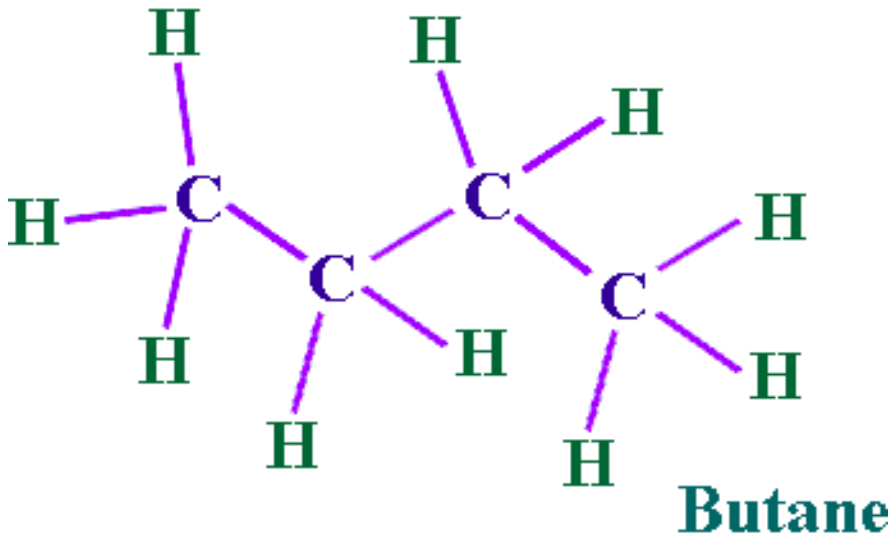
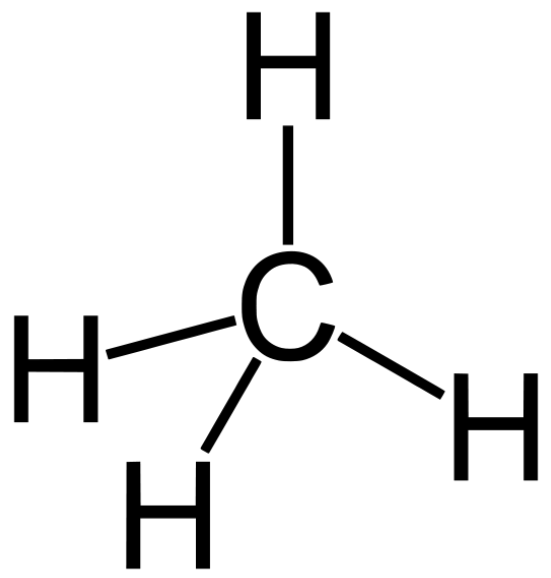
Macromolecules

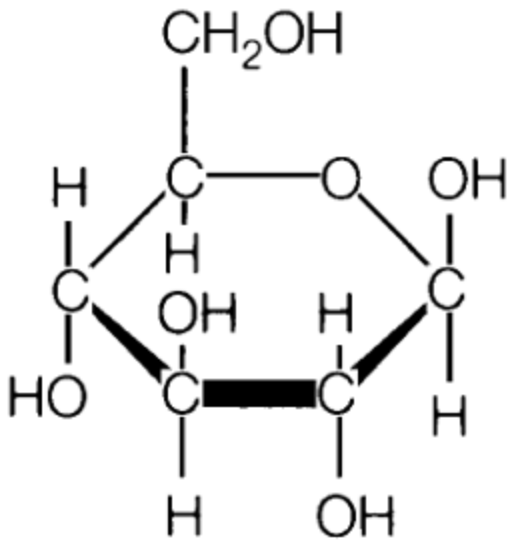
Carbon (Organic) Compounds

- Carbon = basic unit of macromolecules



Butane



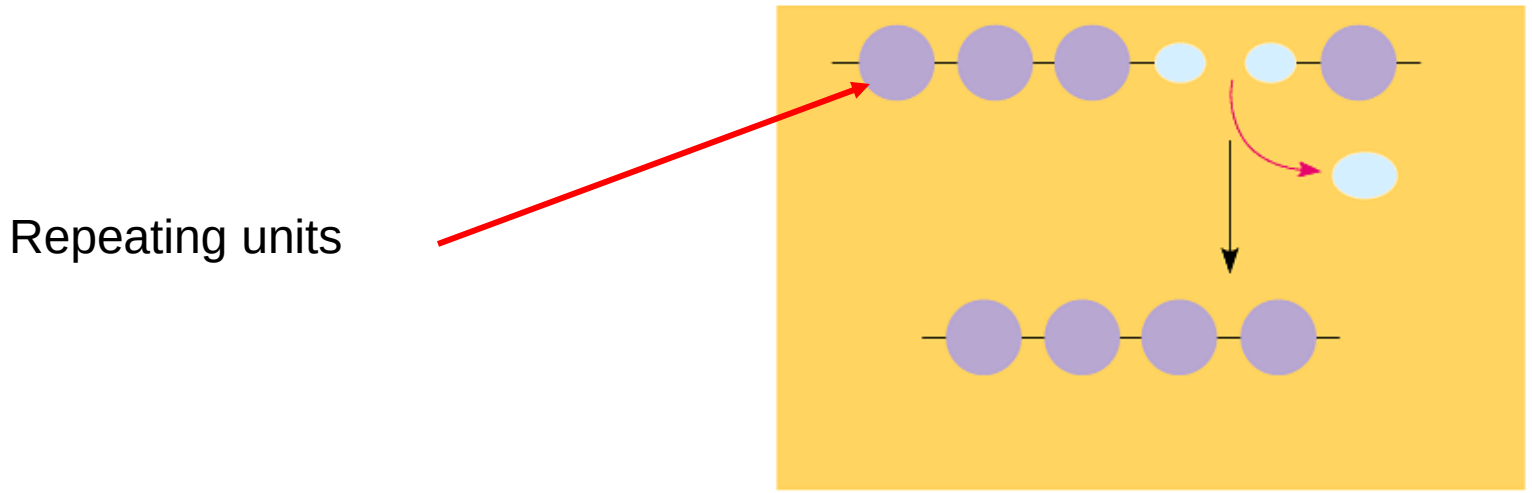


4 Main Type of Macromolecules (Organic molecules or Biomolecules

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

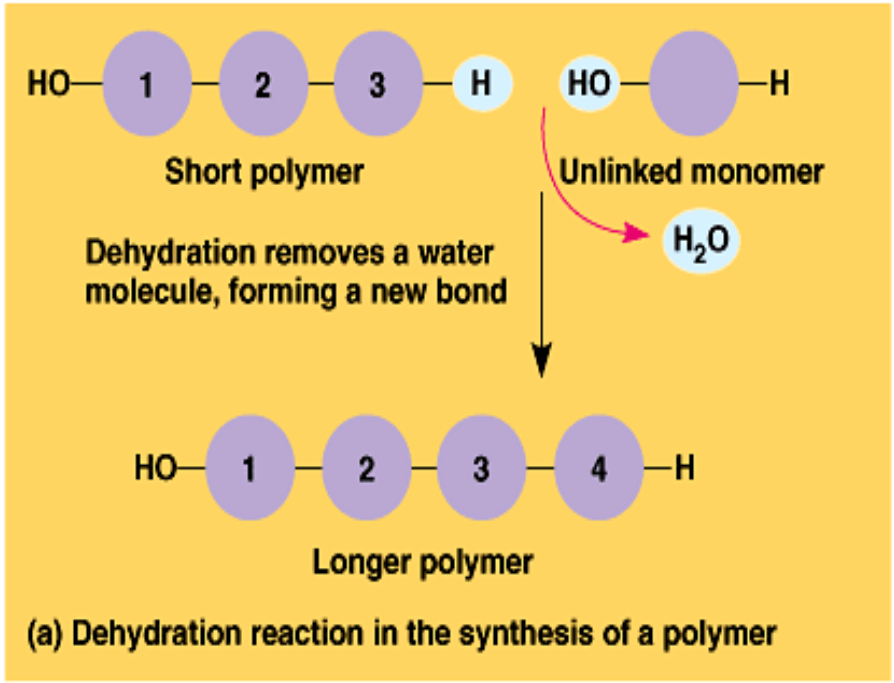
Polymers

- Carbohydrates, proteins and nucleic acids are polymers
- **Polymers**: long molecule built by linking repeating units with covalent bonds
  - Each unit of polymer = monomer

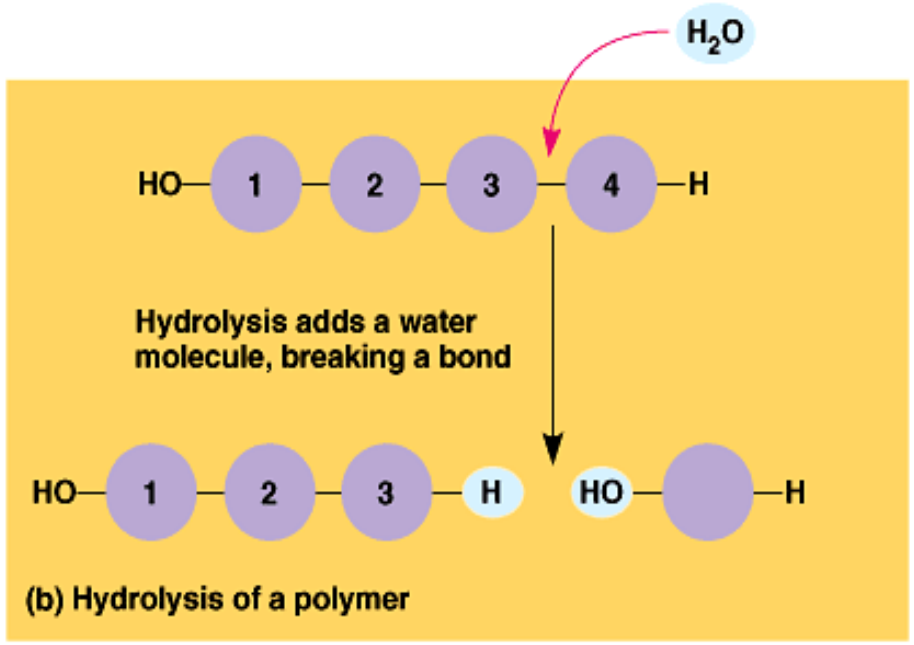


Synthesis of Polymers

- Dehydration synthesis: H_2O is lost
  - Monomers joined by removal of water
    - One contributes –OH
    - One contributes –H
    - Together → H_2O
  - Process requires energy and enzymes (proteins)



Breakdown of Polymers



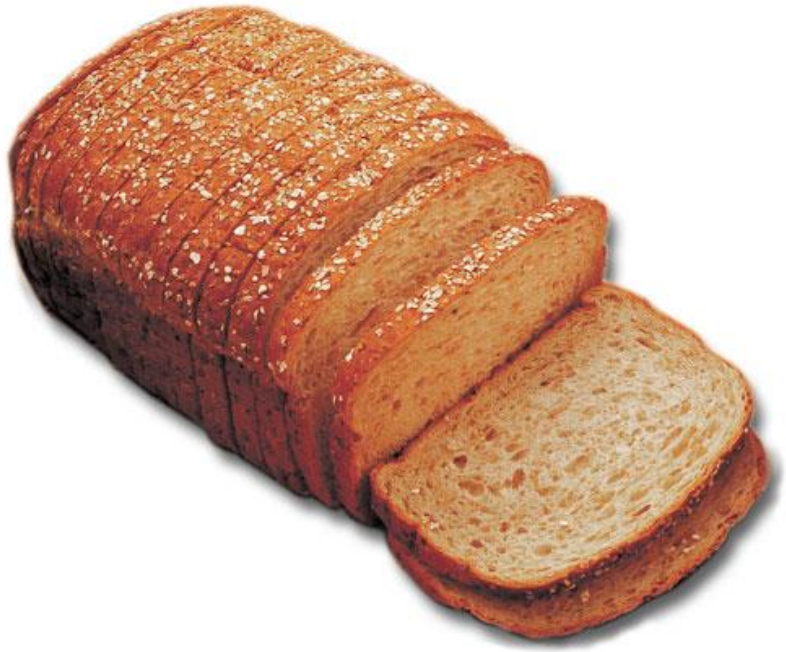
- Hydrolysis Reaction:
  - Hydro = water
  - Lysis = to break apart
  - Reverse of dehydration synthesis reaction
  - Uses water to split polymer
  - H_2O splits into -H & -OH
  - -H & -OH bond to where covalent bond was before

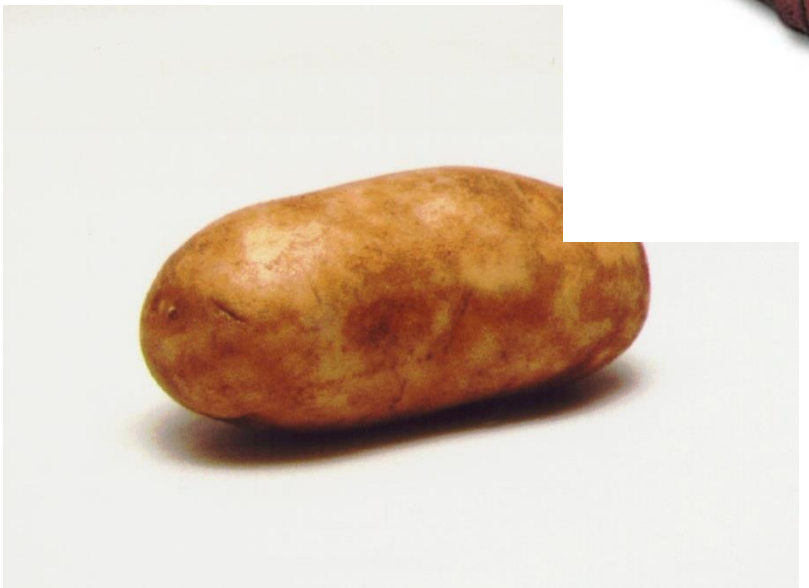
Why is it important to learn about nutrition?

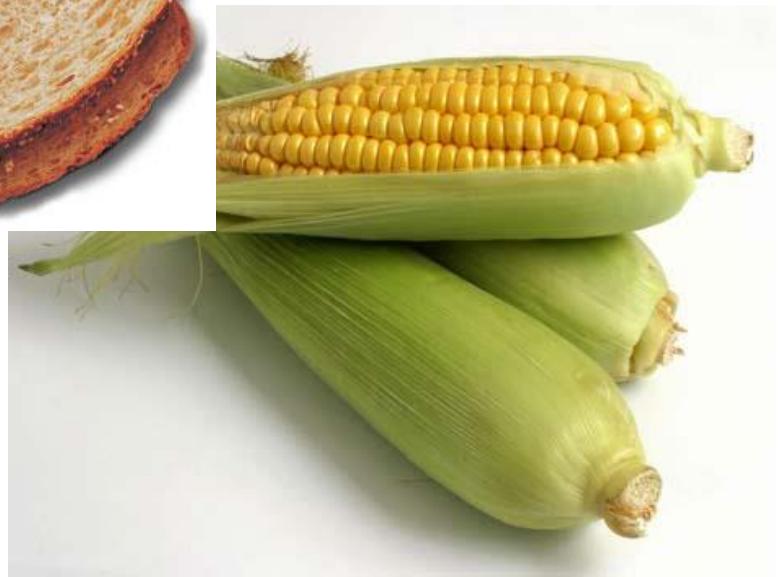
Do you know how many carbs, proteins, and fats you are supposed to eat in a day?

What do these things do for your body?

Guess the Macromolecule







Carbohydrate

Elements: C, H, O with a ratio of 1:2:1

Monomer: monosaccharide (example: glucose)

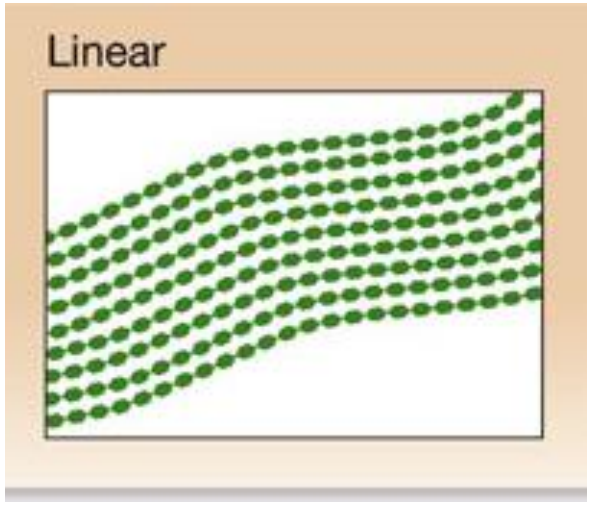
Polymer: polysaccharide (saccharide = sugar)

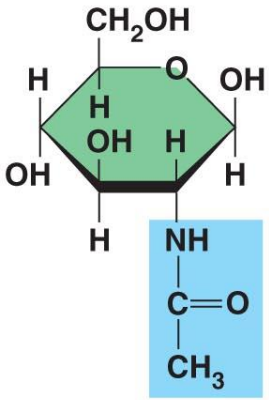
Function: Immediate energy and structure

Examples: Plants = cellulose and starch and Animals = glycogen

Carb Structure and Energy Sources

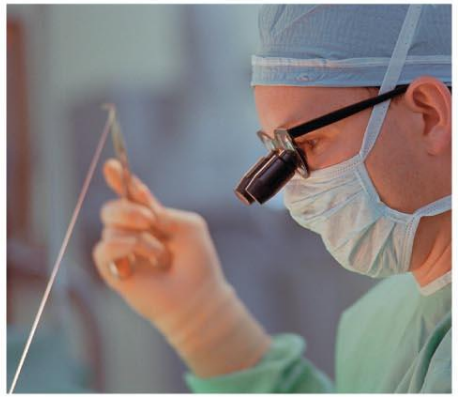
- Structural Carbohydrates
  - Cellulose – every other glucose molecule is flipped upside down which allows the rows to fit closely together (beta configuration)
  - Chitin – similar glucose arrangement to cellulose but found in fungi cell walls



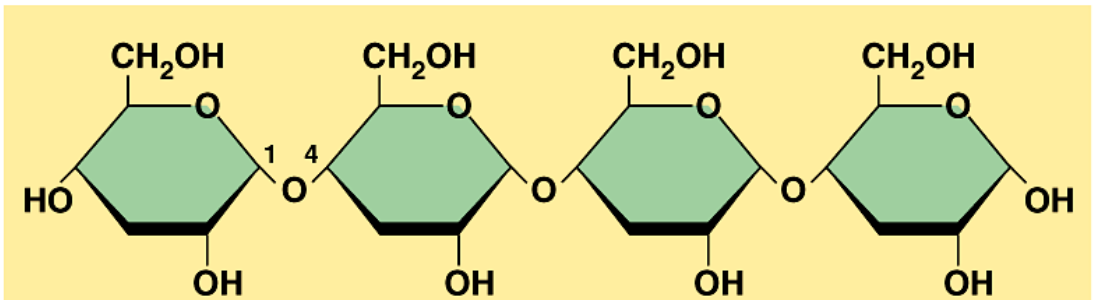


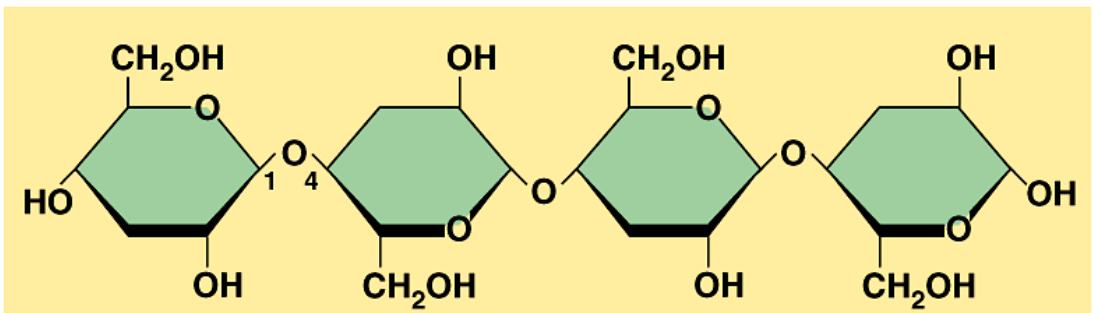
(a) The structure of the chitin monomer.

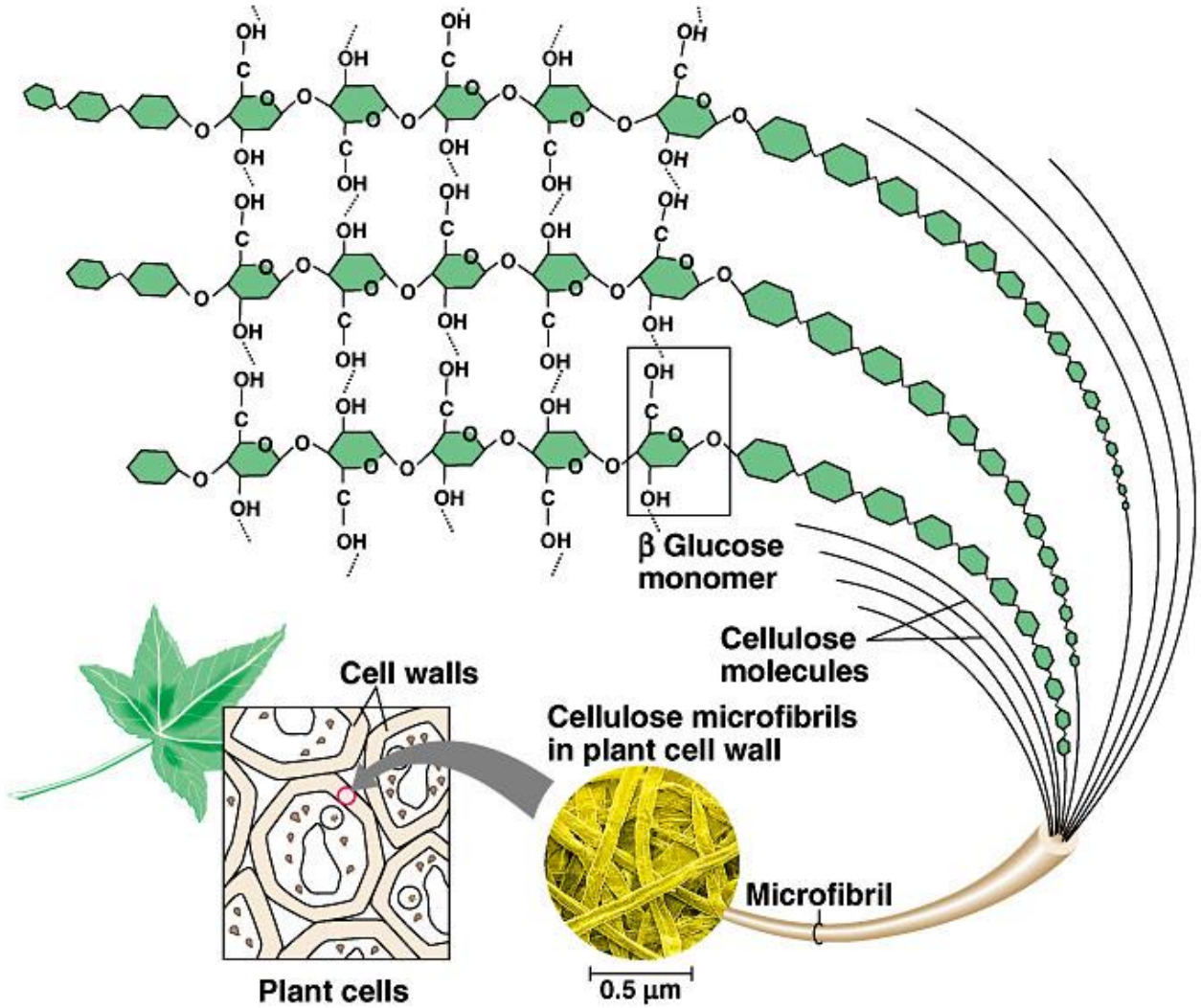
(b) Chitin forms the exoskeleton of arthropods.



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

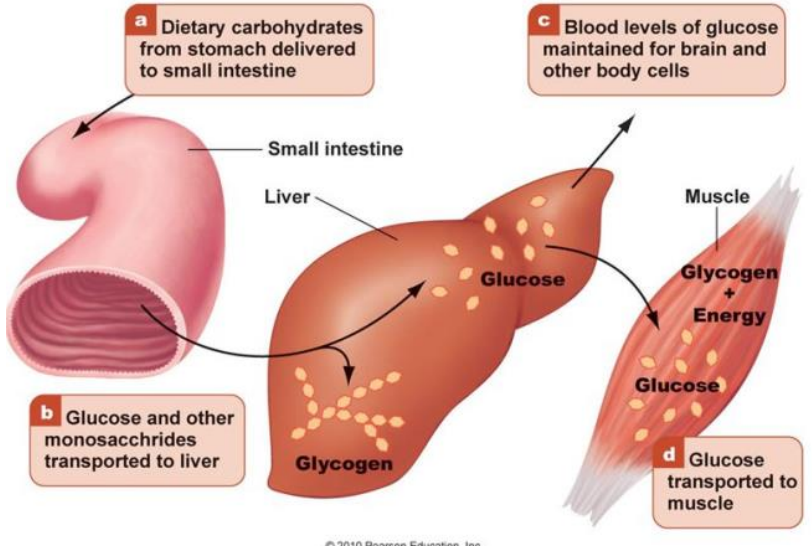


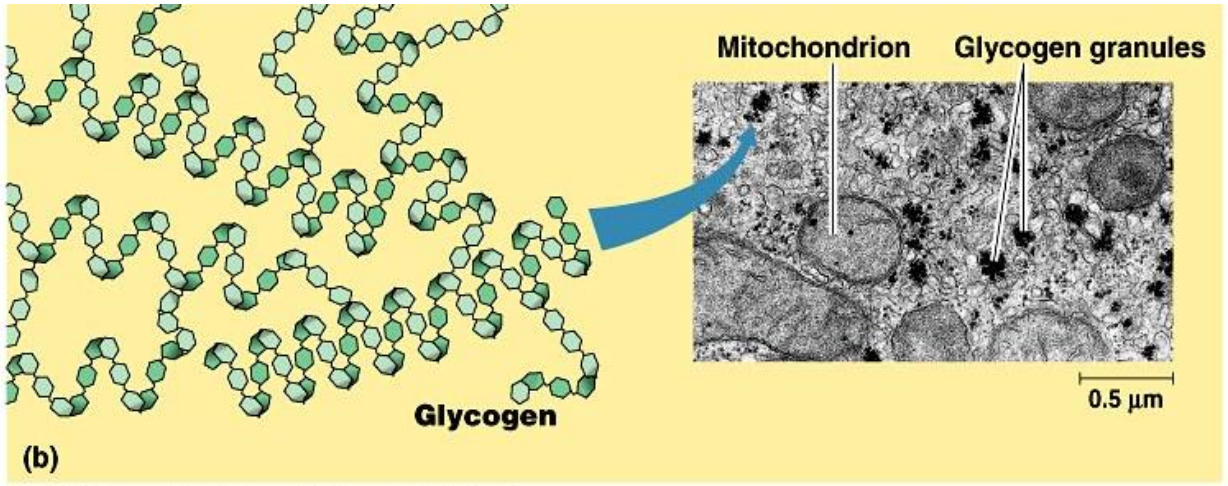




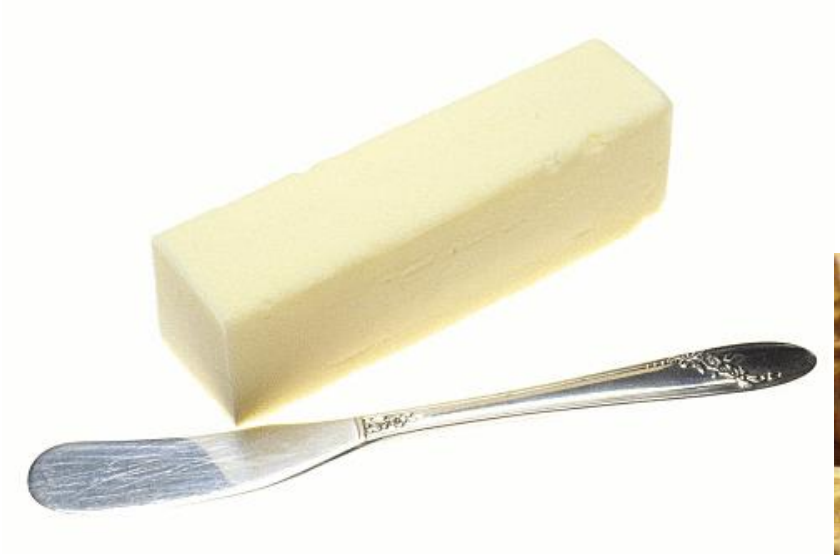
Carb Structure and Energy Sources

- Energy Carbohydrates
  - Glycogen - stored glucose in the liver in the alpha configuration
  - Starch – glucose molecules are all the same orientation so it forms a spiral and can be broken down (alpha configuration)





Guess the Macromolecule



Lipids

Elements: C,H,O with C-H chains

Monomer: fatty acid

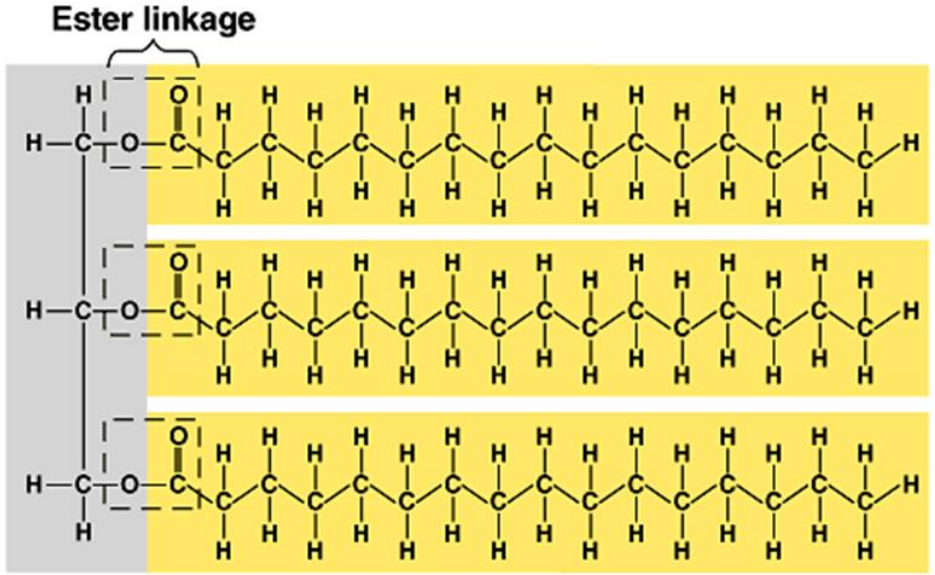
Polymer: no true polymers

Function: Stored energy, Structure, and
Protection and insulation

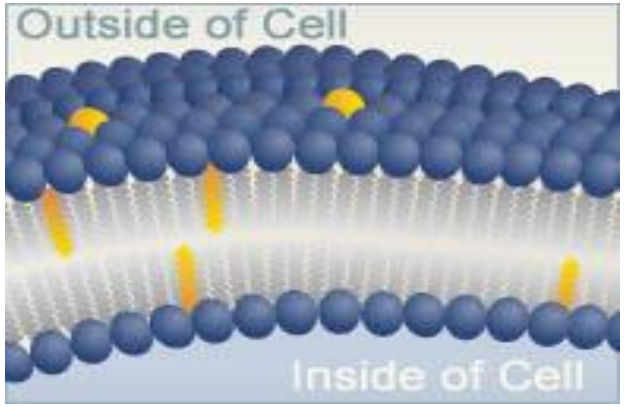
Lipids

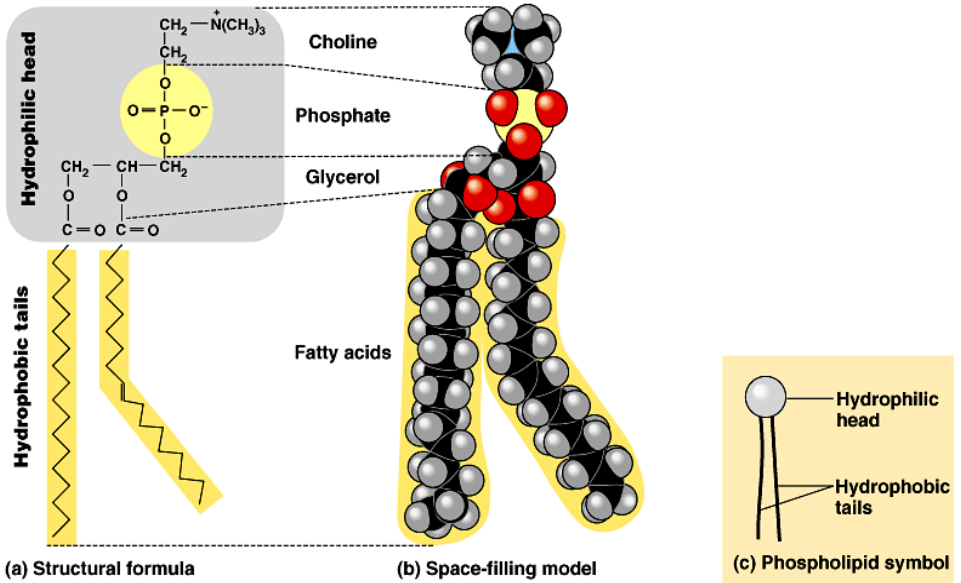
Examples:

- Triglyceride = fat
- Phospholipid
- Wax, Hormones, Steroids, and Cholesterol



(b) Fat molecule (triacylglycerol)

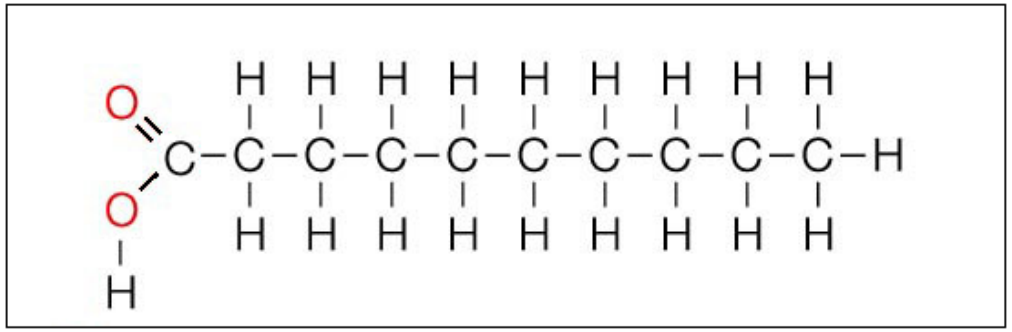


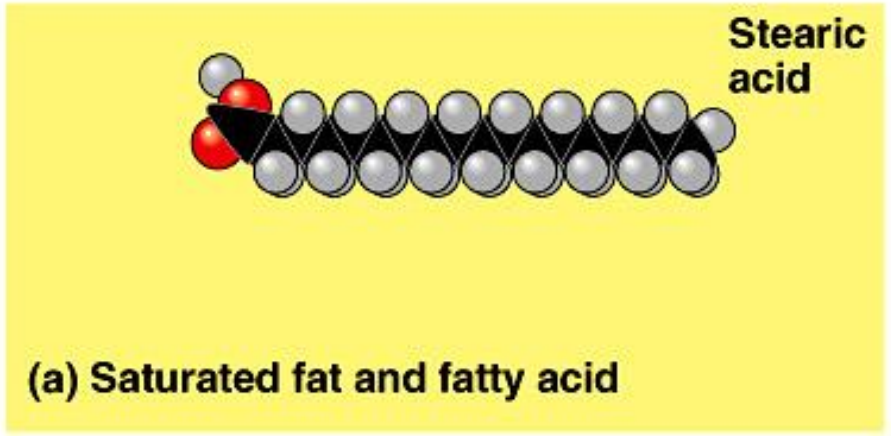


Saturated Fats

- Contains all the hydrogens that can be bound to the carbons in the chain
- Solid at room temperature
- Contributes to cardiovascular disease

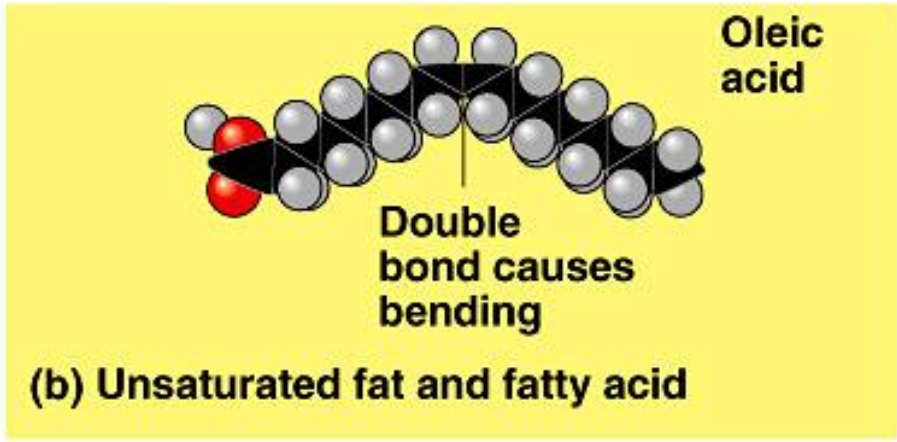
10-carbon saturated fatty acid (10:0 capric acid)





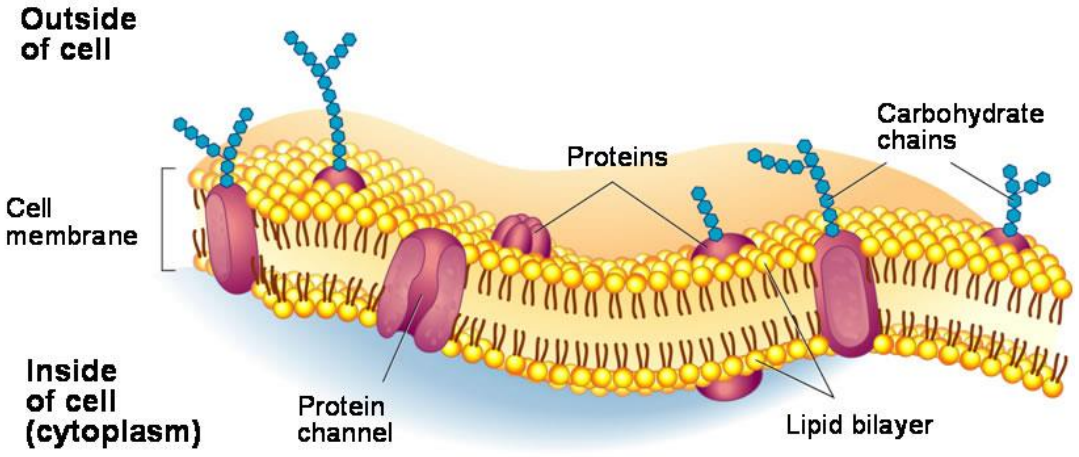
Unsaturated Fats

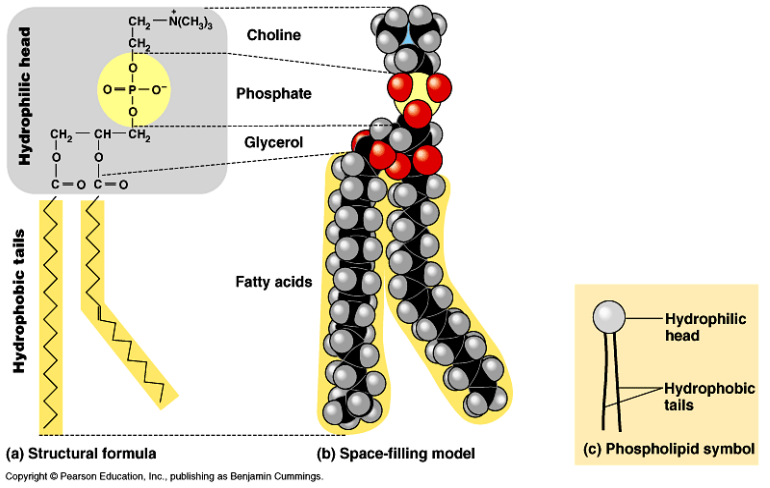
- Lacks all the hydrogens that can be bound to the carbons in the chain which forms double bonds between electrons
- Liquid at room temperature
- Fatty acid chains are bent
  - Won't stack - makes liquids



Phospholipids

- Make up the cell membrane which is the boundary of the cell
- Has two regions:
  - Hydrophobic tails that repel water
  - Hydrophilic head that attracts water





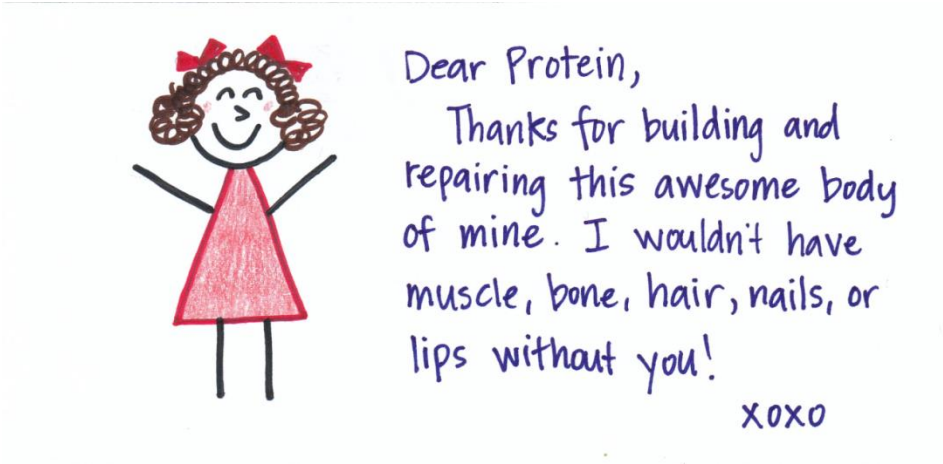
Guess the Macromolecule

Protein

Elements: C, H, O, N

Monomer: amino acid

Polymer: polypeptide

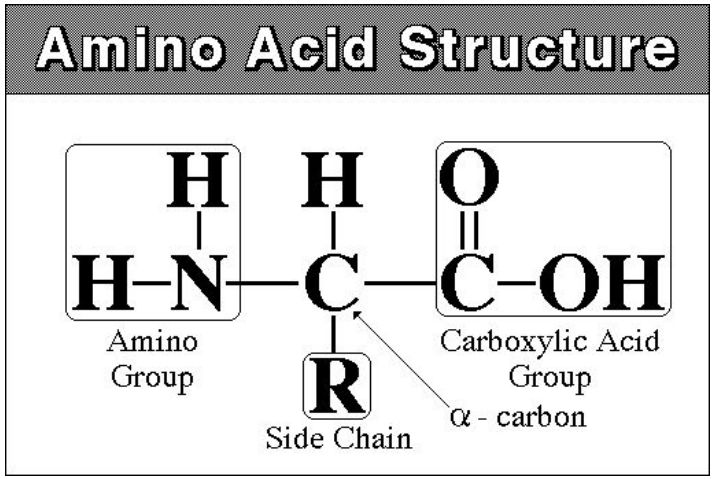


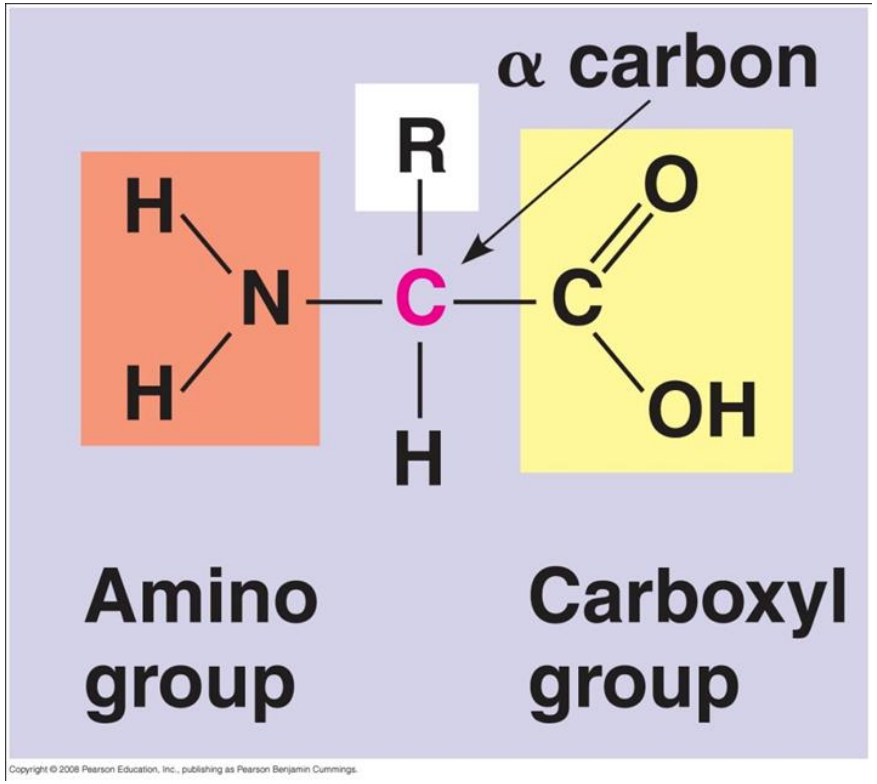
Function: Structure, Chemical reactions, Movement, Transport oxygen, Immunity (defense)

Examples: Transport proteins, enzymes, muscle proteins, hemoglobin, antibodies

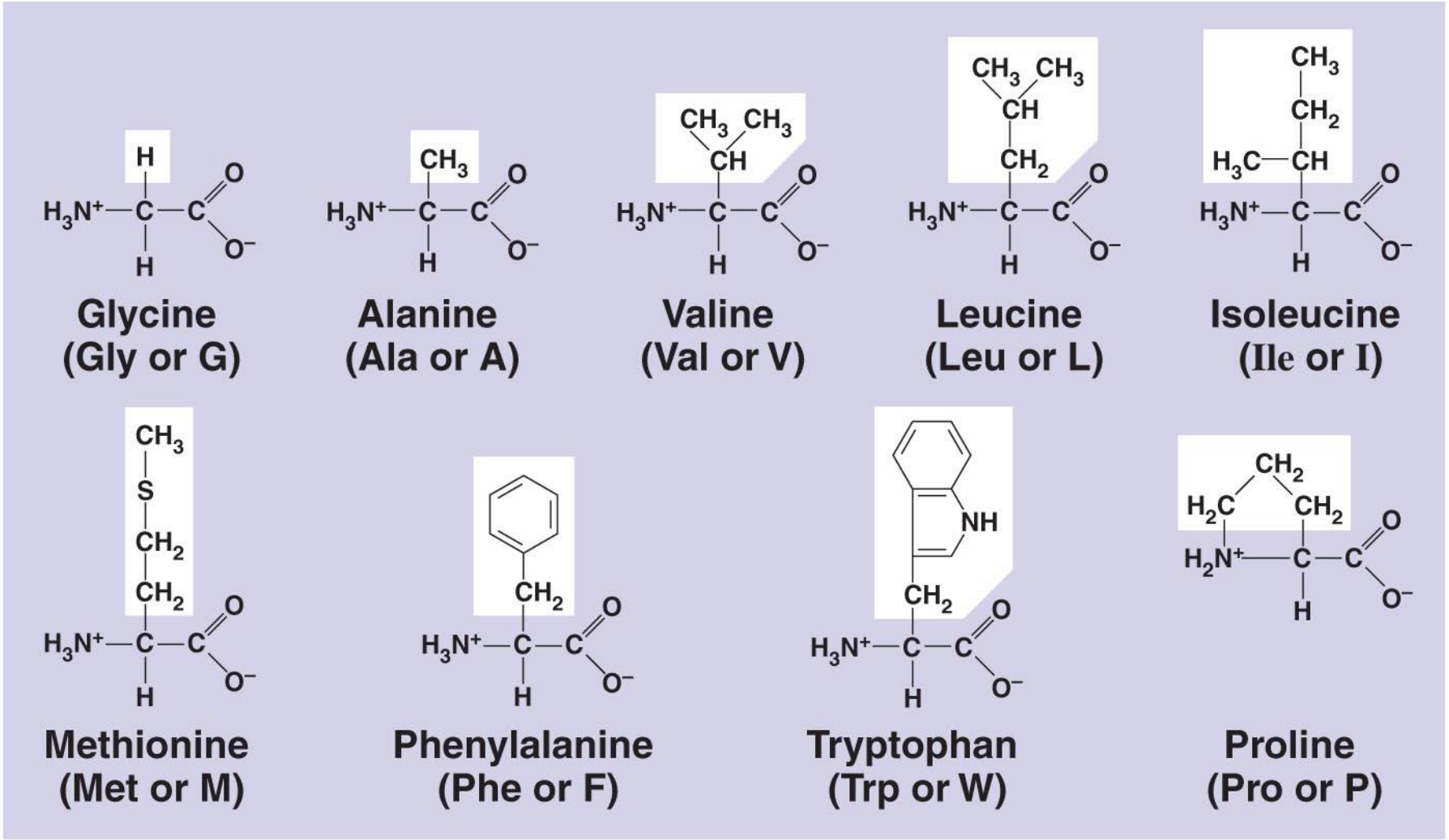
Protein

- **Amino acid structure:**
  - Central Carbon atom
  - Contains an amino group with a NH_2, a Carboxyl group with a COOH, and a H
  - The last side group is the R group. Each amino acid has a different R group that gives the amino acid a unique characteristic

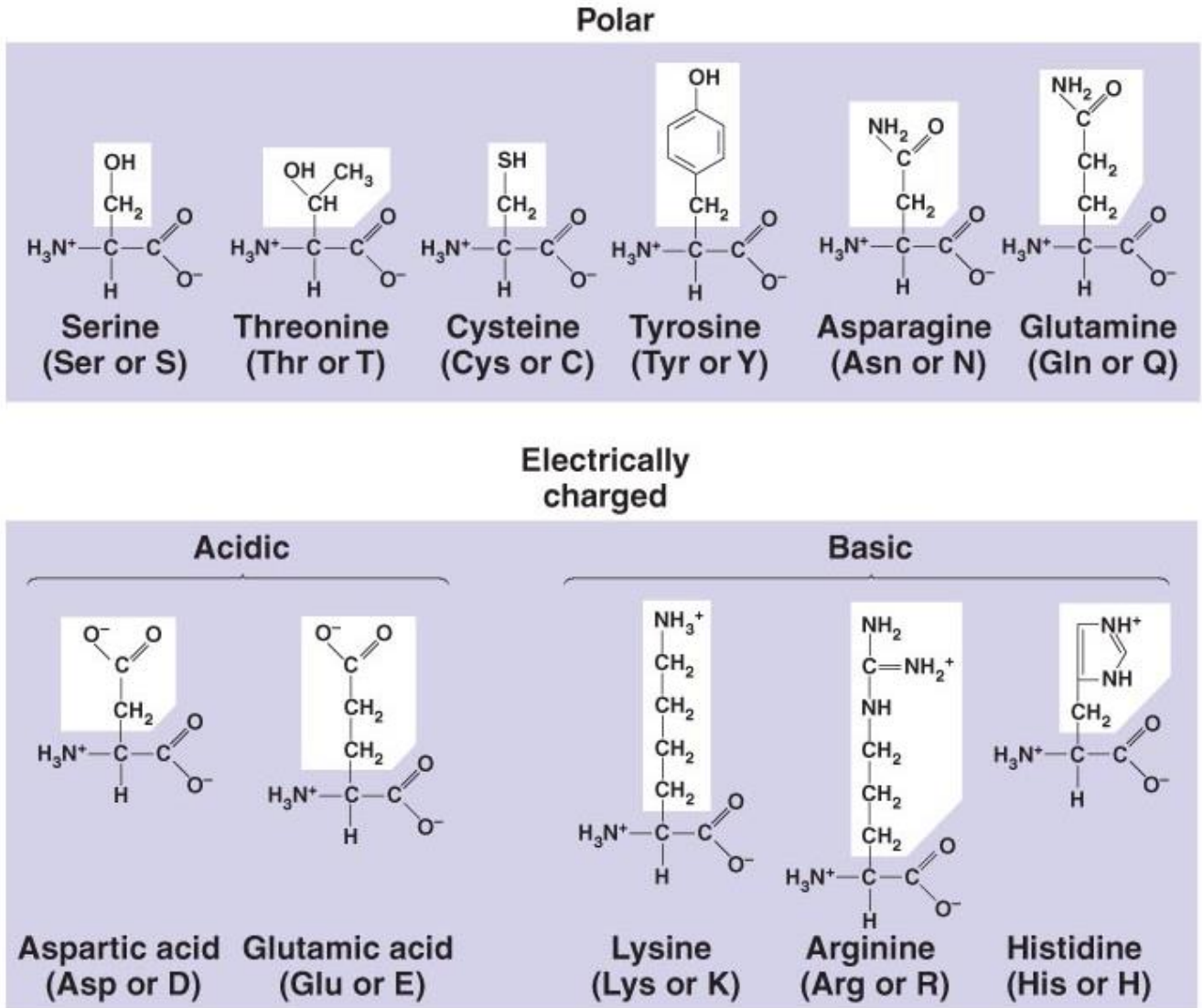




Nonpolar Amino Acids



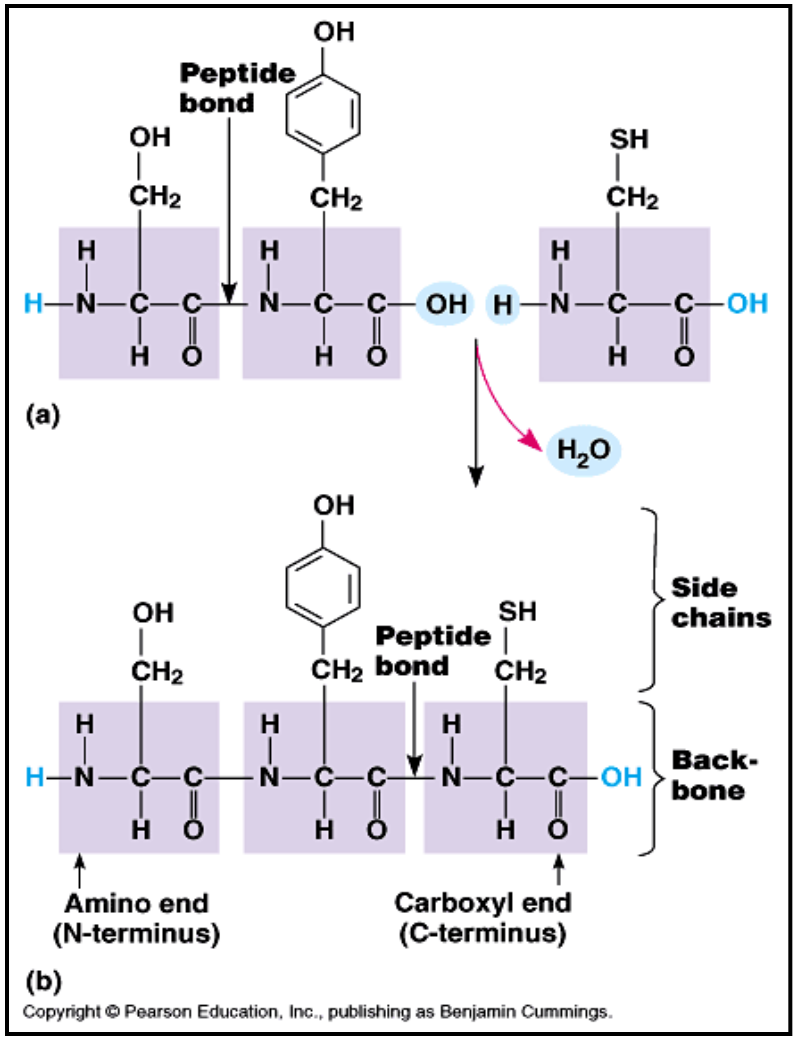
Polar Amino Acids



- 20 amino acids in living organisms

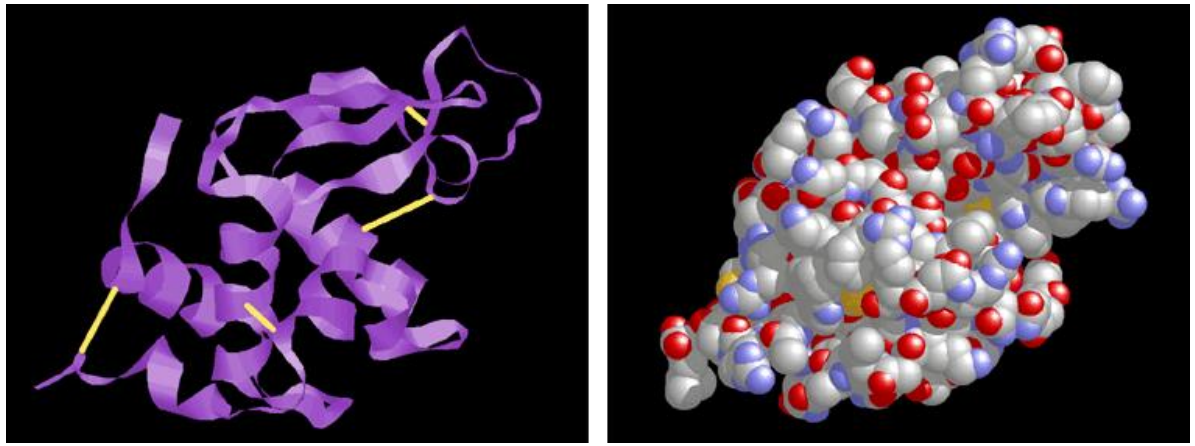
How to build proteins

- Dehydration synthesis of 2 or more amino acids
- (-COOH) and (NH_2) group are joined by a covalent called a **peptide bond**
- The bonds create a repeated N-C-C sequence which is backbone of polypeptide chain



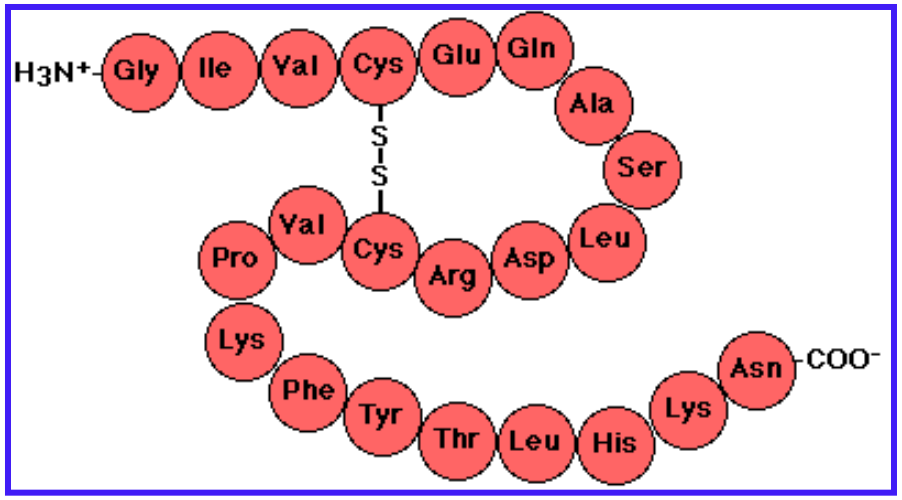
Protein Structure & Function

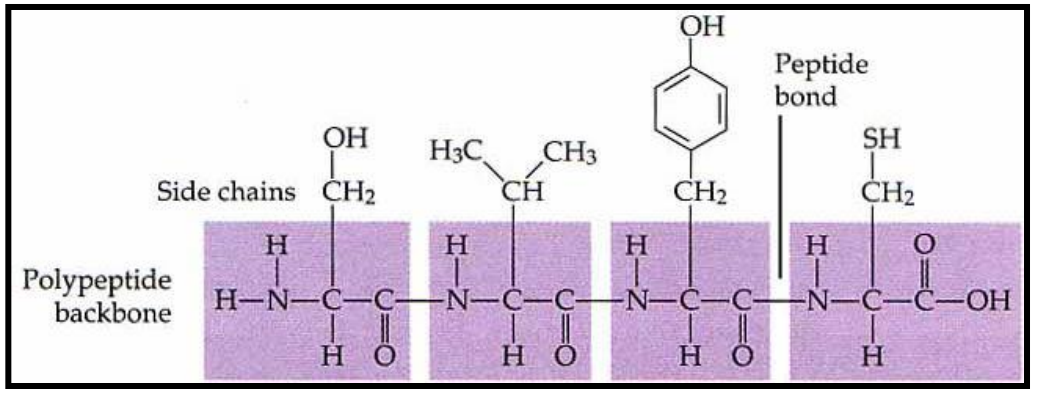
- **Function depends on structure** – it all starts with amino acid sequence
  - Folded, twisted, coiled into specialized shape
  - There are **4 levels** of protein structure



Protein Structure - Primary

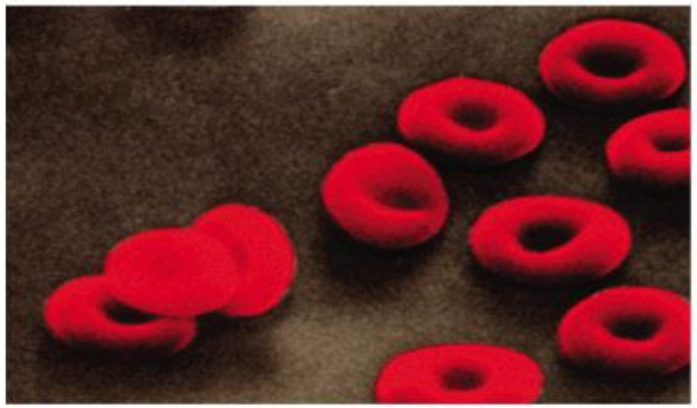
- **Linear structure** based on the order of amino acids and **peptide bonds**
- Each type of protein has a unique primary structure of amino acids
- Amino acid sequence is determined by the DNA sequence
  - Small change in DNA will affect the protein and can cause serious problems





Sickle Cell Anemia

- Result of only one amino acid change in primary structure of hemoglobin.

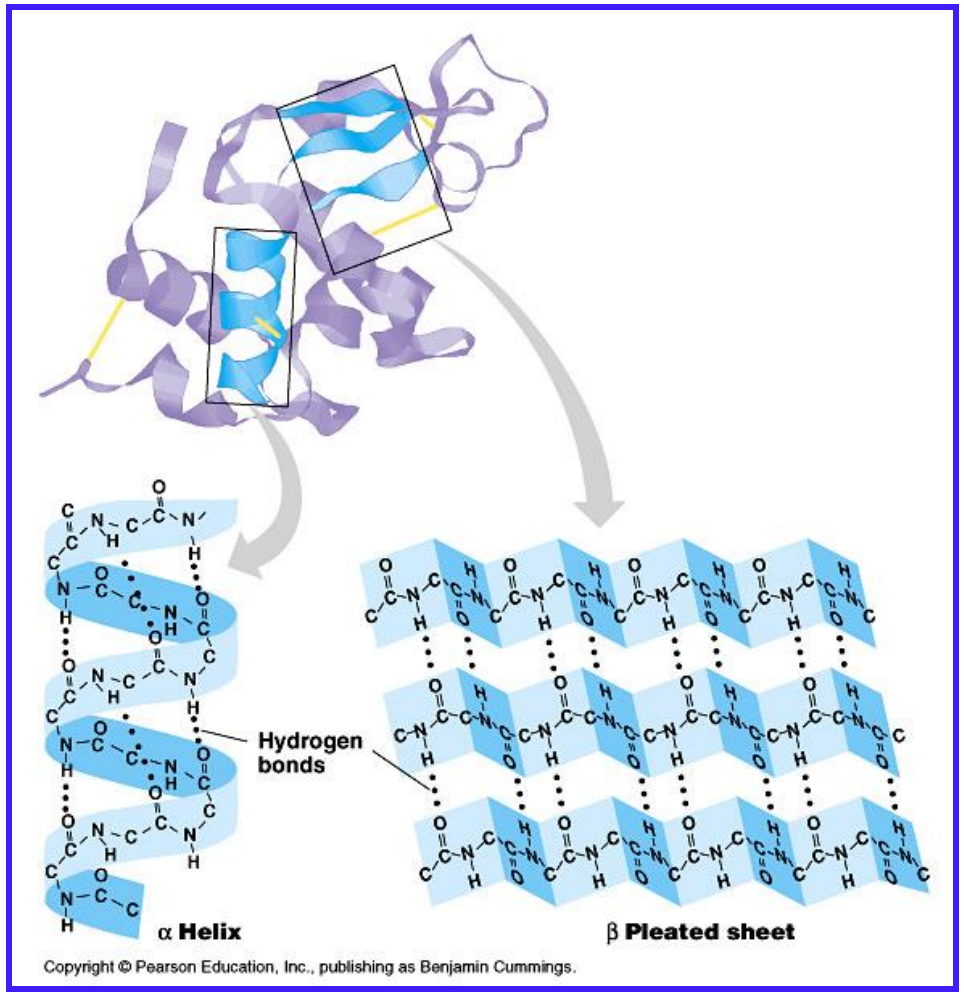


(a) Normal red blood cells and the primary structure of normal hemoglobin

(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

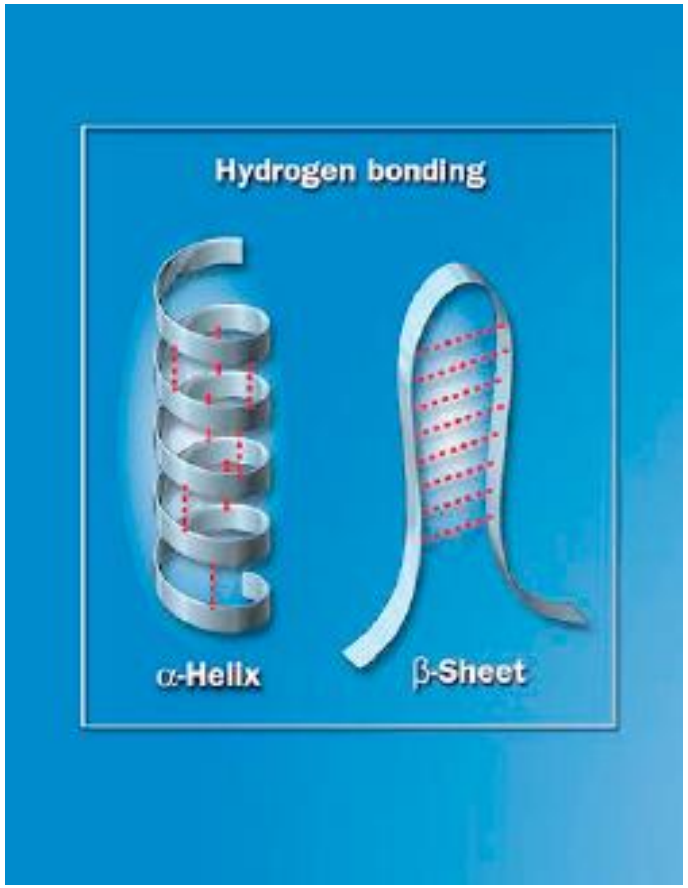
Protein Structure - Secondary

- Folding and coiling of the amino acid chain
  - Can be an alpha (**α**) helix or beta (**β**) pleated sheet
  - Folds are result of **hydrogen bonds** between R-groups of different amino acids

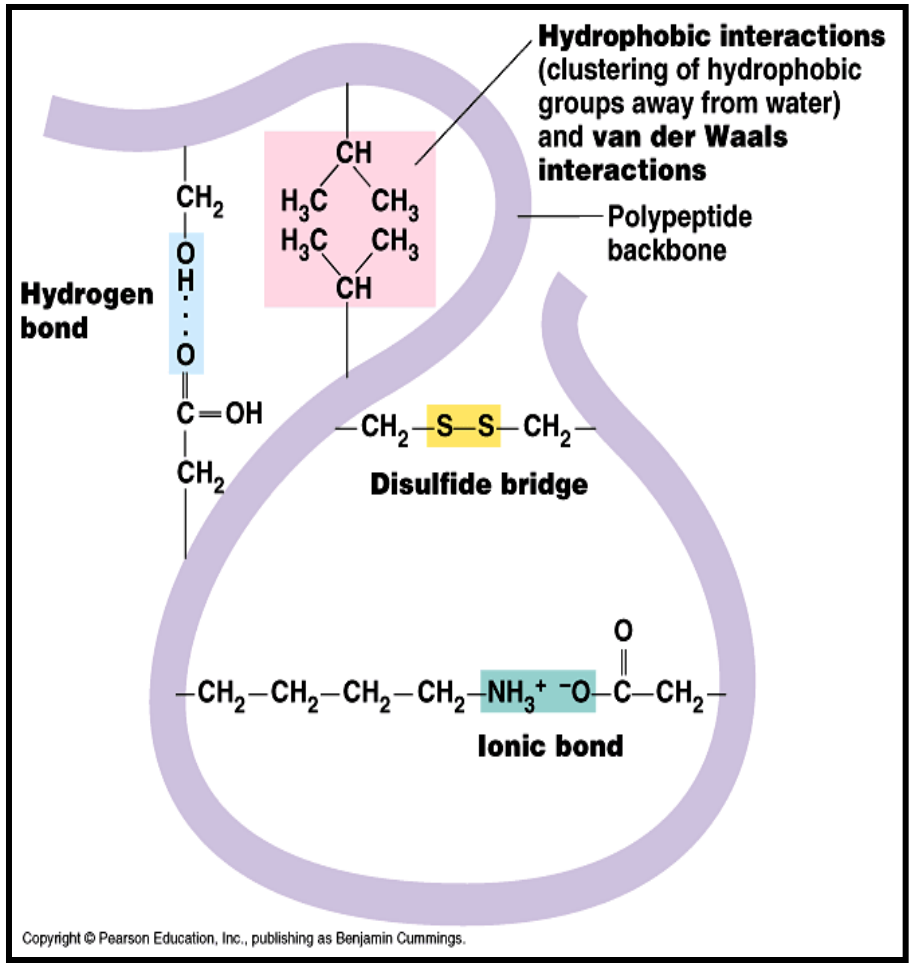


Protein Structure – Secondary

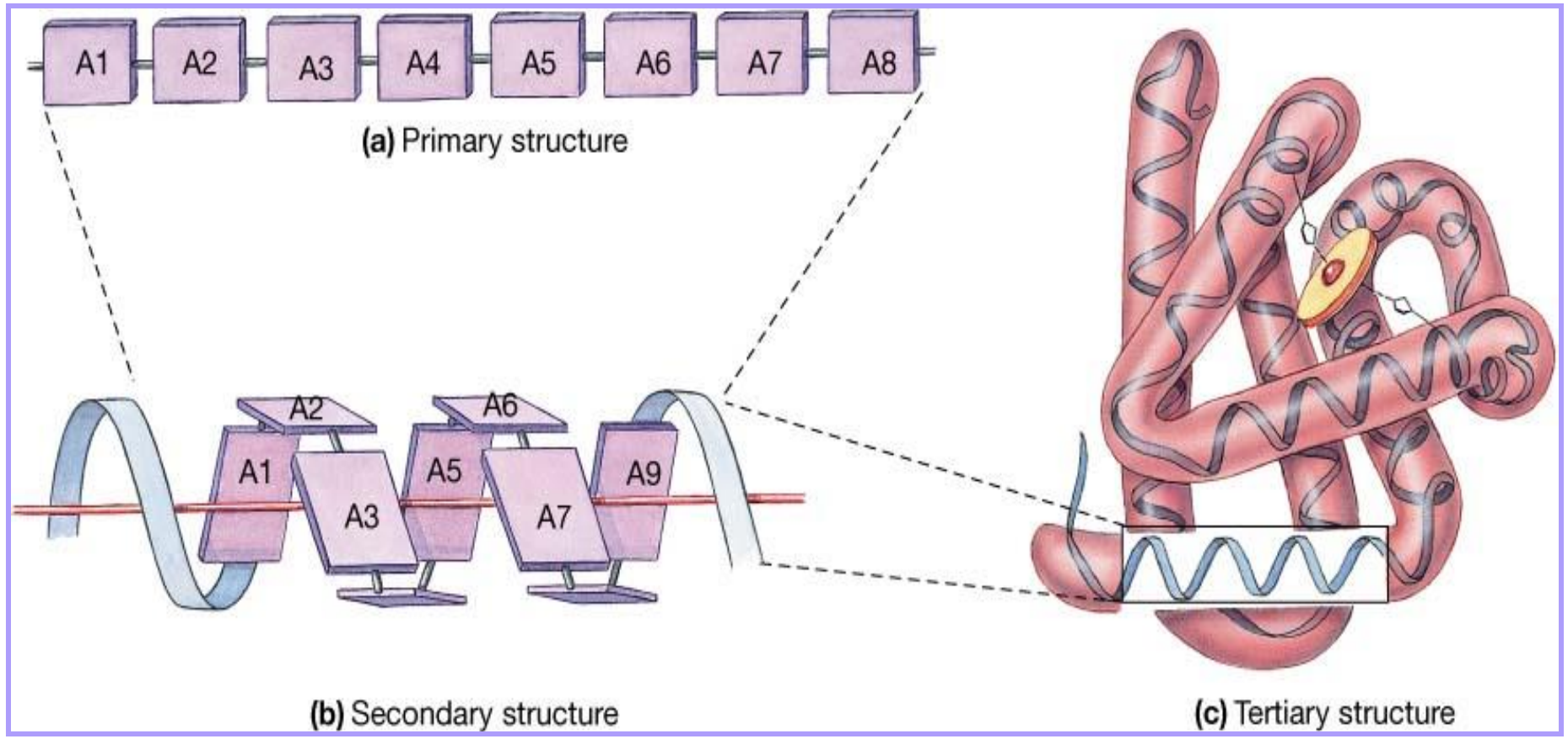
Spider silk: a structural protein containing beta (**β**) pleated sheets



Protein Structure – Tertiary

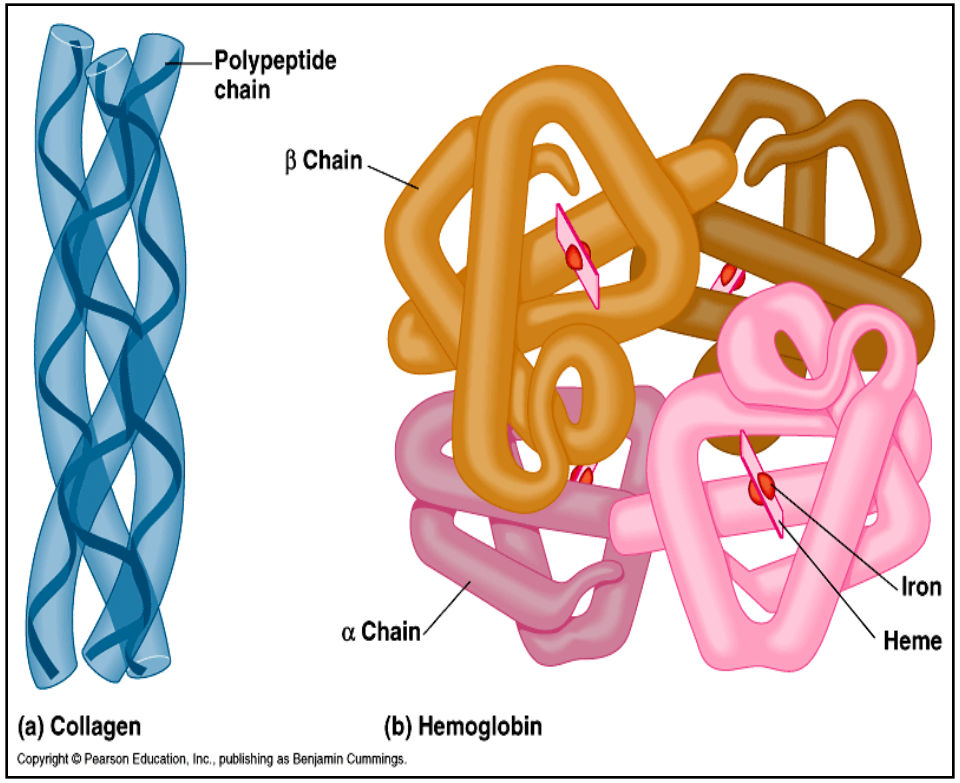


- Determined by interactions and bonding between R-groups
  - Hydrophobic & Hydrophilic interactions due to water around the protein
  - More Hydrogen bonds
  - Disulfide bridges between R-groups with sulfur
  - Ionic bonds with a transfer of electrons

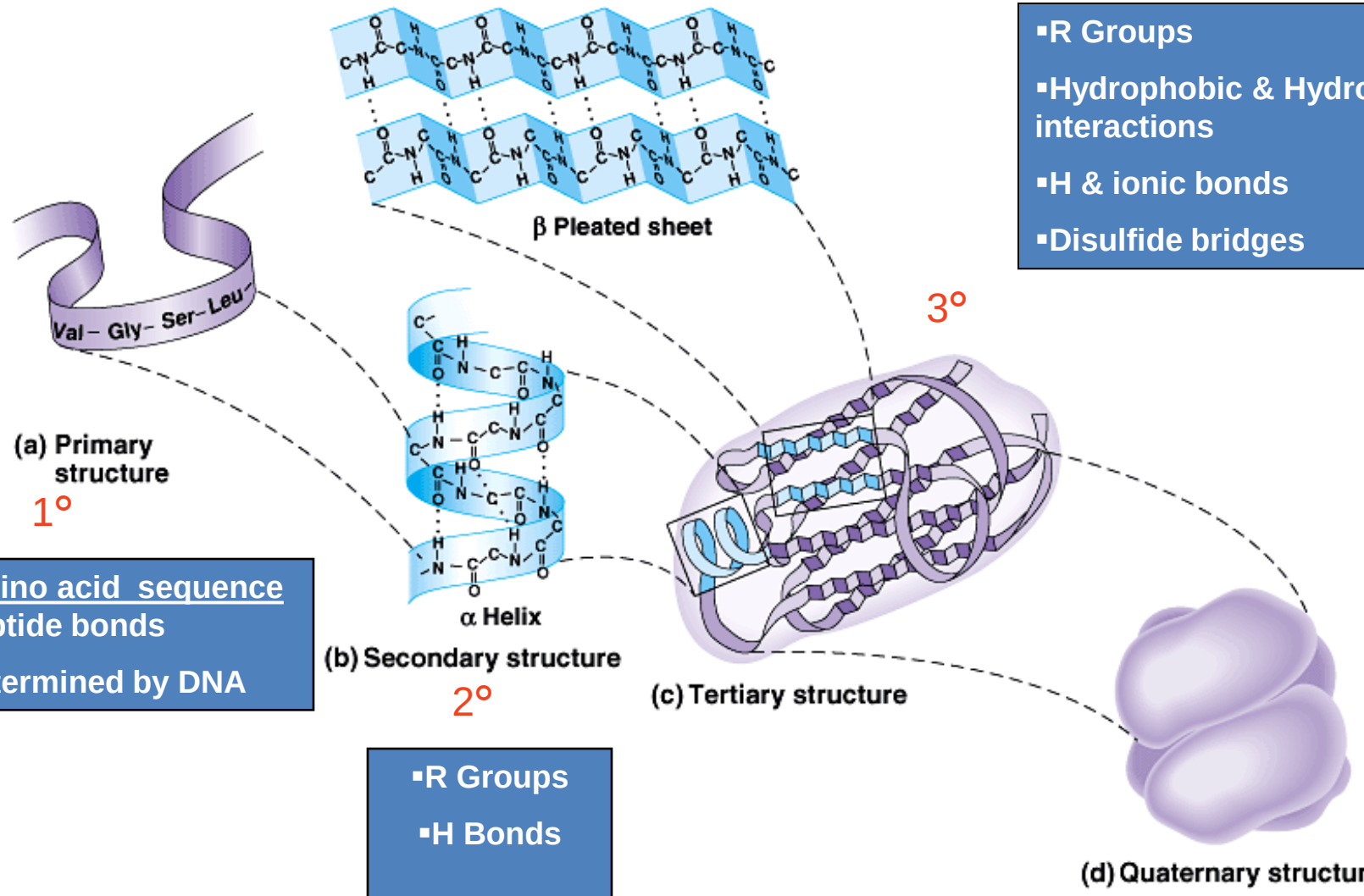

A1
A2
A3
A4
A5
A6
A7
A8
(a) Primary structure
A2
A6
A1
A5
A9
A3
A7
(b) Secondary structure
(c) Tertiary structure

Protein Structure – Quaternary

- Two or more polypeptide chains joined together causing the overall protein structure
  - Ex: Collagen – fibrous protein
    - helical subunits twisted into one large subunit
  - Ex: Hemoglobin – oxygen binding protein of red blood cells
    - 4 polypeptide subunits



Protein Structure Review



- R Groups
- Hydrophobic & Hydrophilic interactions
- H & ionic bonds
- Disulfide bridges

3°

1°

Amino acid sequence
peptide bonds

Determined by DNA

2°

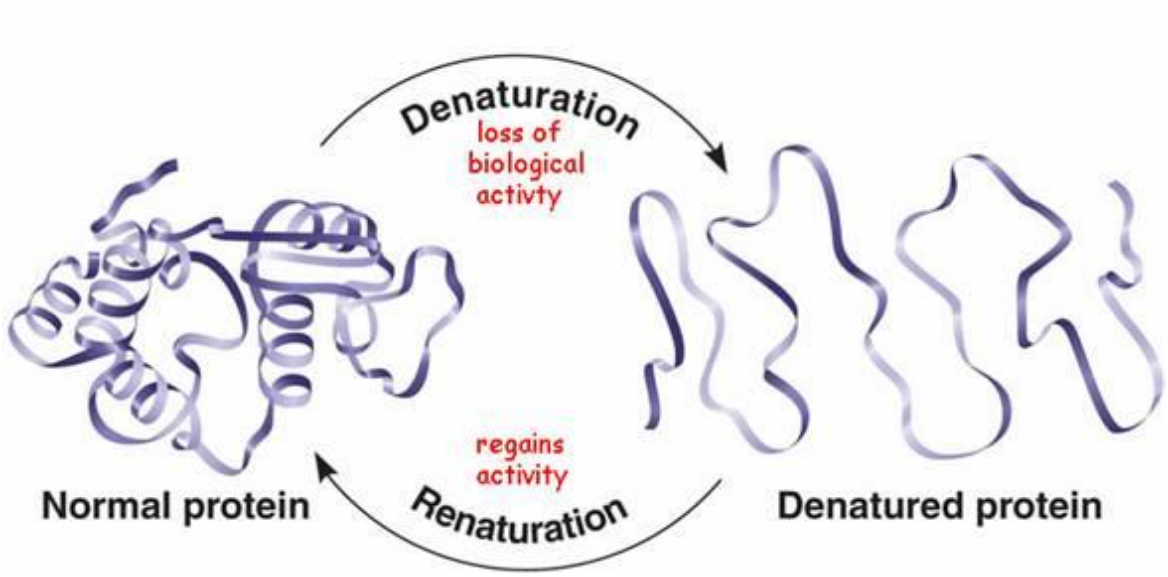
- R Groups
- H Bonds

4°

- Multiple polypeptides

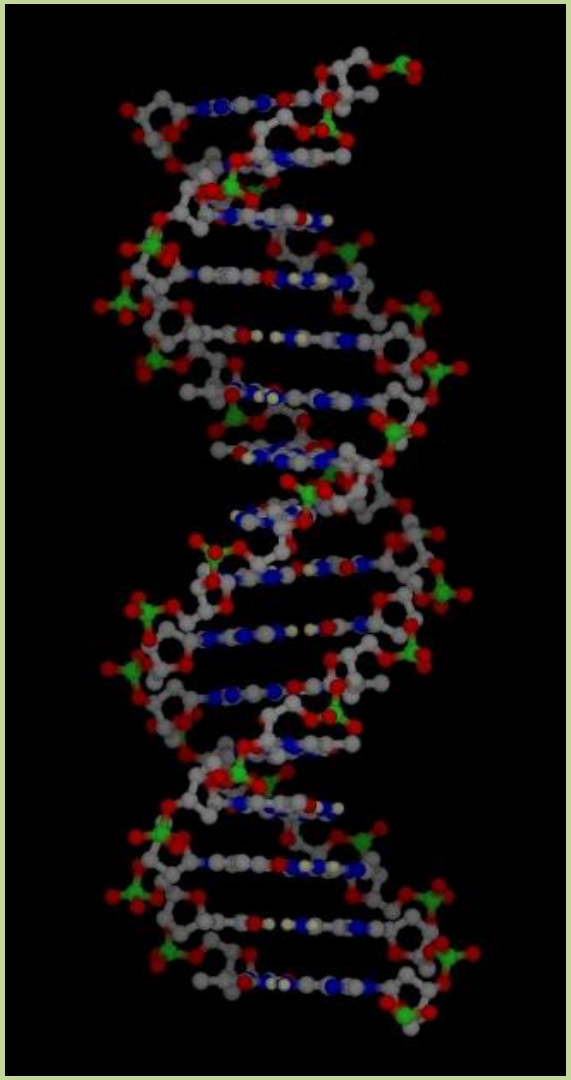
Denaturation

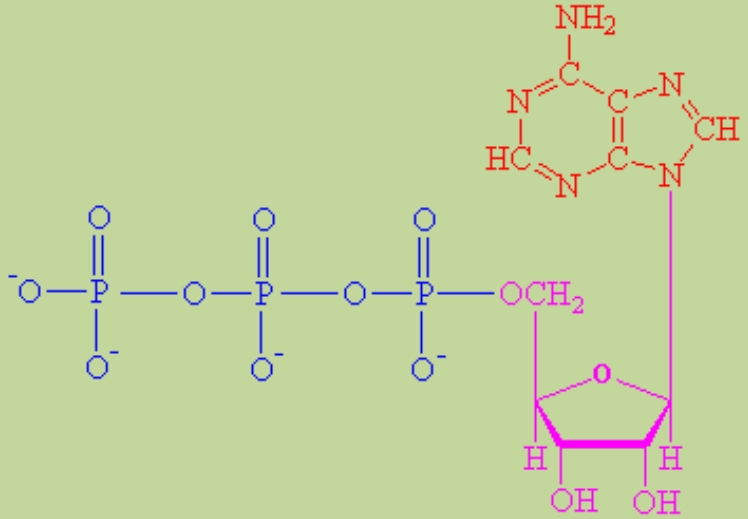
- Protein conformation depends on physical and chemical conditions of environment.
- Proteins will denature when they are subjected to:
  - pH changes
  - High Temperature

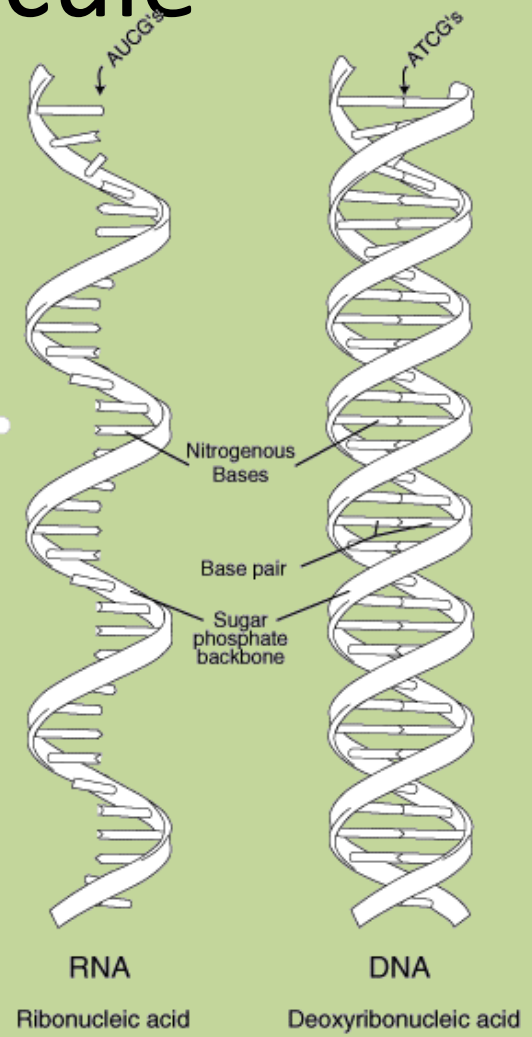


- Protein may unfold and loose its structure, thus losing its function

Guess the Macromolecule

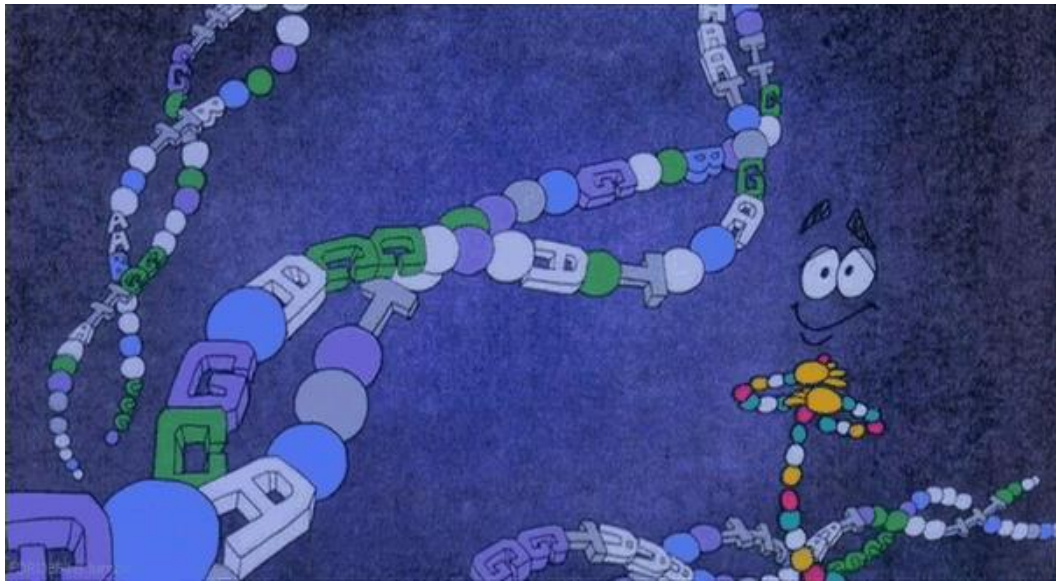






Nucleic Acid

Elements: C, H, O, N, P



Monomer: nucleotide

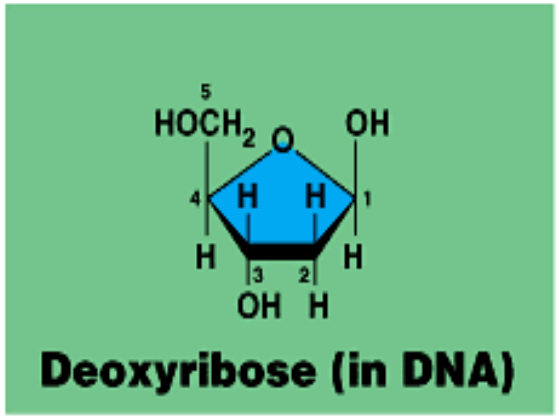
Polymer: DNA, RNA

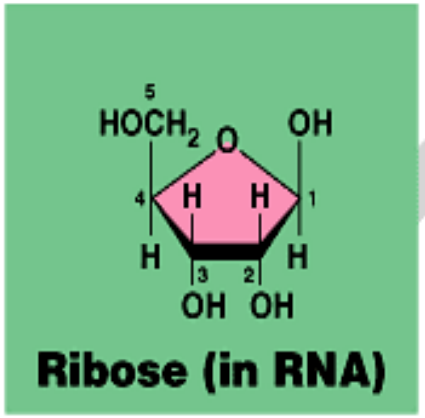
Function: Genetic information – stores and transports

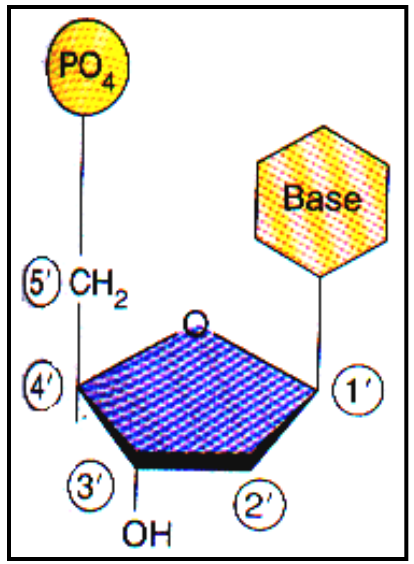
Examples: DNA, RNA, ATP

Nucleotide Structure

- <u>3 Parts</u>:
  1. Nitrogen containing base
  2. Sugar (5C)
     - Deoxyribose in DNA
     - Ribose in RNA
  3. Phosphate Group

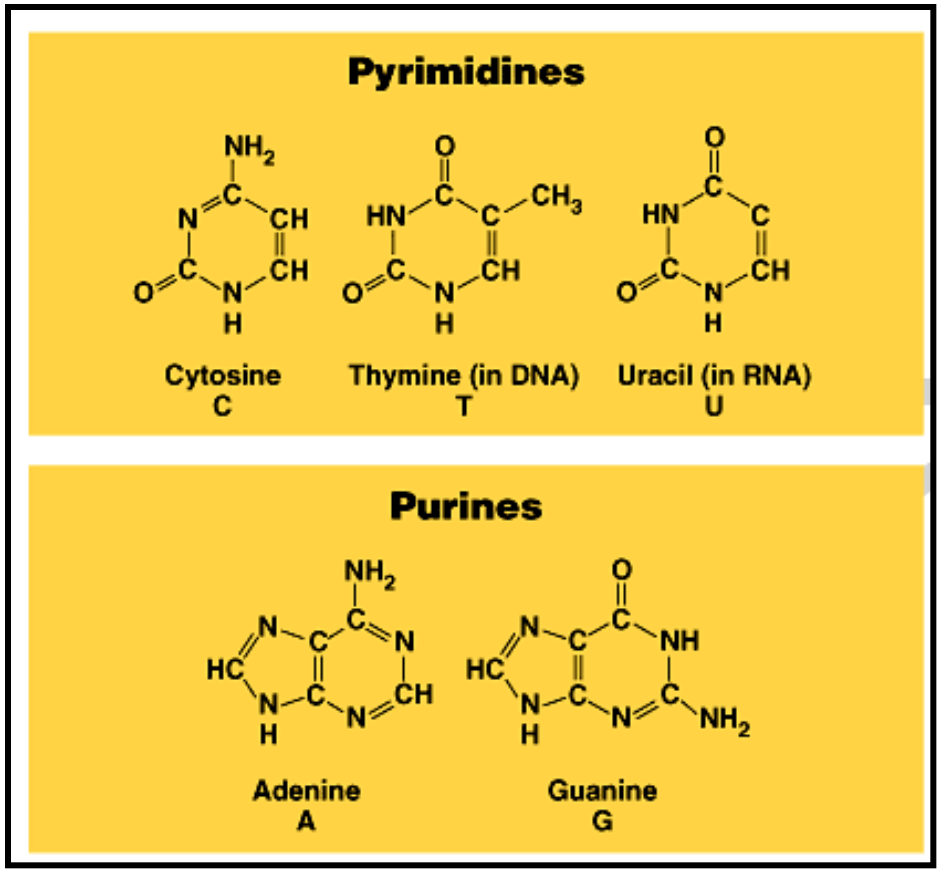






Types of Nucleotide Bases

- 2 Types of Bases
  1. **Pyrimidines**
     - Single ring N-base
     - Cytosine (C)
     - Thymine (T)
     - Uracil (U)
  2. **Purines**
     - Double ring N-base
     - Adenine (A)
     - Guanine (G)



ATP Structure

- Used for cellular energy
- Adenine nitrogen base
- Ribose sugar
- 3 phosphate groups