Biological molecules (Chapters 2 and 3)

Organic molecules

Molecules containing carbon atoms

Biological Macromolecules

Large organic molecules that are vital components of all living things

- The four major types are lipids, carbohydrates, proteins, and nucleic acids

- Each of the four macromolecule types is a polymer:

Macromolecule	Monomers
Lipids	Fatty acids and glycerol
Carbohydrates	Monosaccharides
Proteins	Amino acids
Nucleic acids	Nucleotides

Monomer

Any small organic molecule that can become linked to another monomer

Polymer

A chain of linked monomers

Carbohydrate (saccharide)

A monosaccharide (simple sugar), a disaccharide (two monosaccharides linked together), or a polysaccharide (many monosaccharides linked together)

• The body uses carbohydrates for energy

Monosaccharide (simple sugar)

Any small molecule with the general formula $C_nH_{2n}O_n$

• Most simple sugar names end in “-ose”

√ Examples: Glucose, fructose, galactose, ribose

• Glucose is the most abundant simple sugar

√ Glucose molecular formula = $C_6H_{12}O_6$

√ Glucose is our “blood sugar”

√ Cells use glucose as their main fuel

• Glucose is usually shown as a hexagon:

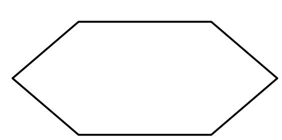


Fig 2.18

Disaccharide

A carbohydrate made from two monosaccharides joined together

- Maltose = glucose + glucose
- Sucrose (table sugar) = glucose + fructose
- Lactose (milk sugar) = glucose + galactose

Fig 2.19

Polysaccharides

A large number of glucoses joined together

- Made to store glucose (to store energy)
- Starch = The glucose polysaccharide in plants
  - √ Bread, pasta, rice, corn, and potatoes are high in starch
- Glycogen = The glucose polysaccharide in our body
  - √ Glycogen is stored mostly in the liver and the muscles

Fig 2.20

Lipids

Hydrophobic macromolecules

- Examples: Fat, oil, grease, wax

- Lipid molecules are composed of many more carbon atoms than oxygen atoms

    √ This is what makes lipids hydrophobic

- Major functions: Energy storage, insulation, cell membranes

- Fatty acid and glycerol are the building block molecules of most lipids

- Fatty acid = A molecule containing a long "tail" of only carbon and hydrogen atoms

- Glycerol = A three-carbon molecule

    √ Each carbon is a docking site for one fatty acid

Fig 2.21

Triglyceride (fat and oil)

Three fatty acids joined to a glycerol molecule

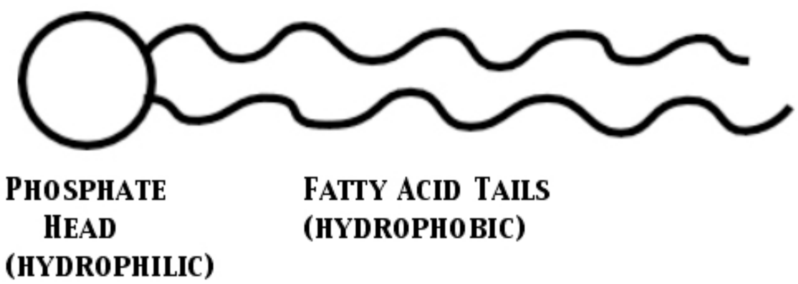
• Fats and oils are used for energy storage and insulation

Fig 2.21

Phospholipid

Two fatty acids and a phosphate joined to a glycerol molecule

• Phospholipids are usually diagramed as a circle with two tails



• The main function of phospholipids is to form cell membranes

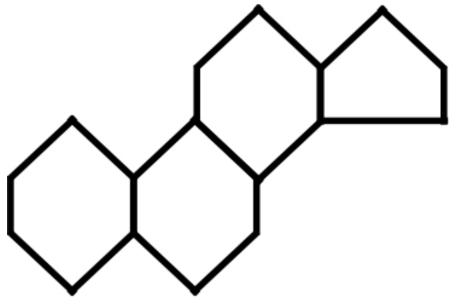
√ Cell membranes are phospholipid bilayers (two layers of phospholipids)

√ The phospholipid tails prevent most solutes from passing through the membrane

Figs 2.23a, 3.2, and 3.3

Steroids

Lipids with a backbone of 4 fused rings of carbon in this shape:



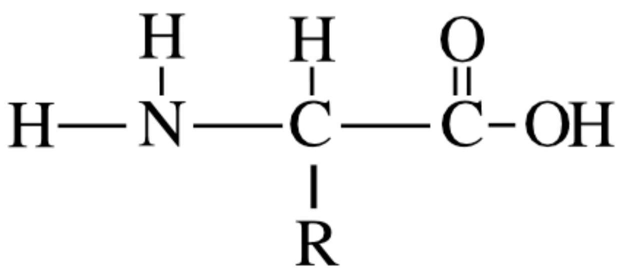
- Examples: cholesterol, steroid hormones (estrogen, testosterone, progesterone, corticosterone), vitamin D

Fig 2.23b

Proteins

Polymers of amino acids

- There are 20 different types of amino acids, but all have this general structure:



√ The R part of the structure is different for each of the 20 amino acids

- Proteins are the most abundant macromolecules in the body

- Proteins have many diverse functions in the body

√ Major types of proteins: enzymes, receptors, channel proteins, and fibrous proteins

Figs 2.24 and 2.26

Enzymes

Proteins that perform chemical reactions in the body

- Each enzyme is highly specific to perform one and only one chemical reaction

- Active site = The crevice in an enzyme where it binds the molecules that it works on and where it performs its chemical reaction on them

  √ Each enzyme is specific for only one reaction because only one molecule is the right shape to fit into its active site

  √ After the enzyme finishes its chemical reaction, it releases the product molecules (the molecules it has made). The enzyme then repeats its chemical reaction on the next substrate molecule

- Most enzymes are named after the molecule they react with followed by the ending "ase"

  √ Examples: Lipase = An enzyme that reacts with lipids

  Sucrase = An enzyme that reacts with sucrose

Fig 2.27

Receptors

Proteins in the cell membrane that detect molecules outside the cell

- Each receptor is highly specific to detect one and only one molecule because only one molecule fits into its binding site

- When a molecule is detected, the cell is “preprogrammed” to perform some action in response

  - The intracellular region of the receptor triggers the cellular response

Fig 3.4

Channel proteins (also called carrier proteins and pores)

Proteins in the cell membrane that form a tunnel to allow solutes to pass through the membrane

• Each channel protein is highly specific to transport only one solute molecule type

Figs 3.4 and 12.17

Fibrous (structural) proteins

Rope-like proteins that provide strength and framework to tissues

• Examples:

√ Collagen = An extremely strong fibrous protein, abundant in tendons and ligaments

√ Elastin = An elastic (rubber band-like) fibrous protein

√ Keratin = A hard fibrous protein abundant in nails, hair, and the skin

Nucleic acids

Polymers of nucleotide monomers

- DNA and RNA are the two types of nucleic acids
- The genes (the "blueprints" of life inside each cell) are made of DNA

    √ Each gene is a recipe for one of the cell's proteins

    √ Double helix = two intertwined DNA strands

    √ Chromosomes = Structures in the cell made of a long piece DNA

    - Each chromosome contains hundreds of genes

Figs 2.28 and 2.29

Adenosine Triphosphate (ATP)

A high energy molecule inside the cell that supplies proteins with the the energy needed to carry out their work

- An RNA nucleotide with 3 phosphate ions
- The energy is released when one of the three phosphates is removed.
    - This changes ATP into ADP and an unattached phosphate
- The ADP is "recharged" into ATP using the energy of glucose and other nutrients to reattach the removed phosphate ion

Figs 2.30, 24.2, and 24.3