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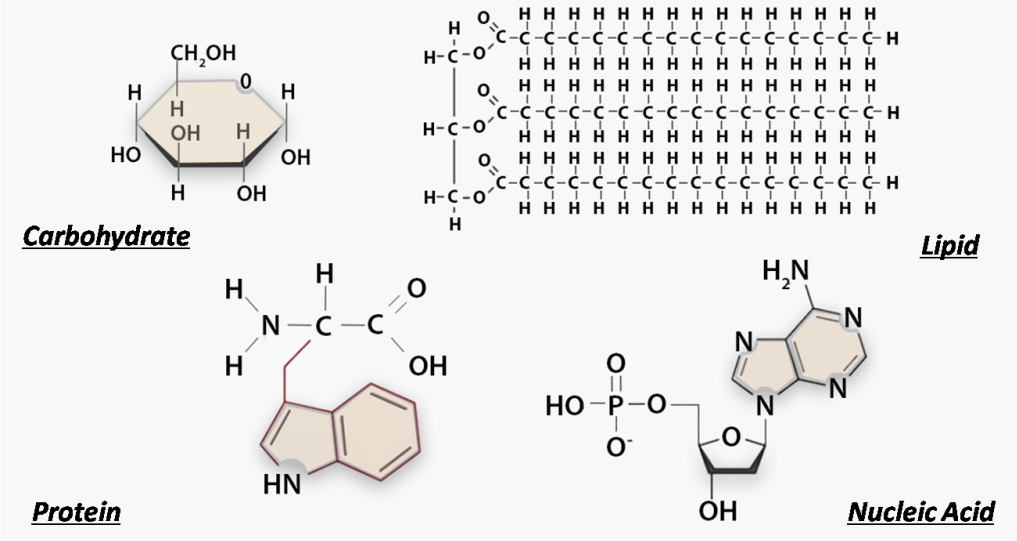
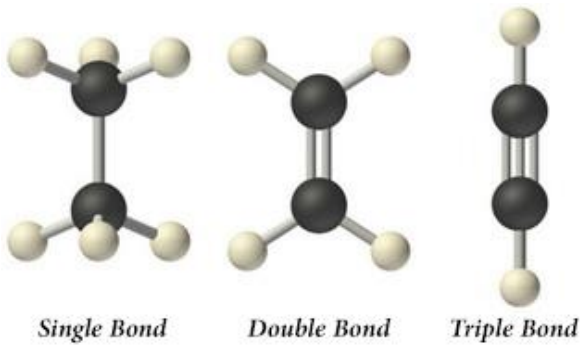
Recall that the six main elements found in living things are _____, hydrogen, oxygen, _____, sulfur and phosphorous. These six atoms bond together in a variety of combinations to form the molecules which make up the structures found in the cells of living things. These molecules then join together to form much larger structures known as _____ . All macromolecules have carbon as their main element. The four macromolecules you will be required to know about for this course are carbohydrates, _____, lipids and nucleic acids.



The Role of Carbon in Living Things

A carbon atom has four electrons in its valence shell. To become stable, carbon will form _____covalent bonds to fill its outer valence shell. These bonds may be with other carbon atoms, or with other elements such as hydrogen and oxygen. When two carbon atoms form a covalent bond, each atom can share:

- one electron to form a _____bond,
- two electrons to form a _____bond or,
- three electrons to form a _____bond.



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Carbon atoms bond to each other in different ways to form compounds of various shapes including, _____-chain, branched-chain, or _____ compounds. These compounds can have any number of carbon atoms and will contain atoms of other elements, the most frequently occurring of which is hydrogen. This results in a huge number of carbon compounds being synthesized in living organisms.

Monomers and Polymers

Carbon compounds vary greatly in _____from a single carbon like that seen in methane (_____) to those which contain hundreds or thousands of atoms. The largest carbon-based molecule known to exist is called PG5 and contains around 15 million carbon atoms.

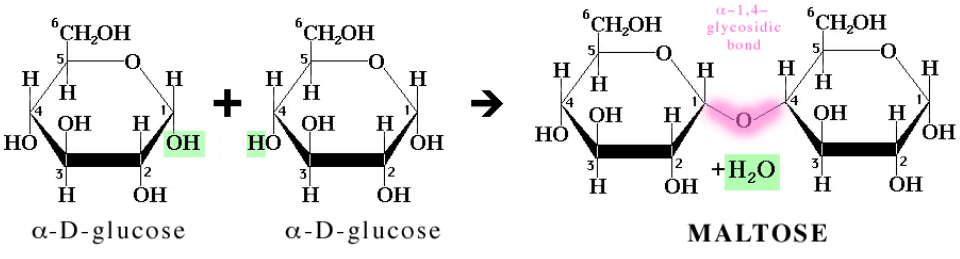
Cells synthesize (make) _____by joining smaller molecules called _____together. These large macromolecules are called _____are defined as a long chain of repeating subunits (_____). An example of this is seen when amino acids are bonded together to form a polypeptide chain.

Condensation reaction (dehydration synthesis)

Polymers are made through a chemical reaction called _____. In this reaction, the monomers which are being bonded together have a hydrogen atom (_____) on one end and a hydroxyl group (_____) group on the other. When the molecules join, the hydrogen atom and hydroxyl group bond and are removed as a _____molecule.

The subunits are bonded together by a **covalent** bond, as the water molecule is released.

The figure below shows the condensation of two glucose molecules to form a maltose molecule. The covalent bond forms between the glucose units.



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When these polymers break apart the reverse reaction called _____ occurs.

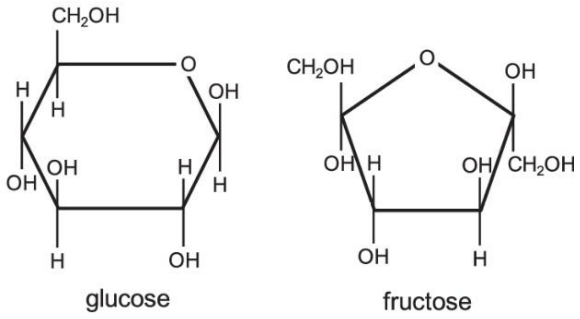
Carbohydrates

Carbohydrates as their name suggest consist of carbon, _____and oxygen. The ratio of these atoms is approximately _____ hydrogen atoms and _____oxygen atom to _____carbon atom. These macromolecules are the most abundant in the living cell and are used as the primary _____source for all living cells.

Carbohydrates have various chain lengths and can be divided into three categories: _____, _____ , and _____.

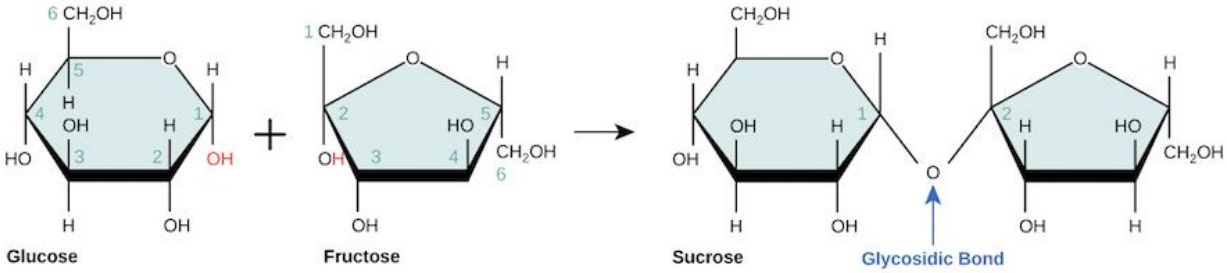
1. **Monosaccharides**

   Monosaccharides (mono- = “one”; sacchar- = “sugar”) are the simplest type of carbohydrates and typically contain between ____ and ____ carbon atoms. The most common examples in this category are the compounds _____ and _____ .



2. **Disaccharides**

   Disaccharides (di- = “two”) are ____-sugar molecules that form when two monosaccharides join via a _____ reaction. For example, when glucose and fructose form a covalent bond, a molecule of sucrose commonly known as table sugar is produced.



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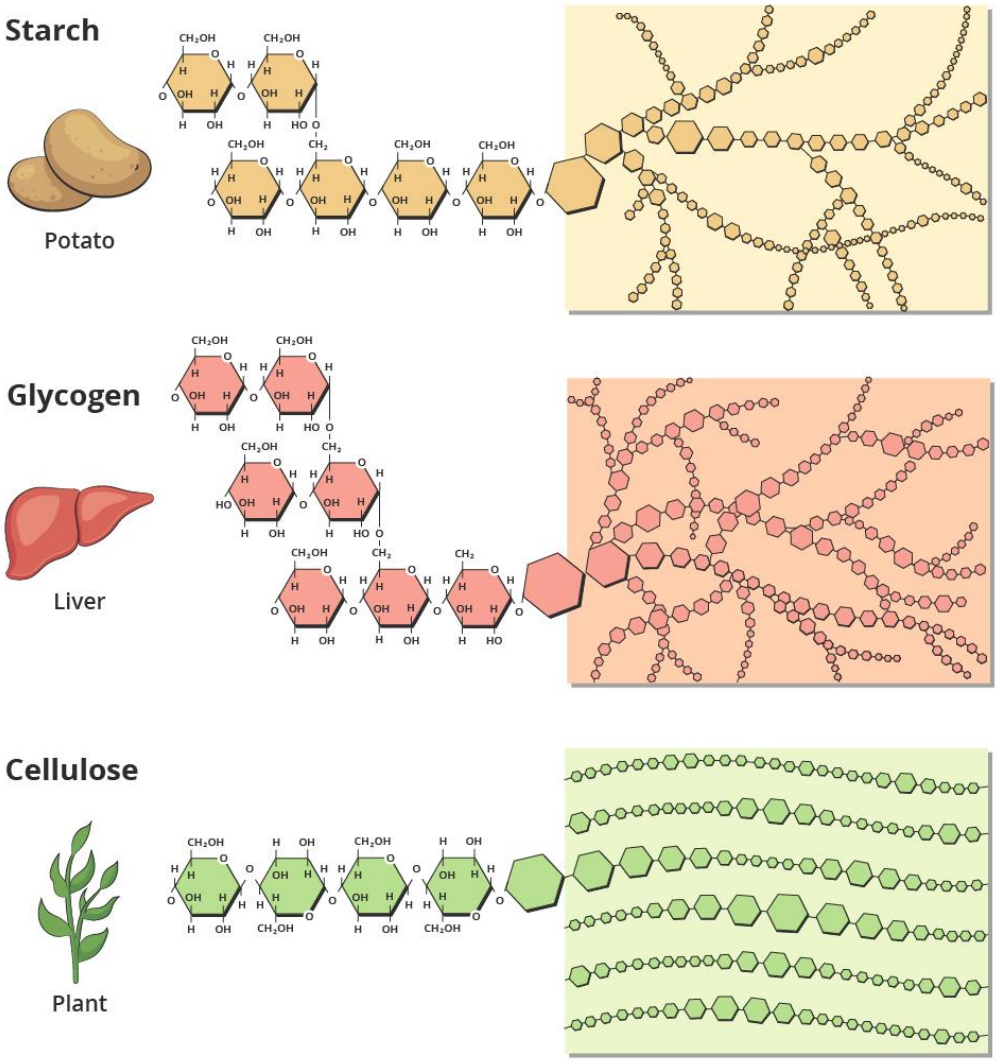
3. Polysaccharides

Polysaccharides (poly- = "many") are the largest carbohydrate molecules. These are long chains of monosaccharides linked together by _____ bonds. Starch, glycogen, and cellulose are examples of polysaccharides that are essential in living organisms. Their structure is shown in the diagram below.

- _____consists of branched chains of glucose molecules and is utilized as energy storage by plants.
- _____ is a highly branched glucose polymer that functions as an _____ storage molecule found in the liver and muscle cells of mammals.
- _____ is a glucose polymer that is typically found in the plant cell walls and serves as _____ support.



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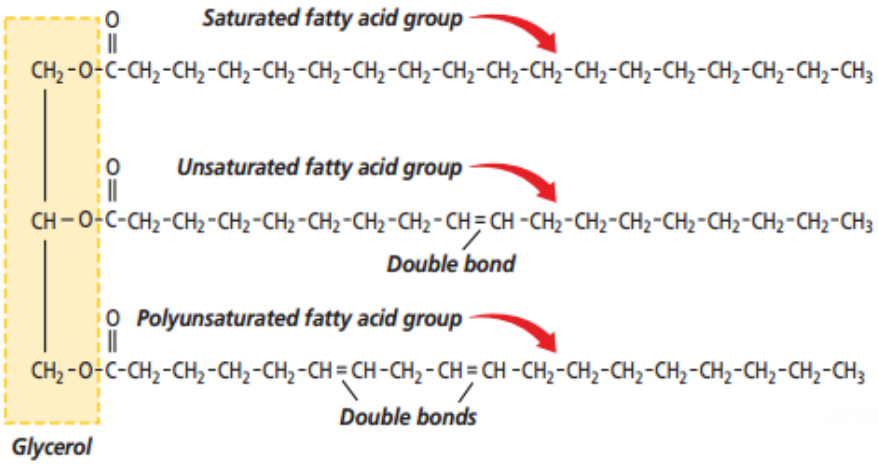
Lipids

Lipids consist of carbon and _____ atoms bonded to a small number of _____ atoms. Lipids are used to store energy, as _____, form cell membranes, and provide the building blocks for hormones such as testosterone and estrogen. The most common examples of lipids are fats, oils, _____, and steroids. Lipids are generally _____ in water because they have a nonpolar region which is not attracted to _____molecules. Lipids are made of glycerol, a three-carbon molecule that serves as the 'backbone' for the structure to which the fatty acids are attached. A fatty acid is a long chain of carbon and hydrogen. If the carbon atoms in the chain are bonded to other carbons with _____bonds, the fatty acid is called a _____ **fatty acid**. When a _____ bond exists in the chain, the fatty acid is called an _____ **fatty acid**. Fatty acids which contain more than one double bond are called _____ **fatty acids**.



Proteins

Proteins are large, complex polymers which are made up of carbon, hydrogen, oxygen, _____, and sometimes _____ . They are one of the most abundant macromolecules found in living systems. A single living cell contains thousands of proteins that perform unique functions such as the contraction of _____ tissue, transportation of _____ in the bloodstream, _____, control of other proteins, and speeding up chemical reactions.

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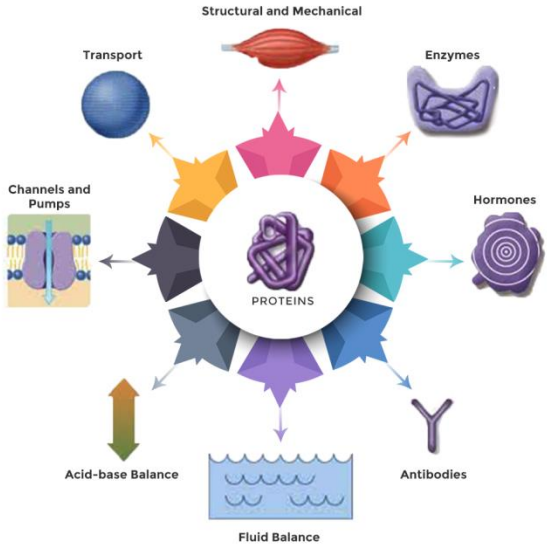
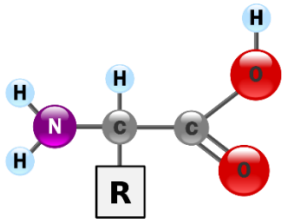


_____ are monomers that form the building blocks of a protein molecule. There are ____ naturally-occurring amino acids that, in various combinations produce thousands of proteins, each with their own unique function. An amino acid is composed of a central _____ atom which is bonded to a hydrogen atom, a carboxyl group (_____), an amine group (____), and a variable group (–R) that makes each amino acid different.



Amino acids are bonded together by covalent bonds called a _____ . The peptide bond is formed when the –H atom from the amine group of one amino acid and the –OH group from the carboxyl group of another amino acid are removed to release a _____molecule as is seen in the reaction below.

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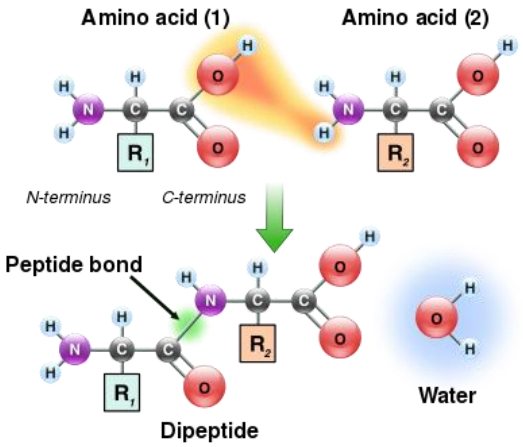
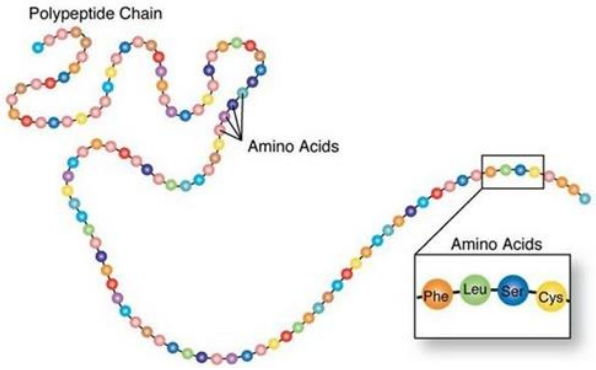


As the amino acids join together, they create a long chain known as a _____ shown in the diagram below.



The different chemical properties of amino acids cause them to attract and repel each other in different ways. The attraction and repulsion of the amino acids cause the polypeptide chain to ____back and forth on itself into pleated sheets or coiled up _____. The folding is then stabilized by hydrogen bonds. As the side chains interact and continue to fold up, the polypeptide forms a three-dimensional structure. This structure then joins with other coiled up polypeptide chains into the final protein which has a specific _____in the cell. This process is summarized in the diagram below.

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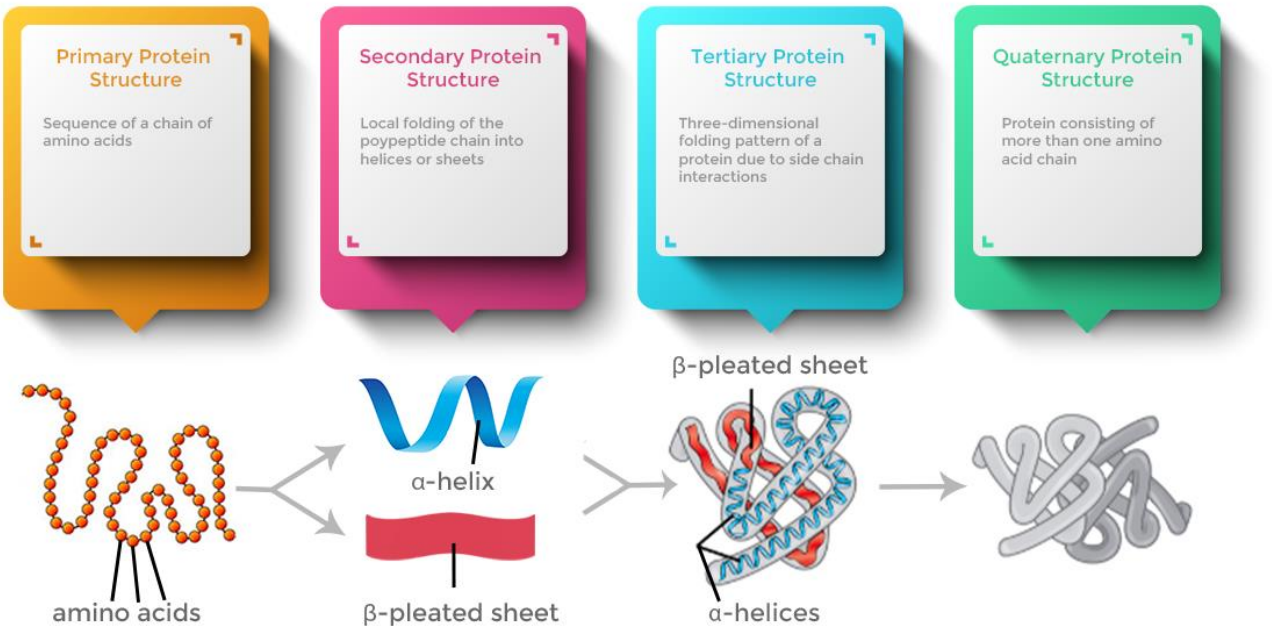

Two of the most common types of proteins which act in the human body are **enzymes** and **hormones**.

1. _____ speed up the rate of a biochemical reaction — for example, salivary amylase acts on starch found in bread, pasta and rice to break it down into monosaccharides such as _____.
2. _____ are biochemical messengers that are released by endocrine cells to control specific processes, such as growth, development, metabolism, and reproduction. The hormone insulin controls the amount of _____ present in the blood.

Nucleic acids

Nucleic acids are the genetic material that stores cellular information. These polymers are made up of small building blocks called _____. Nucleotides are composed of carbon, hydrogen, oxygen, nitrogen, and _____ atoms arranged as three separate molecules (a nitrogenous base, a sugar, and a phosphate molecule) which have been bonded together. The structure of the nucleotide is shown below.

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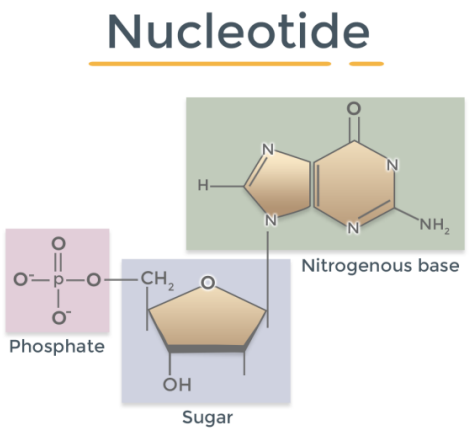

The two naturally-occurring varieties of nucleic acid are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

DNA (Deoxyribonucleic acid)

DNA is a double-stranded molecule which is found in the nucleus of the cell. It is the main copy of an organism's genetic code containing the _____ to create every protein required by the cell. These proteins are then expressed as characteristics or traits in the organism.

RNA (Ribonucleic acid)

RNA is the nucleic acid molecule which forms the copy of DNA that is used to make proteins. Unlike the DNA molecule, RNA is a single-stranded molecule. There are four types of RNA: messenger RNA (_____), ribosomal RNA (_____), transfer RNA (_____), and regulatory RNAs.