Auger's [redacted] Key

Biological Molecules

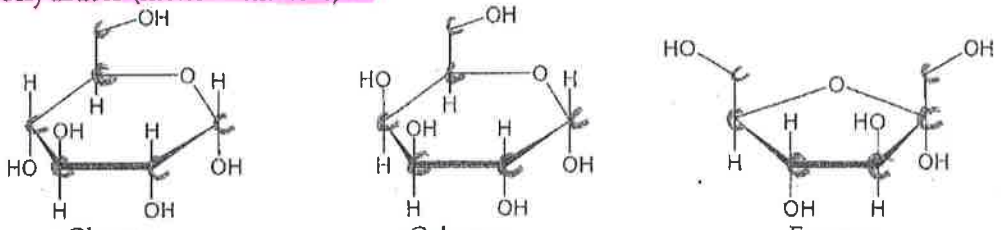
What are the building blocks of life?

Why?

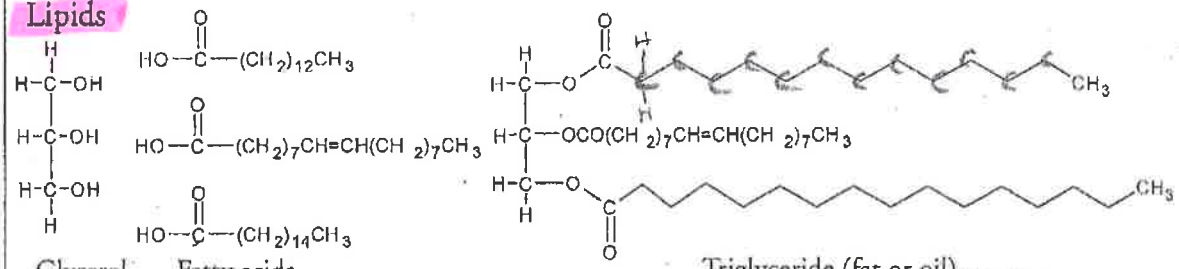
From the smallest single-celled organism to the tallest tree, all life depends on the properties and reactions of four classes of **organic (carbon-based) compounds—carbohydrates, lipids, proteins, and nucleic acids**. These organic molecules are the building blocks of all living things, and are responsible for most of the structure and functions of the body, including energy storage, insulation, growth, repair, communication, and transfer of hereditary information. Simple organic molecules can be joined together to form all the essential biological molecules needed for life.

Model 1 – Molecules of Life

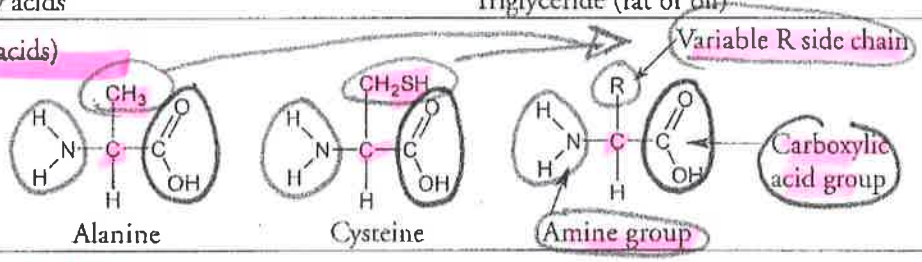
Carbohydrates (monosaccharides)



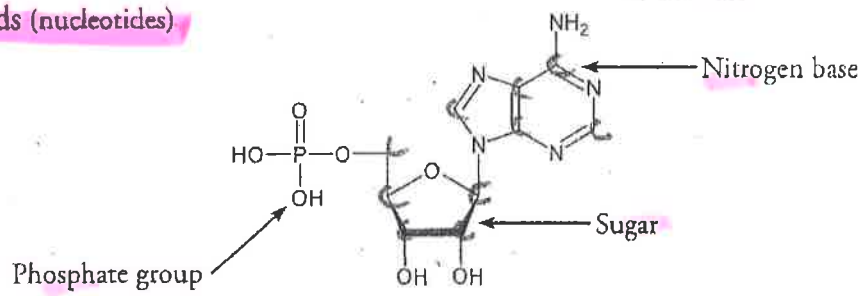
Lipids



Proteins (amino acids)



Nucleic acids (nucleotides)



1. Use Model 1 to show which atoms are present in each type of molecule by listing the symbol for each atom included. Carbohydrate has been done for you.

   a. Carbohydrate— C, H, O

   b. Lipid— C, H, O

   c. Amino acid— C, H, O, N

   d. Nucleic acid— C, H, O, N, P

2. Which type of molecule includes an example with a **long-chain carbon backbone?**

   Lipid

3. In the molecule referred to in the previous question, what is the dominant element attached to the carbon backbone?

   Hydrogen

4. The fatty acid chain of the lipids is often referred to as a hydrocarbon chain. Discuss with your group why the chain is given this name and write a one-sentence definition for a hydrocarbon.

   A hydrocarbon has a central chain of carbon atoms w/ hydrogen atoms attached to the carbon.

5. Which molecule has a central carbon atom with four different components around it?

   Amino acid

6. Which molecule has a sugar, nitrogenous base, and phosphate group?

   Nucleic Acid

7. Discuss with your group members some similarities among all four types of molecules. List as many as you can.

   All contain C, H & O

8. What is the chemical formula of the first carbohydrate molecule shown?

   $C_6H_{12}O_6$

9. What three structural groups shown do all amino acids have in common?

   Amine group, carboxylic acid & R side chain

10. There are 20 naturally-occurring amino acids, and each one only varies in the structure of the R side chain. Two amino acids are shown in Model 1. What are the R side chains in each?

    CH_3 (Alanine)

    CH_2SH (cysteine)

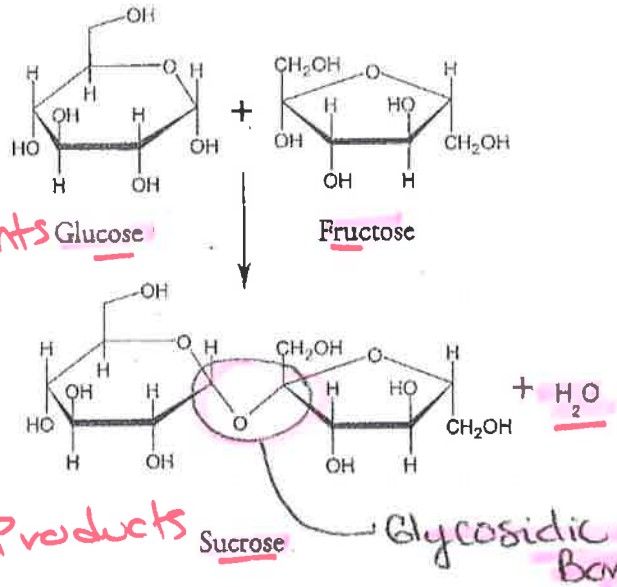
Read This!

During chemical reactions, the bonds in molecules are continually broken and reformed. To break a bond, energy must be absorbed. When bonds are formed, energy is released. If more energy is released than absorbed during a chemical change, the process can be used as a source of energy. A general rule for processes such as respiration is the more carbon atoms there are in a molecule, the more energy that molecule can provide to the organism when it is used as food.

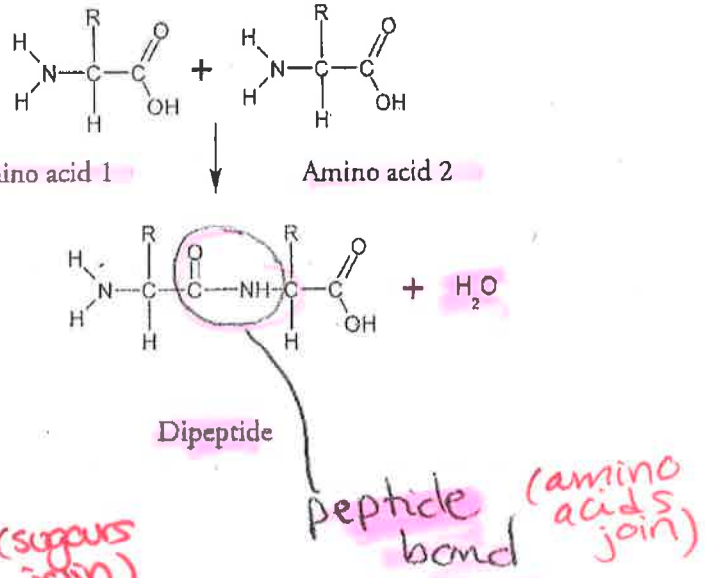
11. Using the information from above, is a carbohydrate or a lipid more likely to be a good source of energy for an organism? Lipids are more likely a good source of energy because lipids are long hydrocarbon chains with a lot more C-C & C-H bonds which are a source of energy

Model 2 – Biochemical Reactions

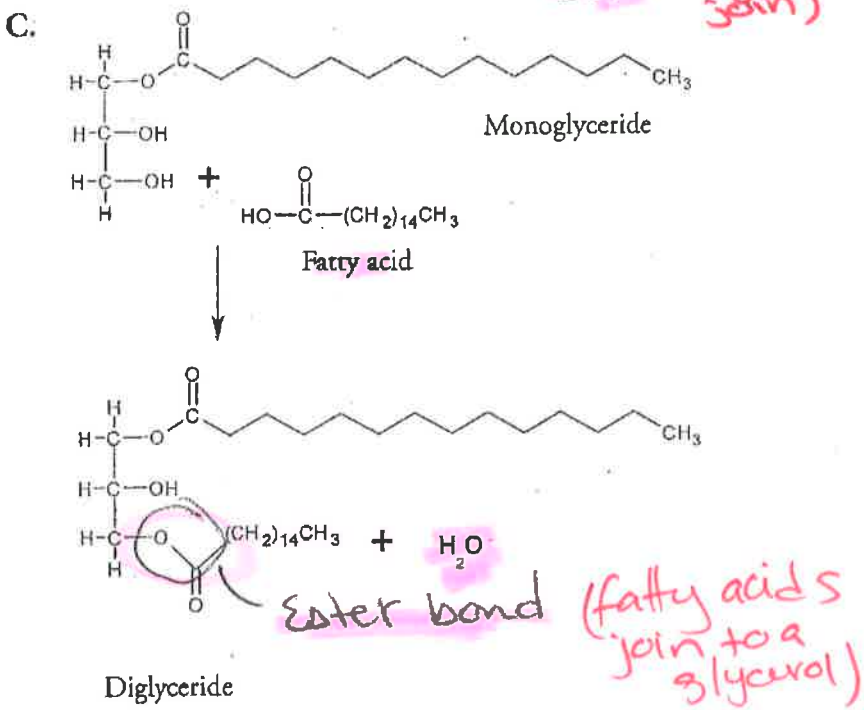
A.



B.



C.



12. What are the reactants of reaction A?

Glucose & Fructose

13. What are the products of reaction A?

Sucrose & water

14. Each of the reactants in reaction A is a single sugar molecule, also called a monosaccharide. What prefix before saccharide would you use to describe sucrose?

Di

15. What are the reactants of reaction B?

2 amino acids

16. When the two molecules in reaction B are joined together, what other two molecules are produced?

water & a dipeptide

17. What product do all three reactions in Model 2 have in common?

They all produce water

STOP

Read This!

When sugars are joined together the new bond that forms is a **glycosidic** bond. When amino acids are joined the new bond that forms is a **peptide** bond. When fatty acids are joined to a glycerol the bond that holds them is an **ester** bond.

18. On the diagrams in Model 2, circle and label the glycosidic, peptide, and ester bonds.

↓ see pg. 3. (A) (B) (C)

19. These reactions are all referred to as **dehydration synthesis** or condensation reactions. With your group develop an explanation for why these terms are used to describe these reactions.

All of the reactions cause water to be removed, so the molecule is "dehydrated" or water is "condensed" from the molecule

20. These reactions can also be reversed, breaking the large molecule into its individual molecules. What substance would need to be added in order to reverse the reaction?

water

21. *Lysis* means to split or separate. What prefix would you add to lysis to mean separate or split using water?

Hydro

22. Using your answers to the previous two questions, what word is used to describe the reaction that uses water to break apart a large molecule?

STOP

Hydrolysis

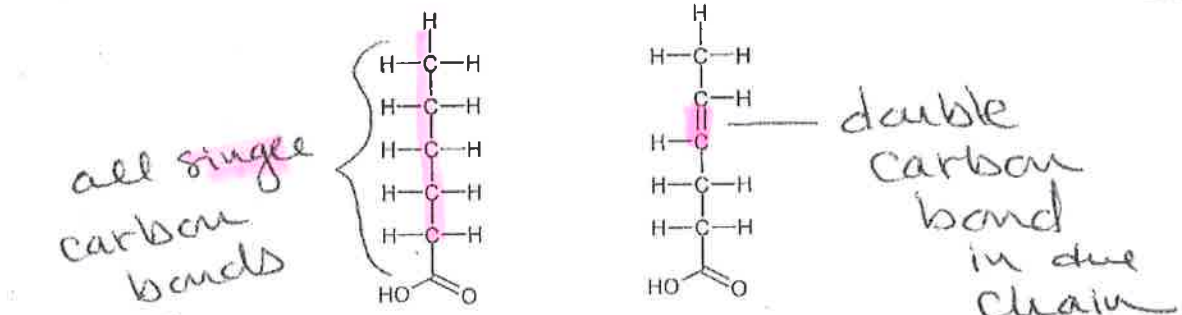
Extension Questions

23. Metabolism is the collective term used to describe all the chemical reactions taking place inside living organisms. Why is water so important for metabolic reactions? without water essential chemical reactions would not take place in our bodies. water is necessary for hydrolytic reactions that occur during the breakdown of organic molecules.

24. We store excess food in our body either in the form of carbohydrates (in muscles and the liver) or as fat (adipose tissue). When our body needs additional energy it uses the carbohydrate source first as a source of "quick" energy, then the fat. Why do you think carbohydrates are used as a source of quick energy rather than fat? Use complete sentences and scientific terminology in your response.

It takes less energy input to break the bonds in carbohydrates compared to the amount of energy yielded, so there is a net release of energy. Fats require a greater input of energy to break bonds. so, even though fats contain more energy, the energy in carbs is easier to access.

25. Look at the two types of fatty acids below, saturated and unsaturated. What is the difference between the two?



Saturated Fatty Acid Unsaturated Fatty Acid

26. Saturated fats are solid fats, like the animal fats lard and butter, whereas unsaturated fats are more fluid and form oils, such as vegetable oil. Trans fats are plant oils that are artificially solidified to make them suitable for baking purposes. In recent years trans fats have been associated with negative health issues and are not as widely used. Explain in simple molecular terms what would have to be done to a plant oil to transform it to a trans fat.

H molecules are added to unsaturated plant lipids by a process called hydrogenation. The addition of H eliminates some double bonds and makes the lipids more saturated, with a higher melting point which is more suitable for baking.