Organic molecules

Molecules with a backbone of 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 monosacchardides linkied together), or a polysaccharide (many simple sugars linked together)

• The body uses monosaccharides for energy for cells

Monosaccharide (simple sugar)

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

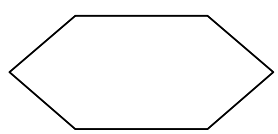
• Glucose is the most common monosaccharide in the body

√ 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:



• Most simple sugar names end in "-ose"

√ Examples: Glucose, fructose, galactose, ribose

Fig 2.18

Disaccharide

A carbohydrate made from two monosaccharides joined together

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 moecules
- Lipid molecules have large regions of only carbon atoms and hydrogen 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

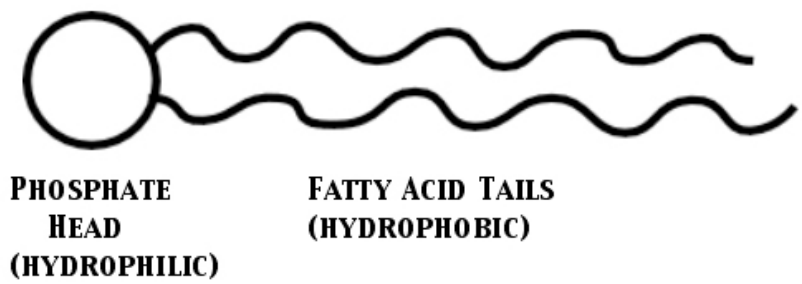
• Fats and oils are used for energy storage and insulation

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

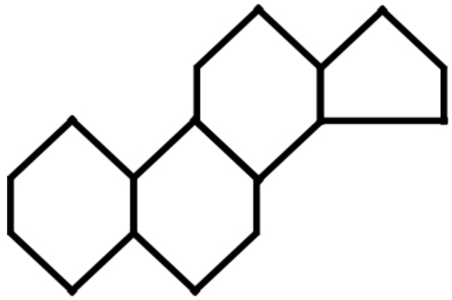
√ Cell membranes are phospholipid bilayers (two layers of phospholipids)

√ The hydrophobic fatty acid 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

√ The average protein is 400 amino acids long

• 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, 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

        - Substrate = The molecule that enters the enzyme's 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

- Sometimes exogenous molecules (molecules from outside the body, such as drugs, bacterial or plant toxins, or animal venoms) are similar in shape to the receptor’s natural molecule and therefore can also fit into the receptor’s binding site

    √ Agonist = An exogenous molecule that fits into the receptor’s binding site and triggers the cellular response

    √ Antagonist = An exogenous molecule that fits into the receptor’s binding site but does not trigger the cellular response

    - Antagonists decrease the response because they block the natural molecule from entering the receptor’s binding site

Fig 3.4

Channel proteins (carrier proteins, 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 the solute molecules that it is supposed to transport

Figs 3.4 and 12.17

Fibrous (structural) proteins

Rope-like proteins that provide strength and framework to tissues

- Examples:

√ Collagen = A strong and leathery fibrous protein

- The more collagen a tissue has the stronger and tougher the tissue will be

√ 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 nucleus, each made of a long piece of 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 energy they need to perform their work

• An RNA nucleotide with 3 phosphate ions

• The energy is released from ATP 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