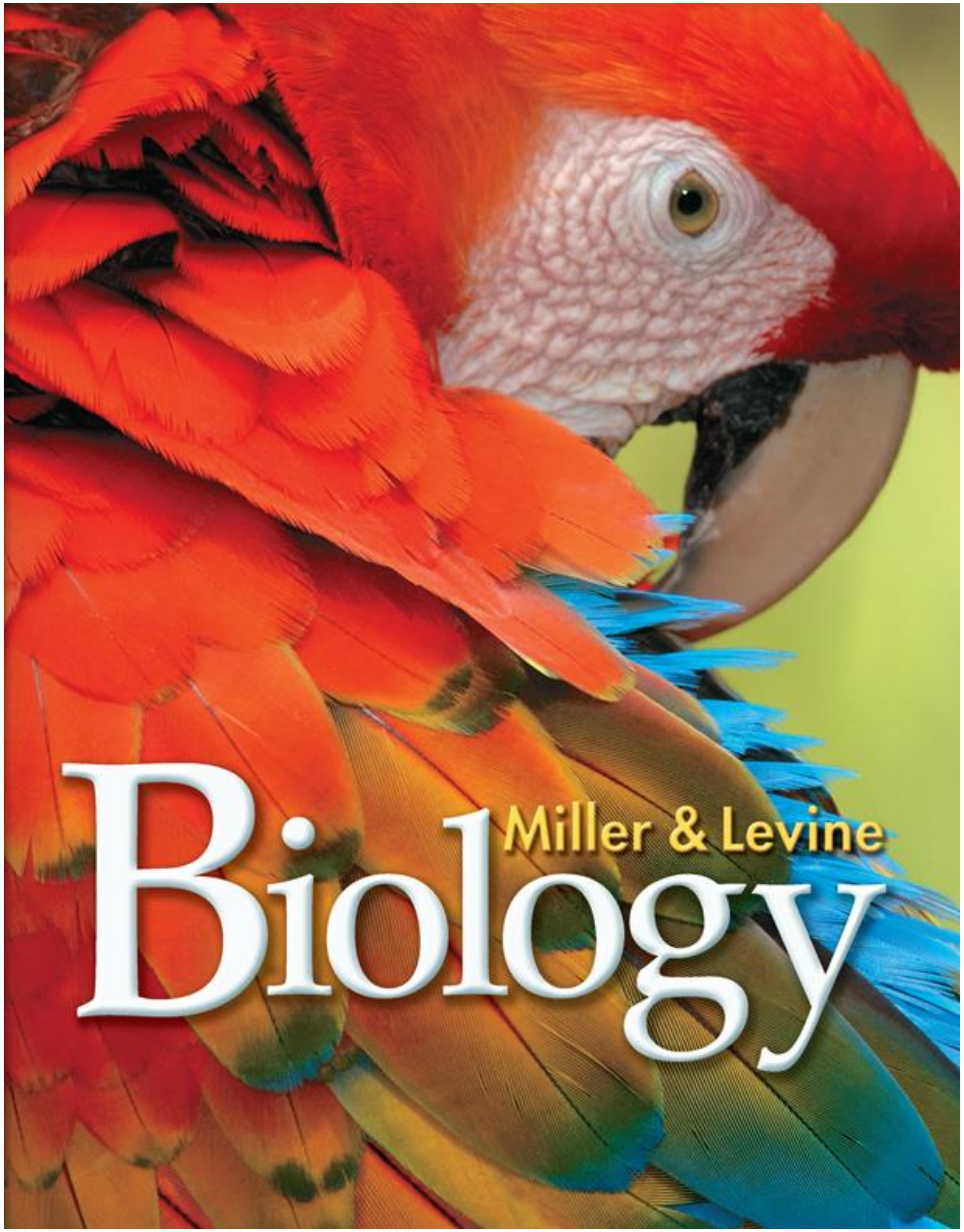

Lesson Overview

2.3 Carbon Compounds

THINK ABOUT IT

In the early 1800s, many chemists called the compounds created by organisms “organic,” believing they were fundamentally different from compounds in nonliving things.

We now understand that the principles governing the chemistry of living and nonliving things are the same, but the term “organic chemistry” is still around.

Today, **organic chemistry** means the study of compounds that contain bonds between carbon atoms, while inorganic chemistry is the study of all other compounds.

The Chemistry of Carbon

- What elements does carbon bond with to make up life's molecules?

- **Carbon can bond with** many elements, including hydrogen, oxygen, phosphorus, sulfur, and nitrogen to form the molecules of life.

The Chemistry of Carbon

Carbon atoms have four valence electrons, allowing them to form strong covalent bonds with many other elements, including hydrogen, oxygen, phosphorus, sulfur, and nitrogen.

Living organisms are made up of molecules that consist of carbon and these other elements.

The Chemistry of Carbon

Carbon atoms can also bond to each other, which gives carbon the ability to form millions of different large and complex structures.

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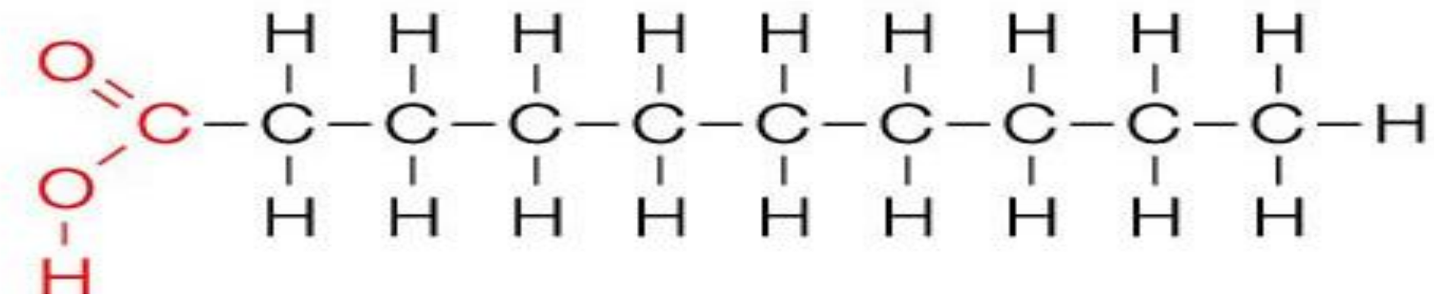
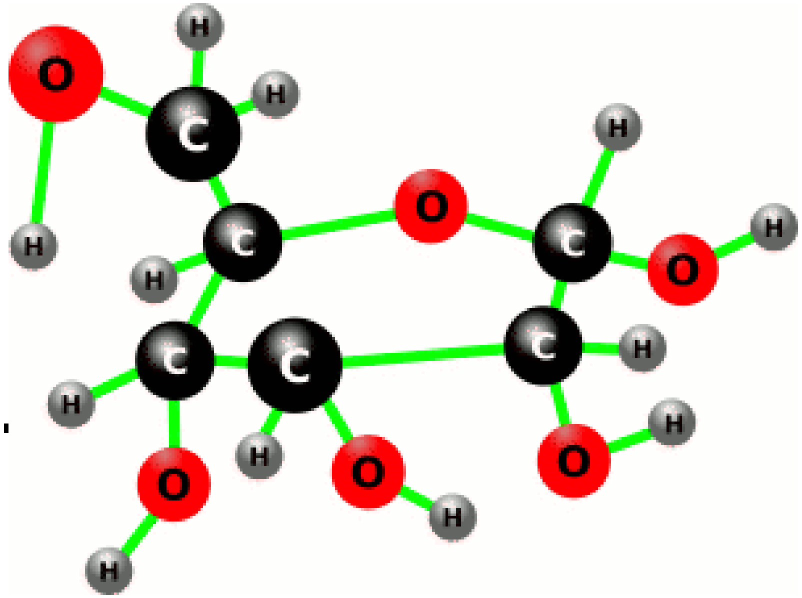


The Chemistry of Carbon

Carbon atoms can also bond to each other, which gives carbon the ability to form millions of different large and complex structures.

Carbon-carbon bonds can be single, double, or triple covalent bonds.

Chains of carbon atoms can close up on themselves to form rings.



Macromolecules

Macromolecules

Carbohydrates-(the bun, tomato, pickle, and lettuce)

Lipids-(the grease from the meat)

Proteins -(the meat)

Nucleic Acids-(the genetic code that made it all)

Macromolecules

- What are the functions of each of the four groups of macromolecules?

- Living things use carbohydrates as their main source of energy. Plants, some animals, and other organisms also use carbohydrates for structural purposes.

Carbohydrates-the main source of energy for living things. Can also be used for structure

Macromolecules

- What are the functions of each of the four groups of macromolecules?

- Lipids can be used to store energy. Some lipids are important parts of biological membranes and waterproof coverings.

Lipids-used to store energy

Macromolecules

- What are the functions of each of the four groups of macromolecules?
- Nucleic acids store and transmit hereditary, or genetic, information.

Nucleic acids-store and transmit genetic information.

Macromolecules

What are the functions of each of the four groups of macromolecules?

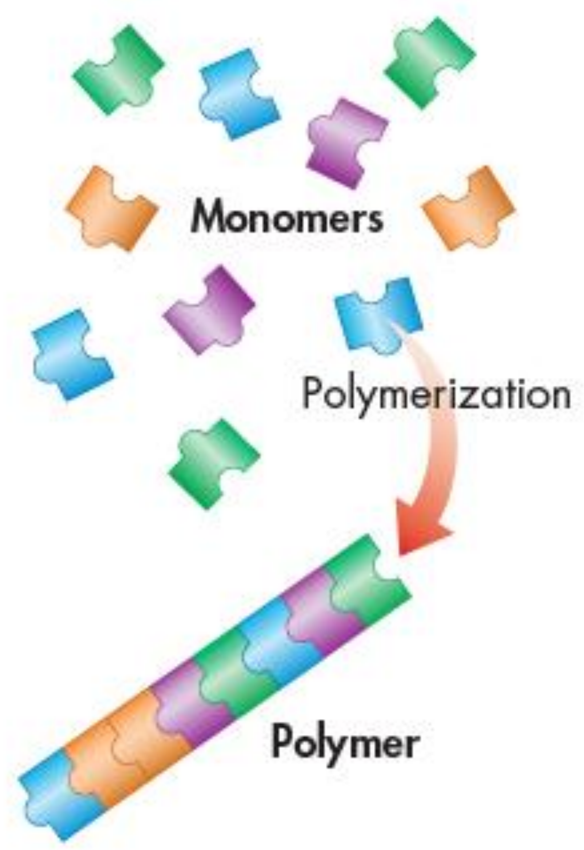
Some proteins control the rate of reactions and regulate cell processes. Others form important cellular structures, while still others transport substances into or out of cells or help to fight disease.

Proteins-control the rate of reactions, regulate cell processes, form important cellular structures, transport substances into or out of cells, and help to fight disease.

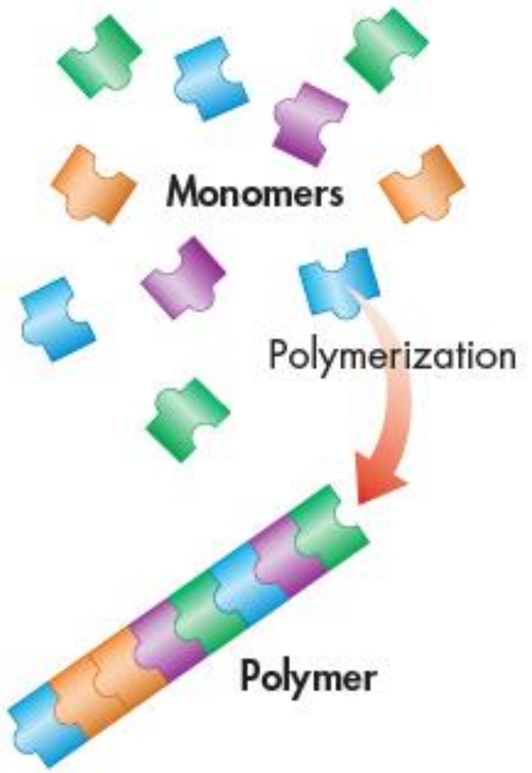
Macromolecules

Many of the organic compounds in living cells are macromolecules, or "giant molecules," made from thousands or even hundreds of thousands of smaller molecules.

Most **macromolecules are formed by a process known as polymerization**, in which large compounds are built by joining smaller ones together.



Macromolecules



The smaller units, or **monomers,** join together to form **polymers**.

The monomers in a polymer may be identical

or different.

Monomers-smaller units

Polymers- many monomers linked together

Macromolecules

Biochemists sort the macromolecules found in living things into groups based on their chemical composition.

The four major groups of macromolecules found in living things are:

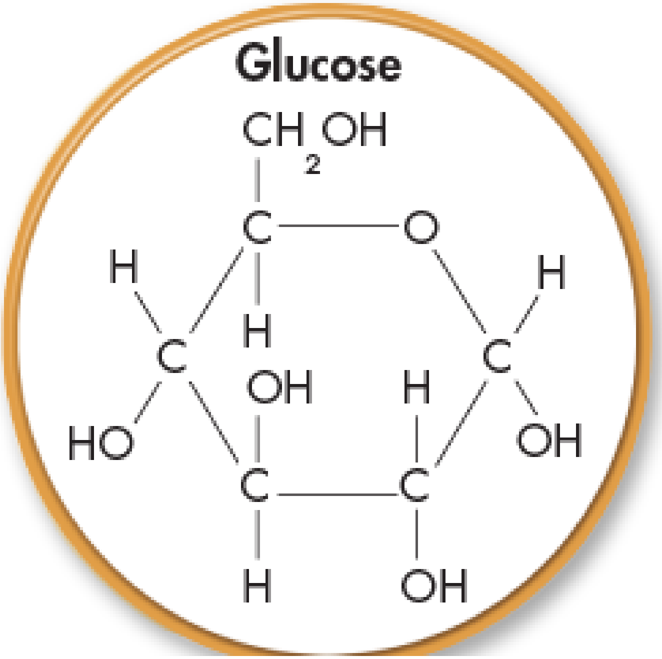
carbohydrates

lipids

nucleic acids

proteins

Carbohydrates



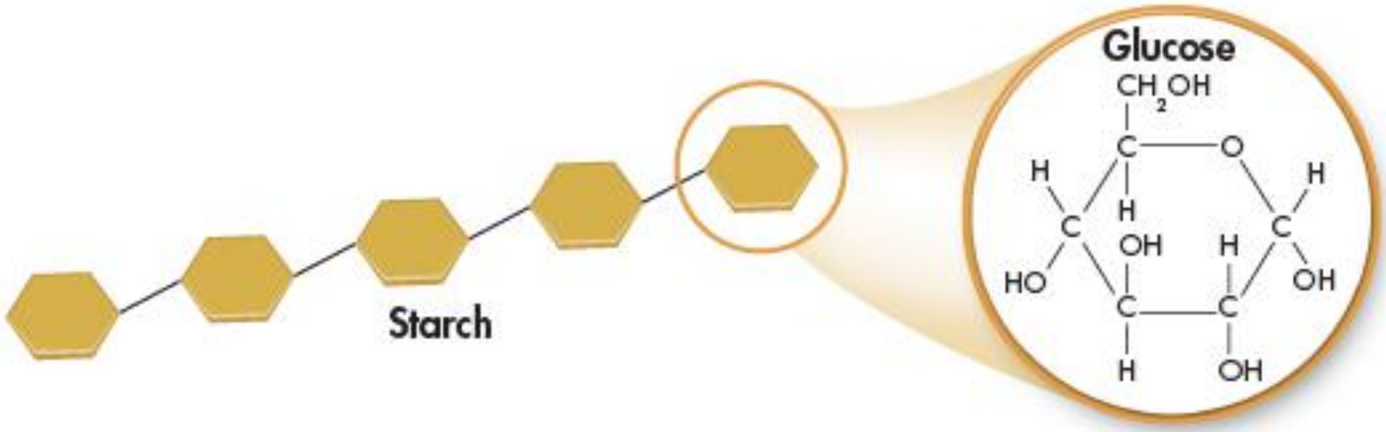
Carbohydrates are compounds made up of carbon, hydrogen, and oxygen atoms, usually in a ratio of 1 : 2 : 1.

Living things use carbohydrates as their main source of energy. The breakdown of sugars, such as glucose, supplies immediate energy for cell activities.

Plants, some animals, and other organisms also use carbohydrates for structural purposes.

Carbohydrates

Many organisms store extra sugar as complex carbohydrates known as starches. The monomers in starch polymers are sugar molecules, such as glucose.



Simple Sugars

Single sugar molecules are also known as **monosaccharides.**

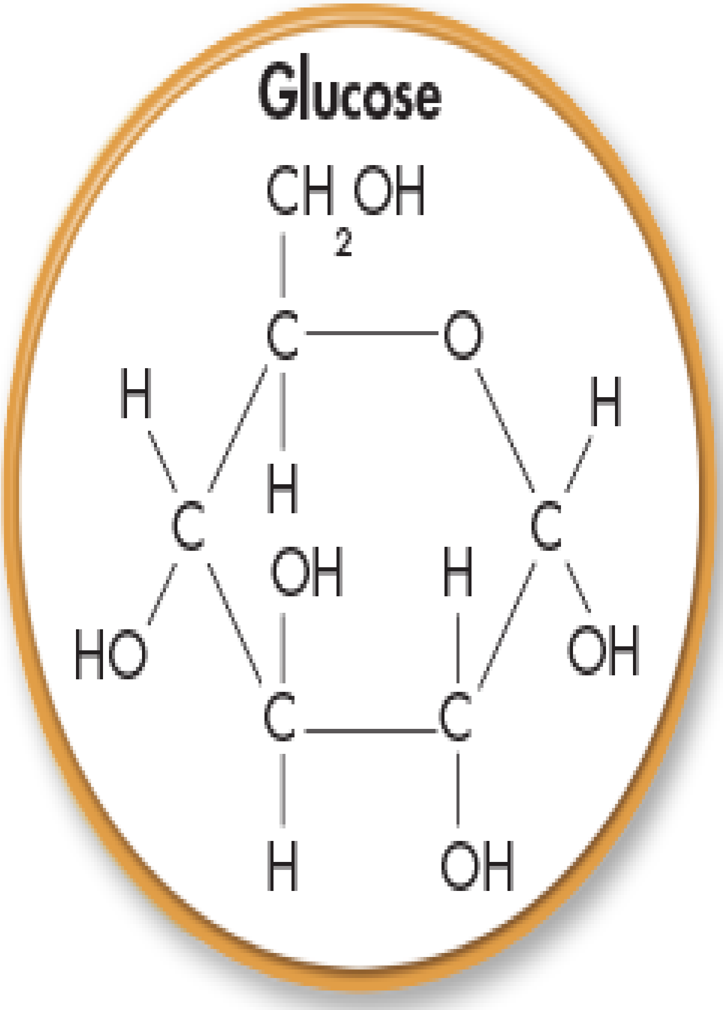
MONOsaccharides-one sugar molecule

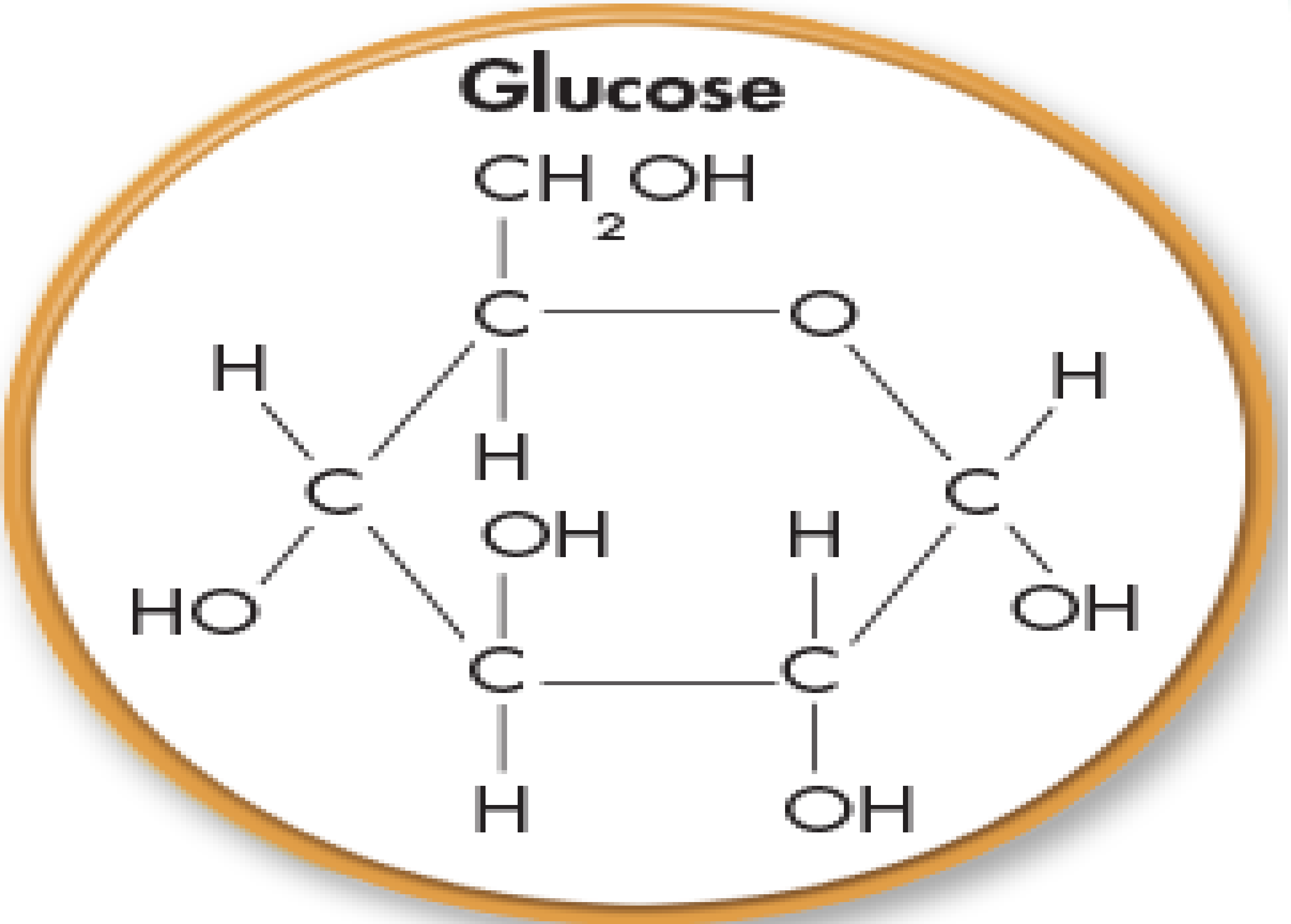
include galactose, which is a component of milk, and fructose, found in many fruits

Disaccharide, a compound made by joining glucose and fructose together.

Disaccharide-two sugar molecules

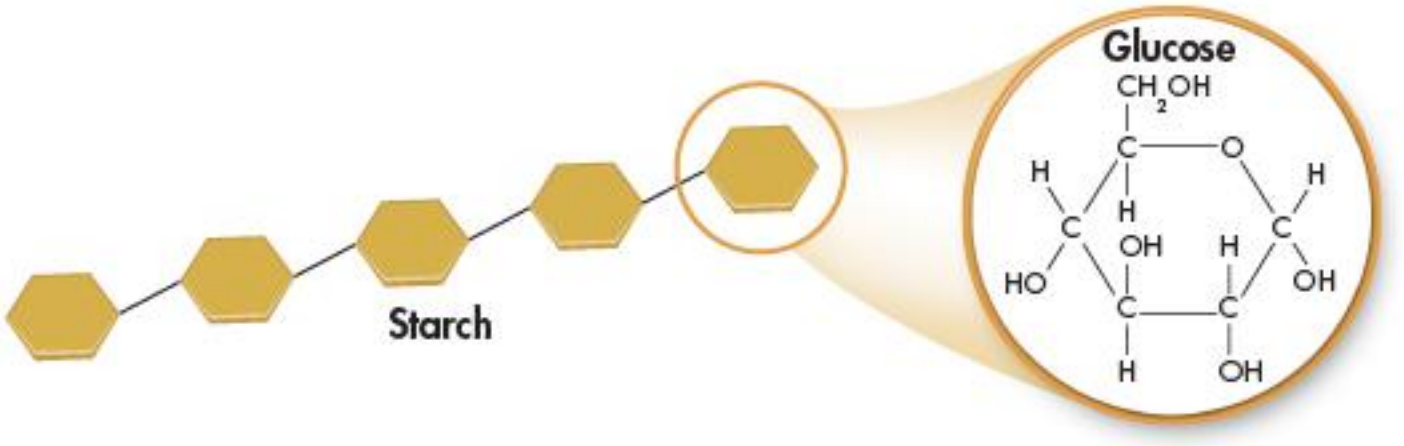
Includes ordinary table sugar, sucrose




Glucose
CH2OH
C
O
H
H
C
OH
H
C
HO
OH
C
C
H
OH

Complex Carbohydrates

Polysaccharides (polymer)- large macromolecules formed from the joining of many monosaccharides (monomer).

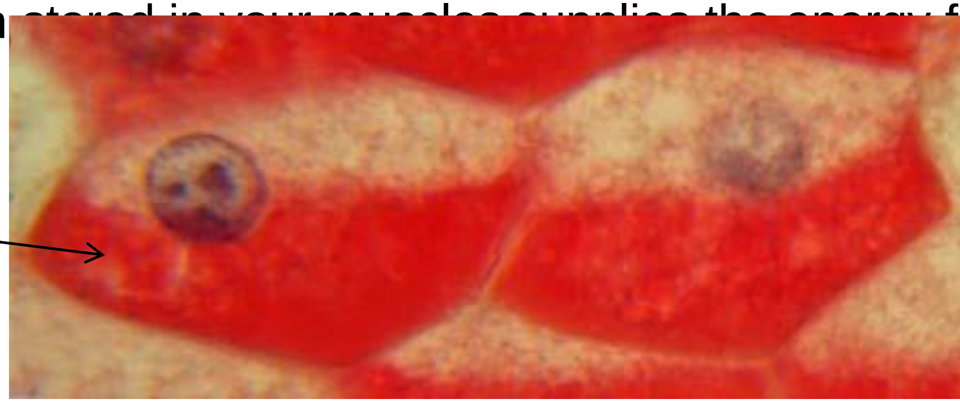


Complex Carbohydrates

Many animals store excess sugar in a polysaccharide called **glycogen**

When the level of glucose in your blood runs low, glycogen is broken down into glucose, which is then released into the blood.

The glycogen stored in your muscles supplies the energy for muscle contraction.

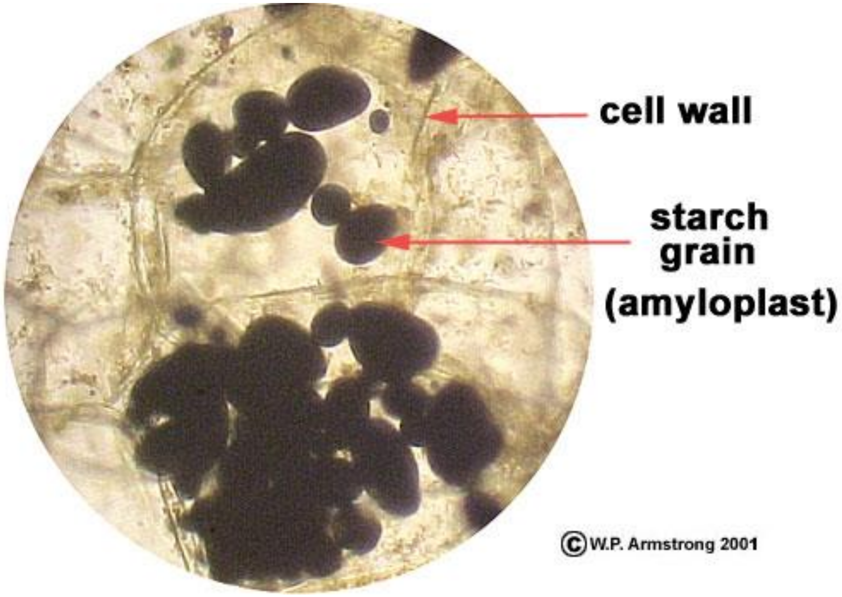


Glycogen

Complex Carbohydrates

Plants use a slightly different polysaccharide, called starch, to store excess sugar.

Plants also make another important polysaccharide called cellulose, which gives plants much of their strength and rigidity.



Lipids

Lipids are a large and varied group of biological molecules.

Lipids are made mostly from **carbon and hydrogen atoms** and are generally **not soluble in water**.

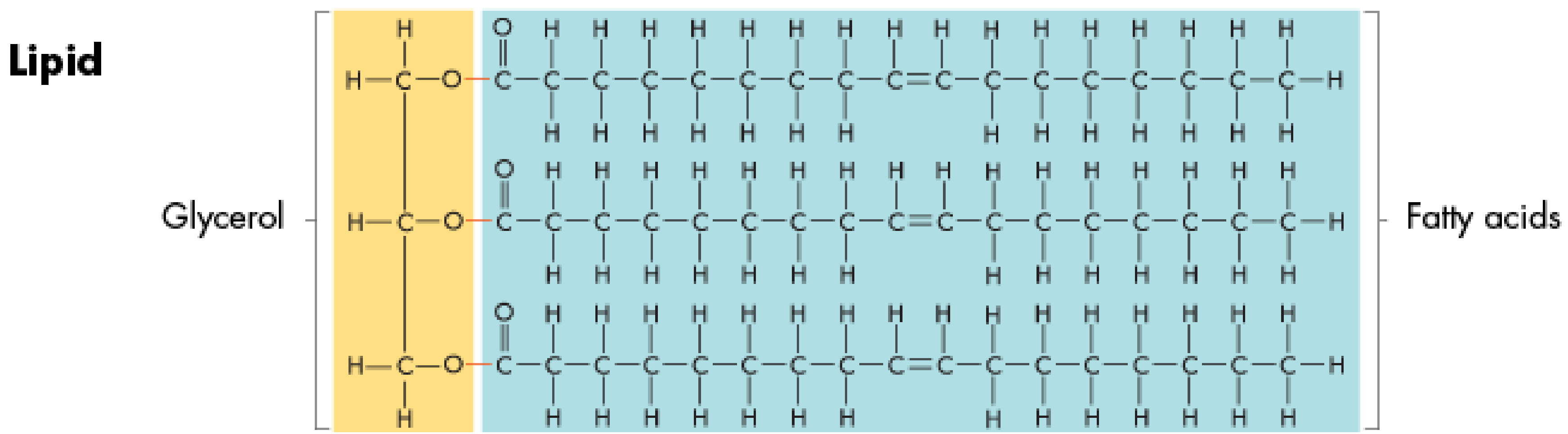
The common categories of lipids are **fats, oils, and waxes**.

Lipids can be used to store energy.

Some lipids are important parts of biological membranes and waterproof coverings.

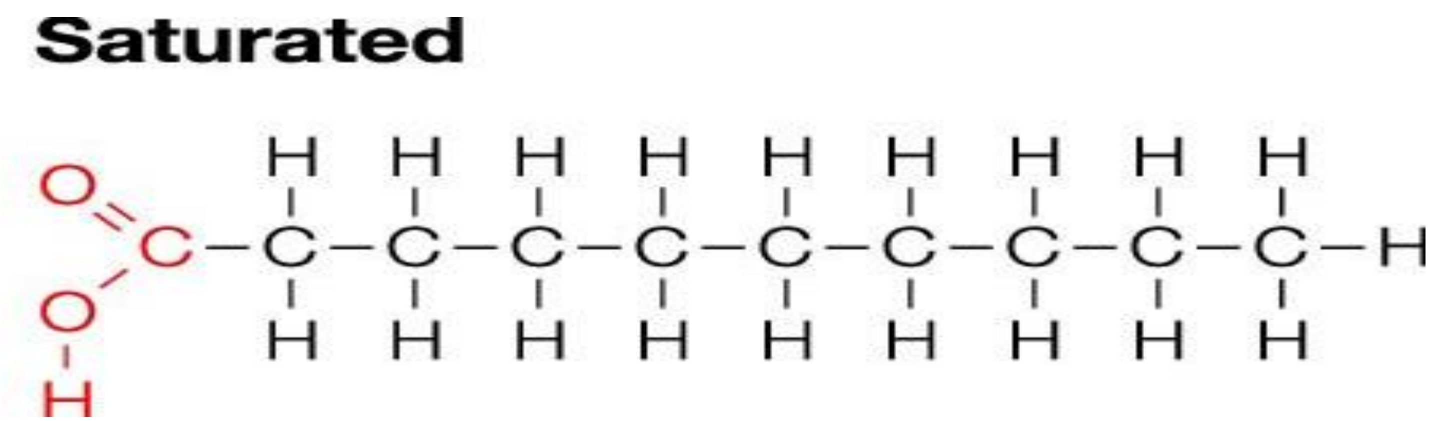
Lipids

Many lipids are formed when a glycerol molecule combines with compounds called fatty acids.

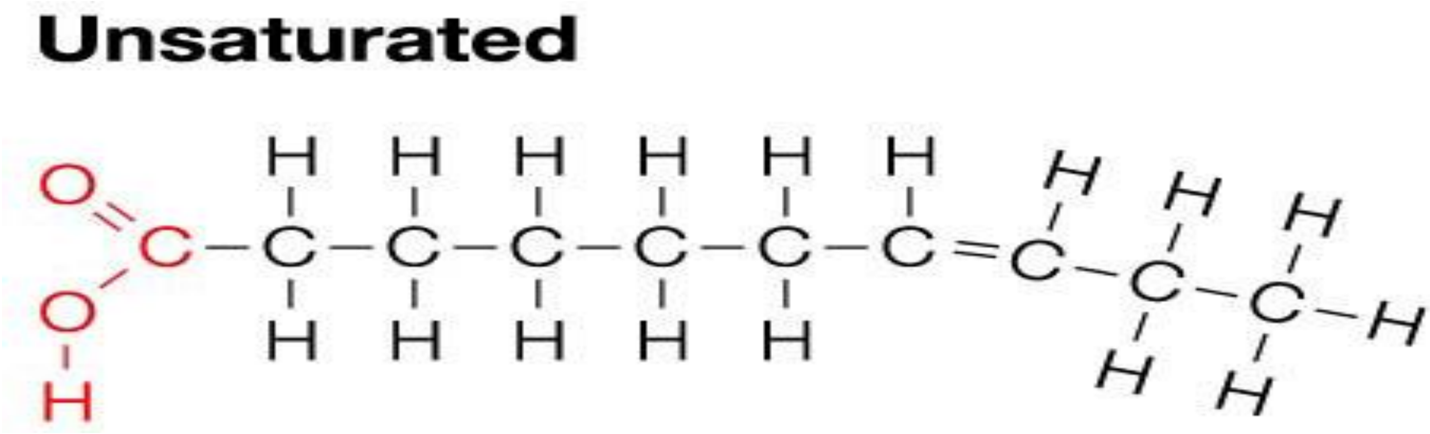


Lipids

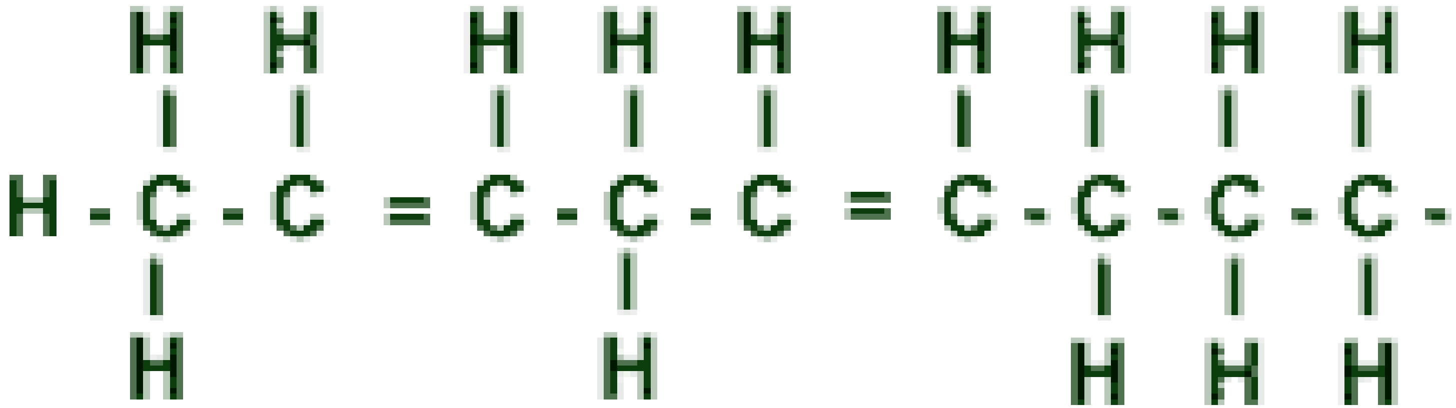
Saturated Fatty Acids-If each carbon atom in a lipid's fatty acid chains is joined to another carbon atom by a single bond



<u>Unsaturated Fatty Acids-</u><u>If there is at least one carbon-carbon double bond in a fatty acid</u>



Polyunsaturated Fatty Acids -Lipids whose fatty acids contain more than one carbon-carbon double bond.



Lipids

Lipids that contain **<u>unsaturated fatty acids</u>**, such as olive oil, **<u>tend to be liquid at room temperature.</u>**

The data in the table illustrate how melting point decreases as the degree of unsaturation (number of double bonds) increases.

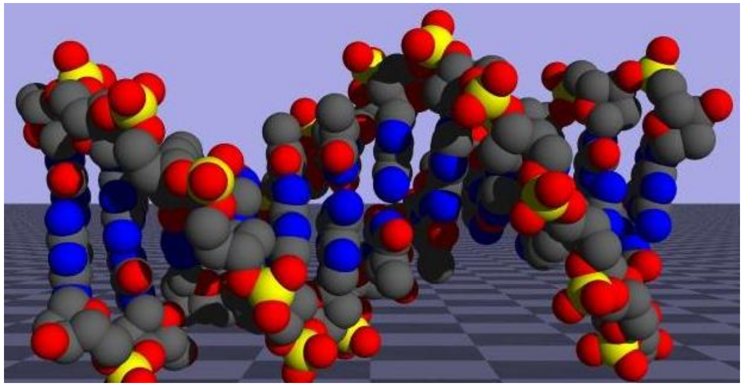
Effect of Carbon Bonds on Melting Point

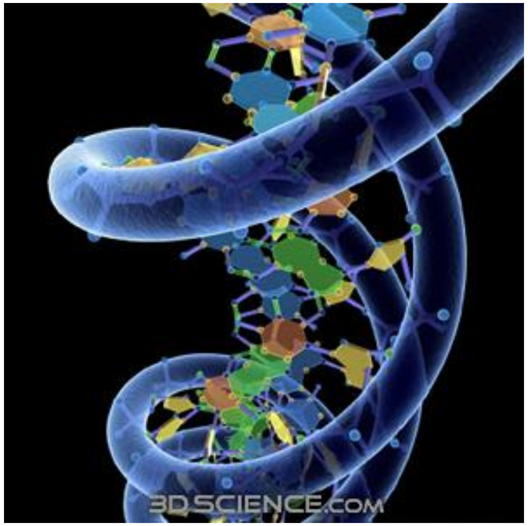
Fatty Acid	Number of Carbons	Number of Double Bonds	Melting Point (ºC)
Stearic acid	18	0	69.6
Oleic acid	18	1	14
Linoleic acid	18	2	-5
Linolenic acid	18	3	-11

Nucleic Acids

Nucleic acids store and transmit hereditary, or genetic, information.

Nucleic acids-hydrogen, oxygen, nitrogen, carbon, and phosphorus.



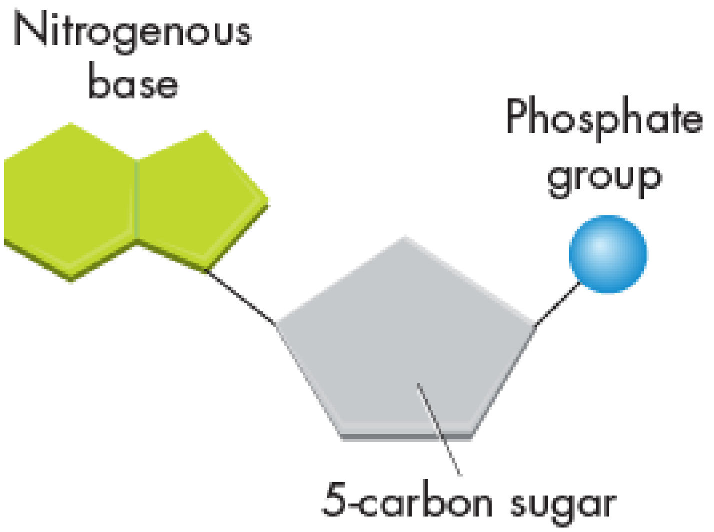


Nucleic acids are polymers assembled from individual monomers known as nucleotides.

Nucleic Acids

Nucleotides consist of three parts: a 5-carbon sugar, a phosphate group (–PO_4), and a nitrogenous base.

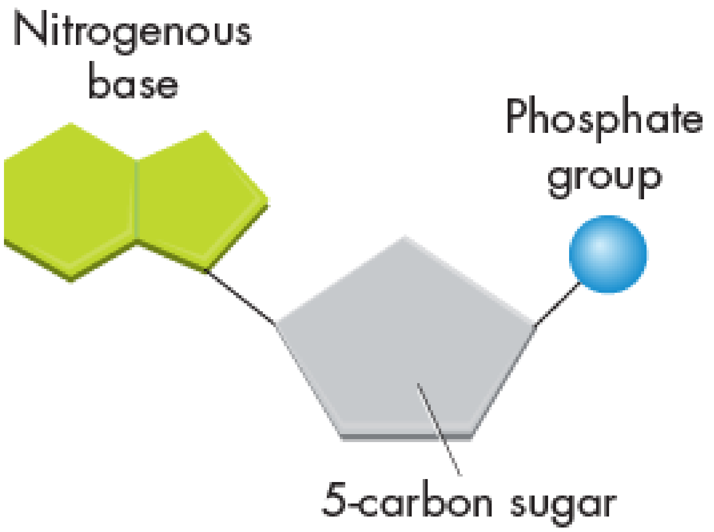
Some nucleotides, including adenosine triphosphate (ATP), play important roles in capturing and transferring chemical energy.



Nucleic Acids

Individual nucleotides can be joined by covalent bonds to form a polynucleotide, or nucleic acid.

There are two kinds of nucleic acids: ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). RNA contains the sugar ribose and DNA contains the sugar deoxyribose.



RNA-ribose

DNA-deoxyribose

Protein

Proteins contain nitrogen, carbon, hydrogen, and oxygen.

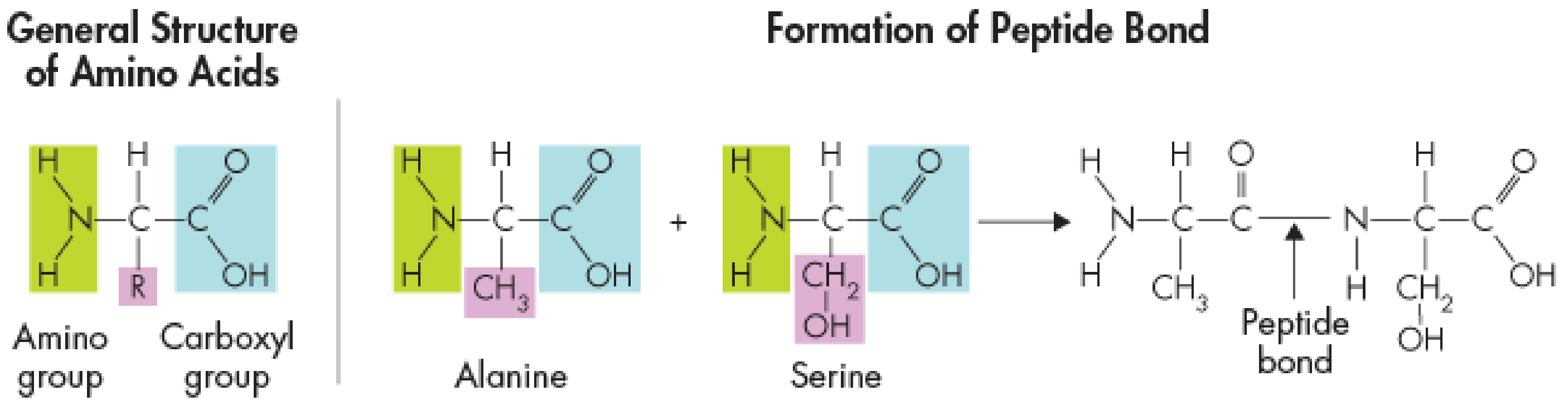
Proteins are polymers of molecules called amino acids.

Proteins perform many varied functions, such as controlling the rate of reactions and regulating cell processes, forming cellular structures, transporting substances into or out of cells, and helping to fight disease.

Protein

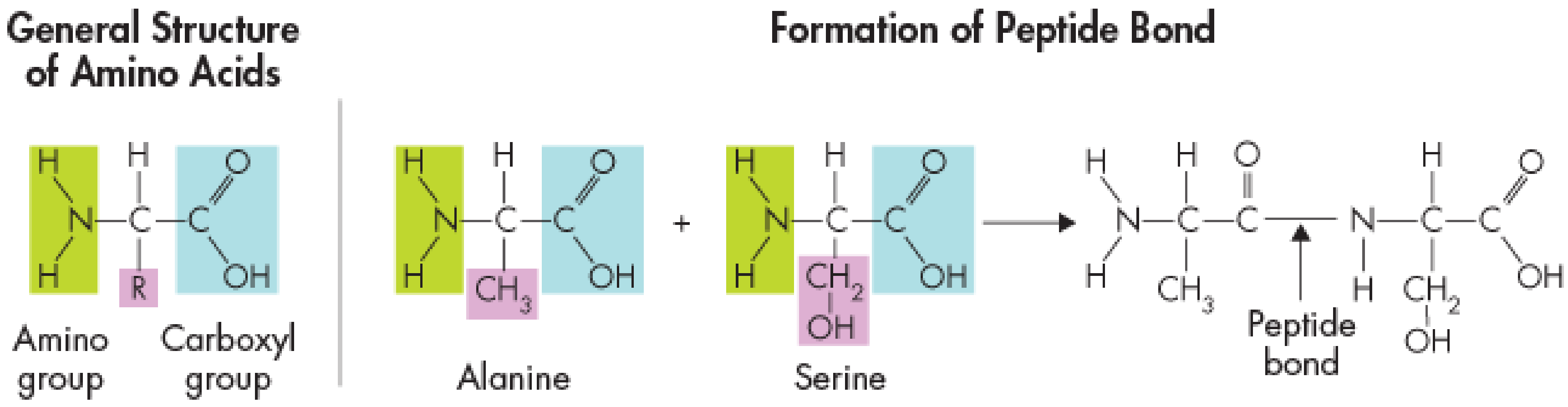
Amino acids are compounds with an amino group ($-NH_2$) on one end and a carboxyl group ($-COOH$) on the other end.

Covalent bonds called peptide bonds link amino acids together to form a protein. This occurs in the RIBOSOMES of cells.



Structure and Function

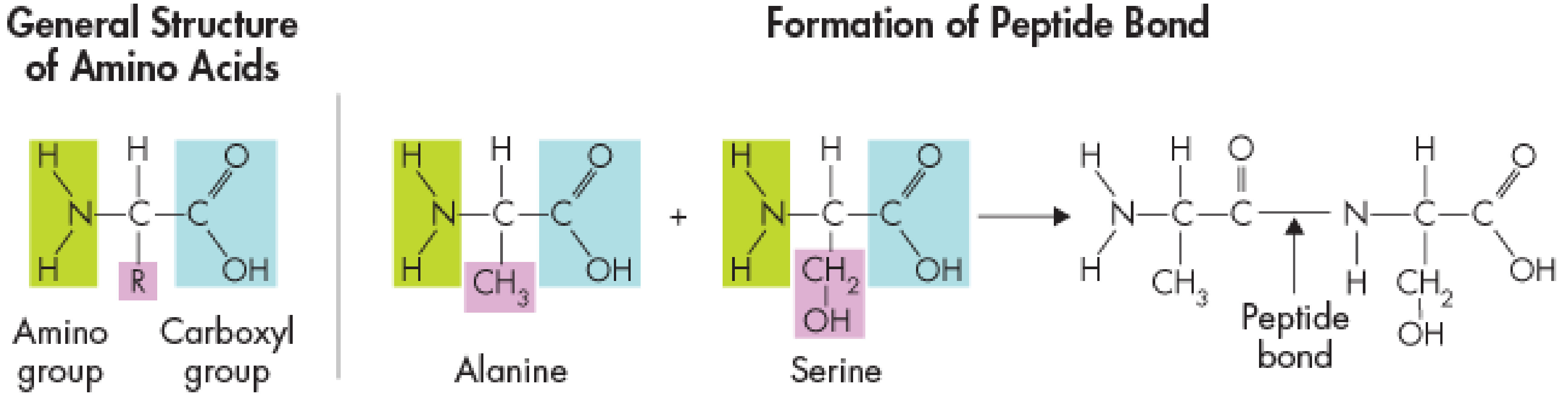
All amino acids are identical in the amino and carboxyl groups. Any amino acid can be joined to any other amino acid by a peptide bond formed between these amino and carboxyl groups.



Structure and Function

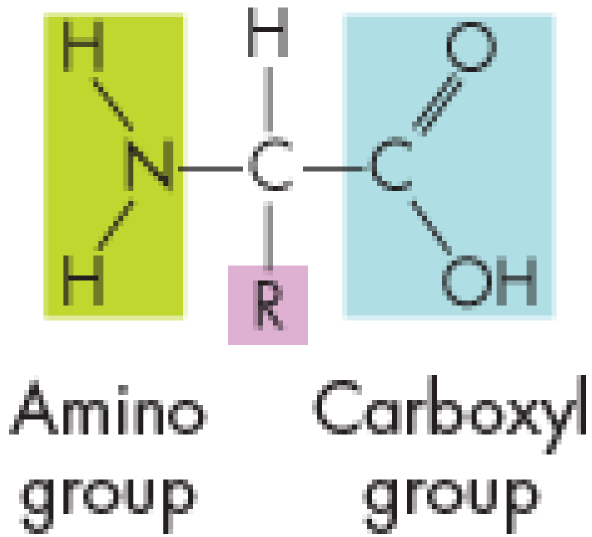
Amino acids differ from each other in a side chain called the R-group, which have a range of different properties.

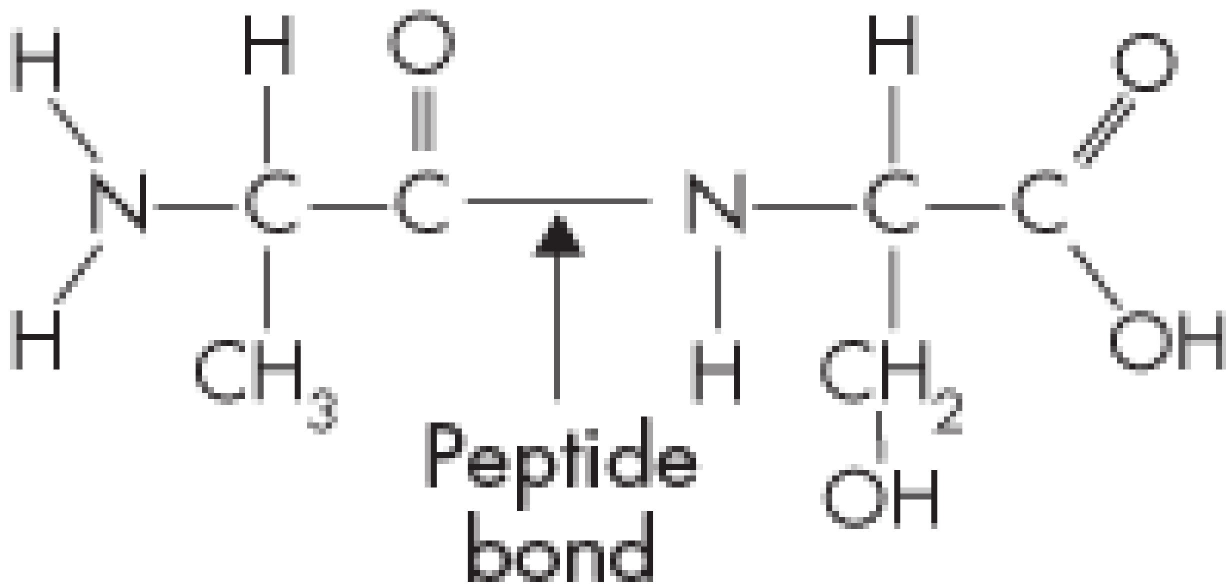
There are 20 different amino acids are found in nature.



arbon Compounds

General Structure of Amino Acids

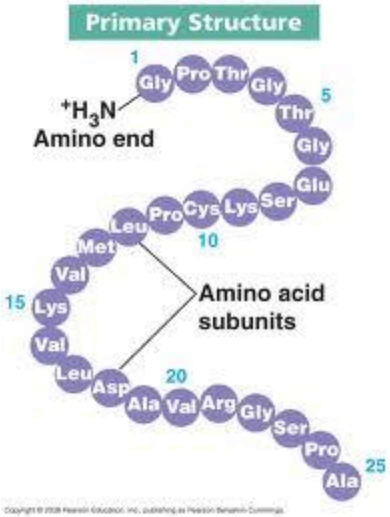




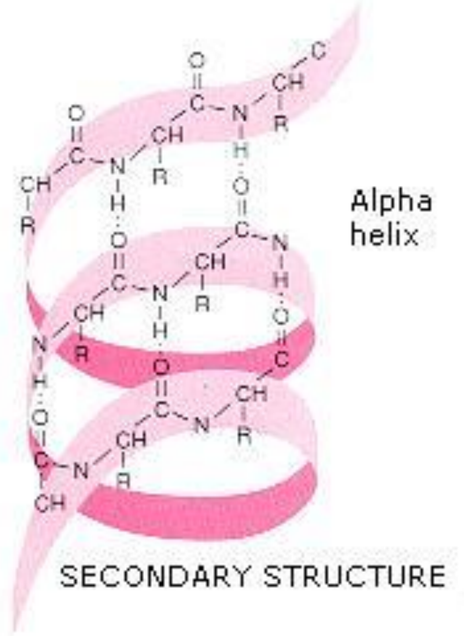
Levels of Organization

Proteins have four levels of structure.

1. **Primary structure-** the sequence of its amino acids.

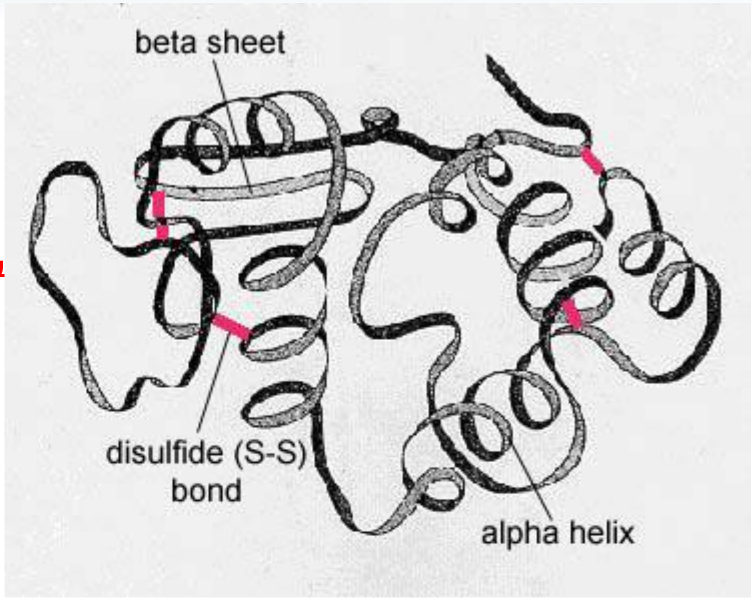


2. **Secondary structure-** the folding or coiling of the polypeptide chain.

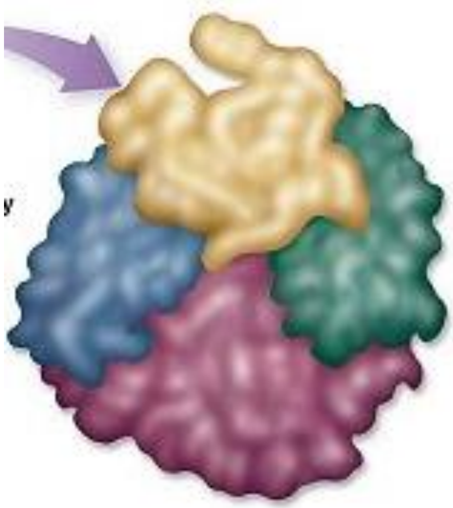


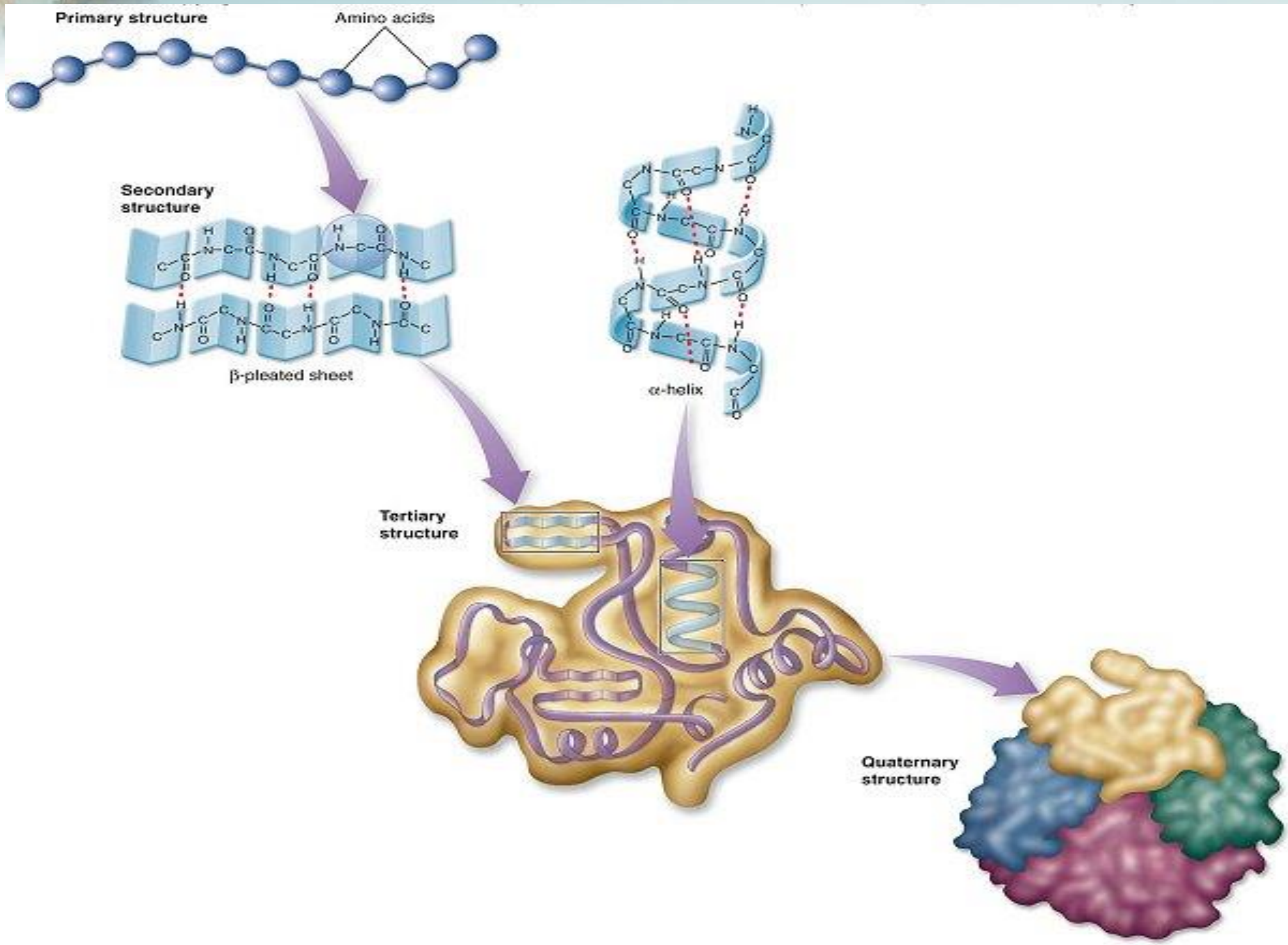
Levels of Organization

3. **Tertiary structure-** complete, three-dimensional arrangement of a polypeptide chain.



4. Quaternary structure- Proteins with more than one chain have a fourth level of structure.




Primary structure
Amino acids
Secondary structure
β-pleated sheet
α-helix
Tertiary structure
Quaternary structure

Enzymes

- What role do enzymes play in living things and what affects their function?
- **Enzymes:** protein catalysts that speed up chemical reactions in cells.
- **Catalyst**-a substance that speeds up the rate of a chemical reaction