MOLECULES OF CELLS

Objectives

1. Describe the special binding properties of carbon.
2. Identify the building blocks of carbohydrates, lipids, phospholipids, proteins and nucleic acids.
3. Describe the four levels of protein structure.

Outline

A. Organic (Carbon) Compounds
   1. Carbohydrates
   2. Lipids
   3. Proteins
   4. Nucleic Acids

A. Organic (Carbon) Compounds

- Based upon carbon skeleton
  - Major building block of cells

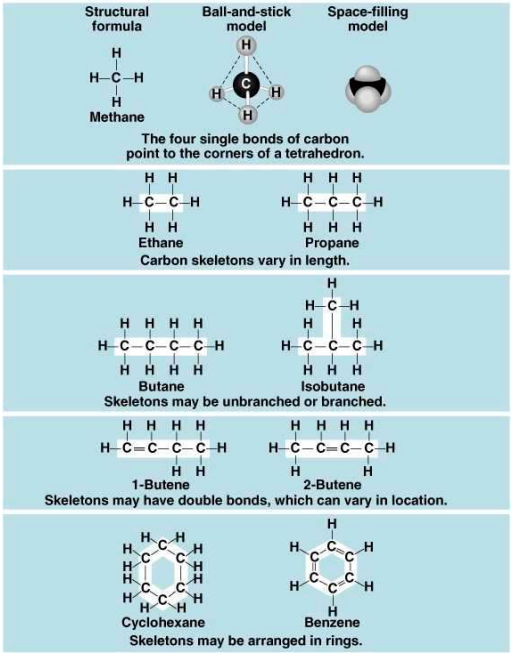
- Special properties of carbon (C)
  - Forms four covalent bonds

  - Forms long chains with itself
    - Can grow very large

  - Forms bonds with many elements
    - e.g., H, O, N, S, P

  - C–H has high energy
    - Hydrocarbons

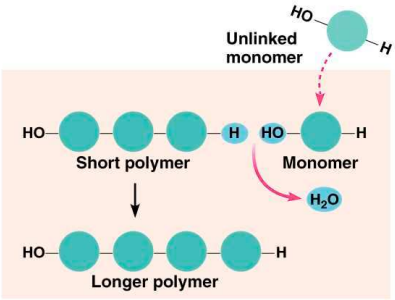
  - Can form 5 and 6 atom rings

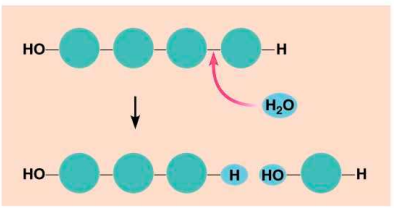


- Functional groups
  - hydroxyl –OH
  - amino $–NH_2$
  - carboxyl –COOH
  - carbonyl –CO–

Functional Group	General Formula	Name of Compounds	Example	Where Else Found
Hydroxyl —OH (or HO—)	—O—H	Alcohols	Ethanol	Sugars; water-soluble vitamins
Carbonyl CO	—C(=O)—H	Aldehydes	Propanal	Some sugars; formaldehyde (a preservative)
	—C(=O)—	Ketones	Acetone	Some sugars; "ketone bodies" in urine (from fat breakdown)
Carboxyl —COOH	—C(=O)—OH	Carboxylic acids	Acetic acid	Amino acids; proteins; some vitamins; fatty acids
Amino —NH_2 (or H_2N—)	—N(H)H	Amines	Methylamine	Amino acids; proteins; urea in urine (from protein breakdown)

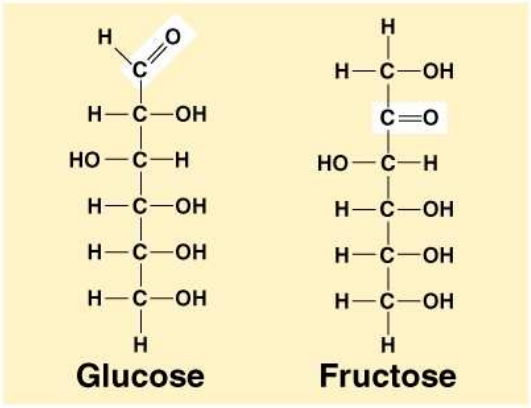
- Special units (monomers)





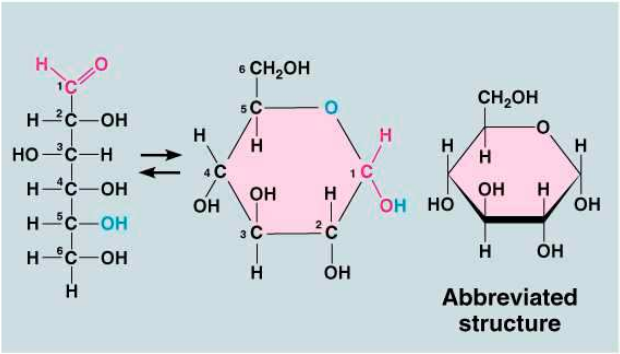
1. Carbohydrates

- C, H, O
- monomeric ratio CH_2O



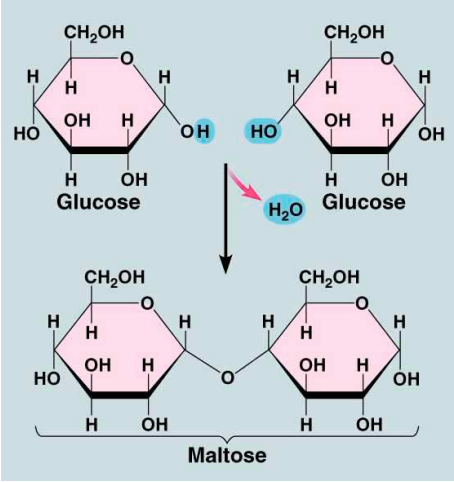
- monosaccharide
  - 3-7 C

    - glucose (dextrose), fructose (6 C)

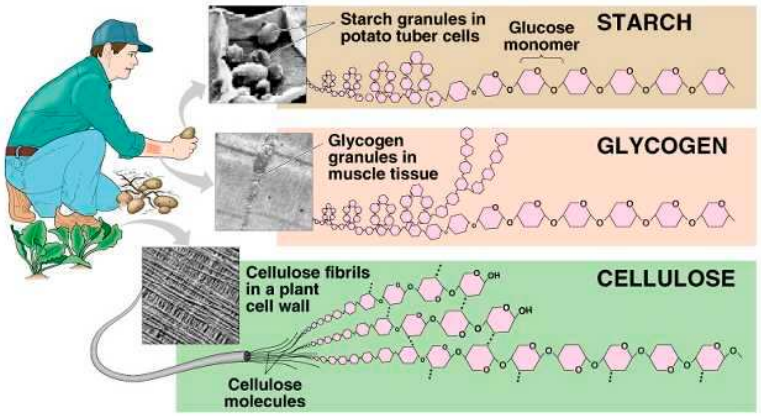


    - ribose, deoxyribose (5 C)

- disaccharide



- polysaccharide



  - energy storage (starch, glycogen)

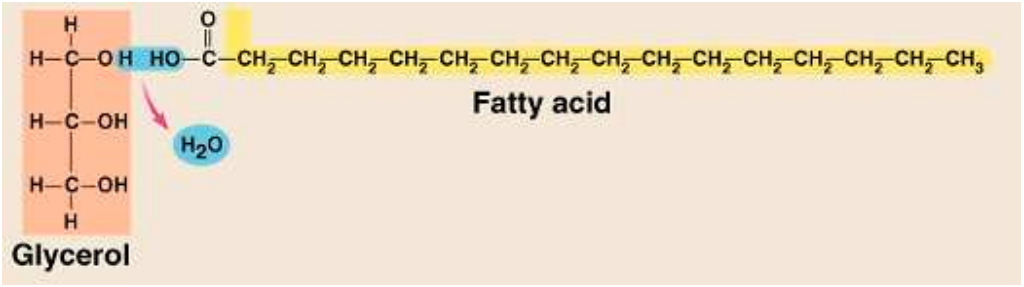
  - structure (cellulose)

2. Lipids

- C, H, O, sometimes P

- nonpolar
  - oils, fats, waxes, steroids

- building blocks



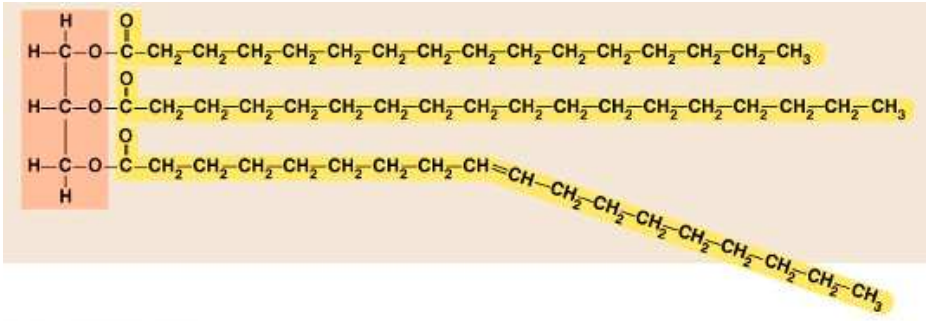
  - glycerol

  - fatty acid

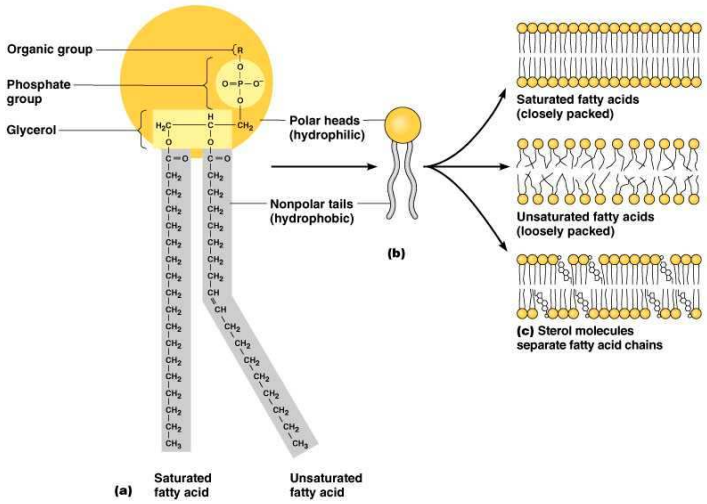
    - saturated

    - unsaturated

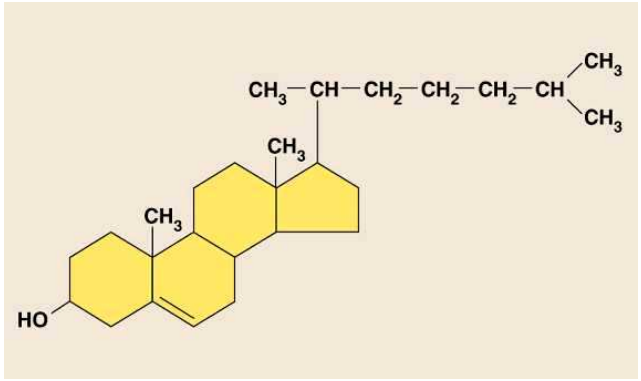
- triglyceride (simple lipids)
  - energy storage, insulation, buoyancy



- phospholipids
  - membranes



- steroids
  - hormones, membranes

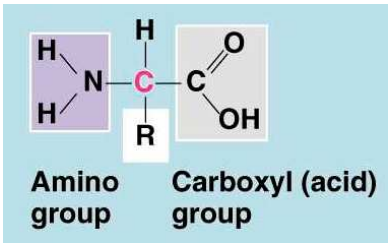


3. Proteins

- C, H, O, N, S
- 50% of cell dry weight

- most diverse group of compounds
  - supports, enzymes, transporters, toxins, signals, antibodies, etc.

- amino acid

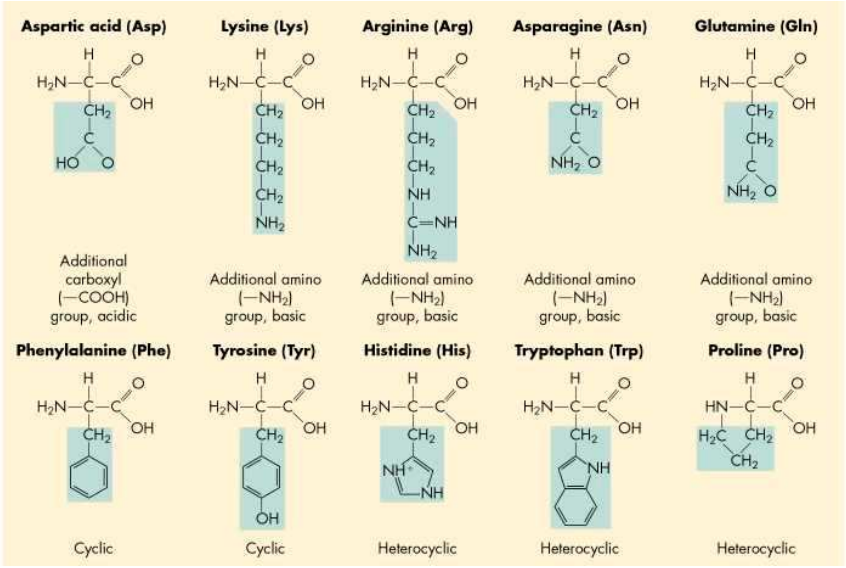


  - amino group (acts as base)

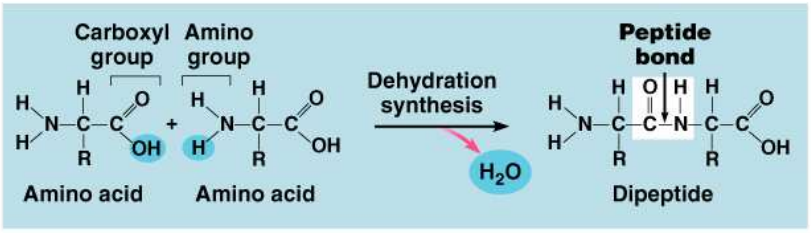
  - carboxyl group (acts as acid)

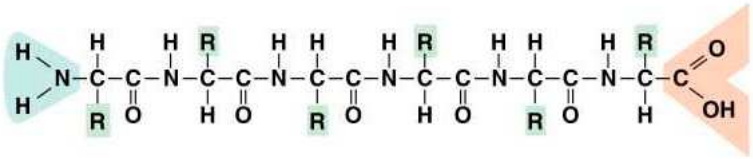
  - R group – gives special properties

  - 20 amino acids



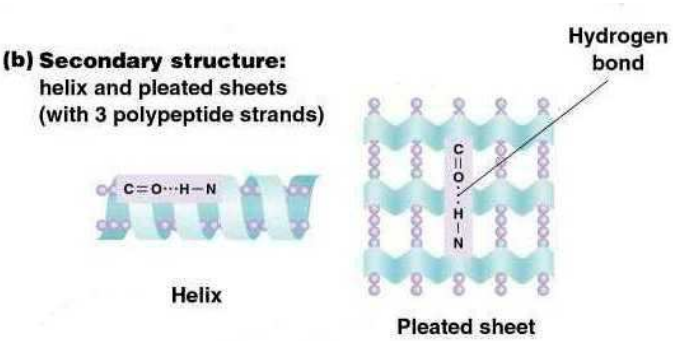
- protein structure
  - primary structure
    - sequence of amino acids
      - peptide bond





(a) Primary structure:
polypeptide strand

  - secondary structure
    - α-helix, β-pleats, β-sheets
      - hydrogen bonds



- tertiary and quaternary structure

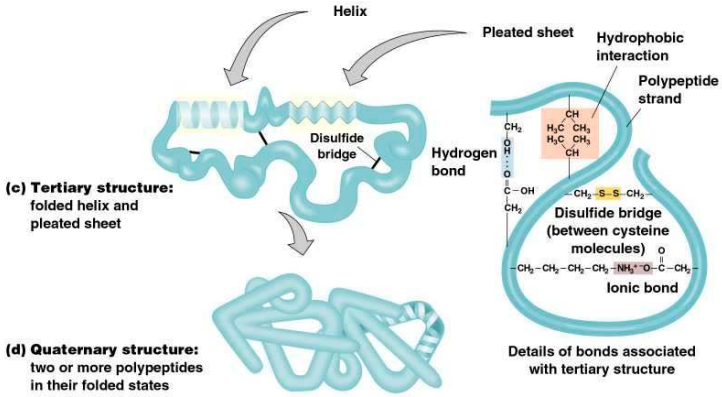
    - additional 3D folding
        - disulfide bridges

        - ionic bonds

        - hydrogen bonds

        - hydrophobic interactions

    - tertiary – single polypeptide



    - quaternary – multiple polypeptides

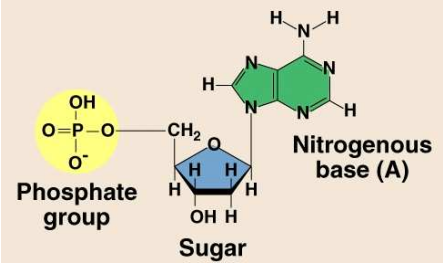
- conjugated proteins
    - e.g., glycoproteins, phosphoproteins, hemoglobin

- denaturation

4. Nucleic Acids

- C, H, O, N, P
- DNA, RNA

- nucleotides



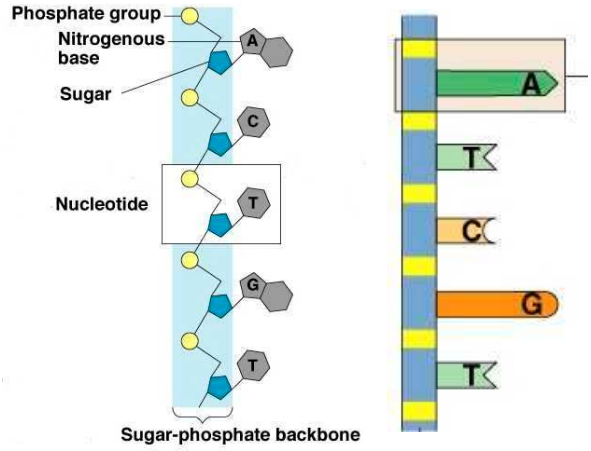
  - nitrogenous base

  - pentose – ribose or deoxyribose

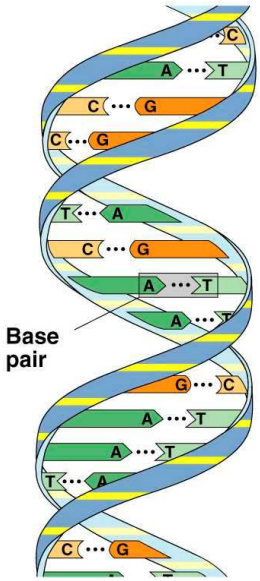
  - phosphate – one, two or three

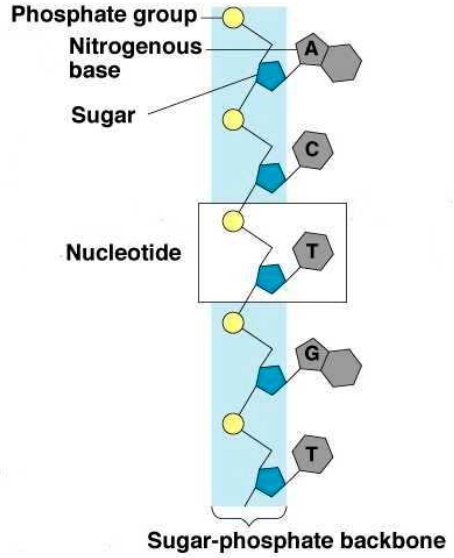
- polynucleotide

  - sugar–phosphate connect



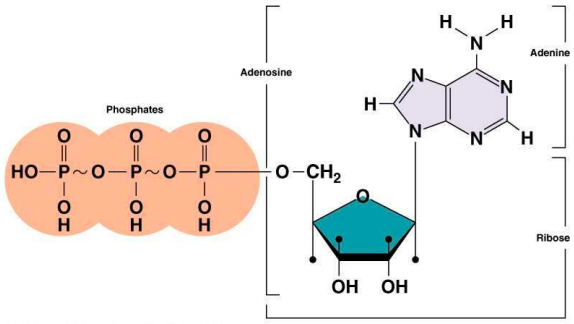
- DNA
  - double-helix
  - hydrogen bonding
  - genetic material



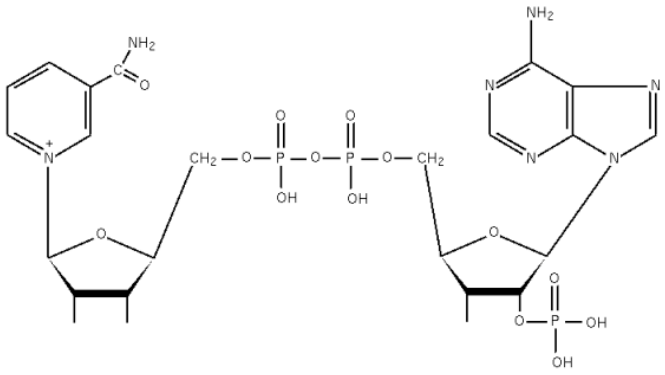


- RNA
  - single-stranded
  - protein synthesis

- special nucleotides
  - energy transport
    - ATP ↔ ADP



  - electron transport
    - $NAD^+ \leftrightarrow NADH$
    - $NADP^+ \leftrightarrow NADPH$



    - $FAD \leftrightarrow FADH_2$