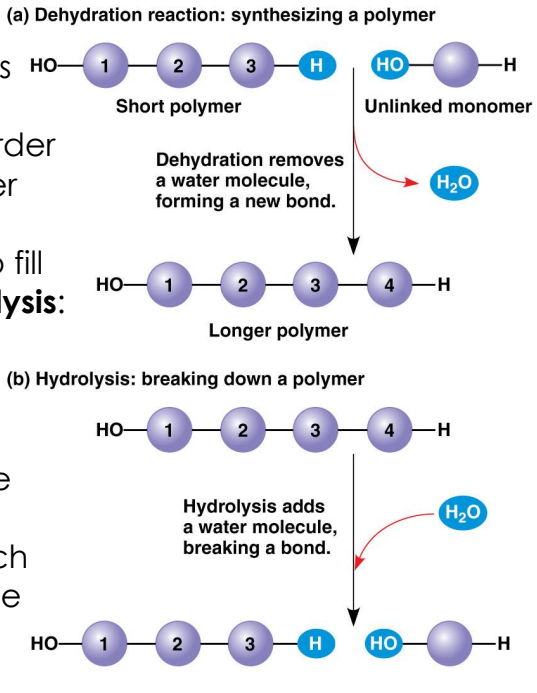
Name(s):	Period:	Date:

Dehydration Synthesis and Hydrolysis

The chemical reactions that bond together macromolecules are similar and require water. When macromolecules are consumed, they must be broken down during digestion in order to be absorbed by the body. Polymers are bonded together with covalent bonds (shared electrons between atoms). To break this bond, water (H_2O) molecules are split and used to fill the space created by the broken bond. This is called **hydrolysis**: "hydro" means water, and "lysis" means to split apart.

Once a polymer has been broken apart and the monomers have been absorbed, they may need to be bonded back together to form new polymers within the body. To allow the bond between monomers, a hydrogen (H) atom and a hydroxide (OH) molecule are removed from the ends of each monomer. When these are removed, it creates a spot for the two monomers to form a covalent bond with each other; thus the H and OH come together to form a water (H_2O) molecule. This is called **dehydration synthesis**: "dehydration" means losing water, and "synthesis" means to create.



http://classconnection.s3.amazonaws.com/739/flashcards/850739/jpg/05_02_polymers-l1326646861804.jpg

Analysis & Interpretation

Answer the following questions using data from your lab.

Analysis Questions – *answer questions on a separate sheet of paper*

1. What is the difference between a monomer and a polymer?
2. In this activity what did the Velcro represent?
3. Energy is both stored and released. How was that modeled using the Velcro?
4. Make a table listing the monomers and polymers of proteins, carbohydrates, lipids, and nucleic acids.
5. All polymers and monomers are organic molecules. What are the three criteria that make these molecules organic?
6. What is the meaning of the following terms… hydro? Lysis? Dehydration? Synthesis?
7. What is the purpose of hydrolysis?
8. What is the purpose of dehydration synthesis?
9. Explain hydrolysis using a diagram from the activity.
10. Explain dehydration synthesis using a diagram from the activity.
11. How do the dehydration synthesis and hydrolysis reactions compare to each other?
12. Based on what you have learned about hydrolysis and dehydration synthesis, why do you think water is so important to the body?

Macromolecules and Digestion

HASPI Medical Biology Lab 07a

Part A: Building Macromolecules

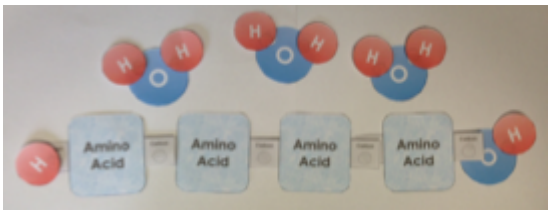
Our bodies are amazing machines capable of breaking down and building up complex molecules required for life. Since these molecules are microscopic, it is easier to understand how they are built using models. In this part of the activity, your team will be modeling dehydration synthesis and hydrolysis to obtain a better understanding of these processes before investigating digestion.

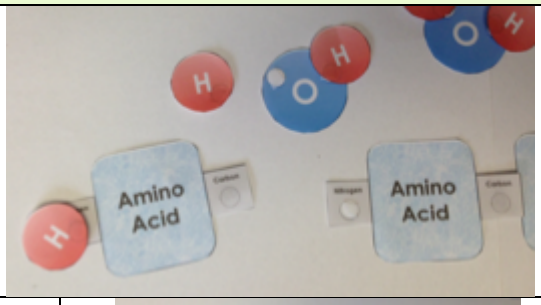
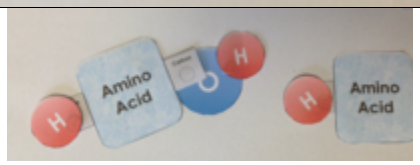
Materials

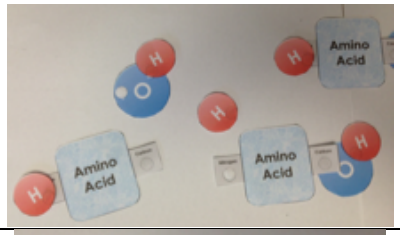
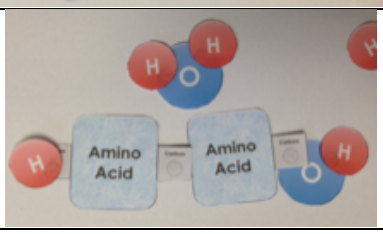
Velcro dots black (10)
Velcro dots white (10)
Macromolecule template
Scissors

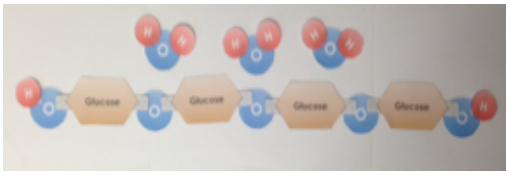
Procedure/Directions

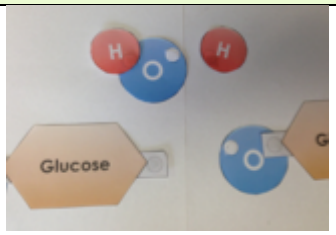
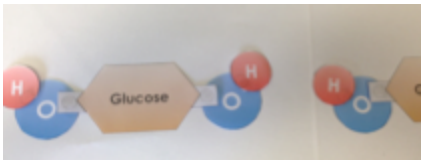
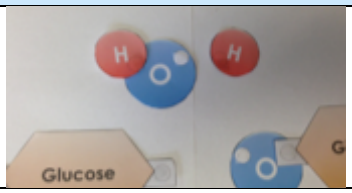
Your lab team will be given tasks, or directions, to perform on the left. Record your questions, observations, or required response to each task on the right.

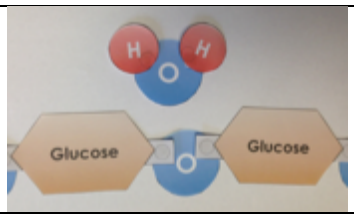
Proteins (p)		
	Task	**Response**
1p	Put the 4 amino acid monomers, 4 oxygen atoms, and 8 hydrogen atoms on the table. Push all of the other items to the side.	*a. What are the monomers of protein?*
2p	Each of the black Velcro dot sections will attach to the white Velcro dot sections. The Velcro represents bonds between molecules.	*b. What does the Velcro represent?*
3p	Create the molecules you will need. Make three water molecules. To form a protein, bond each amino acid to each other between the carbon and nitrogen atoms. There cannot be any open bonds (Velcro), so bond an oxygen and hydrogen to the right end and a hydrogen to the left end of the protein chain (see image).	

Hydrolysis of Proteins		
4p	When the body needs to break down protein, it splits the bond between each amino acid molecule, and splits water to fill the bonds.	
5p	To perform hydrolysis on your protein chain, break a bond (separate the Velcro) between two of the amino acid molecules.	
6p	Break the bond between one of the hydrogen atoms and oxygen on the water molecule.	
7p	The hydrogen atom bonds to the nitrogen atom, and the OH bonds to the carbon atom.	
8p	Repeat steps 6-8 on the remaining amino acids. This process happens when your body digests proteins into the building block amnio acids.	

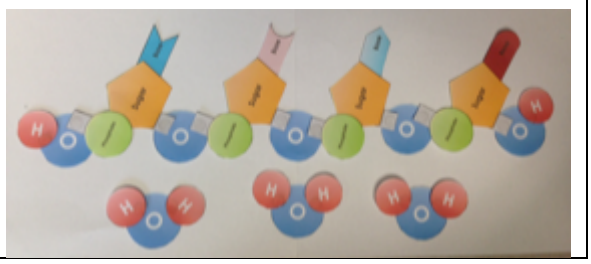
Dehydration Synthesis of Proteins		
9p	The body uses the amino acids it has broken down to build proteins needed for the body to function correctly.	
10p	This is the opposite of hydrolysis. Remove the hydrogen atom from the nitrogen of one amino acid molecule, and an OH molecule from the carbon of a <u>different</u> amino acid molecule.	
11p	Bond the carbon and nitrogen atoms to each other.	
12p	Notice you have a hydrogen atom and an OH molecule remaining. Bond these together to form a water molecule.	
13p	Repeat steps 11-13 for the remaining amino acid molecules.	

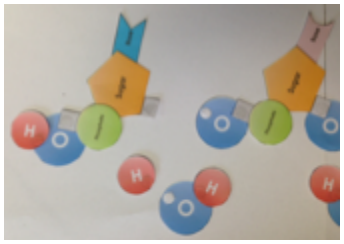
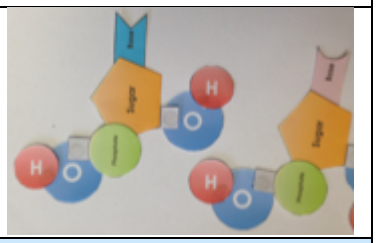
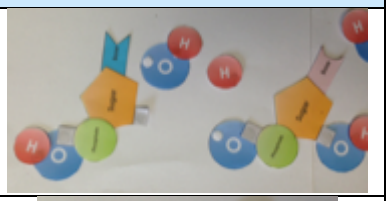
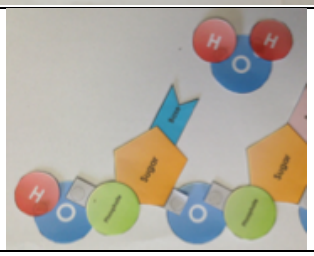
Carbohydrates (c)		
	Task	**Response**
1c	Put the 4 glucose monomers, 8 oxygen atoms, and 8 hydrogen atoms on the table. Push all of the other items to the side.	*a. List two monomers of carbohydrates.*
2c	Form three water molecules. To form a carbohydrate chain, connect each glucose molecule with an oxygen atom. There cannot be any open bonds, so add OH to both ends of the carbohydrate chain (see image). Carbohydrate chains can be thousands of sugar molecules long.	

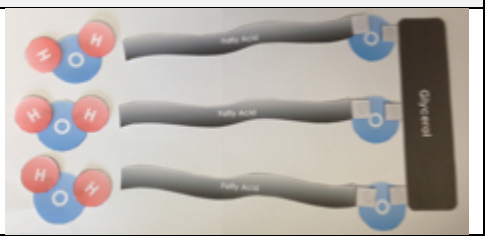
3c	When carbohydrates are consumed, they must be broken down into individual sugar molecules to be used to create energy in cellular respiration.	
Hydrolysis of Carbohydrates		
4c	When the body needs to break down carbohydrates, it splits the bond between each sugar molecule, and splits water to fill the bonds.	
5c	To perform hydrolysis on your carbohydrate chain, break a bond (separate the Velcro) between two of the glucose molecules.	
6c	Break the bond between one of the hydrogen atoms and oxygen on the water molecule.	
7c	One of the glucose molecules should still have an oxygen atom attached. Bond the hydrogen atom that you split from the water molecule to this oxygen atom.	
8c	Bond the OH molecule remaining from water to the remaining open bond on the glucose molecule (see image).	
9c	Repeat steps 7-10 for the two remaining bonds on the carbohydrate chain.	
Dehydration Synthesis of Carbohydrates		
10c	If the body has excess sugar, it can bond sugar together and store it for later use.	
11c	This is the opposite of hydrolysis. Remove the hydrogen atom from the right side of one glucose molecule, and an OH molecule from the left side of a <u>different</u> glucose molecule.	

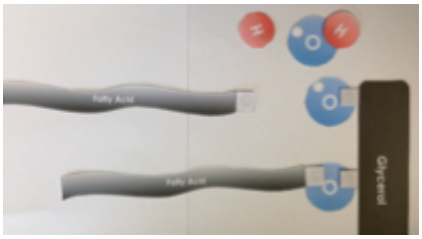
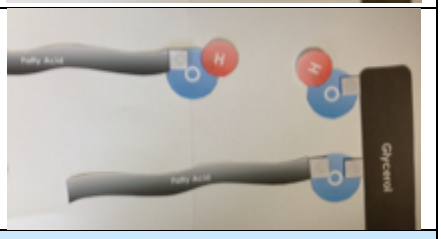
12c	Bond the remaining oxygen atom that is attached to glucose to the other glucose molecule.	
13c	Notice you have a hydrogen atom and an OH molecule remaining. Bond these together to form a water molecule.	
14c	Repeat steps 13-15 for the two remaining glucose molecules. You should end up with a carbohydrate chain and 3 waters.	

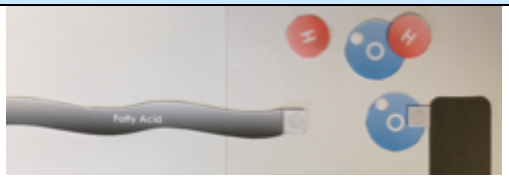
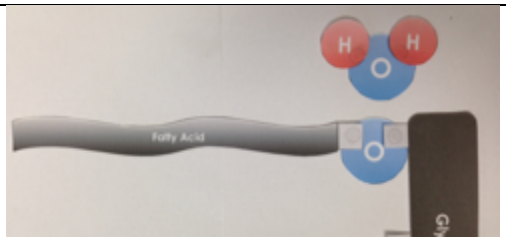
Nucleic Acids (n)

	Task	Response
1n	Put the 4 nucleotide monomers, 8 oxygen atoms, and 8 hydrogen atoms on the table. Push all of the other items to the side.	*a. What are the monomers of nucleic acids?*
2n	To form a nucleic acid (DNA), attach each nucleotide to one another using an oxygen atom between the sugar and phosphate (see image). You will also need 3 water molecules.	
3n	There cannot be any open bonds (Velcro), so it is necessary to bond an oxygen and hydrogen to both ends of the nucleic acid (see image).	

Hydrolysis of Nucleic Acids		
4n	When the body needs to break down nucleic acids, it splits the bond between each nucleotide, and splits water to fill the bonds.	
5n	To perform hydrolysis on your nucleic acid, break a bond (separate the Velcro) between nucleotides. Leave the oxygen attached to one of the nucleotides.	
6n	Break the bond between one of the hydrogen atoms and oxygen on the water molecule.	
7n	The hydrogen atom bonds to the remaining oxygen on a nucleotide, and the OH bonds to the other nucleotide.	
8n	Repeat steps 7-9 on the remaining nucleotides.	
Dehydration Synthesis of Nucleic Acids		
9n	Nucleotides are bonded together to form nucleic acids, which include DNA and RNA.	
10n	This is the opposite of hydrolysis. Remove an OH molecule from one nucleotide, and a hydrogen atom from a <u>different</u> nucleotide.	
11n	Bond the nucleotides to each other using the oxygen atom.	
12n	Notice you have a hydrogen atom and an OH molecule remaining. Bond these together to form a water molecule. Repeat steps 12-14 for the remaining nucleotide molecules.	

Lipids (L)		
Task		**Response**
1L	Put the 3 fatty acid molecules, glycerol molecule, 6 oxygen atoms, and 6 hydrogen atoms on the table. Push all of the other items to the side.	*a. What are the monomers of lipids?*
2L	Each of the black Velcro dot sections will attach to the white Velcro dot sections. The Velcro represents bonds between molecules.	
3L	To form a lipid, attach each fatty acid molecule to the glycerol molecule using an oxygen atom (see image).	
4L	Water is also needed for hydrolysis, so using the remaining oxygen and hydrogen atoms create 3 water molecules.	

Hydrolysis of Lipids		
5L	When the body needs to break down lipids, it splits the bond between fatty acid molecules, and splits water to fill the bonds.	
6L	To perform hydrolysis on your lipid, break a bond (separate the Velcro) between a fatty acid and glycerol. Leave the oxygen attached to glycerol.	
7L	Break the bond between one of the hydrogen atoms and oxygen on the water molecule.	
8L	The hydrogen atom bonds to the remaining oxygen on glycerol, and the OH bonds to the fatty acid.	
9L	Repeat steps 6-8 on the remaining fatty acids.	

Dehydration Synthesis of Lipids		
10L	Fatty acids and glycerol are bonded together to form lipids, or fats.	
11L	This is the opposite of hydrolysis. Remove the OH molecule from the fatty acid molecule, and the hydrogen atom from the glycerol.	
12L	Bond the fatty acid and glycerol molecules to each other using the oxygen atom.	
13L	Notice you have a hydrogen atom and an OH molecule remaining. Bond these together to form a water molecule.	
14L	Repeat steps 11-13 for the remaining fatty acid molecules.	