absorb and transfer heat (perspiration carries heat away by evaporation)

b. Oxygen- O_2

-transported by red blood cells

-needed for energy release that is necessary for metabolic activity

c. Carbon Dioxide- CO_2

-a simple carbon containing inorganic molecule

-this is a waste product released during metabolic processes

-most carbon dioxide reacts with water to form carbonic acid (H_2CO_3) in the blood

-this ionizes and forms H^+ and HCO_3^-

-in the lungs the reaction reverses and CO_2 is eliminated by exhaling

d. Inorganic Salts (Table 2.6)

-sources of many ions that play important roles in homeostasis

-includes: sodium, chloride, potassium, calcium, magnesium, phosphate, carbonate, bicarbonate, and sulfate

-we must have an electrolyte balance to be healthy

-phosphate ions are required for ATP, bicarbonate ions help maintain the pH balance; calcium is necessary for bone development, muscle and nerve function, and blood clotting; hydrogen is necessary to maintain pH; potassium and sodium ions are necessary for nerve function

2. Organic substances

a. carbohydrates-provide energy for the cell

-these are necessary for cell structures (glycoprotein)

-carbohydrates are water soluble molecules containing carbon, hydrogen,

and oxygen in a 1:2:1 ratio

-Carbs are classified by size

- Simple sugars are monosaccharides with 3-7 carbons in a ring or a chain
- These include glucose or dextrose (blood sugar), fructose (fruit sugar), and galactose
- Disaccharides are composed of two, six carbon units and include sucrose (table sugar), lactose (milk sugar) , and maltose (malt sugar)
- Complex carbohydrates are also known as polysaccharides
- One is called cellulose is found in plants. Humans need this for fiber, but can't digest it
- Plant starch is easily digested
- Animals have starch too, but it is called glycogen and it is stored in the muscles and liver

b. Lipids-fats, phospholipids, steroids

-organic chemicals that are insoluble in water (won't dissolve)

-these are vital for homeostasis, but should be limited to 30% of the diet

-most common type of lipid is fat, which is used for energy (at least twice the energy from sugar, probably more like 9 times the energy)

-fat is composed of carbon, hydrogen, and oxygen, but in different proportions than sugar

-the building block of fat is the fatty acid molecule and the glycerol molecule

-all fats have a carboxyl group (COOH) at the end of a chain of carbons

- -saturated fatty acids are linked by a single carbon-carbon bond and are saturated with hydrogens.
 - these are solid at room temperature and come from animals
 - limit consumption of this type of fatty acid to <10% of your total fat intake per day.
- -unsaturated fats have some double bonds in between carbons, so they are not completely saturated with hydrogens
 - these are liquid at room temperature and come from plants, and are more healthy
 - polyunsaturated fats have two or more double bonds
 - monounsaturated fats have one double bond
 - triglycerides have a glycerol and 3 fatty acid chains
- -phospholipids have 2 fatty acid chains and a portion containing a phosphate group
 - the phosphate group is hydrophilic (water loving) and is called the head

- the fatty acid portion is hydrophobic (water fearing) and is called the tail
- phospholipids are important in cell membrane construction
- steroids are complex rings of carbon and include cholesterol, sex hormones, and adrenal hormones

3. Proteins

- there are both structural and functional proteins
- proteins may function as antibody, as receptors on cell surfaces, as energy sources, as chemical messengers, etc
- one type of protein is an enzyme
- enzymes are modified proteins that act as catalysts and speed up metabolic reactions
- proteins are made of building blocks called amino acids (20 different kinds)
- all proteins have an amino group (NH_2), a central carbon (C), a carboxyl group (COOH), and an 'R' group
- we have primary, secondary, tertiary, and quaternary structures (see page 53)
- proteins can be denatured (destroyed) by high temperatures, radiation, extremes in pH, and some types of chemicals

4. Nucleic Acids

- these are necessary to give instruction to cells, form genes, and protein synthesis
- includes DNA or deoxyribonucleic acid and RNA or ribonucleic acid
- DNA has a double helix shape, has a sugar called deoxyribose, has a sugar/phosphate backbone, and has 4 nucleotide bases (adenine, guanine, cytosine, thymine)
- RNA has a single strand, has a sugar called ribose, has a sugar/phosphate backbone, and has 4 nucleotide bases (adenine, guanine, cytosine, uracil)
- Note the only difference in the bases is RNA has uracil instead of thymine
- Chargaff's Rule states that the bases will pair up in a certain way. Typically adenine links only to thymine in DNA, and to uracil in RNA. Cytosine will pair with guanine.