Elements & Macromolecules in Organisms

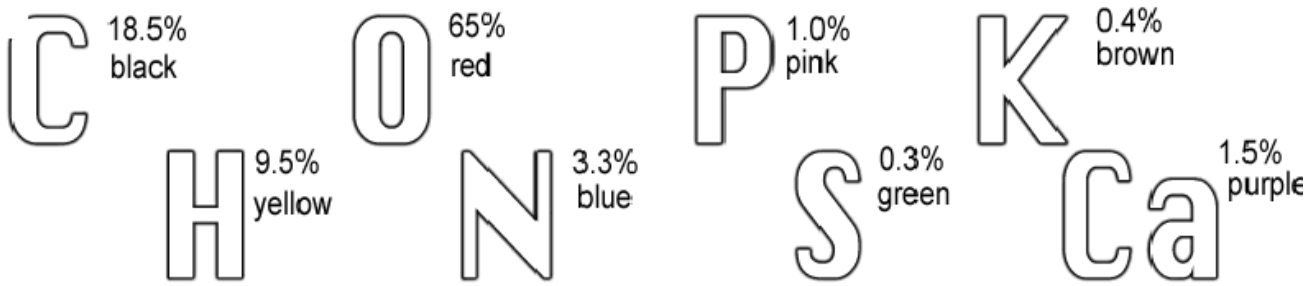
Most common elements in living things are **carbon, hydrogen, nitrogen, and oxygen**. These four elements constitute about **95% of your body weight**. All compounds can be classified in two broad categories --- **organic and inorganic compounds**. Organic compounds are made primarily of **carbon**. Carbon has **four outer electrons** and can form four bonds. Carbon can form **single** bonds with another atom and also bond to other carbon molecules forming **double, triple, or quadruple bonds**. Organic compounds also contain **hydrogen**. Since hydrogen has only one electron, it can form only **single bonds**.

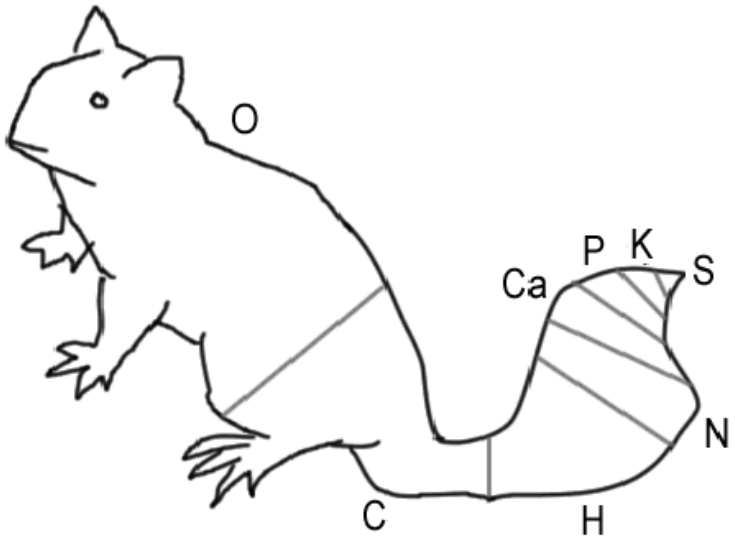
Each small organic molecule can be a unit of a large organic molecule called a **macromolecule**. There are **four classes of macromolecules** (polysaccharides or **carbohydrates**, triglycerides or **lipids**, polypeptides or **proteins**, and **nucleic acids** such as DNA & RNA). **Carbohydrates and lipids** are made of only carbon, hydrogen, and oxygen **(CHO)**. **Proteins** are made of carbon, hydrogen, oxygen, and nitrogen **(CHON)**. **Nucleic acids** such as DNA and RNA contain carbon, hydrogen, oxygen, nitrogen, and phosphorus **(CHON P)**.

Use the drawing of the **amino acid on this worksheet** (look ahead to another page for this sketch and remember that the NUMBER OF LINES from a single atom is their NUMBER OF BONDS) to determine the number of bonds formed by:

_____ Oxygen _____Hydrogen _____ Nitrogen

The body also needs trace amounts of other elements such as calcium, potassium, and sulfur for proper functioning of muscles, nerves, etc. ***Color*** each of the **elements on the next page** according to the color listed next to the element's symbol. Then ***Color code*** the **squirrel** with the correct proportion of each element's color. Now ***color code*** the carrot with the same colors as you used on the squirrel.





Questions:

1. Name the 4 main elements that make up 95% of an organism.

Carbon, hydrogen, oxygen, and nitrogen

2. Name the 4 types of bonds carbon can form.

Single, double, triple, and quadruple

3. What are macromolecules?

Large organic molecules

4. Name the 4 classes of macromolecules. Carbohydrates, lipids, proteins, and nucleic acids

5. Give 2 examples of nucleic acids. DNA and RNA

6. What elements make up carbohydrates & lipids (symbols)? CHO

7. Name 3 elements your body needs trace amounts of for proper functioning. Calcium, sulfur, potassium

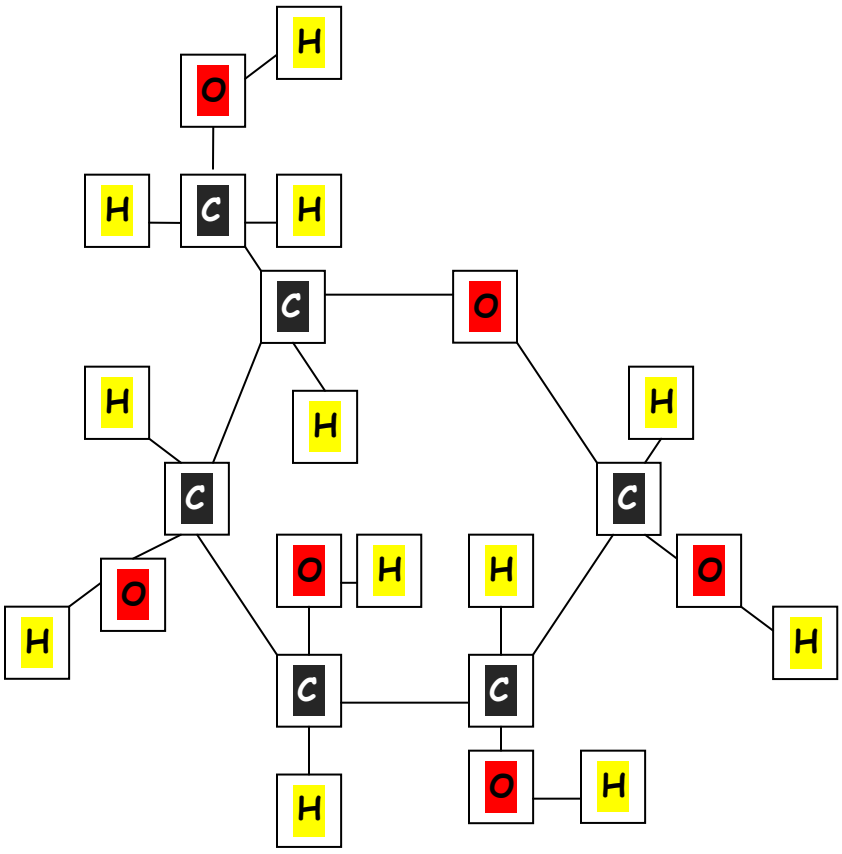
The **four main classes of organic compounds** (carbohydrates, lipids, proteins, and nucleic acids) that are essential to the proper functioning of all living things are known as **polymers or macromolecules**. All of these compounds are built primarily of **carbon, hydrogen, and oxygen** but in different ratios. This gives each compound different **properties**.

Carbohydrates are used by the body for **energy** and **structural support** in cell walls of plants and exoskeletons of insects and crustaceans. They are made of smaller subunits called **monosaccharides**. Monosaccharides have carbon, hydrogen, and oxygen in a **1:2:1 ratio**. Monosaccharides or **simple sugars** include **glucose, galactose, and fructose**. Although their chemical formulas are the same, they have **different structural formulas**. These simple sugars combine to make **disaccharides** (double sugars like sucrose) and **polysaccharides** (long chains like cellulose, chitin, and glycogen). ***Color code*** the glucose molecule on this worksheet (carbon-black, hydrogen-yellow, and oxygen-red). Use your **textbook** to help ***draw*** the structural formulas for glucose: (p60)

Use the diagram of glucose to tell how many carbons, hydrogens, and oxygens are in a single molecule.

#C __6_____ # H __12_____ # O ____6____

Glucose Molecule



Questions:

8. Macromolecules are also known as __polymers_____.

9. If all the macromolecules are made mainly of the elements **CHO**, how are they different?

The ratios of the atoms are different

10. Name 2 ways your body uses carbohydrates. Short-term energy, structural support

11. What are the subunits called that make up carbohydrates? monosaccharides

12. What is the ratio of C, H, and O in monosaccharides? 1:2:1

13. Name 3 monosaccharides. Glucose, galactose, fructose

14. Monosaccharides are ___simple_____ sugars.

15. What are disaccharides & give an example? 2 monosaccharides hooked together, sucrose is an example

16. Long chains of sugars are __polysaccharides_____. Name three.

Cellulose, chitin, glycogen

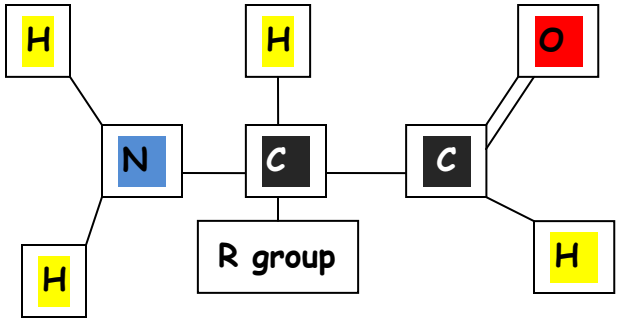
Proteins are made of subunits called **amino acids** and are used to build cells and do much of the work inside organisms. They also act as **enzymes** helping to control metabolic reactions in organisms. Amino acids contain two **functional groups**, the **carboxyl group (-COOH)** and the **amino group ($-NH_2$)**.

Use your textbook and sketch the **amino** and **carboxyl** groups. (p62)

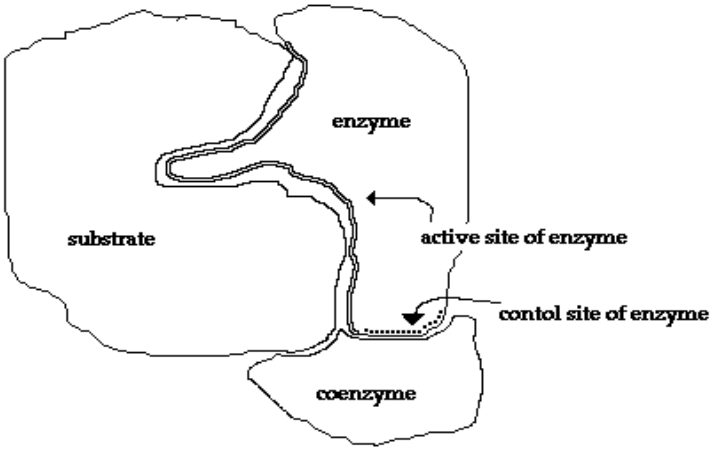
Amino group Carboxyl group

Color code the amino acid on this worksheet (carbon-black, hydrogen-yellow, nitrogen-blue, and oxygen-red).

Basic Structure of Amino acid



Enzymes are protein molecules that act as **biological catalysts**. Cells contain **thousands** of different enzymes to control the functions of the cell. Enzymes must physically fit a specific **substrate(s)** to work properly. The place where a substrate fits an enzyme to be catalyzed is called the **active site**. **Excess heat, a change in pH from neutral**, etc. change the shape of enzymes and their active sites so the enzyme is unable to work. Some enzymes have a second site where a coenzyme attaches to help make the substrate better fit the active site of the enzyme. ***Color*** the enzyme purple, the substrate yellow, and the coenzyme green. Also ***color*** the active site red.



Enzyme-Substrate Complex

Condensation (removal of a water molecule) links amino acids link together to form chains called **polypeptides**. Polypeptide chains join to form proteins. The bonds holding amino acids to each other are known as **peptide bonds**.

Questions:

17. What subunits make up proteins? Amino acids

18. Proteins also act as _enzymes_____ in cells to control reactions.

19. Name the 2 functional groups in amino acids. Carboxyl and amino

20. Cells have _thousands__of enzymes to act as biological __catalysts_____.

21. Enzymes have an attachment site called the __active _____ site for the __substrate_____ to join.

22. What is the effect of excess heat or temperature on an enzyme?

Changes the shape of the active site

23. Amino acids are linked together to make proteins by removing a molecule of _water___ in a process called __condensation_____.

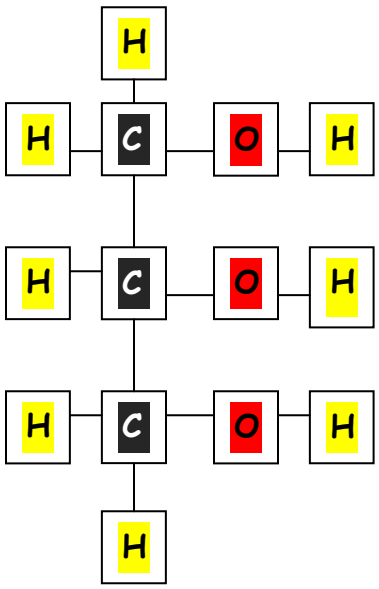
24. Chains of amino acids make _polypeptides___ which can join together to make a __protein_____.

25. __Peptide_____ bonds form when water is removed to hold __amino_____ acids together.

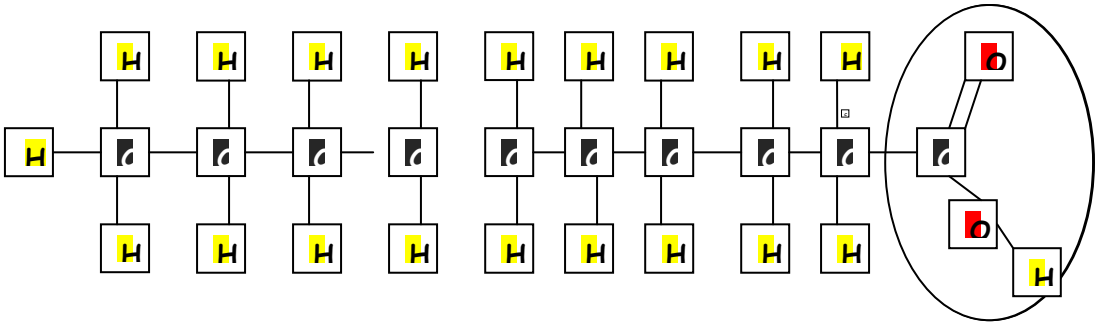
Lipids are large, **nonpola**r (won't dissolve in water) molecules. **Phospholipids** make up cell membranes. Lipids also serve as waxy coverings **(cuticle)** on plants, **pigments** (chlorophyll), and **steroids**. Lipids have **more carbon and hydrogen atoms** than oxygen atoms. Fats are made of a **glycerol** (alcohol) and **three fatty acid chains**.

This subunit is called a **triglyceride**. ***Color*** the glycerol molecule using the same colors for carbon, hydrogen, and oxygen as you did before. The fatty acid chains may be **saturated** (only single bonds between carbons) or **unsaturated** (contain at least one double bond). A **carboxyl functional group** (-COOH) is found on the end of the fatty acid that does NOT attach to glycerol. ***CIRCLE AND LABEL*** the carboxyl groups in the 2 fatty acids on this worksheet. ***Color*** the fatty acid chains the same colors for carbon, hydrogen, and oxygen as you did before. A special type of lipid called phospholipids help make up the cell membrane. Two layers of these phospholipids make up the membrane. Phospholipids have a "water-loving" hydrophilic head and two "water-fearing" hydrophobic tails. ***Find*** the cell membrane on this sheet and ***CIRCLE AND LABEL*** a phospholipid. Proteins are also embedded in the cell membrane. ***Color*** the two proteins in the cell membrane **blue**.

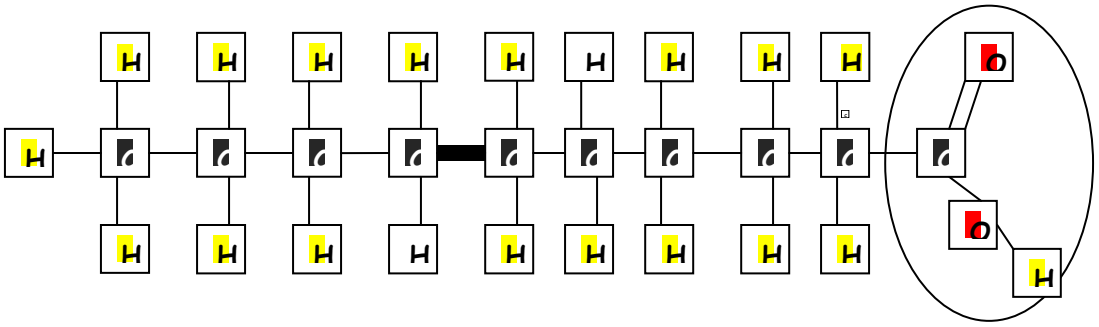
Glycerol



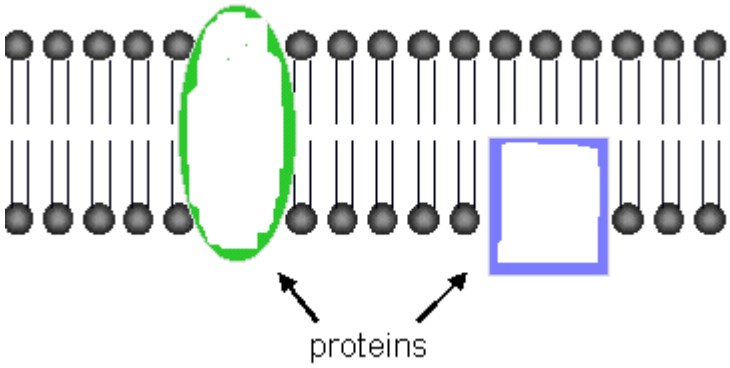
Saturated fatty Acid



Unsaturated Fatty Acid - Double Bond



Cell Membrane



Questions:

26. Lipids are nonpolar. What does this mean? They do not dissolve in water

27. What **WILL** lipids (oils and fats) dissolve in? (Question for thought)

28. __Phospholipids_____ make up cell membranes.

29. Name a waxy lipid covering plants. cuticle

30. Plant pigments like chlorophyll_____ are also __lipids_____.

31. Lipids have more _carbon _____ and _hydrogen __ than they do oxygen atoms.

32. Fats are made of an alcohol called __glycerol_____ and three _____fatty___ ___acid___ chains. This is known as a _triglyceride_____.

33. If there are all SINGLE bonds between __carbons_ in the fatty acid chain, then it is said to be _saturated_____.

34. If there is a DOUBLE bond between _carbons_____ in the fatty acid chain, then it is said to be _unsaturated_____.

35. The end of the fatty acid that does NOT attach to glycerol has what functional group? Write the formula for this group. -COOH

36. _2__ layers of _phospholipids__ make up the cell membrane.

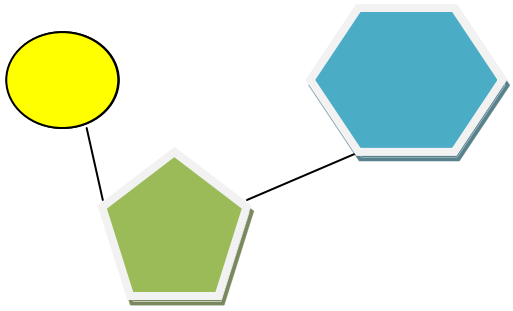
37. The head of a phospholipid __loves_____ water and is said to be __hydrophillic_____.

38. The 2 tails of a phospholipid _hate ___ water and are said to be _____hydrophobic_____.

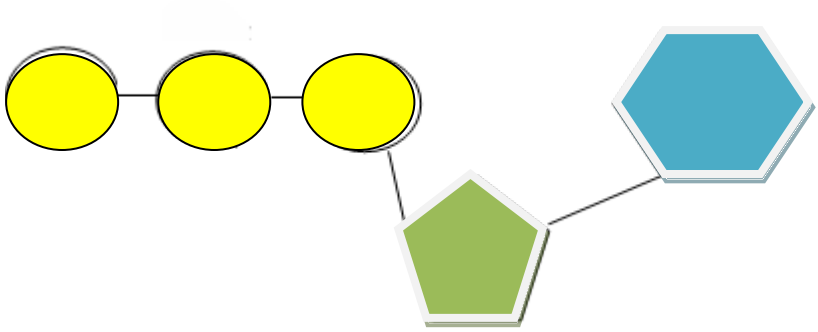
Nucleic acids carry the genetic information in a cell. **DNA or deoxyribose nucleic acid** contains all the instructions for making every protein needed by a living thing. **RNA** copies and transfers this genetic information so that proteins can be made. The subunits that make up nucleic acids are called **nucleotides**.

COLOR AND LABEL the parts of a nucleotide --- **sugar (5-sided)**-green, **phosphate group** (**round**)-yellow, and **nitrogen base** (**6-sided**)-blue. ATP used for cellular energy is a high energy nucleotide with three phosphate groups. ***Color*** code the ATP and **LABEL THE PHOSPHATES.**

Nucleotide



ATP



Questions:

39. Nucleic acids carry __genetic _____ information in a molecule called ___DNA_____ or ___deoxyribonucleic_ acid.

40. DNA has the instructions for making a cell's __proteins_____.

41. The nucleic acid __RNA____ copies DNA so ___proteins___ can be made.

42. _Nucleotides___ are the subunits making up nucleic acid.

43. The 3 parts of a nucleotide are a 5 carbon __sugar___, a phosphate, and a nitrogen _base_____.

44. ___ATP___ is a high energy molecule made from a __nucleotide_____ with ____3___ phosphates.

Final Questions:

1. Give the symbols for the elements that make up each of the following:

_CHO___carbohydrates __CHO__lipids _CHONP__DNA CHONS__proteins

2. Name the 4 classes of macromolecules & give a function for each.

Carbohydrates- short term energy; lipids- long-term energy; proteins- do all cell jobs; nucleic acids- carry instructions for how to build proteins

3. Name the subunits that make up each of the macromolecules.

Carbohydrates- monosaccharides, lipids- glycerol and fatty acids; proteins- amino acids; nucleic acids- nucleotides

4. Enzymes can be denatured (unfolded) by what environmental factors? pH and temperature

5. What process is used to link amino acids together? Removal of a water molecule- condensation

6. Name the bonds found between amino acids in a polypeptide chain.

These are peptide bonds

7. Explain the difference between a disaccharide and a polysaccharide. Give an example of each.

A disaccharide is 2 simple sugars put together. A polysaccharide is many simple sugars hooked together.

8. What two functional groups are found in amino acids?

A carboxyl group and an amino group

9. Why are enzymes important to organisms? They speed up chemical reactions in our cells

10. Name the subunit that makes up fats. triglyceride

11. What alcohol is found in a triglyceride? glycerol

12. What is the difference between a saturated and unsaturated fatty acid? A saturated fat has only single bonds between carbons, and an unsaturated fat has at least one double bond between the carbons.