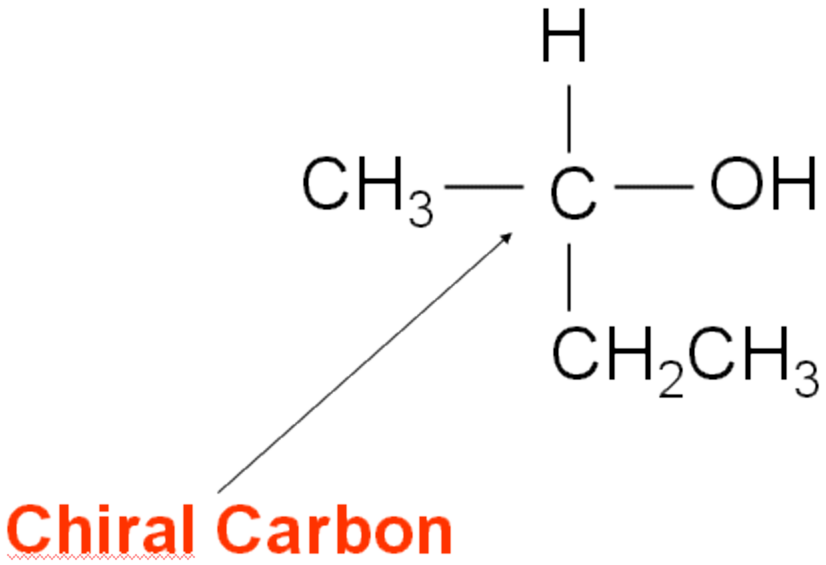
# Natural Polymers

Chapter 2.6

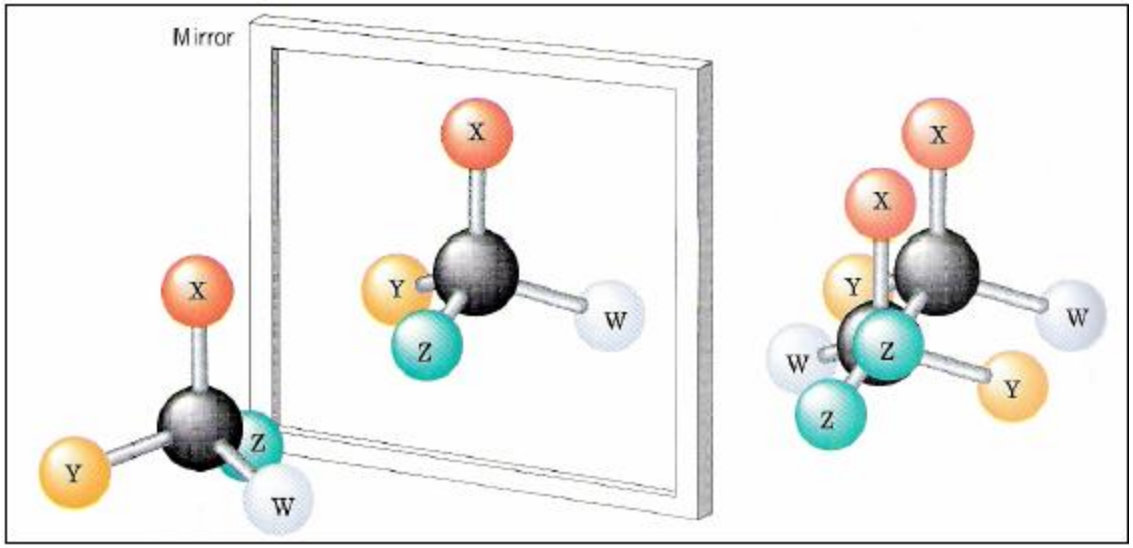
# Another Type of Isomer

- Many organic compounds contain **chiral** carbon atoms
- A **chiral** carbon atom is a carbon that is surrounded by four different groups



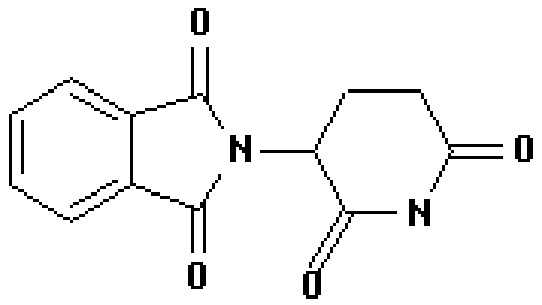
# Another Type of Isomer

- **Enantiomers** are molecules that are mirror images of each other around a single chiral carbon atom
- They are not superimposable, thus they are different molecules with different properties



# So What?

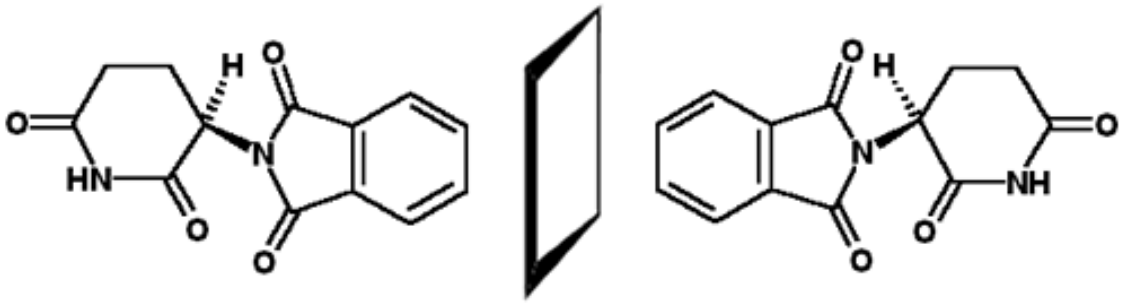
- Thalidomide is a doctor prescribed drug that was used in the late 1950's and early 1960's
- Can you spot the chiral carbon?




2-(2,6-dioxo-3-piperidinyl)-
1H-isoindole-1,3(2H)-dione)
**thalidomide**

# So What?

- The two enantiomers of thalidomide had very different effects




R-Thalidomide
(sleep-inducing)

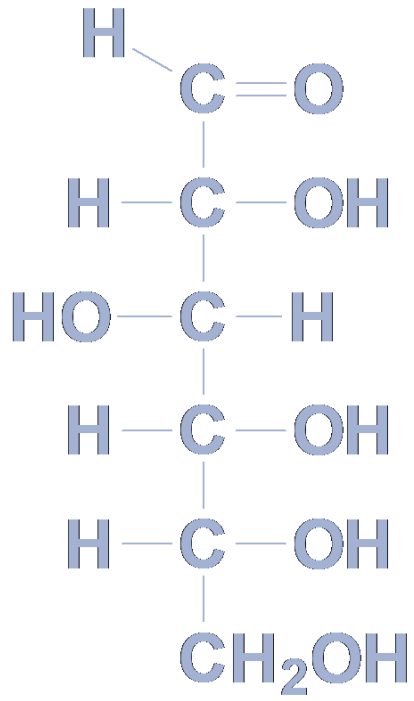
S-Thalidomide
(teratogenic)

# Examples of Natural Polymers

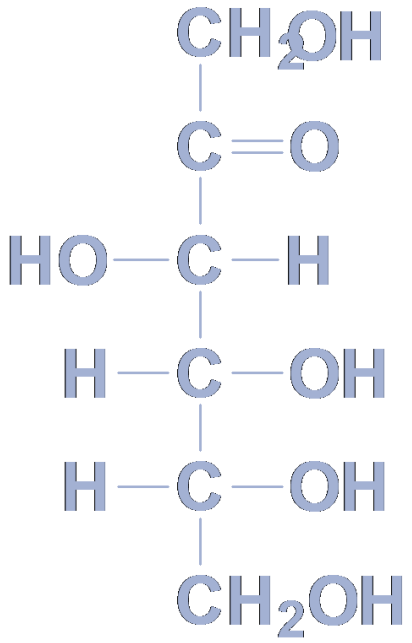
- Polysaccharides
- Peptides and Proteins
- Nucleic Acids

# From Simple Sugars to Carbohydrates

- Monosaccharides are aldehydes or ketones with 5 or 6 carbon atoms and many hydroxyl groups. They are simple sugars that are the monomers of carbohydrates




D-Glucose




D-Fructose

# From Simple Sugars to Carbohydrates

- Many monosaccharides exist in both a linear and ring form

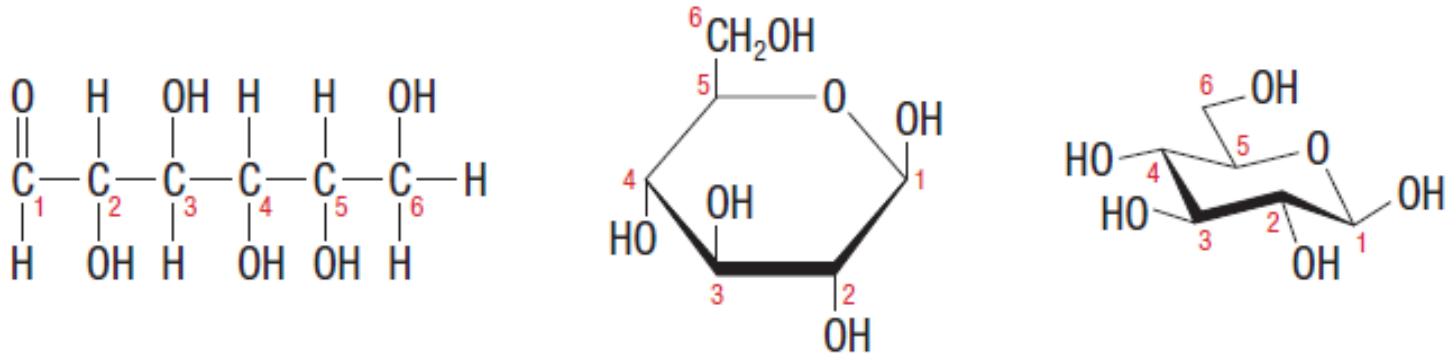
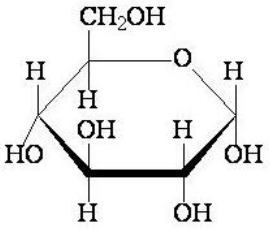


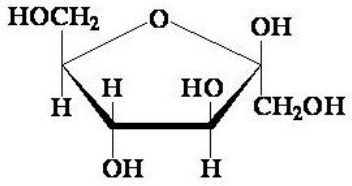
**Figure 2** Three ways to draw the structure of glucose

# From Simple Sugars to Carbohydrates

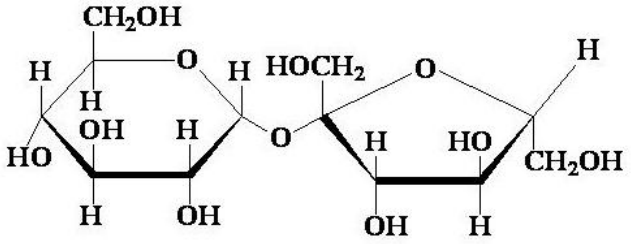
- Hydroxyl groups from two monosaccharides can undergo a condensation reaction resulting in an ether linkage (**glycosidic bond**)




**glucose**



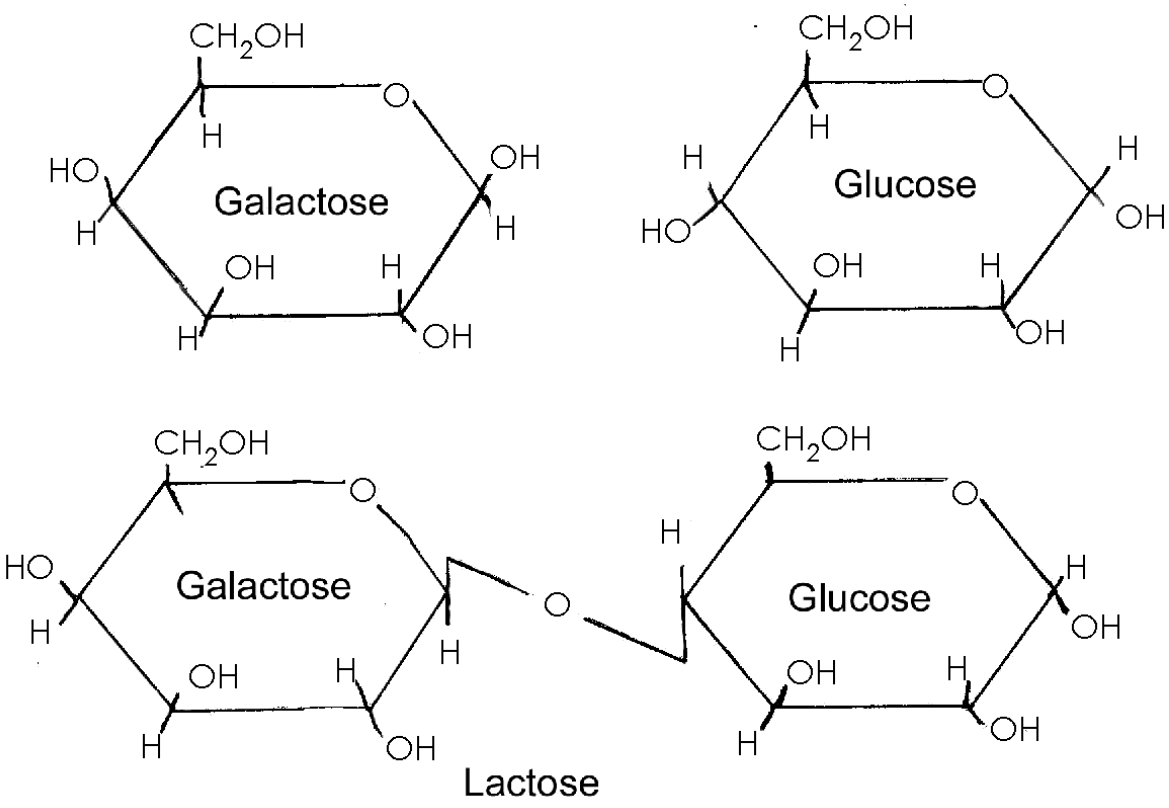

**fructose**




**sucrose**

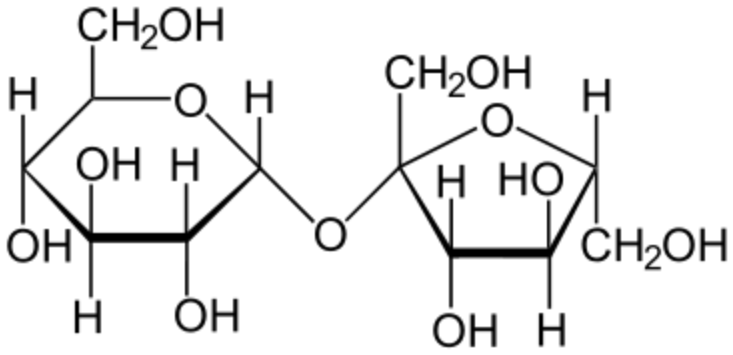
# From Simple Sugars to Carbohydrates

- Lactose is the sugar found in milk
- It is made up of glucose and galactose

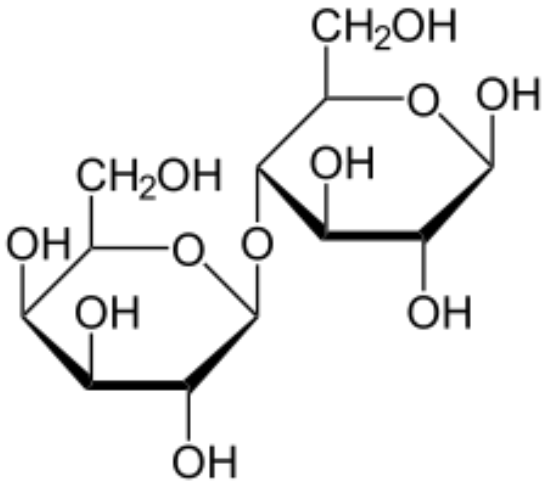


# From Simple Sugars to Carbohydrates

- Sucrose

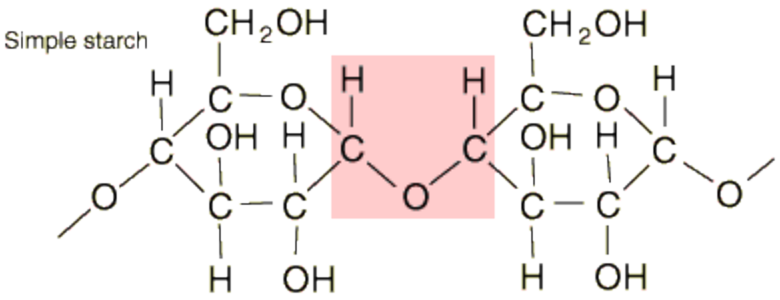


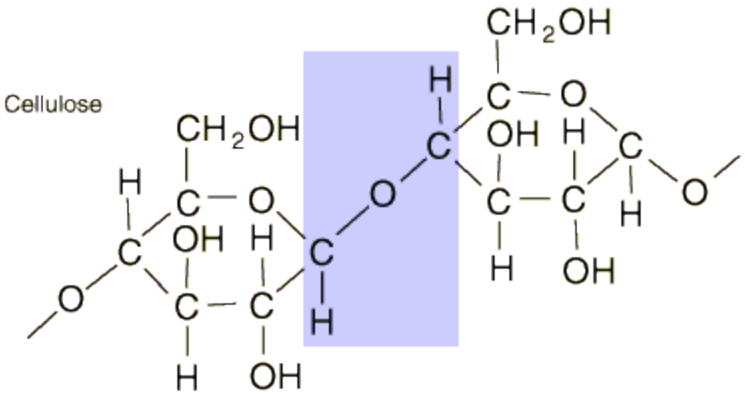

- Lactose

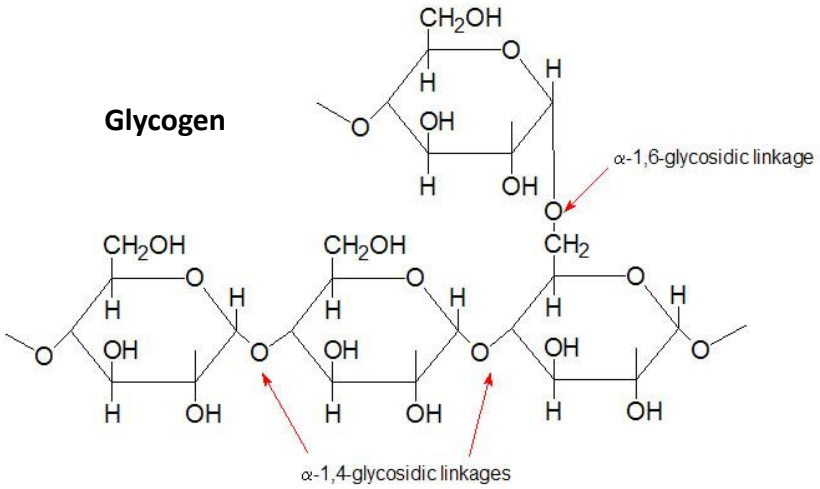


# From Simple Sugars to Carbohydrates

- Polysaccharides are large polymers consisting of many monosaccharides. Cellulose, glycogen, and starch are examples

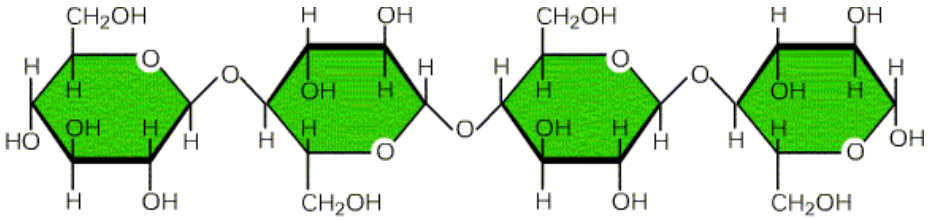


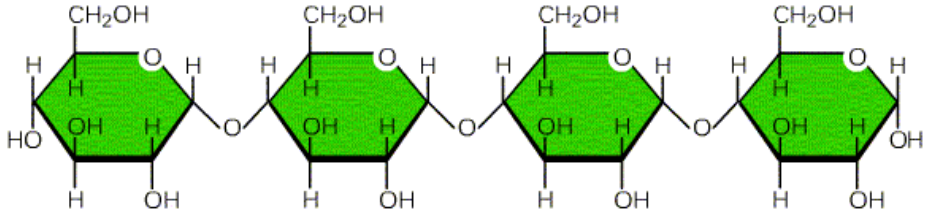



# From Simple Sugars to Carbohydrates

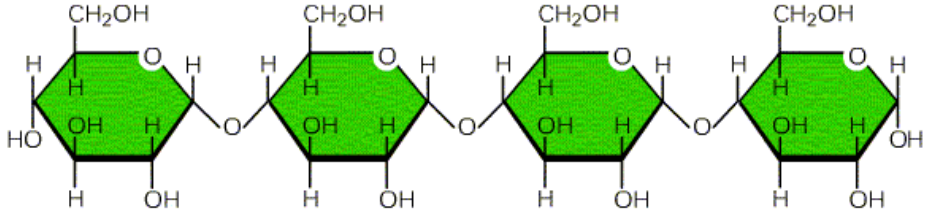
Cellulose



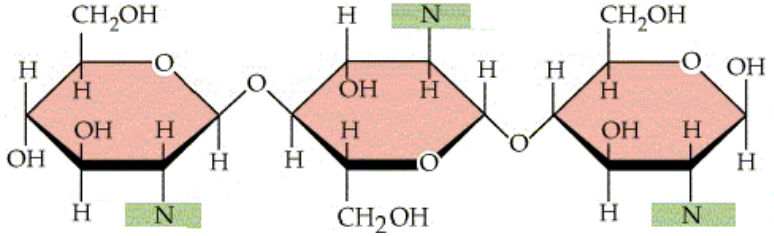
Starch



Glycogen

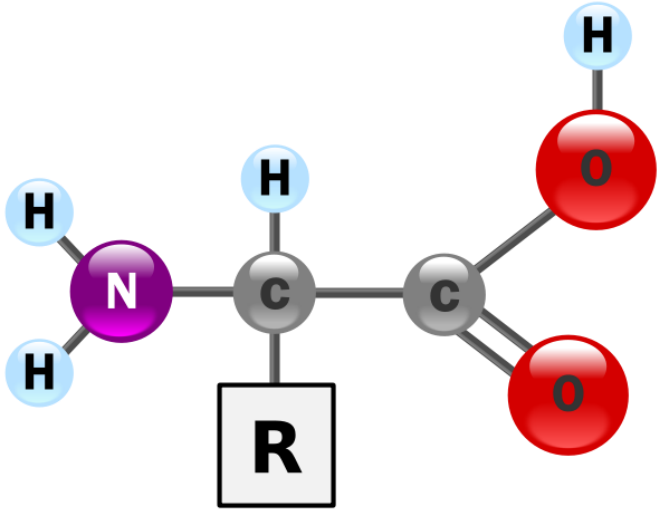


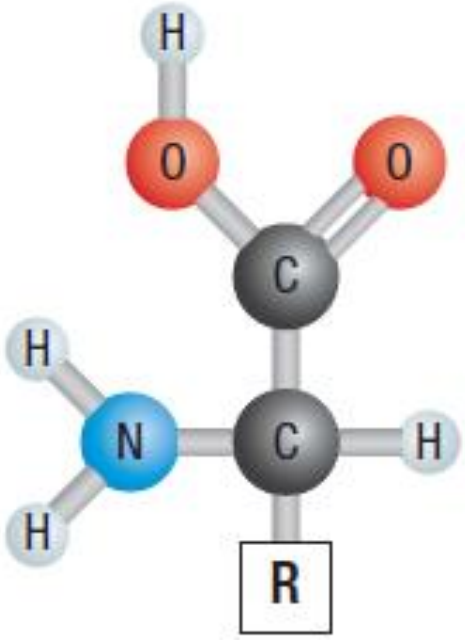
**Chitin**



# From Amino Acids to Peptides and Proteins

- An **amino acid** is an organic molecule that contains a carboxyl group (-COOH), an amino group ($-NH_2$), and a hydrogen atom all attached to the same carbon atom
- The fourth bond on that central carbon is an additional group of atoms (the R group)



# From Amino Acids to Peptides and Proteins

- The R group gives each amino acid its distinct properties

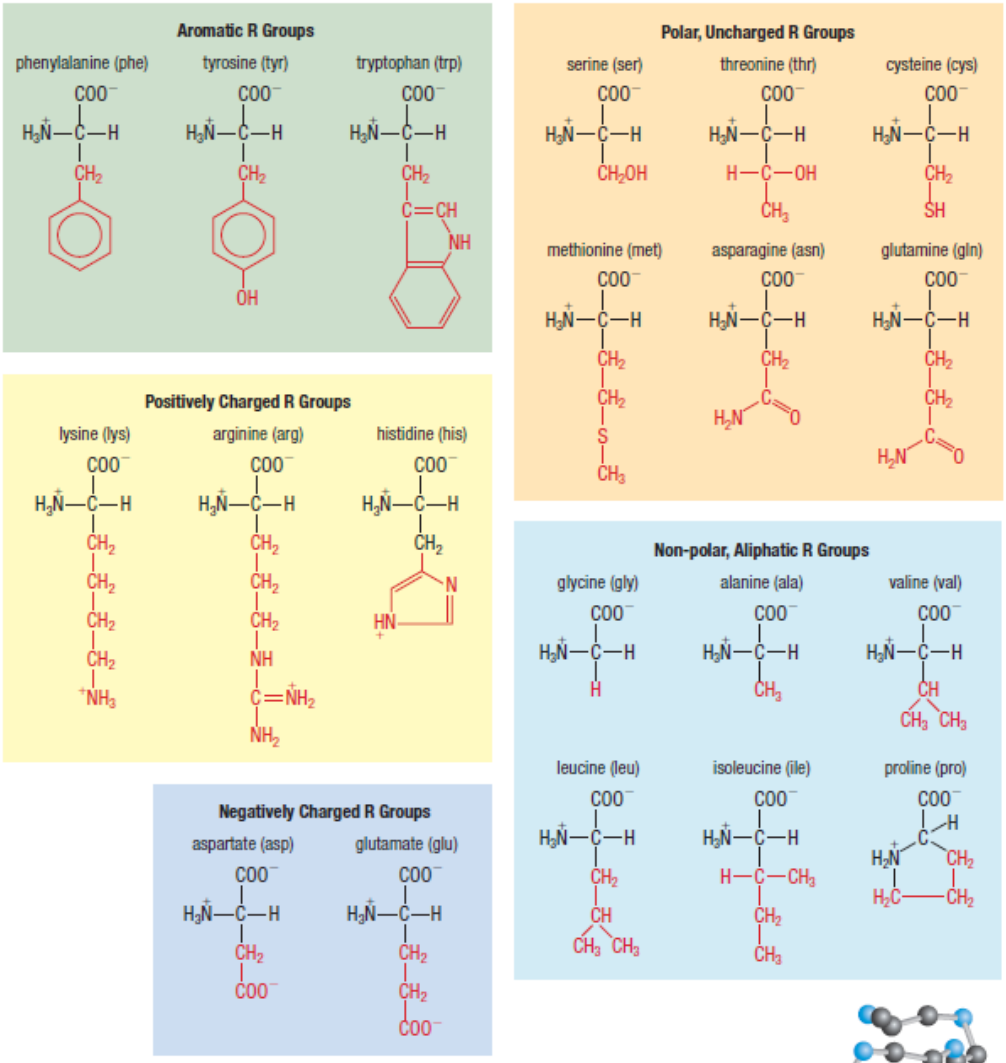
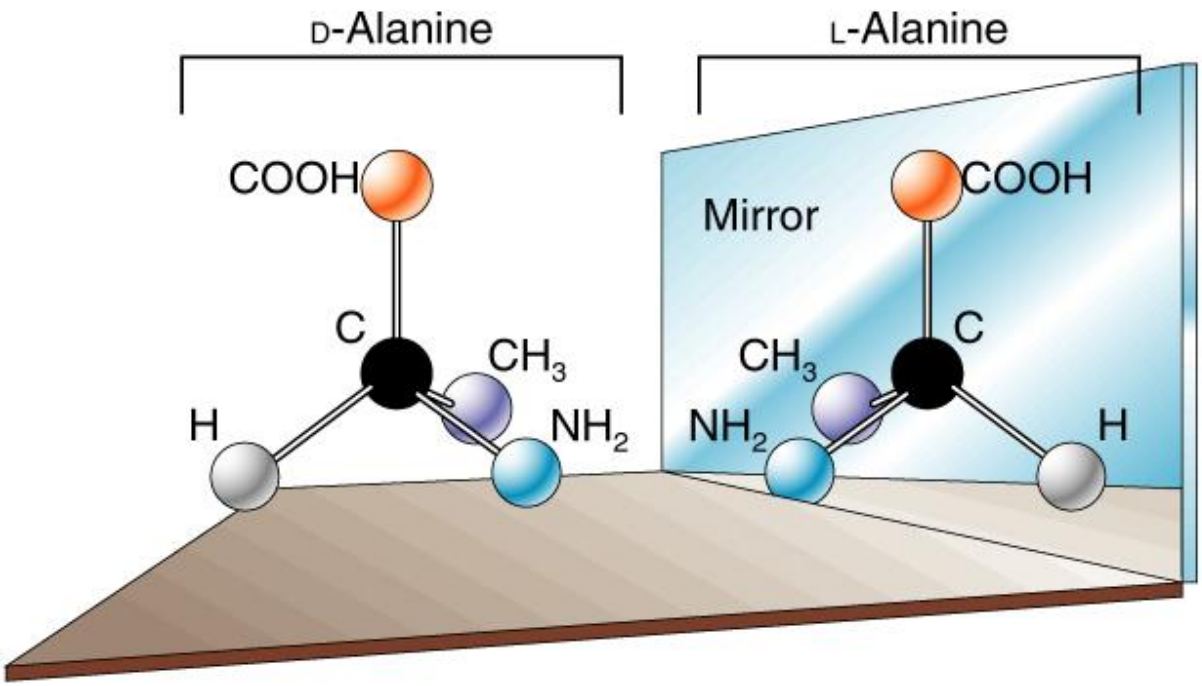



**Figure 6** The 20 amino acids all have different side chains (R groups), shown here in red.

# From Amino Acids to Peptides and Proteins

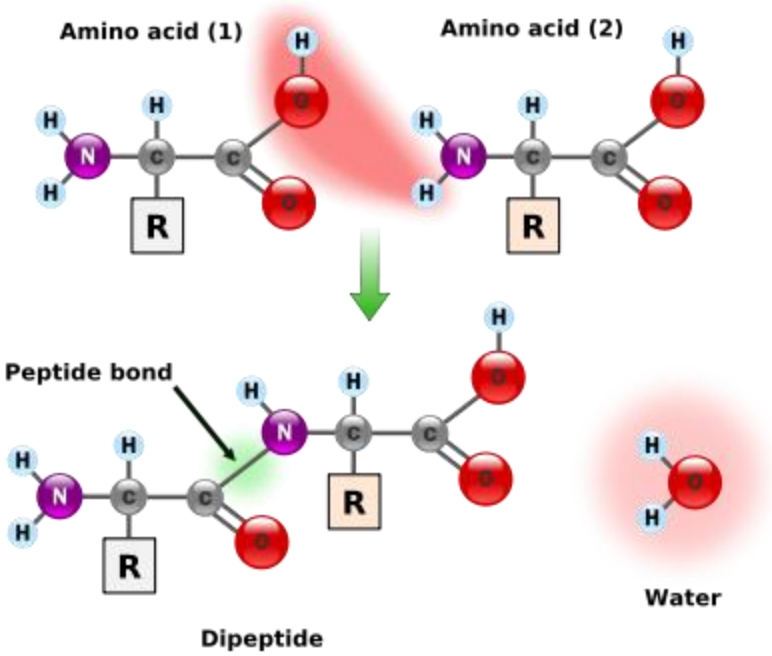
- Most amino acids contain a chiral carbon




- The “L” enantiomers are the ones found in our bodies

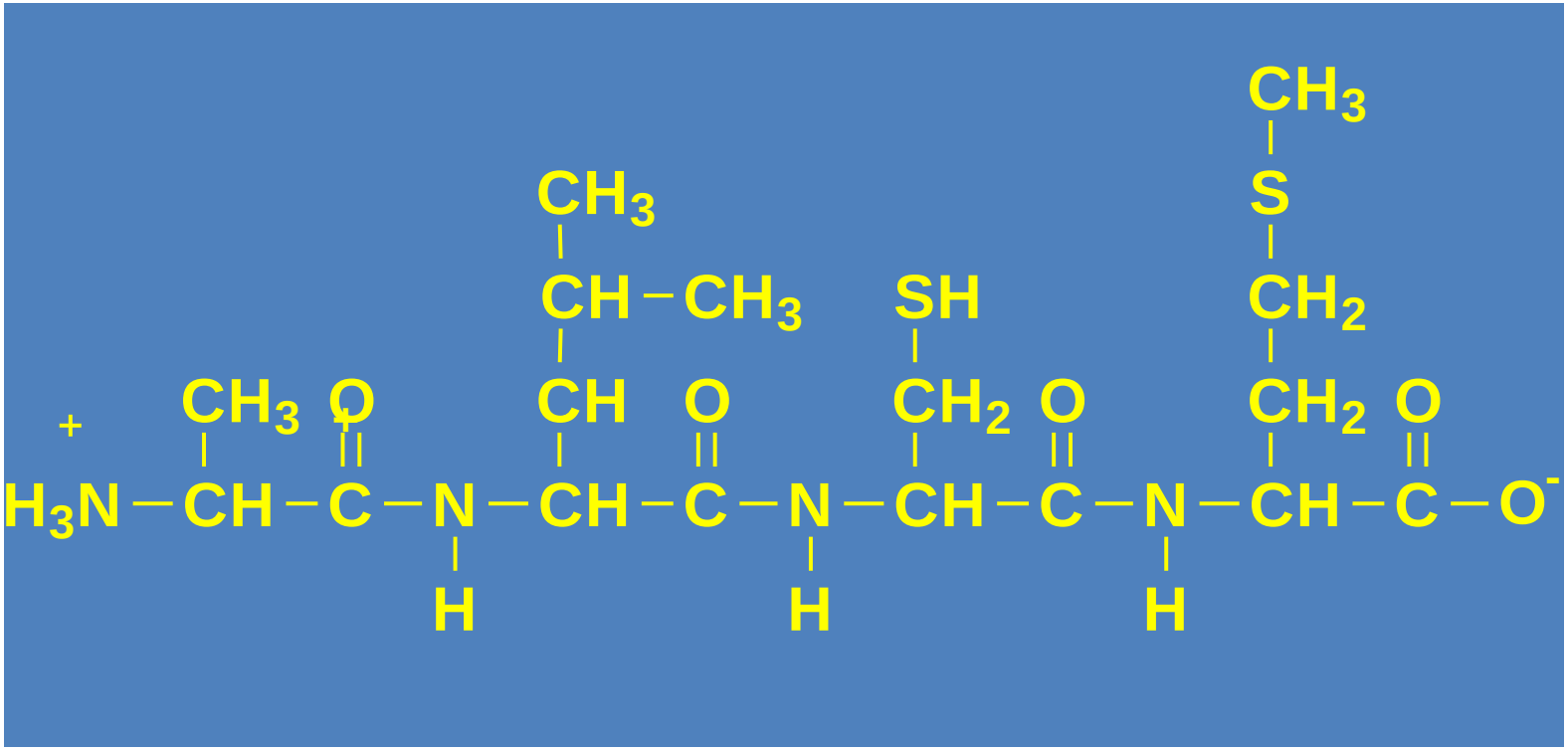
# From Amino Acids to Peptides and Proteins

- A protein polymer is built by condensation reactions between amino acids to form **peptide bonds**



# From Amino Acids to Peptides and Proteins

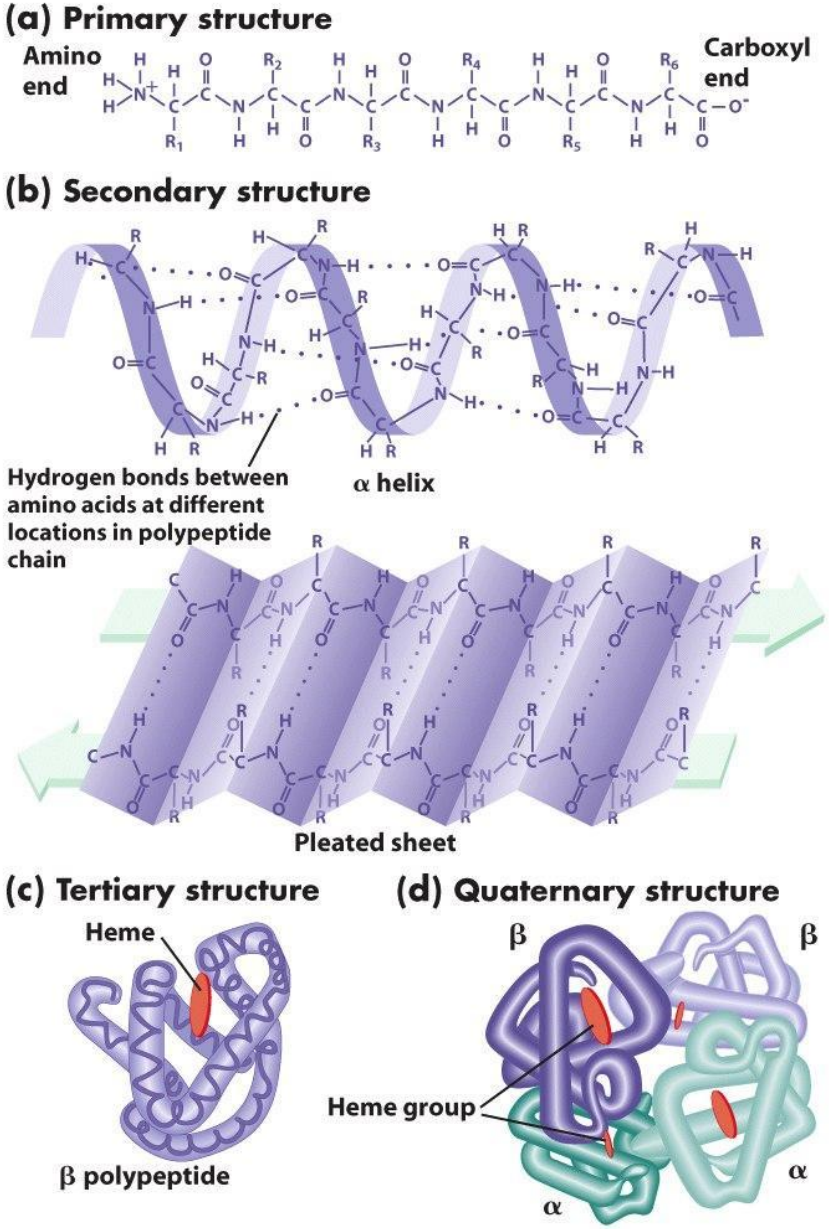
- The sequence of amino acids in the protein chain is called the **primary structure**
- The 20 amino acids can be assembled in any order, so there is essentially an infinite number of possible protein structures
- Ex: Which amino acids are present in the polypeptide below?



# Practice

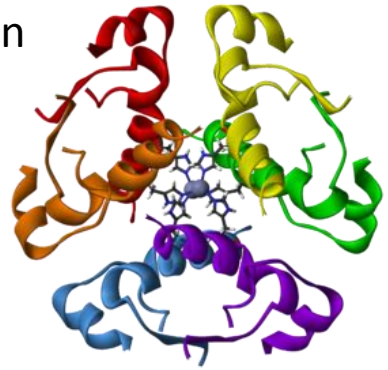
- Draw the tripeptide tyrosine-aspartate-lysine

# From Amino Acids to Peptides and Proteins

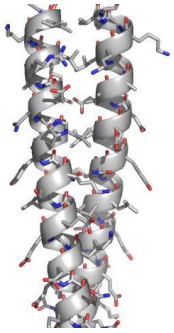



The function of a protein is based on its specific three dimensional shape

Insulin

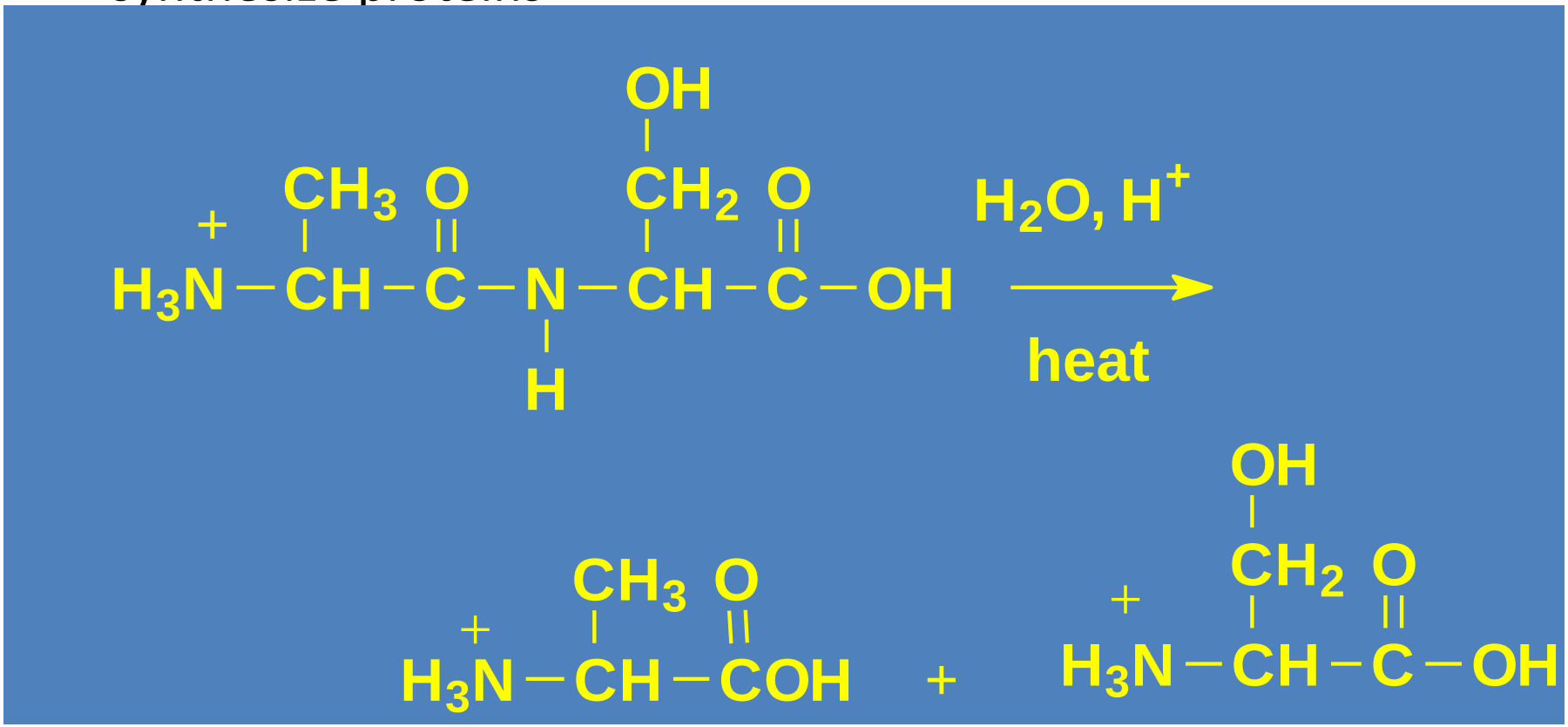


Keratin



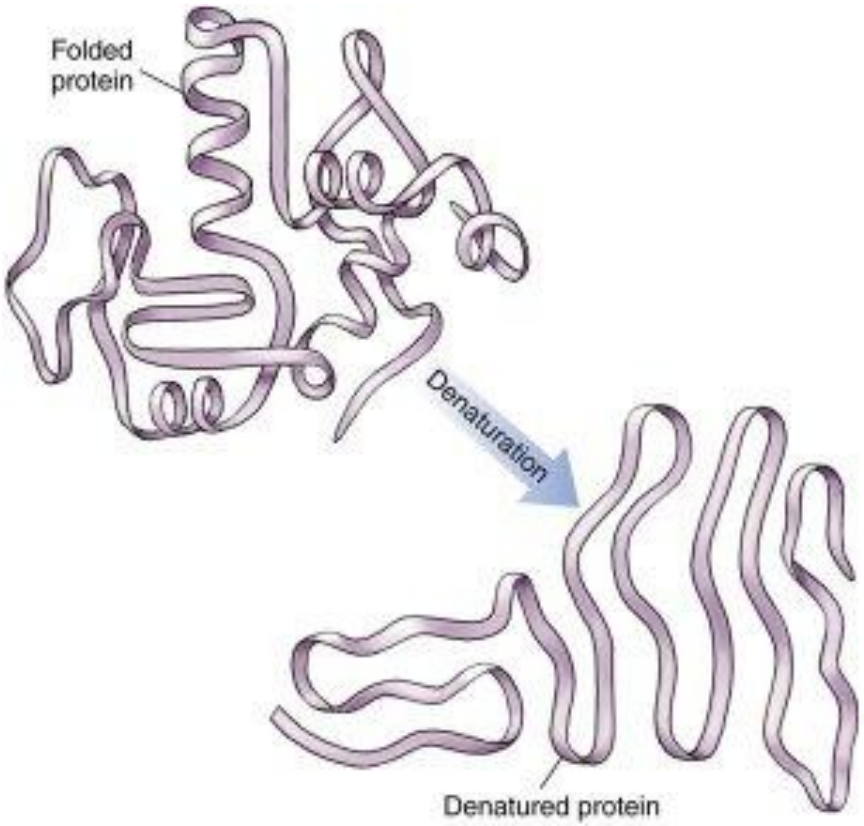
# Protein Hydrolysis

- Peptide bonds in proteins can be broken to give amino acids
- This reaction requires acid or base, heat, and water
- This occurs during digestion to provide amino acids to synthesize proteins



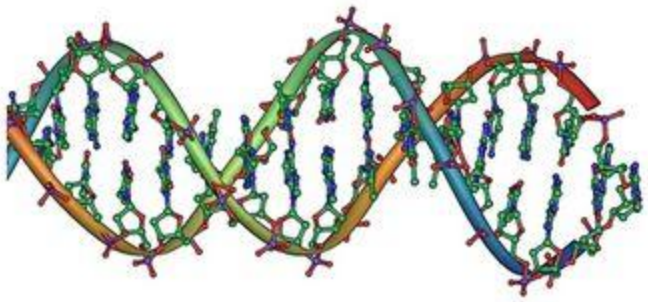
# Protein Denaturation

- **Denaturation** is disruption of the secondary, tertiary, and quaternary structure of a protein
- A protein that is denatured can no longer function
- Denaturation can be achieved through heat, organic solvents, acids, bases, or agitation



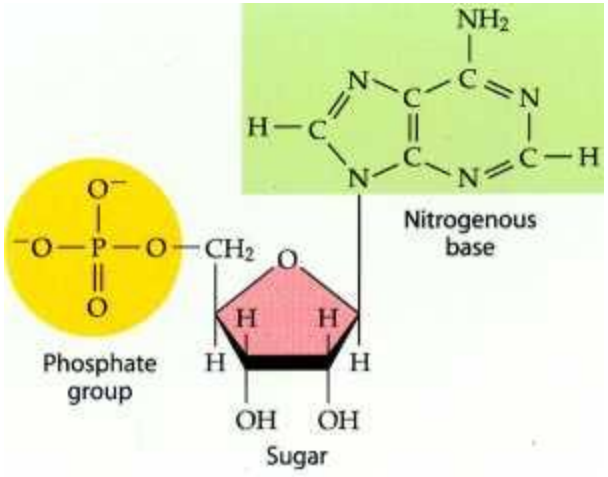
# Nucleic Acids

- DNA and RNA are polymers in the cell that store and transmit genetic information
- **Nucleic acids** are the polymer molecules that make up DNA and RNA



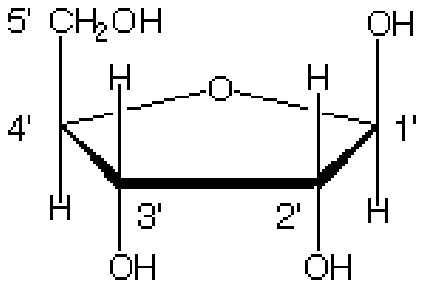
# Nucleic Acids

- The monomers of nucleic acids are called **nucleotides**
- Nucleotides have **three parts**
  1. A 5-carbon sugar
  2. A nitrogen containing organic base
  3. A phosphoric acid molecule

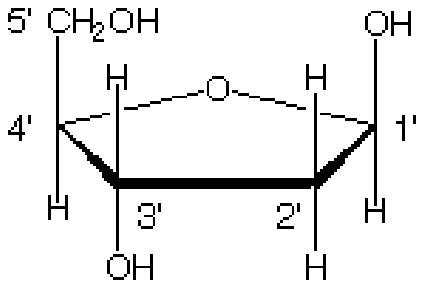


# Nucleotides Have Three Parts

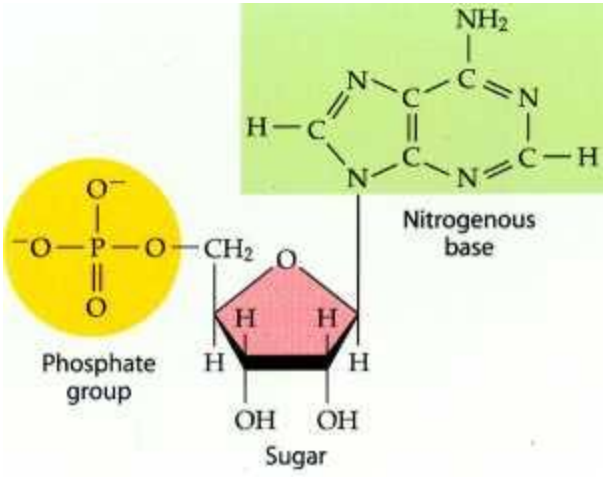
1) A 5- carbon sugar




**Ribose**

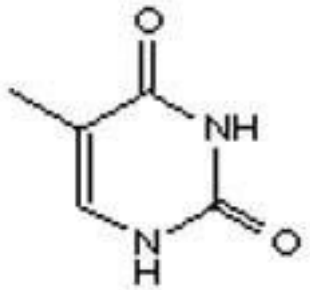



**Deoxyribose**

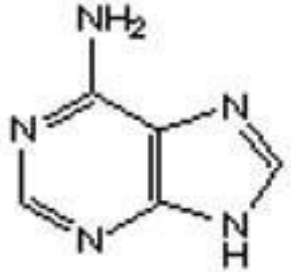


# Nucleotides Have Three Parts

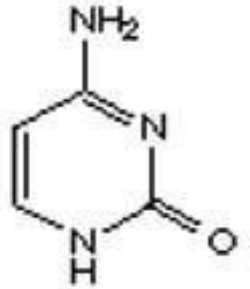
2) A nitrogen-containing organic base



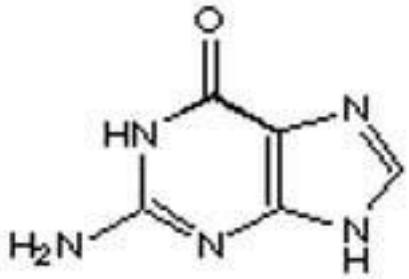

Thymine (T)



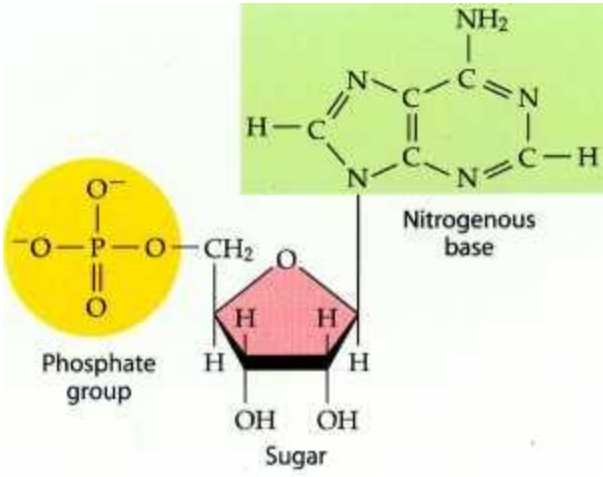

Adenine (A)




Cytosine (C)

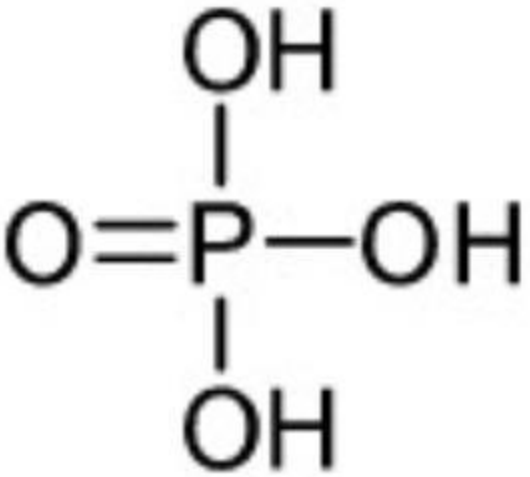


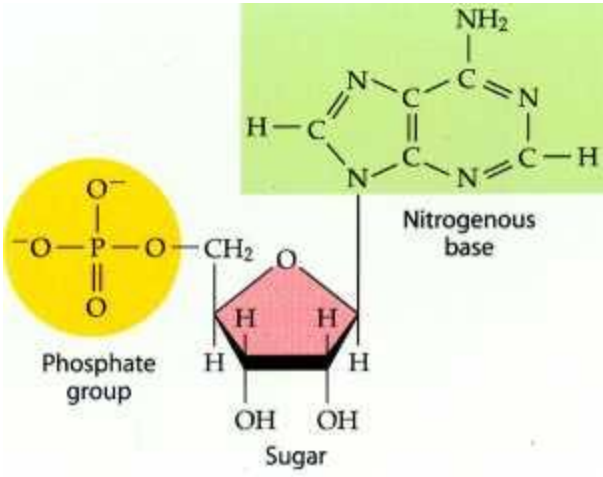

Guanine (G)



# Nucleotides Have Three Parts

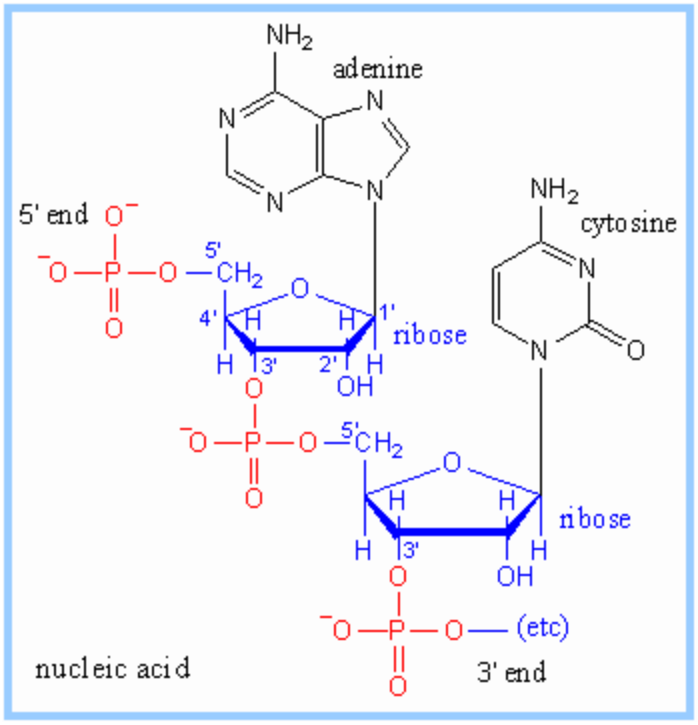
3) A phosphoric acid molecule (phosphate group)

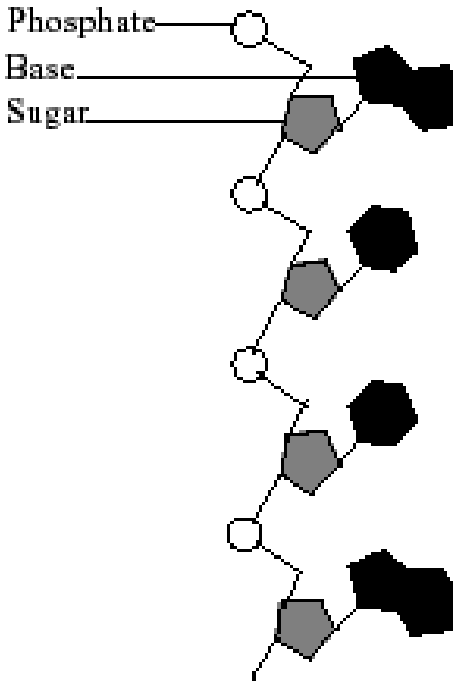


# From Nucleotides to Nucleic Acids

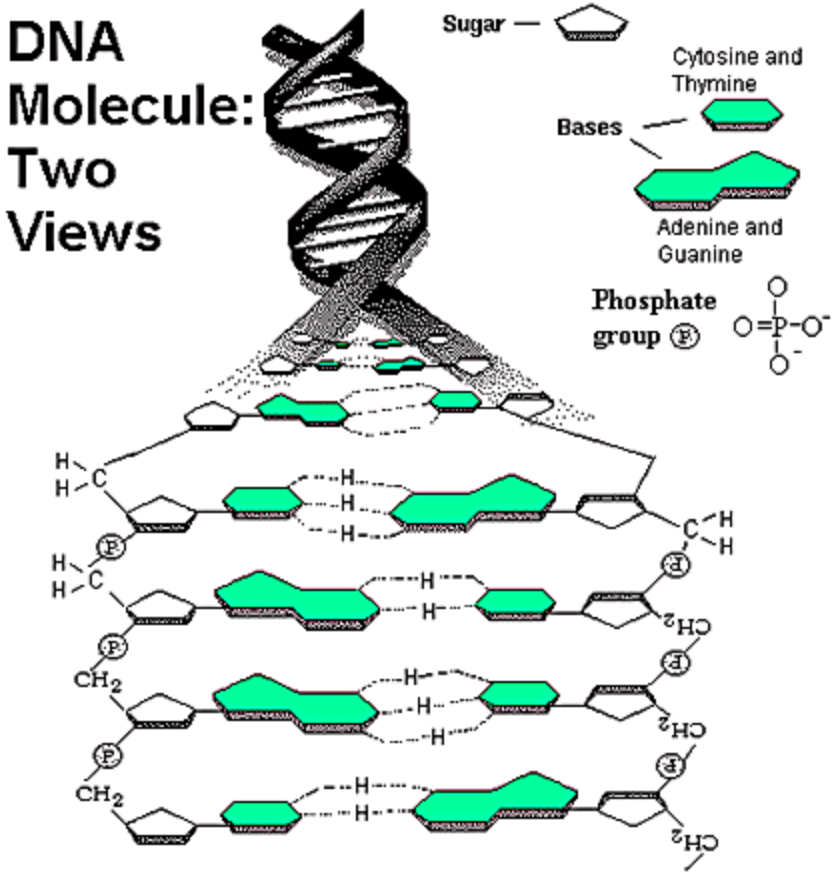
- Nucleic acids undergo condensation reactions to form phosphodiester bonds

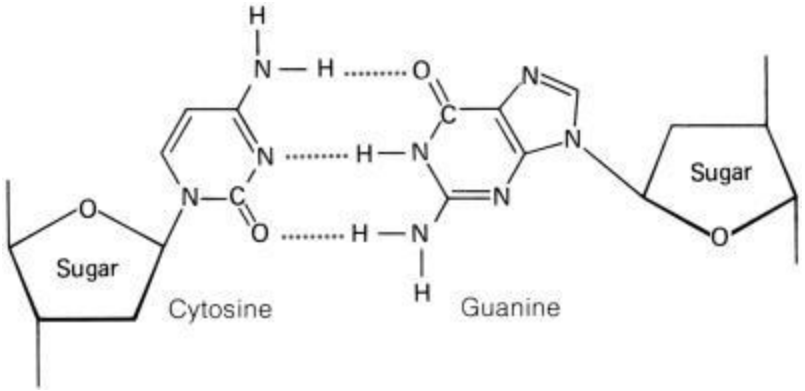


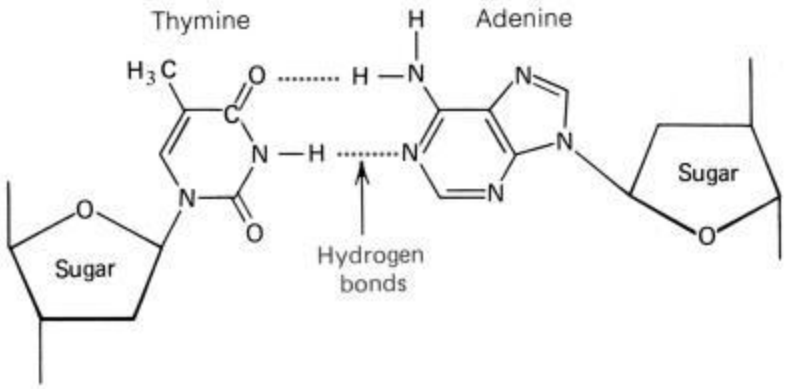



# Double Helix Structure of DNA

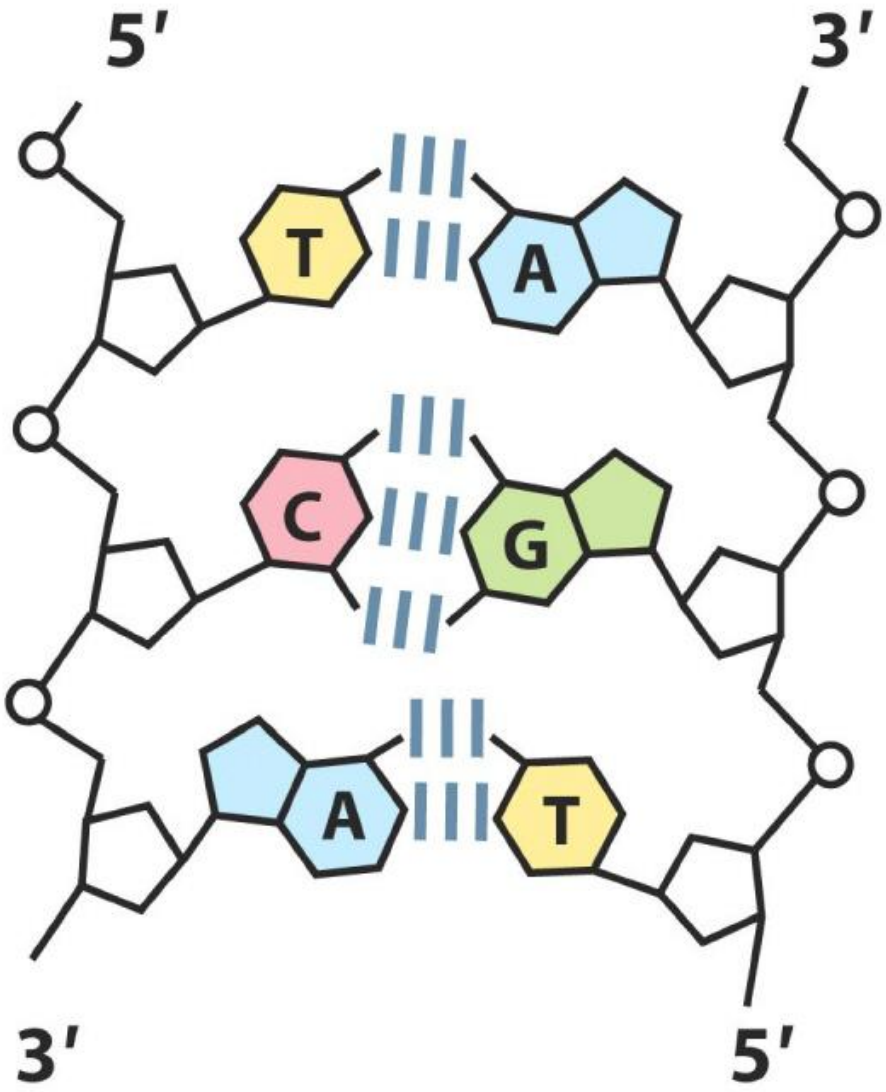
- In a DNA molecule two complimentary polypeptide chains are held together by hydrogen bonding between the base groups



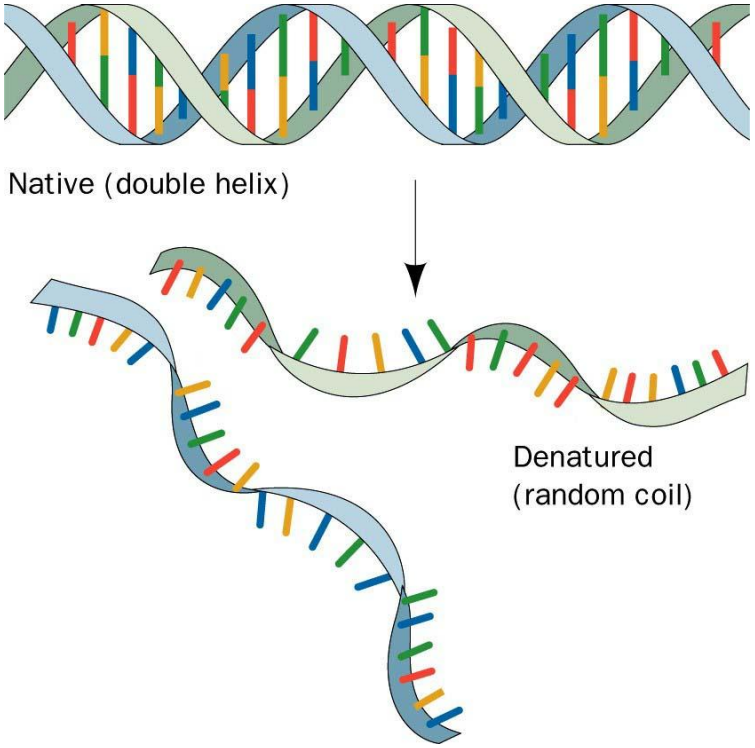



# Double Helix Structure of DNA

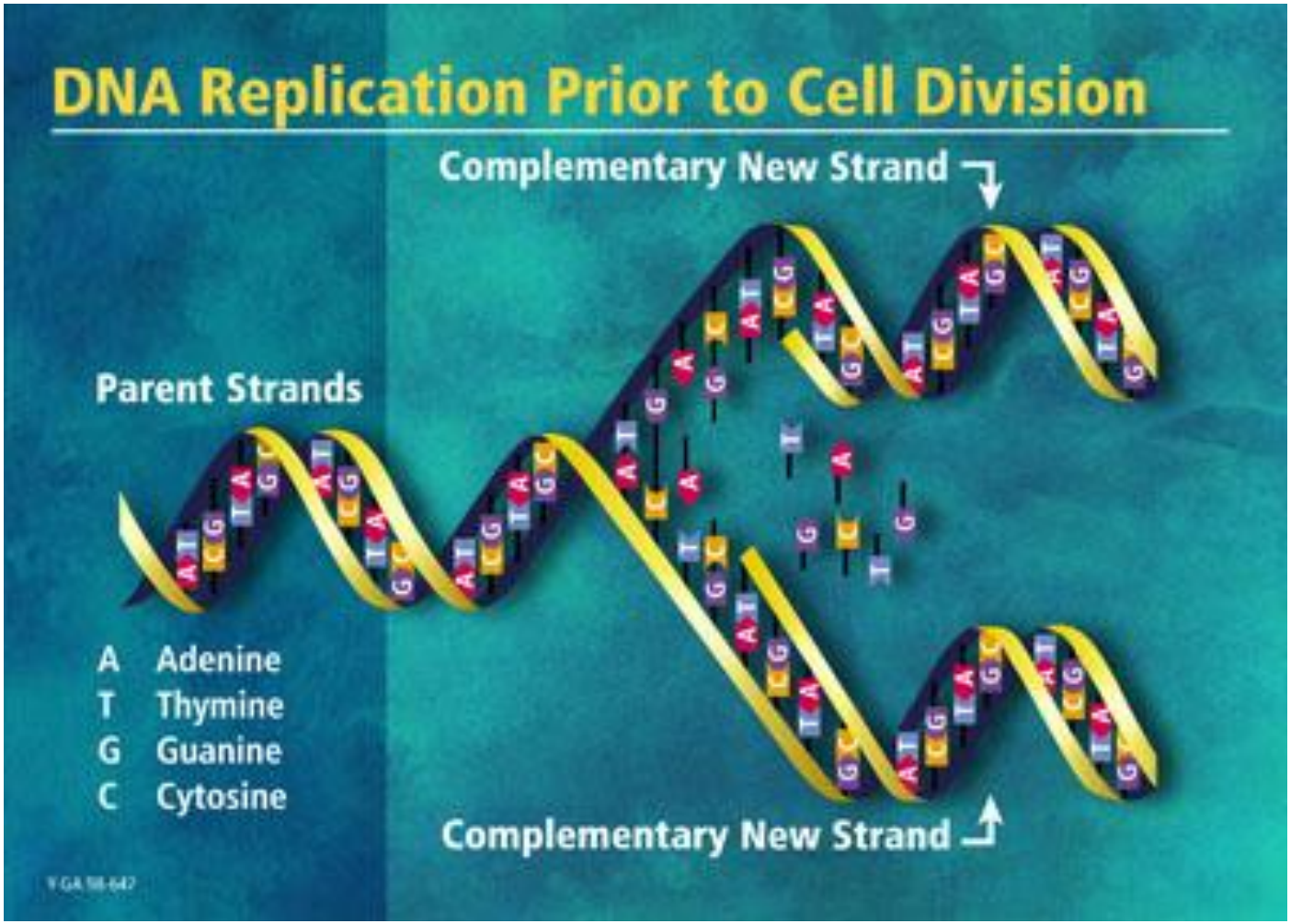


# Double Helix Structure of DNA

- Like proteins, DNA can be denatured and lose its shape
- Special enzymes in the cell denature the DNA in order to replicate it or to use it to synthesize proteins

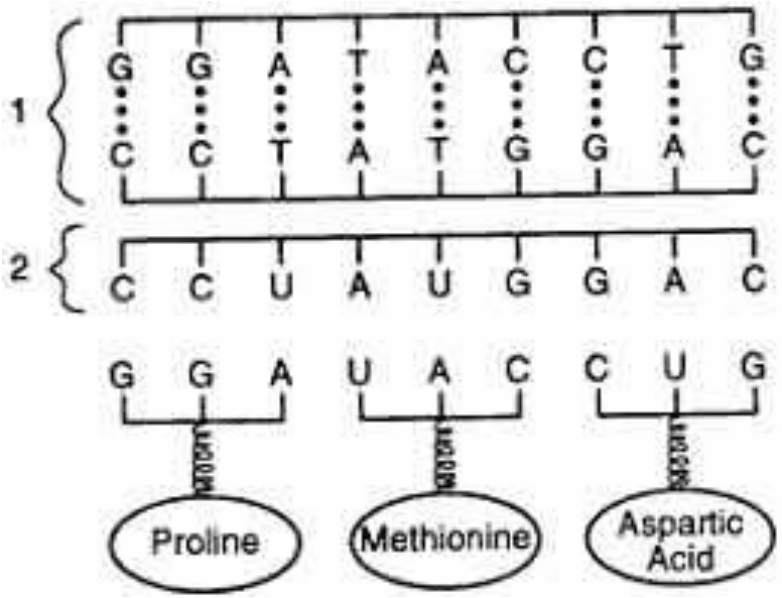


# DNA Replication



# DNA is Used for Protein Synthesis

- A given segment of the DNA, called a gene, contains the code for a specific protein



# HOMEWORK

Required Reading:

p. 101-105

(remember to supplement your notes!)

Questions:

p. 105 #1-7