

Objective: You will be able to describe the types of properties found in each monomer.

Do now:

- Relate polar, nonpolar molecules with the concepts of hydrophobic and hydrophilic

Functional Groups

- A chemical group with specific properties that impacts chemical reactions and the overall property of a molecule
 - Hydroxyl group
 - Carboxyl group
 - Amino group
 - Phosphate group

Figure 3.6-1a

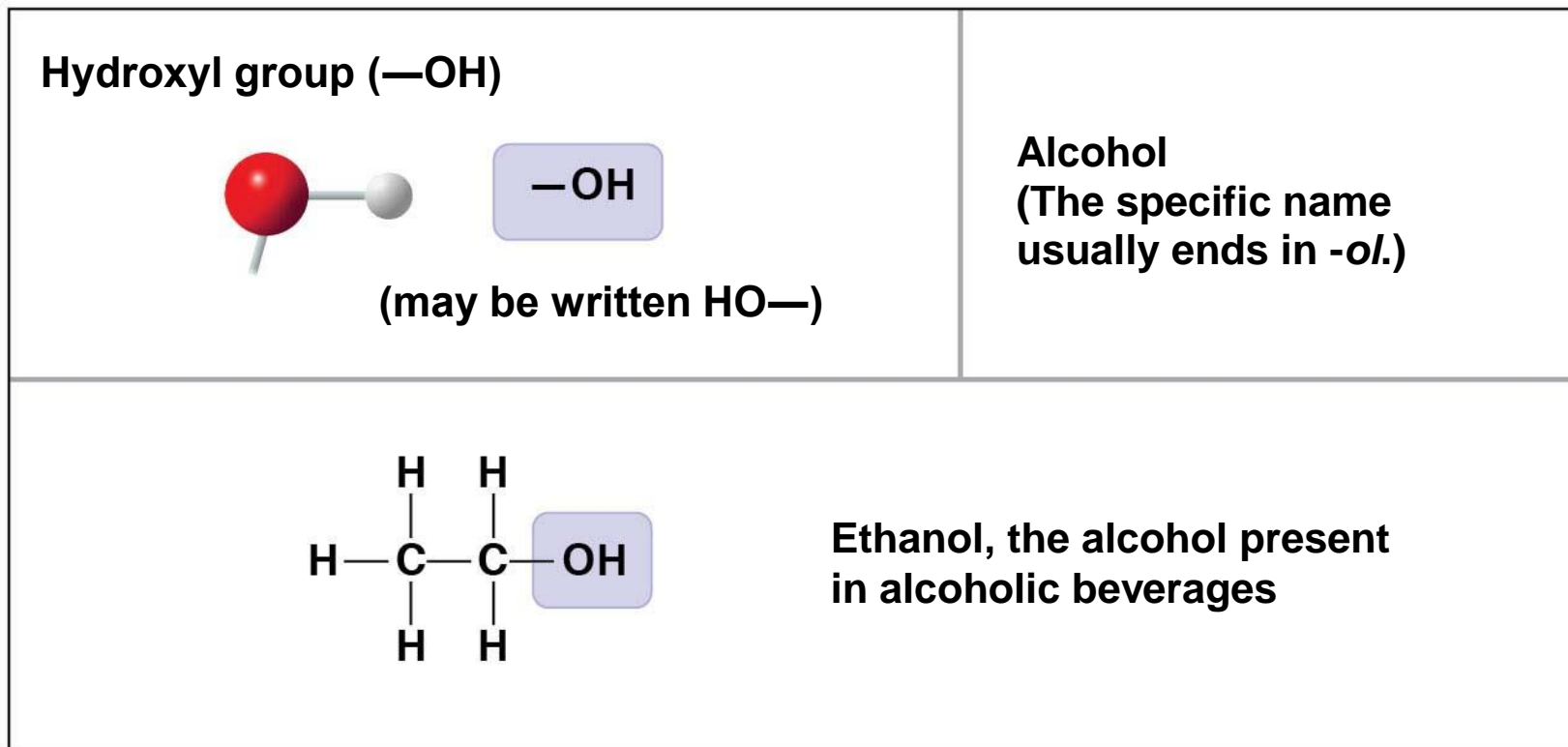


Figure 3.6-1c

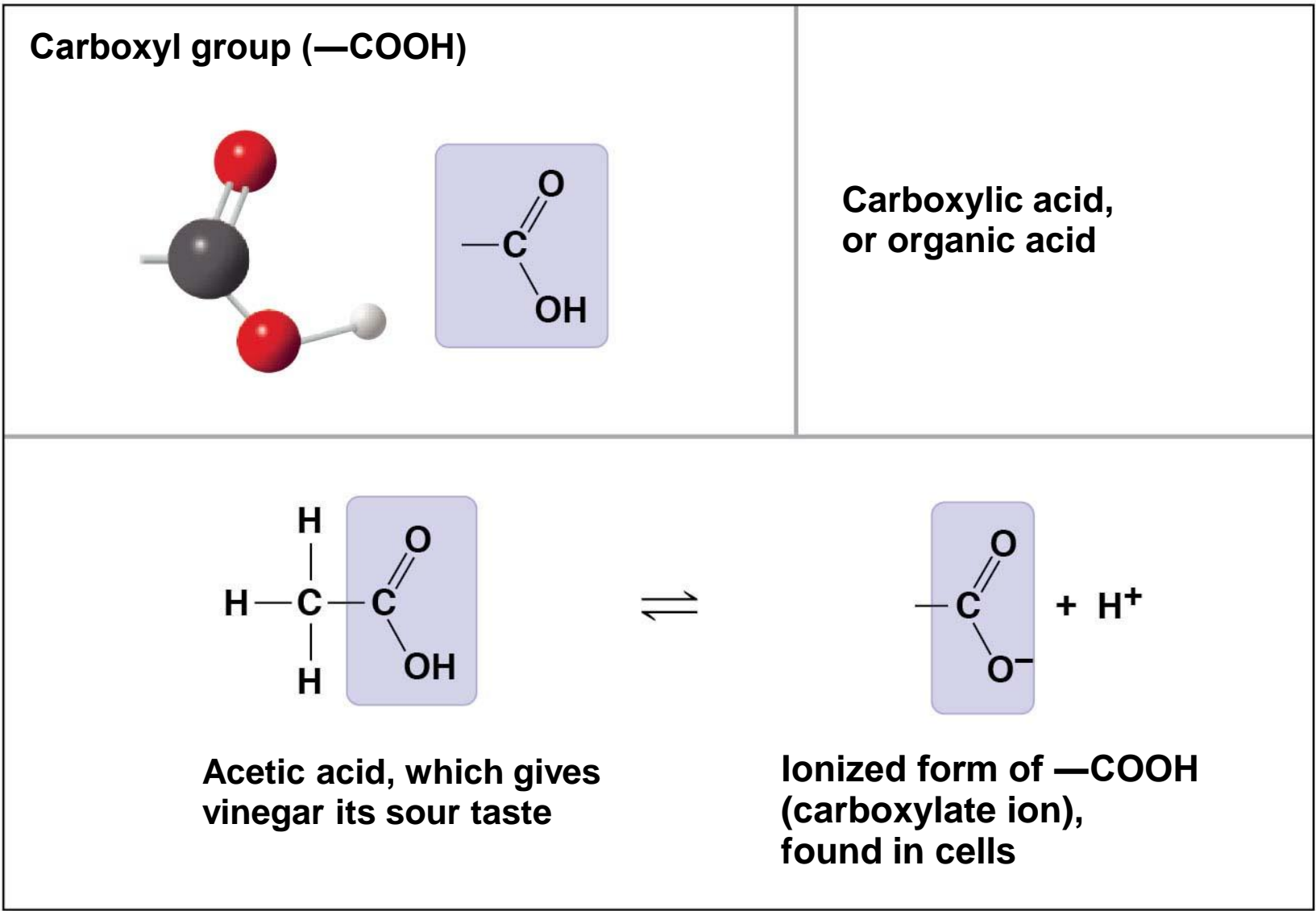


Figure 3.6-1d

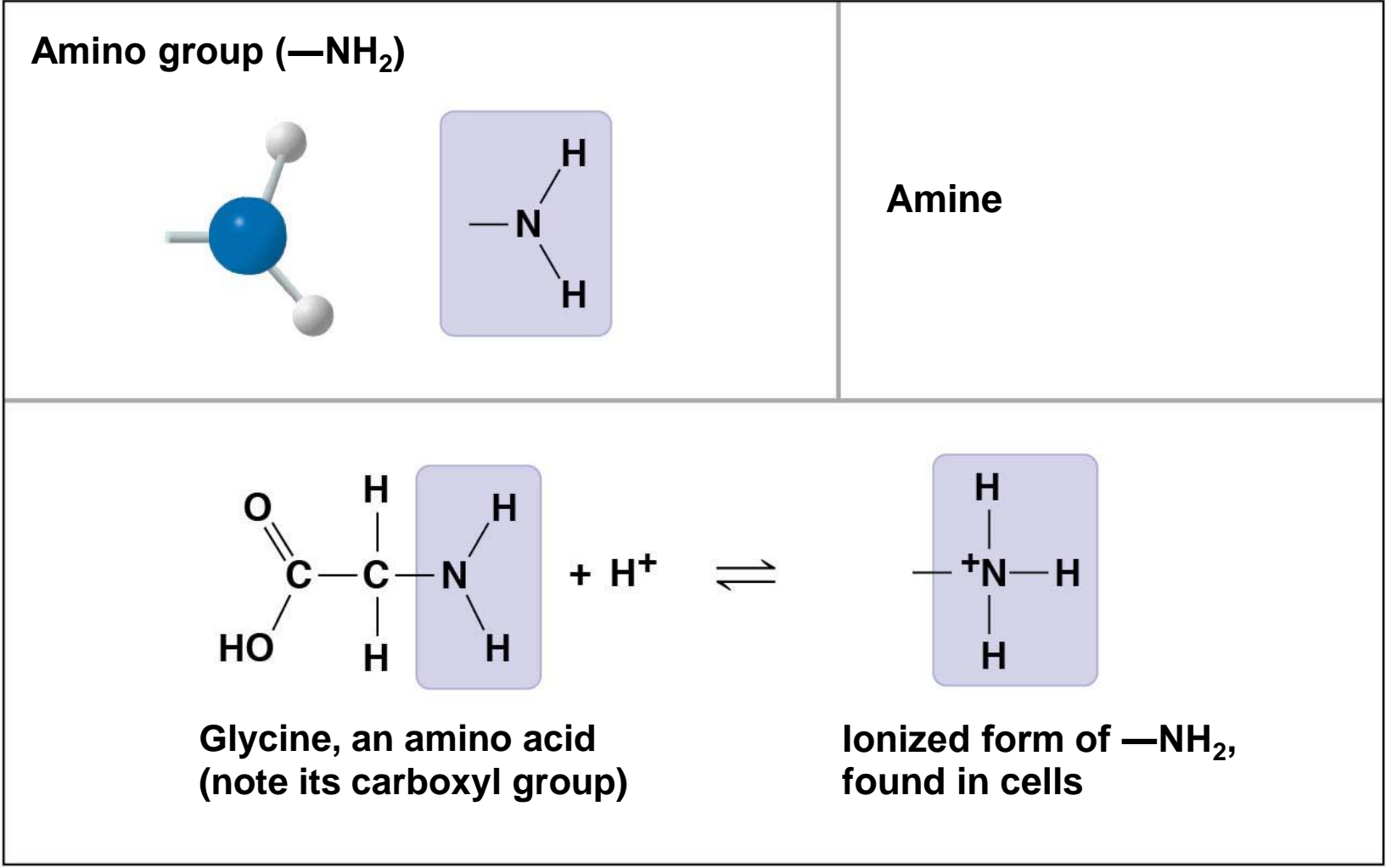


Figure 3.6-2b

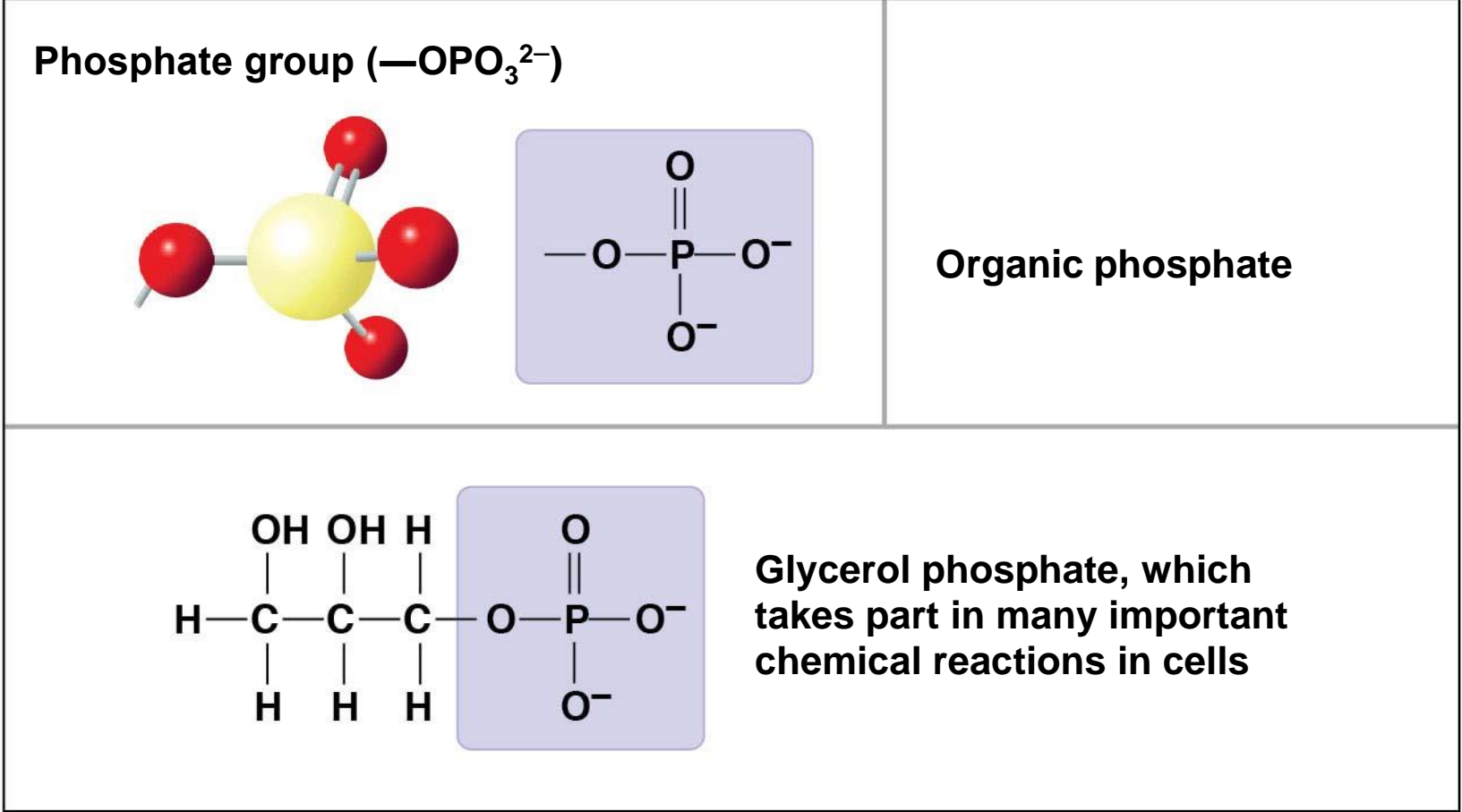
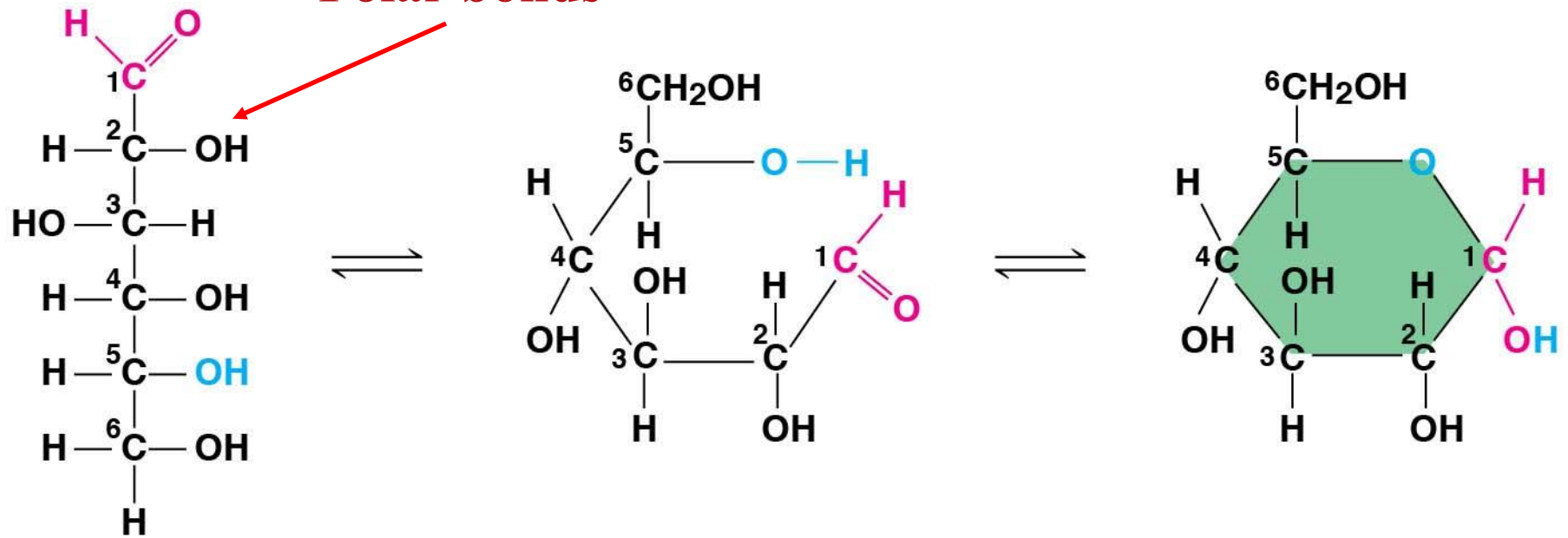


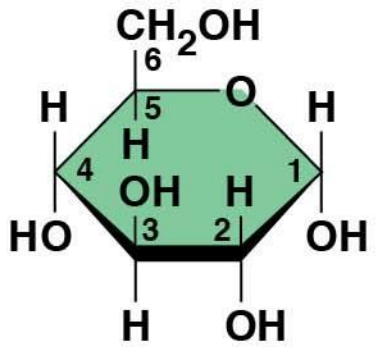
Figure 3.9

Polar bonds



(a) Linear and ring forms

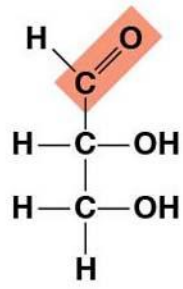
Monosaccharides



(b) Abbreviated ring structure

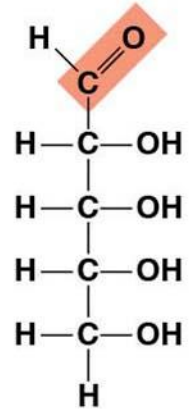
Figure 3.8

Triose: three-carbon sugar (C₃H₆O₃)



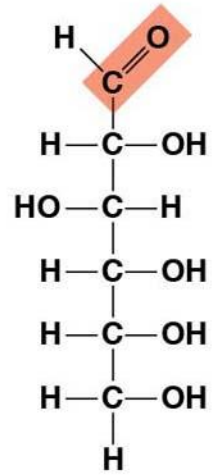
Glyceraldehyde
An initial breakdown
product of glucose in cells

Pentose: five-carbon sugar (C₅H₁₀O₅)

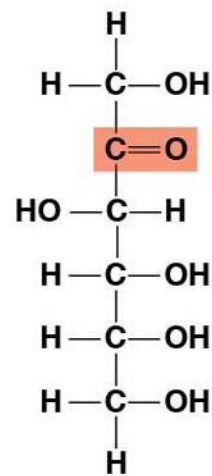


Ribose
A component of RNA

Hexoses: six-carbon sugars (C₆H₁₂O₆)



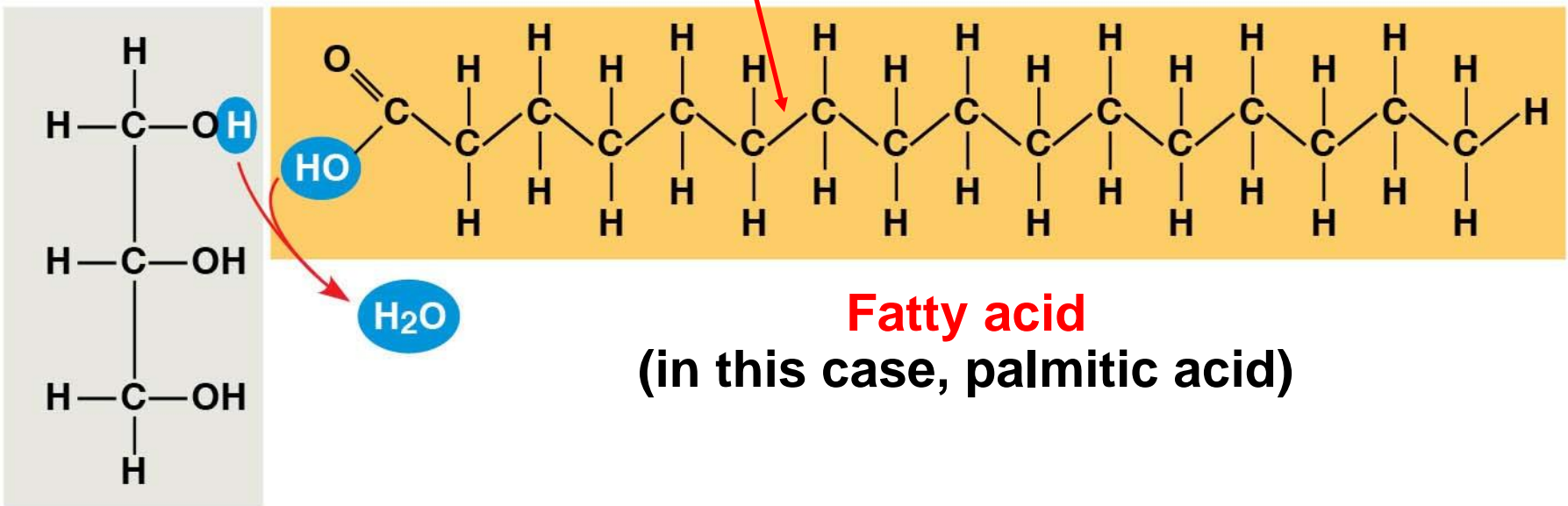
Glucose
Energy sources for organisms



Fructose

**How do you know
that these are
monosaccharides?**

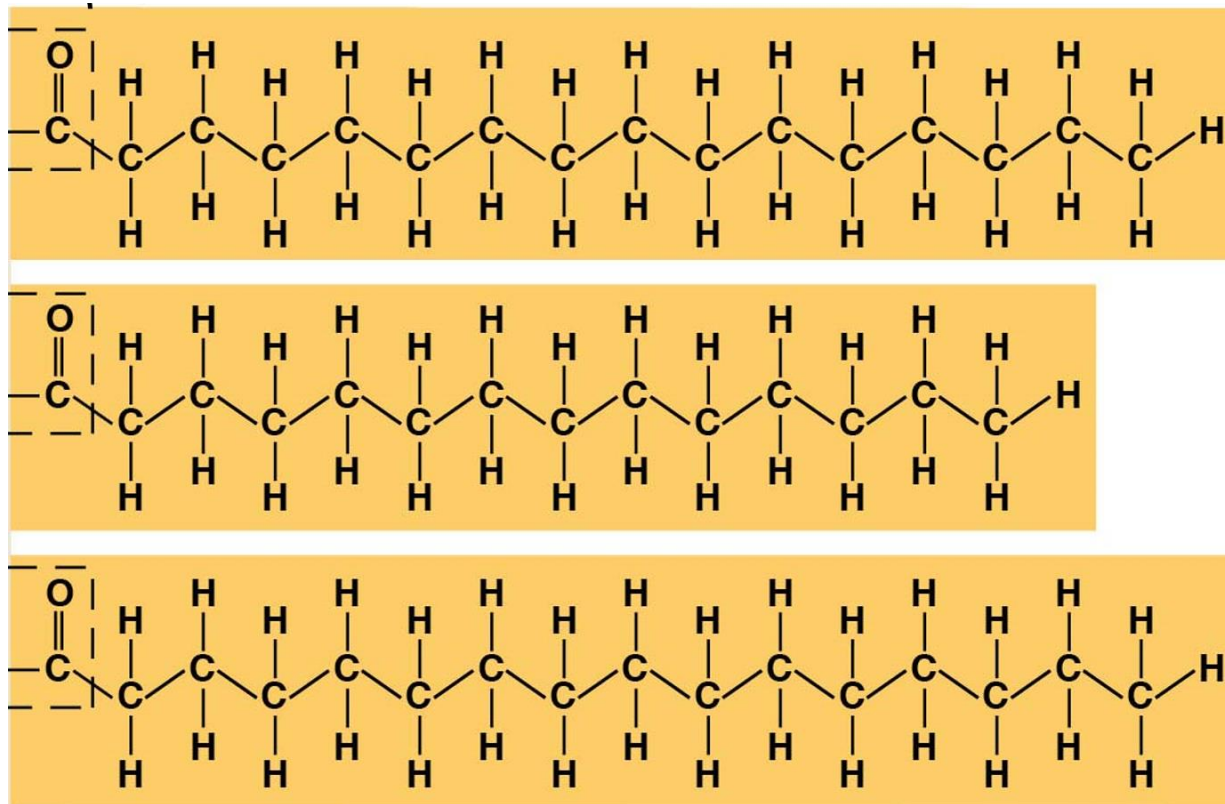
Nonpolar bonds



Glycerol

(a) One of three dehydration reactions in the synthesis of a fat

How do you know that these are fatty acids?



Amino Acids

Side chain (R group)

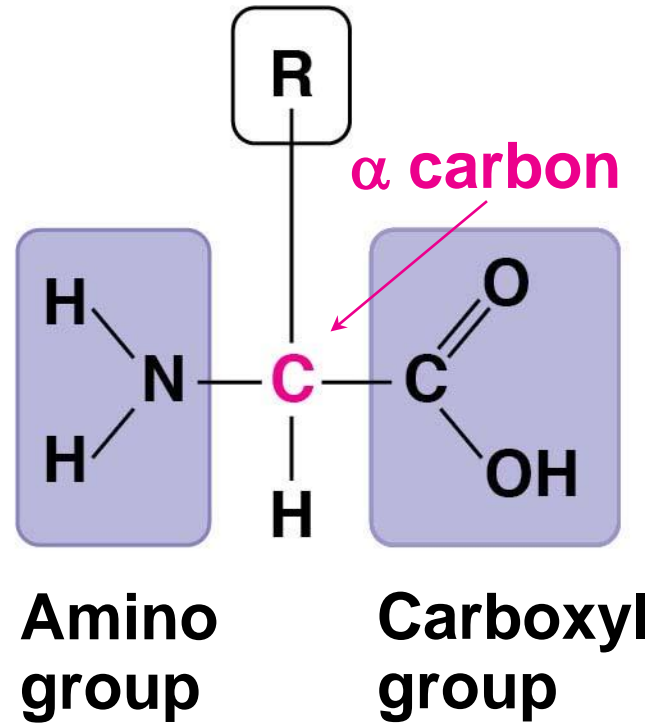
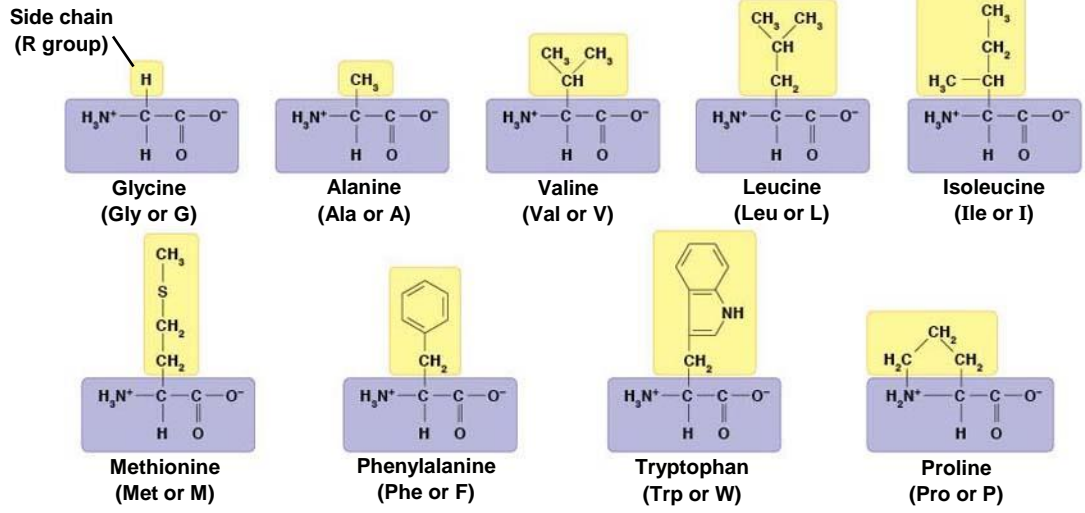


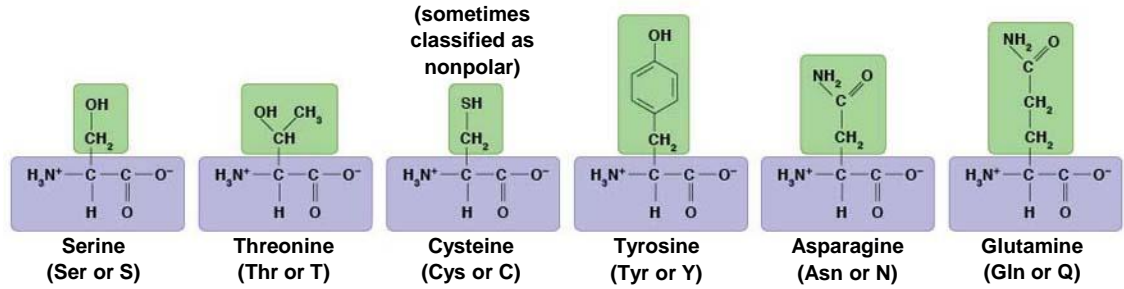
Figure 3.18

Amino Acids

Nonpolar side chains; hydrophobic



Polar side chains; hydrophilic



Electrically charged side chains; hydrophilic

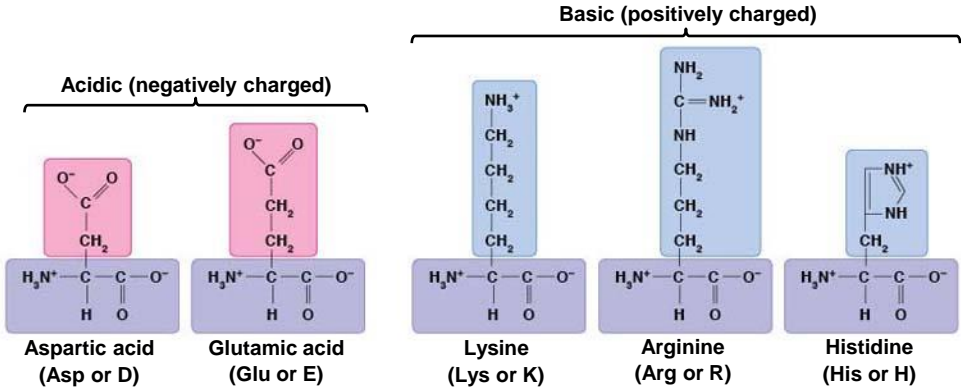
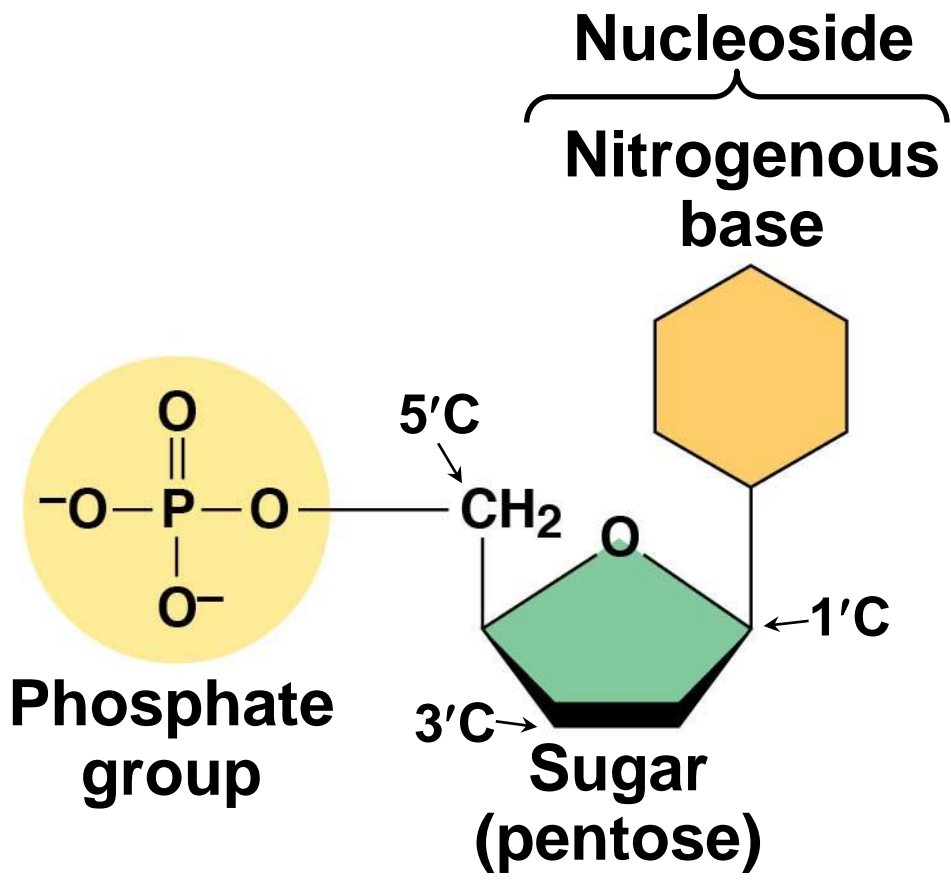
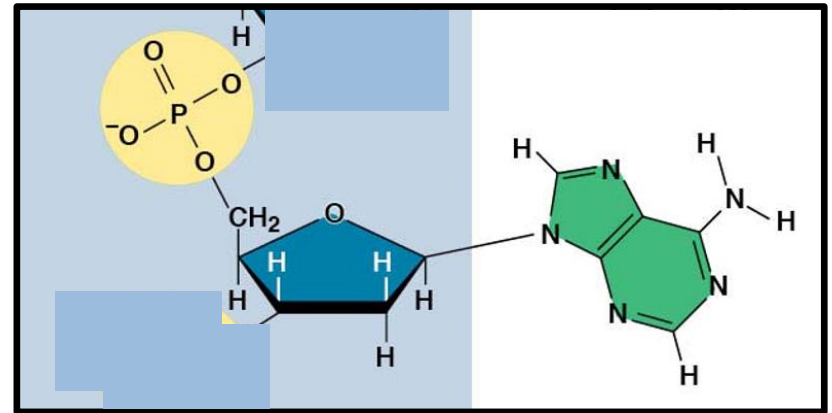
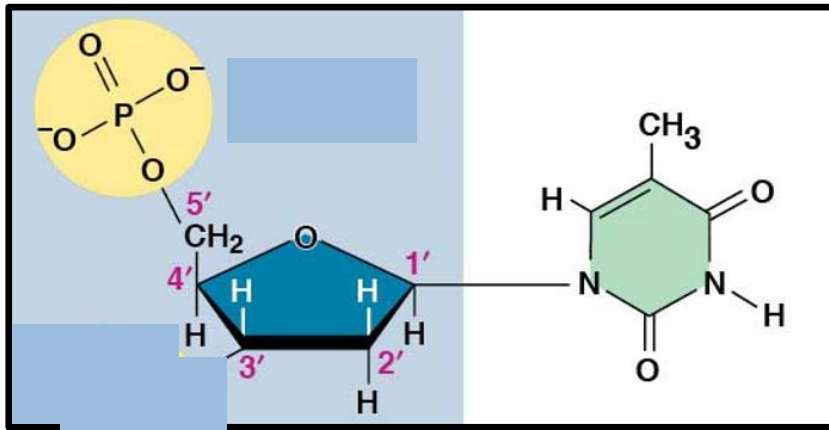


Figure 3.27-2



(b) Nucleotide

How do you know that these are nucleotides?



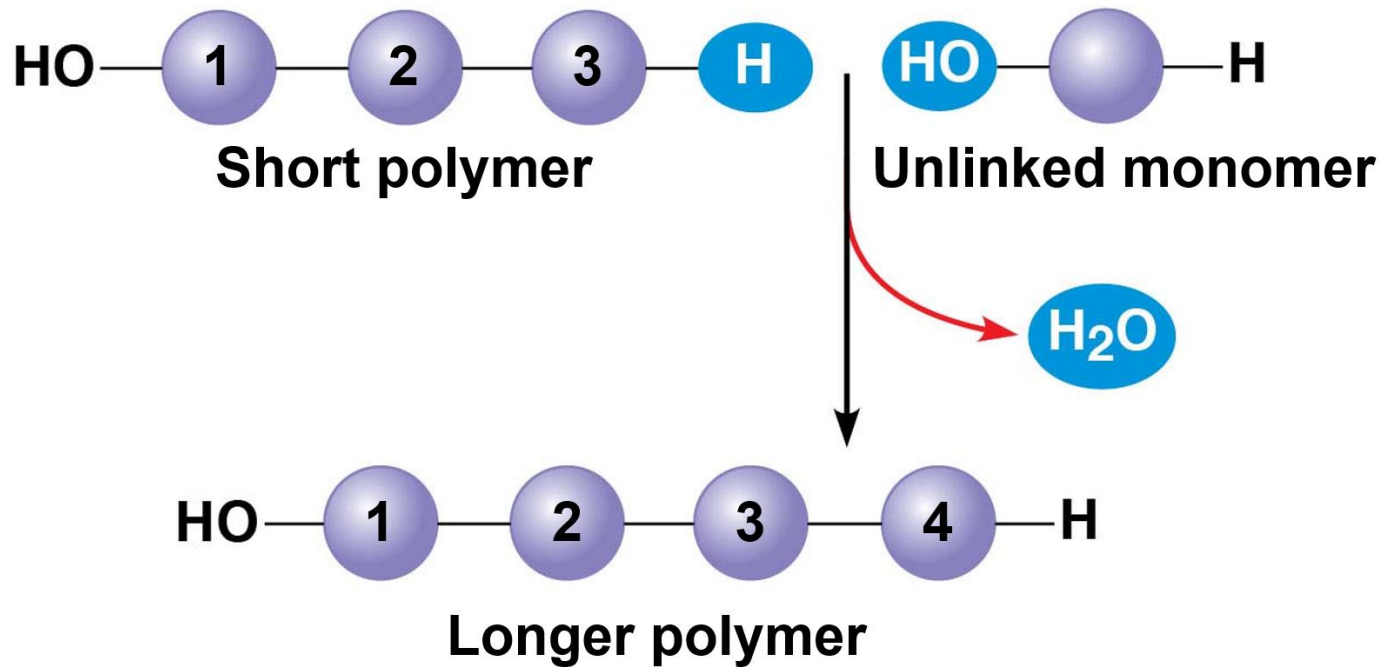
Objective: You will be able to describe the types of bonds that connect monomers to form polymers.

Do now:

- Using context clues, speculate on the meaning of these two terms:
 - Dehydration Synthesis
 - Hydrolysis

Dehydration synthesis forms covalent bonds between monomers to form polymers

(a) Dehydration reaction: synthesizing a polymer



Hydrolysis breaks covalent bonds in polymers to form monomers

(b) Hydrolysis: breaking down a polymer

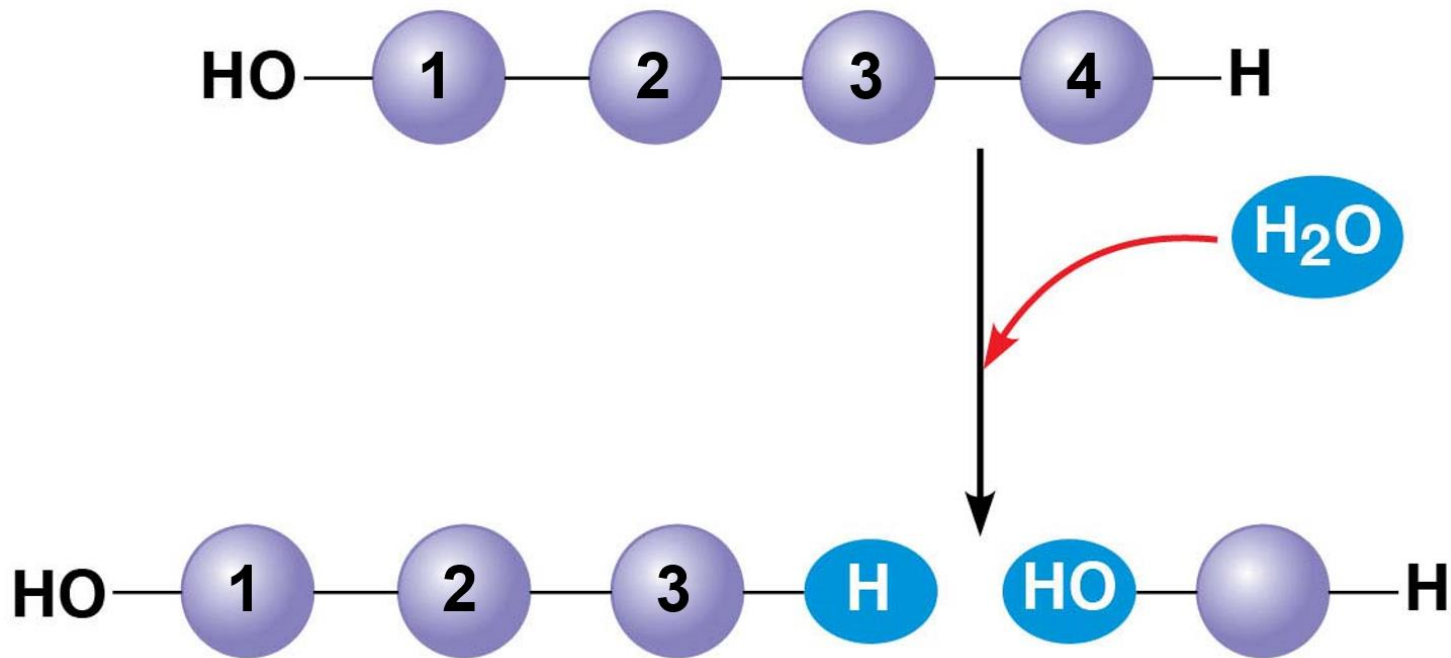
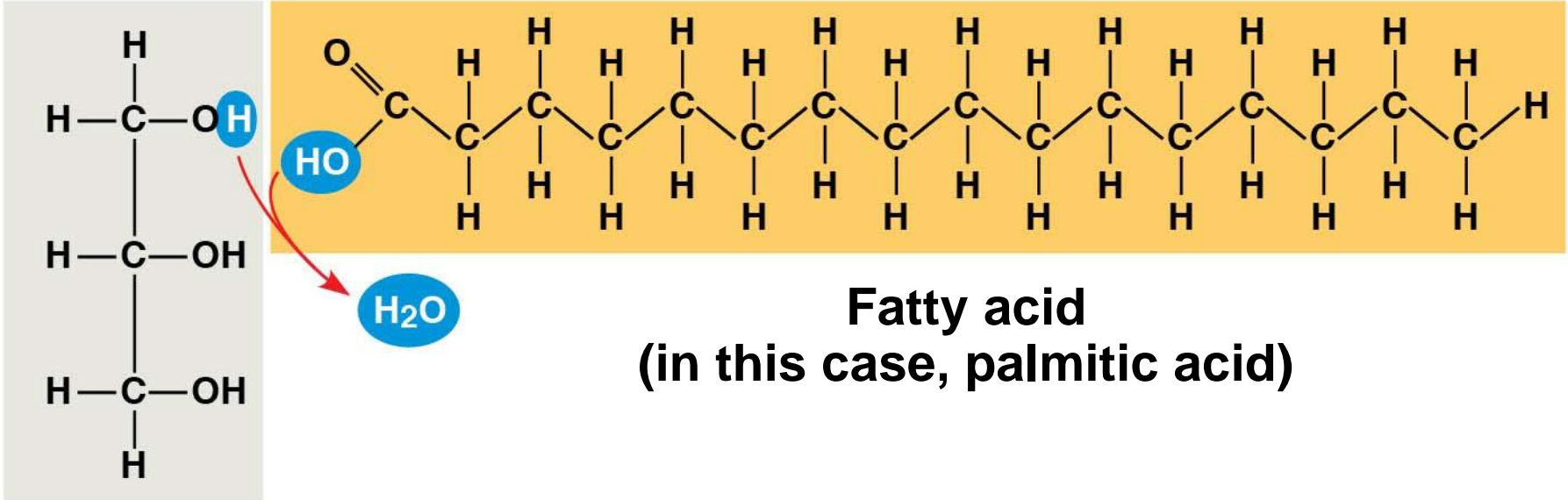


Figure 3.13-1



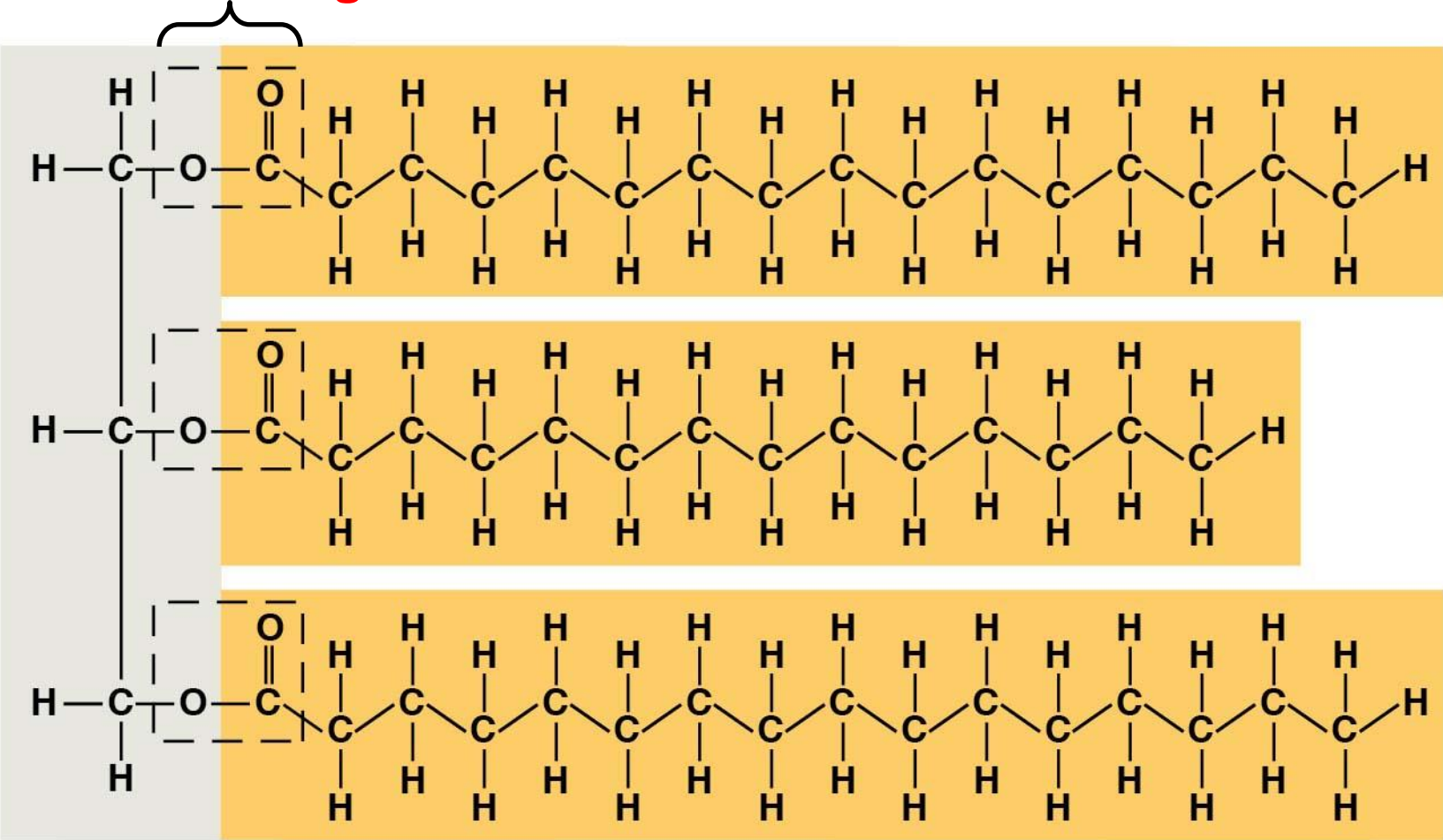
Glycerol

**Fatty acid
(in this case, palmitic acid)**

(a) One of three dehydration reactions in the synthesis of a fat

Figure 3.13-2

Ester linkage

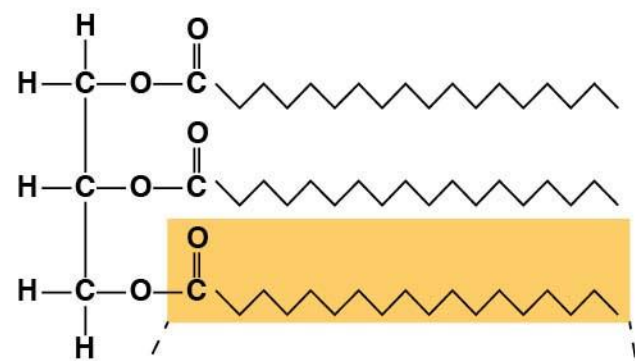


(b) Fat molecule (triacylglycerol)

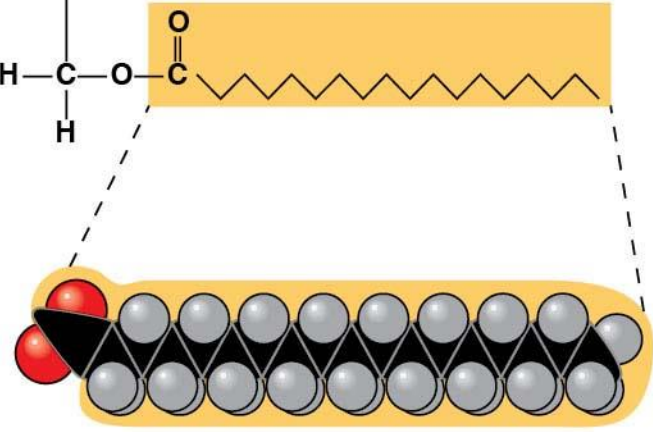
(a) Saturated fat



Structural formula of a saturated fat molecule



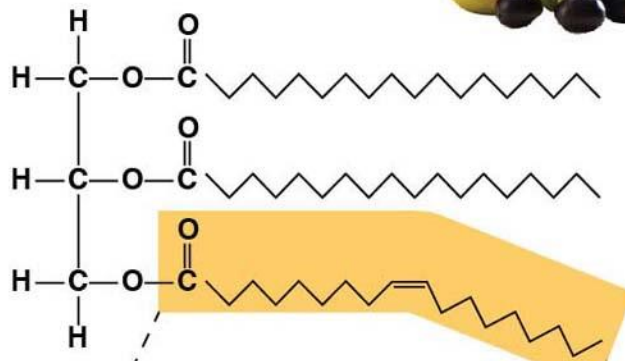
Space-filling model of stearic acid, a saturated fatty acid



(b) Unsaturated fat

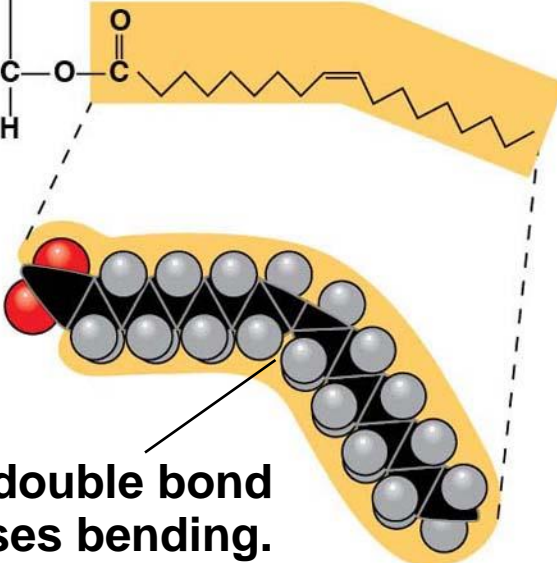


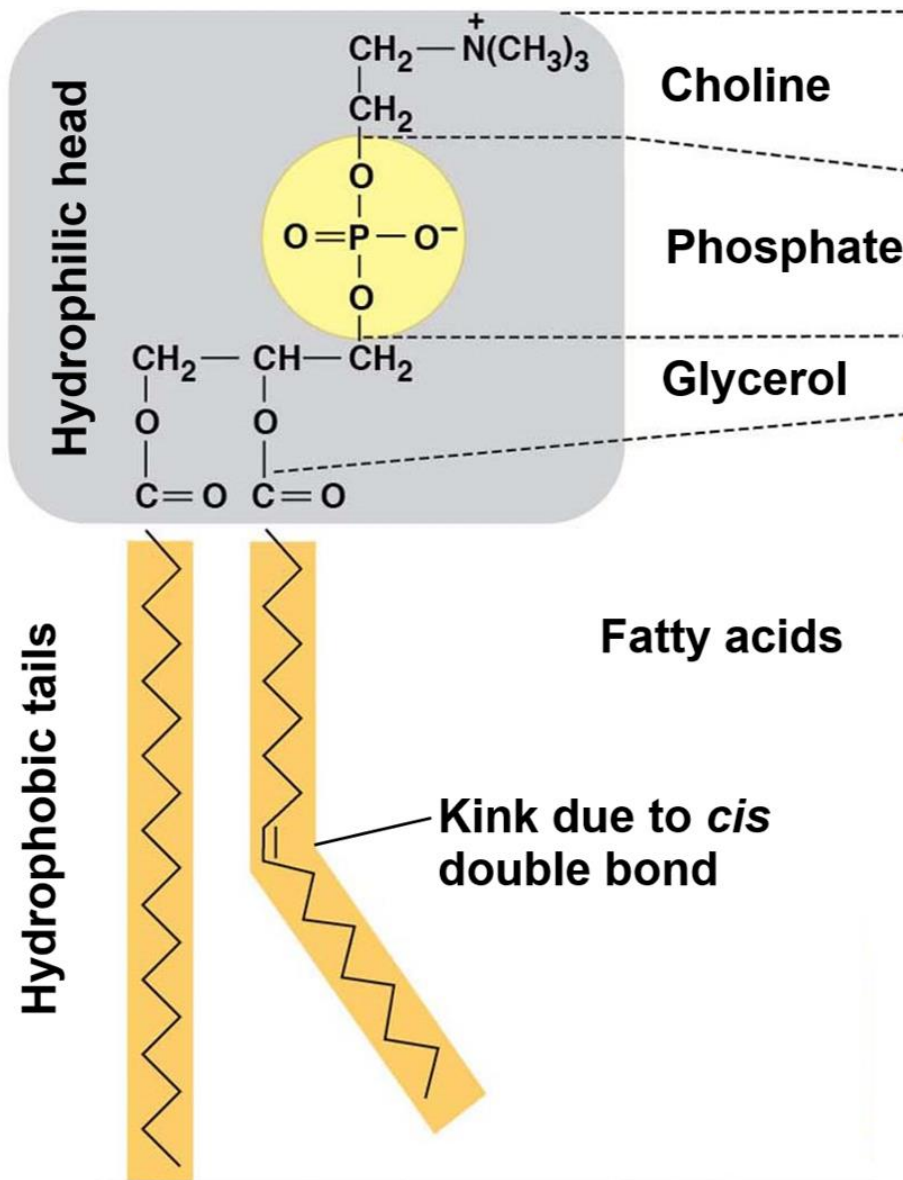
**Structural formula
of an unsaturated
fat molecule**



**Space-filling
model of oleic
acid, an
unsaturated
fatty acid**

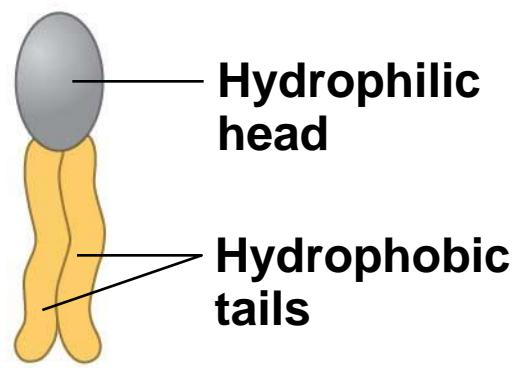
***Cis* double bond
causes bending.**



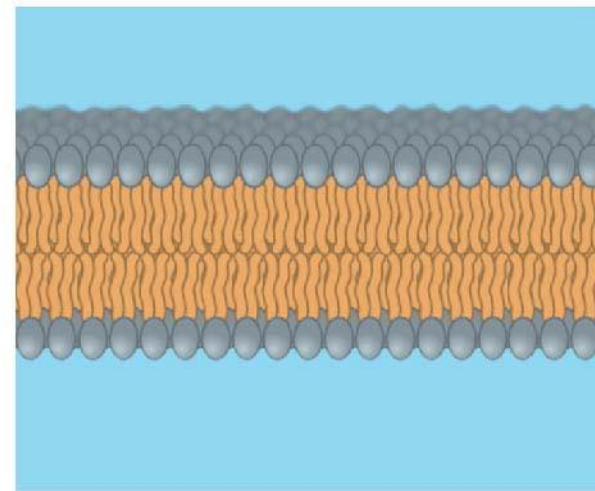


**This is a phospholipid,
how is it similar to a fat?**

How is it different?



(c) Phospholipid symbol



(d) Phospholipid bilayer

Figure 3.16

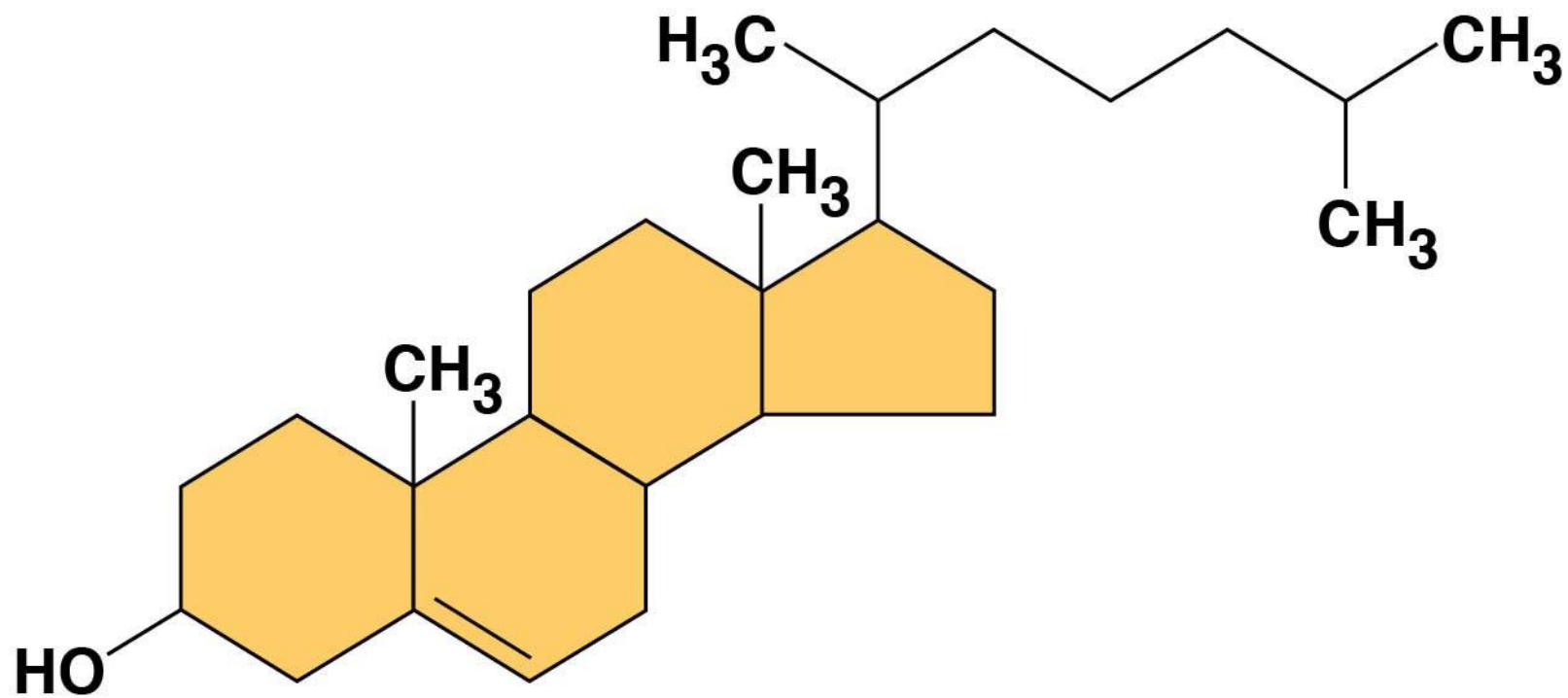
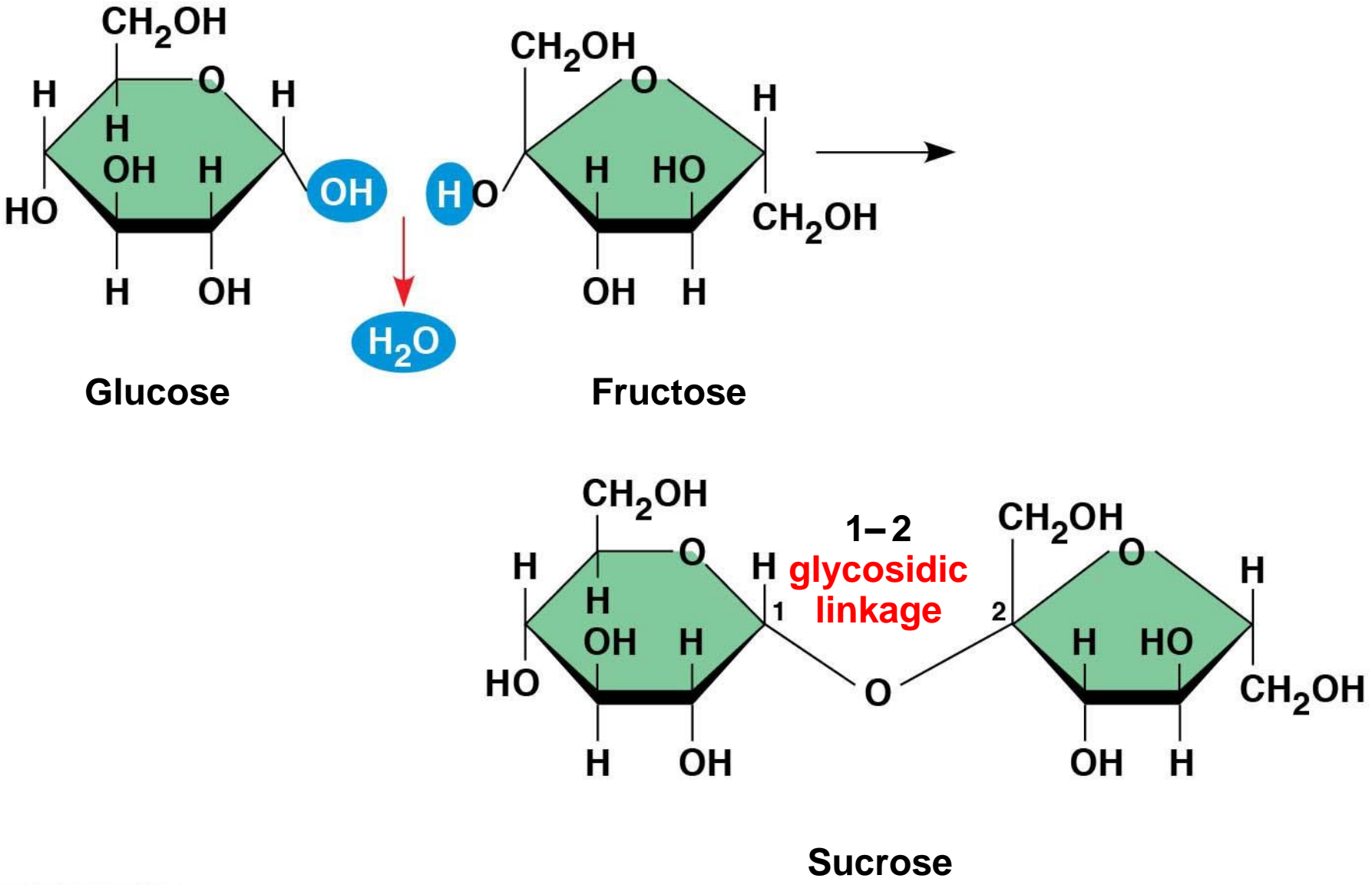
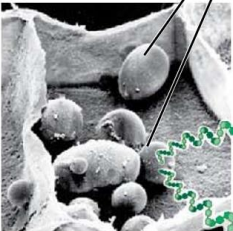


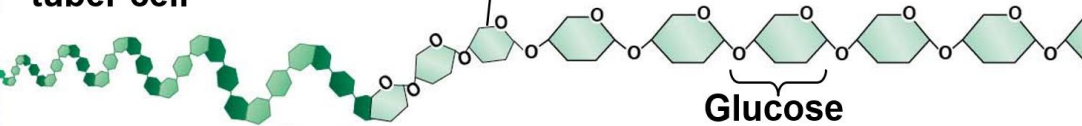
Figure 3.10-s2



Storage structures (plastids) containing starch granules in a potato tuber cell



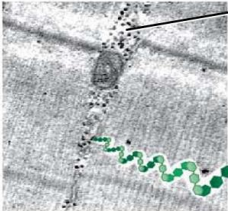
Starch (Amylose)



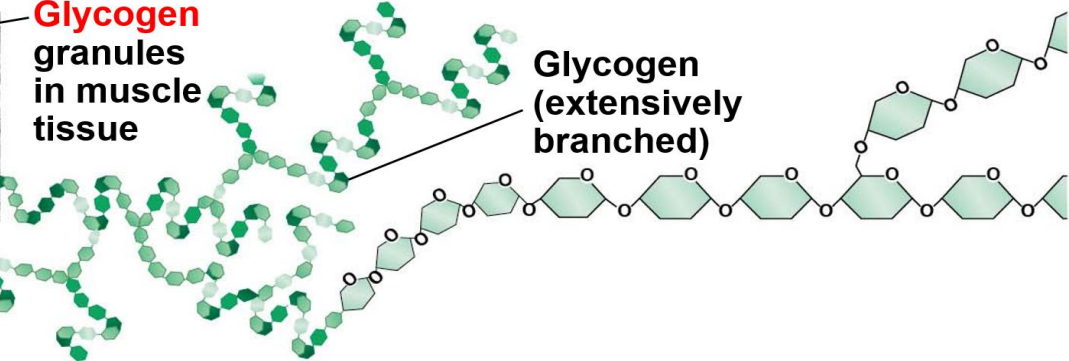
Glucose monomer

Detailed description: This panel illustrates the storage of starch in a potato tuber cell. On the left, a micrograph shows several large, rounded starch granules within plastids of a potato tuber cell. Lines connect these granules to a diagram of a starch molecule. The diagram shows a long, wavy chain of glucose monomers (represented as green hexagons) linked by alpha-1,4-glycosidic bonds. A bracket under one of the glucose units is labeled 'Glucose monomer'. The entire chain is labeled 'Starch (Amylose)'.

Glycogen granules in muscle tissue

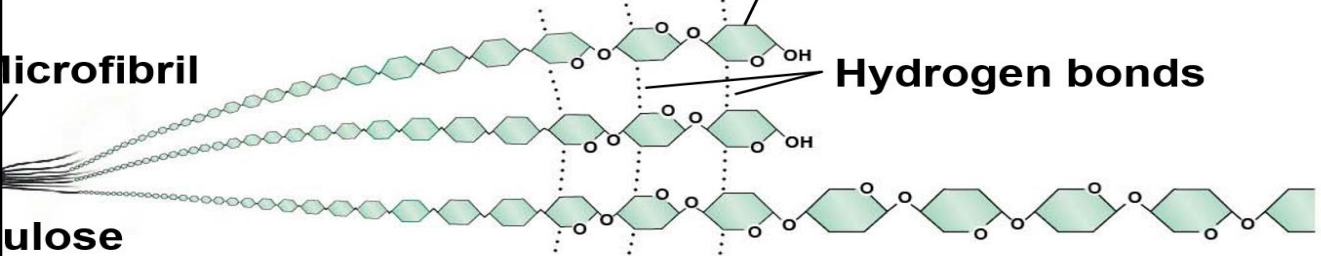


Glycogen (extensively branched)



Detailed description: This panel illustrates the storage of glycogen in muscle tissue. On the left, a micrograph shows numerous small, dark glycogen granules within muscle tissue. Lines connect these granules to a diagram of a glycogen molecule. The diagram shows a highly branched chain of glucose monomers (represented as green hexagons) linked by alpha-1,4-glycosidic bonds, with alpha-1,6-glycosidic bonds forming the branches. The entire structure is labeled 'Glycogen (extensively branched)'. A scale bar is present in the bottom left of the micrograph.

Cellulose microfibrils in a plant cell wall



Cellulose molecule (unbranched)

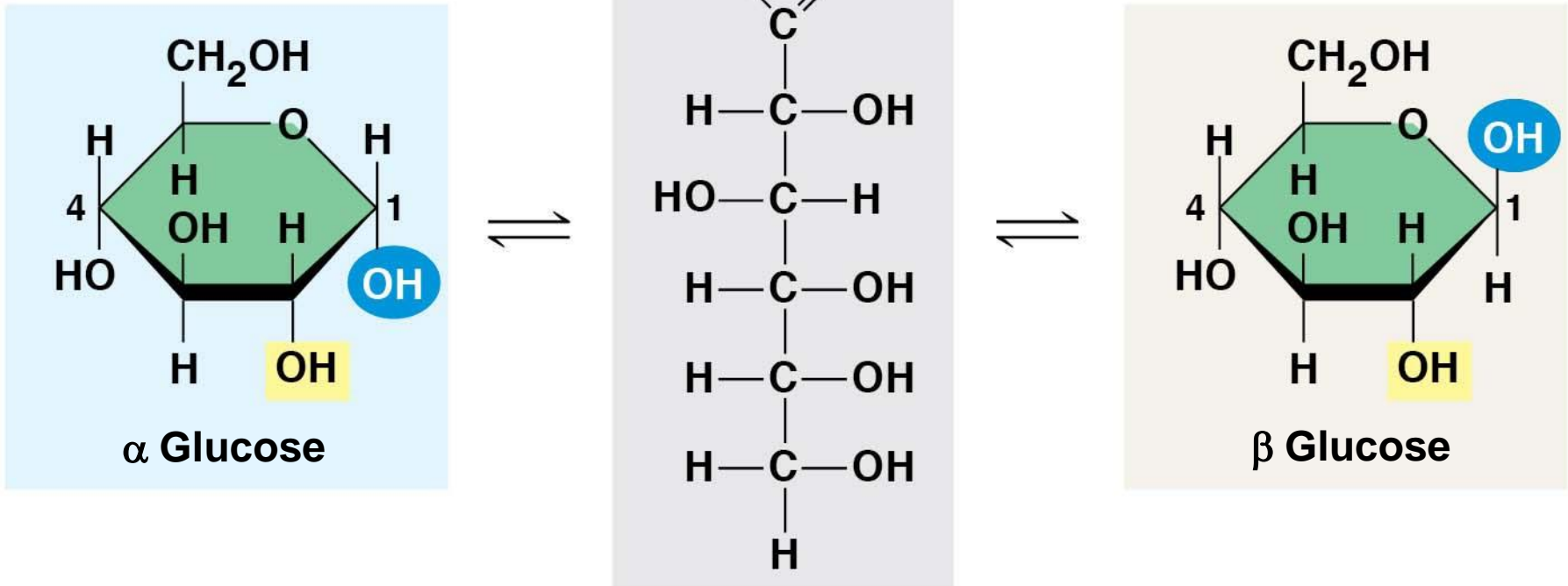
Hydrogen bonds

Microfibril

Cellulose

Detailed description: This panel illustrates the structure of cellulose in a plant cell wall. On the left, a bundle of cellulose microfibrils is shown. Lines connect these microfibrils to a diagram of a cellulose molecule. The diagram shows a long, unbranched chain of glucose monomers (represented as green hexagons) linked by beta-1,4-glycosidic bonds. Dotted lines represent hydrogen bonds between the hydroxyl groups of adjacent cellulose chains. The entire structure is labeled 'Cellulose molecule (unbranched)'. The label 'Hydrogen bonds' points to the dotted lines. The label 'Microfibril' points to the bundle of chains, and 'Cellulose' points to the individual chains.

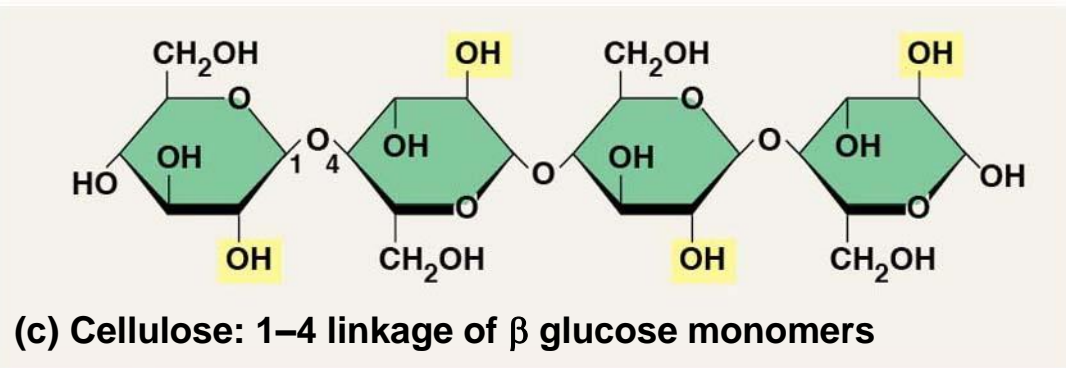
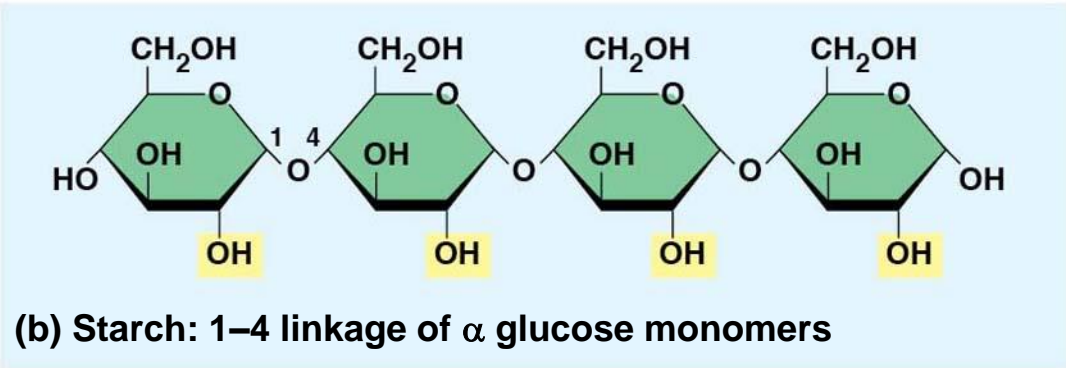
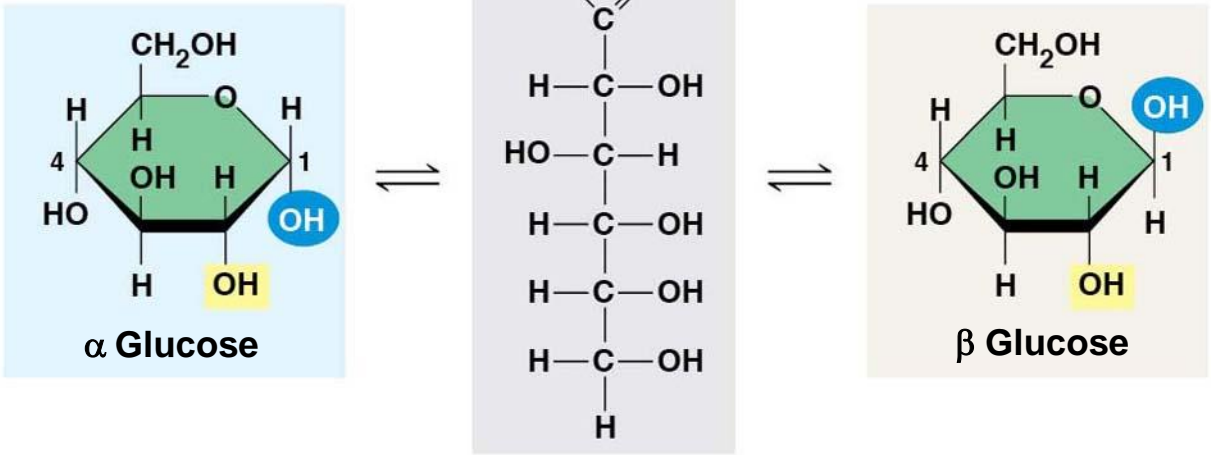
(a) α and β glucose ring structures



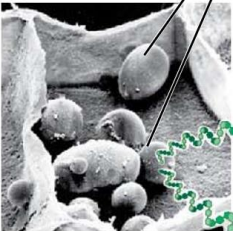
- Keep your polysaccharide intact
- Find 2 alpha (α) glucose and 2 beta (β) glucose molecules
- Combine the monosaccharides in this order $\alpha - \beta - \alpha - \beta$
- Compare the two polysaccharides

Figure 3.12

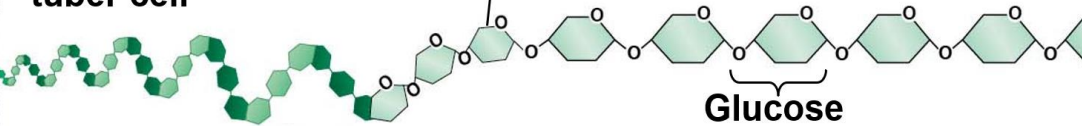
(a) α and β glucose ring structures



Storage structures (plastids) containing starch granules in a potato tuber cell

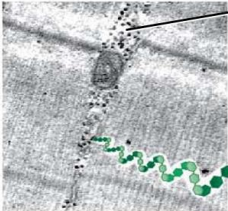


Starch (Amylose)

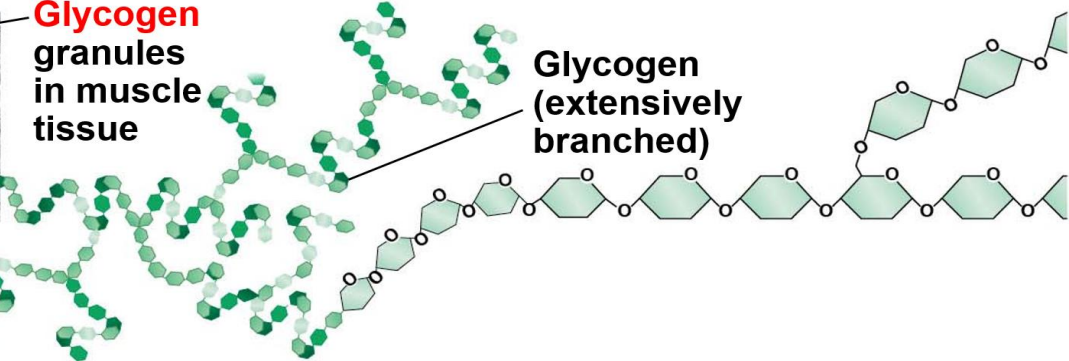


Glucose monomer


Glycogen granules in muscle tissue



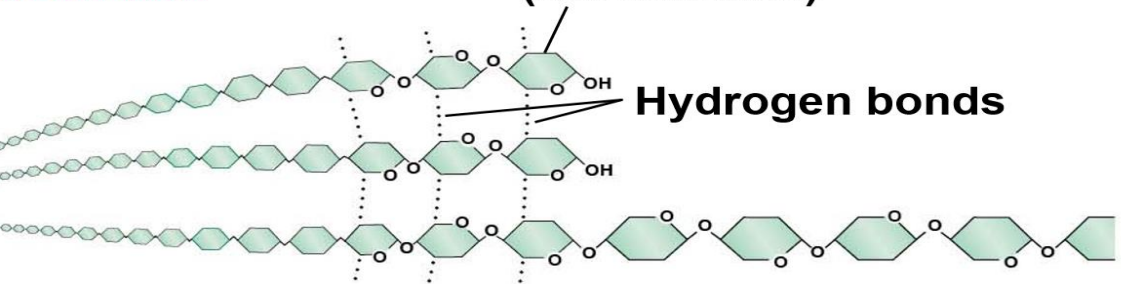
Glycogen (extensively branched)



Cellulose microfibrils in a plant cell wall



Cellulose molecule (unbranched)


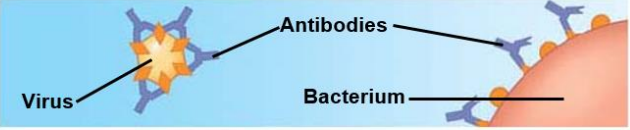
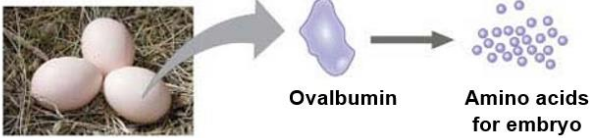
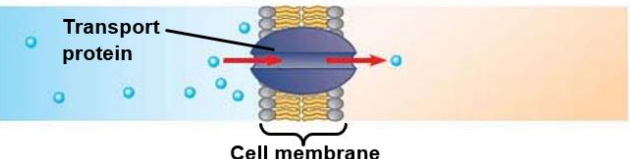
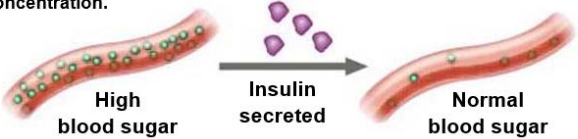
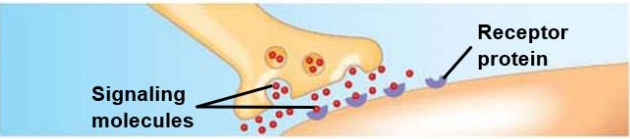
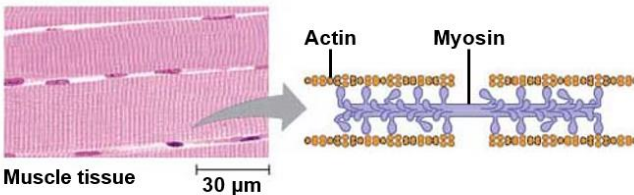
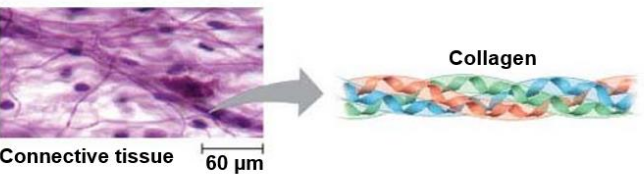


Hydrogen bonds

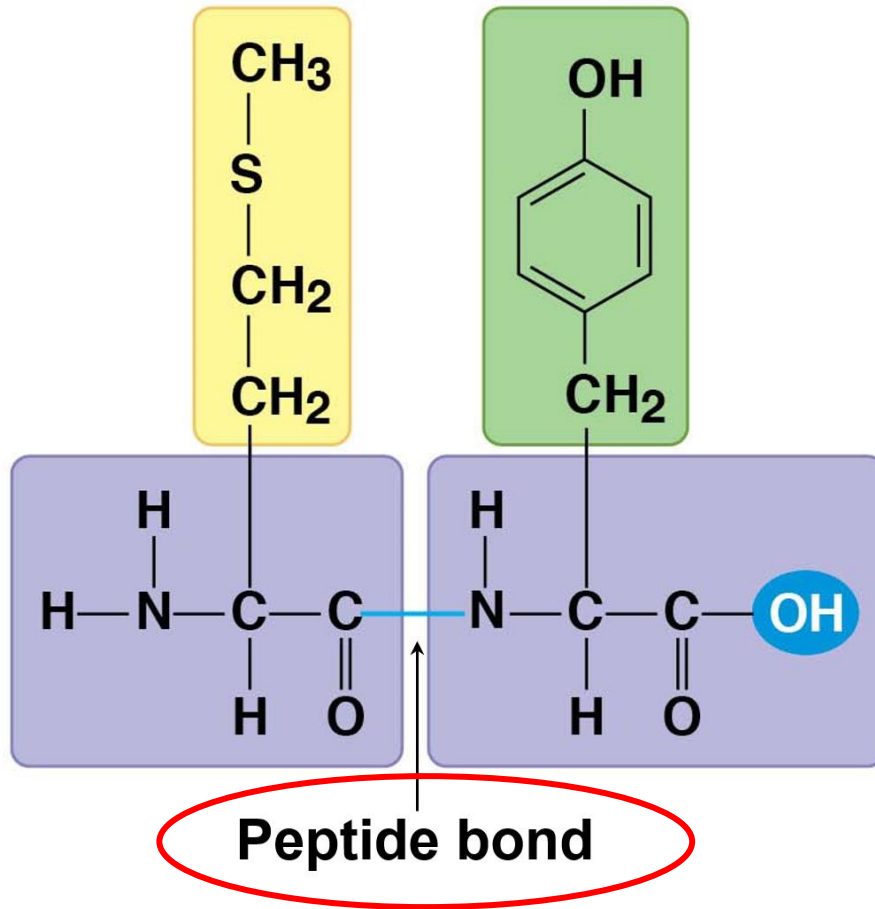
Cellulose

Objective: You will be able to describe the molecular structure of a protein.

Do now:

<p>Enzymatic proteins</p> <p>Function: Selective acceleration of chemical reactions</p> <p>Example: Digestive enzymes catalyze the hydrolysis of bonds in food molecules.</p> 	<p>Defensive proteins</p> <p>Function: Protection against disease</p> <p>Example: Antibodies inactivate and help destroy viruses and bacteria.</p> 
<p>Storage proteins</p> <p>Function: Storage of amino acids</p> <p>Examples: Casein, the protein of milk, is the major source of amino acids for baby mammals. Plants have storage proteins in their seeds. Ovalbumin is the protein of egg white, used as an amino acid source for the developing embryo.</p> 	<p>Transport proteins</p> <p>Function: Transport of substances</p> <p>Examples: Hemoglobin, the iron-containing protein of vertebrate blood, transports oxygen from the lungs to other parts of the body. Other proteins transport molecules across membranes, as shown here.</p> 
<p>Hormonal proteins</p> <p>Function: Coordination of an organism's activities</p> <p>Example: Insulin, a hormone secreted by the pancreas, causes other tissues to take up glucose, thus regulating blood sugar concentration.</p> 	<p>Receptor proteins</p> <p>Function: Response of cell to chemical stimuli</p> <p>Example: Receptors built into the membrane of a nerve cell detect signaling molecules released by other nerve cells.</p> 
<p>Contractile and motor proteins</p> <p>Function: Movement</p> <p>Examples: Motor proteins are responsible for the undulations of cilia and flagella. Actin and myosin proteins are responsible for the contraction of muscles.</p> 	<p>Structural proteins</p> <p>Function: Support</p> <p>Examples: Keratin is the protein of hair, horns, feathers, and other skin appendages. Insects and spiders use silk fibers to make their cocoons and webs, respectively. Collagen and elastin proteins provide a fibrous framework in animal connective tissues.</p> 

Dipeptide



- Combine the rest of your amino acids

- To do this, you must connect the amino group end of the newly joining amino acid to the carboxyl group end of the dipeptide (*remove water*)

- You created the macromolecule know as a polypeptide or protein**

- Once the water is removed, notice how you are left with an **N-C-C backbone**

- Compare the **sequence** of your polypeptide with that of your neighbors.

- This sequence is called its **primary structure**.

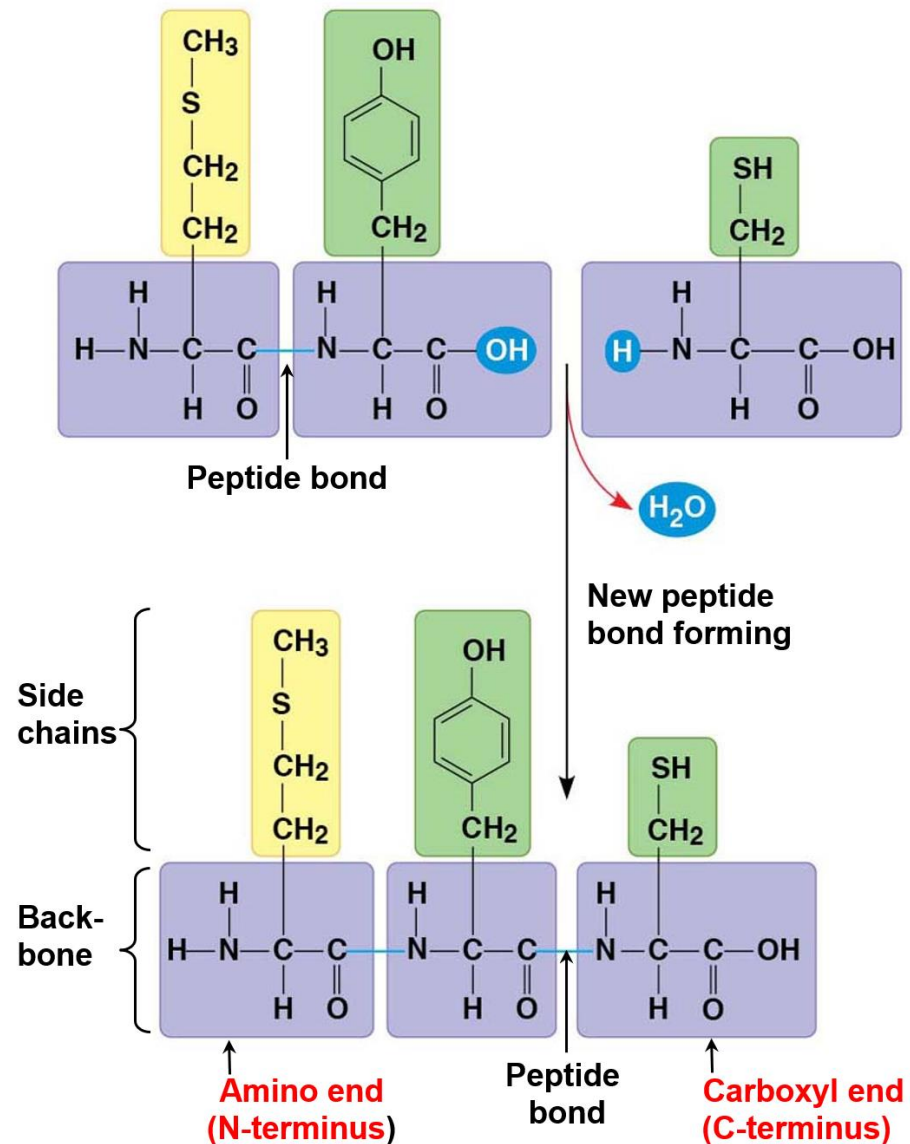


Figure 3.22-1a

Primary Structure

Amino acids

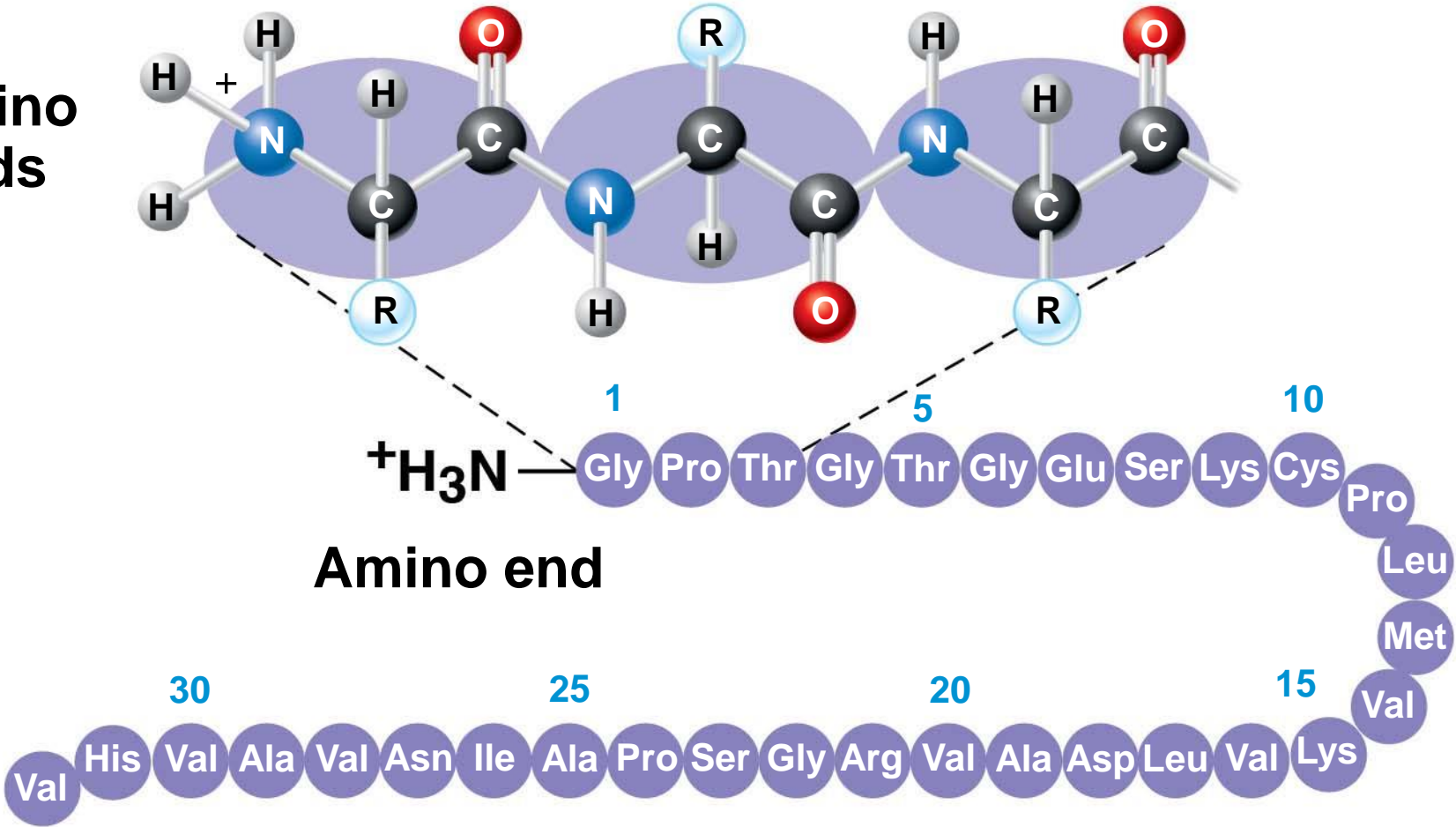


Figure 3.22-1

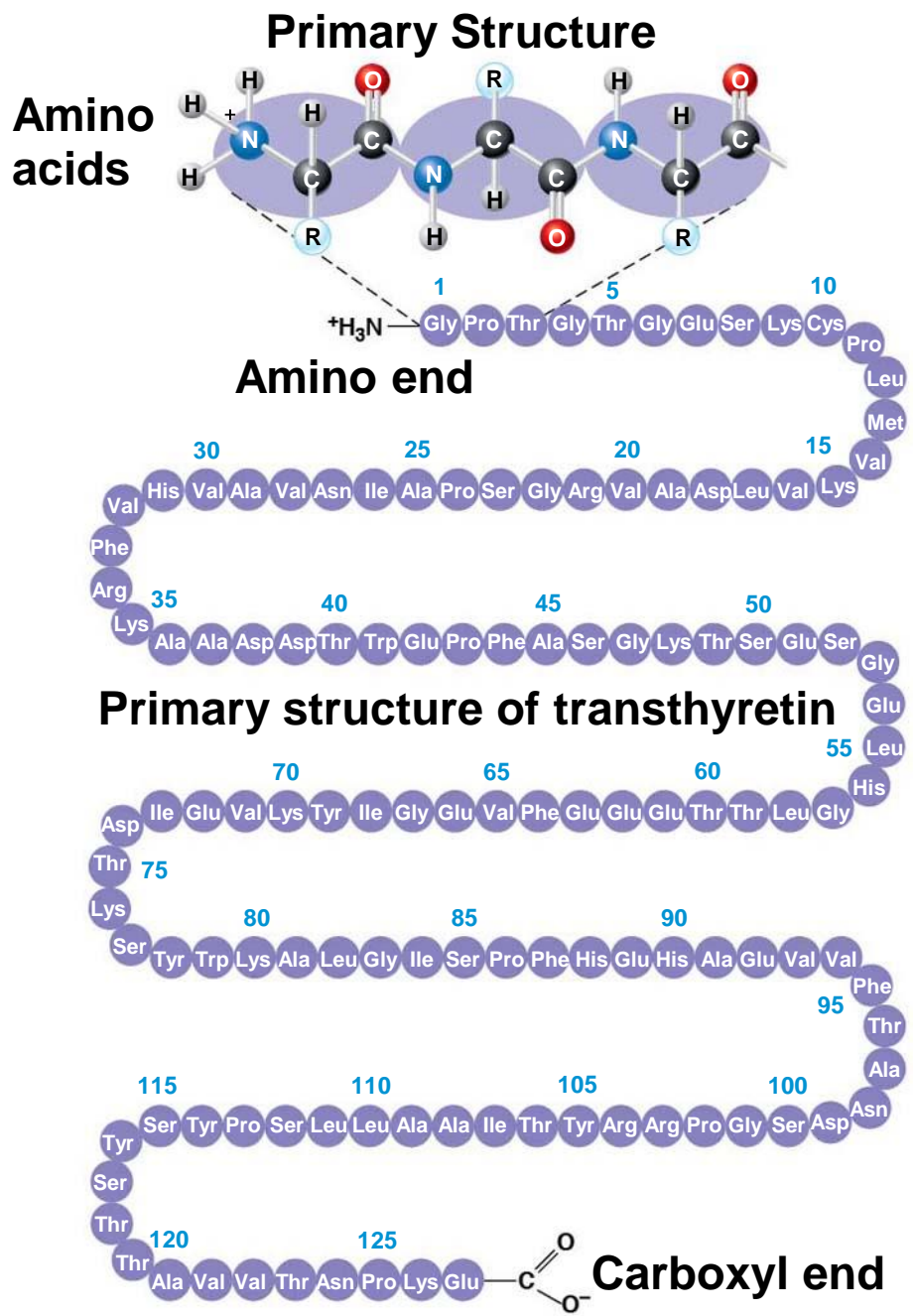
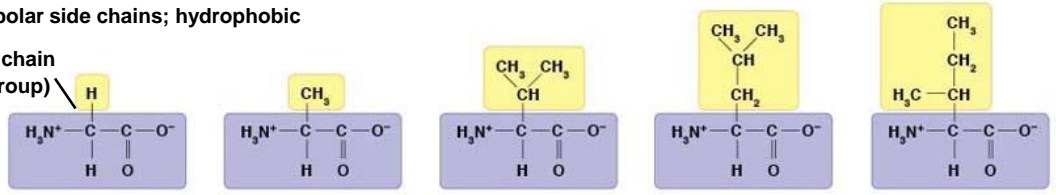


Figure 3.18

Nonpolar side chains; hydrophobic

Side chain (R group)



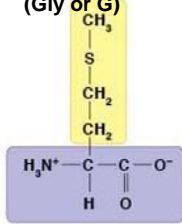
Glycine (Gly or G)

Alanine (Ala or A)

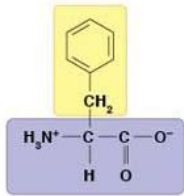
Valine (Val or V)

Leucine (Leu or L)

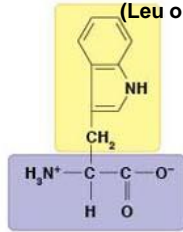
Isoleucine (Ile or I)



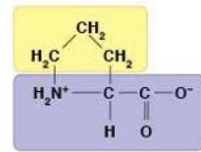
Methionine (Met or M)



Phenylalanine (Phe or F)

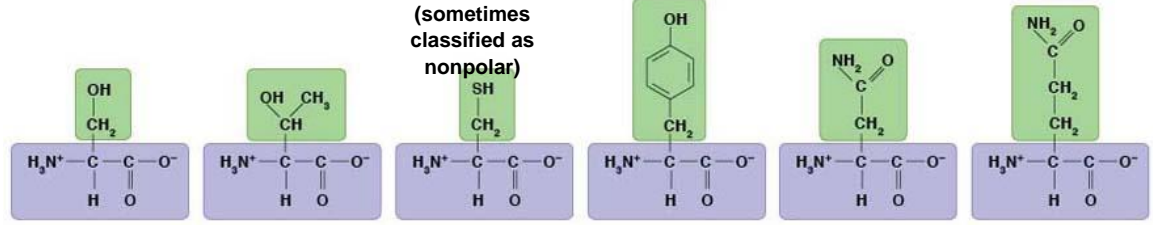


Tryptophan (Trp or W)



Proline (Pro or P)

Polar side chains; hydrophilic



Serine (Ser or S)

Threonine (Thr or T)

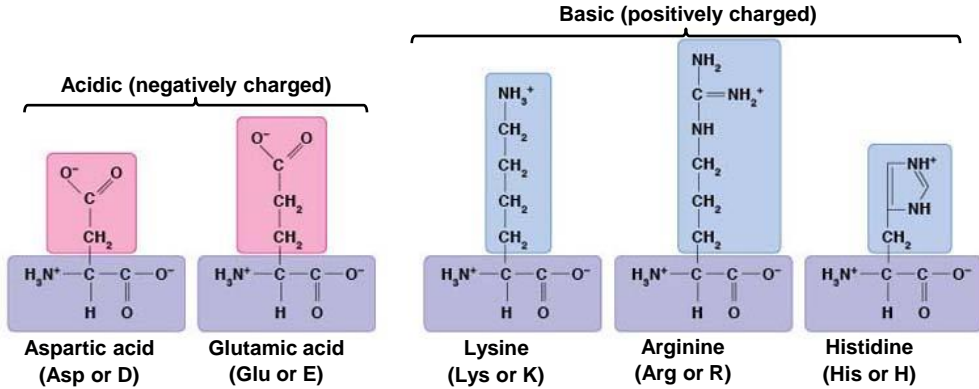
Cysteine (Cys or C)

Tyrosine (Tyr or Y)

Asparagine (Asn or N)

Glutamine (Gln or Q)

Electrically charged side chains; hydrophilic



Aspartic acid (Asp or D)

Glutamic acid (Glu or E)

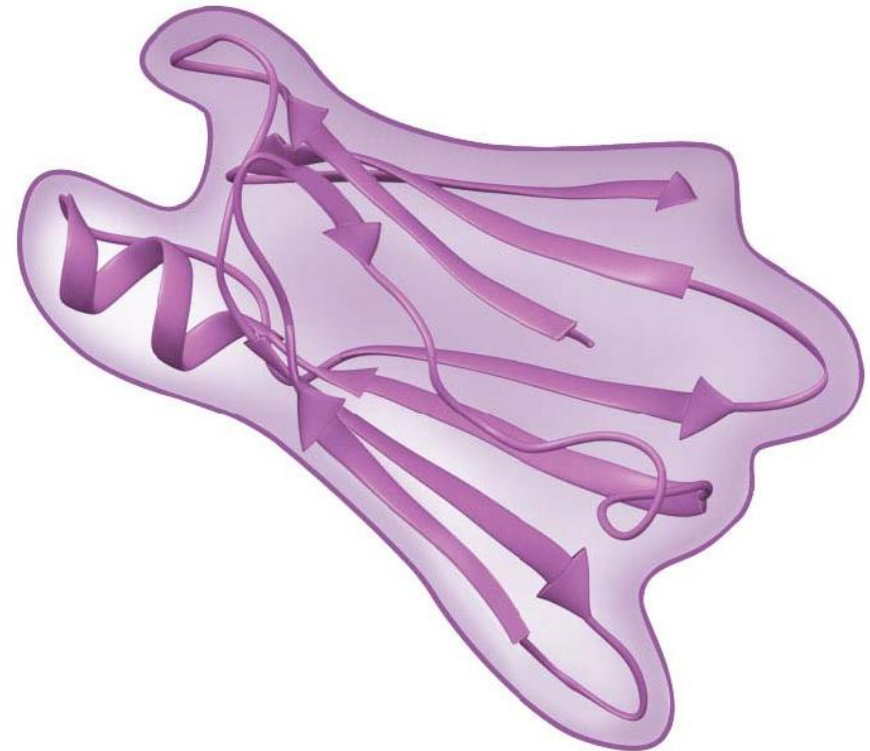
Lysine (Lys or K)

Arginine (Arg or R)

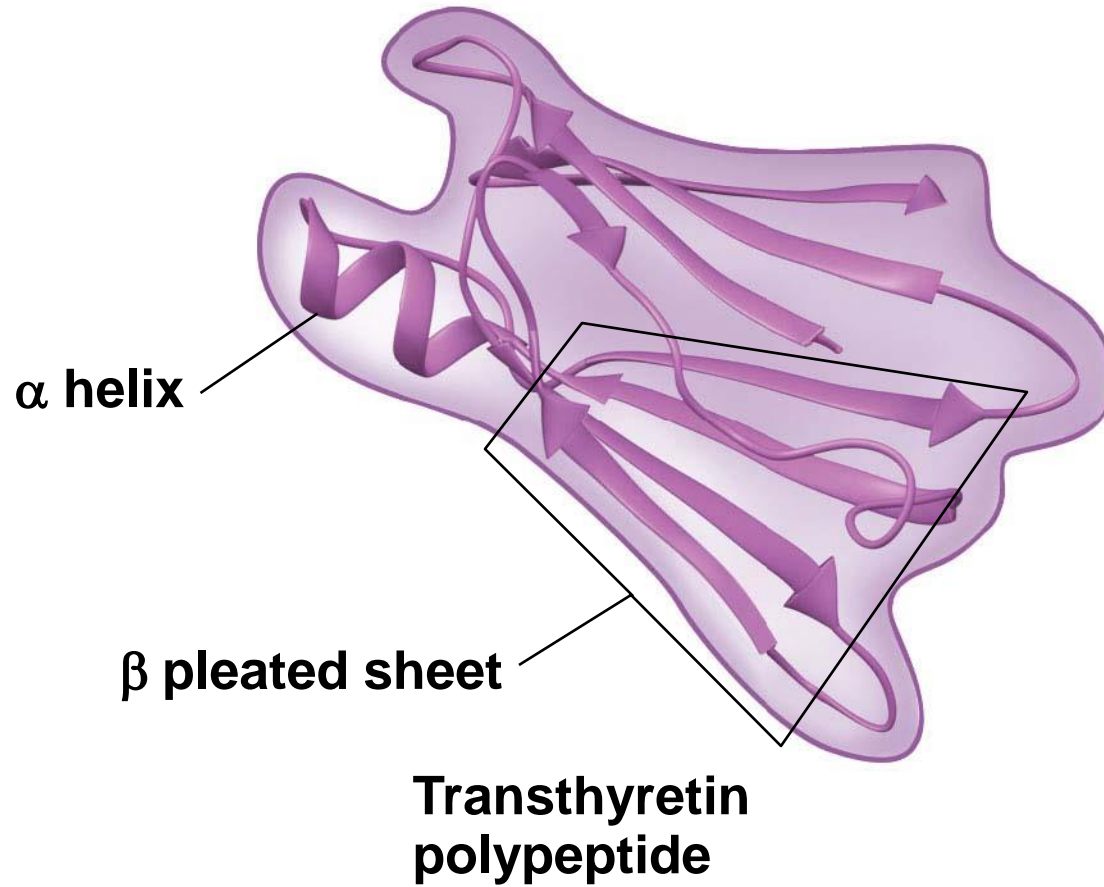
Histidine (His or H)

Protein Conformation

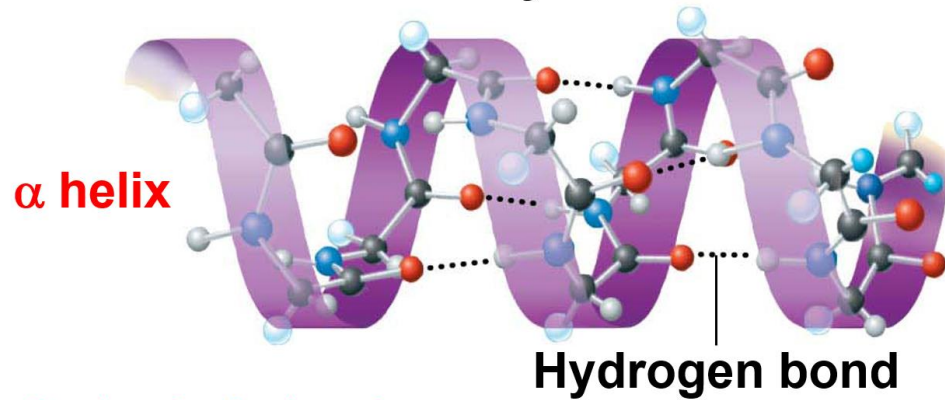
- A protein's 3-D shape, conformation, is ultimately determined by the primary structure (sequence of bases).
- The function of a protein is completely dependent on its structure.



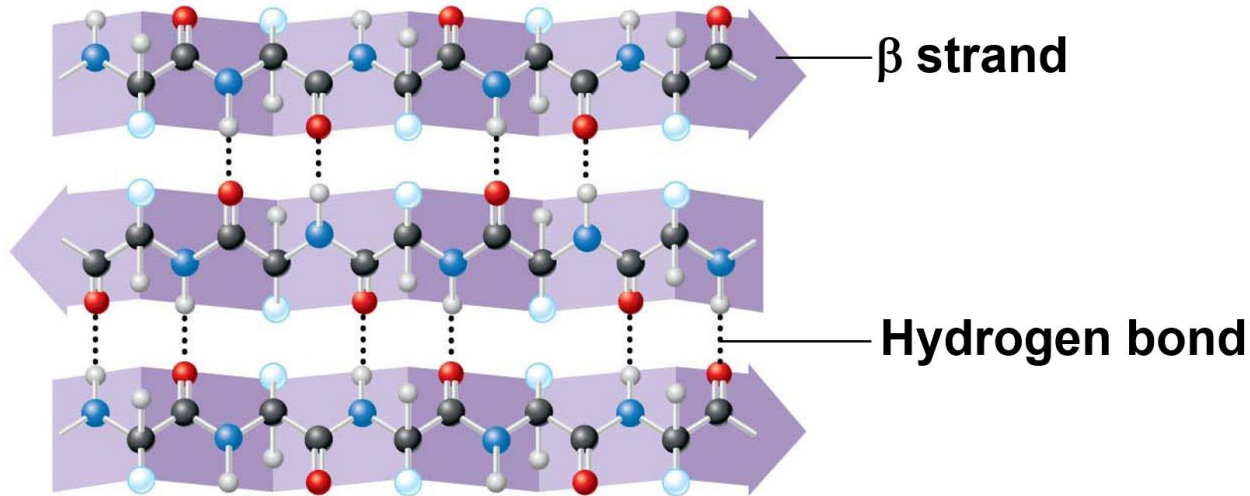
Polypeptide Shape



Secondary Structure

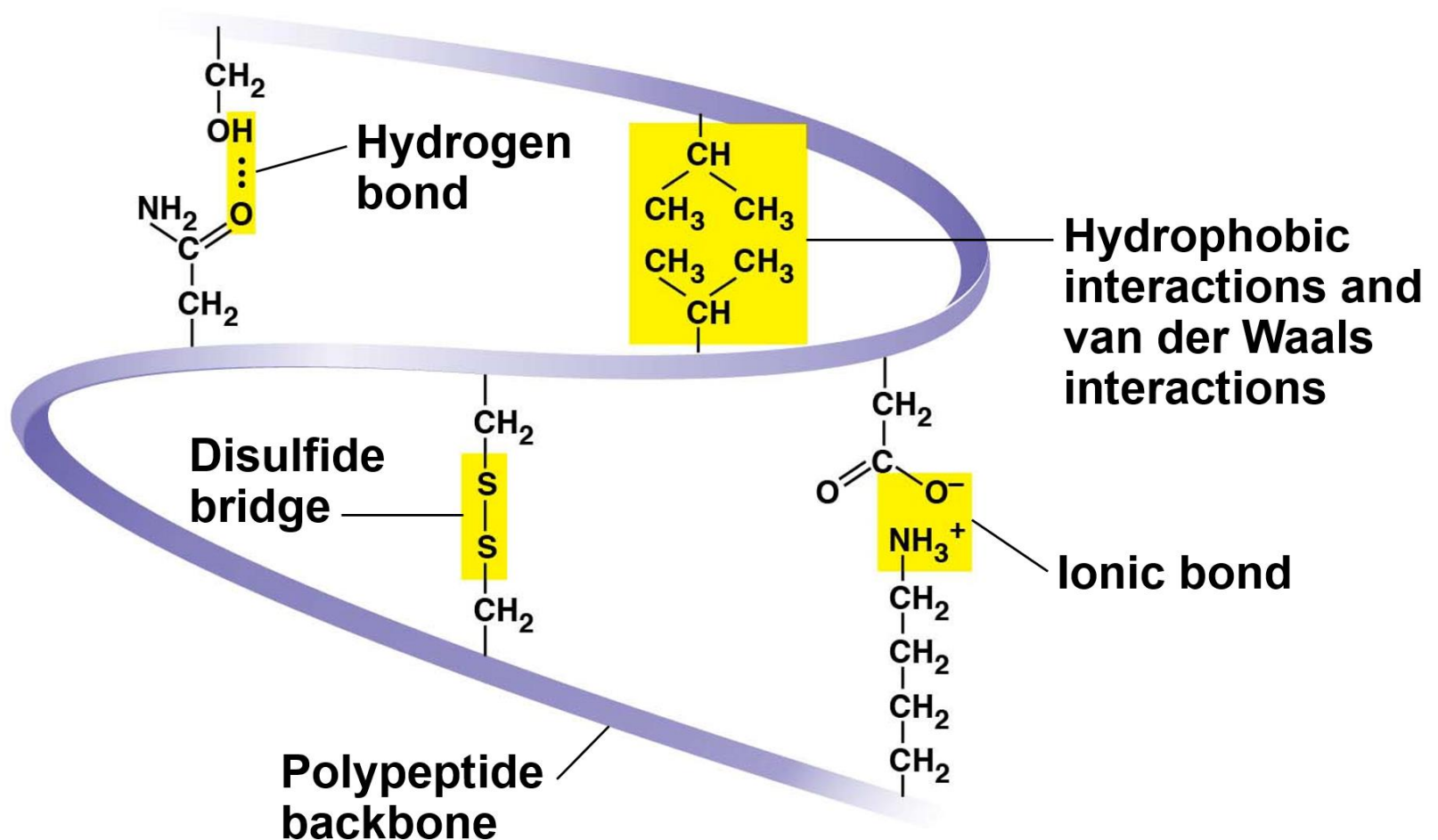


β pleated sheet



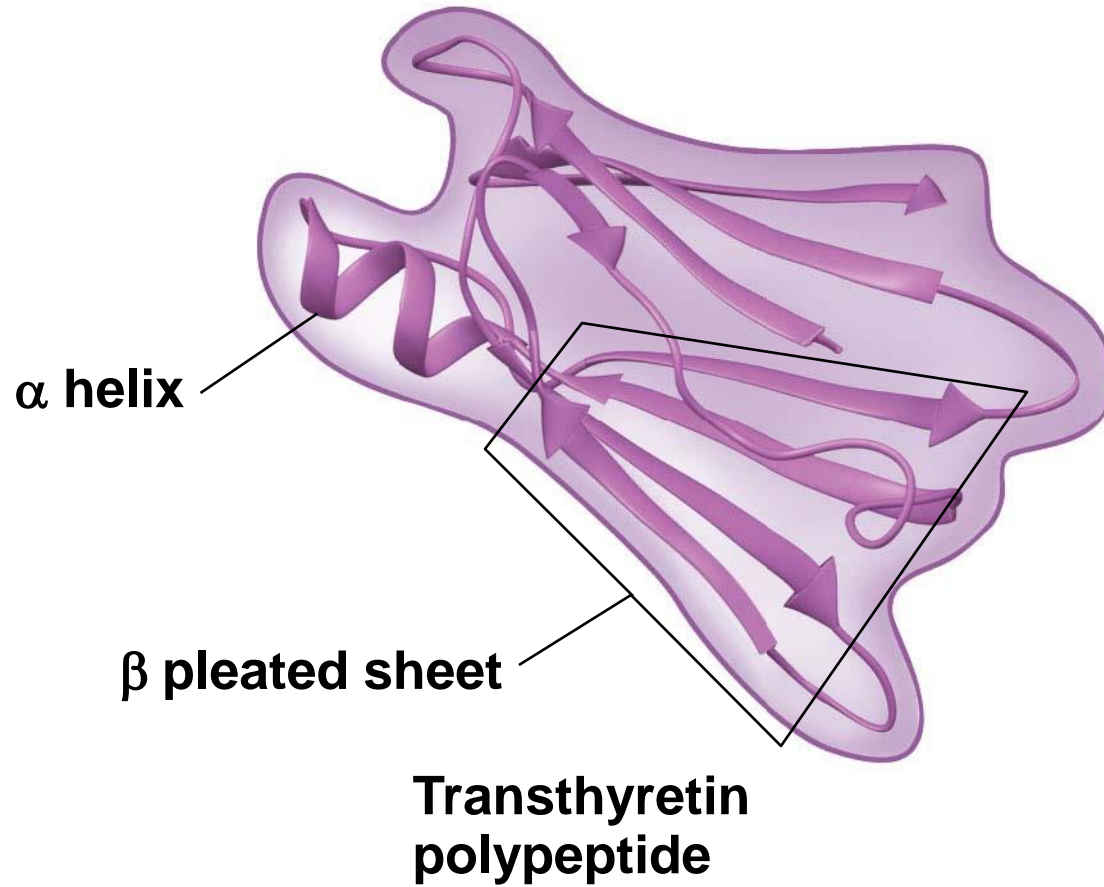
Primary structure determines the protein's conformation because it "puts" the amino acids in the specific sequence to cause the helixes and sheets to form.

Tertiary Structure

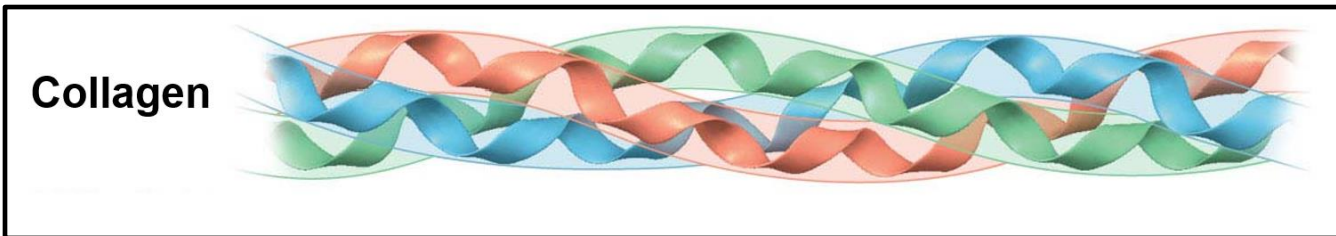
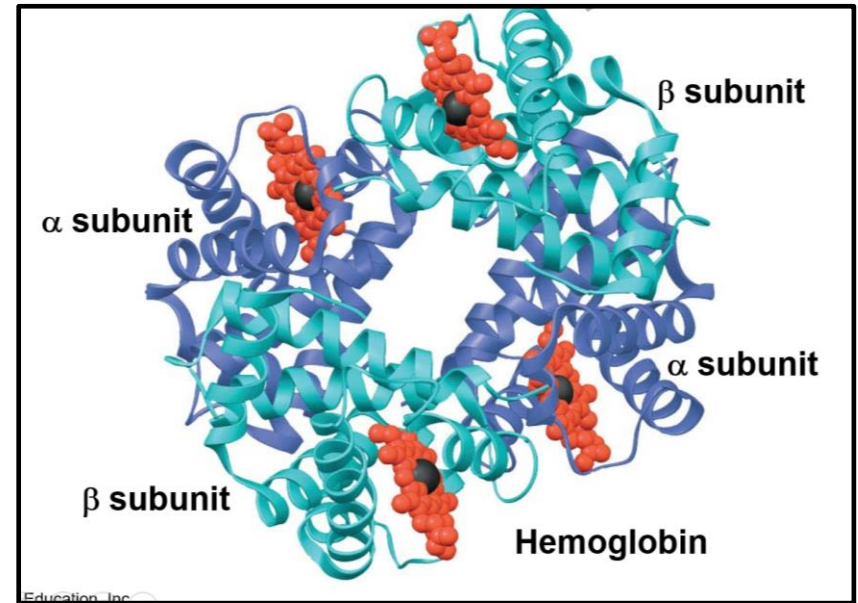
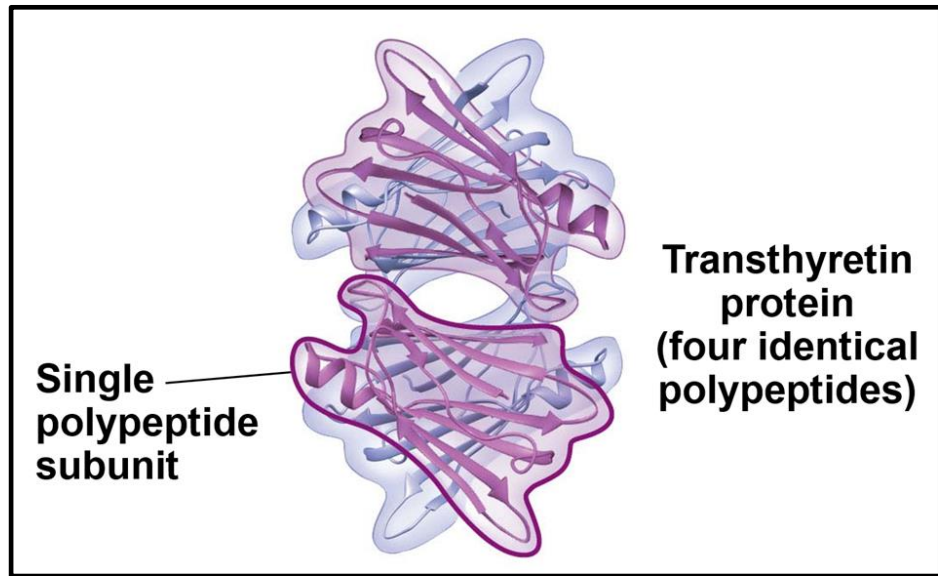


Primary structure determines the protein's conformation because it "puts" the amino acids in the specific sequence to cause the interactions between side chains.

Polypeptide Shape


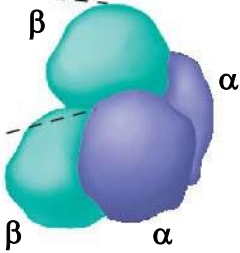
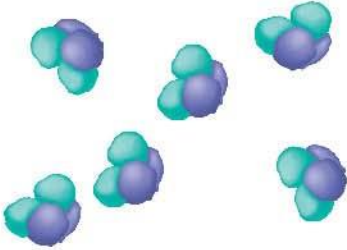

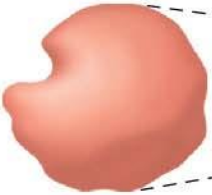
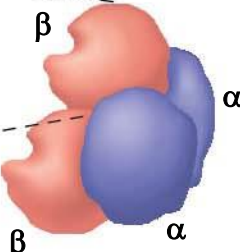
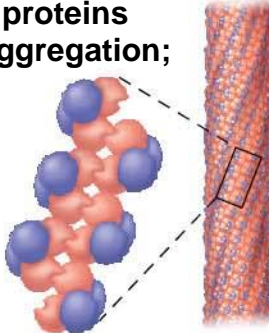



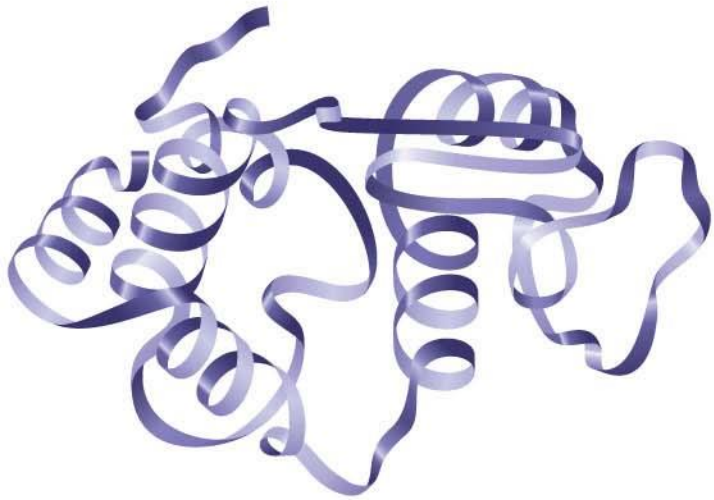
Quaternary structure



These proteins all have a specific shape to perform a specific function.

Impact of changing the primary structure...

	Primary Structure	Secondary and Tertiary Structures	Quaternary Structure	Function	Red Blood Cell Shape
Normal	1 Val 2 His 3 Leu 4 Thr 5 Pro 6 Glu 7 Glu	Normal β subunit 	Normal hemoglobin 	Proteins do not associate; each carries oxygen. 	Normal red blood cells are full of individual hemoglobin proteins.  5 μm
Sickle-cell	1 Val 2 His 3 Leu 4 Thr 5 Pro 6 Val 7 Glu	Sickle-cell β subunit 	Sickle-cell hemoglobin 	Hydrophobic interactions between proteins lead to aggregation; oxygen carrying capacity reduced. 	Fibers of abnormal hemoglobin deform red blood cell into sickle shape.  5 μm



Normal protein

Figure 3.24-s2

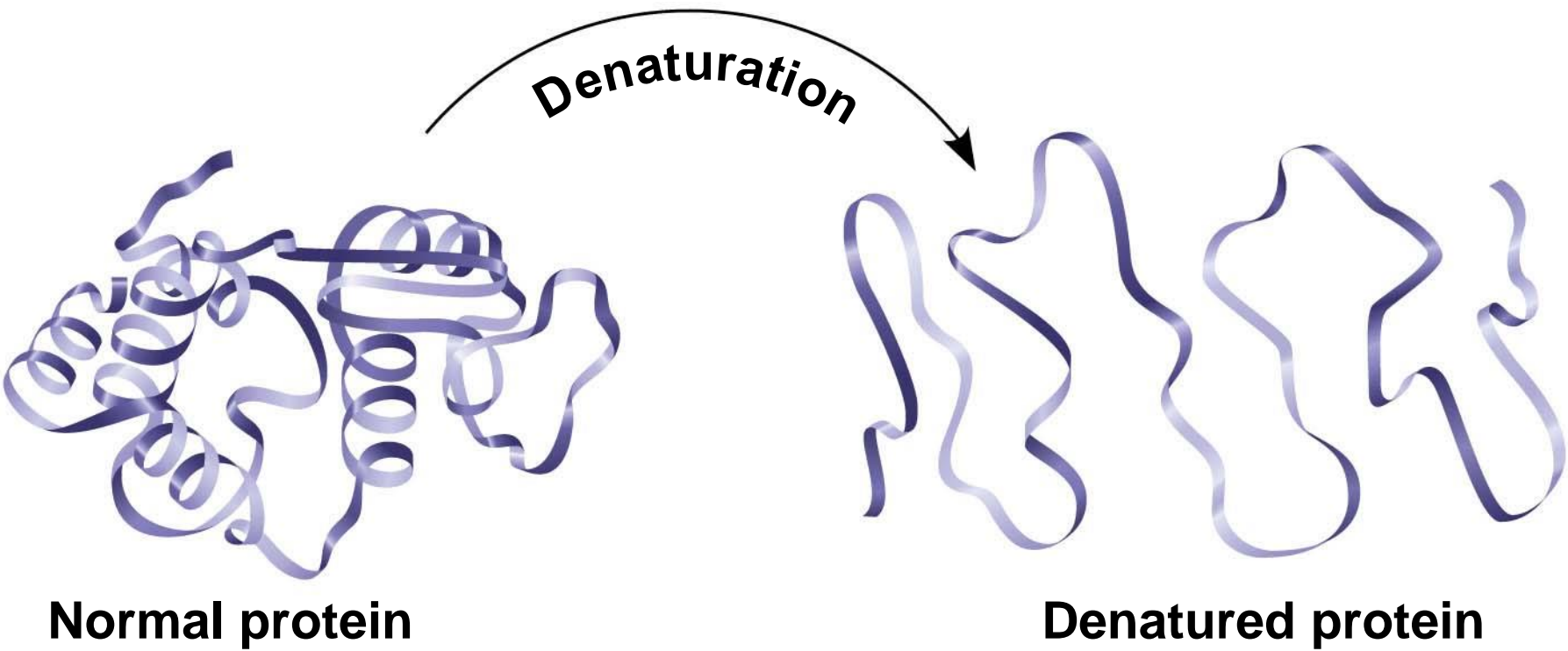
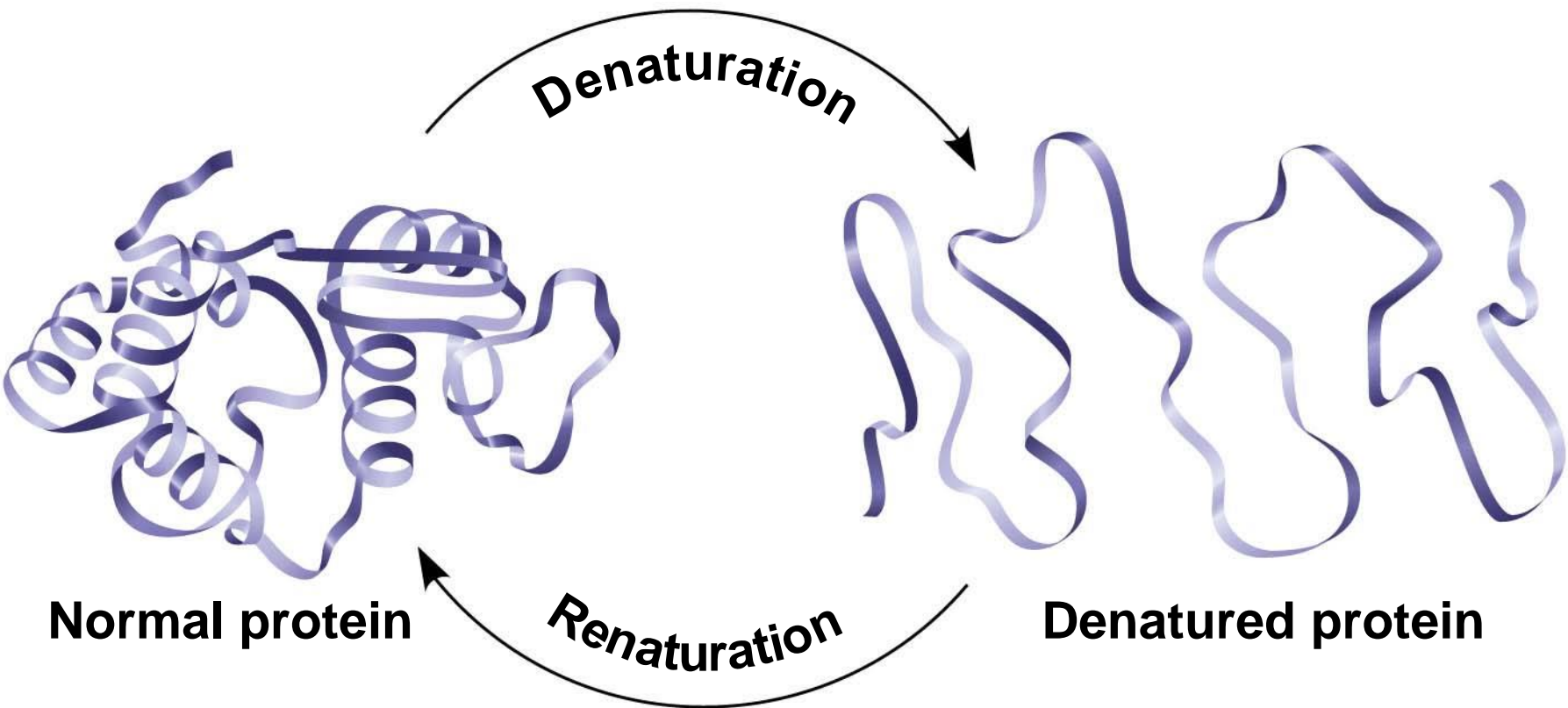


Figure 3.24-s3

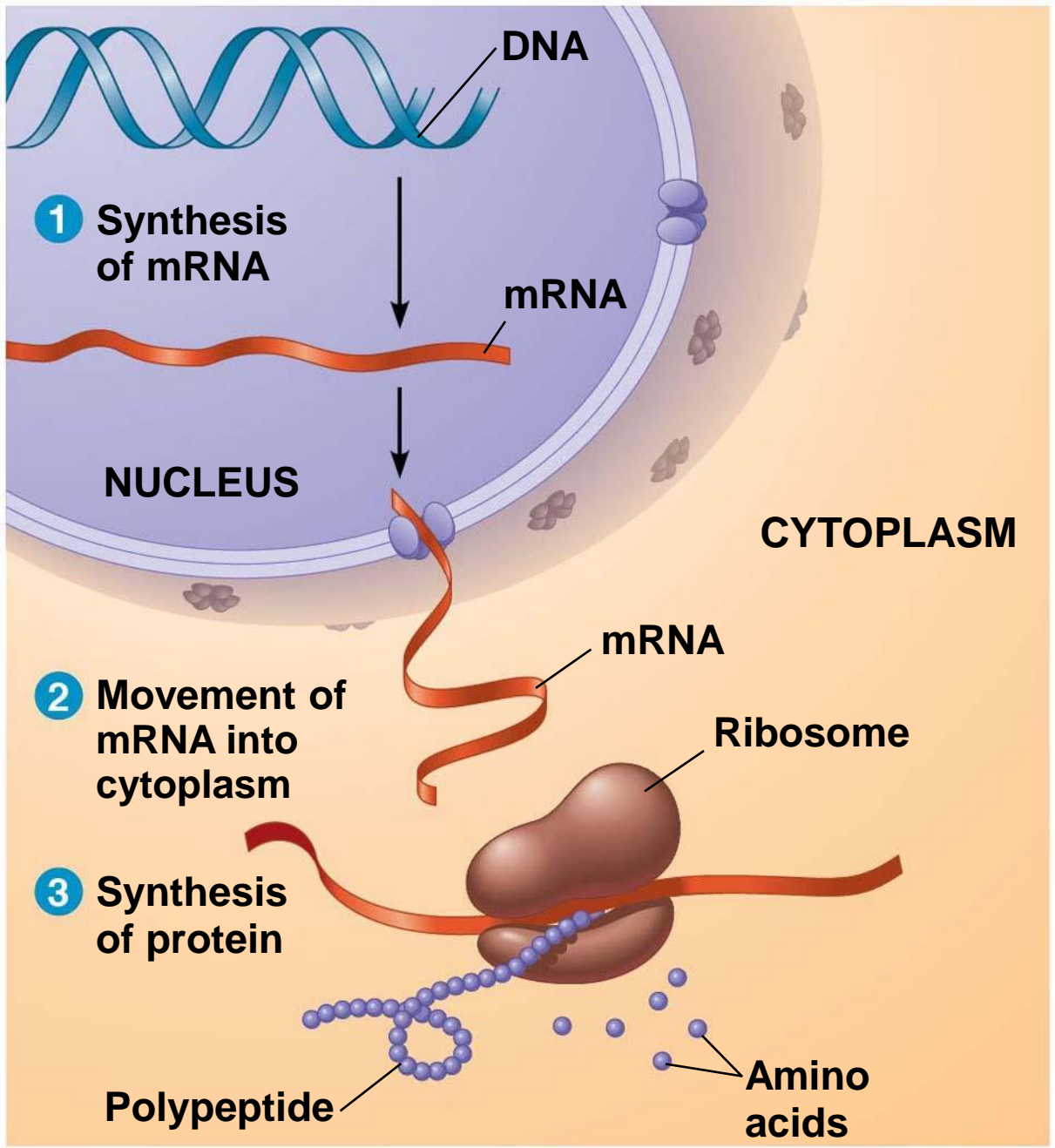


Objective: You will be able to describe the molecular structure of nucleic acids.

Do now:

- In nucleic acids, biological information is encoded in the sequences of nucleotide monomers.

Figure 3.26-s3



The monomer of nucleic acids are called nucleotides

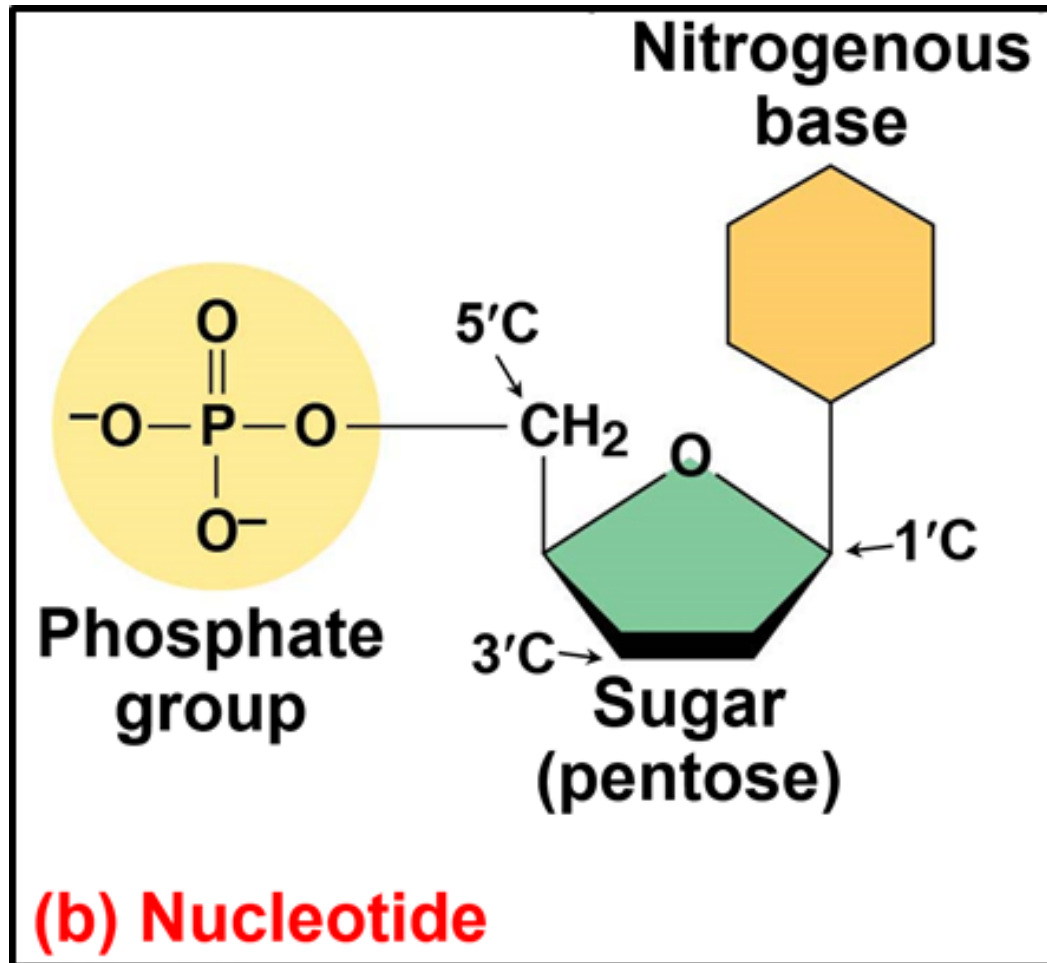


Figure 3.27-1

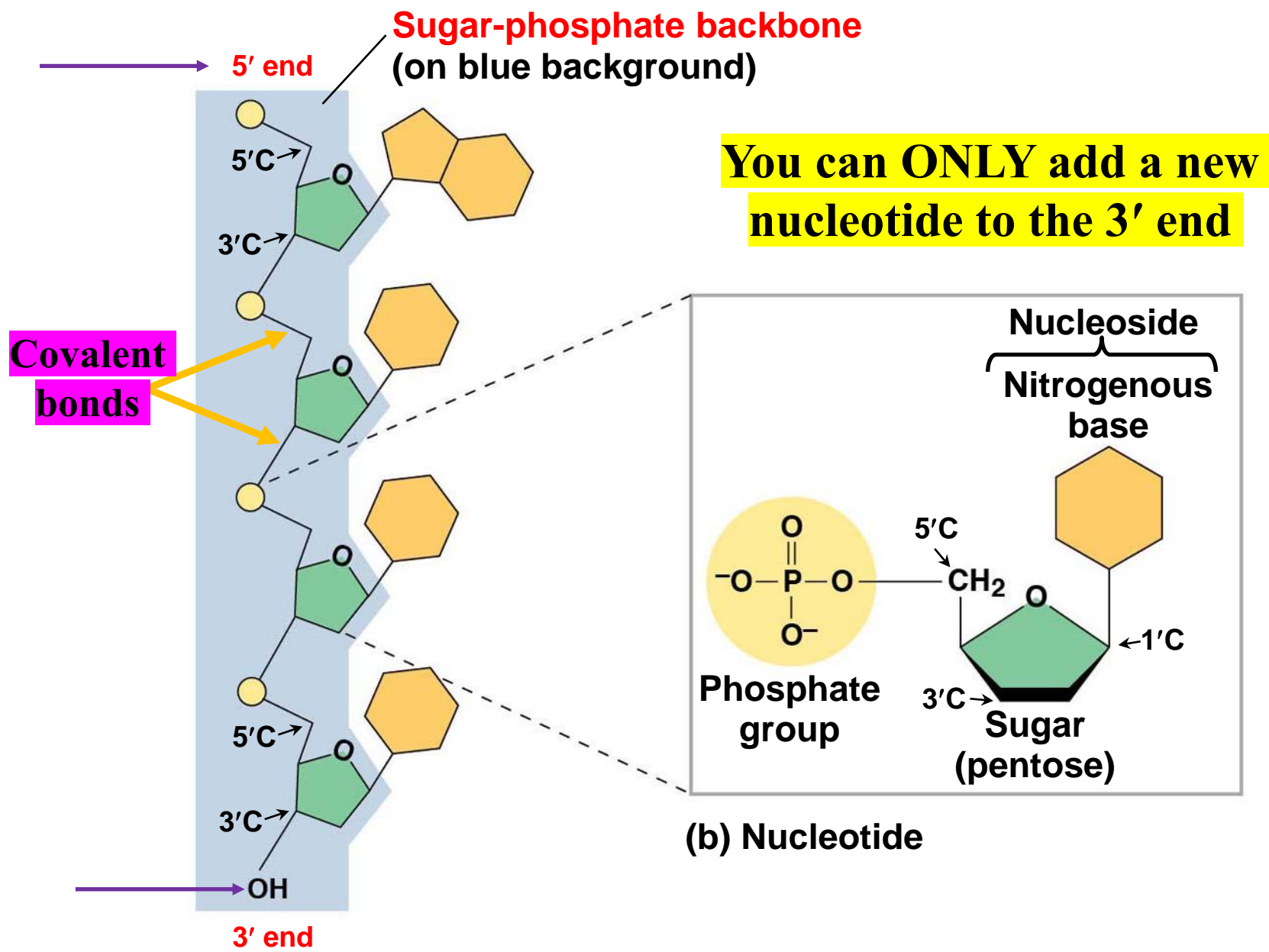
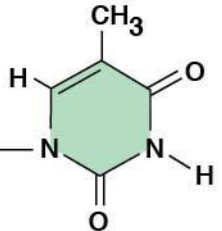
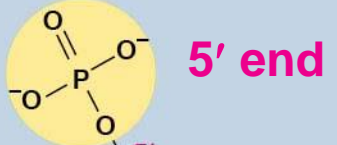


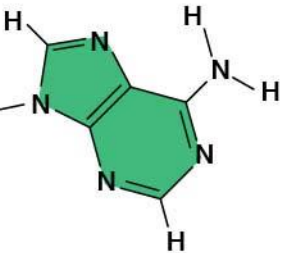
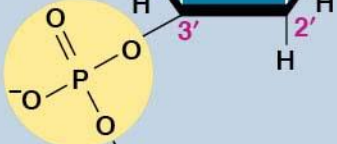
Figure 13.6

Sugar-phosphate backbone

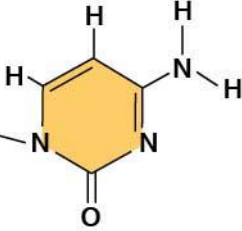
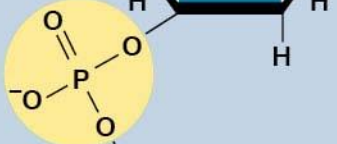
Nitrogenous bases



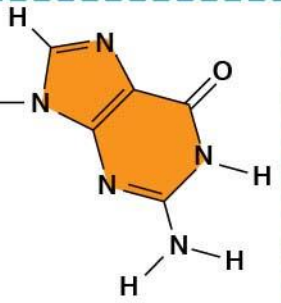
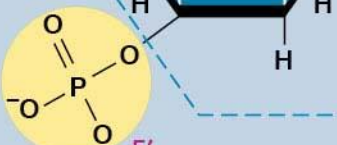
Thymine (T)



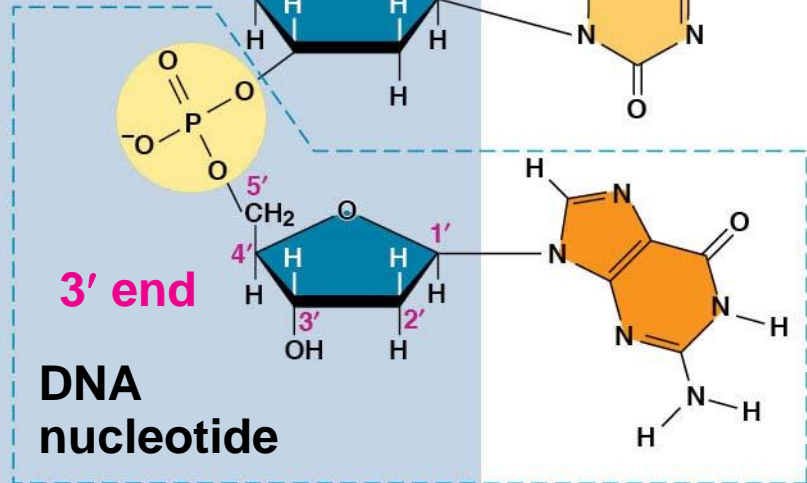
Adenine (A)



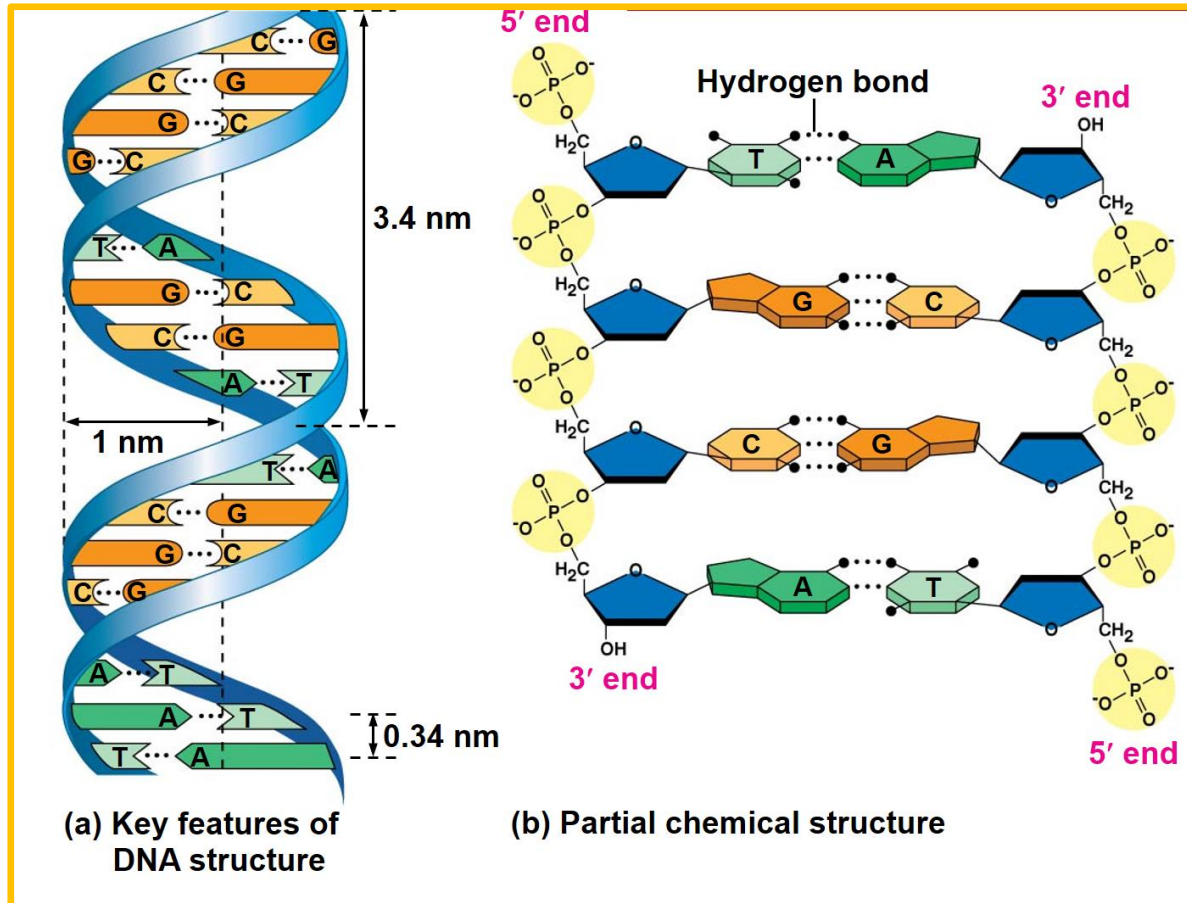
Cytosine (C)



Guanine (G)



- DNA is double stranded with 2 anti-parallel strands



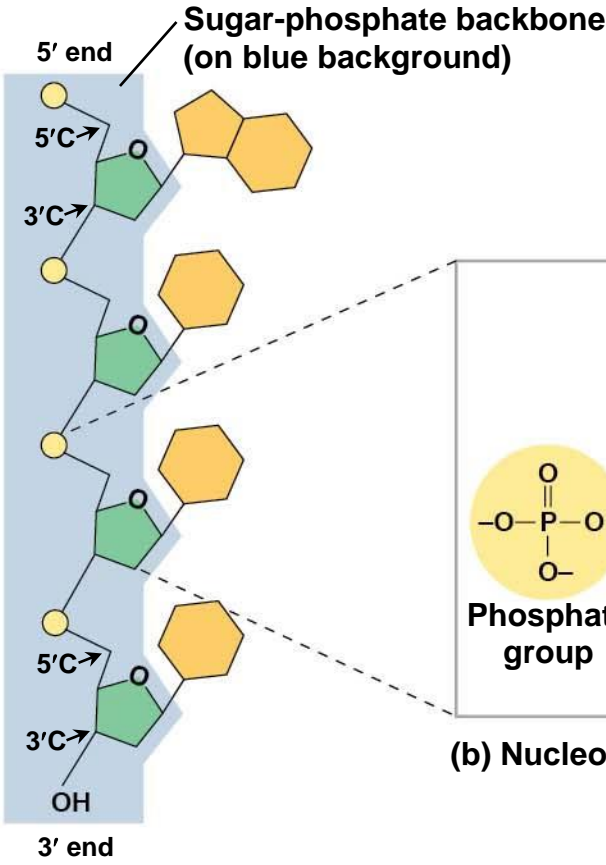
- Information is stored within the DNA molecule due to the sequence of bases.

Objective: You will be able to describe the molecular structure of DNA and RNA.

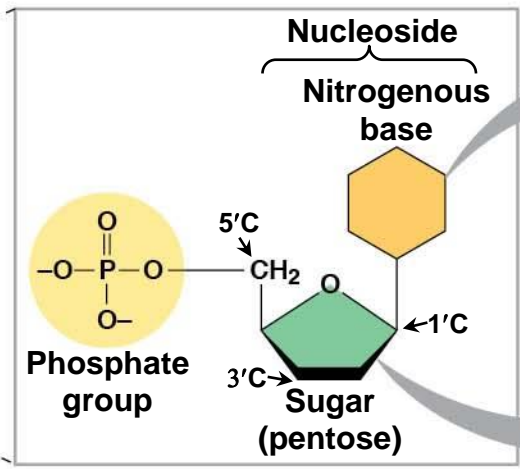
Do now:

- List what you can remember about the structure of DNA

Figure 3.27



(a) Polynucleotide, or nucleic acid



(b) Nucleotide

NITROGENOUS BASES

Pyrimidines

NC1=NC(=O)NC(=O)N1 CC1=CNC(=O)NC1=O O=C1NC=CC(=O)N1

Cytosine (C) **Thymine (T, in DNA)** **Uracil (U, in RNA)**

Purines

NC1=NC=NC2=C1N=CN2 NC1=NC2=C(N=CN2)C(=O)N1

Adenine (A) **Guanine (G)**

SUGARS

OC[C@H]1O[C@@H](O)[C@H](O)[C@@H]1O OC[C@H]1O[C@@H](O)[C@H](O)[C@@H]1O

Deoxyribose (in DNA) **Ribose (in RNA)**

(c) Nucleoside components

Figure 3.26-s3

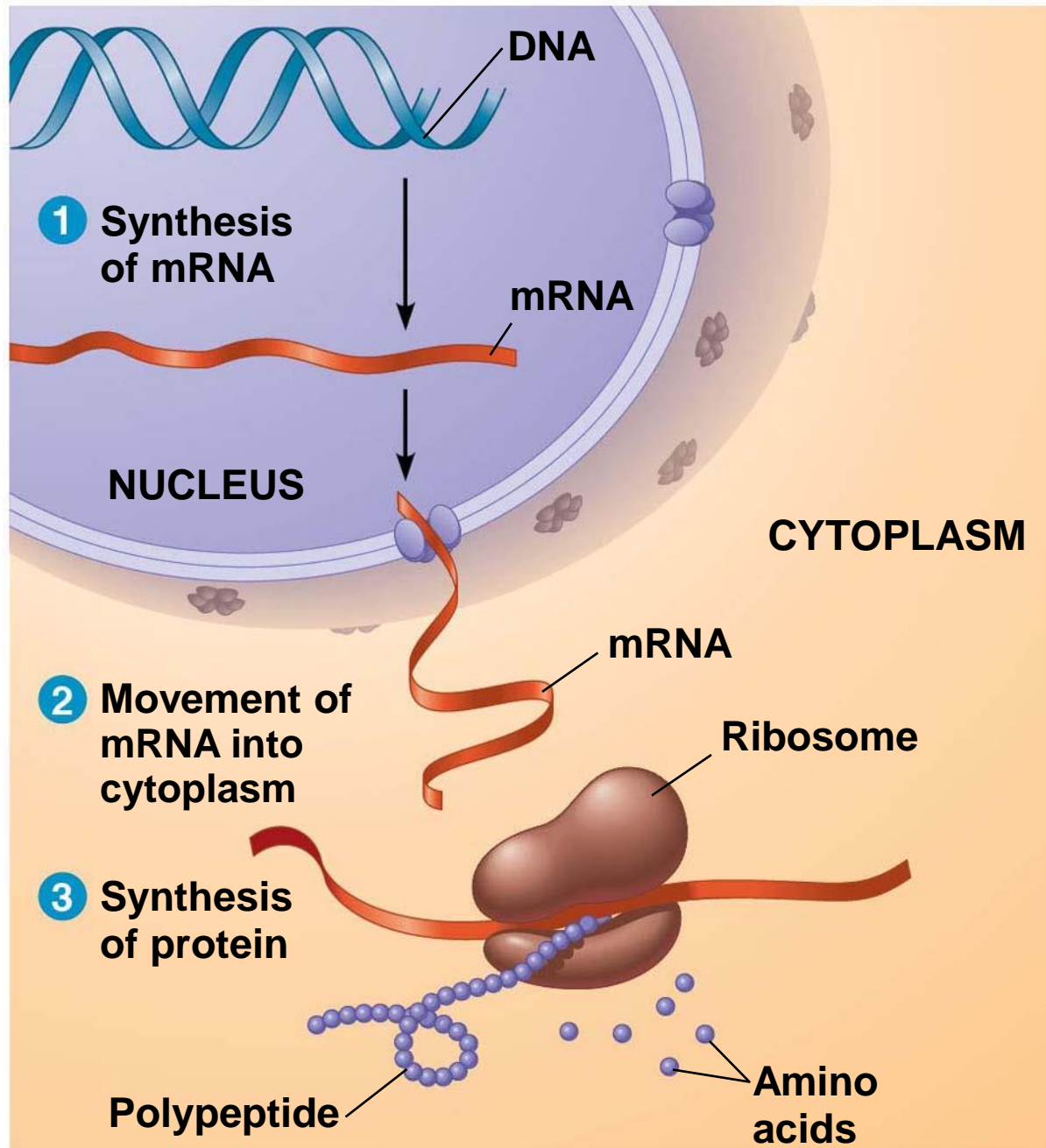


Figure 3.UN08

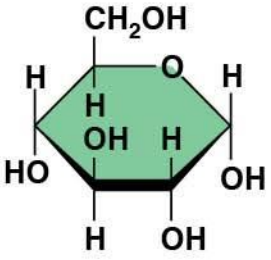
Components	Examples	Functions
 <p data-bbox="198 878 494 956">Monosaccharide monomer</p>	<p>Monosaccharides: glucose, fructose</p>	<p>Fuel; carbon sources that can be converted to other molecules or combined into polymers</p>
	<p>Disaccharides: lactose, sucrose</p>	
	<p>Polysaccharides:</p> <ul style="list-style-type: none"> • Cellulose (plants) • Starch (plants) • Glycogen (animals) • Chitin (animals and fungi) 	<ul style="list-style-type: none"> • Strengthens plant cell walls • Stores glucose for energy • Stores glucose for energy • Strengthens exoskeletons and fungal cell walls

Figure 3.UN09

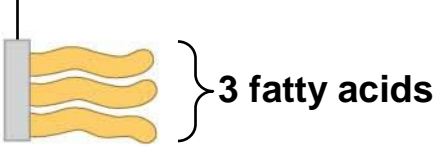

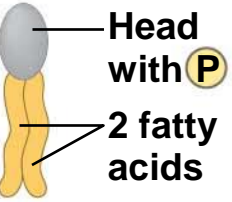
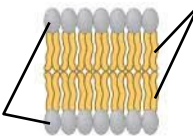
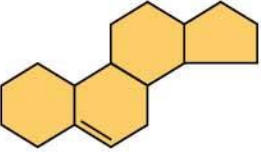
Components	Examples	Functions
<p>Glycerol</p> 	<p>Triacylglycerols (fats or oils): glycerol + three fatty acids</p>	<p>Important energy source</p> 
	<p>Phospholipids: glycerol + phosphate group + two fatty acids</p>	<p>Lipid bilayers of membranes</p> 
 <p>Steroid backbone</p>	<p>Steroids: four fused rings with attached chemical groups</p>	<ul style="list-style-type: none"> • Component of cell membranes (cholesterol) • Signaling molecules that travel through the body (hormones)

Figure 3.UN10

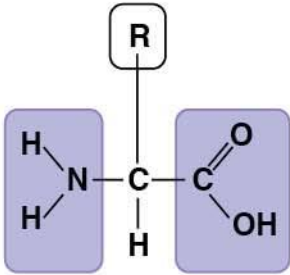
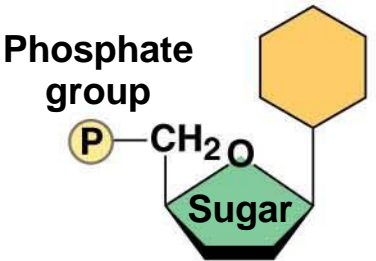


Components	Examples	Functions
 <p data-bbox="144 863 531 942">Amino acid monomer (20 types)</p>	<ul data-bbox="627 564 994 935" style="list-style-type: none">• Enzymes• Structural proteins• Storage proteins• Transport proteins• Hormones• Receptor proteins• Motor proteins• Defensive proteins	<ul data-bbox="1207 564 1845 935" style="list-style-type: none">• 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

Figure 3.UN11

Components	Examples	Functions
<p style="text-align: center;">Nitrogenous base</p> <p>Phosphate group</p>  <p style="text-align: center;">Nucleotide monomer</p>	<p>DNA: </p> <ul style="list-style-type: none"> • Sugar = deoxyribose • Nitrogenous bases = C, G, A, T • Usually double-stranded <hr/> <p>RNA: </p> <ul style="list-style-type: none"> • Sugar = ribose • Nitrogenous bases = C, G, A, U • Usually single-stranded 	<p>Stores hereditary information</p> <hr/> <p>Various functions in gene expression, including carrying instructions from DNA to ribosomes</p>