CHEMISTRY OF NUTRIENTS KIT

Each set you will use will consist of the following parts:

14 Black Carbon atoms	4 Blue Nitrogen atoms
13 Red Oxygen atoms	58 Green covalent bonds
32 White Hydrogen atoms	8 flexible white covalent bonds

CARBOHYDRATES: CH_2O

Monosaccharides: Most monosaccharides contain six carbon atoms in the molecule. Examples are glucose and fructose, both of which have the molecular formula $C_6H_{12}O_6$ and possess ring structures which are readily broken.

GLUCOSE: Exists most commonly in the form of a six-membered ring.

1. Construct first a ring as in figure 1 using the green bond connectors. Place the model on a flat surface, aligned as in figure 1, and attach groups as shown in figure 2 to the upward pointing carbon pegs.

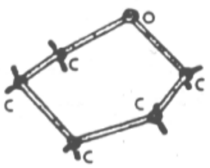


Figure 1

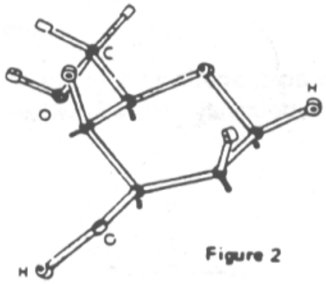


Figure 2

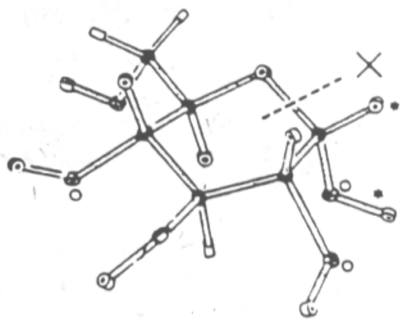


Figure 3

2. Finally attach the remaining groups to the down-pointed pegs as in figure 3. The form you have made is a model of Alpha-glucose.

Q.1. Does this molecule have a center or plane of symmetry?

Q.2. How many asymettric carbon atoms are there in glucose?

3. Refer again to figure 3. The two groups, (-H) and (-OH), marked with asterisks (*) may occur in the exchanged position. The form produced is Beta-glucose. Make a model of Beta-glucose, starting with Alpha-glucose.

FRUCTOSE: A five-membered ring structure exists for fructose. It occurs as a building unit in disaccharides. The five-membered ring structure is called fructofuranose.

4. Construct a model starting with a five-membered ring as in figure 4, and then add groups above and below this ring as in figure 5.

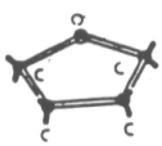


Figure 4

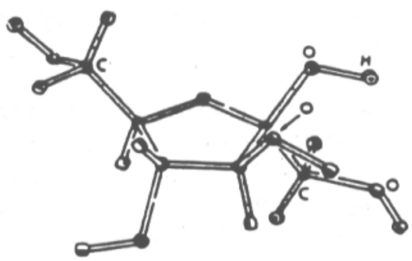


Figure 5

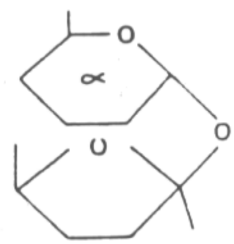


Figure 6 sucrose

Disaccharides: Consist of two monosaccharides.

SUCROSE: Occurs in sugar beets and sugar cane. Its structure consists of a glucose ring linked to a fructofuranose ring by the emination of a molecule of water from two hydroxyl groups. Figure 6 (above) shows the structure.

5. Construct a model of sucrose by detaching the two linking hydroxyl groups from glucose and fructose models and connect the two free carbon valances by means of an oxygen atom. The result is a model of the sucrose molecule. On hydrolysis with dilute acid, sucrose breaks up into its two constituent monosaccharides once more:

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$

LIPIDS

Glycerol: $C_3H_5(OH)_3$

Construct a model of gylcerol as in figure 7.

Q.3. Is glycerol a carbohydrate? Why?

Fatty Acids: $CH_3(CH_2)_nCOOH$

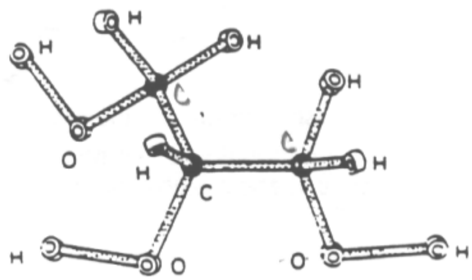


Figure 7

Now construct a model of the simplest fatty acid, acetic acid - CH_3COOH. Do the same for buteric acid and caproic acid as shown below in figures 8 and 9 respectively. Note how few oxygen atoms are present compared to carbohydrates.

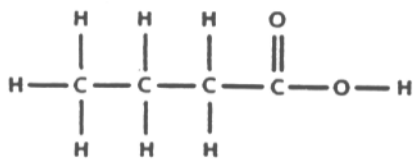


Figure 8

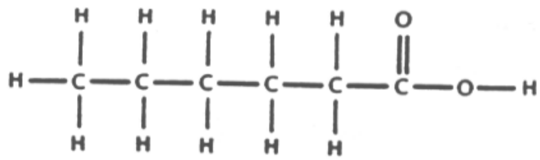


Figure 9

Your teacher may also want you to construct a molecule of lauric acid - $C_{11}H_{23}COOH$ - before going on.

Construction of a Lipid (for groups of 2-4 students)

1. Use the molecular models above to construct a molecule of glycerol again and three acetic acid molecules which will represent any fatty acid molecule.

2. When the four molecules are completed, remove three hydroxyl groups (-OH) from the glycerol molecule. Where these were removed, open bonds exist which may combine with other molecules.

3. Now remove a hydrogen (-H) from each of the carboxyl ends of the 3 fatty acids. As you can see an oxygen bond now exists, which will join to the open -C bond of glycerol. Once you have attached the 3 acetic acid molecules to glycerol, you have constructed a model which represents a fat. Depending on which fatty acids are linked to glycerol will determine the kind of fat.

You will also notice you have 3 (-H) and 3 (-OH) left which will combine to form three molecules of water.

Q.4. How can you represent this in an equation?

Q.5. What does dehydration synthesis mean?

Q.6. By adding water to a molecule of fat, it can be broken down into glycerol and fatty acids. What is the process called?

Q.7. Can these reactions take place in a living cell? What other molecule is necessary to insure the reaction will take place?

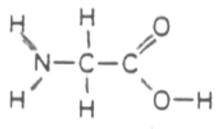
PROTEINS

<u>Amino Acids</u> - the building blocks of proteins. There are 20 which occur commonly in nature, and they are all alpha-amino acids. The general formula is $NH_2CHRCOOH$.

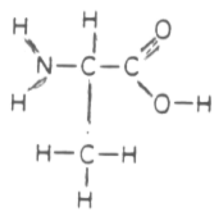
GLYCINE: (aminoacetic acid) This is the simplest amino acid. It has a general formula of NH_2CH_2COOH.

Q.8. What is the formation of the R group in glycine?

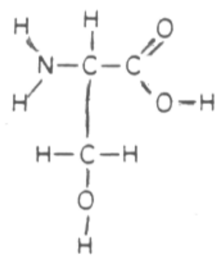
1. Construct a model of glycine as shown.



GLYCINE



ALANINE



SERINE

2. Now construct models of alanine and serine as shown above.

3. Once these models have been constructed, remove the (-OH) from the carboxyl group of one amino acid and the (-H) from an amino group of another and join the molecules together where these open bonds exist.

Q.9. What process was accomplished above?

The bond that joins these molecules together is called a peptide bond. Two amino acids joined form a dipeptide and many will form a protein.

Q.10. How do amino acids differ form fatty acids?

Q.11. How is digestion completed with proteins?

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