

Dr. Bbosa Science

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Chemicals of life

Overview

All cells are made up of a variety of substances some of which organic while others are inorganic. Water forms the largest component and is also a medium for all reactions in the cell. The other substance includes acids, bases, salts, vitamins, carbohydrates, lipids and proteins. There are enzymes and nucleic acids which perform a variety of functions.

Water

This is the most abundant compound, typically making up of 60-95% fresh mass of an organism.

Uses of water

- (i) It makes up structures of organism
- (ii) It is a solvent
- (iii) It is a reagent in hydrolysis
- (iv) Provide support for aquatic organism
- (v) Is a medium of fertilization through which gametes swim.
- (vi) Medium for removal of waste products
- (vii) Temperature control
- (viii) Hearing and balance as endolymph

Uses of water to the plants

- (i) Aid seed dispersal
- (ii) Provide support to herbaceous plants
- (iii) Breaks up the testa of a seed during germination

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- (iv) Reagent in photosynthesis
- (v) Loss of water through the leaves cools the plant.
- (vi) Medium of fertilization

Uses of water to the animals

- (i) A medium of transport
- (ii) Evaporation cools the animal
- (iii) Lubricates joints, eyes, lungs
- (iv) Constituent of protecting fluids such as tears, mucus.

Carbohydrates

Carbohydrates are food substances with a general formula $(CH_2O)_n$ where n is natural number. They are energy giving foods.

Classification

- (i) Monosaccharides e.g. glucose, galactose and fructose

Sources: honey, fruits

Properties

- They are sweet
- Are soluble in water
- They reduce blue copper II ions to red precipitates in alkaline medium.

Testing for reducing sugars

When boiled with Benedict's or Fehling's solutions the color changes from blue to green to yellow to oranges ppt.

- (ii) **Disaccharides**

They are made of two simple sugars as shown in table below

Disaccharides	Composition	Source
Maltose	glucose + glucose	malt
Lactose	Glucose + galactose	milk
Sucrose	Glucose + fructose	Sugar cane Sugar beets
Cellubiose	Glucose + glucose	wood

Testing for non-reducing sugars

1. When boiled with Benedict's solution or Fehling's' solution, the color remains blue.

2. When boiled with HCl, the solution cooled, neutralized by NaOH, boiled Benedict's or Fehling's solution, the color changes from green, to yellow to orange.

HCl hydrolyses non-reducing sugars

NaOH neutralizes the excess acid because Benedict's or Fehling's solution does not work in acidic medium.

Polysaccharide $(\text{CH}_2\text{O})_n$

These are made of very many mono saccharides per unit molecule e.g. starch and cellulose

Testing for starch

It changes the color of iodine black or blue.

Functions of carbohydrates

1. Glucose, galactose and fructose are oxidized to release energy in the body
2. Glyceraldehyde is an intermediate molecule in photosynthesis.
3. Ribose is component nucleotides.
4. Sucrose is a form in which carbohydrates are transported in plants
5. Lactose is a source of energy in milk
6. Storage of energy (starch in plants, glycogen in animals, inulin in some plants like Dahlia)
7. Formation of cellular structures (cellulose in plant cell walls, chitin in)

Lipids

Lipids are made of fats and oils. Fats are solids at room temperature while oils are liquids at room temperature

Uses of lipids

Structural functions

- Make up cell membrane
- Protection: lipids are constituents of the waxy cuticle of plants and insects
- Lipids are water repellent thus prevent water loss from or entry into an animal skin
- Their spongy nature protects delicate organs as shock absorbers.
- Being bad conductors, they reduce water loss from the body when deposited beneath the skin for insulation
- Storage ; they are better storage compounds than carbohydrates due to high calories value, due to high hydrogen content, they are light, insoluble in water, compact to fit in a small volume and are easily used when required.

Physiological functions

- Source of metabolic water

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- Store fat soluble vitamins (A, D, E, K)
- Source of metabolic water
- Raw materials for hormones

Testing for lipids

- They form a translucent mark on paper that does not disappear when the paper is dried on a flame.
- Emulsion test
When 2cm³ of fats or oil are dissolved in 2cm³ of absolute ethanol followed by water, a white cloudy suspension is formed.
- Sudan III
When a few drops of Sudan III are added to a mixture of 2cm³ of water and 2 cm³ of oil and shaken, a red stained oil layer separates out.

Advantage of storing fats over carbohydrate

- Has high energy content than carbohydrates
- It is lighter
- It is compact and requires less space
- It is a raw material for hormones
- Insoluble in water that they have low osmotic value

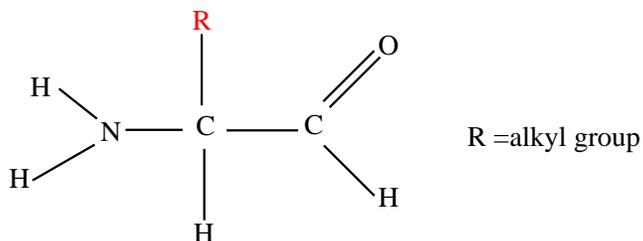
Proteins

These are classified into two groups

- Structural proteins:** insoluble proteins that make up body structures like bones and muscles. Fibrinogen is a soluble structure protein used in blood clotting.
- Globular proteins are soluble proteins such as enzymes, antibodies, hormones and so on.

Composition of proteins

The basic unit of proteins is amino acids



There are about 22 different amino acids in the body of which isoleucine, leucine, methionine, phenylamine, proline, threonine and valine cannot be synthesized in human body and they are referred to as **essential amino acids**.

Uses of proteins

- (i) Make up structures, e.g., collagen make up connective tissues.
- (ii) Make up enzymes such as catalyze and amylase.
- (iii) Are constituent of hormone such as insulin
- (iv) Are constituents of antibodies that protect the body from foreign particles.
- (v) Make up muscles such as myosin and actin
- (vi) They are storage food e.g. egg white
- (vii) Constitute toxins such as snake venom for protection.

Testing for proteins

- a. They coagulate on heating
- b. They coagulate on addition of Melon's reagent and on heating they form a pink precipitate.
- c. They form a purple color when mixed with equal amount of NaOH followed by 3 drops of copper sulphate solution.

Vitamins

Specific objects

The learner should be able to:

- a. State the type of vitamins i.e., water soluble and fat soluble; essential and nonessential.
- b. State the importance of vitamins in organism
- c. Test for vitamin C.
- d. Demonstrate effect of over boiling vegetables
- e. Demonstrate the effects of storage on the quality of fresh food.

Vitamins are complex organic compounds present in very small quantities in natural food which are essential for good healthy body and maintains its normal metabolic activities. Some vitamins are fat soluble (ADEK) while others are not.

Vitamin C / ascorbic acid

Sources: citrus fruits, green vegetables, potatoes, tomatoes, etc.

Function of vitamin C

Concerned with the metabolism of connective tissues and the production of strong skin.

Deficient disease : anemia and scurvy: the germs bleed, wounds fail to heal.

Testing for Vitamin C

It decolorizes DCPIP.

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Other vitamins and their deficient diseases

Vitamin	
A	Night blindness
K	Delayed clotting
E	Reduced fertility in rats

Functions of vitamins

- protect the body against diseases
- formation of coenzyme that facilitate enzyme reactions
- blood clotting
- components of visual pigment

Revision questions

1. Iodized table salt is eaten in order to
 - A. Strengthen bones
 - B. Avoid goiter
 - C. Get balanced diet
 - D. Avoid getting high blood pressure
2. Which one of the following pairs of nutrients consists of disaccharides only?
 - A. Glucose and galactose
 - B. Maltose and lactose
 - C. Fructose and glucose
 - D. Sucrose and glucose
3. Which of the following sets of carbohydrates are monosaccharides
 - A. Lactose, maltose, sucrose
 - B. Lactose, maltose, glycogen
 - C. Sucrose, lactose, cellulose
 - D. Glucose, fructose, galactose
4. Which one of the following conditions may result from under secretion of thyroxine?
 - A. Enlarged thyroid gland
 - B. Protruding eyeball
 - C. Increased metabolism
 - D. Loss of weight
5. Which of the following is a monosaccharide?
 - A. Maltose
 - B. Sucrose
 - C. Galactose
 - D. Lactose
6. In Biuret's test, the color which indicates a positive result is
 - A. Purple

- B. Blue
 - C. Pink
 - D. Red brown
7. Diet most suitable for strengthening of teeth and bones should be rich in
- A. Iodine and vitamin K
 - B. Calcium and vitamin D
 - C. Magnesium and vitamin C
 - D. Iron and vitamin B
8. Controlled feeding on food rich in vitamin A may improve
- A. Calcium deposition
 - B. Number of red blood cells
 - C. Night vision
 - D. Healing of wounds
9. Which of the following monosaccharides make up sucrose
- A. Galactose and fructose
 - B. Galactose and glucose
 - C. Fructose and glucose
 - D. Two glucose molecules
10. Lack of iodine in human diet cause
- A. Anaemia
 - B. Scurvy
 - C. Goiter
 - D. Rickets
11. Which of the following is end product of lactose?
- A. Glucose and sucrose
 - B. Glucose and galactose
 - C. Glucose and fructose
 - D. Fructose and galactose

12. To identify a substance Y, a student performed the following experiment

Test	Observation
(i) heat Y with Benedict's solution	Solution remained blue
(ii) heat Y with hydrochloric acid, cooled, added sodium hydrogen carbonate, benedict's solution, then boiled again.	Solution turned from blue to orange

From the observation, the most likely food substance in Y is

- A. Starch
 - B. Maltose
 - C. Sucrose
 - D. Glucose
13. Which of the following is a function of thyroxine hormone?
- A. Promotes development of follicle in the ovary
 - B. Prepares the body for fright-fight action
 - C. Controls metabolic rate
 - D. Regulates sugar content of the body
14. Yellowing of leaves in growing maize plant indicates a deficiency of
- A. Calcium
 - B. Sulphur
 - C. Nitrogen
 - D. Magnesium
15. Describe an experiment you would carry out in the laboratory to test for presence of a non-reducing sugar in a solution of a food sample. In your description, state the use of each reagent used.

Suggested answers

1	B	3	D	5	C	7	B	9	C	11	B	13	C
2	B	4	A	6	A	8	C	10	C	12	C	14	D

15. Testing for non-reducing sugars

- (a) When boiled with Benedict's solution or Fehling's' solution, the color remains blue.
- (b) When boiled with HCl, the solution cooled, neutralized by NaOH, boiled Benedict's or Fehling's solution, the color changes from green, to yellow to orange.
- (c) Uses of reagents
 - HCl hydrolyses non-reducing sugars
 - NaOH neutralizes the excess acid because Benedict's or Fehling's solution does not work in acidic medium.
 - Benedict's solution test for reducing sugars produced in hydrolysis