# Assignment Summary

For this assignment, you will develop a model of a macromolecule and use the model to predict the effect of structural and environmental changes on the function of the macromolecule. As part of the assignment, you will conduct research to learn about structural and environmental changes that may affect the function of the macromolecule of your choice.

Background Information

Three of the main biological macromolecules are carbohydrates, nucleic acids, and proteins. Carbohydrates include both sugars and polymers of sugars. Monosaccharaides include monomers such as glucose and fructose. If sugars are not used immediately for energy, they may form bonds. For example, two monosaccharide molecules called glucose and fructose bond to form sucrose. Carbohydrates that include two monomers of sugars are called disaccharides. Polysaccharides may have a few hundred to a few thousand monosaccharides joined by glycosidic linkages. The function and structure of a polysaccharide are determined by its sugar monomers and by the positions of its glycosidic linkages. Typically, all carbohydrates share the same ratio of carbon, hydrogen, and oxygen: 1:2:1. Most of the glucose monomers in starch are linked by α-1,4 glycosidic bonds. The simplest form of starch, amylose, is unbranched. The more complex starch, amylopectin, has the same basic structure, but they are branched polymers with α-1,6 linkages at the branch points. Like starch, glycogen is composed of D-glucose units. Its structure is very similar to the structure of amylopectin. However, glycogen is highly branched. In both starch and glycogen, the polymer chains tend to form helices in unbranched regions because of the angle of the α-1,4 linkage between the glucose monomers. Cellulose is a polymer of glucose with 1,4 glycosidic linkages. However, the linkages of the glucose monomers of cellulose are all in the β configuration instead of the α configuration in starches.

Nucleic acids are made up of monomers called nucleotides. Nucleotides usually have three components: a nitrogenous base, a five-carbon sugar, and a phosphate group. The phosphate and sugar form the backbone of the polynucleotide. Pyrimidines are larger and consist of one ring of carbon and nitrogen atoms. There are three types of bases with this structure: cytosine, thymine, and uracil.

Purines consist of two rings of carbon and nitrogen fused together. There are two types of bases with this structure: adenine and guanine. Cytosine, adenine, and guanine are found in both deoxyribonucleic acid, or DNA, and ribonucleic acid, or RNA. Thymine is only found in DNA and uracil is only found in RNA. These bases bond to one another with a hydrogen bond. Cytosine bonds with guanine. Adenine bonds with thymine in DNA and uracil in RNA. DNA is made up of two strands that are bound together with hydrogen bonds of the four bases. These strands twist around one another, creating a double helix structure. DNA strands are complimentary to one another, which is useful for making copies for new cells. Nitrogen base pairs found in DNA are paired in predictable ways, which is important for making accurate copies. Adenine bonds to thymine and guanine bonds to cytosine. RNA is single stranded, but its base pairs also bond in predictable ways. Adenine bonds to uracil and guanine to cytosine.

All proteins are made up of the same set of monomers: 20 amino acids. These 20 amino acids make up thousands of different proteins. The bond that forms between two amino acids is called a peptide bond. It, like all other polymers, forms via dehydration synthesis. Proteins have four levels of structures.

The primary structure consists of a long chain of amino acids bonded to one another with a peptide bond. The secondary structure appears when the chain of amino acids is coiled and folded. These coils are stabilized by hydrogen bonds between atoms of the polypeptide backbone. The tertiary structure is created when the side chains of the amino acids interact. As a polypeptide folds, amino acids with hydrophobic, nonpolar side chains usually form clusters at the central area of the protein. Once nonpolar amino acid side chains are close together, van der Waals interactions help keep them together. Hydrogen bonds between polar side chains and ionic bonds between positively and negatively charged side chains help stabilize the tertiary structure. Disulfide bridges may further stabilize the shape of a protein. Disulfide bridges are covalent bonds that form where two cysteine monomers, which have sulfhydryl groups on their side chains, get close together due to the folding of the protein. The sulfur of one cysteine bonds to the sulfur of the other cysteine, and the disulfide bridge connects parts of the protein. When the smaller subunits of the tertiary structure combine, the quaternary structure is made. The quaternary structure is the overall structure when the subunits of polypeptides are combined. In this transthyretin protein, there are four identical polypeptides that make up the structure. The sequence and the number of amino acids ultimately determine a protein's shape and size.

Any changes in structure and/or the environment can have a range of effects on any of these macromolecules. For example, mutations cause changes in the structure of DNA. These changes may result in various outcomes. Some mutations are helpful and others are harmful. For example, in humans, a mutation may lead to lactose tolerance, which is helpful. Or, a mutation may cause a genetic disorder or cancer.

Materials

* Access to the internet or other sources for conducting research
* Drawing supplies (colored pencils, paper, etc.)

# Assignment Instructions

For this project, you are expected to submit one item.

1. A completed version of this guide, featuring your diagrams and written analysis.

**Step 1: Prepare for the project.**

1. Read through the guide before you begin so you know the expectations for this project.
2. If there is anything that is not clear to you, be sure to ask your teacher.

**Step 2: Choose and research a macromolecule.**

1. Study the structure and function of the macromolecule of your choosing.
2. Research structural and environmental changes that can happen to the macromolecule.

**Step 3: Draw a diagram of your macromolecule.**

1. In the section below, draw a diagram of the macromolecule you researched.
2. Make sure you label monomers, polymers, and bonds.

**Step 4: Describe and diagram the predicted effect of the change on the structure of the macromolecule.**

1. Choose a structural or environmental change that occurs to your macromolecule.
2. Predict the effect this change will have on your macromolecule by answering question #1 in the **Written Analysis** section below.
3. Create a diagram modeling the structural change of the macromolecule in the **Written Analysis** section below.

**Step 5: Relate the change in structure to the change in function of the macromolecule.**

1. Describe how the change in structure changes the function of the macromolecule by answering question #3 in the **Written Analysis** section below.

**Step 6: Evaluate your project using this checklist.**

If you can check each box below, you are ready to submit your project.

* Did you research the structure and function of a macromolecule?
* Does your research include possible structural and environmental changes that can happen to your molecule?
* Did you draw and label a diagram of the macromolecule you researched?
* Did you choose a structural or environmental change that occurs to your macromolecule?
* Did you include a prediction of the effect this change will have on your macromolecule?
* Did you draw a diagram of the structural change of the macromolecule?
* Did you complete the **Written Analysis** section, including a description of how the structural changes of the macromolecule change its function?

**Step 7: Revise and submit your project.**

1. If you were unable to check off all of the requirements on the checklist, go back and make sure that your project is complete.
2. Submit your diagrams and written analysis to your teacher.
3. Congratulations! You have completed your project.

Macromolecule Diagram

In the box below, draw a diagram of your chosen macromolecule. Be sure to label each part of the macromolecule.

Written Analysis

Answer the questions below.

1. Describe the structural or environmental change of your chosen macromolecule. Then predict the effect this change will have on the macromolecule. Include scientific reasoning that supports your prediction.
2. Draw a diagram that demonstrates the structural change of your macromolecule.
3. How does the change in structure of the macromolecule changes its function? How might these changes effect an organism as a whole?