

Macromolecules

- Biological macromolecules are incredibly diverse
- Four major classes of macromolecules are lipids, carbohydrates, proteins and nucleic acids
- Many macromolecules are polymers

Polymers

- Polymers are large molecules built of smaller repeating subunits
- The subunits are called monomers
- Adjacent monomers are often joined by condensation (dehydration) reactions
- Molecules that serve as monomers may also have other functions

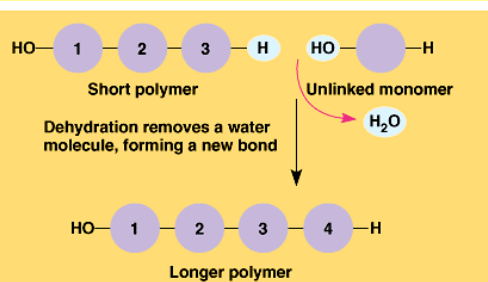
Examples of biological polymers

This Polymer	Is made from this monomer
• Proteins	amino acids
• DNA	nucleotides
• RNA	nucleotides
• Starch	monosaccharide (sugar)
• Glycogen	monosaccharide
• Cellulose	monosaccharide

Polymers, cont.

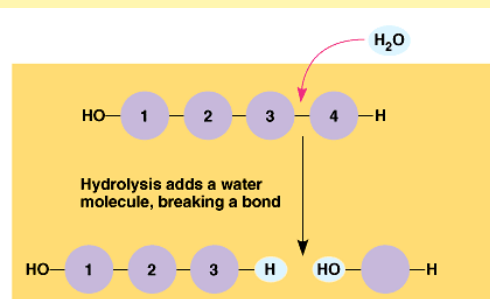
- From a small set of monomers, you can make a practically infinite set of polymers
- Monomers are often identical in different life forms, but polymers (macromolecules) differ

Condensation or Dehydration Reactions Join Monomers Together



(a) Dehydration reaction in the synthesis of a polymer

Bonds between monomers are broken by hydrolysis



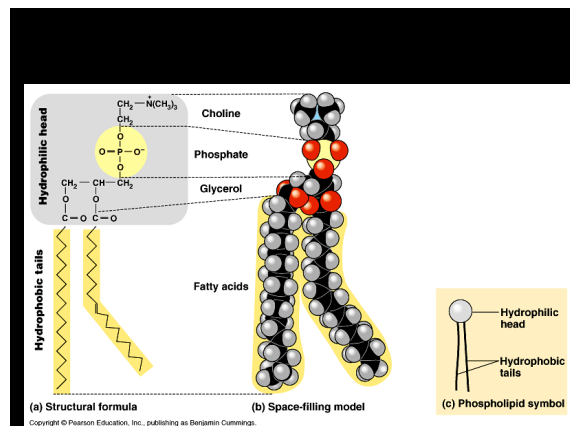
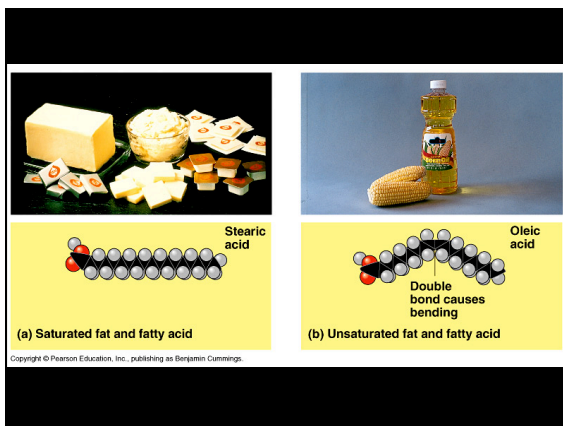
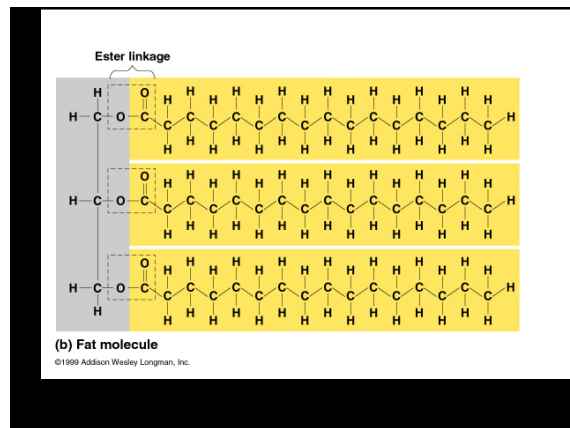
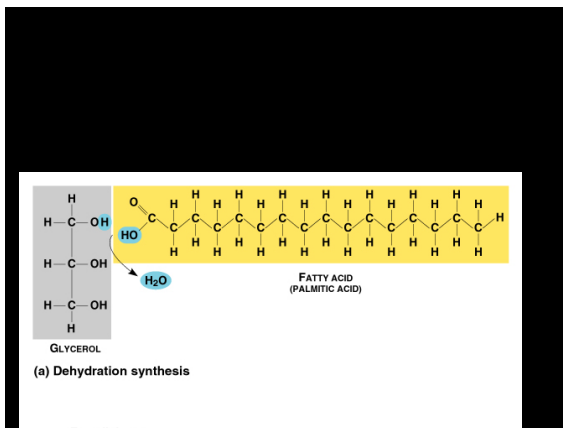
(b) Hydrolysis of a polymer

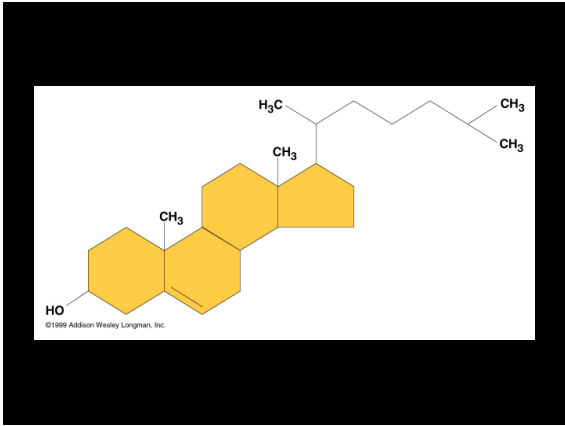
The four classes of macromolecules

- Lipids
- Proteins
- Carbohydrates
- Nucleic Acids

Lipids

- Diverse molecules, all hydrophobic
- Lipids do not form polymers
- Examples (functions):
 - Fatty acids (energy transport)
 - Neutral fats or triacylglycerols (storage)
 - Phospholipids (cell membranes)
 - Steroids (membranes, hormones)





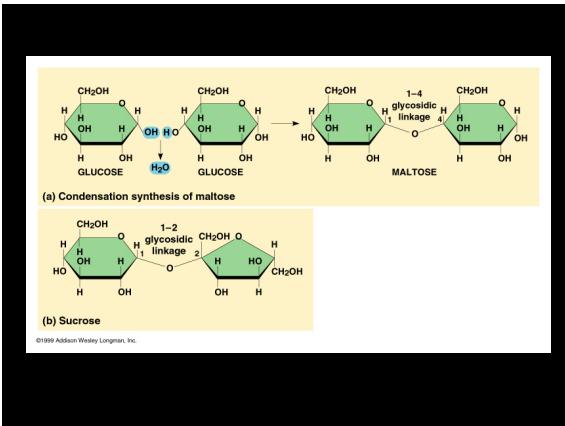
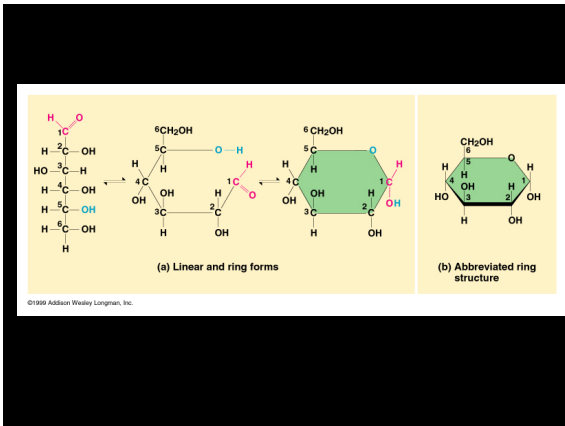
Carbohydrates

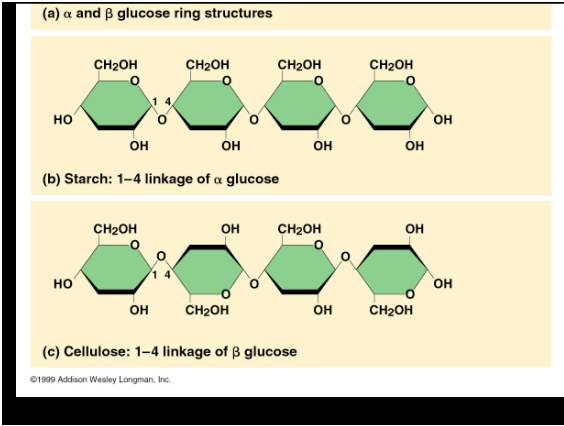
- Used for fuel, structure, carbon storage
- Based on sugar monomers
- Monosaccharides, disaccharides, polysaccharides
- Starches vs. cellulose

How can you recognize carbohydrates?

	TRIOSE SUGARS (C ₃ H ₆ O ₃)	PENTOSE SUGARS (C ₅ H ₁₀ O ₅)	HEXOSE SUGARS (C ₆ H ₁₂ O ₆)	
ALDOSES	$\begin{array}{c} \text{H} \\ \\ \text{C}=\text{O} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Glycerinaldehyde	$\begin{array}{c} \text{H} \\ \\ \text{C}=\text{O} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Ribose	$\begin{array}{c} \text{H} \\ \\ \text{C}=\text{O} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{HO}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Glucose	$\begin{array}{c} \text{H} \\ \\ \text{C}=\text{O} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{HO}-\text{C}-\text{H} \\ \\ \text{HO}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Galactose
KETOSES	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{C}=\text{O} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Dihydroxyacetone	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{C}=\text{O} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Ribulose	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{C}=\text{O} \\ \\ \text{HO}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ Fructose	

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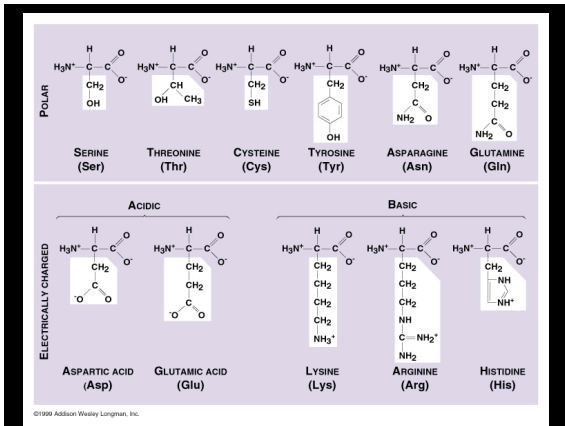
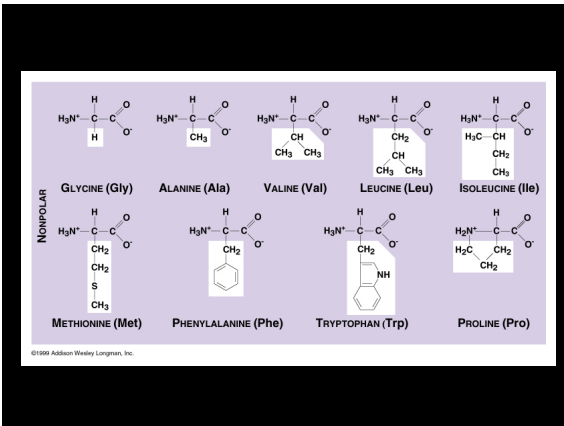
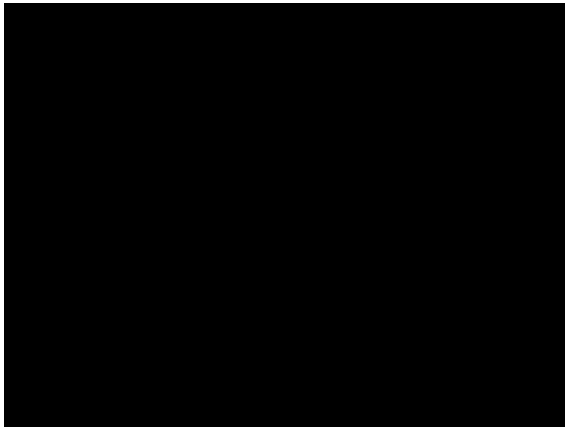
Some Functions of Proteins

and some examples

- Support - collagen
- Transport
- Signaling - hormones
- Movement - myosin and actin
- Defense - antibodies
- Catalysis - enzymes
- Storage - albumin
- Signal reception

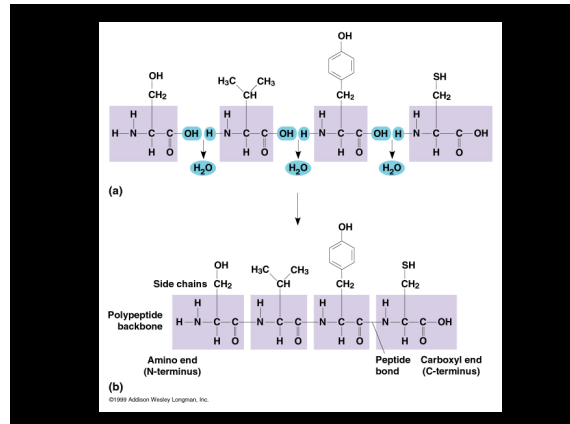
Proteins are made of amino acids

- Amino acids are the monomers that make up proteins
- Each amino acid consists of a central carbon attached to a hydrogen, a carboxyl group, an amino group and an "R" group.
- There are 20 different amino acids



Protein Structure I

- Amino acids can be joined by "peptide bonds" (dehydration synthesis again)
- A *polypeptide* is a polymer of amino acids
- A *protein* consists of one or more polypeptide strands

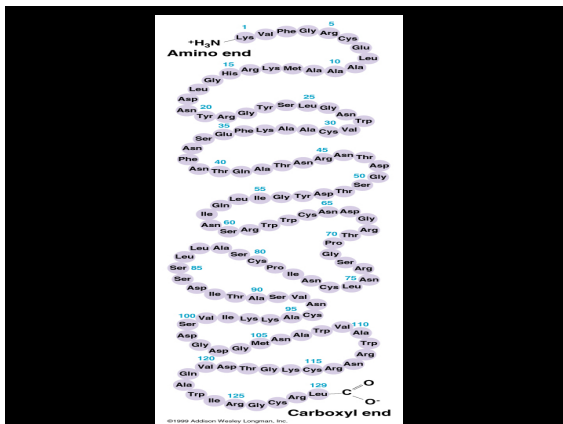


Protein Structure II

- A protein's function depends on its shape
- There are four levels of protein structure that together determine its final shape

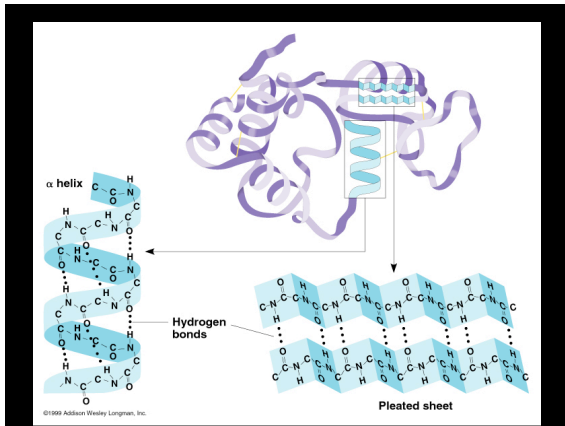
Primary Structure...

- ... is the specific order of amino acids making up a polypeptide chain



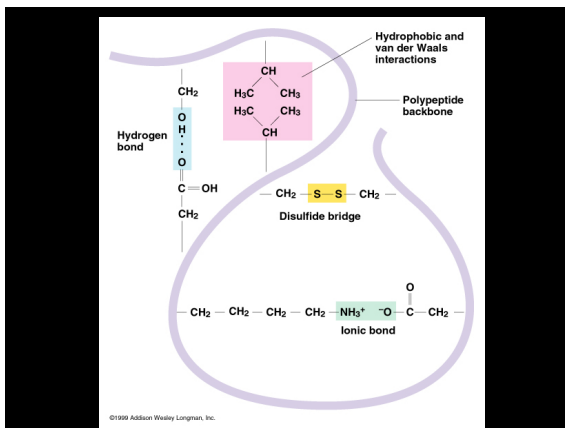
Secondary Structures...

- ...are regular repeated shapes formed by certain sequences of amino acids:
 - Alpha-helices
 - Beta pleated sheets
- These are stabilized by hydrogen bonds between *backbone* molecules (not side chains)



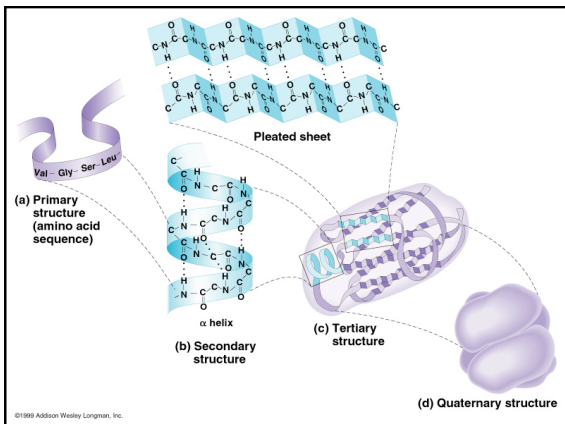
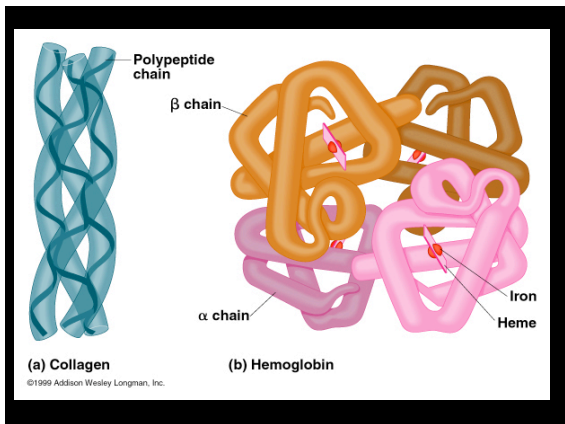
Tertiary Structure...

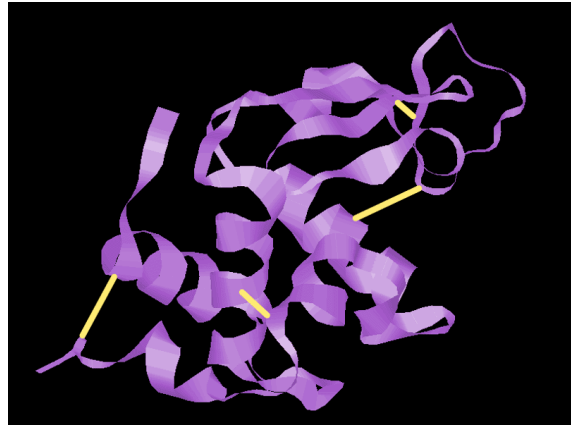
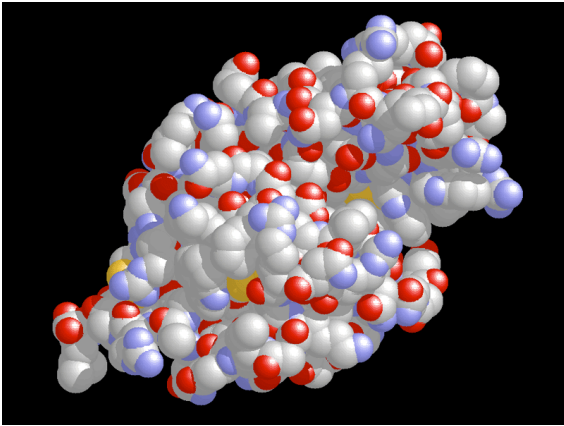
- ...is irregular folding of polypeptides
- Tertiary structures are stabilized by varied bonds between side chains ("R groups")



Quaternary Structure...

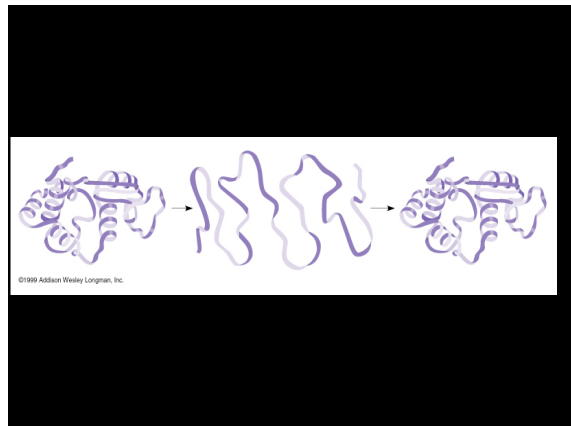
...is the joining of two or more polypeptide chains into a specific arrangement





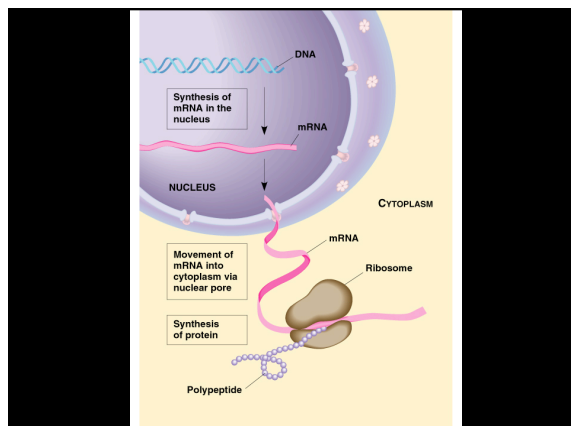
Protein Denaturing

- Under harsh conditions (extreme temperatures, acid or alkaline solution) proteins lose their shape - they *denature*
- Denaturing may be reversible or irreversible



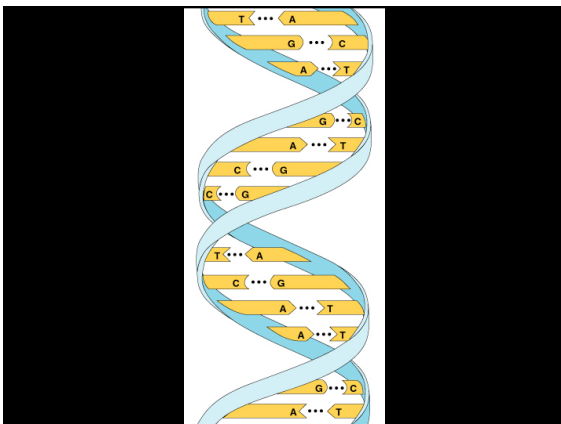
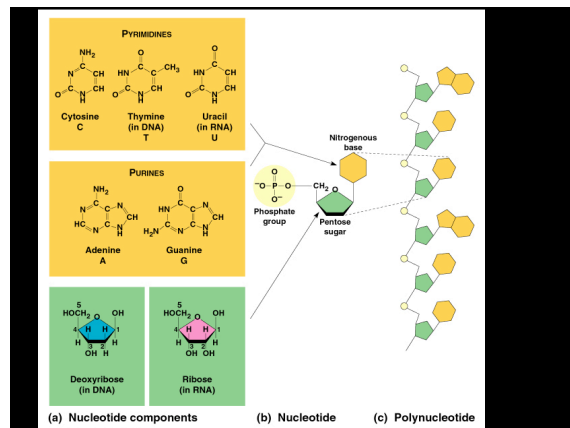
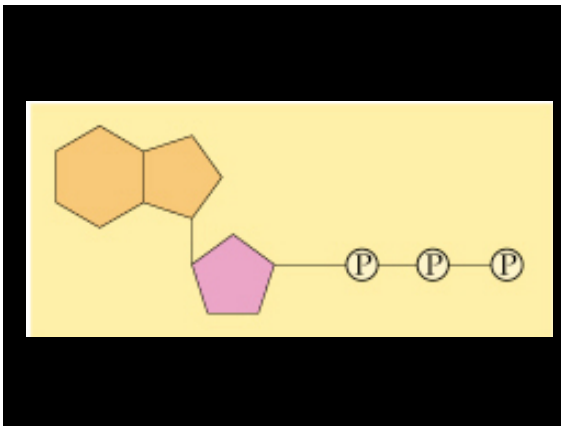
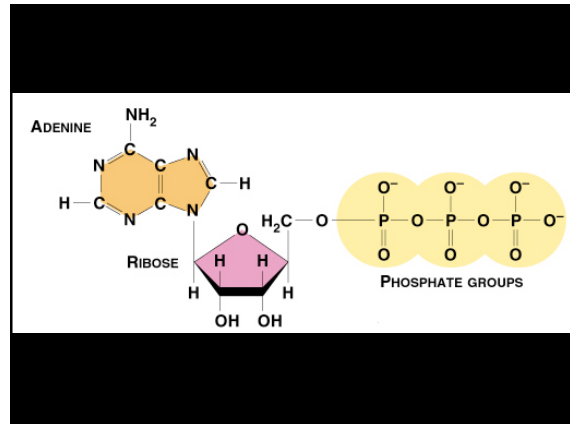
Nucleic Acids

- Nucleic acids store and transmit hereditary information, both within the cell and between generations
- Information in a cell flows from DNA to RNA to protein
- DNA contains the blueprint for making specific proteins



Nucleic acids are made from monomers called nucleotides

- Nucleotides consist of three parts -
 - a five carbon sugar
 - a phosphate group
 - a nitrogenous base
- Different bases make for different nucleotides



DNA vs RNA

- They differ in the sugar (deoxyribose vs ribose)
- DNA's four bases are Adenine, Cytosine, Guanine, Thymine (A, C, G, and T)
- RNA contains Uracil, no Thymine (A, C, G, and U)
- DNA forms a double helix, RNA is single-stranded