

Biological Molecules

Based on the provided notes and the principles of IGCSE O Levels Biology, here are detailed notes on the key biological molecules and their detection methods.

1. Carbohydrates

- **Composition:** Composed of the elements carbon, hydrogen, and oxygen.
- **Function:** They are the primary energy source for the body.
- **Types:**
 - **Simple sugars (monosaccharides):** Such as glucose and maltose.
 - **Complex carbohydrates (polysaccharides):** Formed by the combination of simple sugars.
 - **Starch:** An energy reserve in plants.
 - **Cellulose:** A structural component of plant cell walls.
 - **Glycogen:** An energy reserve in animals.

2. Lipids (Fats)

- **Composition:** Composed of carbon, hydrogen, and oxygen.
- **Function:** Used for long-term energy storage and insulation. They are formed from glycerol and fatty acids.

3. Proteins

- **Composition:** Composed of carbon, hydrogen, oxygen, and nitrogen. They are polymers of amino acids.
- **Function:**
 - Building blocks for tissues like hair, skin, and bones.
 - Function as enzymes, hormones, and antibodies.
 - Enzymes are proteins that act as biological catalysts.

4. Detection Methods

- **Starch:** The test uses an iodine solution. A positive result is a color change from orange-brown to blue-black.

- **Glucose and Maltose (Simple Sugars):** The test uses Benedict's solution and heat. A positive result is a color change from blue to a brick-red precipitate.
 - **Proteins:** The test is the Biuret test. A positive result is a color change from blue to violet or purple.
 - **Lipids:** The test is the ethanol emulsion test. A positive result is the formation of a cloudy white emulsion.
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IGCSE O Levels Biology Past Paper Questions

Constructed Answer Questions

Question 1

- A student carries out food tests on a liquid food sample. They add Benedict's solution to 2 cm³ of the sample in a test tube and heat it in a water bath. The solution turns from blue to brick-red.
 - **a)** Identify the food substance present in the sample.
 - **b)** Describe how the student would test for the presence of starch in a separate sample of the same food.
 - **c)** Explain why a control experiment is important when carrying out food tests.
- **Constructed Answer:**
 - **a)** The food substance present is a reducing sugar (e.g., glucose or maltose).
 - **b)** The student would take a new sample of the liquid food. They would add a few drops of iodine solution to the sample. A positive result, indicating the presence of starch, would be a color change from orange-brown to blue-black.
 - **c)** A control experiment is important to ensure that the results are reliable. For example, testing distilled water with Benedict's solution would show a negative result (no color change) and confirm that the change in the food sample was due to the presence of the reducing sugar and not the heating or the reagent itself.
- **Examiner Report Notes:** Candidates should be precise with their terminology. For part (a), "sugar" is generally acceptable, but "reducing sugar" or a specific example like "glucose" is better. For part (b), students must mention both the reagent (iodine solution) and the specific color change. For part (c), the key is to mention the

comparison aspect of a control to show that the reagent or experimental conditions are not causing the observed result.

Question 2

- A sample of groundnut was crushed and mixed with ethanol. An equal volume of cold water was added, and the mixture was shaken. A cloudy white emulsion was formed.
 - **a)** Name the food group being tested.
 - **b)** State the purpose of the ethanol in this test.
 - **c)** Explain why the final mixture appears as a cloudy white emulsion.
- **Constructed Answer:**
 - **a)** Lipids (fats/oils).
 - **b)** Ethanol is a solvent for lipids. It dissolves the lipids from the food sample.
 - **c)** When the ethanol-lipid solution is poured into water, the lipids are insoluble and precipitate out of the solution, forming tiny droplets that scatter light, which makes the mixture appear as a cloudy white emulsion.
- **Examiner Report Notes:** Many students correctly identify lipids but may struggle to explain the role of ethanol. It is crucial to state that lipids dissolve in ethanol but not in water. The explanation for the cloudy appearance should mention the formation of an "emulsion" or "tiny droplets" of the lipid.

Question 3

- Describe the Biuret test for proteins and state the expected results for a positive and a negative test.
- **Constructed Answer:**
 - The Biuret test is used to detect the presence of proteins. A small amount of the food sample is mixed with an equal volume of sodium hydroxide solution. A few drops of copper sulfate solution are then added. A positive result for a protein is a color change from blue to violet or purple. A negative result would be no color change, with the solution remaining blue.
- **Examiner Report Notes:** Students often forget to mention the initial color of the reagent (blue) and the specific final color (violet/purple). The use of both reagents, copper sulfate and sodium hydroxide, must be mentioned.

Question 4

- Compare the chemical elements found in carbohydrates and proteins.
- **Constructed Answer:**
 - Both carbohydrates and proteins contain the elements carbon, hydrogen, and oxygen. However, proteins also contain nitrogen, which is not found in carbohydrates. Some proteins may also contain sulfur.
- **Examiner Report Notes:** A common mistake is to only mention that proteins have nitrogen, without also stating the shared elements. The best answers clearly list the elements for each molecule and then highlight the key difference.

Question 5

- Starch and glycogen are both polysaccharides. Explain their key differences in terms of their source and function.
- **Constructed Answer:**
 - Starch is a polysaccharide that serves as an energy storage molecule in plants. Glycogen is a polysaccharide that serves as an energy storage molecule in animals (e.g., in the liver and muscles). Therefore, starch is the energy reserve of plants, and glycogen is the energy reserve of animals.
- **Examiner Report Notes:** Examiners look for a clear distinction between the source (plants vs. animals) and the function (energy storage in each). Simply saying "one is in plants, one is in animals" is not enough; the answer must link the molecule to its specific role as an energy reserve.

Question 6

- Name the smaller units (monomers) that make up:
 - a) Proteins
 - b) Starch
- **Constructed Answer:**
 - a) Amino acids
 - b) Glucose

- **Examiner Report Notes:** This is a straightforward recall question. Candidates must provide the correct scientific term for the monomers. A common error is mixing up the monomers for different macromolecules.

Question 7

- Describe two safety precautions that should be taken when performing the Benedict's test on a food sample.
- **Constructed Answer:**
 - 1. Wear safety goggles to protect the eyes from the hot solution and any potential splashes.
 - 2. Handle the hot test tube with a test tube holder to avoid burns.
- **Examiner Report Notes:** This question tests practical skills and lab safety knowledge. Students must provide specific, valid safety measures. Vague answers like "be careful" are not sufficient.

Question 8

- Explain the role of cellulose in a plant cell.
- **Constructed Answer:**
 - Cellulose is a polysaccharide that provides structural support and rigidity to the plant cell wall. It prevents the plant cell from bursting when it takes in too much water through osmosis.
- **Examiner Report Notes:** Good answers mention both the "structural support" and "rigidity" aspects. The best answers also relate this function to osmosis and preventing the cell from bursting, showing a deeper understanding of cell physiology.

Question 9

- A student tested four different food samples (A, B, C, and D) for the presence of glucose, starch, and protein. The results are shown in the table below.
 - | Sample | Benedict's Test | Iodine Test | Biuret Test |
 - |---|---|---|---|

- | A | Blue | Orange-brown | Blue |
- | B | Brick-red | Blue-black | Blue |
- | C | Blue | Orange-brown | Violet |
- | D | Blue | Orange-brown | Blue |
- Based on the results, identify which sample contains:
 - a) Protein only
 - b) Starch only
 - c) Glucose and Starch
- **Constructed Answer:**
 - a) Sample C contains protein only.
 - b) No sample contains starch only. Sample B contains both starch and glucose.
 - c) Sample B contains both glucose and starch.
- **Examiner Report Notes:** Candidates should be able to interpret the results of multiple food tests. They must correctly identify the positive and negative results for each test (e.g., Benedict's changing from blue to brick-red is positive for glucose).

Question 10

- What is the difference between a monosaccharide and a polysaccharide? Give an example of each.
- **Constructed Answer:**
 - A monosaccharide is a simple sugar and is the basic unit of a carbohydrate. An example is glucose.
 - A polysaccharide is a complex carbohydrate made up of many monosaccharide units joined together. An example is starch or glycogen.
- **Examiner Report Notes:** Students should clearly define each term and provide a correct, distinct example for each category.¹

Multiple-Choice Questions²

1. Which of the following is a correct statement about biological molecules?

* A) Biuret reagent is used to test for reducing sugars.

- * B) Glycogen is made of smaller glycerol molecules.
- * C) Oils contain the chemical elements carbon, hydrogen, oxygen and nitrogen.
- * D) Protein is made of smaller amino acid molecules.

****Answer:** D.**

*** **Explanation:**** Proteins are polymers made from amino acid monomers.

2. Which food-testing reagent shows a positive result when it turns from blue to purple?

- * A) Benedict's solution
- * B) Biuret reagent
- * C) Ethanol
- * D) Iodine solution

****Answer:** B.**

*** **Explanation:**** The Biuret test is used for proteins, and a positive result is a color change from blue to violet or purple.

3. What is the end product of starch digestion?

- * A) Fatty acids
- * B) Amino acids
- * C) Glucose
- * D) Glycerol

****Answer:** C.**

*** **Explanation:**** Starch is a polymer of glucose, so its digestion breaks it down into glucose monomers.

4. Which of the following is an example of a polysaccharide?

- * A) Glucose
- * B) Cellulose
- * C) Maltose
- * D) Sucrose

****Answer:** B.**

* **Explanation:** Cellulose is a complex carbohydrate, a polysaccharide. Glucose is a monosaccharide, and maltose and sucrose are disaccharides.

5. A sample of food is mixed with ethanol and then shaken with an equal volume of water. A cloudy white emulsion is formed. Which food group is present?

- * A) Starch
- * B) Protein
- * C) Lipid
- * D) Sugar

Answer: C.

* **Explanation:** The ethanol emulsion test is a specific test for lipids, and the formation of a cloudy white emulsion is a positive result.

6. Which elements are found in both carbohydrates and lipids?

- * A) Carbon, hydrogen, oxygen, nitrogen
- * B) Carbon, hydrogen, oxygen
- * C) Hydrogen and oxygen only
- * D) Carbon and hydrogen only

Answer: B.

* **Explanation:** Both carbohydrates and lipids are composed of carbon, hydrogen, and oxygen.

7. Which test is used to detect the presence of starch?

- * A) Benedict's test
- * B) Biuret test
- * C) Ethanol emulsion test
- * D) Iodine test

Answer: D.

* **Explanation:** The iodine test is used to detect starch, and a positive result is a color change to blue-black.

8. Which of the following is a function of proteins?

- * A) Long-term energy storage
- * B) Providing the primary energy source
- * C) Insulation
- * D) Acting as enzymes

****Answer:** D.**

*** **Explanation:**** Proteins function as enzymes, hormones, and antibodies.

9. The monomer of a protein is called:

- * A) Glucose
- * B) Amino acid
- * C) Fatty acid
- * D) Glycerol

****Answer:** B.**

*** **Explanation:**** Amino acids are the building blocks of proteins.

10. Which of these tests requires heating to obtain a positive result?

- * A) Benedict's test
- * B) Biuret test
- * C) Iodine test
- * D) Ethanol emulsion test

****Answer:** A.**

*** **Explanation:**** Benedict's test for reducing sugars requires heating in a water bath to show a color change to brick-red precipitate.