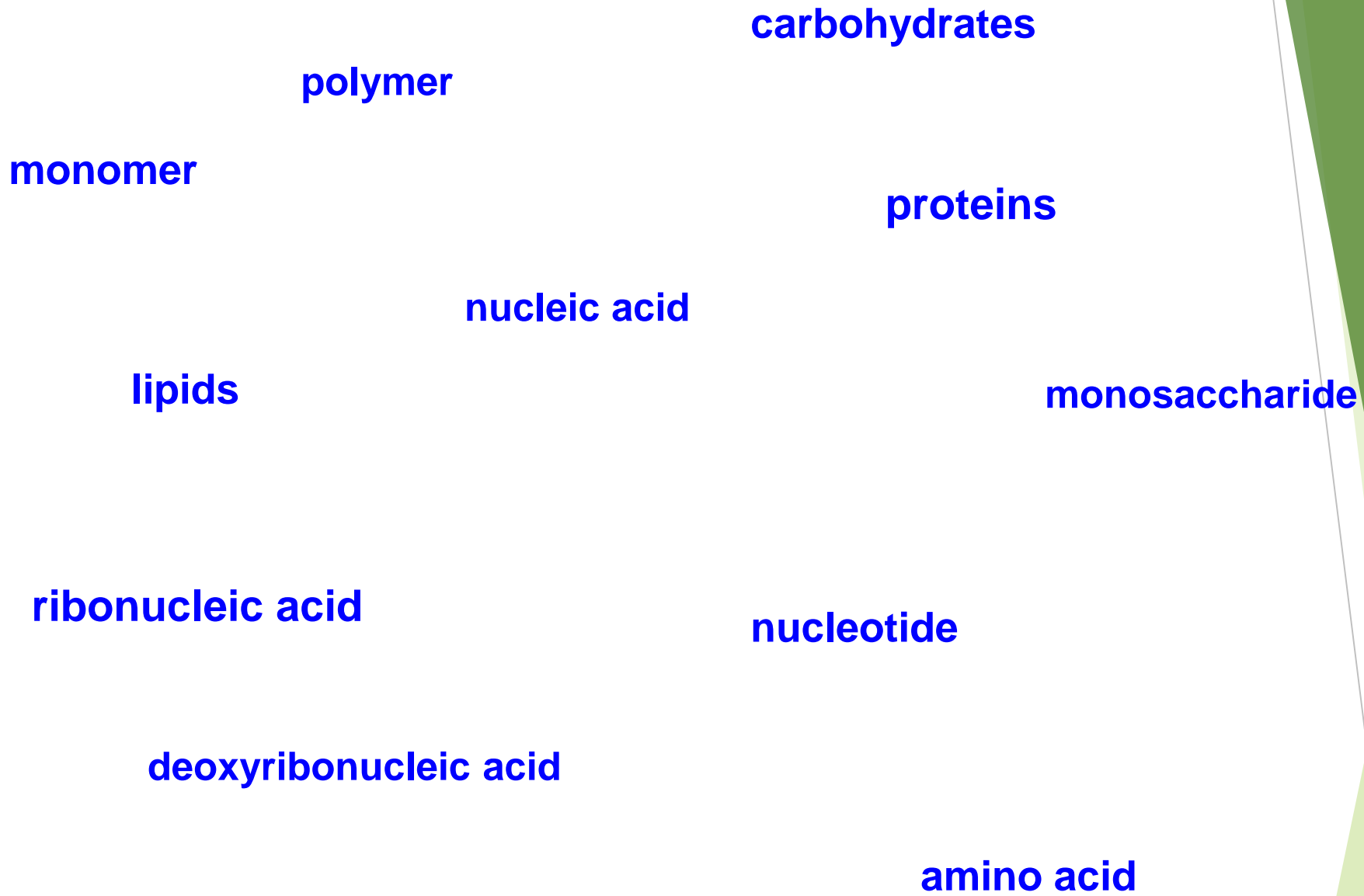


# Chapter 2: The Chemistry of Life

## ORGANIZATION OF LIVING THINGS



# **Chapter 2: The Chemistry of Life**

## **Sec 2-3 Carbon Compounds:**

**What is special about the chemistry of carbon?**

**What are the four major macromolecules?**

**What is the connection between a monomer and a polymer?**

Goal-> To describe the key functions of each group of organic compounds.

1st job of a biologist is to understand the chemistry of life.

Water

Carbon

Energy (sun)

Oxygen

Fuel

**Organic Chemistry = study of all compounds that contain bonds between carbon atoms.**

Why Carbon ?

4 Valence Electrons

-> covalent bonds

Can bond with many elements

->hydrogen, oxygen, phosphorus, sulfur & nitrogen

Carbon bonds to Carbon

-> Chains of unlimited length

->create complex structures

**Result = Versatile**

Macromolecules= 'giant molecules' made of thousands or hundreds of thousands of smaller molecules.

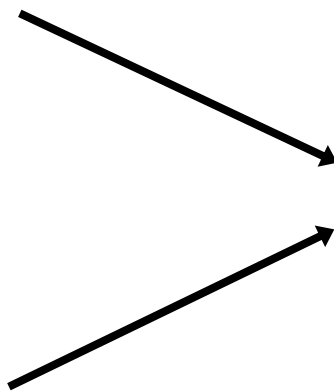
**Monomer (building blocks) -> Polymers-> Macromolecules**

Carbohydrates

Lipids

Nucleic Acids

Proteins



Are in all living things

# Carbohydrates

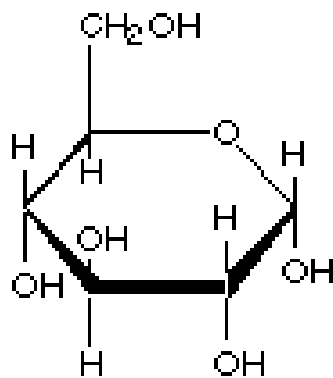
Why are carbohydrates important ?

animals rely on plants for carbohydrates which they produce through photosynthesis

carbon : hydrogen : oxygen  
1 : 2 : 1

**monosaccharides**  
**(single sugar units)**

Glucose (human blood)  
Galactose (milk)  
Fructose (fruit)



$\alpha$ -Glucose

**-ose suffix identifies sugars**

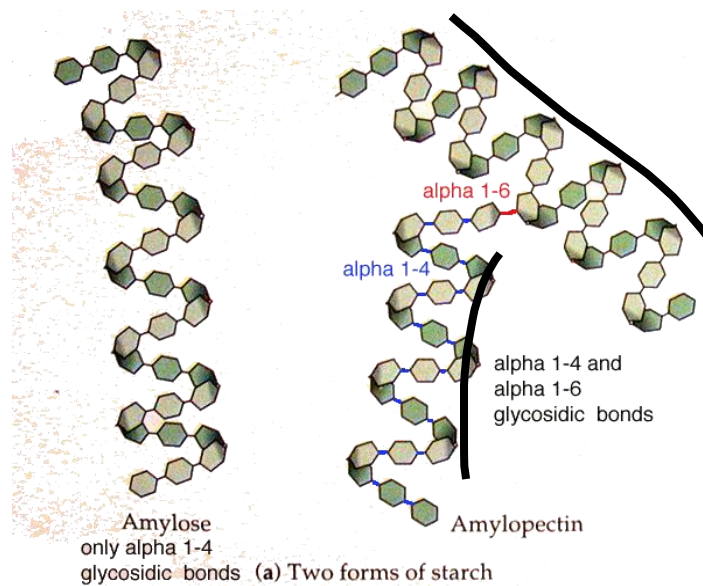
## disaccharides (double sugar unit)

**ex.** *sucrose* (glucose + fructose) and *maltose* (glucose + glucose)  
*lactose* (glucose + galactose)

## polysaccharides (many sugar units)

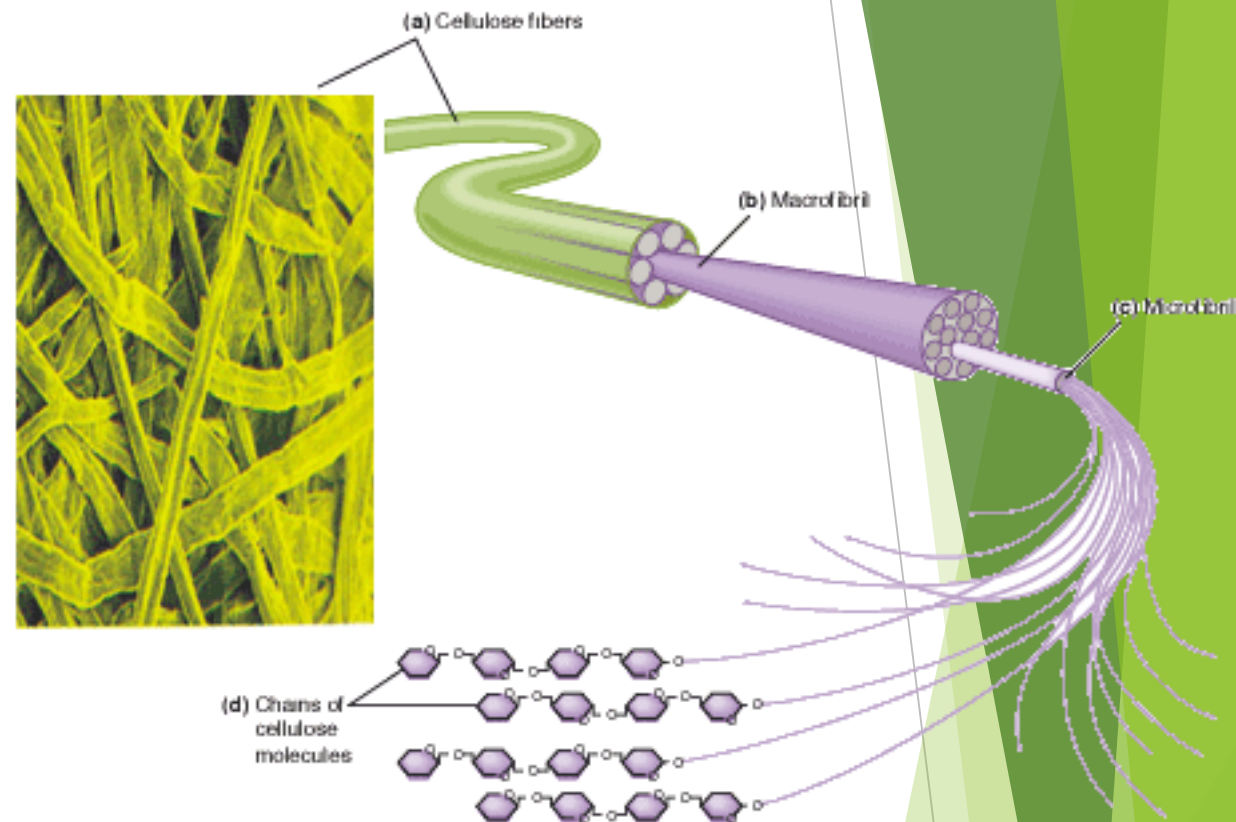
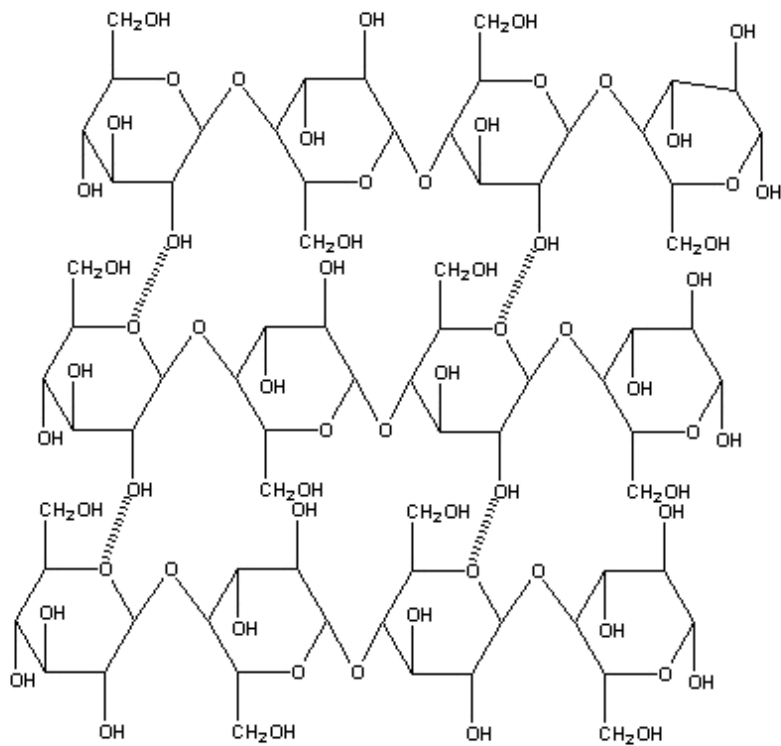
Plants:

1. *amylose* - glucose chain forms a helix.
2. *amylopectin* - glucose chain with short branches extending from main branch



3. *cellulose* - make up plant cell walls, coiled and layered glucose chains strengthened by Hydrogen bonding.

50% of all organic carbon in the biosphere is tied up as cellulose.



# **Lipids**

**Carbon Hydrogen**

**Non-soluble in water -> Why? Some are important parts of biological membranes and waterproof coverings storage of energy when glycogen stores are built up, excess carbohydrates are converted to fat.**

**Other functions:**

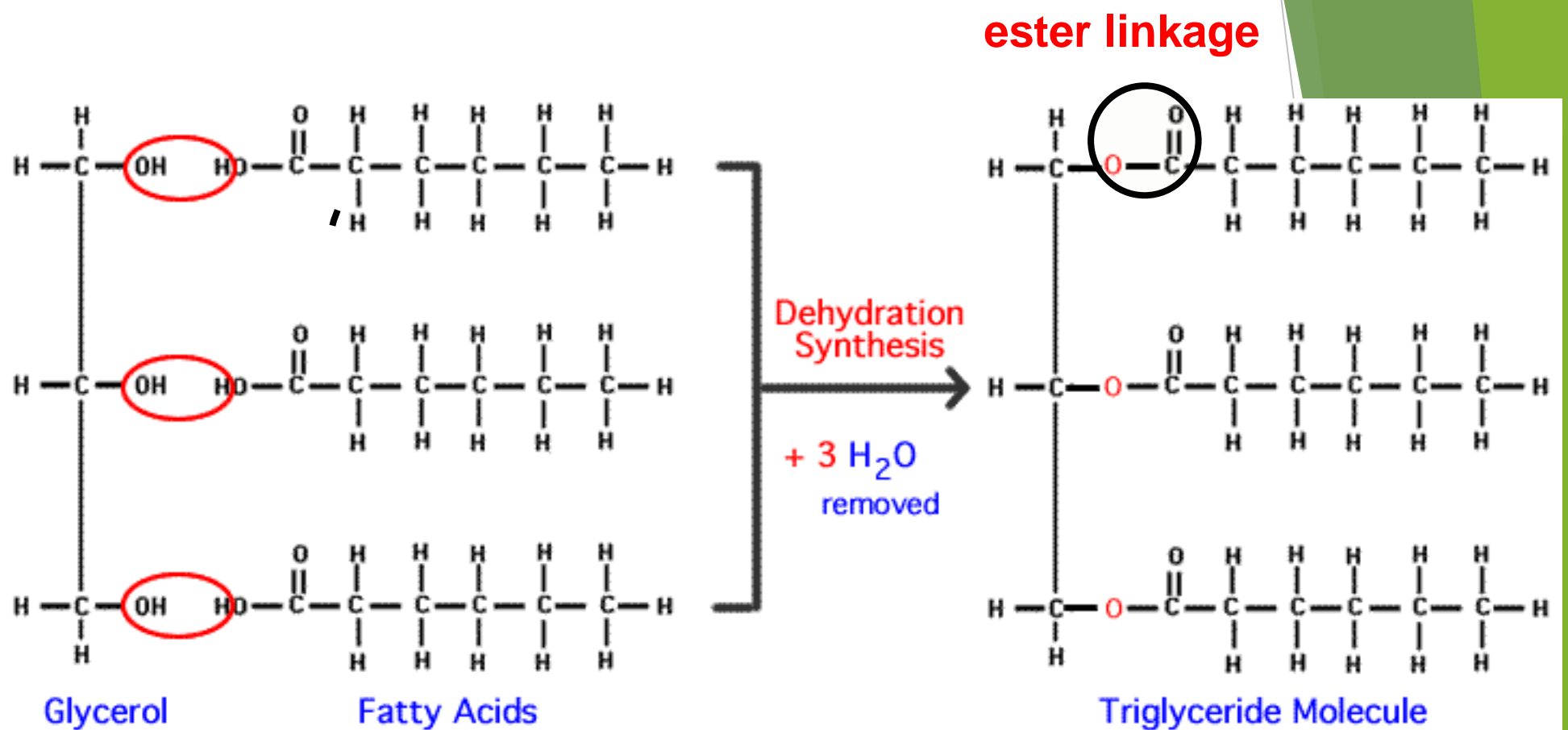
**cushions organs**

**carriers of vitamins A, D, E, K**

**raw material for hormones**



# 1. triglycerides



**fatty acids** - long carbon chain with an acid functional group

**saturated fatty acids** - C-C bonds are all single

**unsaturated fatty acids** - C-C bonds may be double or triple

# **FATS**

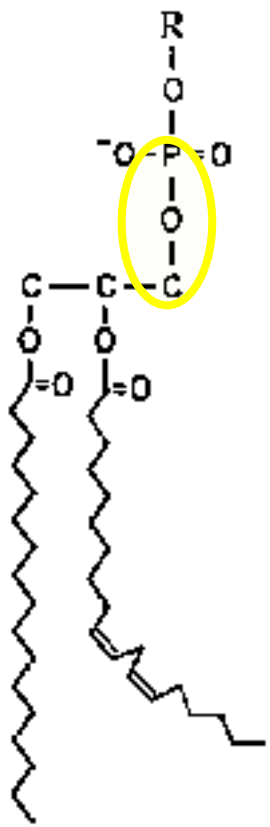
**solid at room temp  
saturated  
animal**

# **OILS**

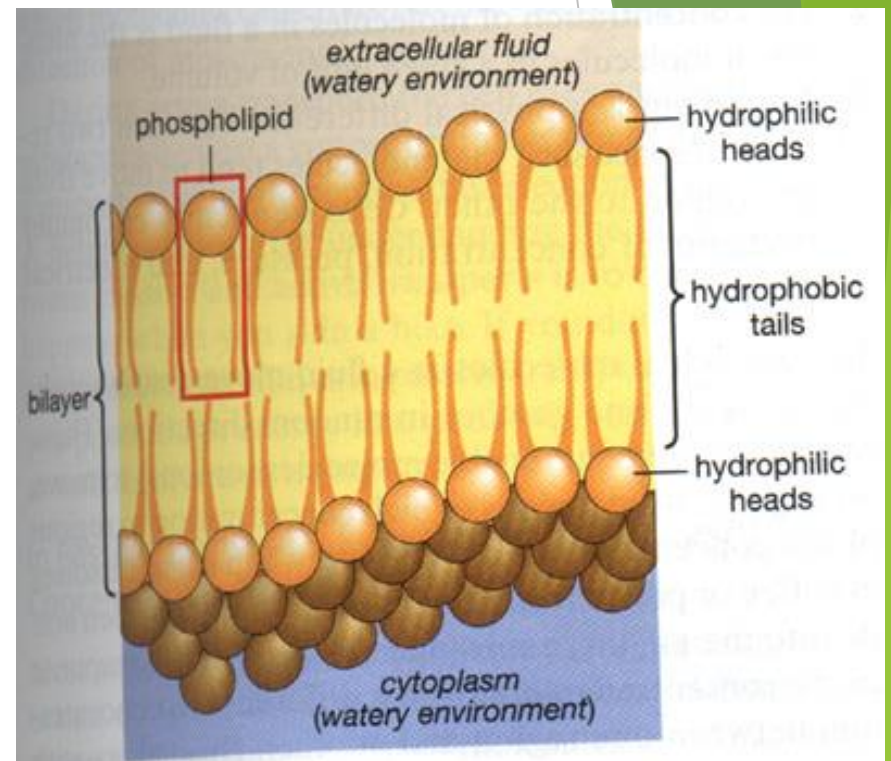
**liquid at room temp  
unsaturated (less stable)  
plants**

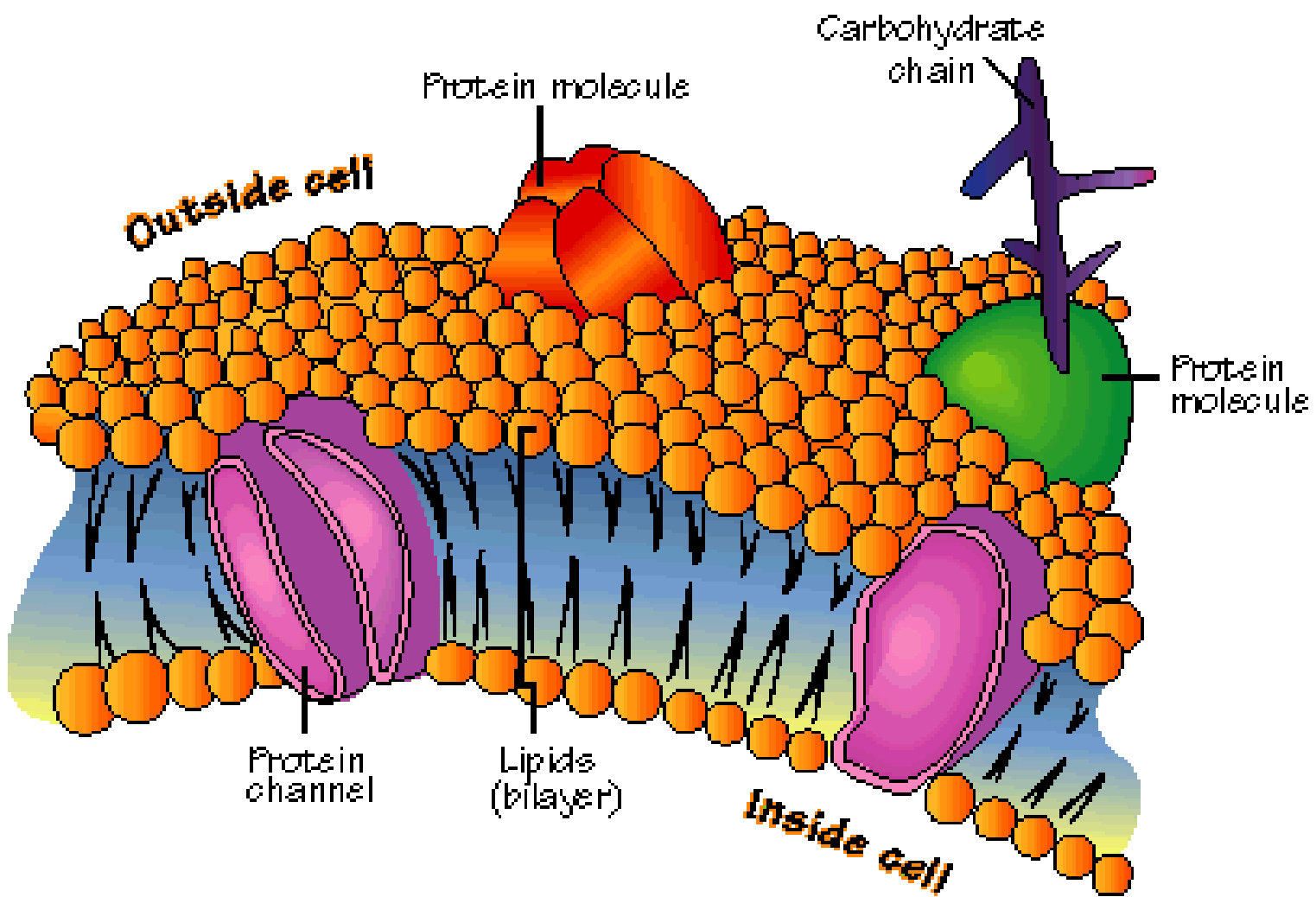
## 2. *phospholipids* (major component of cell membrane)

similar structure to triglyceride, but phosphate group with carbon chain replaces a fatty acid



phosphate-ester bond





## Endo/Exocytosis

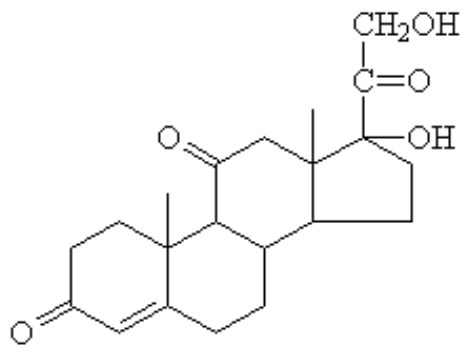
### 3. waxes

Insoluble

Long fatty acid chains join long alcohol chains or carbon rings.

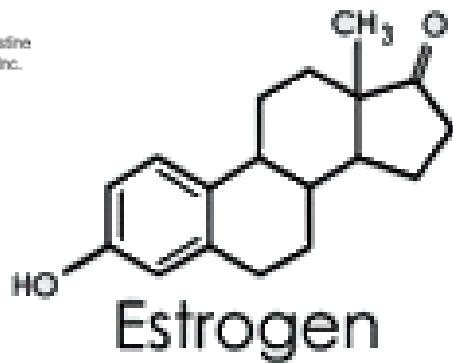
### 4. steroids/steroid hormones

4 or 5 carbon rings joined together

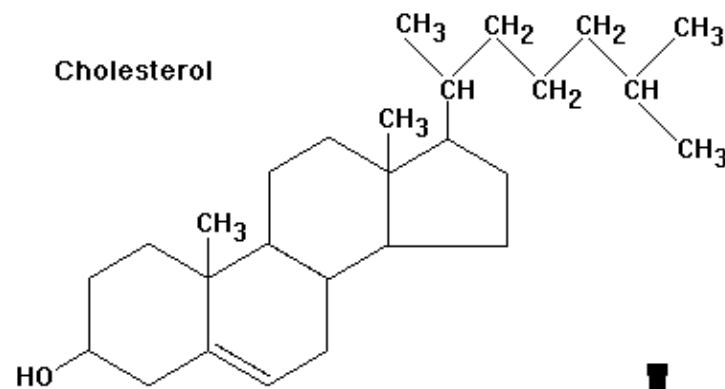


Cortisone

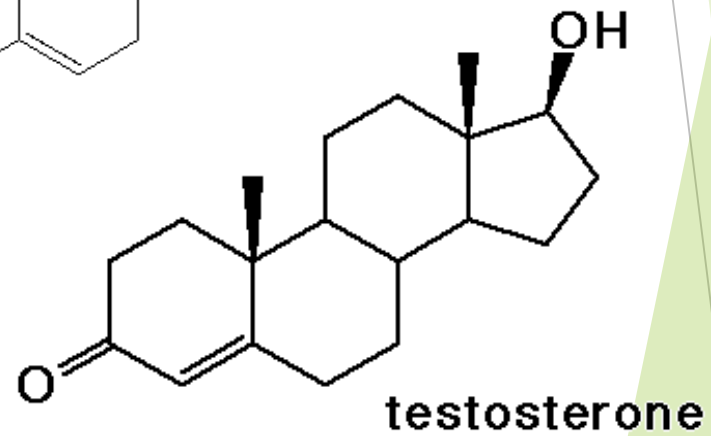
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Estrogen



Cholesterol



testosterone

# **Proteins**

## **Carbon Nitrogen Hydrogen Oxygen**

**Structural components of the cell**

**Build, repair, and maintain cell**

**Can supply energy, but that is not their main function**

**Specialized types:**

**enzymes - speed up chemical reactions**

**antibodies - immune response, defend against disease**

**Monomer: amino acids**

**Polymer: polypeptides**

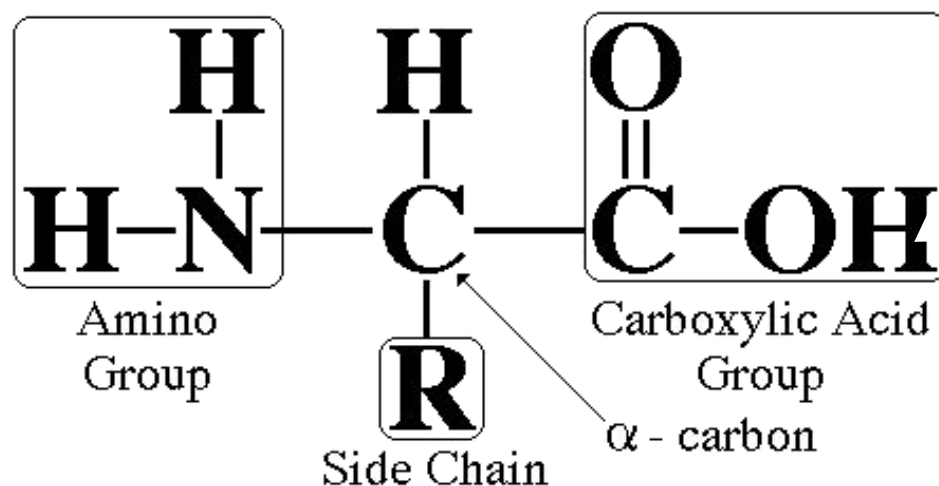
**There are 20 amino acids**

**8 are "essential" and cannot be synthesized by the body, and must be obtained by food sources.**

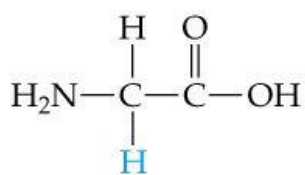
**Size of proteins vary from 8ish amino acids to 1000's.**

**\*\*\*\*the order and number of amino acids determines the type of proteins\*\*\*\***

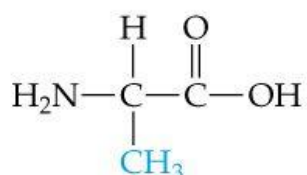
**\*\*\*the sequencing of amino acids is regulated by DNA\*\*\***



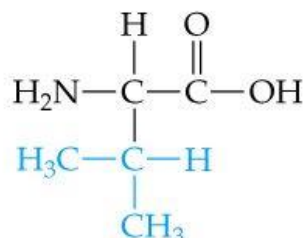
# Amino Acid Structures



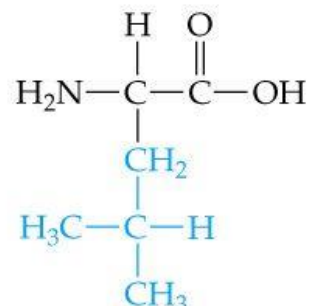
Glycine (Gly)



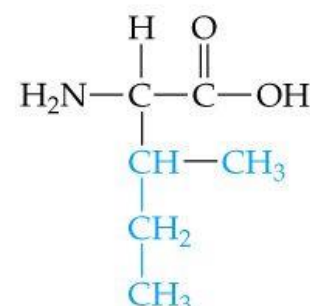
Alanine (Ala)



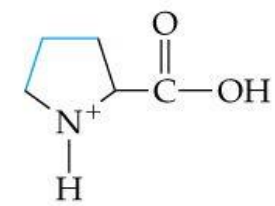
Valine (Val)



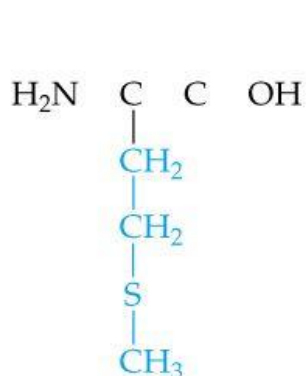
Leucine (Leu)



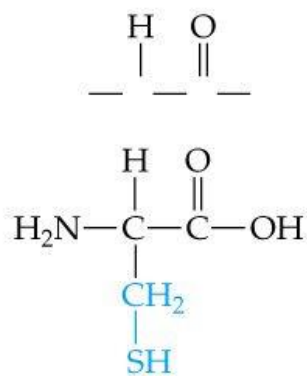
Isoleucine (Ile)



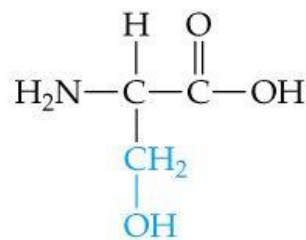
Proline (Pro)



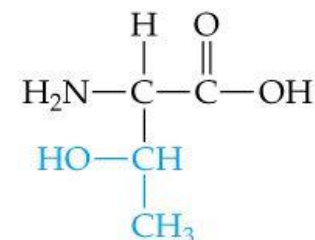
Methionine (Met)



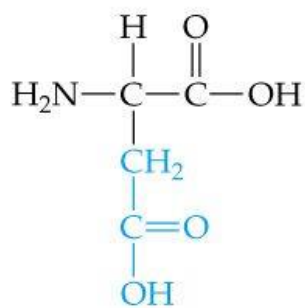
Cysteine (Cys)



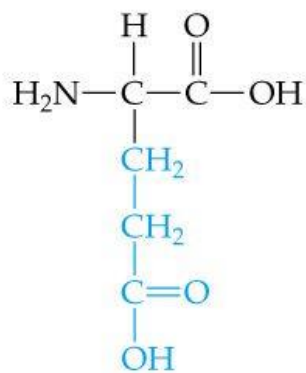
Serine (Ser)



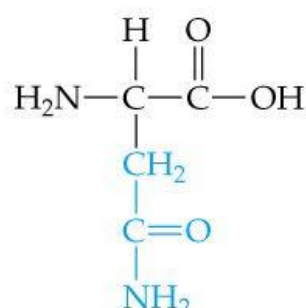
Threonine (Thr)



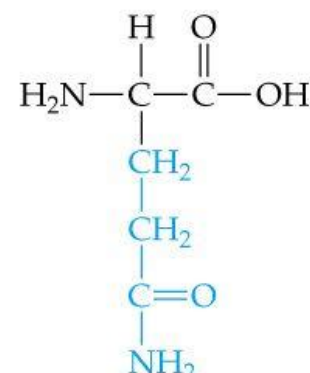
Aspartic acid (Asp)



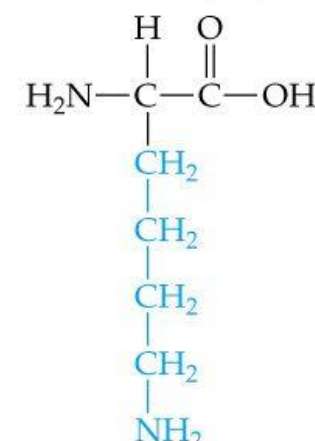
Glutamic acid (Glu)



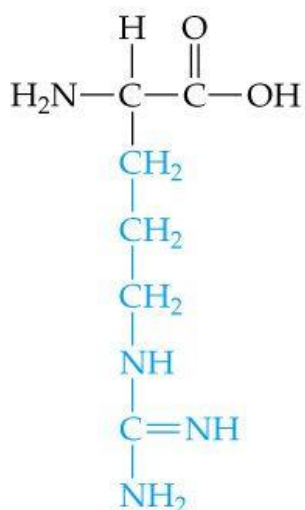
Asparagine (Asn)



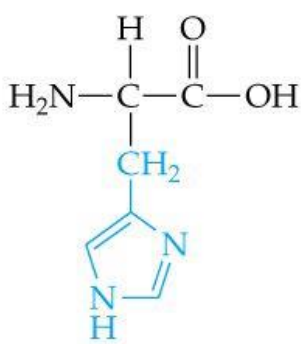
Glutamine (Glu)



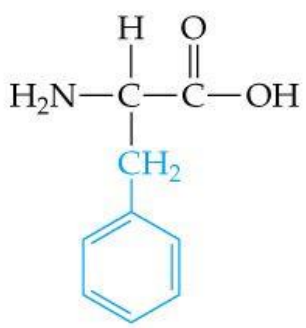
Lysine (Lys)



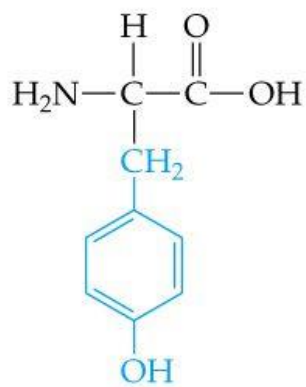
Arginine (Arg)



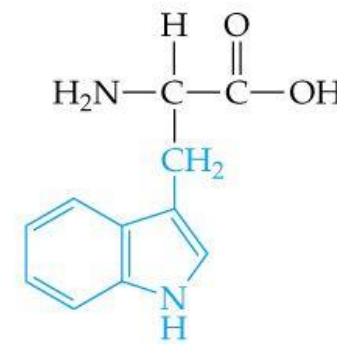
Histidine (His)



Phenylalanine (Phe)



Tyrosine (Tyr)



Tryptophan (Trp)



# BIODIVERSITY

**\*\*\*\*\*THE DIVERSITY AMONG LIVING ORGANISMS IS A RESULT OF AN INFINITE ARRAY OF PROTEINS\*\*\*\*\***

**CARBOHYDRATES AND LIPIDS VARY, BUT THEIR NUMBERS ARE LIMITED.**

**WHY?**



# Nucleic Acids

## Hydrogen Oxygen Nitrogen Carbon

Nucleotides + Nucleotides = Nucleic Acids

Monomers

Polymers

5 Part carbon sugar +  
Nitrogen Base +  
Phosphate group

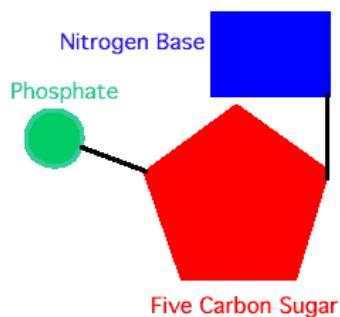
Nucleic Acids store and  
transmit heredity  
or genetic information.

Ex:

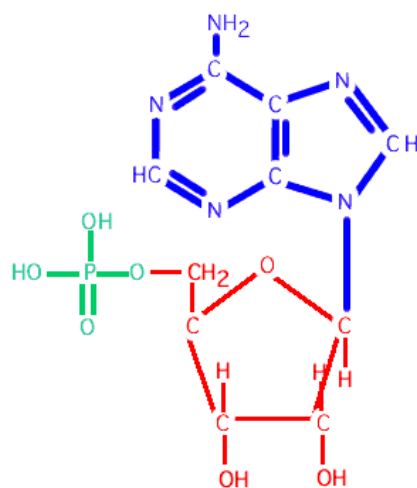
Ribonucleic Acid (RNA)

Deoxyribonucleic Acid (DNA)

Basic Nucleotide Structure



Example



Adenosine 5' phosphoric acid

## Stop! And Think...

1. The main example of a carbohydrate building block is \_\_\_\_\_.
2. A single sugar unit like fructose is a \_\_\_\_\_.
3. Three types of lipids are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
4. What type of lipid is found in the cell membrane?
5. How many bonds does carbon form?
6. What is the predominant bonding type in organic chemistry?
7. Really big molecules are called \_\_\_\_\_.
8. Why are unsaturated fats easier to break down than saturated fats?
9. Name 4 groups of organic compounds found in living things.
10. Which compound do you think is the most important to biology?
11. What would happen if lipids did not exist?
12. Why can proteins have such diverse roles? Name 3 of them.
13. If a compound consists of carbon, nitrogen, hydrogen, oxygen, and phosphorus, what kind of macromolecule is it? What is its function?
14. You've just discovered a new compound (yay). It's structure is  $C_{12}H_{24}O_{12}$ . What kind of macromolecule is it ?