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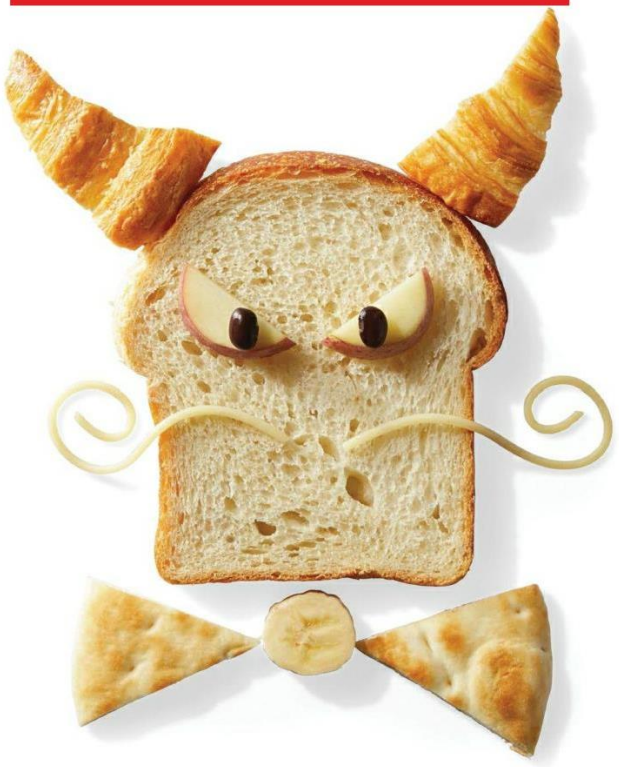

UNIT 02

Chemical and Cellular Basis of Life

Carbohydrates

SAMPATH LANKADHEERA

B.Sc. (Hons), M.Sc.

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SAMPATH LANKADHEERA

Unit 02 Chemical and Cellular Basis o Life
Carbohydrate

This tutorial covers .....

2.1.1 Elemental composition of Life

2.1.2 Physical and chemical properties of water

2.1.3 Chemical nature and functions of carbohydrates

Print 2024 June

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Unit 02

Chemical and Cellular Basis of Life

- Carbohydrates and Lipids

Smart Note

SAMPATH LANKADHEERA

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Unit 02

Chemical and Cellular Basis of Life

Elemental composition of living matter

- There ..... elements recognized in nature. Of which, about ..... elements are essential to continue ..... and ..... (about .....- elements are essential for humans and about ..... for plants).
- Oxygen (O), Carbon (C), Hydrogen (H), and Nitrogen (N) make up ..... of living matter.
- ....., ..., ... and .....- make up most of the remaining ..... of the mass of the organism.
- In addition to these, ..., ..., ..., ..., ..., ..., ..., ..., ... and ..... are also found in minute amounts in living matter.

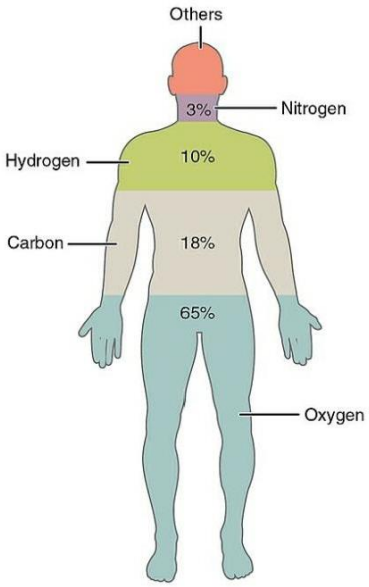


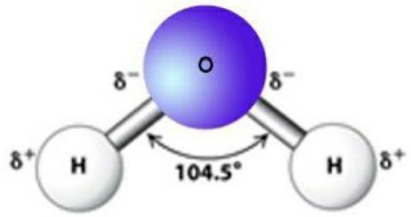
Table 2.1 Elements in the Human Body

Element	Symbol	Percentage of Body Mass (including water)	
Oxygen	O	65.0%	96.3%
Carbon	C	18.5%	
Hydrogen	H	9.5%	
Nitrogen	N	3.3%	
Calcium	Ca	1.5%	3.7%
Phosphorus	P	1.0%	
Potassium	K	0.4%	
Sulfur	S	0.3%	
Sodium	Na	0.2%	
Chlorine	Cl	0.2%	
Magnesium	Mg	0.1%	

Trace elements (less than 0.01% of mass): Boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), zinc (Zn)

Physical and chemical properties of water important for life

- Water is a vital .....; life could not exist on this planet without water. It is important due to following reasons,
  1. .....
  2. .....
- .....and ..... properties of water molecule provide the ability to ..... the .....

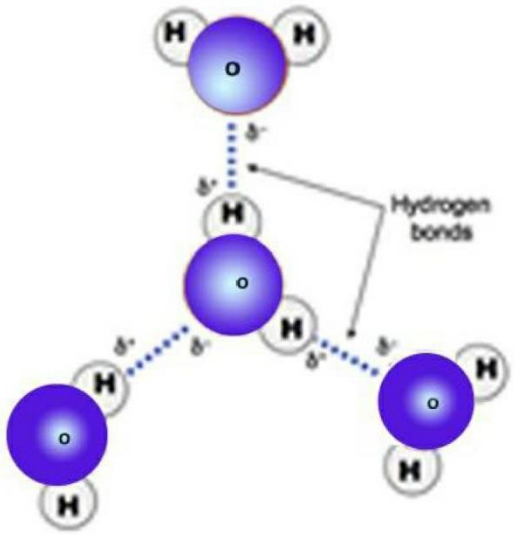


δ+ partial positive

δ-partial negative

Fig 2.1: Chemical structure of the water molecule

- Water molecule is a ……., …… and …….. molecule. Polarity is an …… charge distribution …….. a molecule. In water molecule, oxygen atom is …….. negative and hydrogen atom is slightly …….. . Weak attractions between the slightly …….. hydrogen atom of one water molecule and the slightly polar …….. atom of adjacent water molecule are known as …….. bonds. These hydrogen bonds play a major role in maintaining all the properties of water.



- The properties of water arise due to the hydrogen bonds between …….. water molecules. When the water is in …….. form its H bonds are very …….. H bonds form, break and reform with great ……..

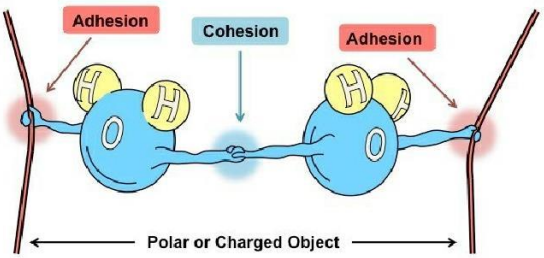
Physical properties of water

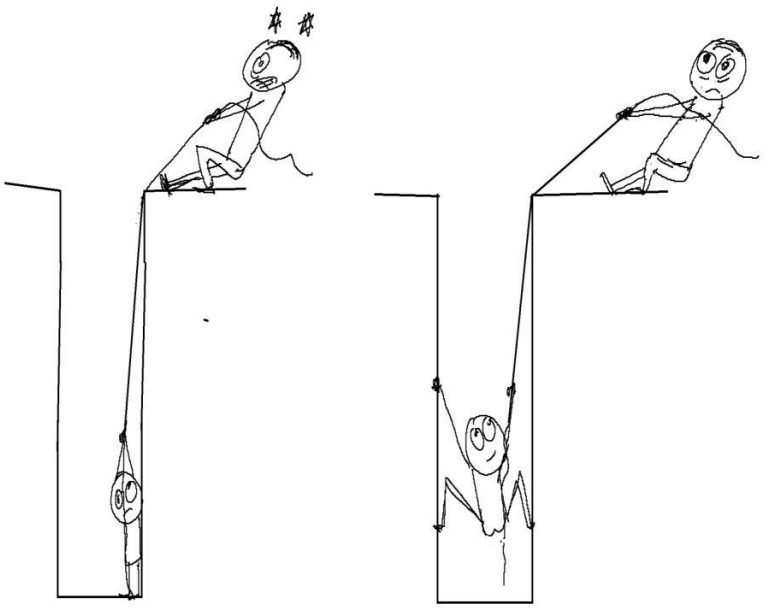
- Four major properties of water to maintain life on earth

1. .....
2. .....
3. .....
4. .....

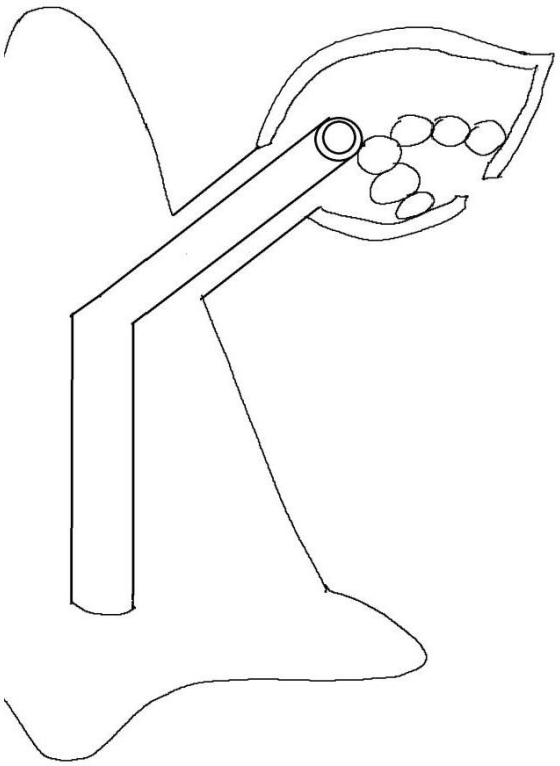
1. Cohesive behavior

- Attraction between water molecules due to ..... bonding is known as ..... Attraction between water molecules and other ..... are known as ..... Both of the above properties of water allow it to act as a ..... Medium.



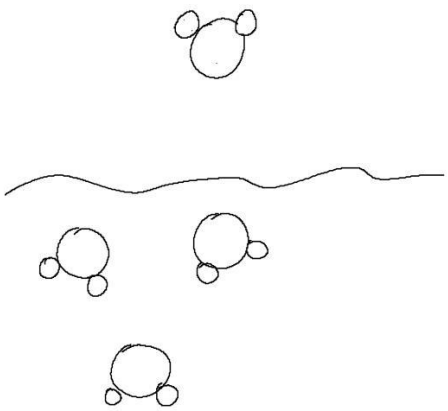


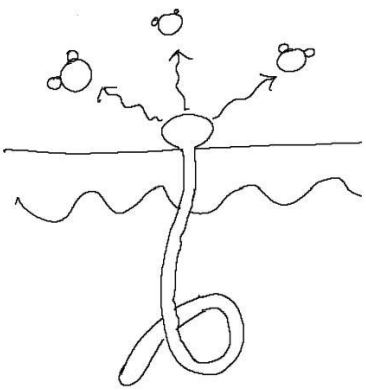
- Due to cohesion between water molecules, water and ..... substances such as ..... are transported as a .....column through ..... against gravity. ..... between water molecules and ..... also helps in conduction of water and dissolved substances.
- Water has a high ..... tension. This ability is given to water molecules, due to ..... between the water molecules. Therefore, in an aquatic system, ... surface water molecules are attracted by ..... surface molecules and it forms a water film. Small insects (Eg. .....) can walk on the surface of a pond.



2. Ability to moderate temperature

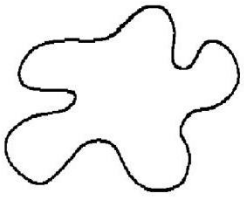
- Water can ..... or ..... a relatively high amount of .....energy by a ..... change in its own temperature. Due to the high specific heat, water will function as ..... buffer in living system and aquatic bodies during the temperature ..... on earth.
- Due to the high heat of ....., with the minimum loss of water an organism can .....much heat energy. Therefore, body surface of an organism maintained as .....surface. Eg. Prevent from overheating.
- Evaporation of sweat from human skin helps to maintain the body temperature at constant level.
- ..... in plants keeps the plant body surface as a cool surface and prevent from becoming too warm in the sunlight.

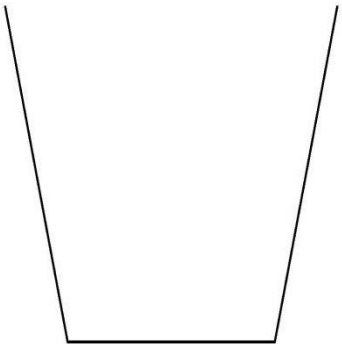


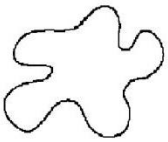


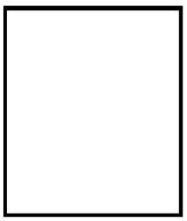
3. Expansion upon freezing

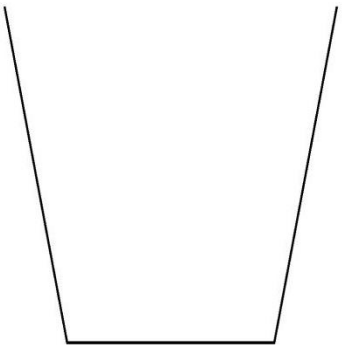
- Generally, in an ..... in .....of any substances, ... their ..... and on the other hand, in a decrease in temperature increases their density. When the temperature of water falls below ....., it begins to freeze and forms a ..... la翩 ce called ice cubes. Water has the maximum density at 4°C. Hence, ice ..... on the surface of water bodies. It is an important property of water in ..... regions, where, organisms in aquatic bodies can survive during the .....





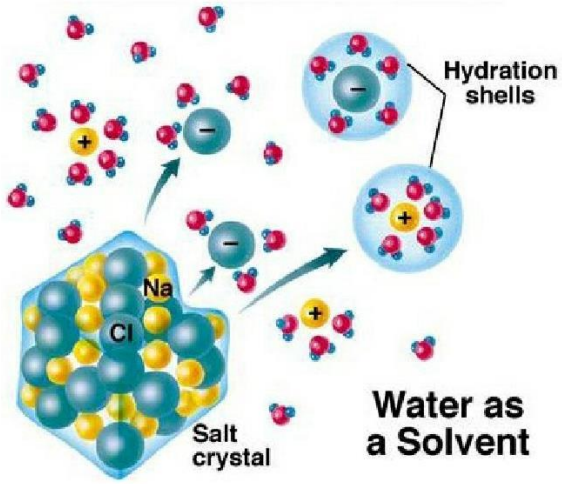


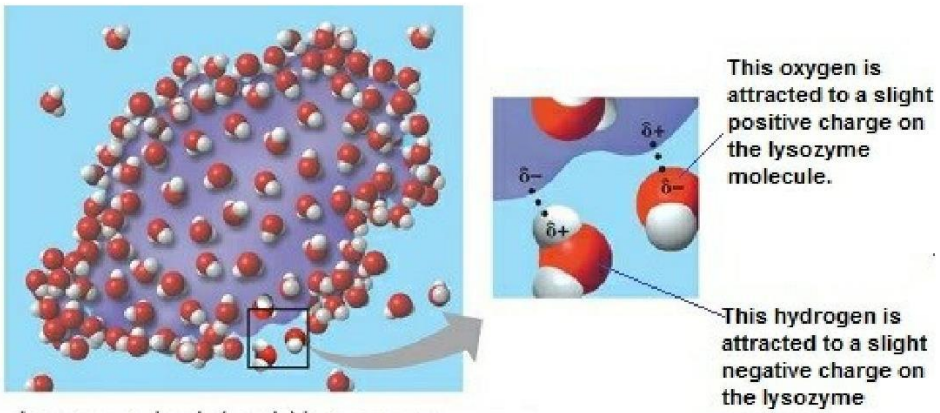




4. Versatility as a solvent

- This ability is given to water due to their ..... Polar molecules (eg. .....), ionic compounds (e.g. .....). molecules with both polar and ionic regions (eg. .....) can dissolve in water. Water molecules surround each of the solute molecules and form ..... bonds with them Therefore, solubility of the ..... depends on ..... and not in their ..... nature.





Lysozyme molecule (purple) in an aqueous environment

Elements in Living Organisms MCQ

1. There are six major elements presents in all living matter. Carbon, Hydrogen, Oxygen and Nitrogen are four of them. What are the other two elements?
   (1) Phosphorus and Sulphur (2) Sodium and Potassium (3) Calcium and Magnesium (4) Iron and Magnesium (5) Iodine and Chromium

2. The four most common elements in living matter are,
   (1) C, H, O, P (2) C, H, O, N (3) C, H, N, P (4) C, H, O, S (5) C, H, O, Ca (AL/2002)

3. Which is the most abundant compound present in living organisms?
   (1) Proteins (2) Fat (3) Sugars (4) Water (5) ATP

4. Which of the following elements is not a micronutrient?
   (1) Mn (2) Cu (3) S (4) Fe (5) Zn

5. The four elements C, H, O, N are the most abundant in living matter. The two elements next in abundance in human are
   (1) Fe and Mg (2) Ca and P (3) Cl and S (4) K and Na (5) I and Sr

6. The four elements that are most abundant in living systems of the planet Earth, are
   (1) C, H, O, N (2) C, H, O,S (3) C, H, O, P (4) C, H, O, K (5) C, H, O, Na (93/ Zoo)

7. Which one of the following elements is most abundant in the human body?
   (1) Calcium (2) Sodium (3) Potassium (4) Iron (5) Copper (1997/Zoo)

8. Which of the following chemical elements is the most abundant in living organisms by mass?
   (1) Hydrogen (2) Carbon (3) Sodium (4) Oxygen (5) Nitrogen
   (2015/1)

Elements in Living Organisms **Structured Essay**

1. State the 4 most abundant elements of living organisms

   .....

2. What are four different organic compounds in living matter. (AL/2002)

   .....

3. Living matter is made of 92 elements. What are 6 main elements in living matter?
   (AL/2011)

   .....

4. What do you understand by the following terms? (92/Bot)

   (a) Essential element:

   .....

   .....

Water MCQ

1. Which one of the characteristics of water listed below is not essential to support life processes?
   (1) Cohesive behavior. (2) Ability to moderate temperature (3) Expansion upon freezing
   (4) Versatility as a solvent. (5) It favors dissociation of dissolved electrolytes.

2. Which of the following characteristics of water is not helpful to moderate temperature?
   (1) Water can absorb and release relatively large amount of heat with slight change of temperature.
   (2) Due to high specific heat act as a thermal buffer.
   (3) Due to high specific heat of vaporization with minimum loss of water can release much heat.
   (4) Evaporation of sweat from human helps to maintain body temperature.
   (5) Increase of density upon decrease of temperature

3. Which one of the following properties of water is most directly responsible for maintaining body temperature of warm blooded animals?
   (1) High latent beat of fusion (2) High adhesive and cohesive forces.
   (3) High latent heat of vaporization (4) High specific heat (5) Polarity (AL/2011)

Water Structured Essay

1. State 4 different properties of water essential to maintain life on earth.

   .....

   .....

   .....

   .....

2. What are adhesive and cohesive forces.

   .....

   .....

   .....

AL 2014 New

1. (A) (i) Water is an essential ingredient for life and it is the most abundant inorganic compound in living matter. State two major functions of water in living organism.

   .....

   .....

   (ii) Name two properties of water which help to moderate changes in temperature in living organisms.

   .....

   .....

Chemical Nature and Functions of Main Organic Compounds of Organisms

Carbohydrates

- Most ..... group of .....compound on earth is ..... Major elemental composition is C, H, and O. ..... of carbon contain the same ..... of H: O which equals to .....: ..... as in water.

General formula is …….. Three major groups of carbohydrates are

……., …….. and polysaccharides.

Generally carbohydrates include sugars (monosaccharides and disaccharides) and polysaccharides.

Monosaccharides

- The simplest form of carbohydrates having general molecular formula as ..... are monosaccharide. Where C varies from ..... . All monosaccharide are reducing sugars, water soluble and occur in ..... form.
- According to the number of carbon atoms, they are named as;

.....

.....

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- According to the type of carbonyl (Keto, Aldo) group, they are classified as;

  1. .....— Glucose, Galactose

  2. .....— Fructose

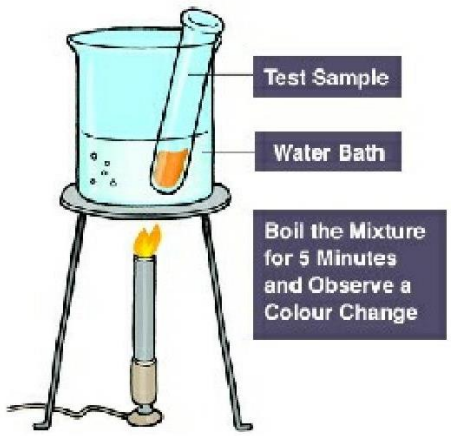
Reducing Property of Monosaccharide

- ..... group easily undergo oxidation. Therefore all monosaccharides are ..... sugars.
- They get oxidize by reducing ..... There are many tests to identify monosaccharide out of them 2 tests are important.

  1. ..... 2. .....

1. Fehling's Test

- Two Fehling's reagents called Fehlind's A and B.
- Add $2cm^3$ of sugar solution and $1cm^3$ Fehlings A and 1 cm^3 of Fehling's B solutions.
- Shake this mixture and then boil in a water bath.
- The mixture is initially blue in colour. This will undergo a series of colour changes as and finally give a brick red precipitate for reducing sugars.
- No colour change for non reducing sugars such as sucrose.
- Brick red precipitate is Cu_2O (Cuprous oxide)

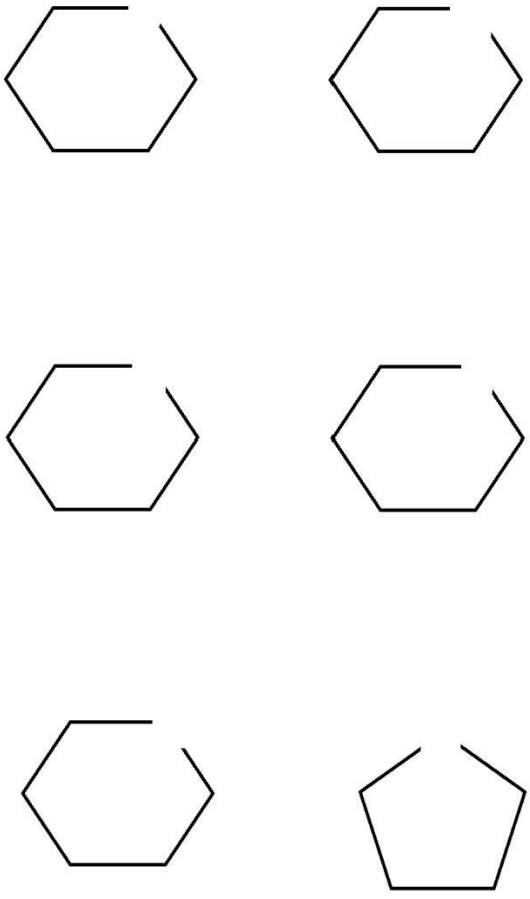


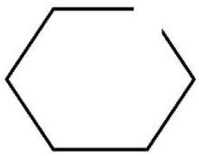
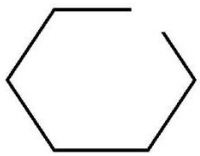
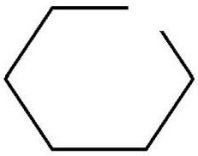
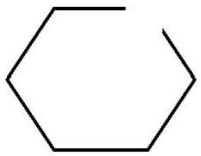
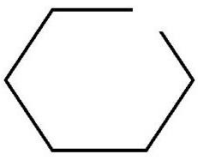
2. Benedict's Test

- Benedict's reagent is a solution contains $CuSO_4$ in NaOH (with Sodium citrate, Sodium carbonate).
- Add $2cm^3$ of a sugar solution to a test tube and add equal amount of Benedict's solution.
- Shake and boil it in a water bath.
- The mixture is initially blue in colour and it will undergo in series of colour changes to give a brick red precipitate.

Disaccharides

- They are sugars formed by joining ..... monosaccharides by a ..... bond. Glycosidic bond is formed by removal of a ..... molecule from two adjacent monosaccharides by a ..... reaction. Water molecule is formed from ..... group of one monosaccharide molecule and ..... from adjoining monosaccharide molecule. Maltose and lactose are ..... sugars and ..... is a non reducing sugar.




Macromolecules/Polymers/AL 2007/2016

- Polymers are a large molecule with a molecular mass of 10^4—10^{10} build up from repeating units of monomers.
- The chemical process of joining monomers to form polymers is called as condensation (Removal of water).
- The reverse reaction or the breakdown of polymers back to monomers is called as hydrolysis. (Addition of water).
- There are 3 important polymers.
  1. Polysaccharide
  2. Proteins

Polysaccharides

- They are ..... and ..... Polysaccharides are made up of ..... to a ..... monosaccharide ..... They are ..... water insoluble and not considered as sugars.
- Some polysaccharides act as .....components where others contribute to the structure of living organisms. Based on their ..... they are categorized as ..... polysaccharides and ..... polysaccharides.

- Based on their function they are categorized as storage polysaccharides and structural polysaccharides.
  1. Storage – ……, ……
  2. Structural – ……, ……, ……

- Based on their architecture they are categorized as
  1. …… - ……, ……
  2. …… - Glycogen, Amylopectin, Hemicellulose

Different Types of Polysaccharides		
Polysaccharide	**Monomer**	**Function**
Starch	Glucose	Stored in plants
Glycogen	Glucose	Stored in animals and fungi
Cellulose	Glucose	Component of Cell wall
Inuline	Fructose	Stored in Tubers of Dhalia
Pectin	Galacturonic acid	Component of middle lamella of plant cell wall
Hemicellulose	pentose	Component plant cell walls
Chitin (nitrogen containing polysaccharide)	Glucosamine	Component of fungal cell walls and exoskeleton of arthropods

Functions of Carbohydrates

Monosaccharides

……

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……

Disaccharides

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Polysaccharides

a.) Storage polysaccharides-

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b.) Structural polysaccharides-

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Laboratory tests for Starch

Iodine Test

- Iodine test is the simplest and most commonly used laboratory test to identify starch.
- Iodine solution is Iodine crystals dissolved in KI solution. (I_2/KI).
- Iodine solution is red-brown in colour.
- In presence of starch, I_2 forms a purple colour complex. (Polyiodine Complex).

Test

- Add $2cm^3$ of 1%w/v starch solution to a test tube. Add few drop of I_2 /KI solution.
- If blue black colour/Purple colour appear it confirms the presence of starch.
- Repeat the same procedure for solid form of starch (Eg: Seed endosperm).
- If same colour appears, that will indicate the presence of starch.

Carbohydrates Structured Essay

1. State the general formula of carbohydrates.

   .....

2. State the properties of sugars.

   .....

3. What are the different examples of monosaccharides present?

   .....

4. What is the type of bond present between monomers of disaccharides?

   .....

5. What are examples of important types of disaccharides

   .....

6. What are the different types of macro-molecules present in cells?

   .....

7. How polysaccharides are grouped based on function.

   .....

   .....

8. How polysaccharides are classified according to architecture.

   .....

   .....

9. Disaccharides are considered as a stored material. State why?

   .....

10. Consider following carbohydrates

    A - Glucose, B - Ribose, C - Starch, D - Lactose, E - Glycogen, F - Sucrose, G - Inulin, H - Hemicellulose

    (i) Which of the above are reducing sugars

    .....

    (ii) Which is water soluble

    .....

(iii) Which answers for Fehling's test

.....

(iv) Polymer of Glucose

.....

(v) Present in cell walls

.....

(vi) Macromolecules

.....

11. What is the structural polysaccharide present in Kingdom: Animalia.

.....

12. State the location.

.....

13. What is the difference of above polysaccharide to other polysaccharides.

.....

14. (1) What is the disaccharide result two glucose molecules by enzymatic hydrolysis.

.....

(2) What is the stored carbohydrate of animals?

.....

(4) State the structure polysaccharide present in insect exoskeleton.

.....

(5) Name the monosaccharide present in the hereditary material.

AL 2007

(B) (i) What are biological polymers?

.....

.....

(ii) Name two major biological polymers found in cells which contain only C, H, O and indicate one function of each of them.

Biological Polymer **Function**

.....

.....

(iii) Describe a simple experiment to distinguish sucrose and maltose.

.....

.....

.....

Carbohydrates/MCQ

1. Which of the following substances is not a carbohydrate or a carbohydrate derivative?
   (1) Pectin (2) Chitin (3) Cutin (4) Hemicelllulose (5) Agar (91/Bot)

2. Which of the following is a monosaccharide
   (1) Amylose (2)Sucrose (3) Maltose (4) Lactose (5) Ribose (93/Bot)

3. Which of the following is not a carbohydrate or a derivative of carbohydrate?
   (1) Cellulose (2) Pectin (3) Starch (4) Chitin (5) Suberin. (94/Bot)

4. Which of the following compounds is the most abundant in plants?
   (1) Chlorophyll (2) Carbohydrates (3) Proteins (4) Lipids (5) Nucleic acids

5. Which of the following represent the composition of sucrose ?
   (1) Glucose - glucose (2) Glucose - fructose (3) Fructose - fructose (4) Galactose - glucose
   (5) Galactose - galactose

6. Which of the following represents the correct combination of monosaccharides in maltose?
   (1) glucose- glucose (2) Glucose- fructose (3) Fructose- fructose (4) glucose-galactose
   (5) glucose-ribose

7. Which one of the following is not made only of glucose units?
   (1) cellulose(2) maltose (3) starch (4) sucrose (5) glycogen (1999/Zoo)

8. Which of the following will not produce a brick red precipitate with Benedicts' Reagent?
   (1) Glucose (2) Fructose (3) Maltose (4) Sucrose (5) Lactose

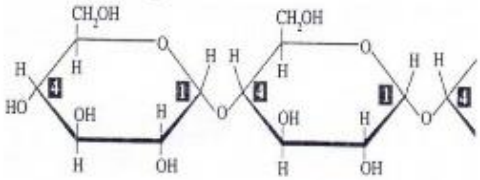
9. Feshlings' reagent,
   (1) Blue (2) Brick red (3) Green (4) Yellow (5) Colorless

10. Three test tubes were prepared as given below,
    (A) Glucose solution (B) Sucrose solution + dilute HCl (C) Starch solution + Amylase
    After one hour Benedicts solution was added to all three test tubes and heat gently in a water bath.
    A red precipitate was observed in
    (1) A only (2) B only (3) A and B only (4) B and C only (5) A, B and C

11. The hydrolysis of one molecule of sucrose produces
    (1) two fructose molecules. (2) one glucose molecule and one fructose molecule.
    (3) two glucose molecules. (4) one glucose molecule and one galactose molecule.
    (5) one fructose molecule and one galactose molecule. (AL/2004)

12. Which of the following carbohydrates gives/ give a reaction in Benedict's test?
(A) Lactose (B) Glucose (C) Sucrose (D) Maltose (E) Ribose (AL/2012 new)

13. Structure of a part of a polysaccharide molecule is shown in the diagram. What is the type of bond involved in joining the monosaccharide molecules?



(1) Peptide bonds (2) Hydrogen bonds (3) Disulphide bonds (4) Glycosidic bonds
(5) Ionic bonds (2013 new)

14. Which of the following is a disaccharide as well as a reducing sugar?
(1) Sucrose (2) Fructose (3) Galactose (4) Maltose (5) Ribose (2013 old)

15. Which of the following statements is incorrect regarding inulin?
(1) It is a polymer of fructose. (2) It is an unbranched molecule.
(3) It is the major storage compound in some plants.
(4) It is present in the middle lamella of plant cells. (5) It is soluble in water. (2013 old)

16. Which one of the following chemical tests can be used to show the presence of glucose in a solution?
(1) Biuret test (2) Benedict test (3) Iodine test (4) Sudan test (5) Methylene blue test (2014)

17. Which of the following polymers is found only in plants?
(1) Glycogen (2) Chitin (3) Ribonucleic acid (4) Inulin (5) Keratin (2015/2)

18. Which of the following is a non-reducing sugar?
(1) Ribose (2) Lactose (3) Maltese (4) Galactose (5) Sucrose (2021 AL/01)

Essay AID 02

1. Describe properties of water and explain how they help to maintain life on earth.

1. **Cohesive behavior**
2. Attraction between water molecules due to hydrogen bonding is known as cohesion.
3. Attraction between water molecules and other substances are known as adhesion.
4. Both of the above properties of water allow it to act as a transport medium.
5. Due to cohesion between water molecules, water and dissolved substances such as minerals and nutrients transport through vascular tissues, xylem and phloem against gravity.
6. Adhesion between water molecules and cell walls also helps in conduction of water and dissolved substances.
7. Water has a high surface tension.
8. This ability is given to water molecules, due to cohesion between the water molecules.
9. Therefore, in an aquatic system, upper surface water molecules are attracted by lower surface molecules and it forms a water film.
10. Small insects can walk on the surface of a pond.
11. **Ability to moderate temperature**
12. Water can absorb or release a relatively high amount of heat energy by a slight change in its own temperature.
13. Due to the high specific heat, water will function as thermal buffer in living system and aquatic bodies during the temperature fluctuations on earth.
14. Due to the high heat of vapourization, with the minimum loss of water an organism can release much heat energy.
15. Therefore, body surface of an organism maintained as cool surface.
16. Transpiration in plants keeps the plant body surface as a cool surface and prevent from becoming too warm in the sunlight.
17. **Expansion upon freezing**
18. Generally, in an increase in temperature of any substances, reduces their density and on the other hand, in a decrease in temperature increases their density.
19. When the temperature of water falls below 4C, it begins to freeze and forms a crystalline la[illegible] ce called ice cubes.
20. Therefore water has the maximum density at 4℃.
21. Hence, ice floats on the surface of water bodies.
22. It is an important property of water in polar regions, where, organisms in aquatic bodies can survive during the winter.
23. **Versatility as a solvent**
24. This ability is given to water due to their polarity.
25. Polar molecules, non polar ionic, both polar and ionic can dissolve in water, because water molecules surround each of the solute molecules and form hydrogen bonds with them.
26. Solubility depends on polarity and not in their ionic nature

(any 25 points 25 x 6 = 150)
(maximum 150)

Essay AID 03

Giving suitable examples, write an account of the basic chemical features and biological functions carbohydrates. (AL/2010)

Answer :

1. Elemental composition = CHO
2. Represented by general formula $C_x(H_2O)_y$ / Ration of H:O is 2:1 Divided into three classes.
3. Monosaccharides
4. Disaccharides
5. Polysaccharides
6. Monosaccharides are single sugar molecules.
7. All monosaccharides are reducing sugars,
8. Classified according to the number of carbon atoms. Examples
9. Trioses (3C)
10. Eg. Glyceraldehyde.
11. Pentoses (5C)
12. E.g. ribose
13. Ribulose
14. Hexoses (6C)
15. Eg. Glucose/Fructose/Galactose
16. Disaccharide contains two monosaccharide
17. Joined by a glyosidic bond.

Examples

18. Maltose = glucose + galactose
19. Sucrose =glucose + fructose
20. Lactose = glucose + galactose
21. Sucrose is a non–reducing sugar
22. Maltose /lactose are reducing sugars
23. Polysaccharides are large polymer molecules/ macromolecules
24. Made by joining many monosaccharides
25. By glyosidic bonds
26. Are generally insoluble in water.

Example

27. Starch/ Glycogen and
28. Cellulose
29. Are glucose polymers.
30. Inuline
31. Is a fructose polymers
32. Pectin
33. Is a galacturonic acid polymer.

Functions:

34. Carbohydrates are primary products of photosynthesis / server as one of the major

Monosaccharides

35. (Trioses) Glyceraldehyde is an intermediate in respiration. (Glycolysis) serves as an intermediate. Raw material of synthesis of many cellular chemicals /compounds.
36. Is a derivative of when first product (phosphoglyceric acid) of photosynthesis/ serves as the major raw material of synthesis of other carbohydrates.
37. (Pentoses) Ribose is a constituent of RNA
38. Constituent of ATP/nucleotides.
39. Constituent of Co-enzymes /NAD/NADP
40. Deoxyribose is a constituent of DNA.
41. Ribulose is a component of CO_2 acceptor (Ribulose 1-5 diphosphate/ RUBP in photosynthesis.
42. (Hexoses) Glucose is a common respiratory substrate.

Disaccharides

43. Sucrose is a storage carbohydrate/ storage compound/stored food.
44. Involved in phloem transport.
45. Lactose is a storage carbohydrate / storage compound/stored food

Polysaccharides

46. Starch is a storage carbohydrate/stored food
47. Cellulose is a structural carbohydrate/ compound in plants.
48. Pectin is a structural carbohydrate/ compound.
49. Inuline is a storage carbohydrate/ compound/ stored food.
50. Glycogen is a storage carbohydrate in animals.

(50 x 03 marks = 150 marks)

Essay AID 04

1. (a) Classifies the carbohydrates based on number of monomers and their reducing nature
(b) Briefly describes the formation of glyosidic bond in carbohydrates
(c) Briefly discusses the major functions of carbohydrate

Answer:

1. (a) Classify the carbohydrates based on number of monomers and their reducing nature

- Three major groups of carbohydrates are monosaccharides,
- disaccharides and
- polysaccharides.
- Maltose and lactose are reducing sugars
- and sucrose is a non reducing sugar
- Polysaccharides are not reducing

(b) Briefly describes the formation of glycosidic bond in carbohydrates

- Glycosidic bond is formed by removal of a water molecule
- from two adjacent monosaccharides by a condensation reaction.
- Water molecule is formed from OH group of one monosaccharide molecule
- and H from adjoining monosaccharide molecule.
- Glucose + Glucose Maltose + H20
- Glucose + fructose Sucrose + H20
- Glucose + Galactose Lactose + H20

(c) Briefly discusses the major functions of carbohydrate

- Monosaccharides
- Energy source
- Building blocks of disaccharides and polysaccharides
- disaccharides
- such as maltose, sucrose
- and polysaccharides such as starch, glycogen.
- Components of nucleotides (DNA, RNA)
- Disaccharides
- Storage sugar in milk- Lactose
- Translocation in phloem –Sucrose
- Storage sugar in sugarcane- Sucrose
- Polysaccharides
- a.) Storage polysaccharides-
- starch stores glucose as energy source in plants and chlorophytes
- glycogen stores glucose as energy source in animals and fungi
- inulin stores fructose as energy source in Dahlia tubers
- b.) structural polysaccharides-
- Cellulose in the cell walls of plants and chlorophytes
- Pectin in the middle lamella of plant tissues.
- Hemicellulose in cell walls of plants.
- Peptidoglycan in the cell walls of prokaryotes.
- Chitin in the cell walls of fungi and in exoskeleton in Arthropods.