General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

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Email: mgotesman@citytech.cuny.edu

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER

Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:

Exams (4): 20% Each
Quizzes: 20% Average

Recap: Lecture 8

A. Polymerization: Monomers → Polymers

1) Dehydration synthesis or condensation reaction → H_2O released
2) Hydrolysis – Splitting by water ← H_2O absorbed

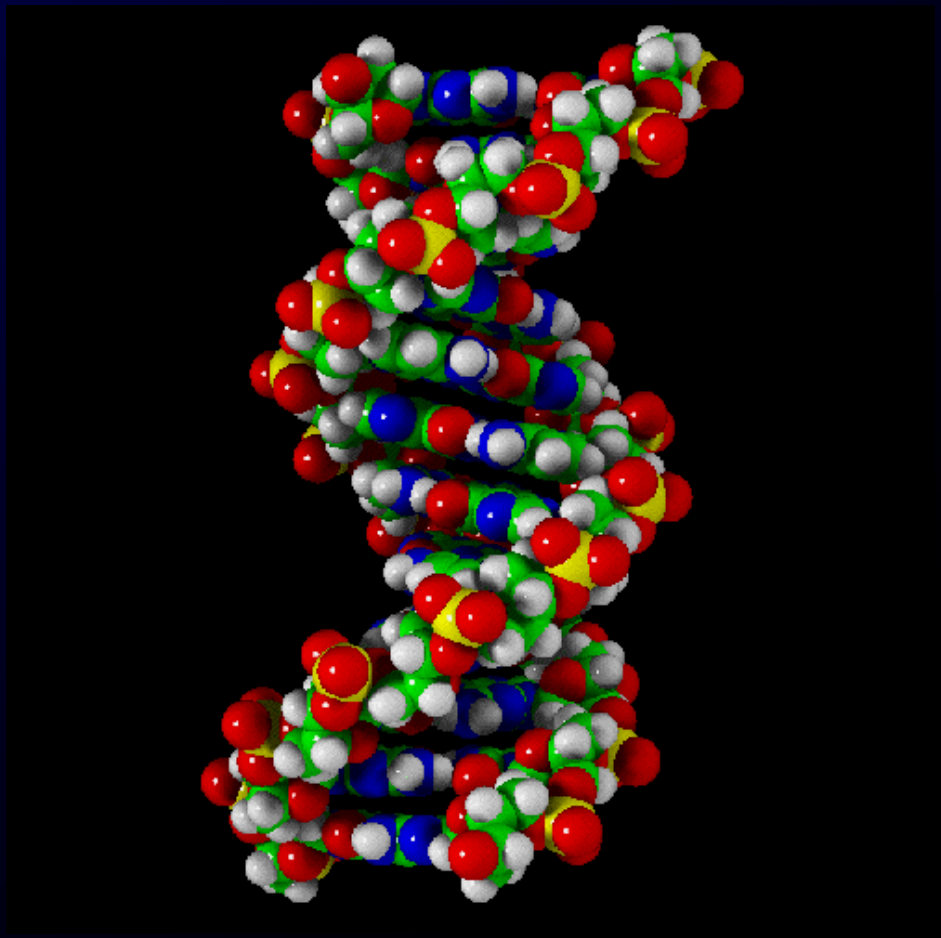
B. Carbohydrates $C_6H_{12}O_6$ → Glycosidic Linkage → Polymers

1) Linear vs Ring [aqueous]
2) Monosaccharide (glucose) → Polysaccharides (Chitin, Glycogen)
3) Triose = 3 C's → (Glycerol) Fats
4) Hexose = 6 C's → Energy Storage -Starch: A)amylose, B)amylopectin
   Glycogen -- animals)
   vs Structural (Peptidyglocan -- bacteria, Cellulose – plants
   Chitin – exoskeleton)
4) Pentose = 5 C's → Ribose???

C. Lipid: Unifying feature having little or no solubility in water

1) Triglycerides: Glycerols (3C alcohol) fuse with
   3 fatty acids (carboxylic acid, 16 or 18 C's) Saturated vs unsaturated
2) Phospholipids: Glycerols fuse with 2 fatty acids AND Phosphate head
3) Sterols (Cholesterol main precursor in animals)
   Estrogen, Progesterone, Testosterone, Cortisol (hydrocortizone)

Macromolecules II

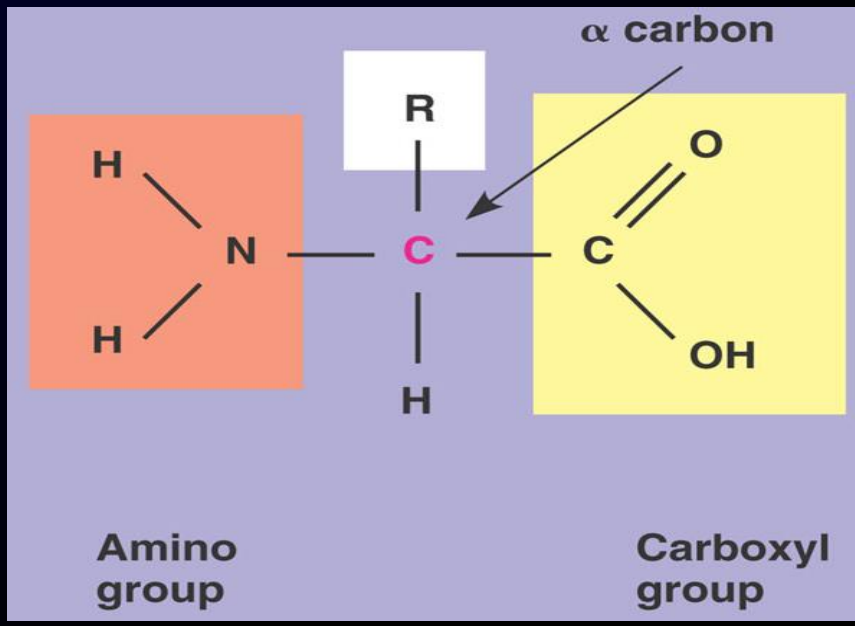


Proteins

- The most diverse Macromolecule
- 50% of the dry weight of cells
- **Polypeptide** is a polymer of amino acids
- A **protein** is a polypeptide (or more than one) folded into a functional conformation. (Conformation = shape. Shape = function!)

Amino Acids

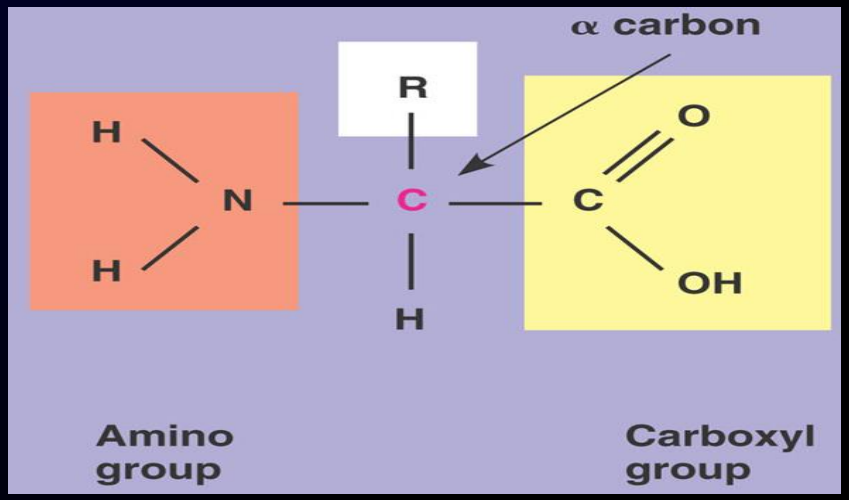
- 20 that commonly appear in nature
- Each has an amino group, a carboxyl group, and a unique side chain
  - At neutral pH, both the amino group and carboxyl group are ionized!
- The Sequence of amino acids in a protein dictates shape, function, etc.



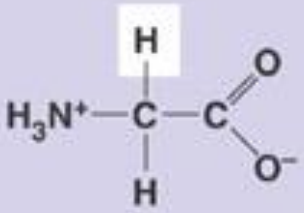
What elements are the components of aa?

Amino Acids

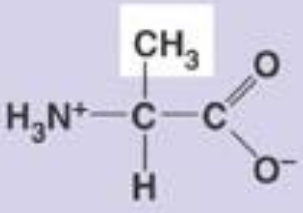
- Three general categories of **side chains**
  - Non polar (hydrophobic)
  - Polar (hydrophilic)
  - Charged (either acid or basic)
- A certain region of a protein has a certain characteristic (e.g., hydrophobic) because the amino acid side chains have that characteristic



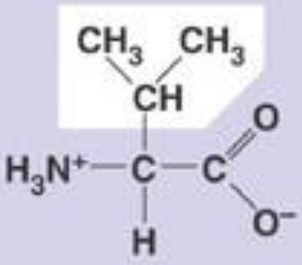
Nonpolar amino acids



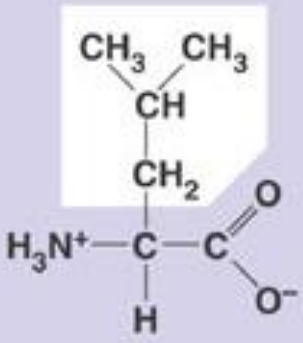
Glycine (Gly)



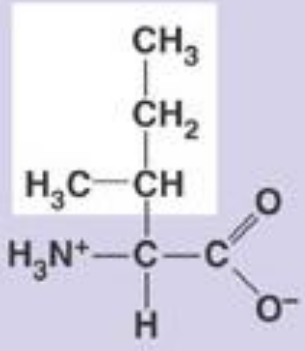
Alanine (Ala)



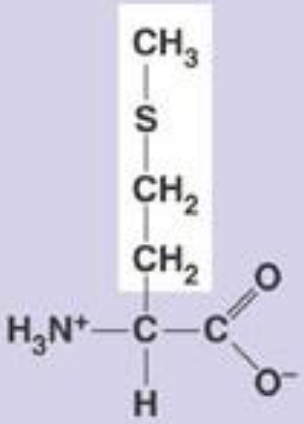
Valine (Val)



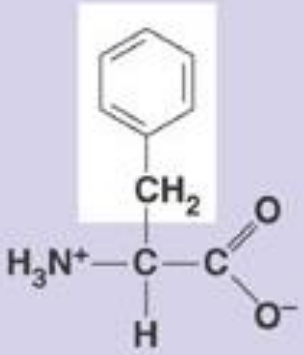
Leucine (Leu)



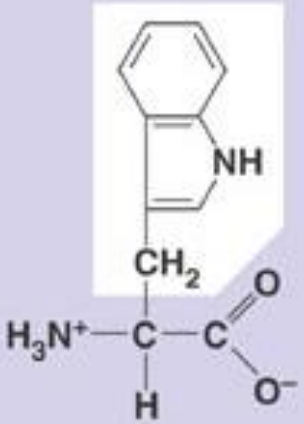
Isoleucine (Ile)



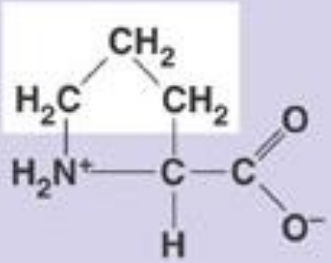
Methionine (Met)



Phenylalanine (Phe)

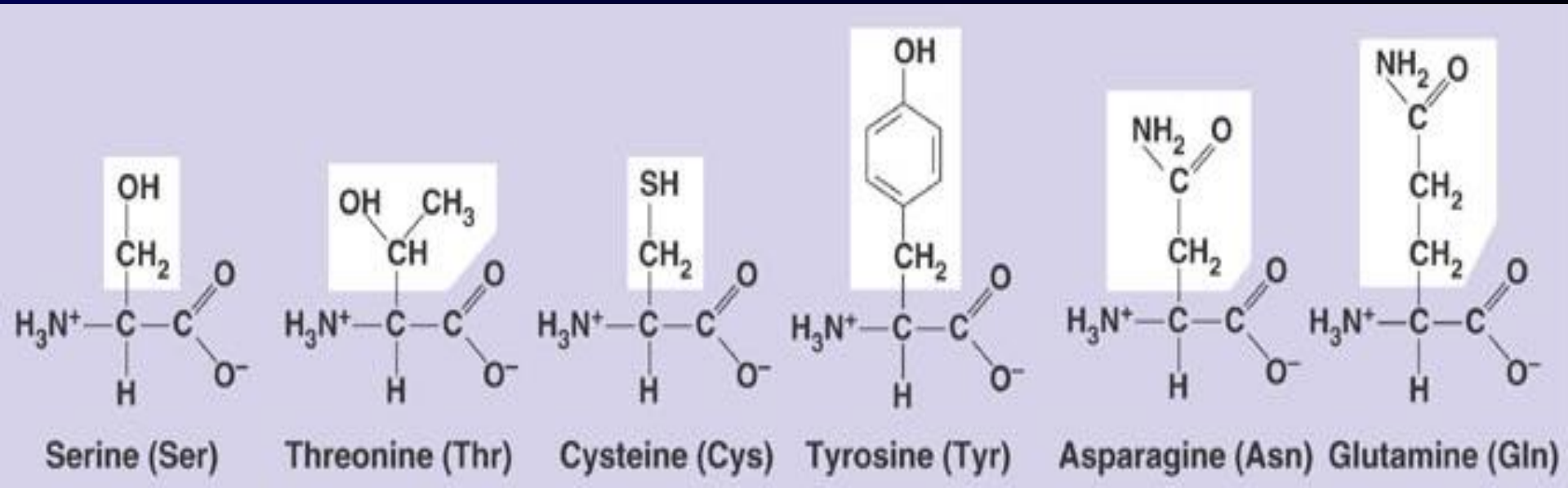


Tryptophan (Trp)

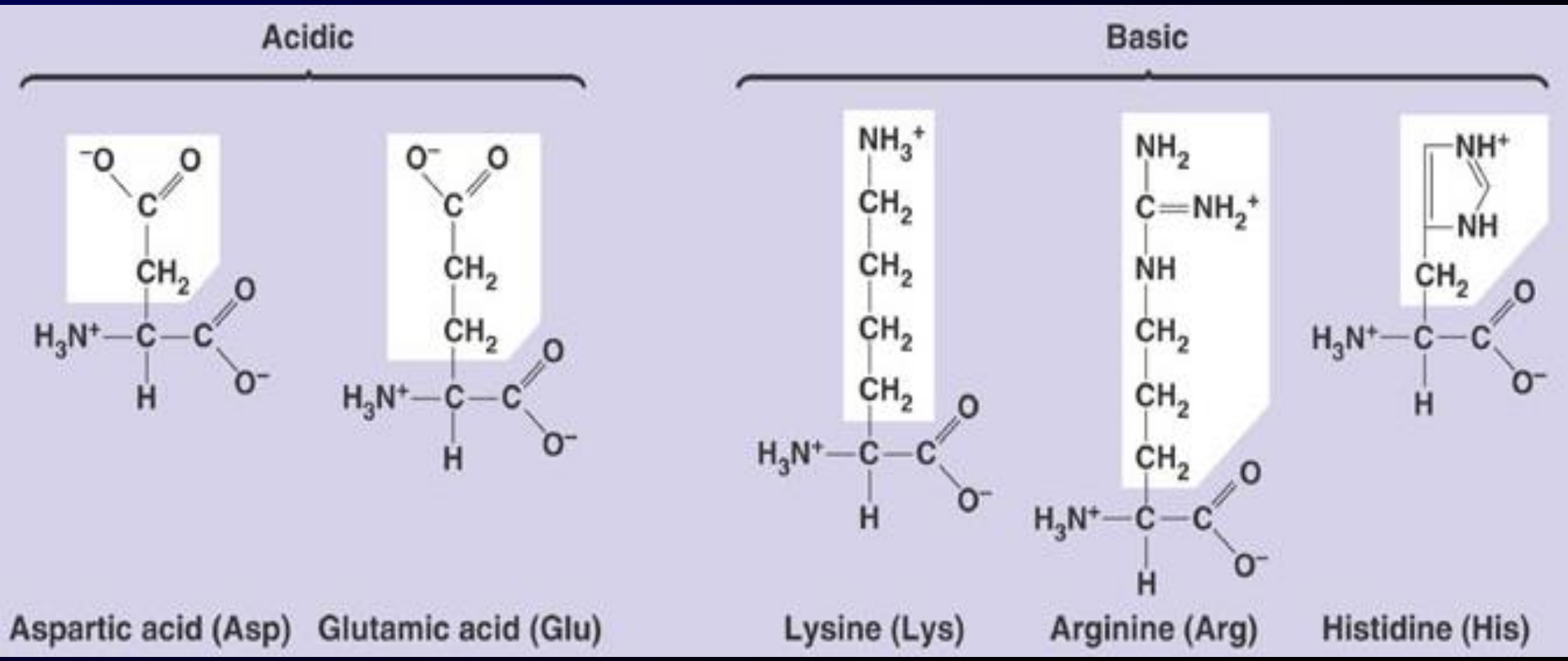


Proline (Pro)

Polar Amino Acids



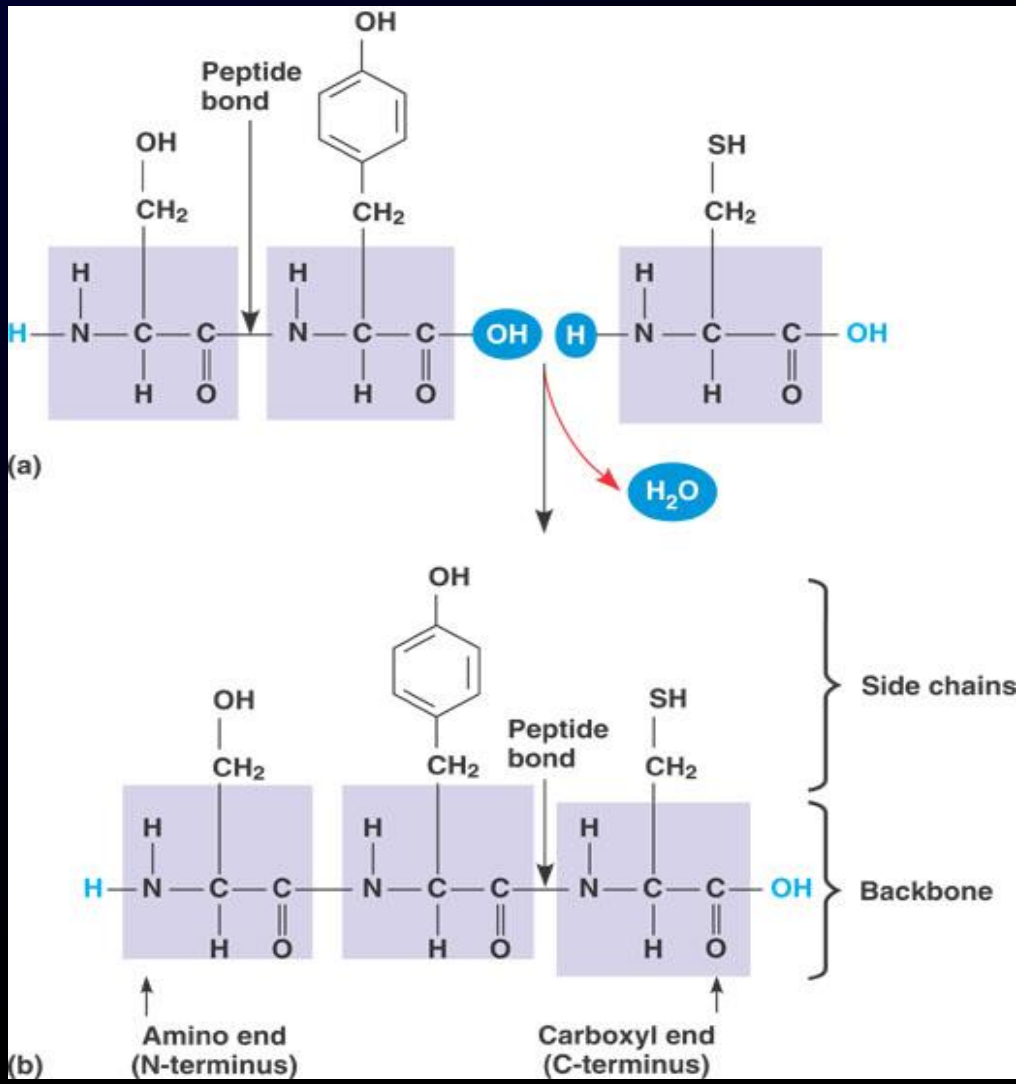
Electrically Charged Amino Acids



Peptide bond formation

- Amino acids are held together by **peptide bonds**

- Once again**, dehydration (condensation) reaction**
- New amino acids are added onto the Carboxyl group “C- terminal” of the growing chain.
- Thus, a protein **begins** with an amino group “N-terminal” and **ends** with a carboxyl group “C-terminal”



Functions of Proteins

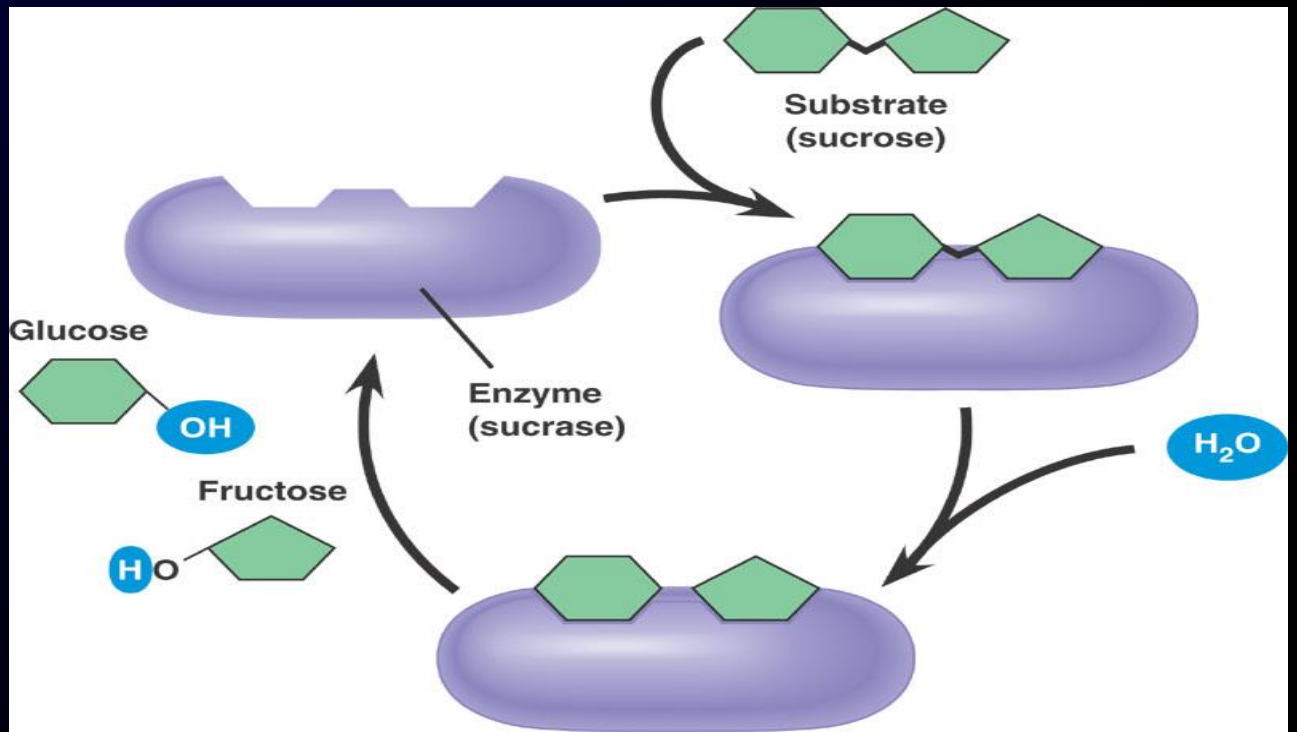
- By far, most are **ENZYMES**
  - Help “catalyze” chemical reactions
- **Structural** Proteins
  - Give support, strength, flexibility
  - Examples: collagen, elastin, keratin
- **Storage** Proteins
  - Storage of amino acids, for building proteins later or energy
  - Examples: egg albumin (ovalbumin), Casein (in milk)

Functions of Proteins, con't

- **Transport** Proteins
  - Examples: Hemoglobin (O_2), H^+ pump
- **Hormonal** Proteins and **receptor** proteins
  - Example: Insulin and Insulin receptor
- Contraction and **Motor** Proteins
  - Actin and myosin perform muscle contraction
- Immune **Defense** Proteins
  - Antibodies help fight infection

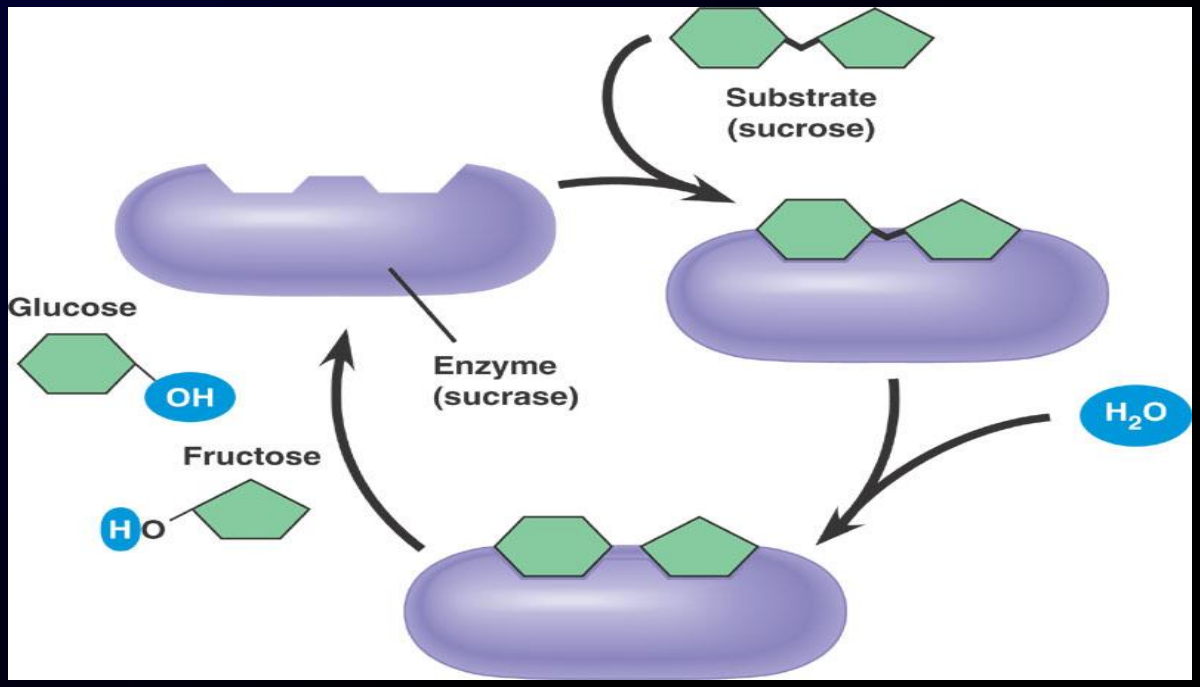
Enzymes

- Biological "**catalyst**" = Facilitate chemical reactions, without being a product or reactant. Enzymes are named for what they do! E.g. Sucrase
- Not CONSUMED in the process. (Recycled)
- Examples: digestive enzymes



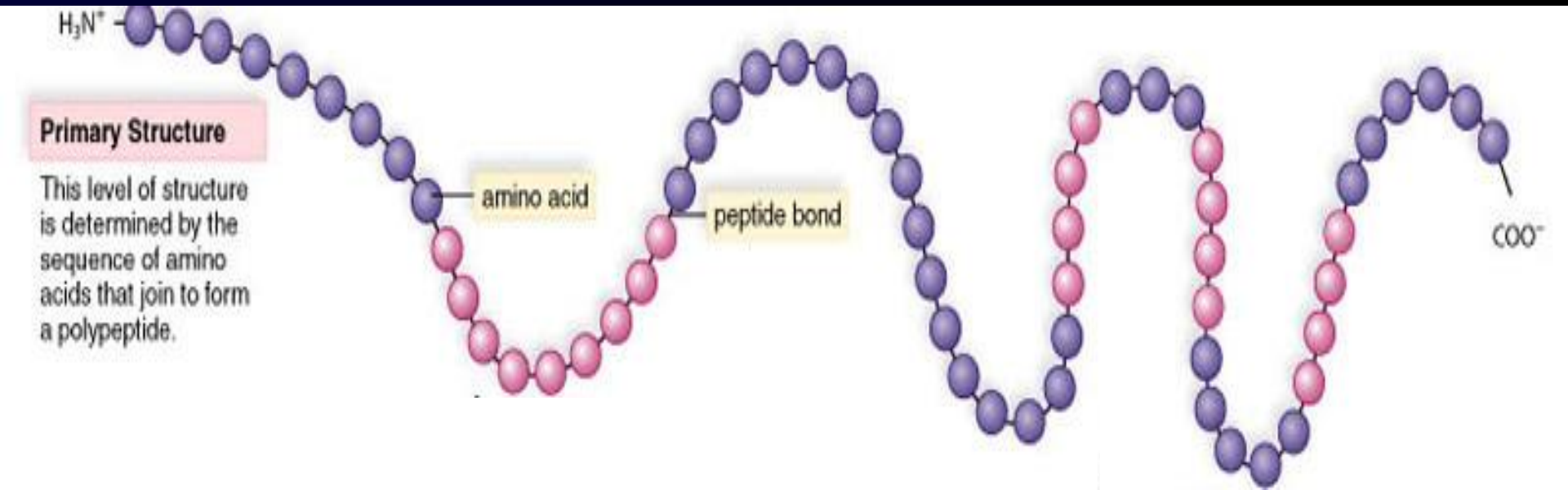
Enzymes

- In a chemical reaction, enzymes bring all the products and co-factors together in the “active site” of the enzyme to make the reaction happen.
- Once again, it is all about SHAPE!



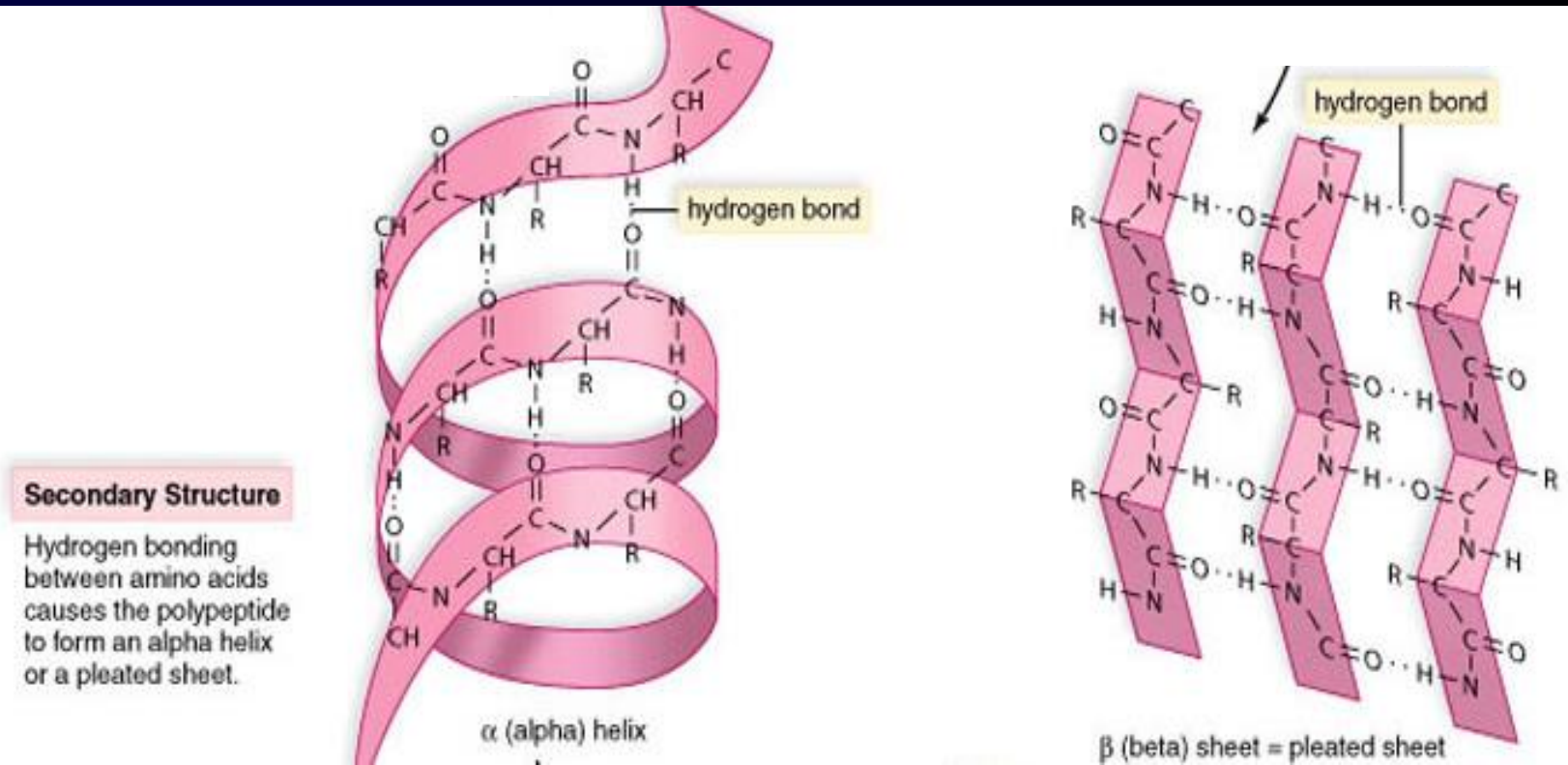
Levels of Protein Structure

- **Primary (1º) Structure** – the amino acid sequence
  - Example: Met-gly-ser-tyr-trp-ser-val-Ile-Phe-Arg-Asn…
  - Everything else depends on this!



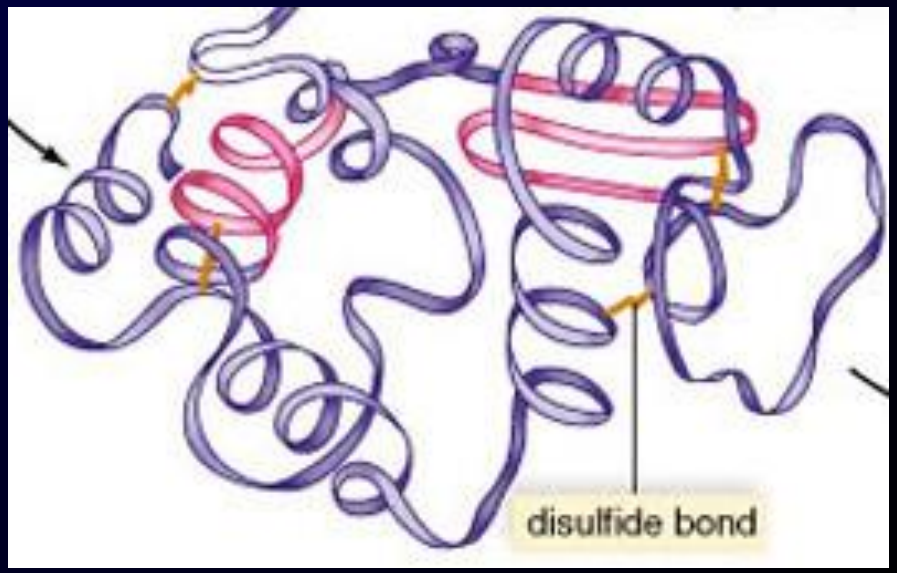
Levels of Protein Structure

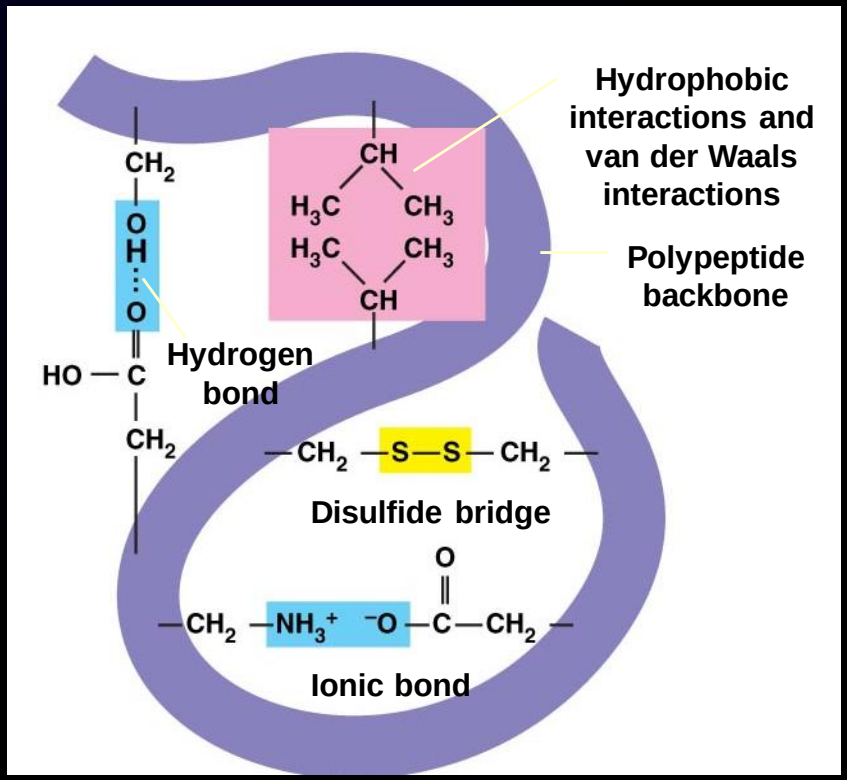
- **Secondary (2º) Structure** – the folding of the polypeptide chain into helices and sheets
  - Called **alpha-helix** and **beta-sheet**



Levels of Protein Structure

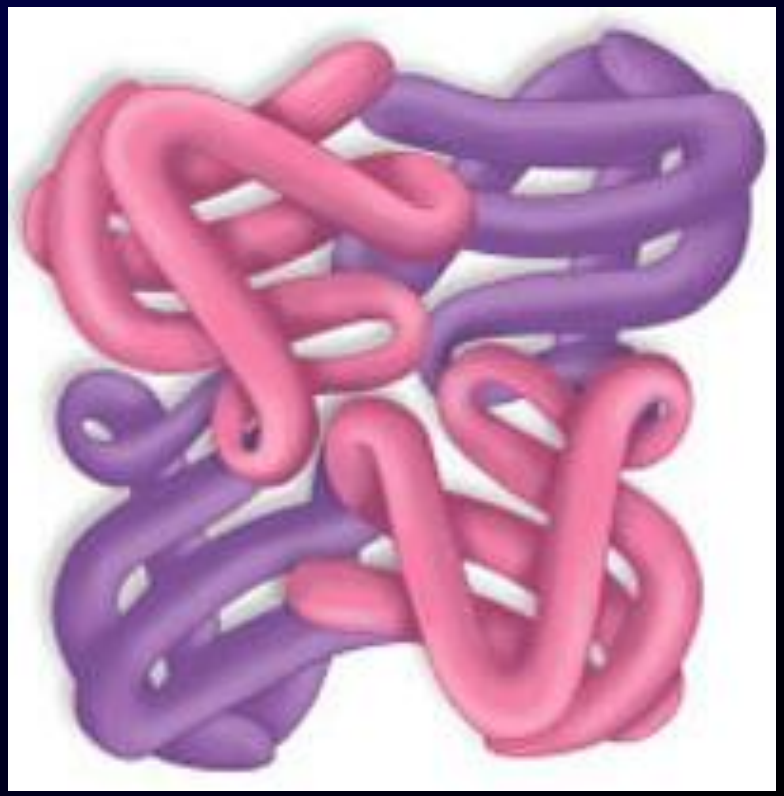
- **Tertiary (3º) Structure** – The complex final overall shape that a polypeptide takes
  - H-bonding, disulfide bridges, hydrophobic interactions, ionic bonds, van der Waals, etc.

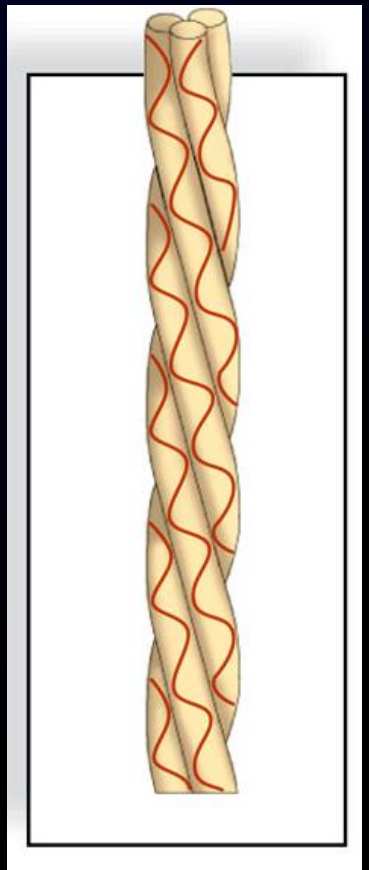




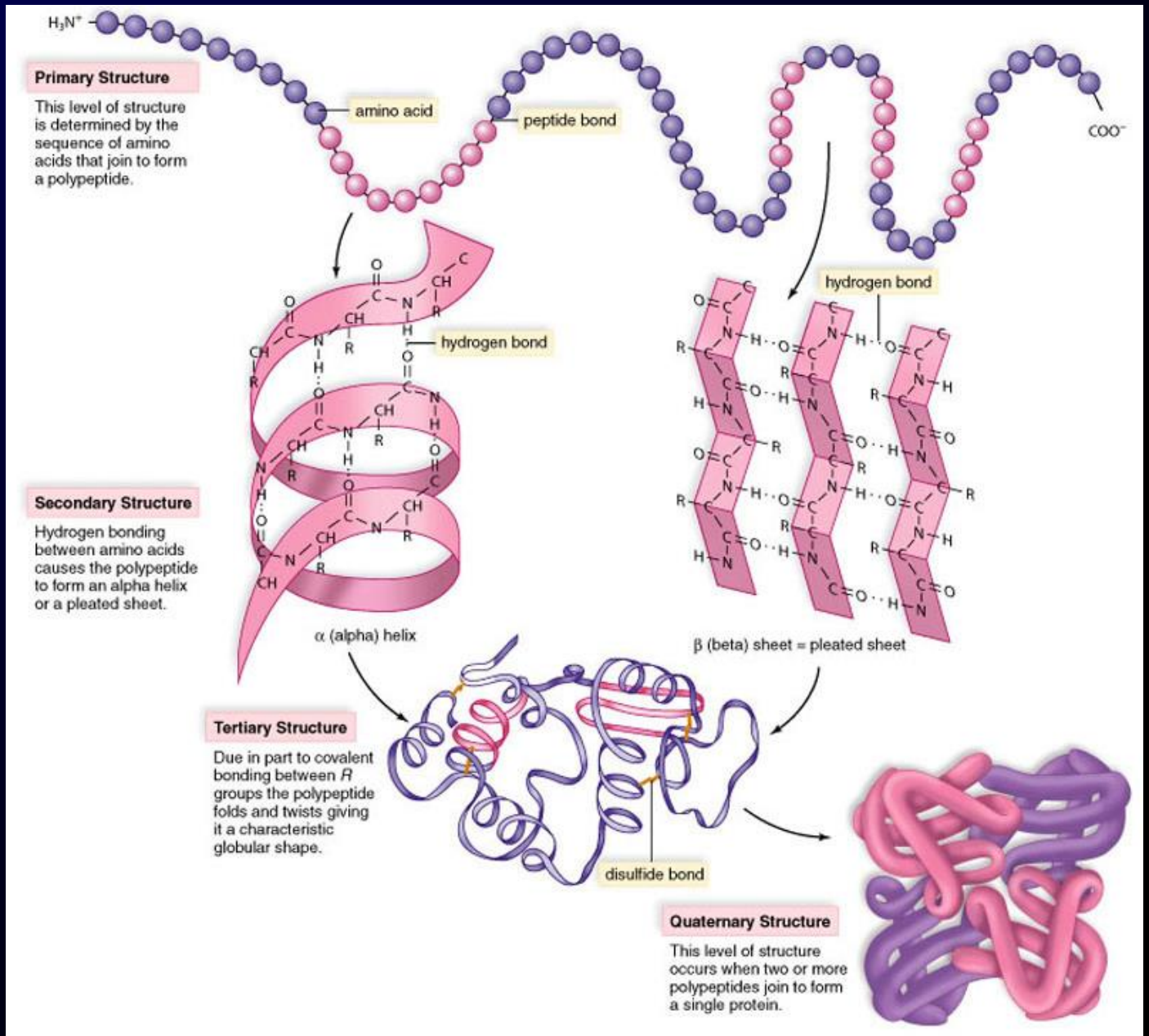
Levels of Protein Structure

- **Quaternary (4º) Structure** – Interaction of multiple polypeptides to form one functional protein
  - Example: Hemoglobin, collagen, keratin

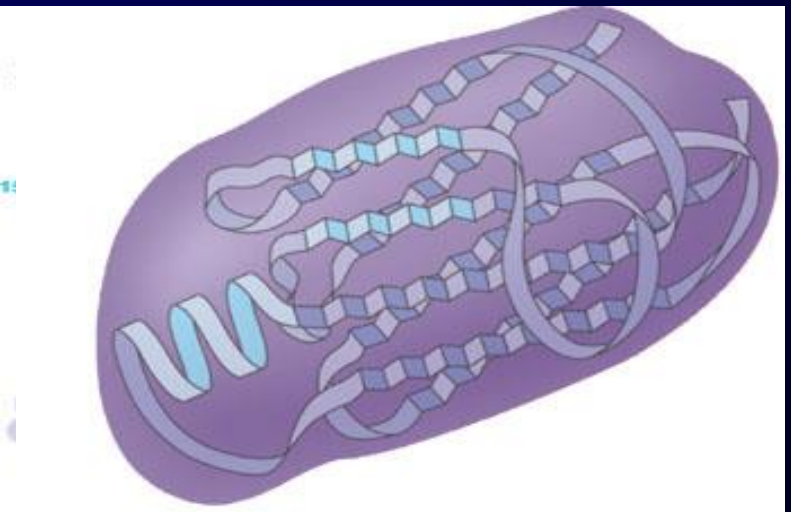


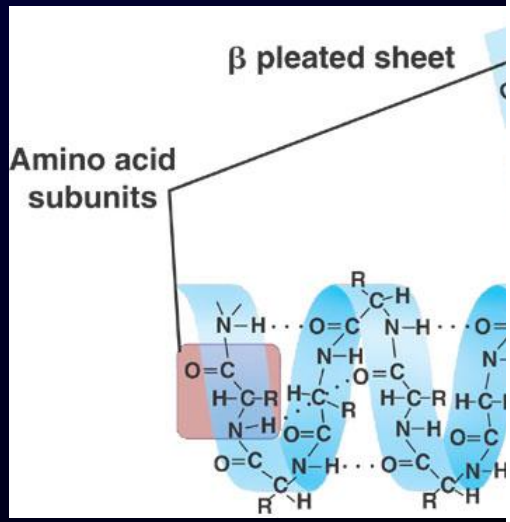


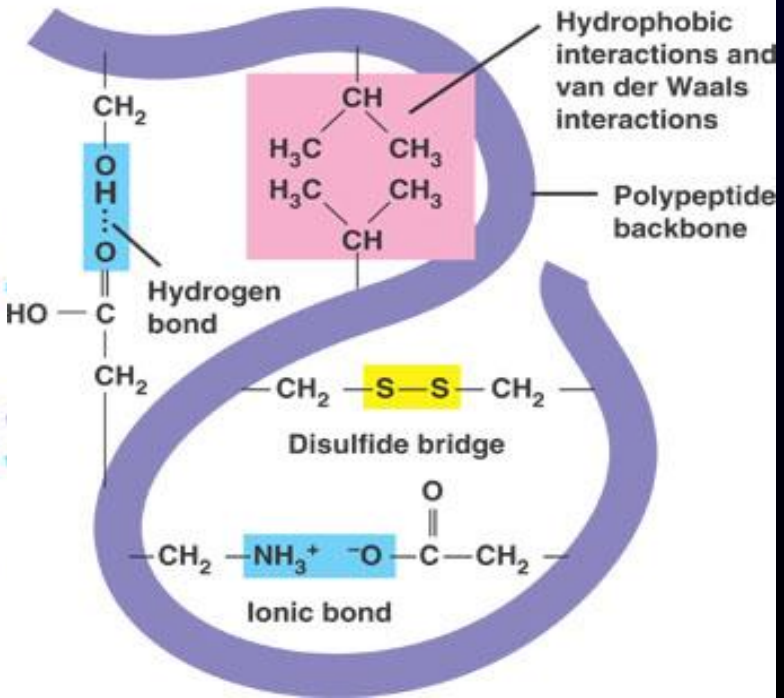
Structure of Proteins **(Important Fig!)**

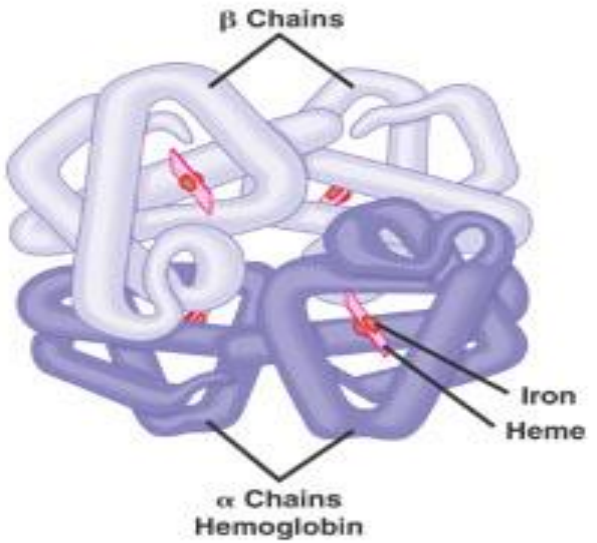


Structure of Proteins



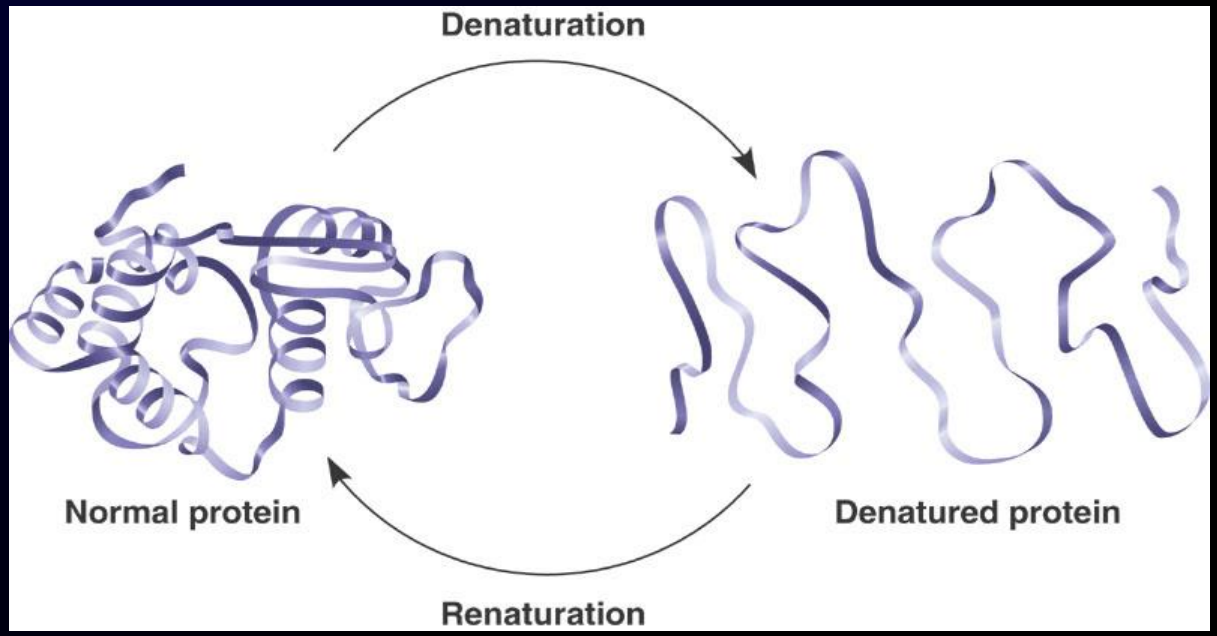






Protein Folding

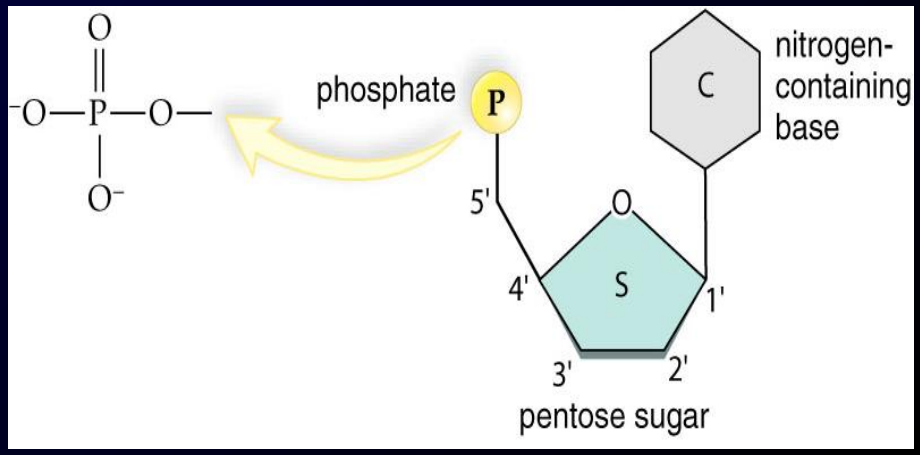
- When a protein encounters extreme conditions, it may unfold or "**denature**"
  - Extreme temperature, pH, salt concentration, organic solvents
  - A denatured protein has no shape, thus no activity
  - Sometimes it is reversible, sometimes not.



Nucleic Acids

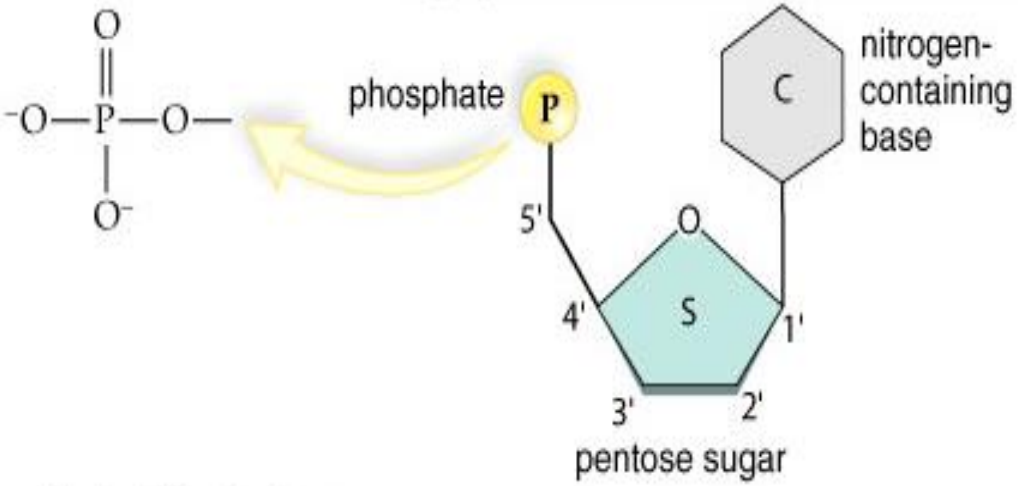
- Named because they are acids found in the nucleus!
- Two types: DNA, RNA (Deoxyribonucleic acid, ribonucleic acid)
- DNA is the ***repository*** of genetic information
- RNA is the ***expression*** of genetic information

Nucleosides

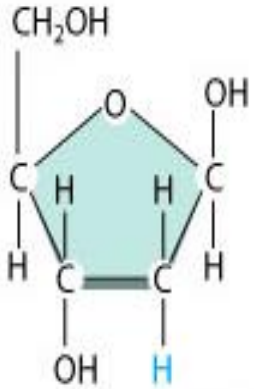


- Three parts to a nucleoside:
  - Five-carbon sugar
  - Nitrogenous base (A, C, G, T, or [RNA] U)
  - 1,2, or 3 phosphate groups (NTP Nucleotide Tri Phosphate)
- There are two families of nitrogenous bases:
  - Pyrimidines have a single six-membered ring (C,T)
  - Purines have a six-membered ring fused to a five-membered ring (A,G)
- In DNA, the sugar is deoxyribose
- In RNA, the sugar is ribose

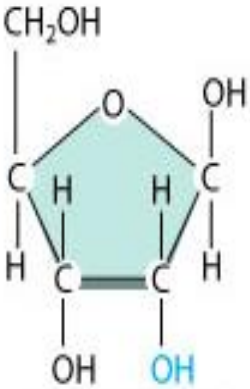
Nucleotides



a. Nucleotide structure

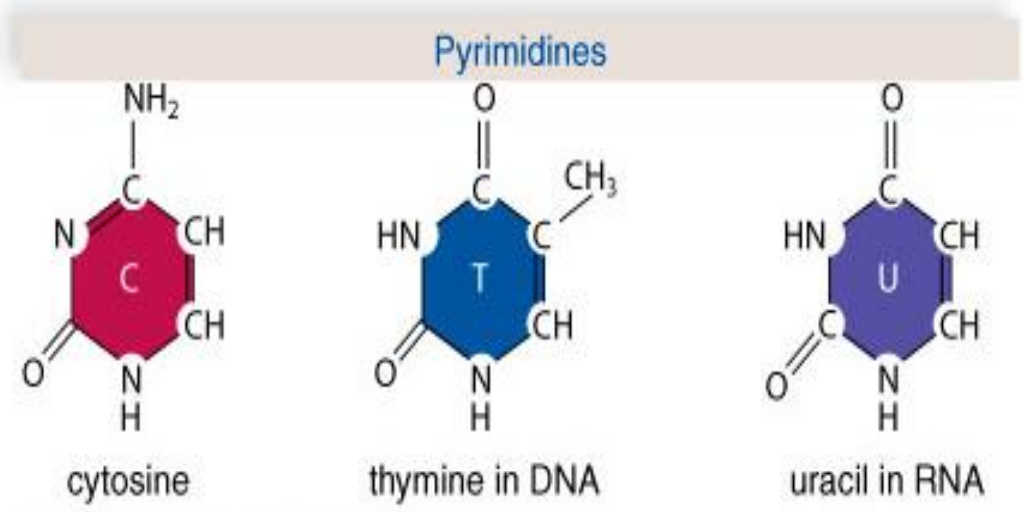


deoxyribose (in DNA)



ribose (in RNA)

b. Deoxyribose versus ribose



cytosine | thymine in DNA | uracil in RNA | adenine | guanine

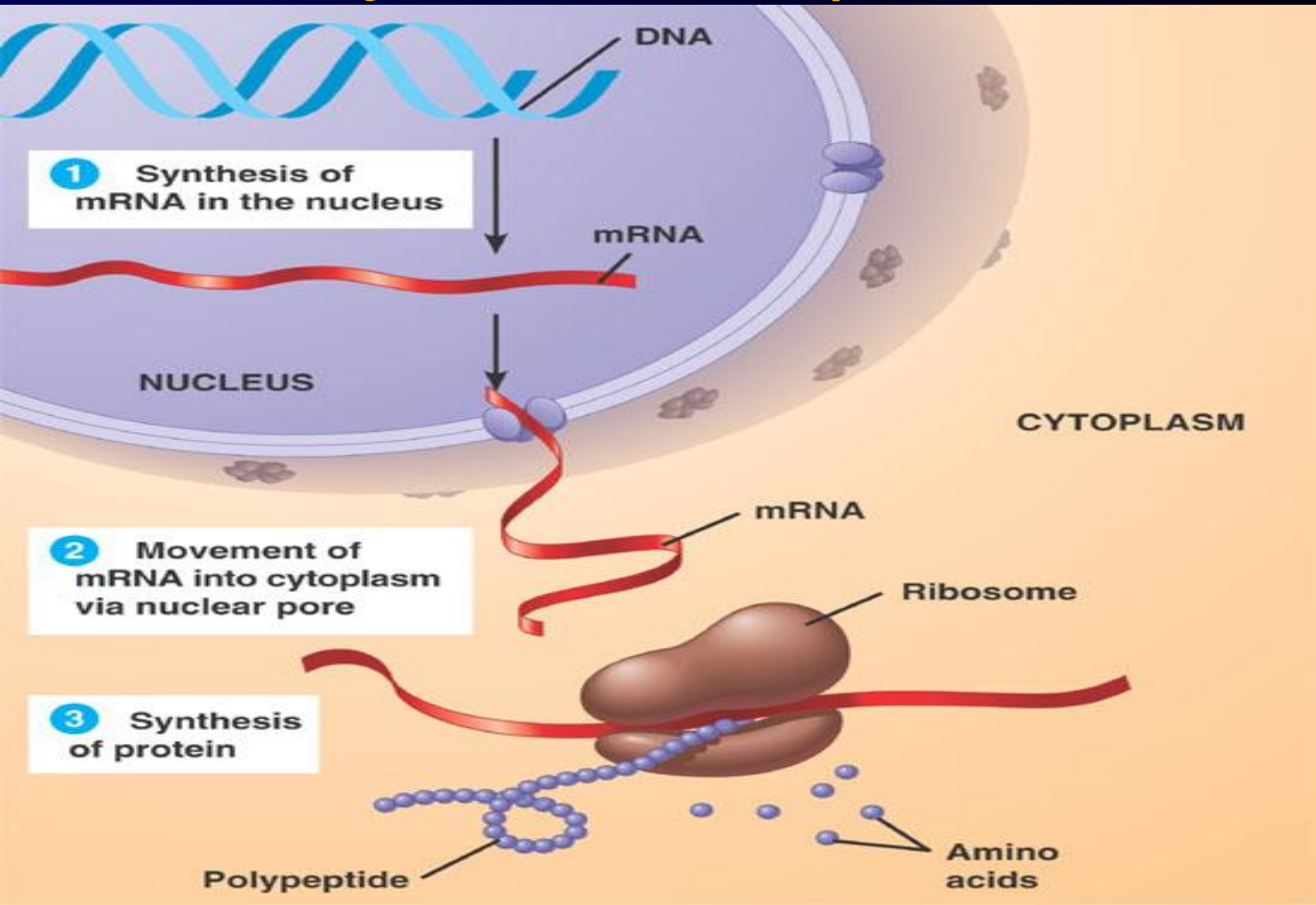
c. Pyrimidines versus purines

Nucleic Acids

- Both RNA and DNA are polymers of Nucleotides
  - The information is stored in the sequence of the nucleotides.
  - Once again, a dehydration/condensation reaction!!!
- Genes are made of DNA. Much of this DNA codes for proteins. RNA transfers the code from DNA to protein.
- Central Dogma of Molecular Biology:

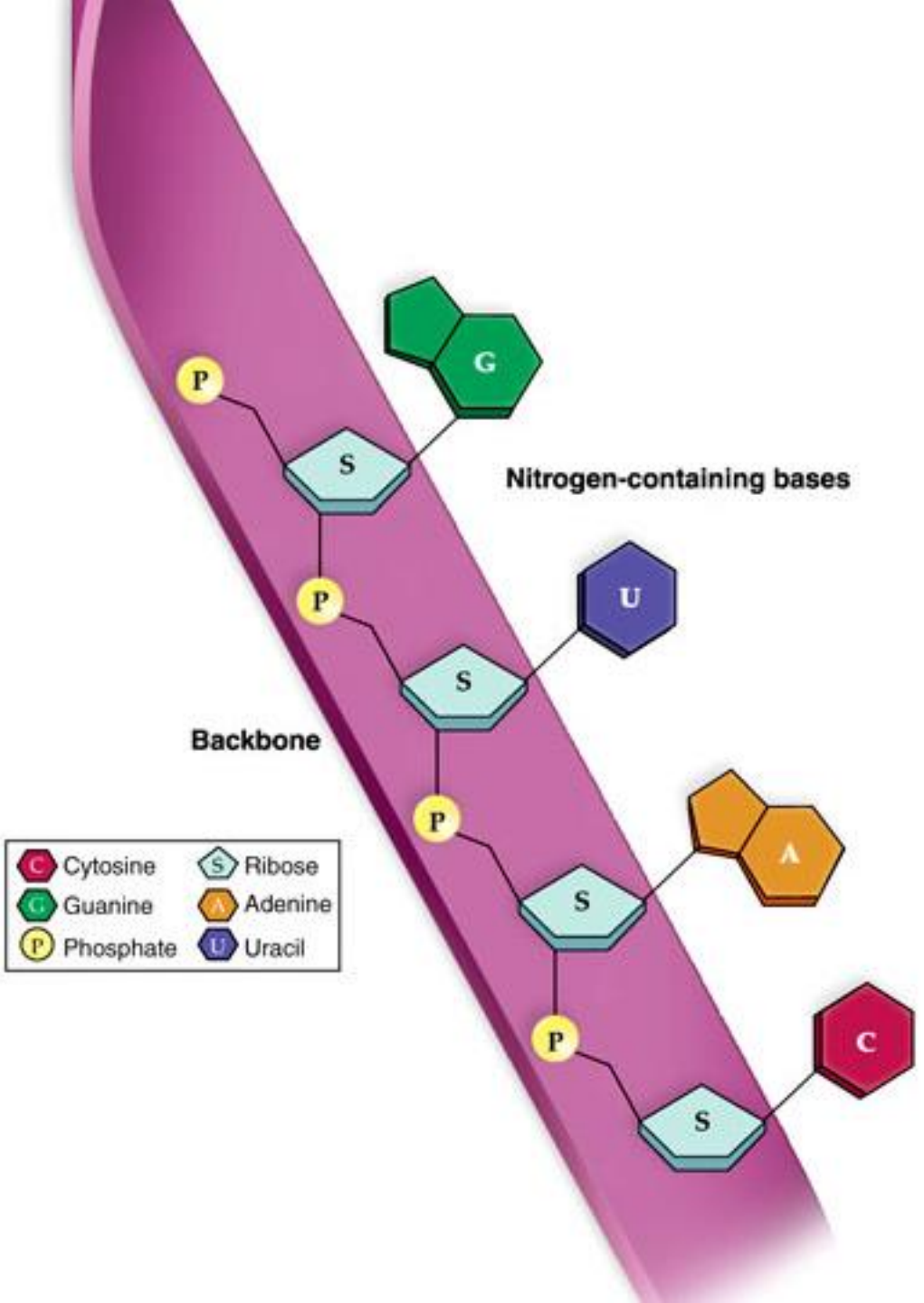
DNA → RNA → protein

Summary of Gene Expression



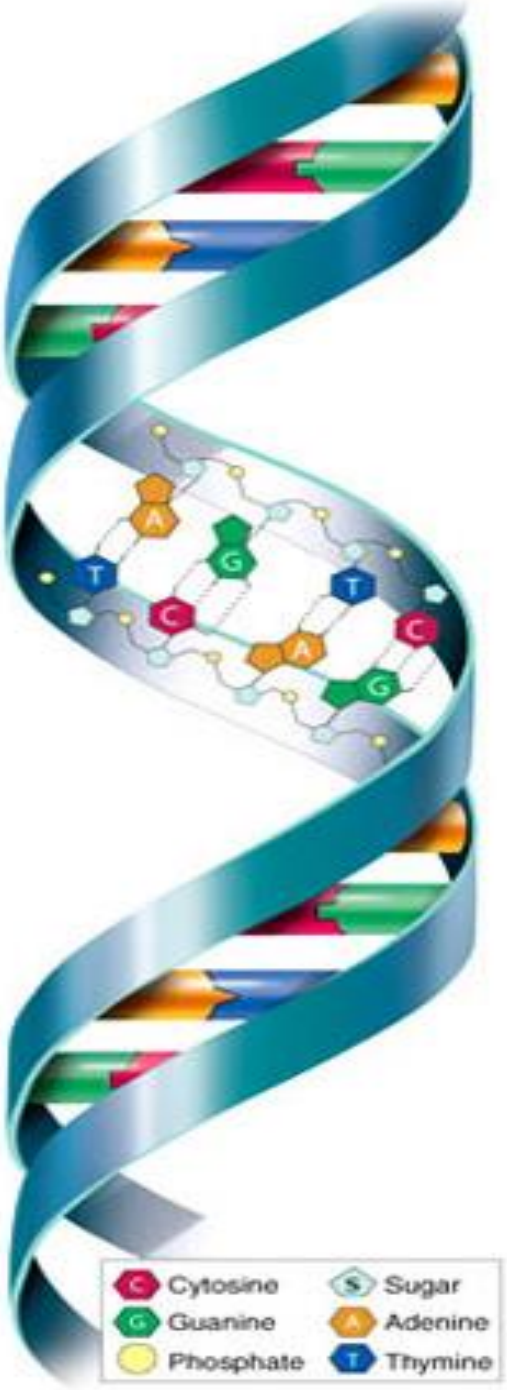
RNA

- Single stranded
- A, U, G, C (no T)
- Sugar: ribose



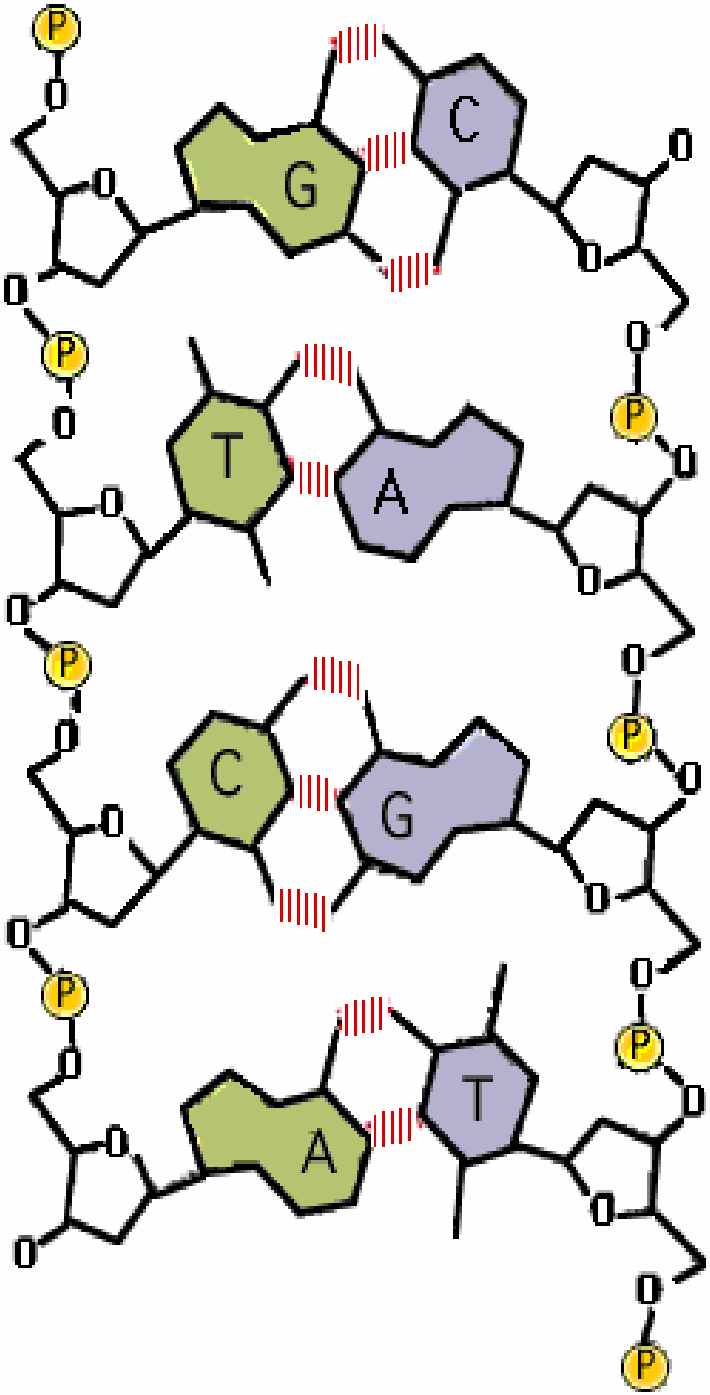
DNA double helix (1953) – James Watson and Francis Crick

- Two polymers (strands) line up, then form a double helix (twisted ladder)
- The sides of the ladder are the sugars and the phosphate groups
- The “rungs” of the ladder are the Nitrogen bases
- The bases hydrogen bond to each other in a specific way called “base pairing”

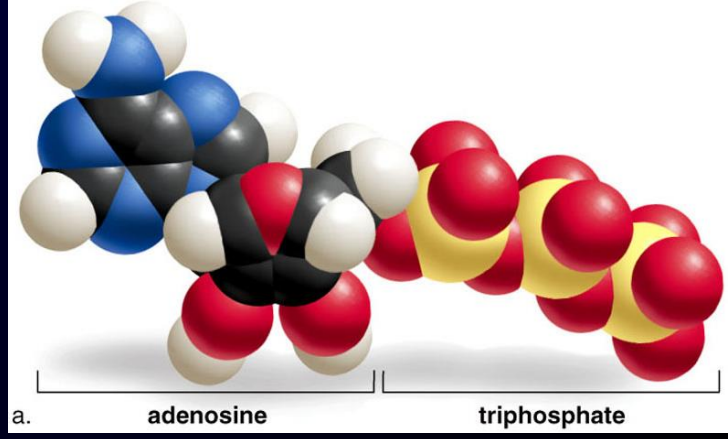


Base-pairing

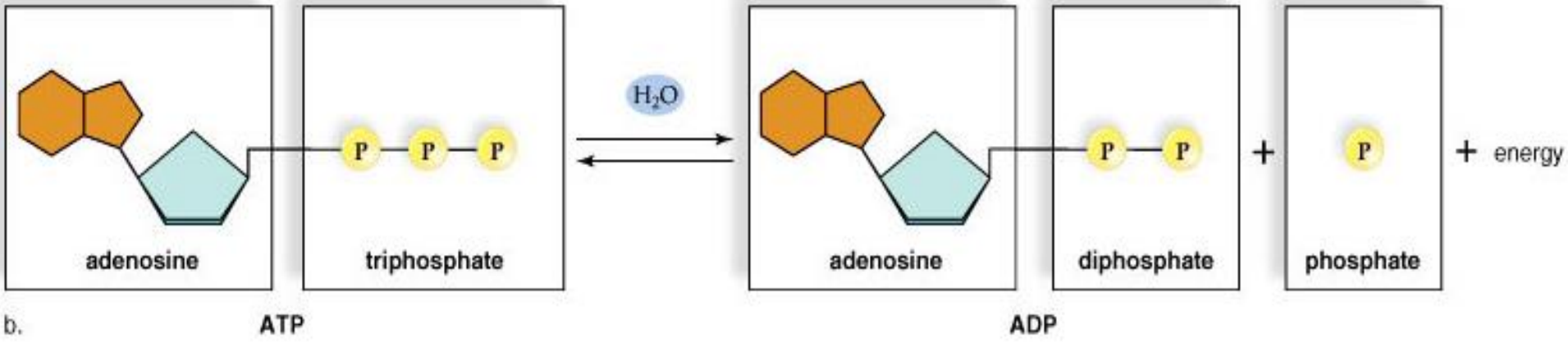
- A and T form two H-bonds
- G and C form three H-bonds
- A “complimentary” DNA sequence is the sequence on the OTHER strand of a DNA molecule
- Example… -A-C-C-G-T-G-A-
  - Answer... -T-G-G-C-A-C-T-



ATP



- **ATP** (adenosine triphosphate) is composed of adenine, ribose, and three phosphates
- In cells, one phosphate bond is hydrolyzed – Yields:
  - The molecule ADP (adenosine diphosphate)
  - An inorganic phosphate molecule p_i
  - **Energy** used for work in the cell

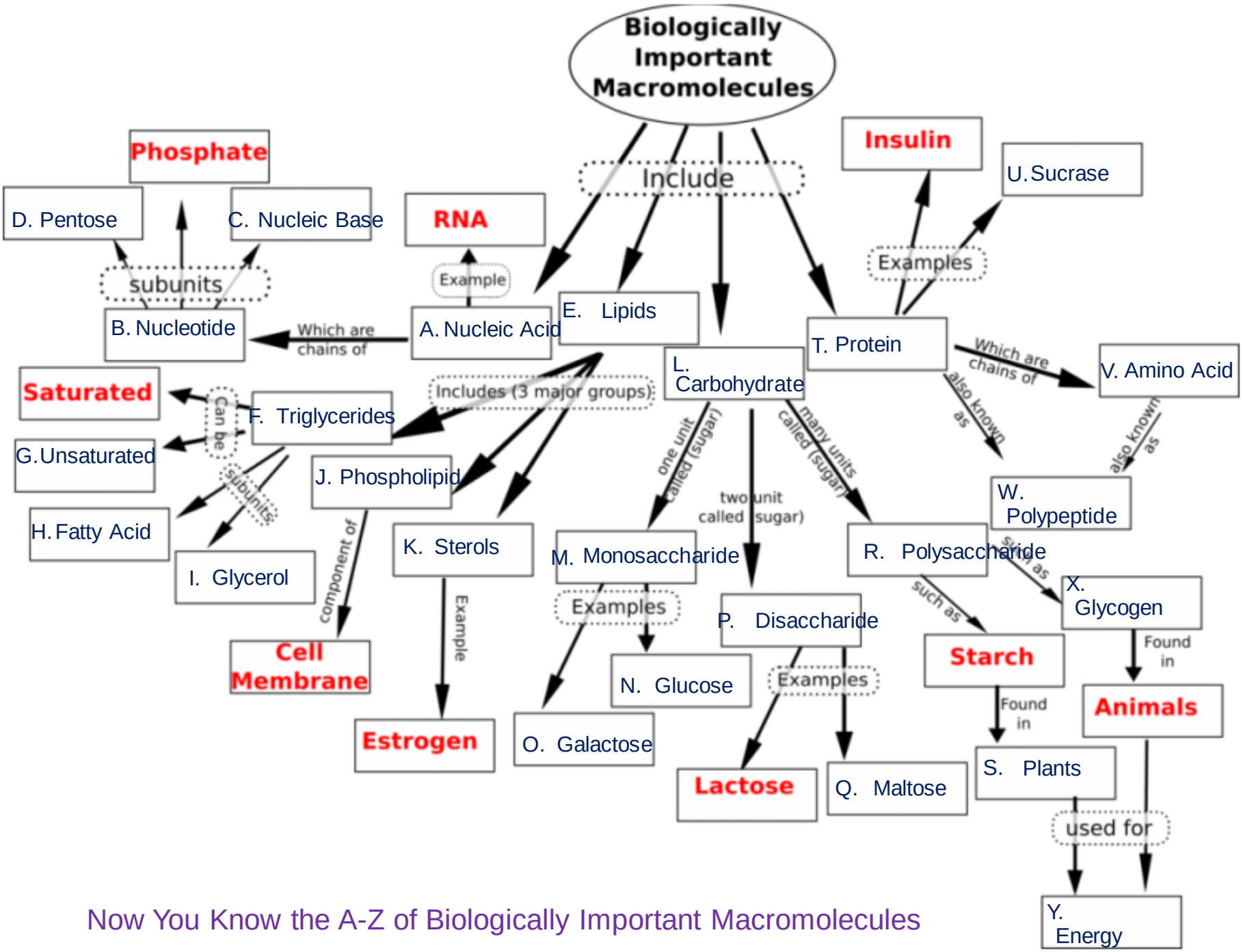


Comparison of DNA & RNA

Feature	***DNA***	***RNA***
Sugar	Deoxyribose	Ribose
Bases	Cytosine, guanine; adenine, *thymine*	Cytosine, guanine; adenine, *uracil*
Strands	Double-stranded; Pairing across strands	Mostly single stranded
Helix	Yes	No
Function	Heredity; cellular control center	Interprets genetic info; protein synthesis
Where	Chromosomes of cell nucleus	Cell nucleus and cytoplasm

Questions?

https://youtu.be/o_-6JXLYS-k



Z. Now You Know the A-Z of Biologically Important Macromolecules

Biological Macromolecules

	Examples	Functions	Monomer (building block)
Carbohydrates	(Hexose) Starch, glycogen (polysaccharides)	Energy storage, cell surface marker, cell signaling	Simple sugars (glucose, galactose)
Proteins	Hemoglobin, Enzymes, Collagen	Catalyze reactions, physical structure, cell signaling	Amino Acids (glycine, cysteine)
Nucleic Acids	(Pentose, Ribose) DNA, RNA	Store Genetic Information, Gene expression	Nucleotides (A,C,G,T)
Lipids	(Triose) Triacylglycerol, cholesterol	Energy Storage, Cell Membranes, Hormones	Fatty Acids and Glycerol

Review Questions

- What is the monomer of Proteins?
- What are the three parts of a nucleotide?
- α-helix is an example of what level of protein structure?
- Why is polymerization of monosaccharides or amino acids called “dehydration synthesis?”
- What type of lipid is used to construct the cell membrane?
- What is an enzyme?
- Name the “linkage” between two…
  - Amino acids, monosaccharides
- What are plant cell walls made of?
- Adenine (A) hydrogen-bonds with which nucleotide?
- What does it mean if a fat is “unsaturated?”

TABLE 3.5

Organic Compounds in Cells

	Categories	*Elements*	*Examples*	*Functions*
Carbohydrates	Monosaccharides 6-carbon sugar 5-carbon sugar	C, H, O	 Glucose Deoxyribose, ribose	 Immediate energy source Structure of DNA, RNA
	Disaccharides 12-carbon sugar	C, H, O	Sucrose	Transport sugar in plants
	Polysaccharides Polymer of glucose	C, H, O	Starch, glycogen Cellulose	Energy storage in plants, animals Plant cell wall structure
Lipids	Triglycerides 1 glycerol + 3 fatty acids	C, H, O	Fats, oils	Long-term energy storage
	Phospholipids Like triglyceride except the head group contains phosphate	C, H, O, P	Lecithin	Plasma membrane component
	Steroids Backbone of 4 fused rings	C, H, O	Cholesterol Testosterone, estrogen	Plasma membrane component Sex hormones
	Waxes Fatty acid + alcohol	C, H, O	Cuticle Earwax	Protective covering in plants Protective wax in ears
Proteins	Polypeptides Polymer of amino acids	C, H, O, N, S	Enzymes Myosin and actin Insulin Hemoglobin Collagen	Speed cellular reactions Muscle cell components Regulates sugar content of blood Oxygen carrier in blood Fibrous support of body parts
Nucleic Acids	Nucleic acids Polymer of nucleotides	C, H, O, N, P	DNA RNA	Genetic material Protein synthesis
	Nucleotides		ATP Coenzymes	Energy carrier Assist enzymes