

# THE CHEMICAL BUILDING BLOCKS OF LIFE

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## Activities

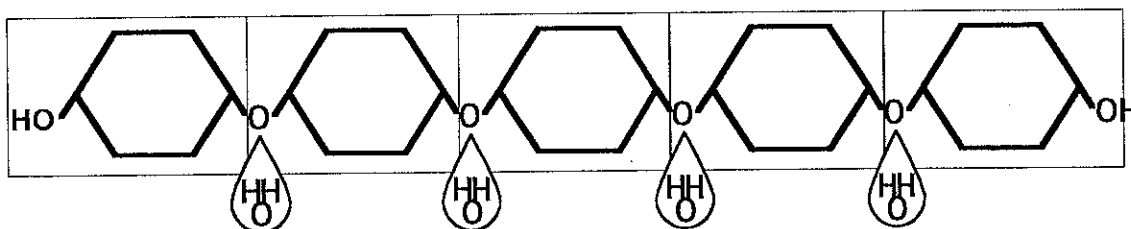
### Building macromolecules

This is a cut-and-tape paper exercise to emphasize the process of dehydration synthesis. Although this may seem elementary for an AP level class, this unit is very abstract and needs tangible reinforcement. This exercise gives students a hands-on educational activity and a concrete model hanging in the classroom throughout the year to remind them of the abstract chemistry concepts.

#### 1. Building Carbohydrates

Copy the glucose molecule onto a variety of colored papers and copy the water drops onto blue paper. Have pairs of students take 2 differently colored glucose molecules. Before making any bonds have the students number the carbons so they become used to that convention (be sure they find the 6' carbon). Then have the students join (bond) the two glucoses together by cutting off an  $-H-$  from one molecule and an  $-OH-$  from another and taping the 2 molecules together forming a glycosidic bond. Then have the students take the trimmed  $H-O-H$ , affix it to the water drop, and tape the water drop onto the glycosidic bond. The students can then name each of their sugar monomers — you can allow them to have fun here and name them imaginative names but they must end in “-ose” to remind them of the naming convention of sugars. Once this is complete they will take their disaccharide and bond it in the same manner with another pair of students using the same paper dehydration synthesis process. This can continue with additional groups until you have a multi-colored long chain polysaccharide which can be hung on the walls of the classroom.

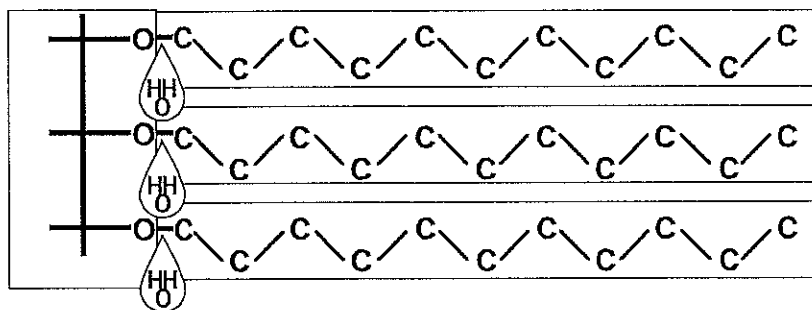
For this exercise, you will need the PDF files for glucose and also water droplets to symbolize dehydration synthesis.



#### 2. Building Lipids (a triglycerol fat)

Copy the glycerol and fatty acid molecules onto a variety of colored papers and copy the water drops onto blue paper. Have pairs of students take one glycerol molecule and three differently colored saturated fatty acid molecules and join them by cutting off an  $-H-$  from one molecule and an  $-OH-$  from another and taping the two molecules together forming an ester bond. Then have them take the trimmed  $H-O-H$ , affix it to the water drop, and tape the water drop onto each ester bond. This emphasizes to the students that lipids are not polymers, rather they are large hydrocarbon molecules.

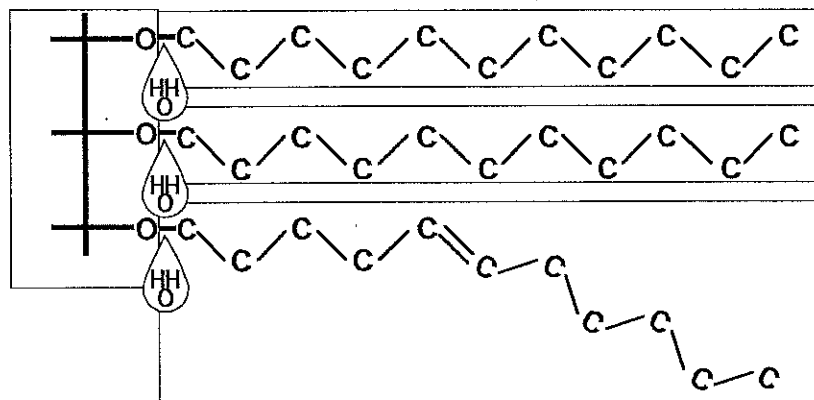
It also illustrates how the saturated hydrocarbon chain of the fatty acid allows the fat molecules to lie close together creating a solid at room temperature, like butter and other animal fats.



Students can then build a second lipid replacing one of the saturated fatty acids with an unsaturated fatty acid to illustrate how the double bond within the fatty acid separates the molecules further apart and creates a liquid at room temperature, like vegetable oils.

For this exercise, you will need the PDF files for glycerol, saturated fatty acids, unsaturated fatty acids and also water droplets to symbolize dehydration synthesis. I tend to use the smaller water droplets so they fit better in the molecule.

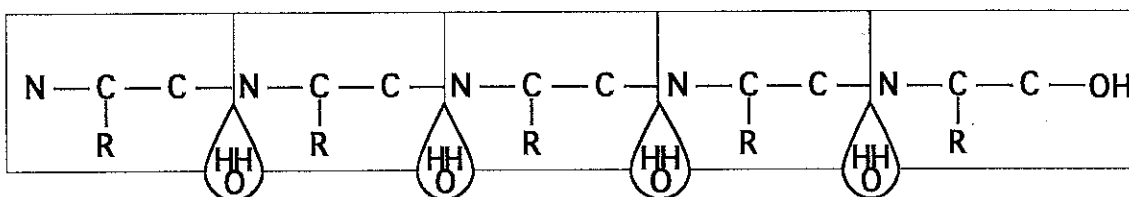
(BTW, I like to have a little fun by holding up one of the completed fat molecules afterwards and asking the students, "Does this make me look fat?" They always groan!)



### 3. Building Proteins (polypeptides)

Copy the amino acid molecules onto a variety of colored papers and copy the water drops onto blue paper. Give groups of students an amino acid sequence to use as a set of instructions. Have the students use the textbook to look up the amino acid names and whether each amino acid is charged or uncharged, polar or nonpolar and have them write the name & the chemical characteristic on each paper amino acid. This emphasizes the different chemical nature of each amino acid. Students join (bond) the amino acids together by cutting off an  $-H-$  from one molecule and an  $-OH-$  from another and taping the two amino acid molecules together forming a peptide bond. Then have them take the trimmed  $H-O-H$ , affix it to the water drop, and tape the water drop onto the peptide bond. Be sure to emphasize that this is a very short polypeptide and that functional proteins can be hundreds of amino acids long. You can allow them to have fun here and name the polypeptide an imaginative name but the name must end in  $-in$  to remind them of the naming convention of sugars.

For this exercise, you will need the PDF files for 20 amino acids and also water droplets to symbolize dehydration synthesis.



#### 4. Building DNA

Copy the template strand of a DNA molecule and the separate nucleotides onto a variety of colored papers. First have students number the carbons on the deoxyribose sugars of the template strand. Be sure they find the 5' carbon. This will help them in the molecular genetics unit. Then have the students build the complementary strand by matching nucleotides to the template strand. Ask them to observe if there is anything different between the two strands and point out the anti-parallel configuration of template and complementary strands as well as the 3' and 5' ends of each strand. Again this will help them in the later molecular genetics unit. Discuss the different bonds within the molecule that make it a good information encoding molecule: the strong covalent bonds in the backbone, the weak H bonds between strands, the complementary base pairing that enable replication and error correction. These DNA molecules can be hung from the lights and ceiling of your classroom.

For this exercise, you will need the PDF files for the template DNA strand, nucleotides, and also water droplets to symbolize dehydration synthesis. I tend to use the smaller water droplets.

Date:            Hour:

Topic:  
Lesson Goal:

Lesson Target:

## Macromolecules Activity Sheet

Carbohydrate - Made up of \_\_\_\_\_

*Paste your molecule here*

Notes about molecule:

How did you "stick" the molecules together?

What do we call this process?

What would happen in the reverse process?

Lipid - made up of \_\_\_\_\_

*Paste your molecule here*

Notes about molecule:

Did the process of "sticking" the molecules together differ from carbs?

What difference did the presence of double bonds make in the molecule?

Protein - Made up of \_\_\_\_\_

*Paste your molecule here*

Notes about molecule:

Did the process of "sticking" the molecules together differ from carbs or lipids?

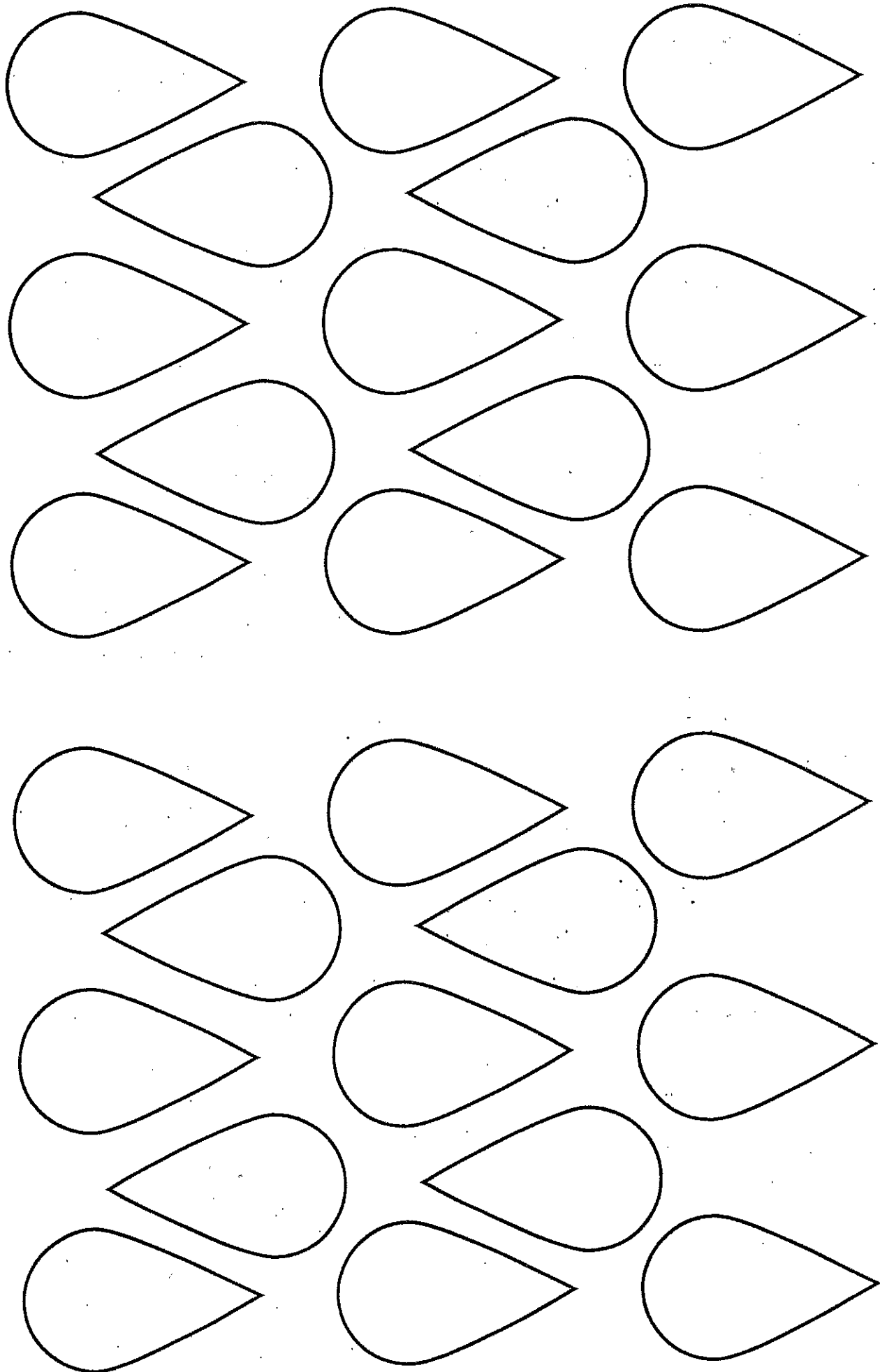
What was different about the type of bond that is formed?

Nucleic Acid (DNA) - Made up of \_\_\_\_\_

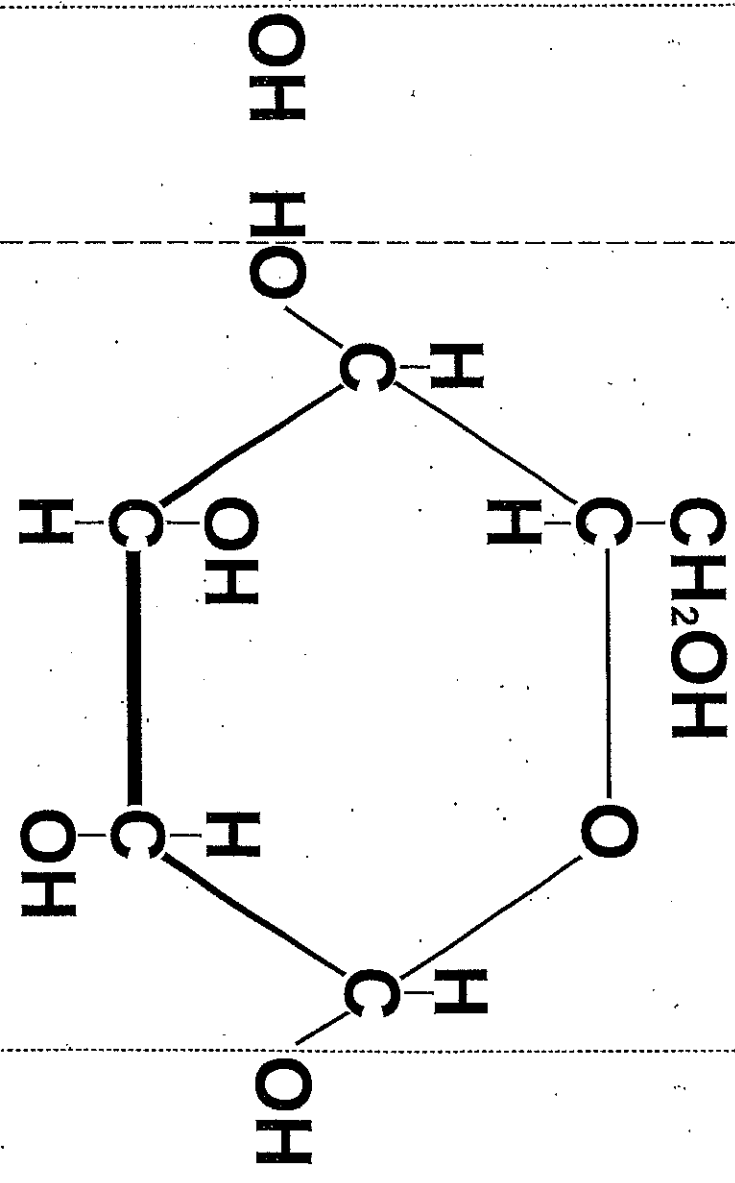
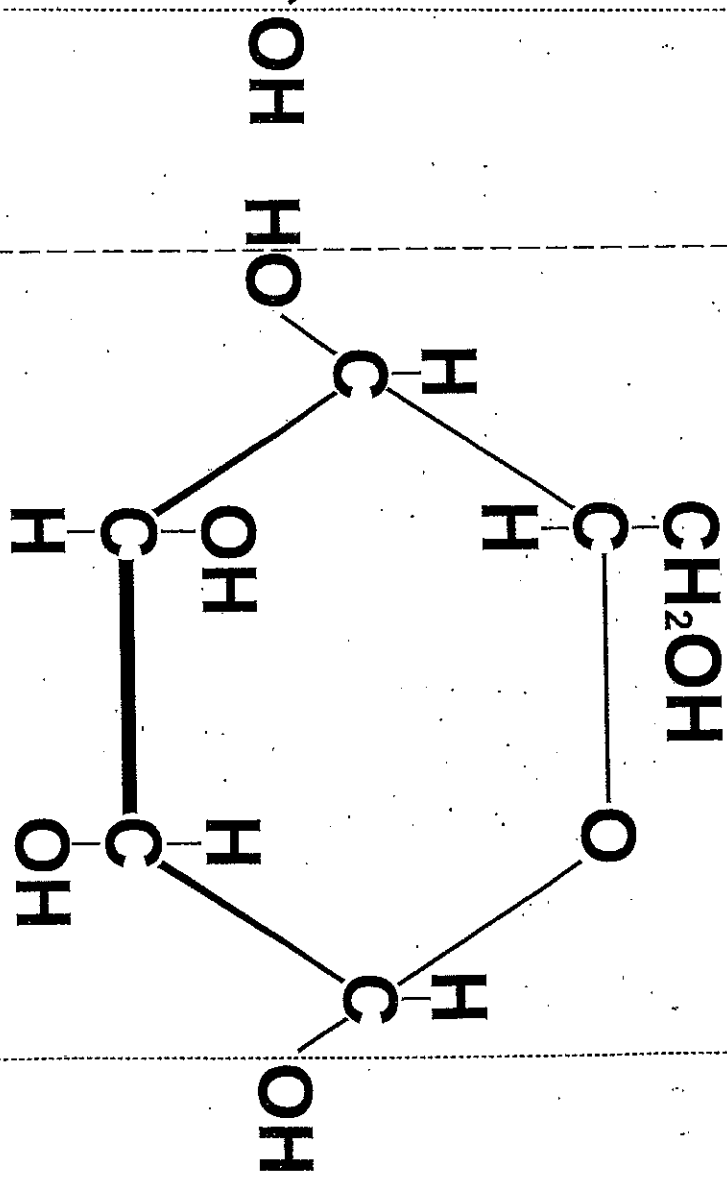
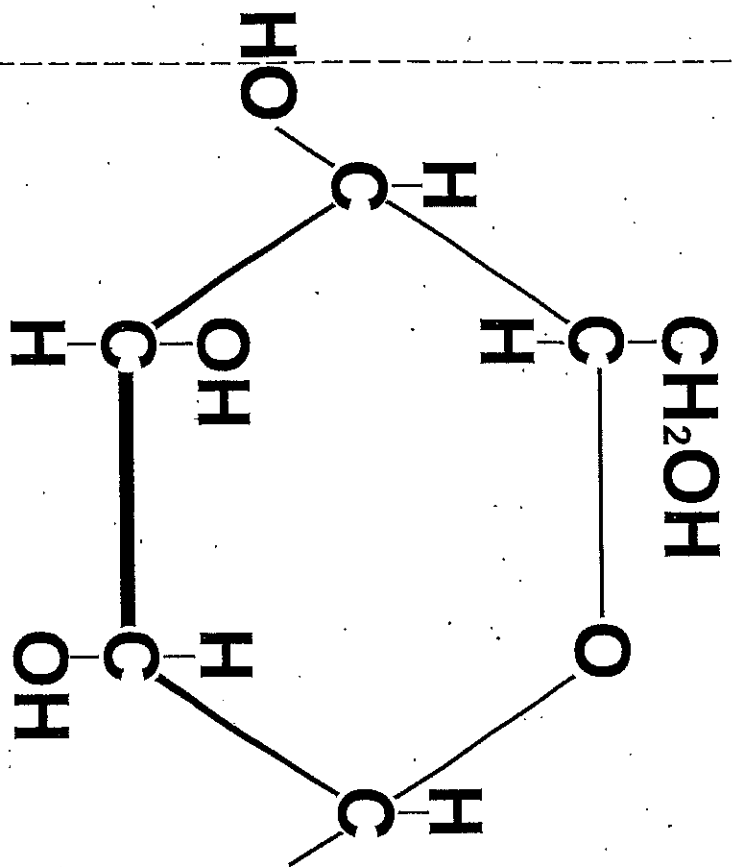
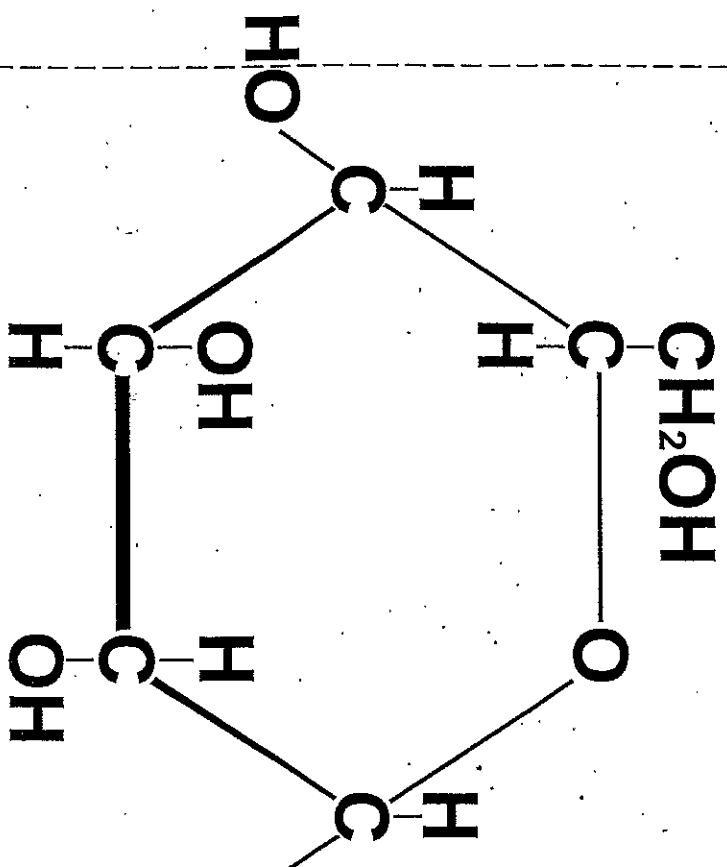
*Paste your molecule here*

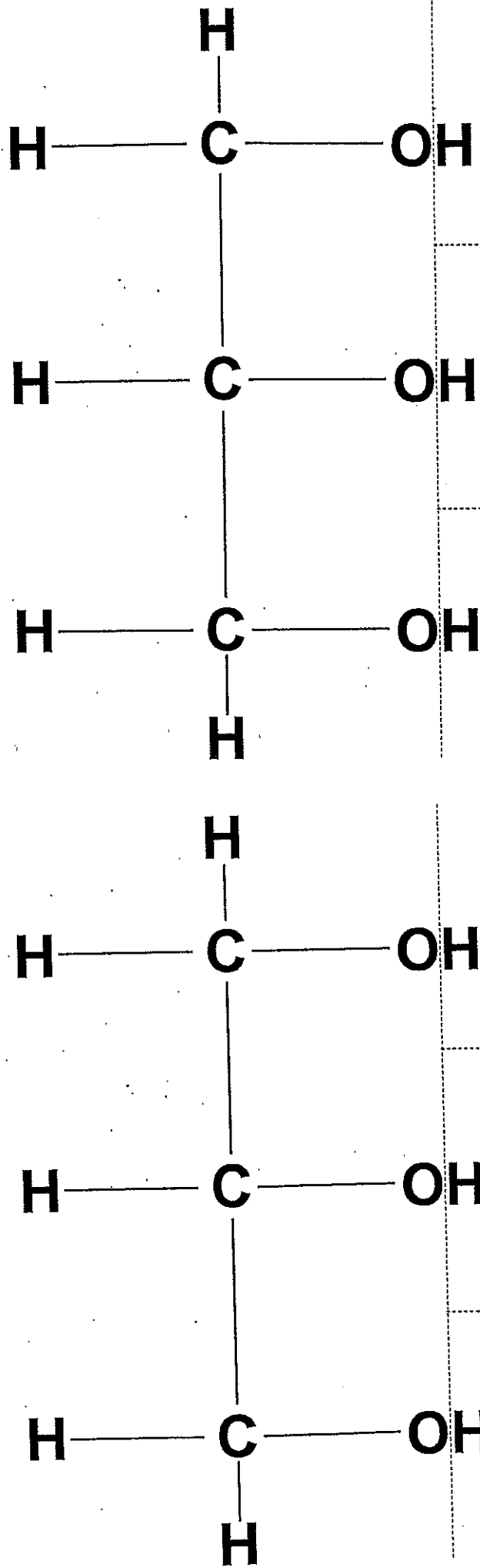
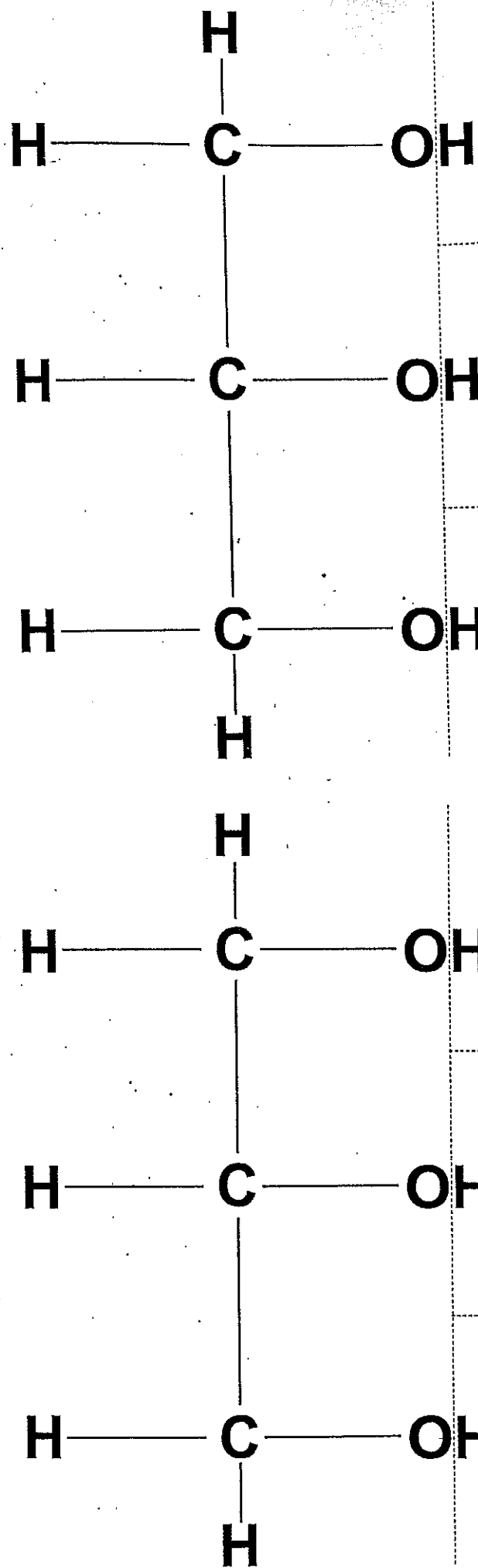
Notes about molecule:

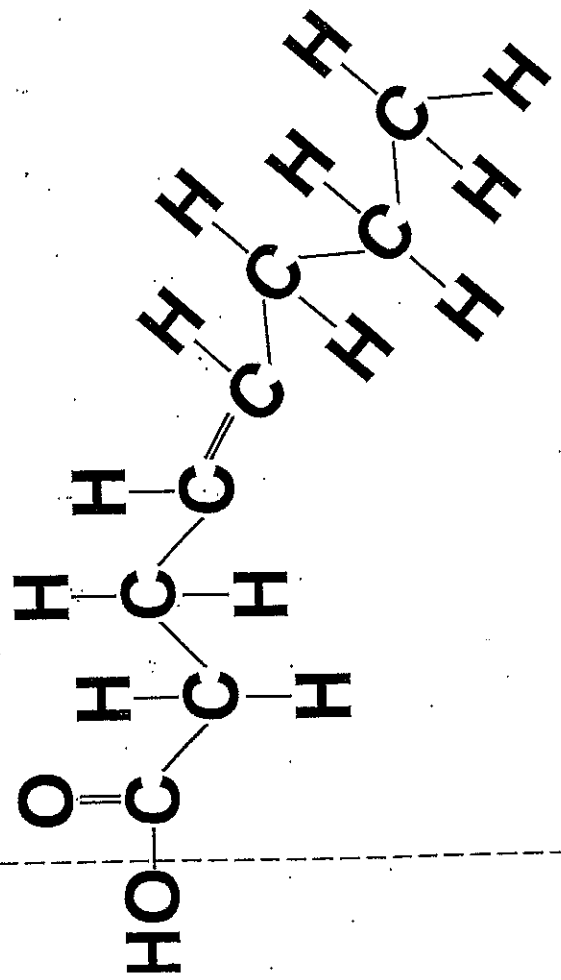
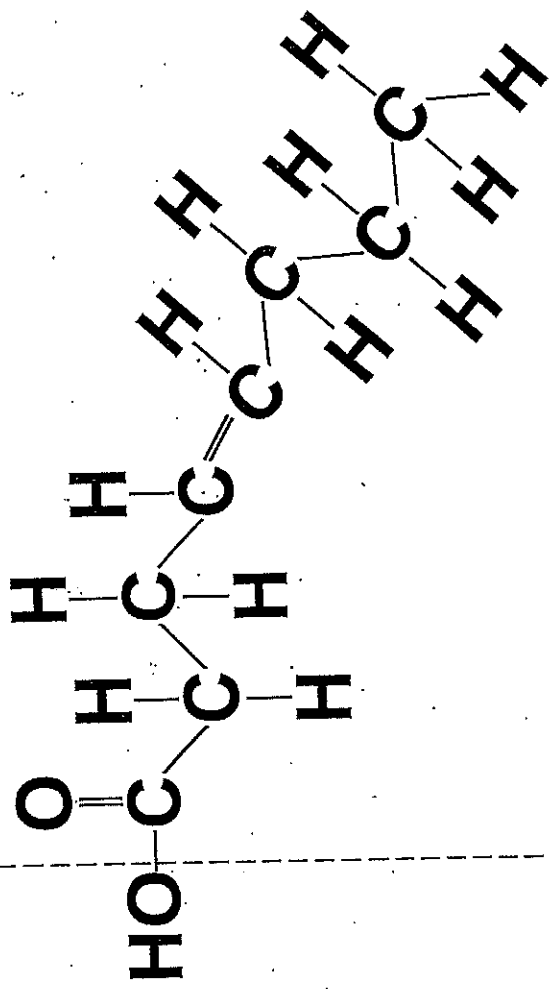
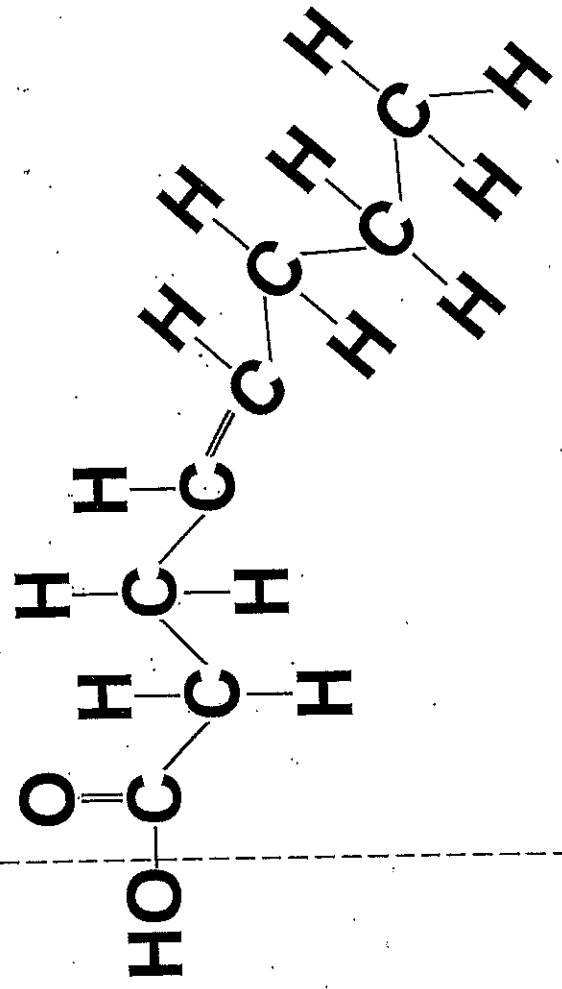
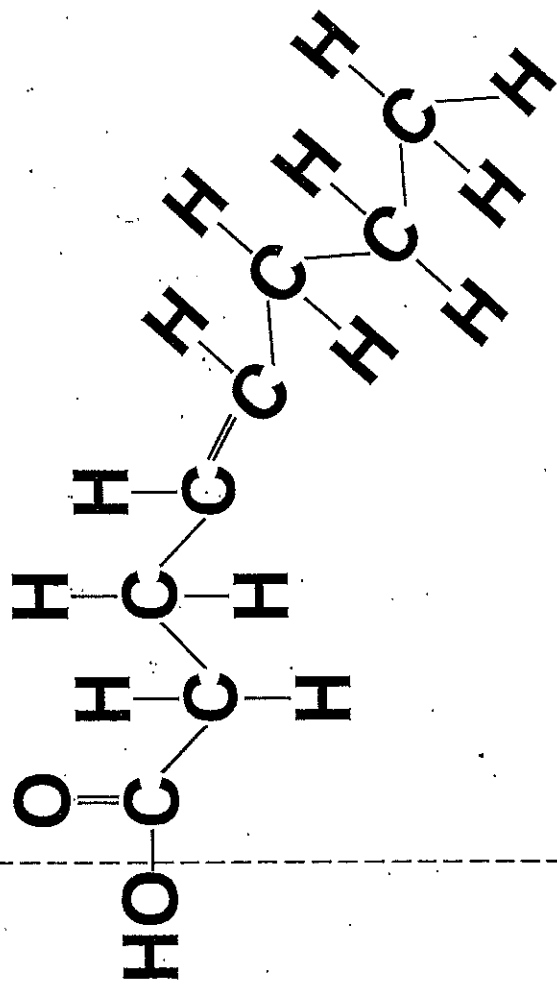
Did the process of "sticking" the molecules together differ from carbs or lipids?

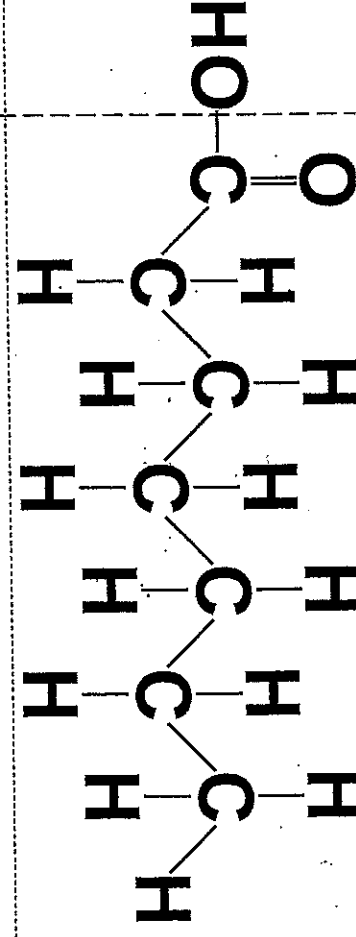
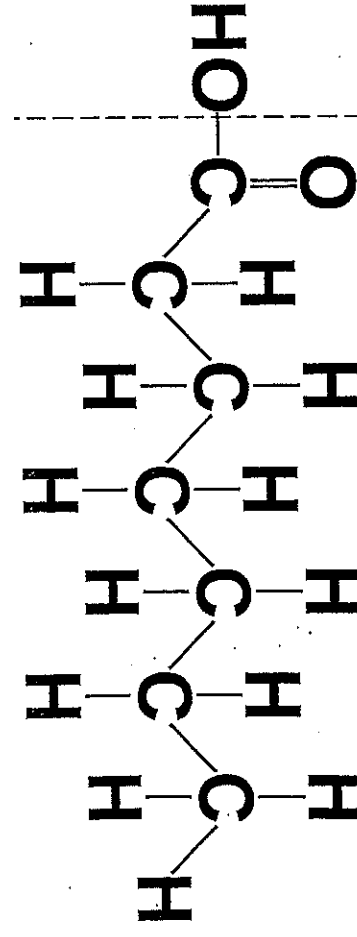
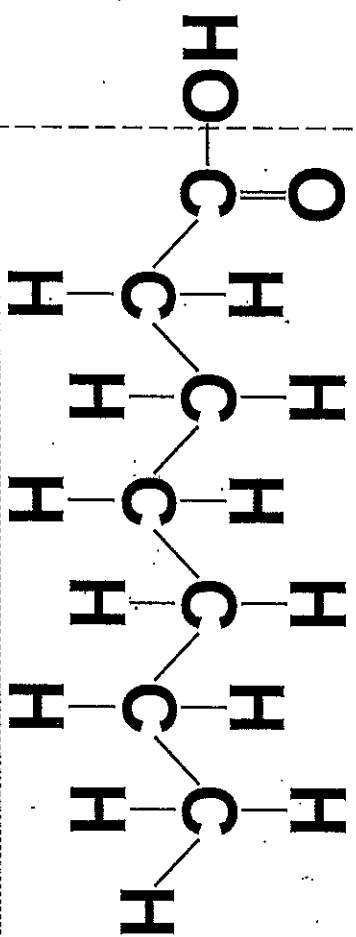
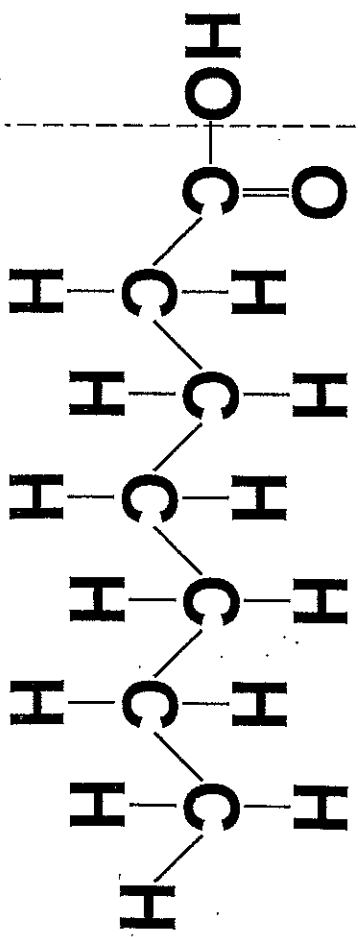
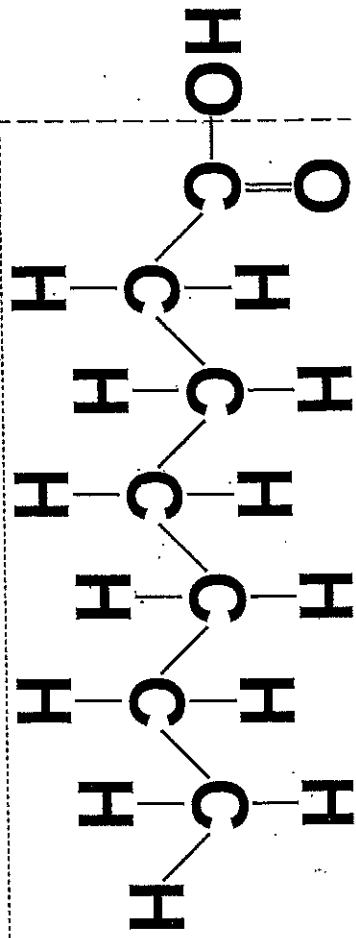
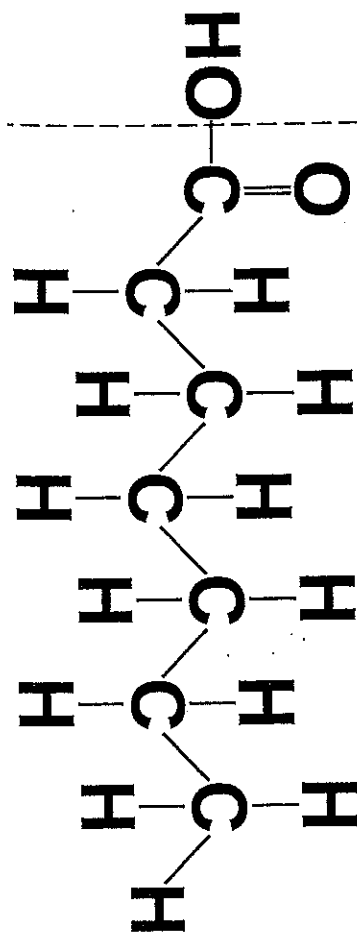
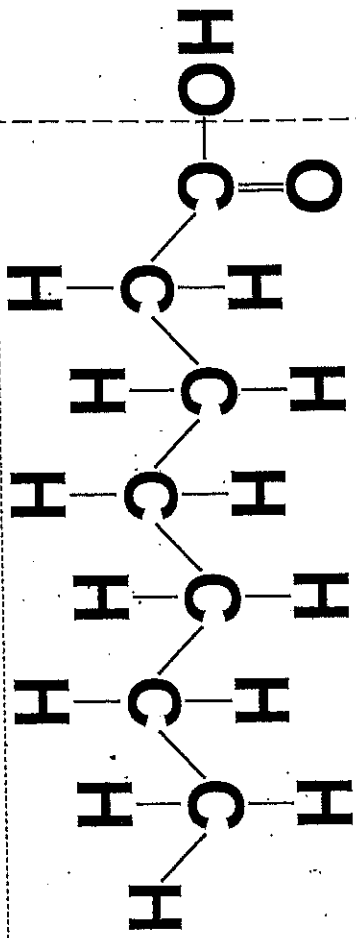
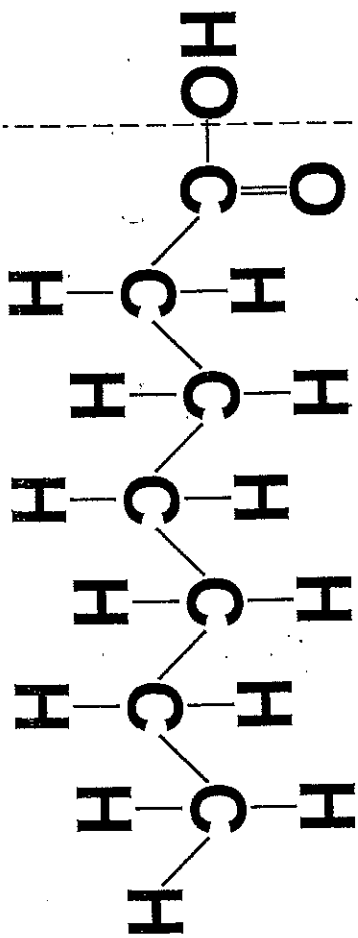






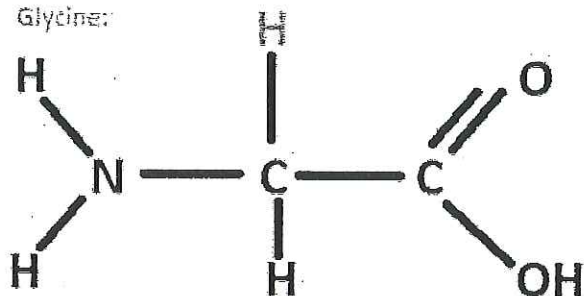




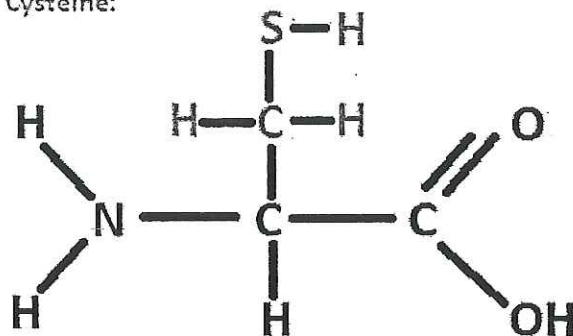


# Amino Acids 1

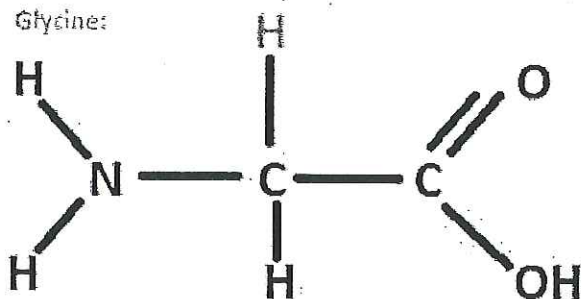
Glycine:



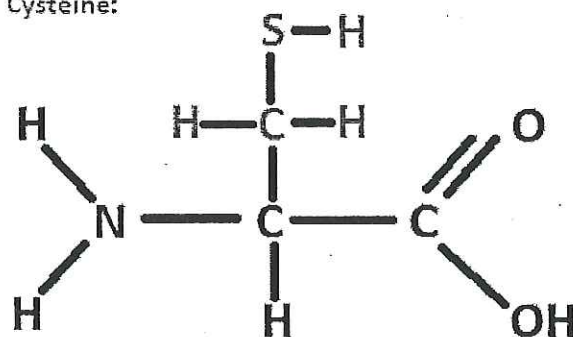
Cysteine:



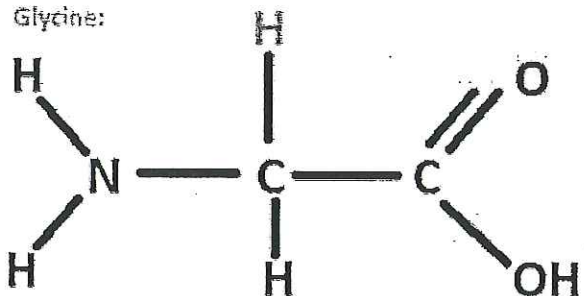
Glycine:



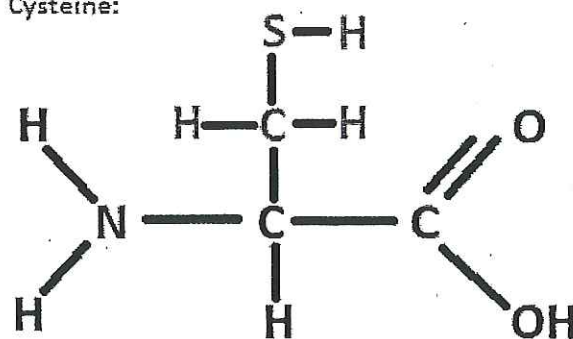
Cysteine:



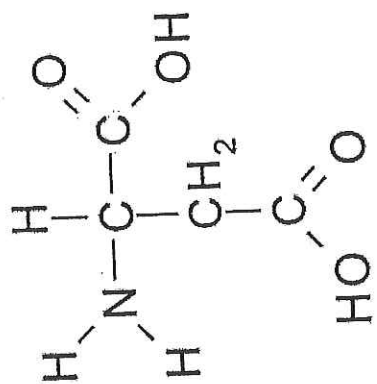
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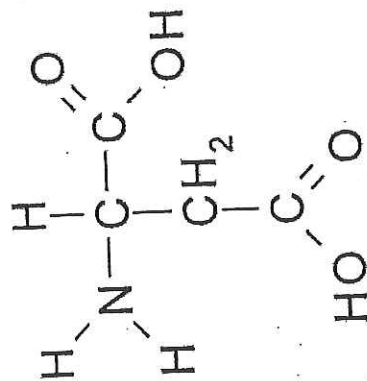
Cysteine:



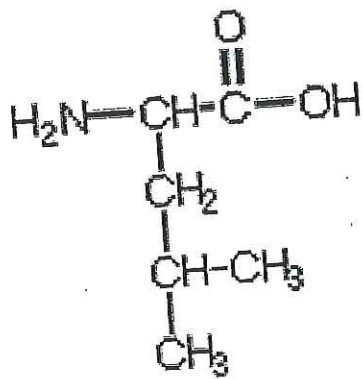
Amino Acids 2



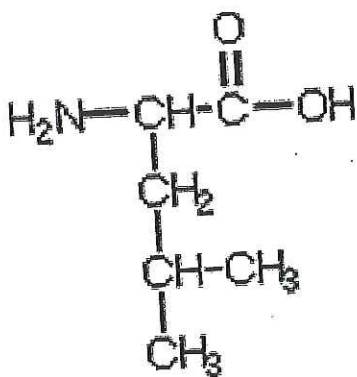
Aspartic Acid



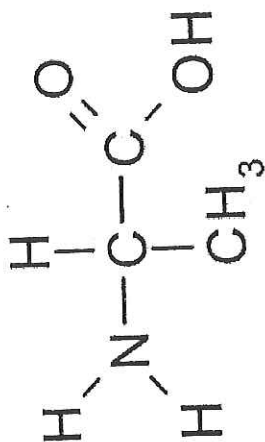
Aspartic Acid



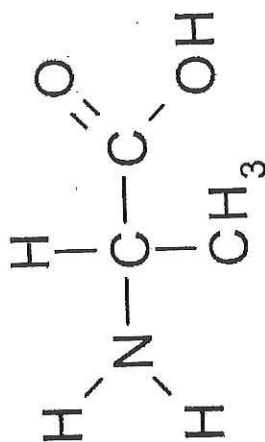
Leucine



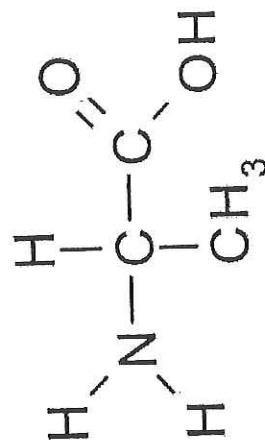
Leucine



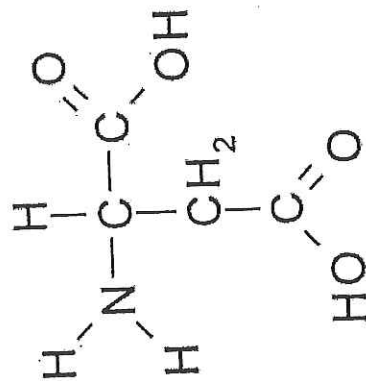
Alanine



Alanine

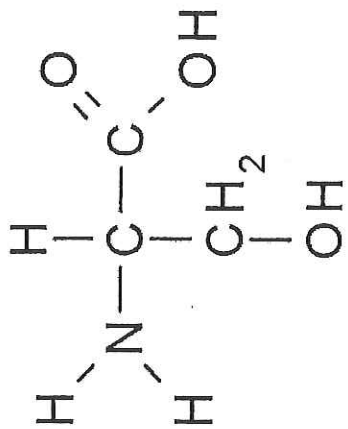


Alanine

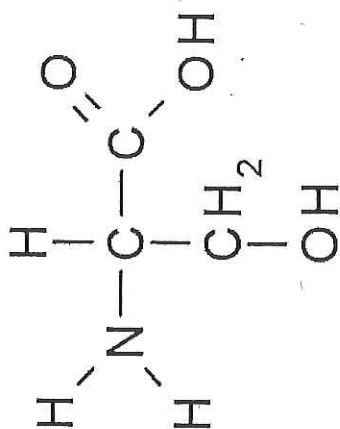


Aspartic Acid

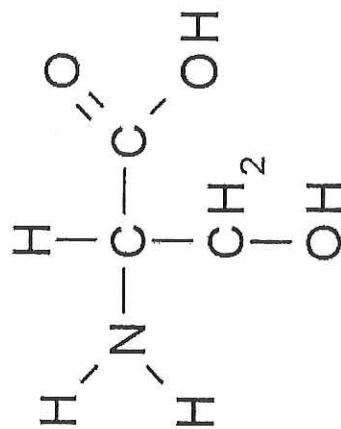
Amino Acids 3.



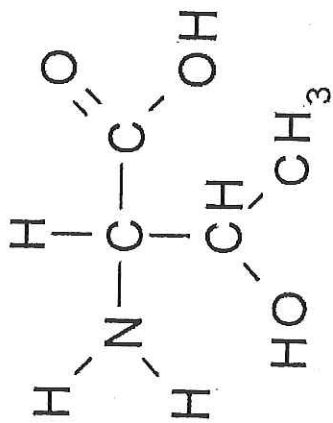
Serine



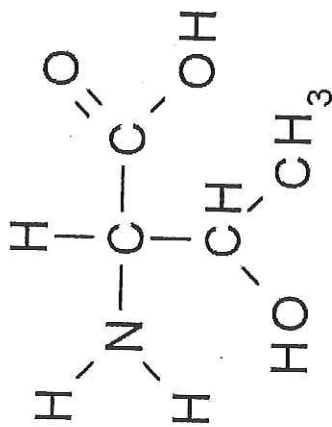
Serine



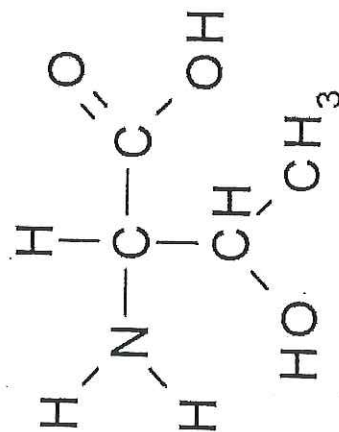
Serine



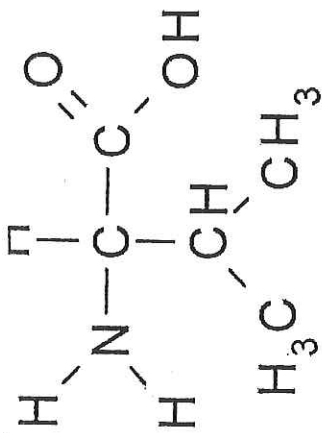
Threonine



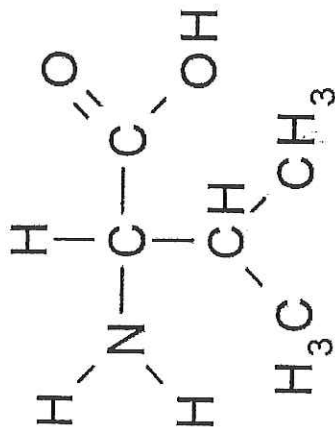
Threonine



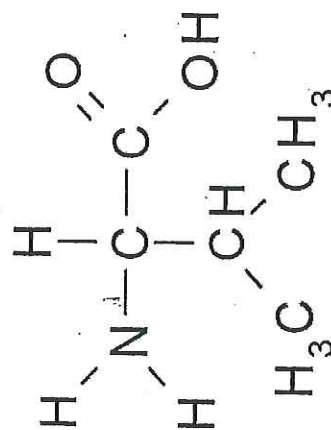
Threonine



Valine



Valine



Valine





