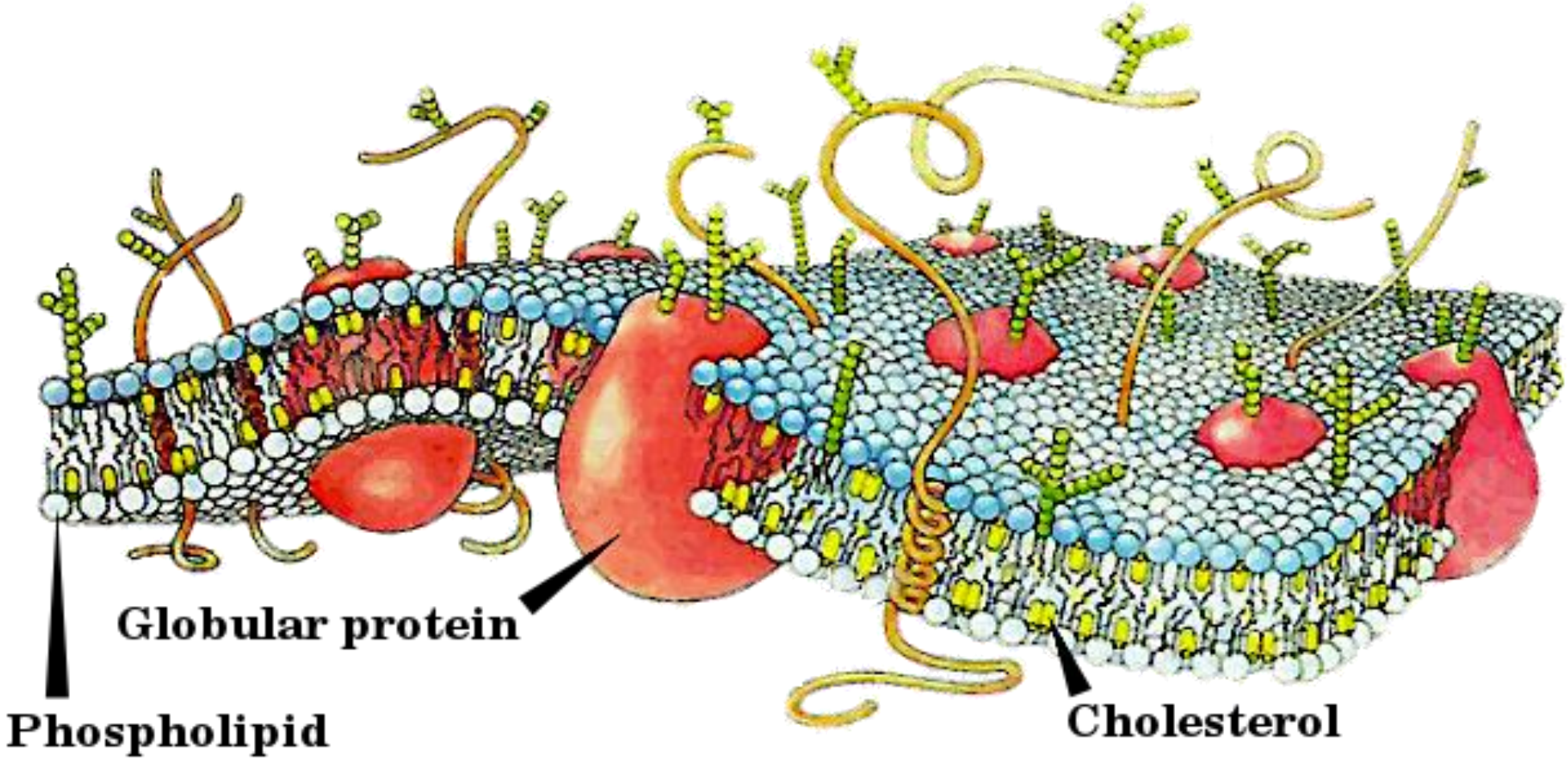
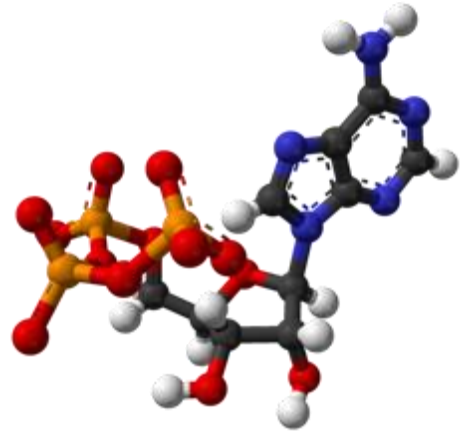
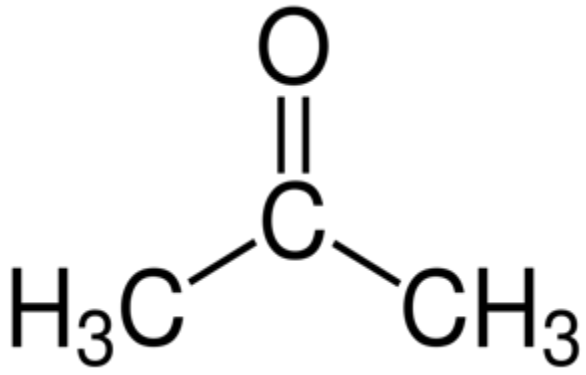
The Matter of Life



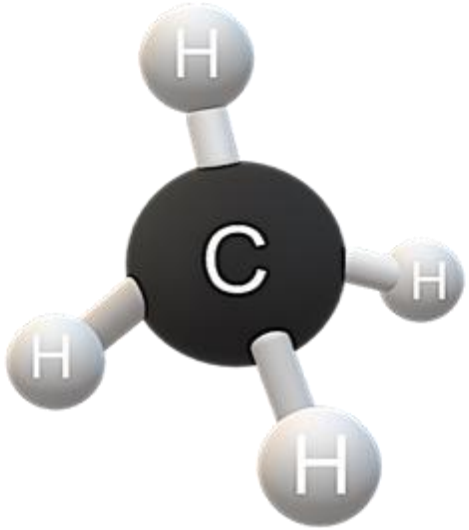
Organic Molecules

- Organic molecules make up nearly all matter in living and previously living things.
- The simplest organic molecule is methane. Methane is also the main ingredient in natural gas.
- Like methane, all organic molecules center on carbon.

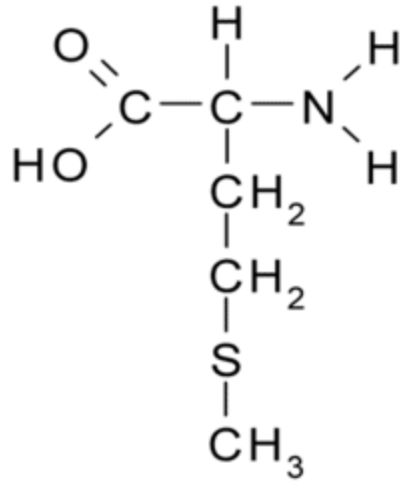


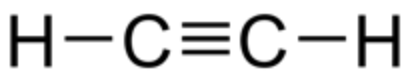


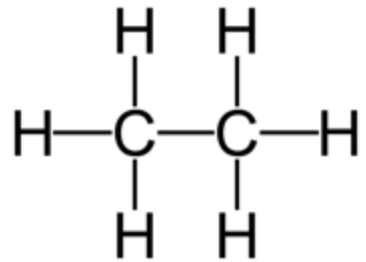
acetone

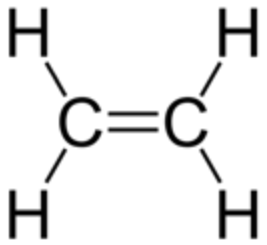


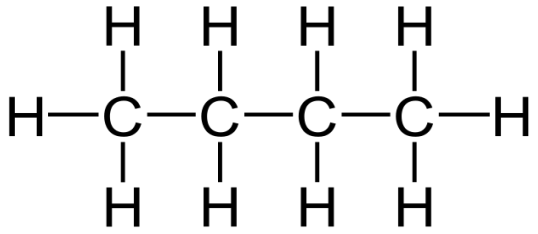
- Carbon is special in its ability to form complex structures in combination with other elements like **hydrogen, oxygen, nitrogen,** and **sulfur**.
- The simple examples below show just a fraction of what carbon can do in combination with just hydrogen.

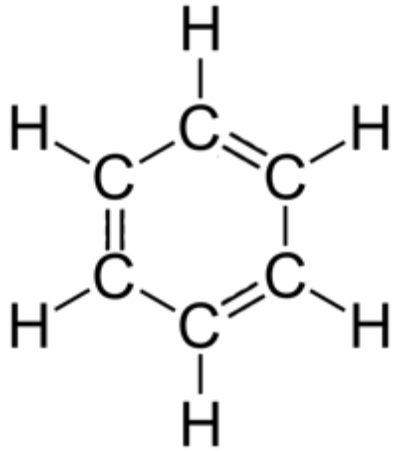


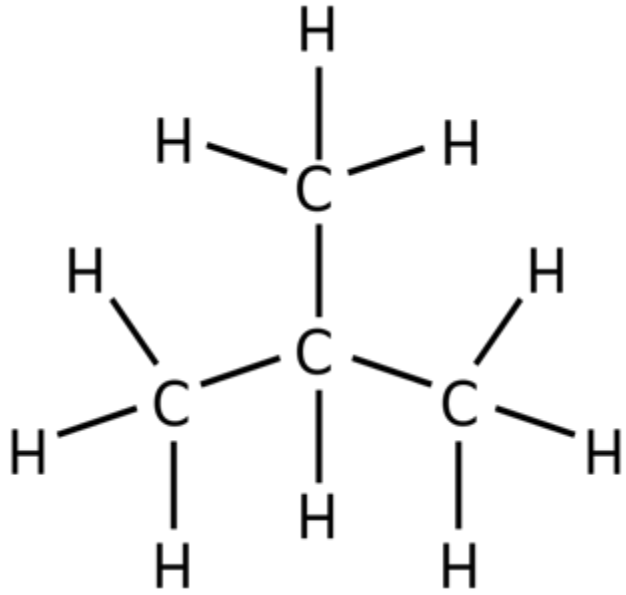




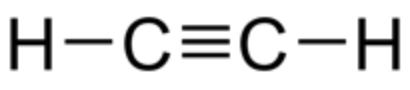


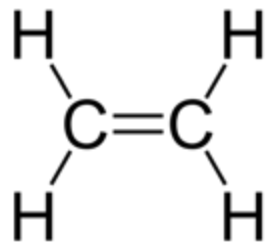


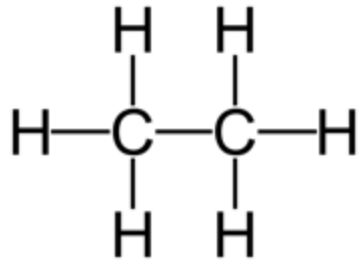


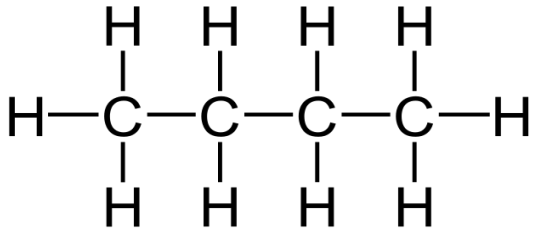


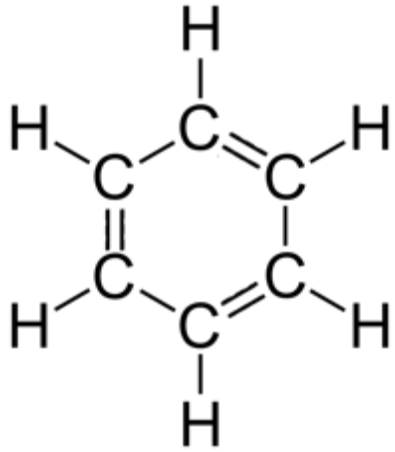
- Carbon is special in its ability to form complex structures in combination with other elements like **hydrogen, oxygen, nitrogen,** and **sulfur**.
- The simple examples below show just a fraction of what carbon can do in combination with just hydrogen.
- All of the **hydrocarbons** depicted below can be found in crude oil.

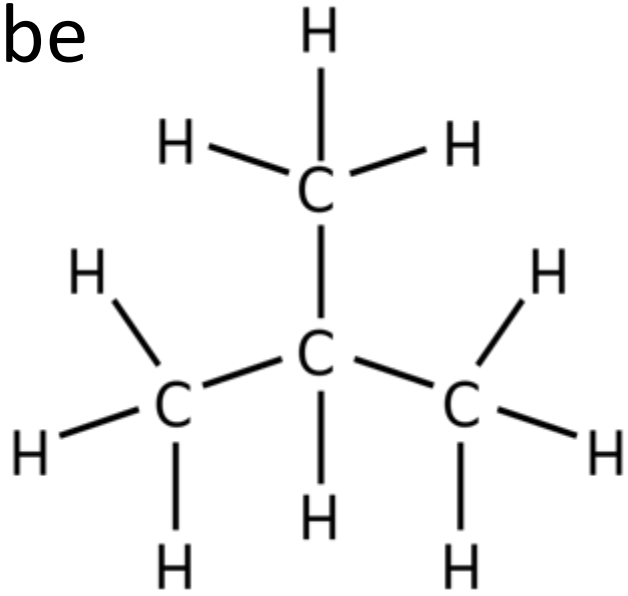








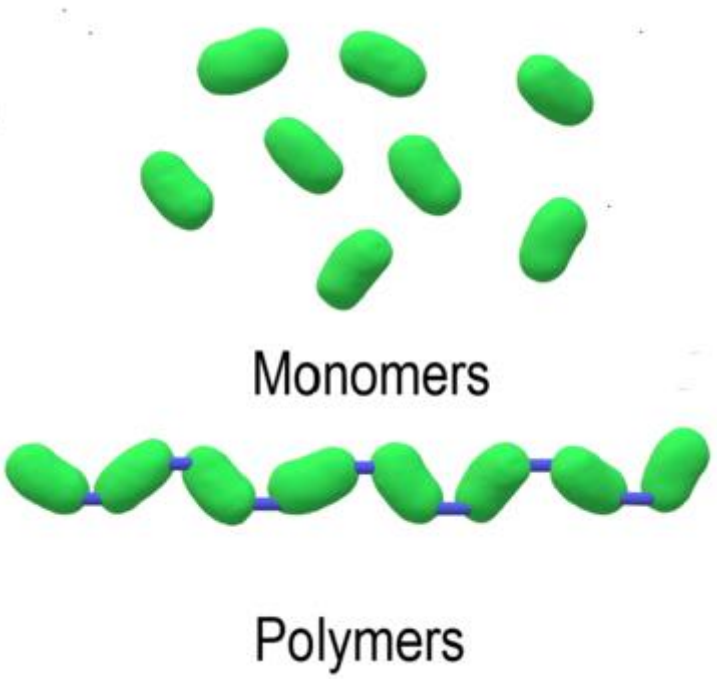




Macromolecules

- Some organic molecules form **polymer** chains from **monomer** building blocks. These include:
  - ✓**Carbohydrates**
  - ✓**Proteins**
  - ✓**Nucleic Acids**

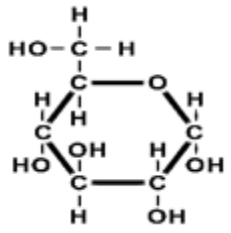
- **Lipids** are not polymers, but they do contain distinct building blocks.



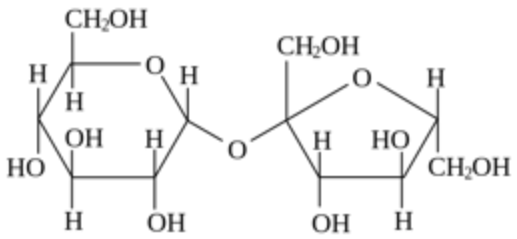
Carbohydrates range in size from simple sugars of 1-2 monomer units to polymers made up of long chains of repeating monomers.

- **Glucose** and **sucrose** are simple sugars that taste sweet. 
- **Starch** and **glycogen** are polymers made from glucose monomers. They are used to **store energy** in plants and animals respectively.
- **Cellulose** is also a polymer made of glucose monomers. It is used by plants for **structural support**. Unlike starch and glycogen, cellulose it is undigestible to most animals.

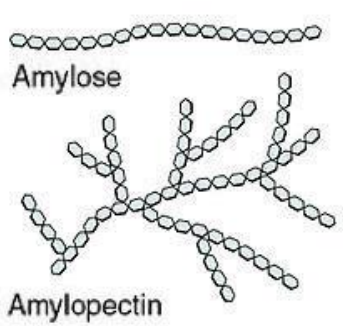
- **Chitin** is a polymer that provides support in the **exoskeletons** of insects & crustaceans.



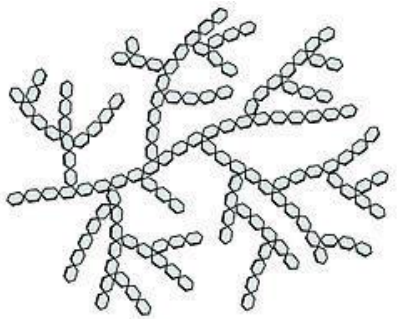
Glucose



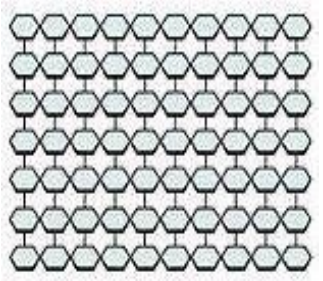
Sucrose



Starch

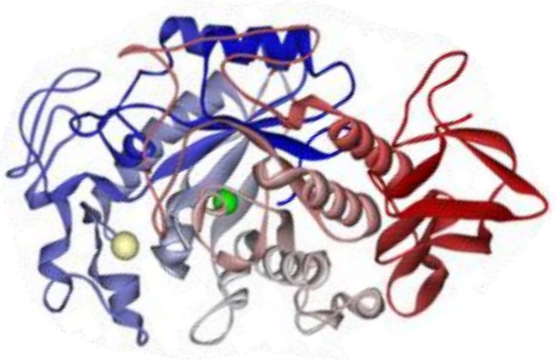


Glycogen

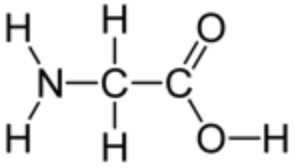


Cellulose (fiber)

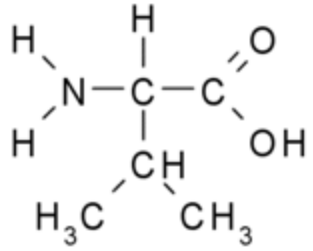
- **Proteins** are enormously diverse polymers that fold into complex 3-dimensional shapes.
- The building blocks of proteins are **amino acids**. Since there are 20 naturally occurring amino acids the possible combinations are infinite.
- Proteins play many roles. Here are just a few:
  - ✓movement
  - ✓gas exchange
  - ✓hormones
  - ✓**enzymes***



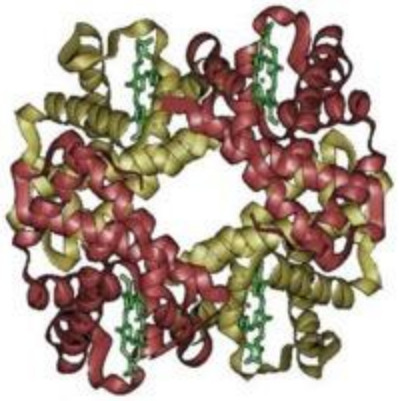
Amylase: the enzyme that breaks down starch



Glycine

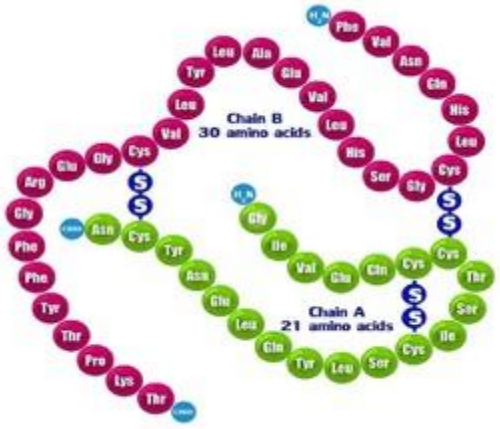


Valine

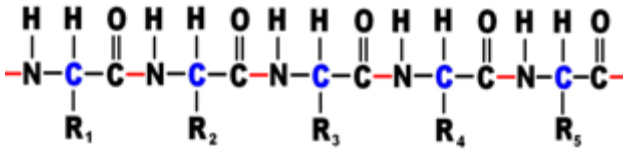


Hemoglobin

Myosin + Actin



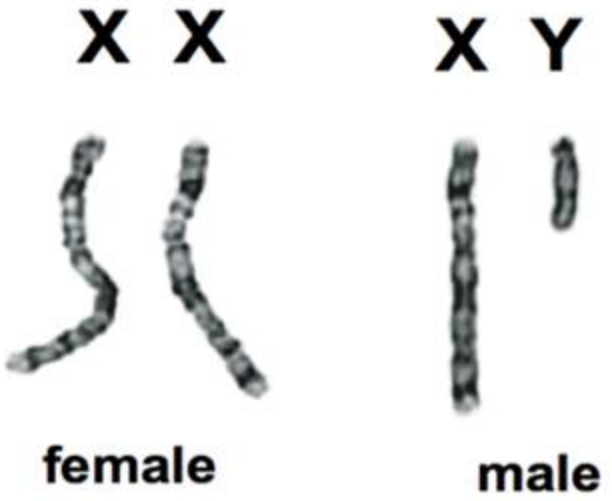
Insulin

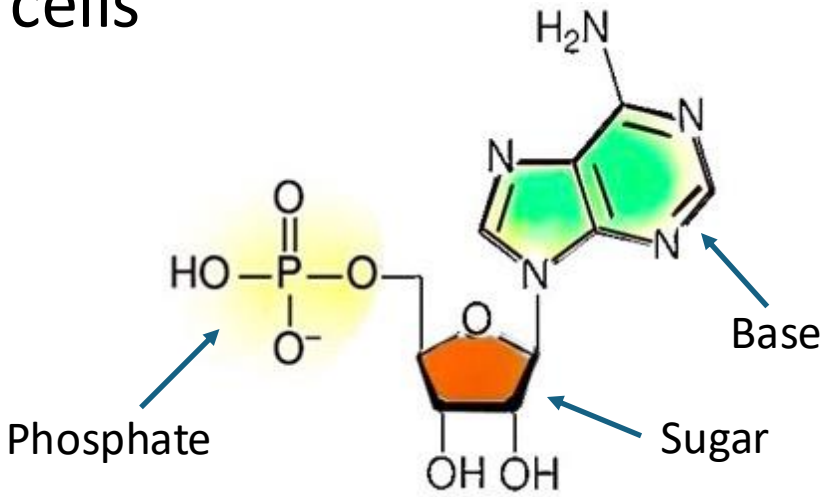


Amino Acid Chain

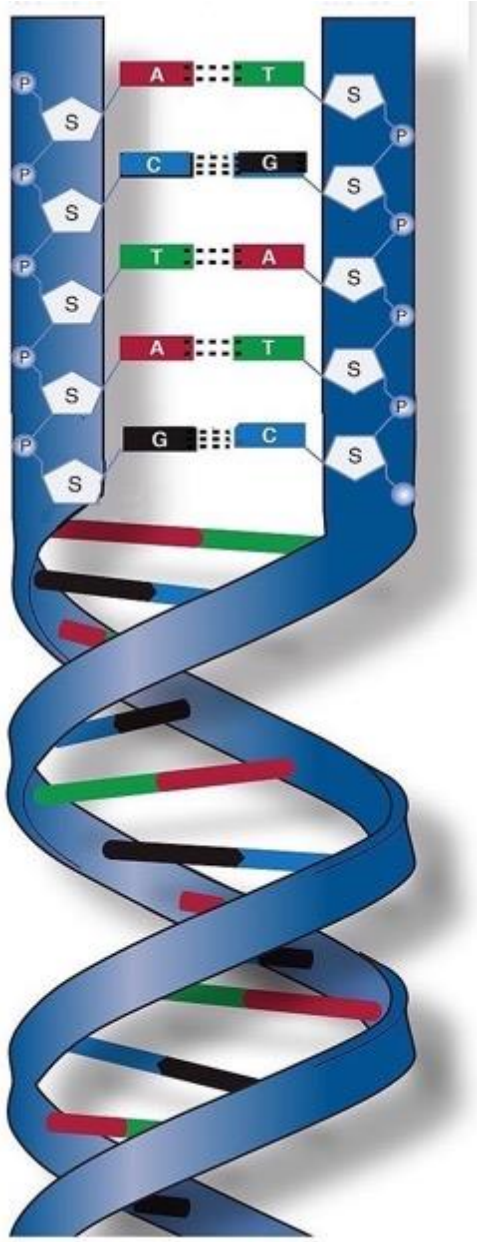
*Without enzymes, nearly all the chemical reactions of life would grind to a halt!

- **Nucleic Acids** are extremely long polymers made from 4 different **nucleotide monomers**. The polymer forms a "double helix" due to complimentary pairing of the bases in the nucleotides.
- The ordering of the bases in **DNA** (A,C,G, & T) determines your genetic make-up.
- DNA is found in the **chromosomes**. Chromosomes are found in the nuclei of living cells





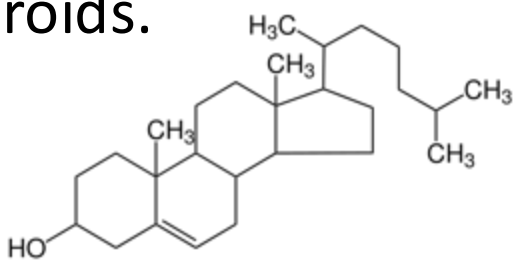
Nucleotide Monomer



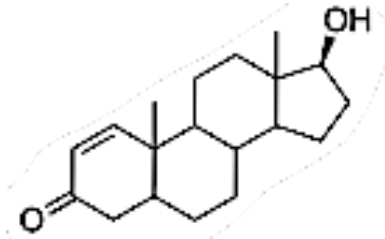
DNA Base Paring

Lipids are made up largely of hydrocarbons. This limits their solubility in water. There are three categories of lipids:

- **Fats and oils** have 3 fatty acids. Their role is **energy storage**, **cushioning**, and **insulation**.
- **Phospholipid**s have just 2 fatty acids. The portion of the molecule containing phosphate is water-soluble. Phospholipid bilayers make up a major component of **cell membranes**.
- **Steroids** consist mainly of 4 interlocking hydrocarbon rings. Cholesterol stabilizes cell membranes and many sex **hormones** are steroids.

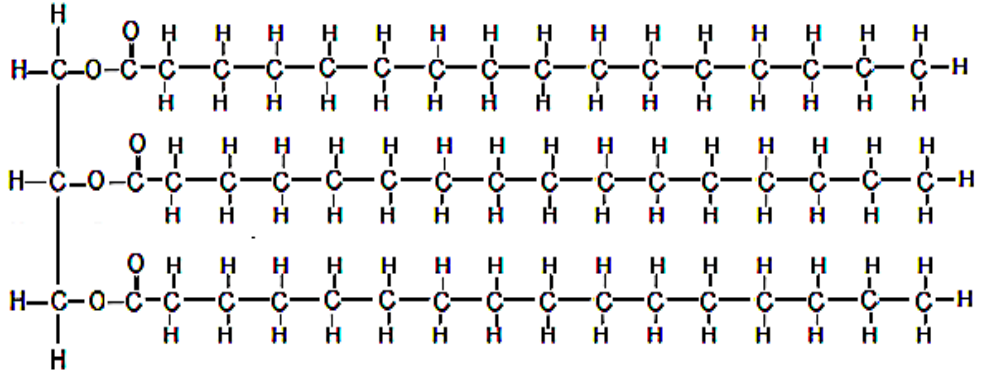


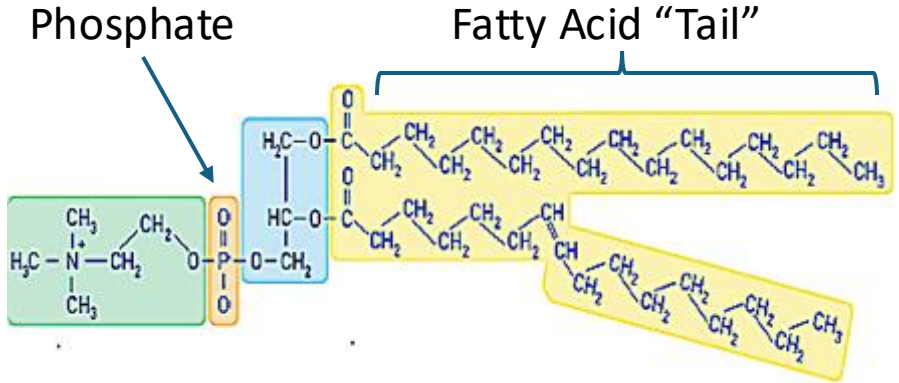
Cholesterol

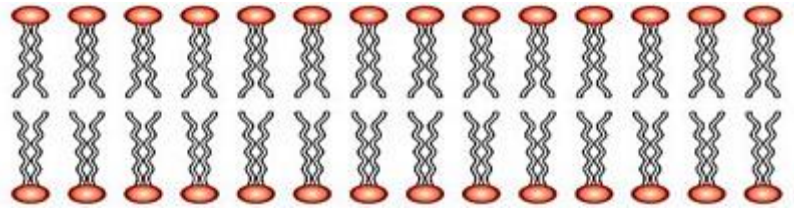


Testosterone

Fat molecule







Phospholipid bilayer with tails facing each other to avoid the water inside and outside the cell.

This is all you need to know about macromolecules. You will not be tested on molecule images.

Macromolecule	Subcategory	Building Blocks	Examples	Functions
Carbohydrates	Simple Sugars	N/A	Glucose, Sucrose	Energy
	Polysaccharides	Monosaccharides (usually glucose)	Starch	Energy
			Cellulose	Structure (plants)
			Chitin	Structure (animals)
Proteins	N/A	Amino Acids	Enzymes, many others…	Catalysts, many other functions…
Nucleic Acids	N/A	Nucleotides	DNA	Genes
Lipids	Fats and Dietary Oils	Mostly Hydrocarbons	Butter, Olive Oil, many others…	Energy, Cushioning, Insulation
	Phospholipids	Mostly Hydrocarbons	N/A	Cell Membranes
	Steroids	Mostly Hydrocarbons	Cholesterol, Sex Hormones	Cell Membranes, Gender Traits

Review Questions

1. What element do all organic molecules have in common?
2. Organic molecules are usually much (larger/smaller) and (more/less) complex than inorganic molecules.
3. What are the four basic categories of macromolecules?

Review Questions

1. What element do all organic molecules have in common? **carbon**
2. Organic molecules are usually much (**larger**/smaller) and (**more**/less) complex than inorganic molecules.
3. What are the four basic categories of macromolecules?

   carbohydrates, lipids, proteins,

   nucleic acids

Review Questions

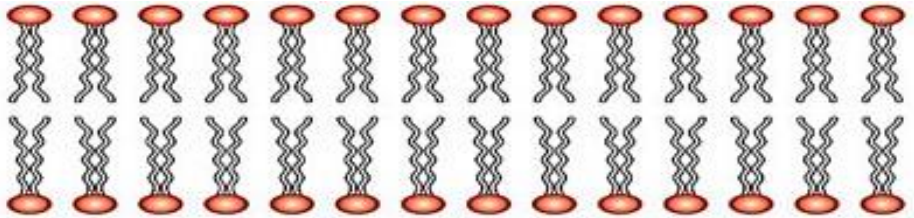
1. What are the main functions of carbohydrates?
2. What are the main functions of lipids?
3. What are the main functions of proteins?
4. What are the main functions of nucleic acids?

Review Questions

1. What are the main functions of carbohydrates? **energy, structure**
2. What are the main functions of lipids? **energy, cushioning, hormones, cell membranes**
3. What are the main functions of proteins? **enzymes, almost everything!**
4. What are the main functions of nucleic acids? **genes**

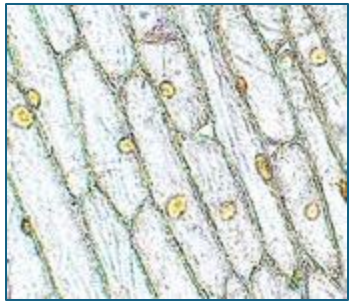
The Organization of Life

- **Cells are the smallest unit of life**. All living organisms are made up of cells and nearly all organisms visible to the naked eye are composed of millions of specialized cells that are organized into distinct tissues like the leaves, roots, skin, and nerves.
- All cells have a **cell membrane** consisting mostly of **phospholipids**. The interior of each cell contains structures that allow it to carry out basic processes of life like the processing of nutrients, removal of wastes, and replication. Most of the **DNA** is inside the **chromosomes**.
- **Some living organisms** like paramecia and bacteria **consist of only one cell**.



Phospholipid bilayer with tails facing each other to avoid the water inside and outside the cell.

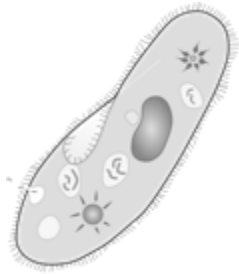
Moss Leaf Cells



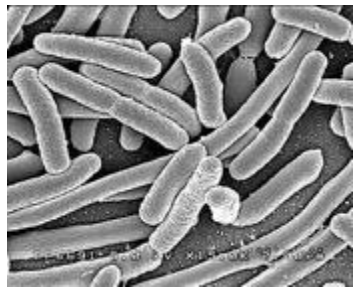
Onion Root Cells

Cheek Cells

Nerve Cell

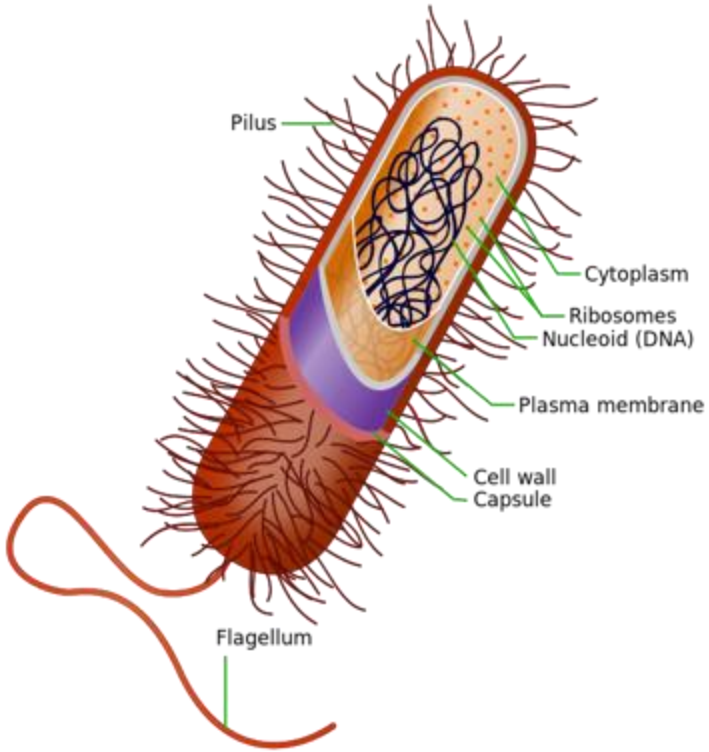


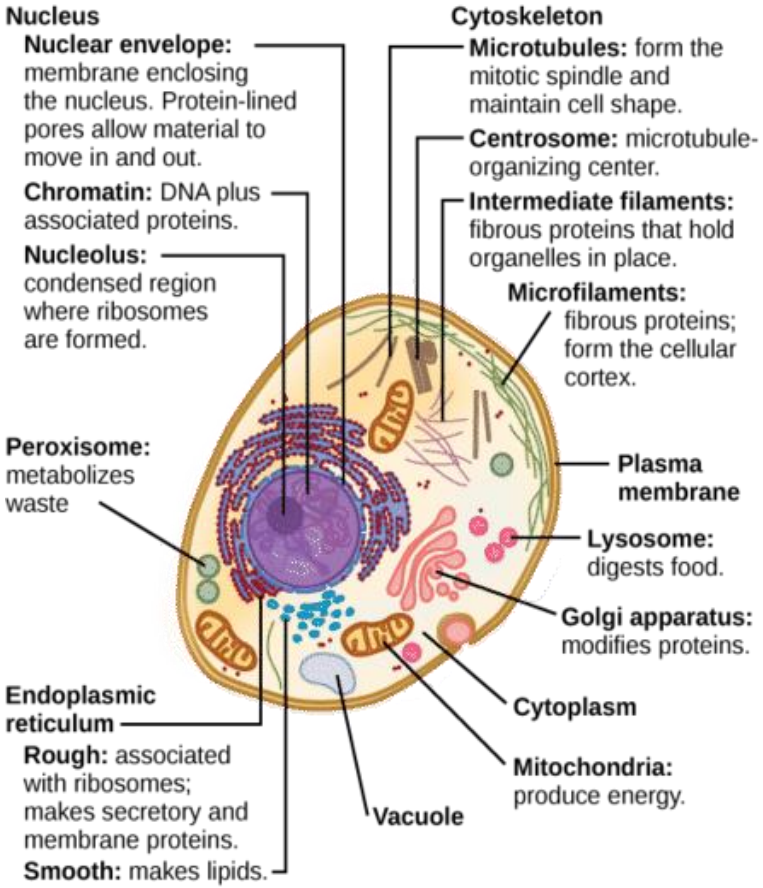
Paramecium

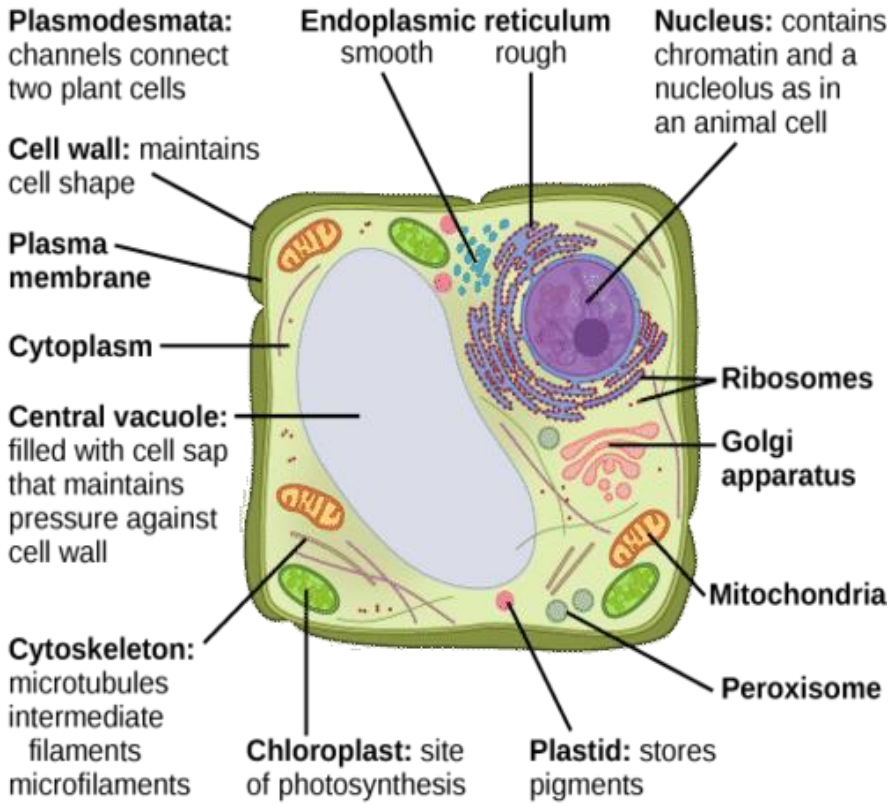


Coliform Bacteria

- **Prokaryotic cells** consist of very simple cells that **lack a nucleus**. Most prokaryotes are **bacteria**.
- **Eukaryote cells** are **larger, more complex, and have a nucleus**. Plants, animals, fungi, and many single-celled organisms are eukaryotes. Plant cells have **cell wall** that is made of **cellulose**.







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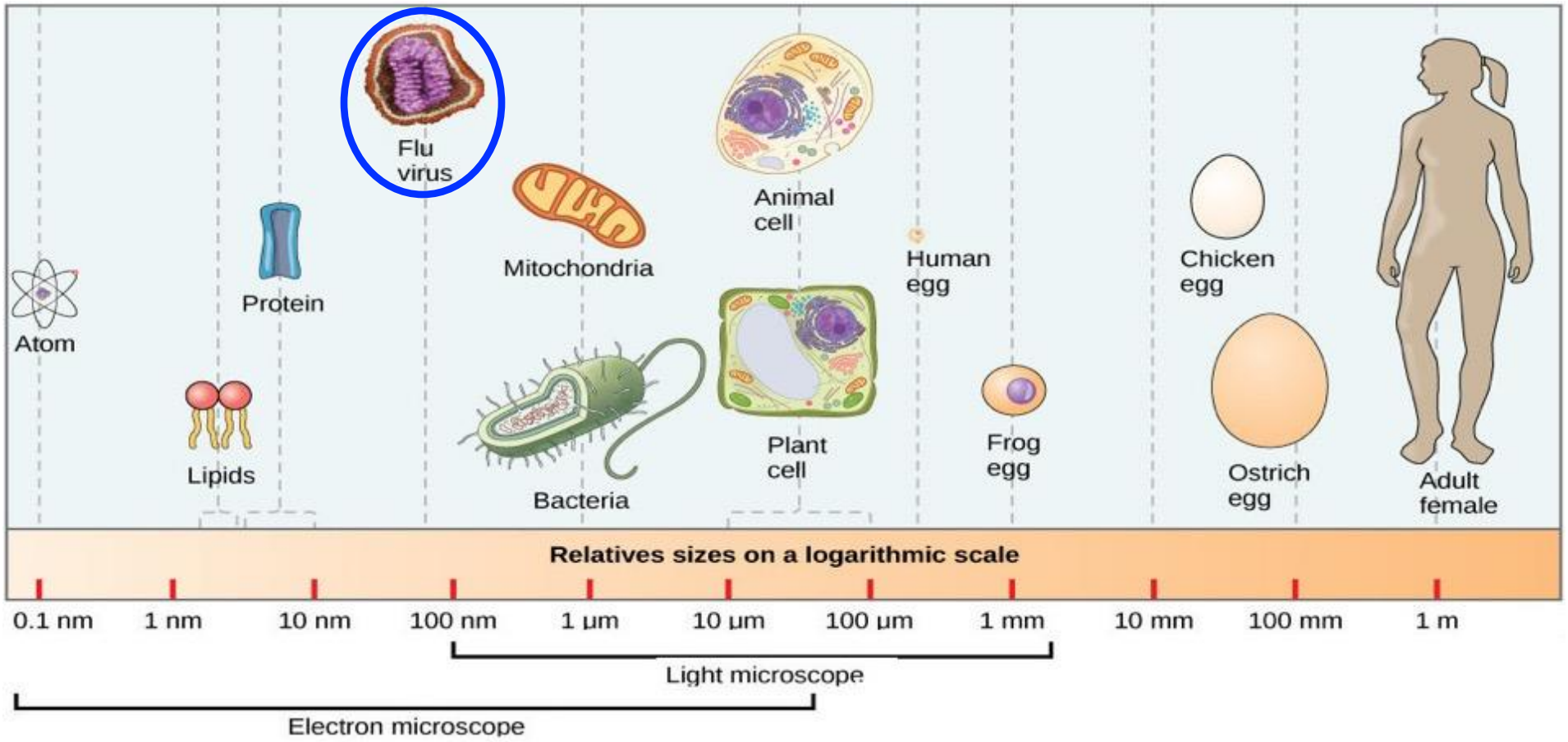
- Most cells can only be seen with the help of a microscope.
- Most **viruses** are so small that they can only be seen with an electron microscope. Viruses can reproduce, but since they are not cells, they are not considered to be "alive." This why viruses are defined as "**infectious particles**."



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