Biological Macromolecules

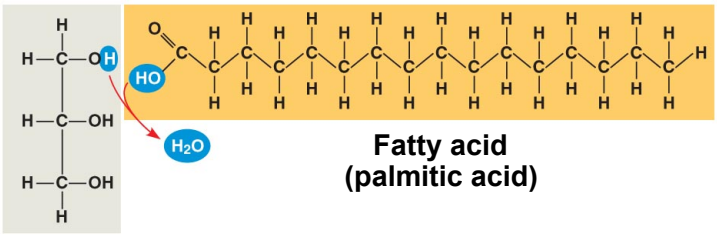
- Much larger than other particles found in cells
- Made up of smaller subunits
- Found in all cells
- Great diversity of functions

Four Classes of Biological Macromolecules

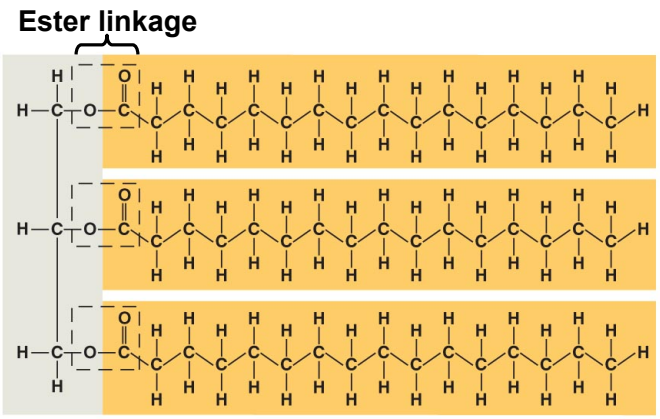
- Lipids
- Polysaccharides
- Proteins
- Nucleic Acids

Lipids

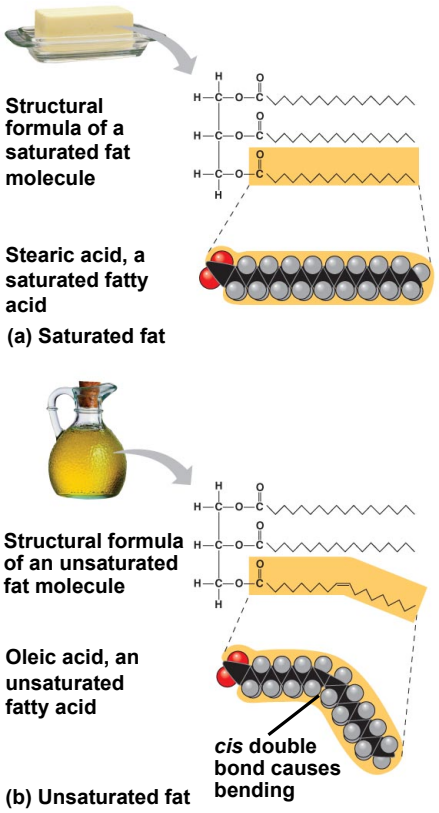
- Hydrophobic or amphipathic
- Important for:
  - energy storage
  - membrane structure
  - signaling
  - cushioning
  - insulation
- Include:
  - fats
  - phospholipids
  - cholesterol and phytosterol
  - some hormones
  - others

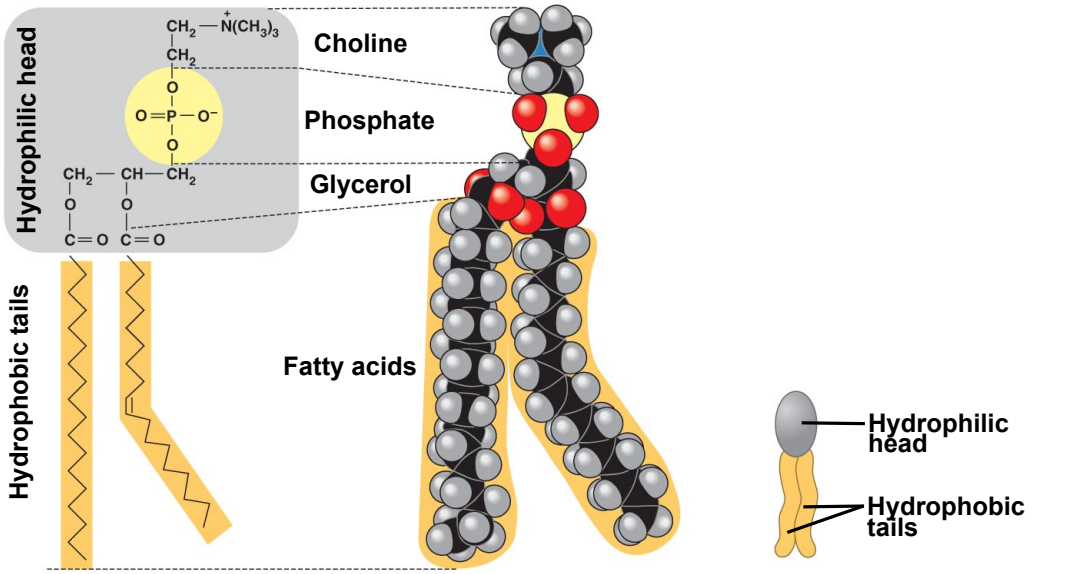


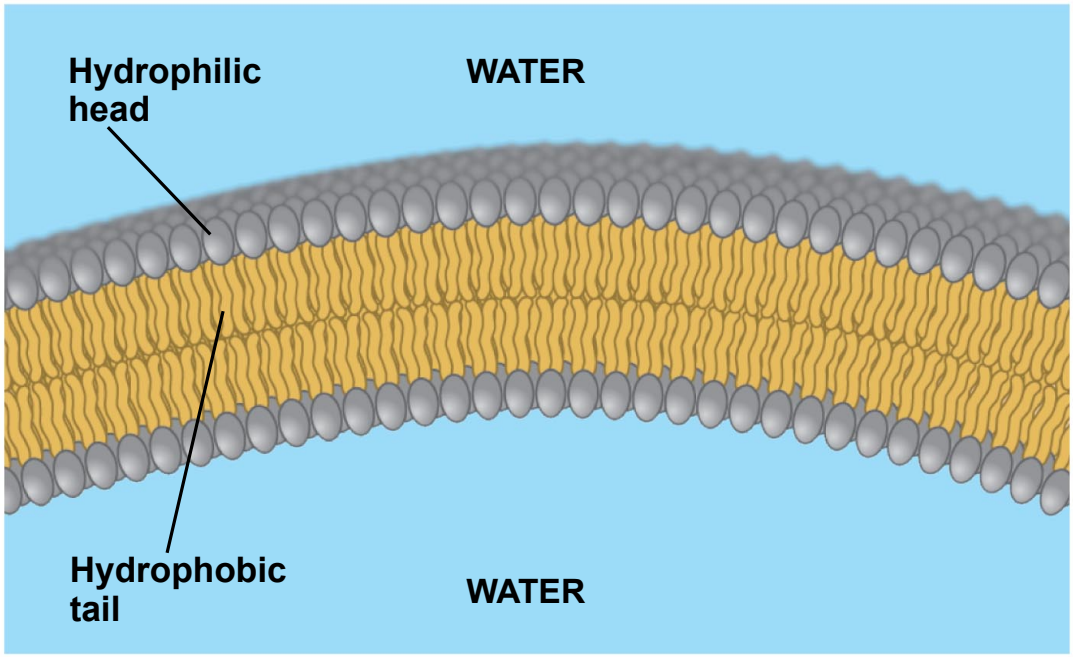
(a) Dehydration reaction in the synthesis of a fat

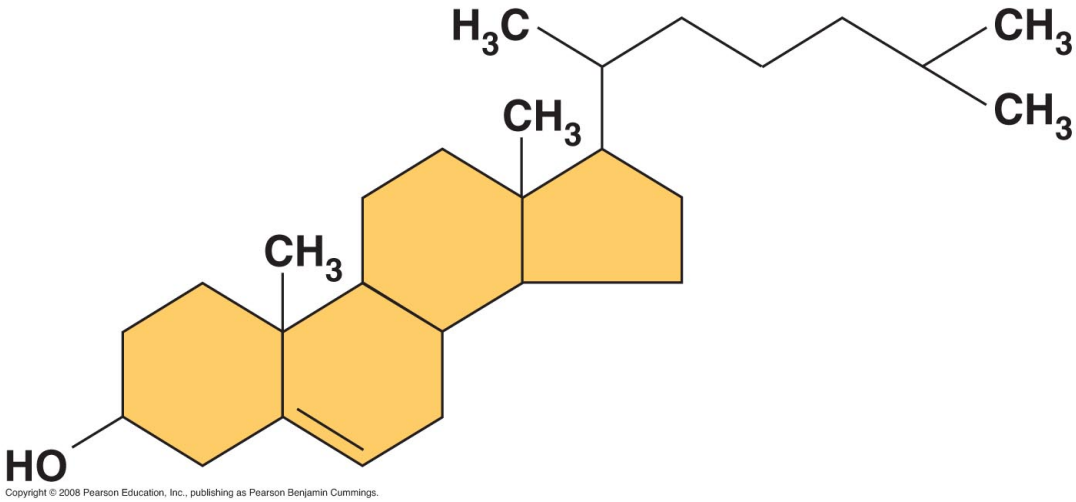


(b) Fat molecule (triacylglycerol)



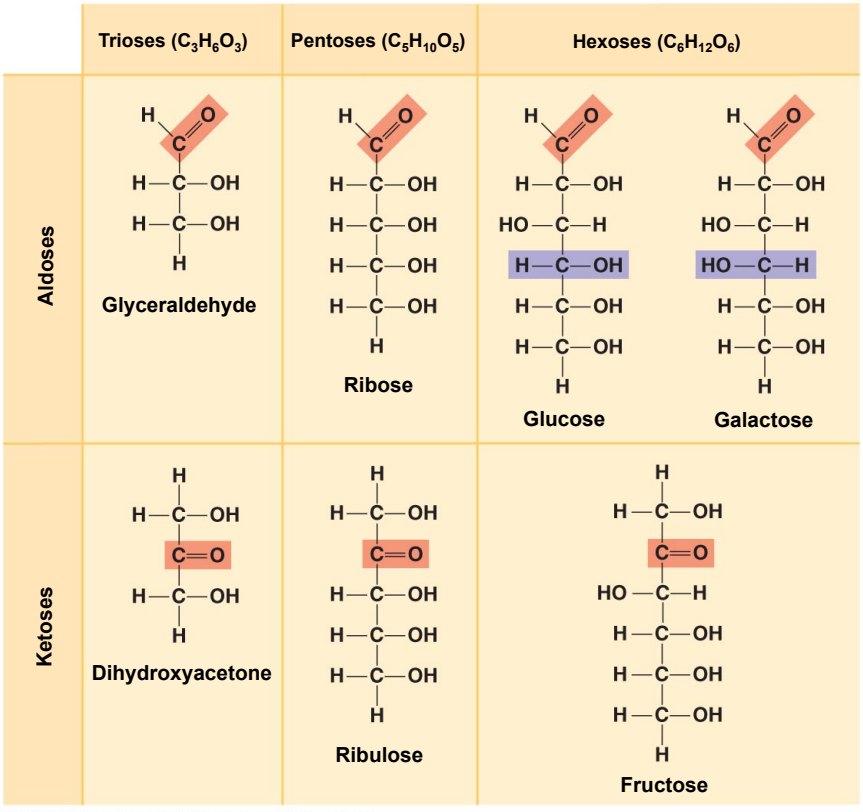


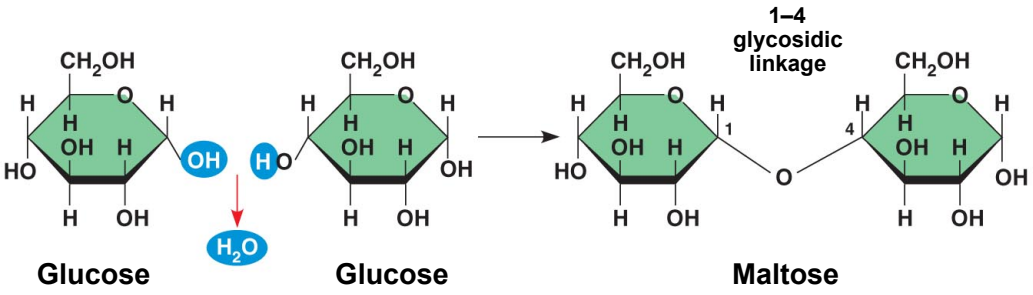




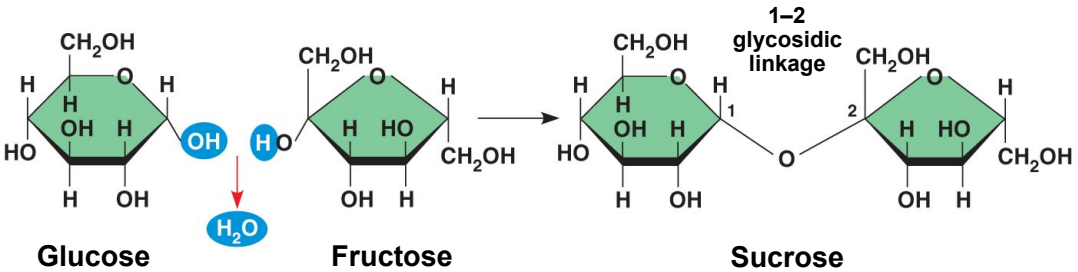
Polysaccharides

- Complex sugars
- Polymers of monosaccharides (simple sugars)
- Polysaccharides and monosaccharides are carbohydrates
- Important for:
  - structure
  - storage of energy
  - cell identity marking

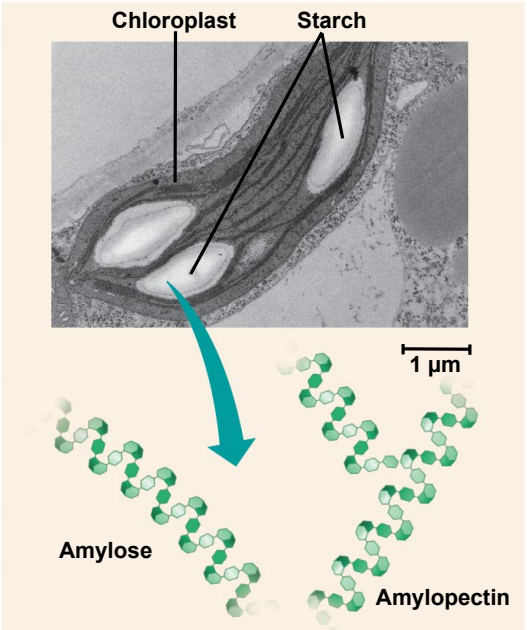




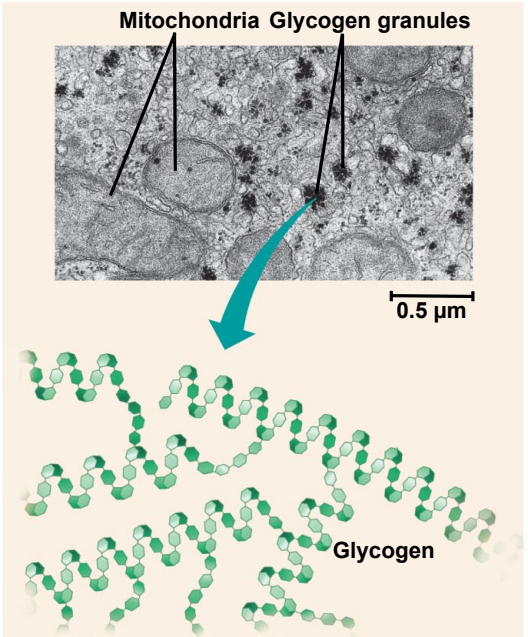
(a) Dehydration reaction in the synthesis of maltose



(b) Dehydration reaction in the synthesis of sucrose

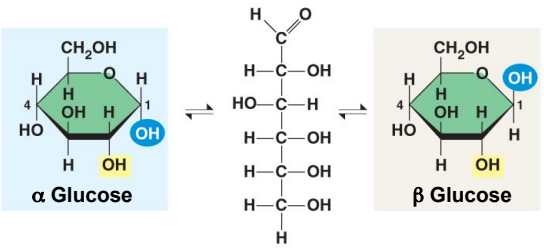


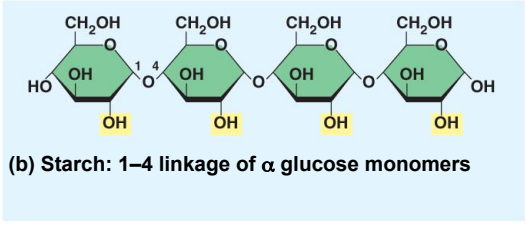
(a) Starch: a plant polysaccharide

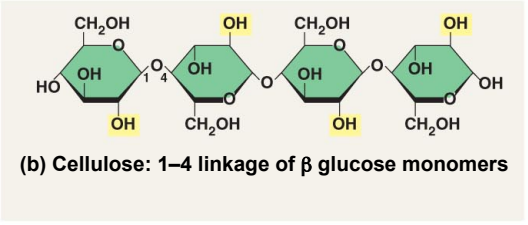


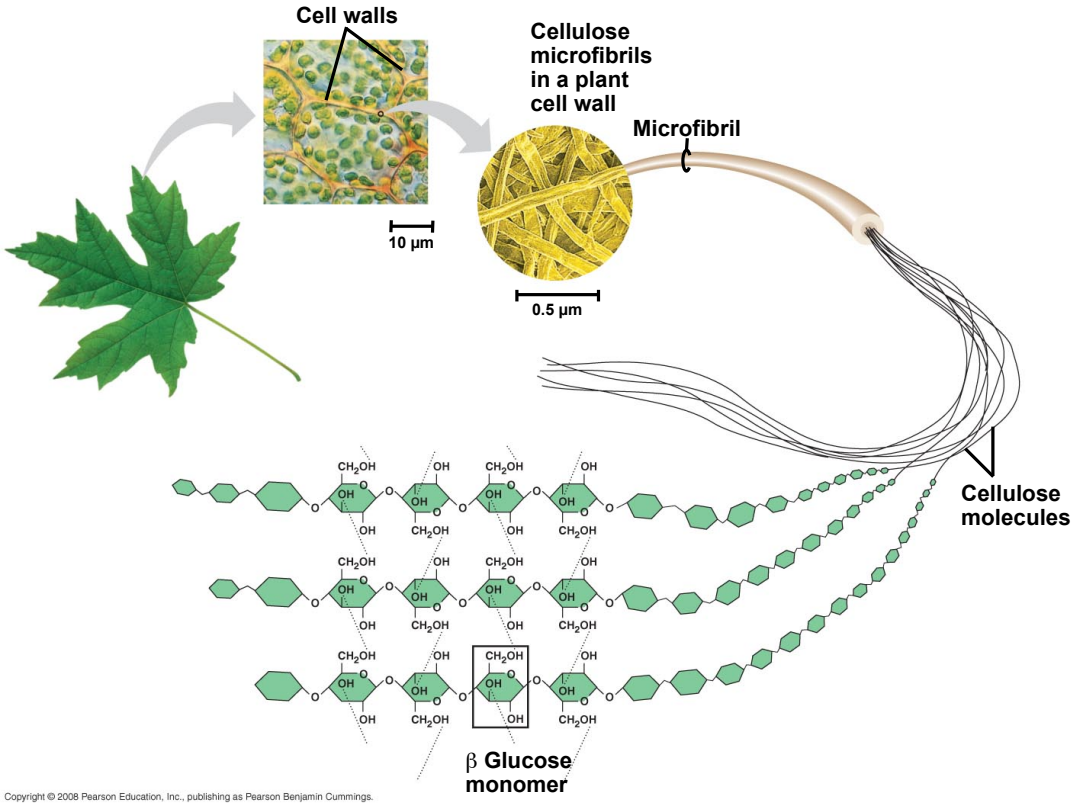
(b) Glycogen: an animal polysaccharide

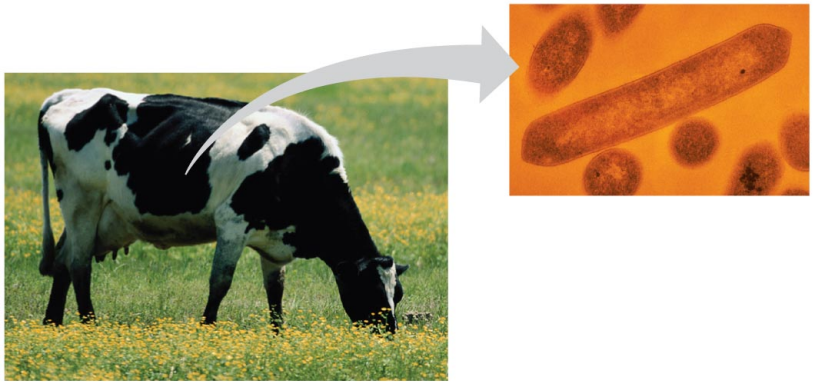
(a) α and β glucose ring structures

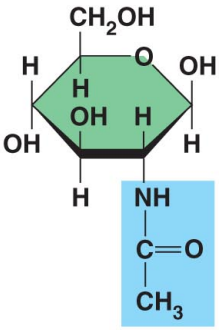






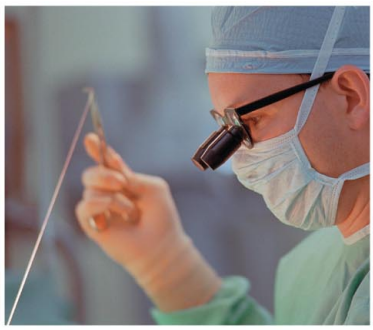






(a) The structure of the chitin monomer.

(b) Chitin forms the exoskeleton of arthropods.



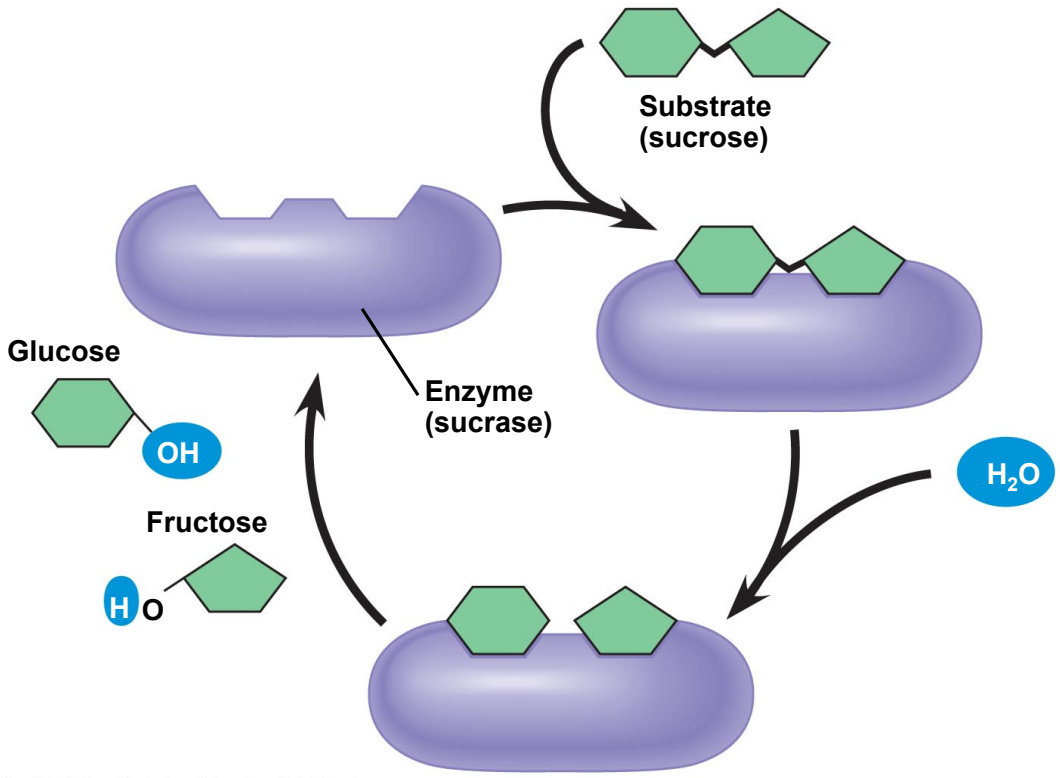
(c) Chitin is used to make a strong and flexible surgical thread.

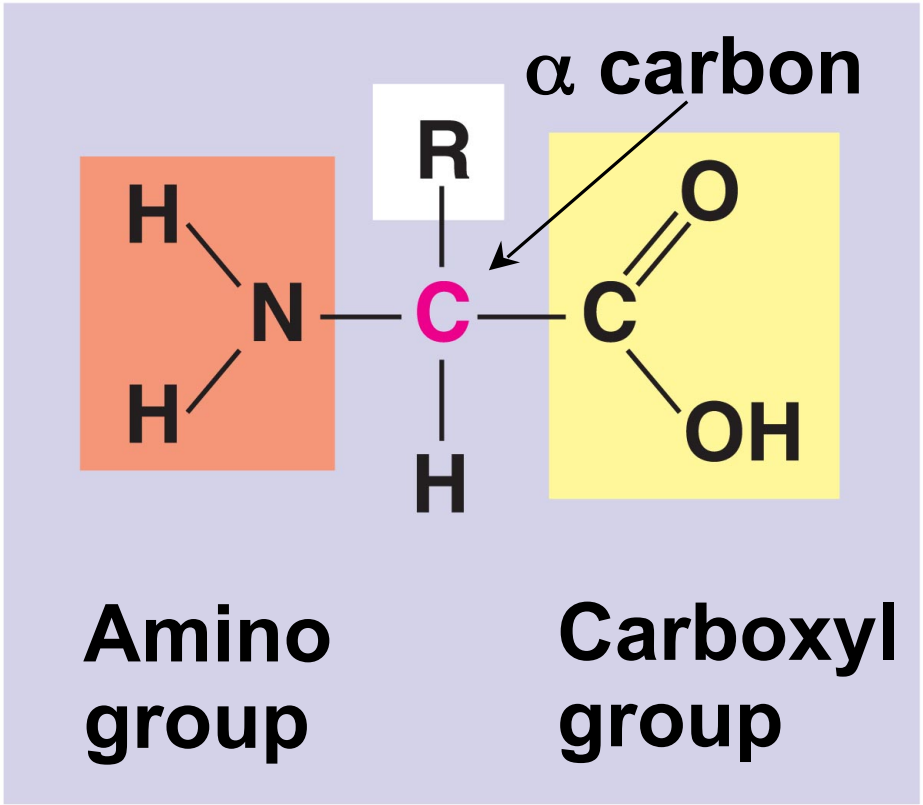
Proteins

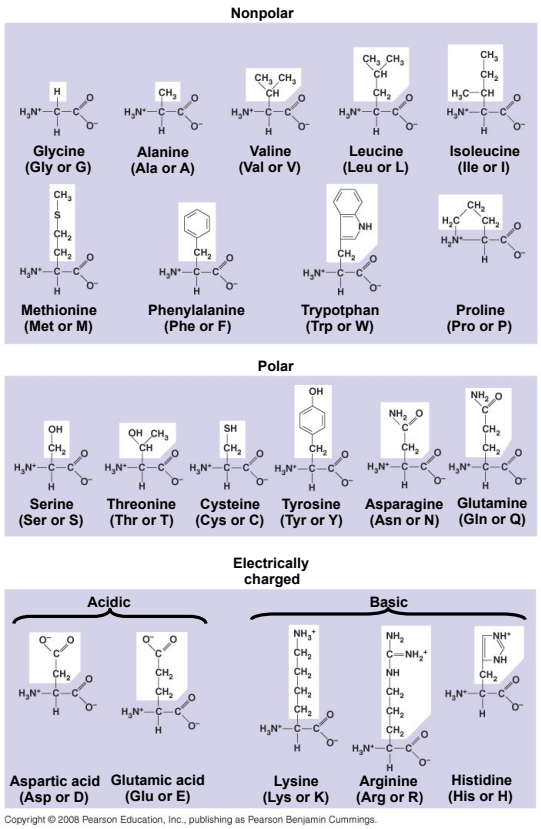
- Polymers of amino acids
- Highly complex shape
- Function is based on shape
- Huge variety of functions

Table 5.1 An Overview of Protein Functions

Type of Protein	Function	Examples
Enzymatic proteins	Selective acceleration of chemical reactions	Digestive enzymes
Structural proteins	Support	Silk fibers; collagen and elastin in animal connective tissues; keratin in hair, horns, feathers, and other skin appendages
Storage proteins	Storage of amino acids	Ovalbumin in egg white; casein, the protein of milk; storage proteins in plant seeds
Transport proteins	Transport of other substances	Hemoglobin, transport proteins
Hormonal proteins	Coordination of an organism's activities	Insulin, a hormone secreted by the pancreas
Receptor proteins	Response of cell to chemical stimuli	Receptors in nerve cell membranes
Contractile and motor proteins	Movement	Actin and myosin in muscles, proteins in cilia and flagella
Defensive proteins	Protection against disease	Antibodies combat bacteria and viruses.







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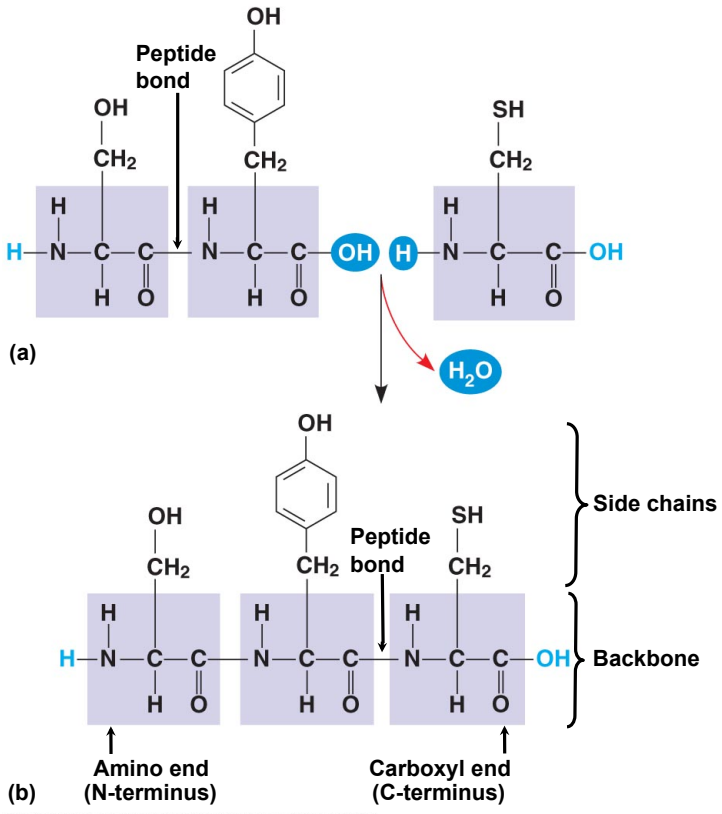

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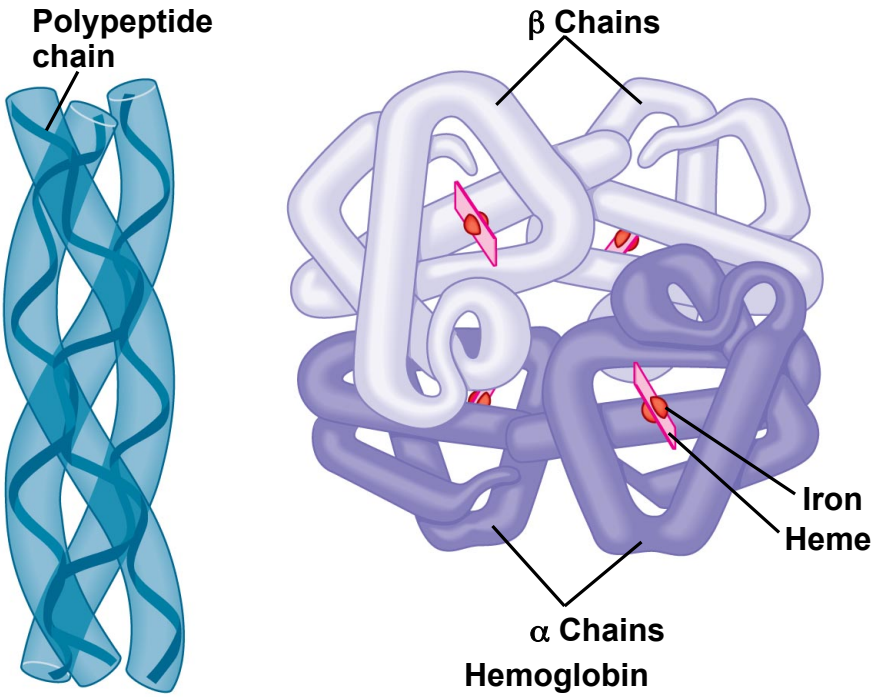

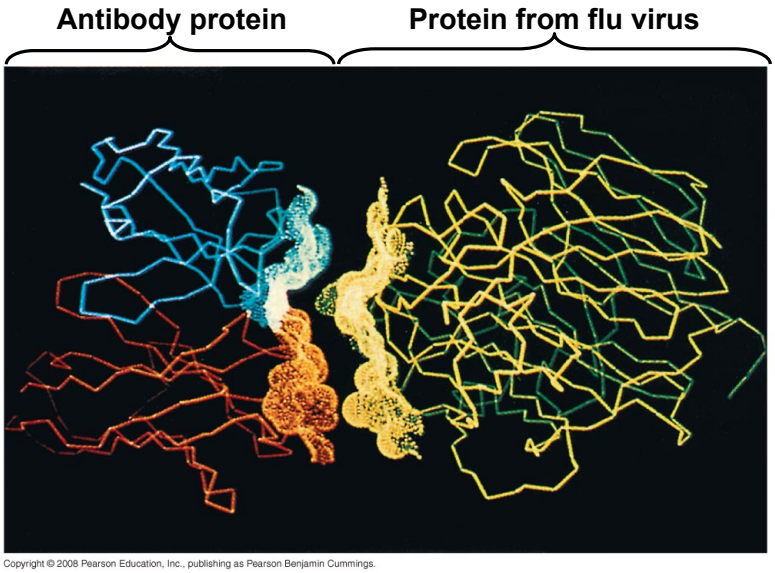

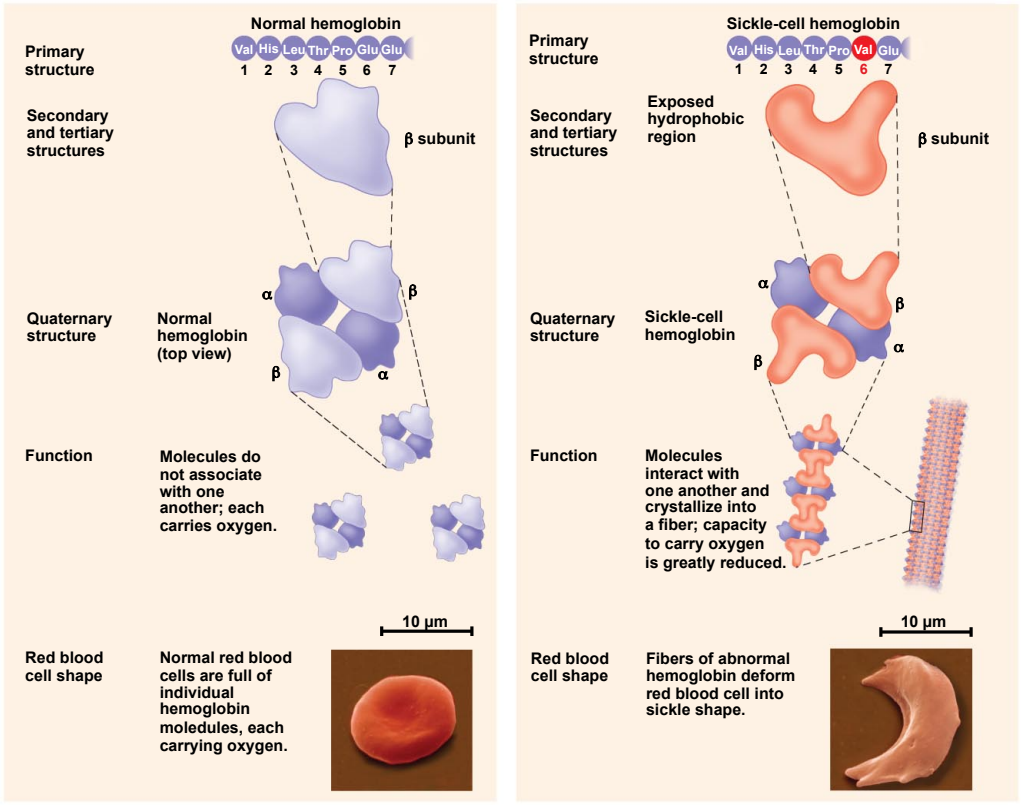

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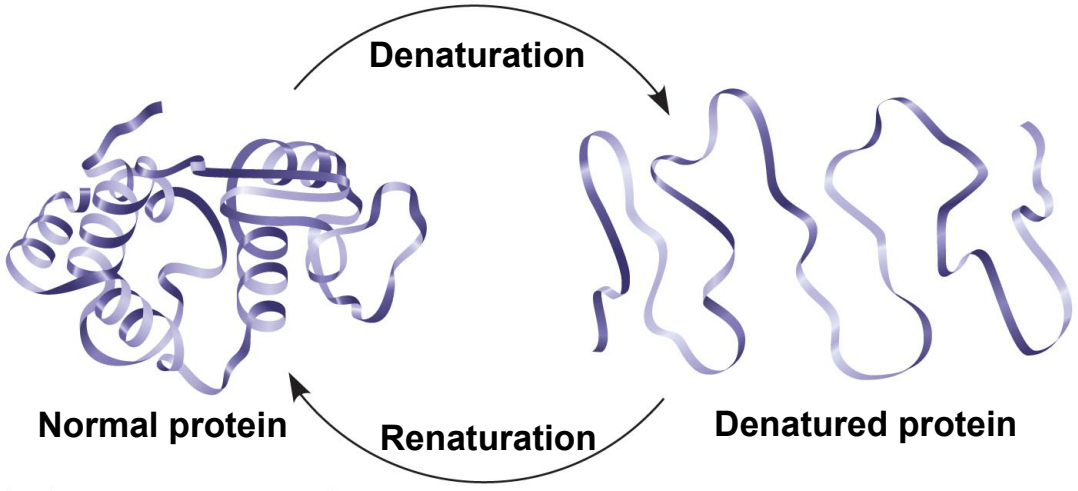
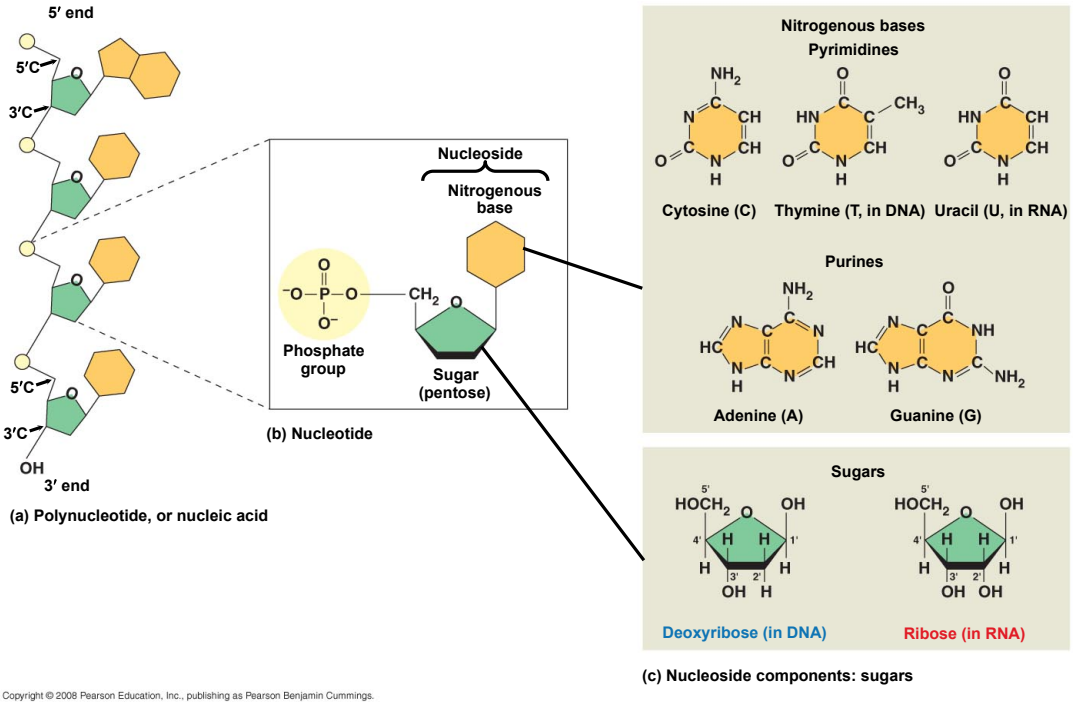
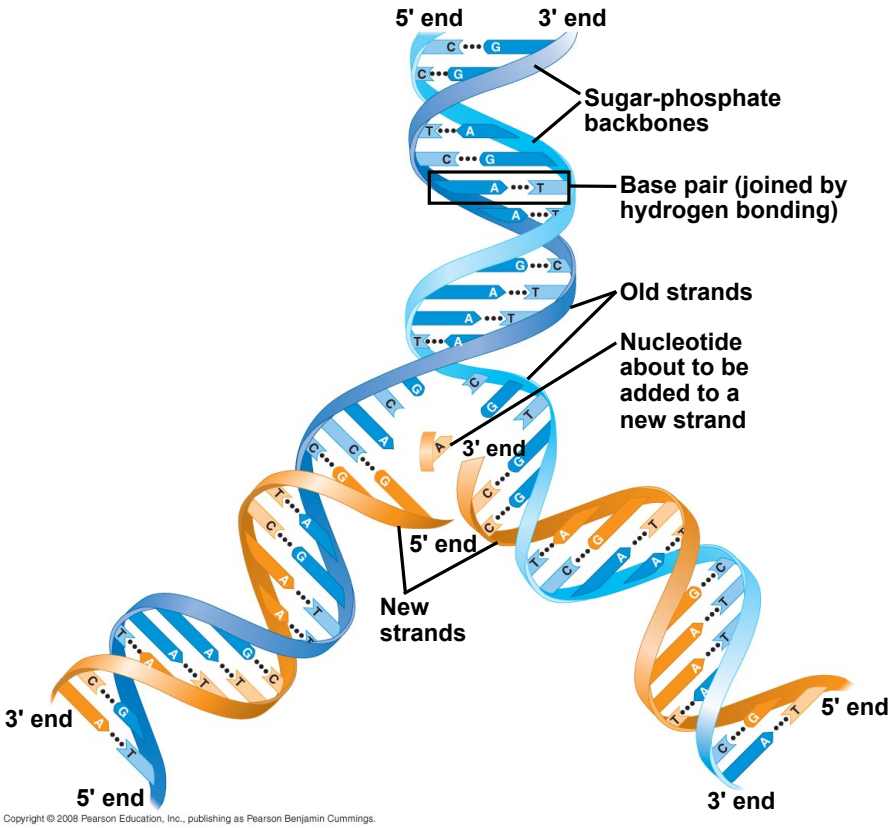


26

Nucleic Acids

- Polymers of nucleotides
  - also called polynucleotides
- Store and convey information
- Instruction manual of the cell
- Include:
  - DNA (deoxyribonucleic acid)
  - RNA (ribonucleic acid)
- Important for:
  - reproduction of cells
  - production of proteins





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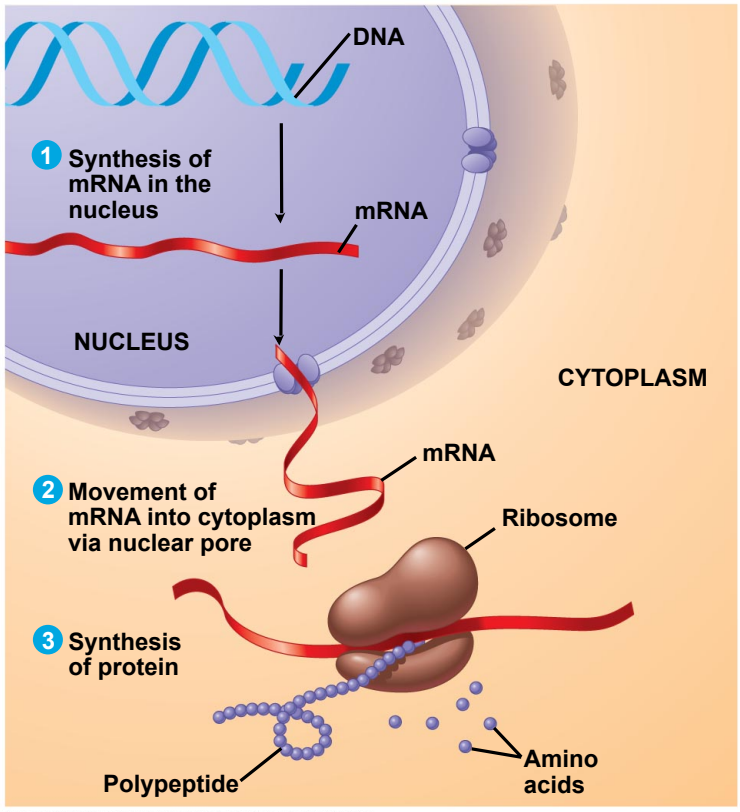
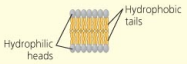
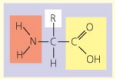
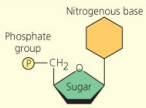


30

Large Biological Molecules	Components	Examples	Functions
Concept 5.2 **Carbohydrates** serve as fuel and building material	 Monosaccharide monomer	Monosaccharides: glucose, fructose	Fuel; carbon sources that can be converted to other molecules or combined into polymers
		Disaccharides: lactose, sucrose	
		Polysaccharides: • Cellulose (plants) • Starch (plants) • Glycogen (animals) • Chitin (animals and fungi)	• Strengthens plant cell walls • Stores glucose for energy • Stores glucose for energy • Strengthens exoskeletons and fungal cell walls
Concept 5.3 **Lipids** are a diverse group of hydrophobic molecules and are not macromolecules		Triacylglycerols (fats or oils): glycerol + 3 fatty acids	Important energy source 
		Phospholipids: phosphate group + 2 fatty acids	Lipid bilayers of membranes 
	 Steroid backbone	Steroids: four fused rings with attached chemical groups	• Component of cell membranes (cholesterol) • Signals that travel through the body (hormones)
Concept 5.4 **Proteins** have many structures, resulting in a wide range of functions	 Amino acid monomer (20 types)	• Enzymes • Structural proteins • Storage proteins • Transport proteins • Hormones • Receptor proteins • Motor proteins • Defensive proteins	• Catalyze chemical reactions • Provide structural support • Store amino acids • Transport substances • Coordinate organismal responses • Receive signals from outside cell • Function in cell movement • Protect against disease
Concept 5.5 Nucleic acids store and transmit hereditary information	 Nucleotide monomer	DNA: • Sugar = deoxyribose • Nitrogenous bases = C, G, A, T • Usually double-stranded	Stores all hereditary information
		RNA: • Sugar = ribose • Nitrogenous bases = C, G, A, U • Usually single-stranded	Carries protein-coding instructions from DNA to protein-synthesizing machinery