

## **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**).

The body also needs trace amounts of other elements such as calcium, potassium, and sulfur for proper functioning of muscles, nerves, etc.

### **Questions:**

1. Name the 4 main elements that make up 95% of an organism.
2. Name the 4 types of bonds carbon can form.
3. What are macromolecules?
4. Name the 4 classes of macromolecules.
5. Give 2 examples of nucleic acids.
6. What elements make up carbohydrates & lipids (symbols)?

7. Name 3 elements your body needs trace amounts of for proper functioning.

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).

*Questions:*

8. Macromolecules are also known as \_\_\_\_ \_\_\_\_.

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

10. Name 2 ways your body uses carbohydrates.

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

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

13. Name 3 monosaccharides .

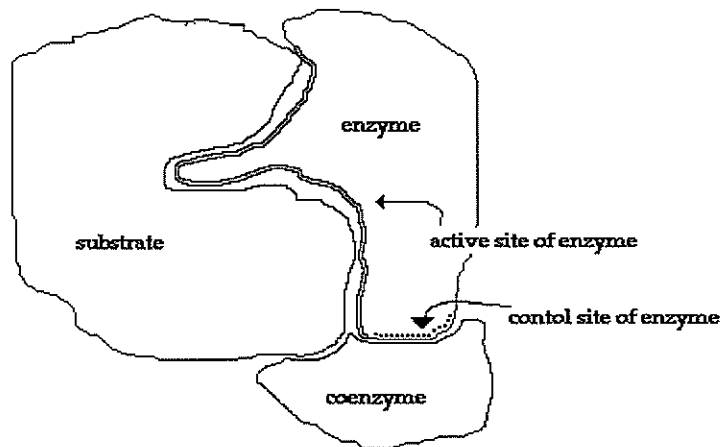
14. Monosaccharides are \_\_\_\_\_ sugars.

15. What are disaccharides & give an example?

16. Long chains of sugars are \_\_\_\_\_. Name three.

**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<sub>2</sub>)**. The **R group** differs for every amino acid, organisms use 20 different amino acid, your body makes 12 of the amino acid you

**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?

18. Proteins also act as \_\_\_\_\_ in cells to control reactions.
19. Name the 2 functional groups in amino acids.
20. Cells have \_\_\_\_\_ of enzymes to act as biological \_\_\_\_\_.
21. Enzymes have an attachment site called the \_\_\_\_\_ site for the \_\_\_\_\_ to join.
22. What is the effect of excess heat or temperature on an enzyme?
23. Amino acids are linked together to make proteins by removing a molecule of \_\_\_\_\_ in a process called \_\_\_\_\_.
24. Chains of amino acids make \_\_\_\_\_ which can join together to make a \_\_\_\_\_.
25. \_\_\_\_\_ bonds form when water is removed to hold \_\_\_\_\_ acids together.

**Lipids** are large, **nonpolar** (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. 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. Proteins are also embedded in the cell membrane..

*Questions:*

26. Lipids are nonpolar. What does this mean?
27. What **WILL** lipids (oils and fats) dissolve in? (Question for thought)

28. \_\_\_\_\_ makes up cell membranes.

29. Name a waxy lipid covering plants.

30. Plant pigments like \_\_\_\_\_ are also \_\_\_\_\_.

31. Lipids have more \_\_\_\_\_ and \_\_\_\_\_ than they do oxygen atoms.

32. Fats are made of an alcohol called glycerol and three fatty acid chains. This is known as a \_\_\_\_\_.

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

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

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

36. \_\_\_\_\_ layers of \_\_\_\_\_ phospholipids \_\_\_\_\_ make up the cell membrane.

37. The head of a phospholipid \_\_\_\_\_ water and is said to be \_\_\_\_\_.

38. The 2 tails of a phospholipid \_\_\_\_\_ water and is said to be \_\_\_\_\_.

**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**.

*Questions:*

39. Nucleic acids carry \_\_\_\_\_ genetic \_\_\_\_\_ information in a molecule called \_\_\_\_\_ or \_\_\_\_\_ acid.

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

41. The nucleic acid \_\_\_\_\_ RNA \_\_\_\_\_ copies DNA so \_\_\_\_\_ can be made.

42. \_\_\_\_\_ are the subunits making up nucleic acid.

43. The 3 parts of a nucleotide are a 5 carbon \_\_\_\_, a phosphate, and a \_\_\_\_\_.

44. \_\_\_\_\_ is a high energy molecule made from a \_\_\_\_\_ with \_\_\_\_\_ phosphates.