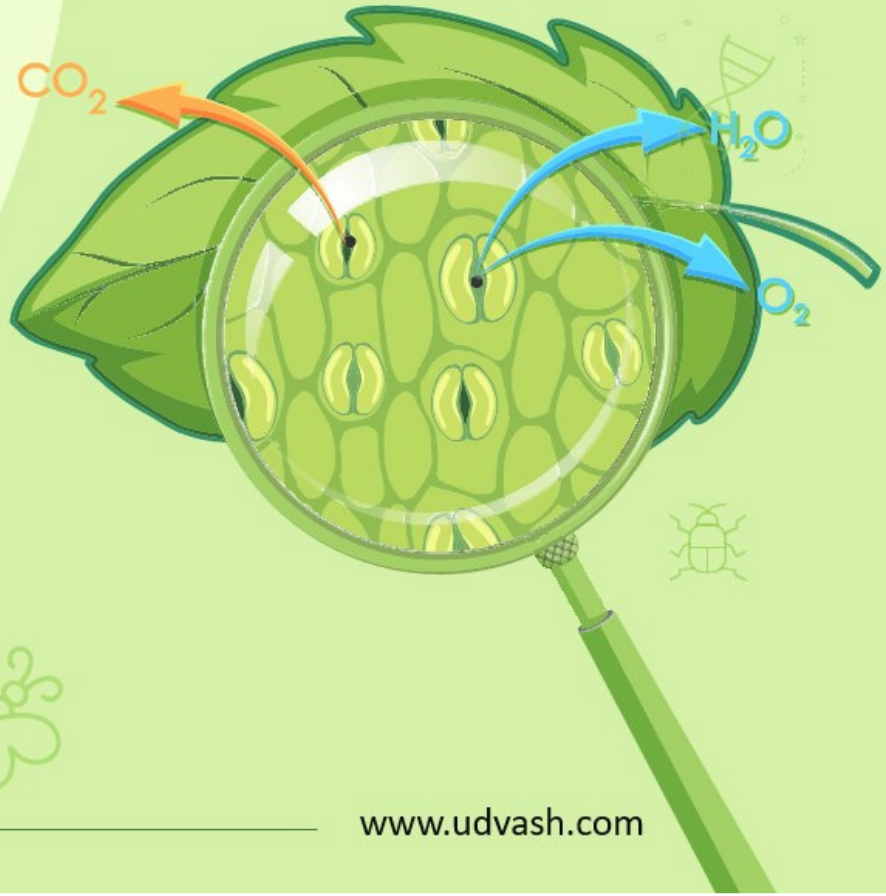
Varsity 'Ka' admission Program 2020

BIOLOGY

Lecture : B-03

Chapter 3 : Cell Chemistry

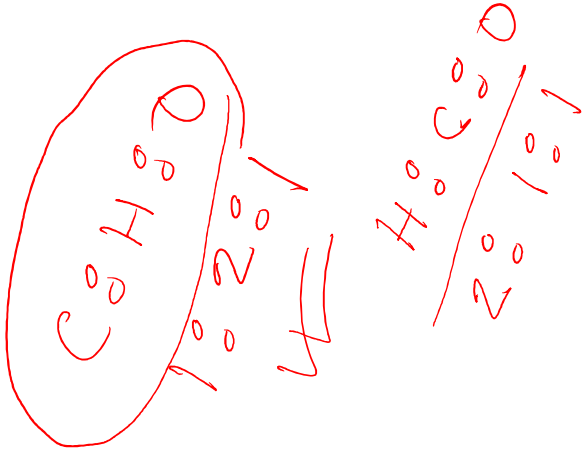



Carbohydrates

Carbohydrates

Formula $(CH_2O)_n$

- Carbohydrates are polyhydroxy aldehydes or polyhydroxy ketone or their derivatives. Their alternative name is hydrates of carbon.
- Ratio of C, H, O is $1:2:1$
- about $50\text{-}80\%$ of dry weight of plants.



Characteristics of Carbohydrates

- They are granular (sugar), fibrous (cellulose) and powder like substances.
- They are sweet (sucrose) or tasteless (cellulose).
- Turns into ash if heated.
- Mostly soluble in water

Functions of Carbohydrates

- ✓ They act as the main source of energy for organisms and produce energy by being oxidized.
- ✓ Acts as structural component of supporting tissues of plants.
- ✓ Provides carbon skeleton to structural components of the plant.
- ✓ Used as lubricant in the bone joints.
- ✓ Deoxyribose sugar for DNA formation and ribose sugar for RNA formation are must..
- ✓ Many components of our basic demand, such as food, clothes, habitat comes from carbohydrate.
- ✓ Cellulose gives protection and rigidity to plant.

Classifications of Carbohydrates

a. Based on taste: 2 types

(i) Sugar
- Tastes sweet, granular, water soluble.
- Examples: glucose, fructose, sucrose

(ii) Non-sugar
- Doesn't taste sweet, agranular, water insoluble.
- Examples: starch, cellulose, glycogen, dextrin

Classifications of Carbohydrates

Based on structural molecule, carbohydrates are divided into 4 types.	
(i) Monosaccharide	• Yields one monosaccharide on hydrolysis. • Such as- glucose
(ii) Disaccharide	• Yields 2 monosaccharides on hydrolysis. • Such as- maltose, sucrose, cellobiose, lactose.
(iii) Oligosaccharide	• Yields 3-10 monosaccharides on hydrolysis. • Such as- raffinose (trisaccharide)
(iv) Polysaccharide	• Yields many monosaccharides on hydrolysis. • Such as- starch, glycogen, cellulose.

Monosaccharides

- **Carbon number is 3-10.**

Type	Aldose sugar	Ketose sugar
Triose $(C_3H_6O_3)$ **(smallest carbohydrate)**	• Glyceraldehyde	• Dihydroxy acetone
Tetrose $(C_4H_8O_4)$	• Erythrose	• Erythralose
Pentose $(C_5H_{10}O_5)$	• Ribose, Xylose, Deoxyribose	• Ribulose, Xylulose
Hexose $(C_6H_{12}O_6)$	• Glucose, Galactose, Mannose	• Fructose

Monosaccharide: Glucose

Dextrose/grape sugar/corn sugar

$C_6H_{12}O_6$

- It is called grape sugar as it is found in 12–30% in ripe grape.
- Primary substance of cellular respiration is glucose.

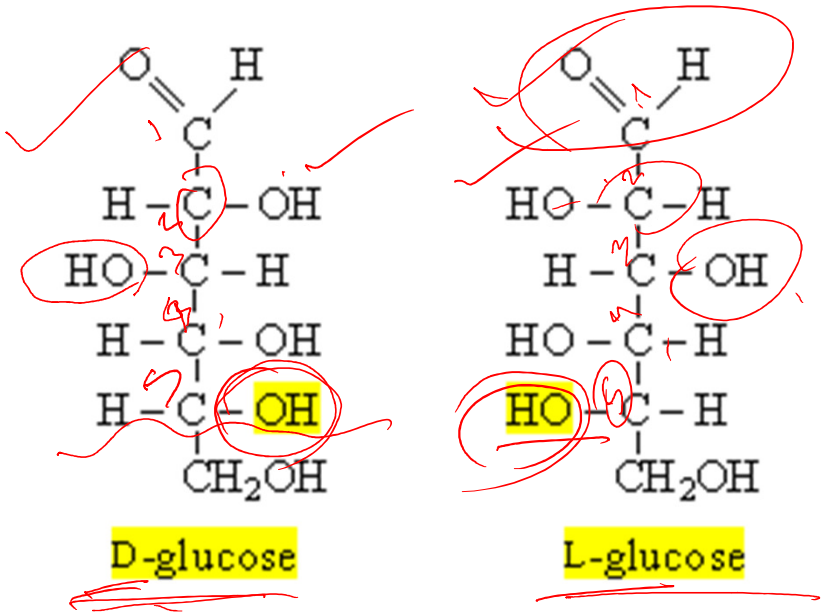
Use:

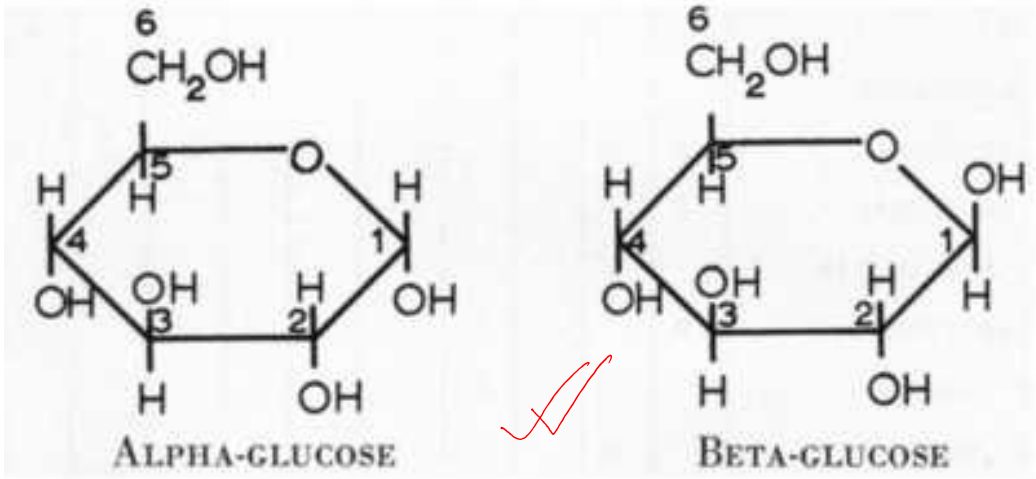
✓ Well known diet. Provides quick energy to patient.

✓ Used in synthessis of vitamin C.

✓ Used in preservation of fruits.

Types of Glucose





Monosaccharide: Fructose

Fructose/Fruit Sugar

$C_6H_{12}O_6$ (isomer of Glucose)

- ❒ most ripe sweet fruit and honey contain fructose
- ✓ Used in production of different sweet food

Disaccharides

formula	$C_{12}H_{22}O_{11}$
Example	Maltose, sucrose, cellobiose, lactose etc

Sucrose or sugar:

- Soluble in water.
- White granular organic substance. Melting point is 188°C.
- Sucrose is twice as sweet as glucose

- ✓ Sugar usually refers to sucrose. Sucrose is called common dietary sugar.
- ✓ Sugar-cane sap has 15% sucrose. So it is called sugar-cane sugar or beat sugar.
- ✓ Sucrose is the main disaccharide of plants.
- ✓ Carbohydrate produced in leaf is supplied to different organs as sucrose.
- ✓ Main raw material of honey is sucrose

Disaccharides

Cellobiose
Produced by two β –Glucose units

Maltose:
Produced by Two molecules of α – Glucose.

Relative sweetness:

Sugar	Relative sweetness	Sugar	Relative sweetness
Sucrose	100	**Lactose**	16
Glucose	74	**Saccharin**	500
Fructose	173		
Moltose	32		

Poll Question-01

What is the number of carbon atoms in glucose molecule?

(a) 5
(b) 4
(c) 6
(d) 7

Oligosaccharides

3-10 molecules of monosaccharide are produced on hydrolysis.	
	Example
Trisaccharide	• Raffinose
Tetrasacharide	• Stachyose
Pentasaccharide	• Verbascose

Disaccharide and trisaccharide	
Maltose	**Glucose + Glucose**
Sucrose	**Glucose + Fructose**
Cellobiose	**Glucose + Glucose**
Lactose	**Glucose + Galactose**
Raffinose	**Glucose + Fructose + Galactose**

Polysaccharides

$(C_6H_{10}O_5)_n$

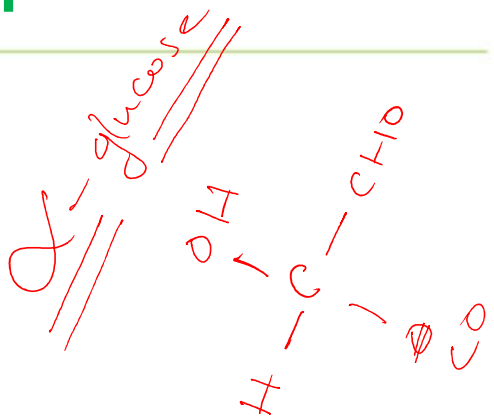
- Insoluble in water and not sweet.
- Starch, Glycogen, Cellulose, Hemicellulose, Inulin, Dextrinetc

Types of polysaccharides

(a) Structural polysaccharide: Cellulose, Pectic acid etc.
(b) Stored polysaccharide: Starch, Glycogen.

Polysaccharide: Starch

$(C_6H_{10}O_5)_n$



Starch is of two types.

Such as-

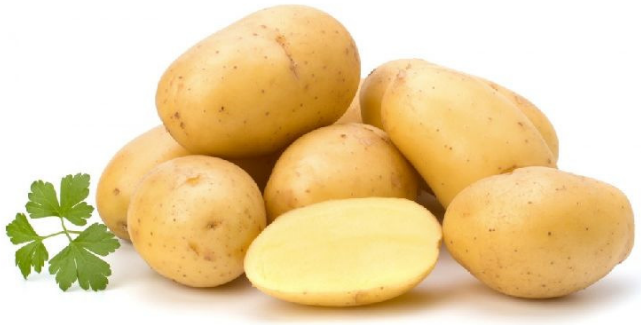
a) amylose and

b) amylopectin.

- Almost 78/75-80% of molecular weight of starch is amylopectin and 22/20-25% is amylose.
- Amylose is made of 200-1,000 glucose molecules.
- 2,000-2,00,000 glucose molecules constitute amylopectin
- Largest starch particle- Potato.
- Smallest starch particle- Rice.

Polysaccharide: Starch

$(C_6H_{10}O_5)_n$



Amylose

- Glucose-1,4- Linkage
- No chain
- 22% of starch
- blue color in iodine solution

Amylopectin

- Glucose-1,4- 1,6- linkage
- Chained
- 78% of starch
- Red color in iodine solution

Polysaccharide: Starch

- It is odorless, colorless and tasteless, white soft non-granular powder-like organic substance.
- They are soluble in water, ether and alcohol in normal temperature.
- They form blue color in iodine solution.

- ✓ Most of the glucose produced in photosynthesis is transformed to starch.
- ✓ Starch is preserved as stored food in plants.
- ✓ Staple food of animal kingdom and humans is starch. Rice, wheat, maize, potato, barley etc. has 70-80% starch.

Polysaccharide: Cellulose

- It is insoluble in water or common solution.
- Not sweet
- It does not give any color in iodine solution
- No nutrition value
- Main structural component of plants।
- Cotton has 94%, linen has 90%, wood has 60%/50% cellulose.
- Grasses have 30-40% and soil with organic matter have 40-70% /70% cellulose.
- 90% of plant fibers is cellulose.

Polysaccharide: Cellulose

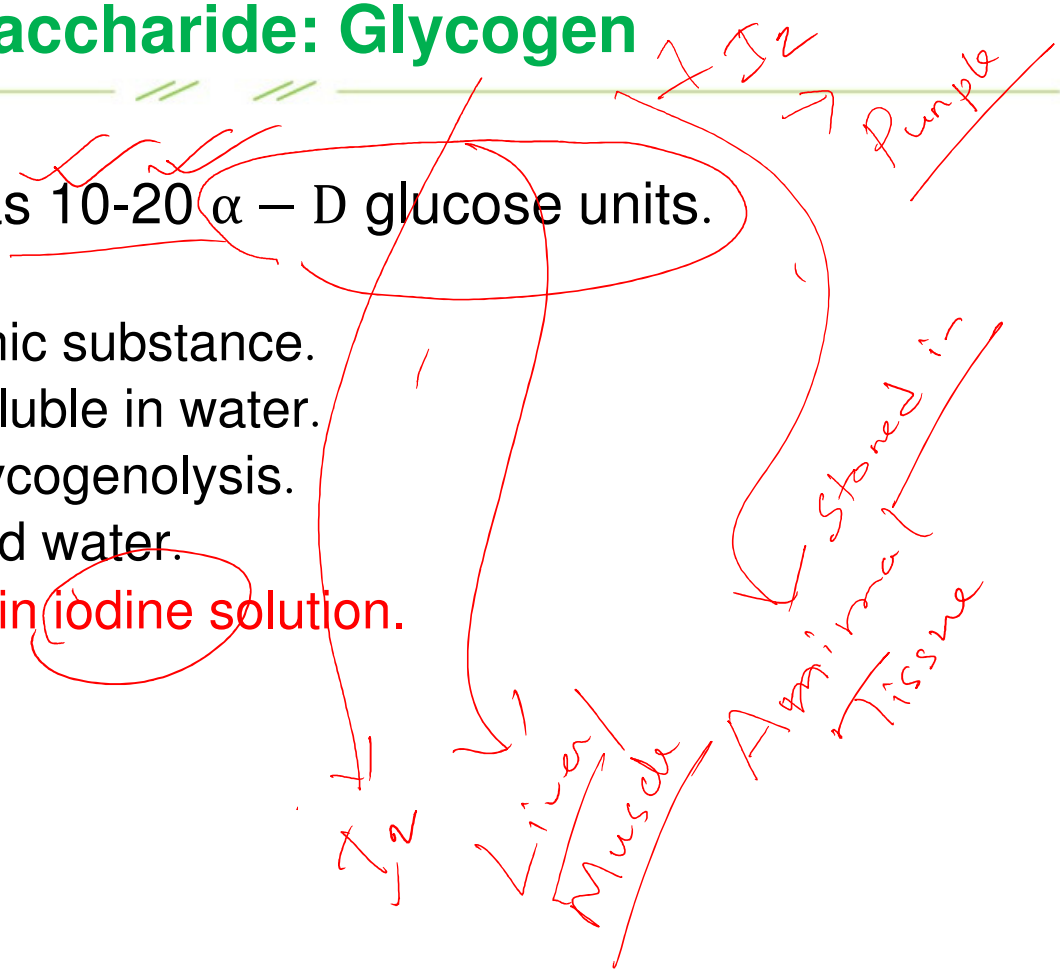
Use:-

- ✓ Plant cell wall is made up of cellulose.
- ✓ It is a main component of paper and garments industry. It is used to manufacture tissue and filter paper and packaging materials.
- ✓ Used as nitrate explosive.
- ✓ Used in building materials and furniture.
- ✓ Used in biotechnology.

Polysaccharide: Glycogen

Each branch of glycogen has 10-20 α – D glucose units.

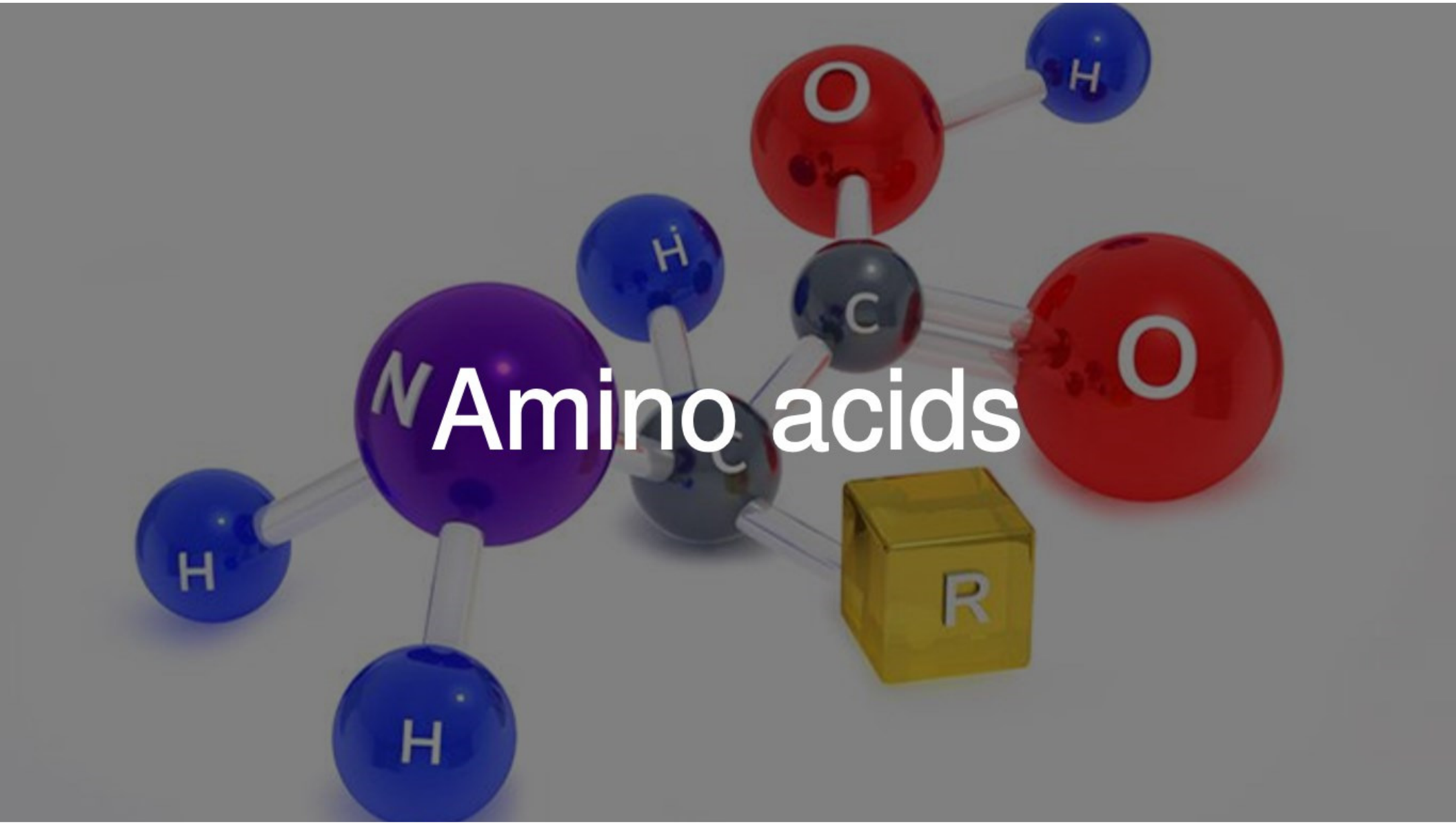
- It is white powder-like organic substance.
- It is easily soluble/partial soluble in water.
- Converted to glucose by glycogenolysis.
- Produces suspension in cold water.
- Forms reddish purple color in iodine solution.



Polysaccharide: Glycogen

USE:-

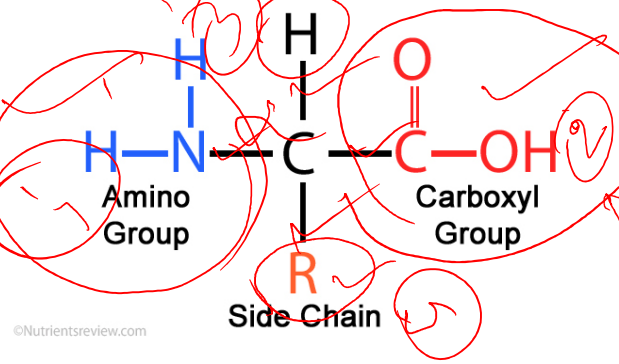
- ✓ Glycogen in muscle gives energy.
- ✓ Glycogen of liver is converted to glucose and flows in blood.
- ✓ Controls the normal level of sugar in blood.


Amino acids
O
H
H
C
O
N
H
C
H
R

Amino acid

- **Discoverer:** Scientist Emil Fischer
- Total more than 28 amino acids are found in plants and animals among which the number of protein amino acids is 20.
- Almost all amino acids found in human body are α-amino acid
- Soluble in water
- One or more amino acids form protein by peptide bonds

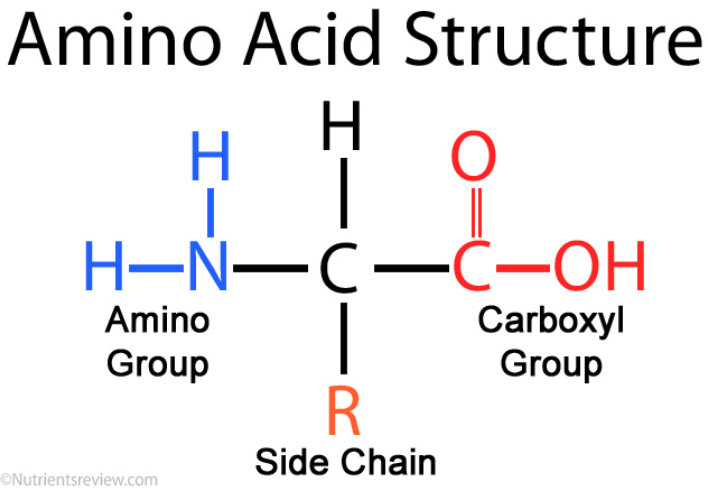
Amino Acid Structure



Amino acid

Functions:

- Protein synthesis.
- Plays role in body structure.
- synthesis of some enzymes,
- Helps in urea synthesis
- Immunity of body is increased.
- Produces melanin pigment present in hair and choracoid layer of eyes।



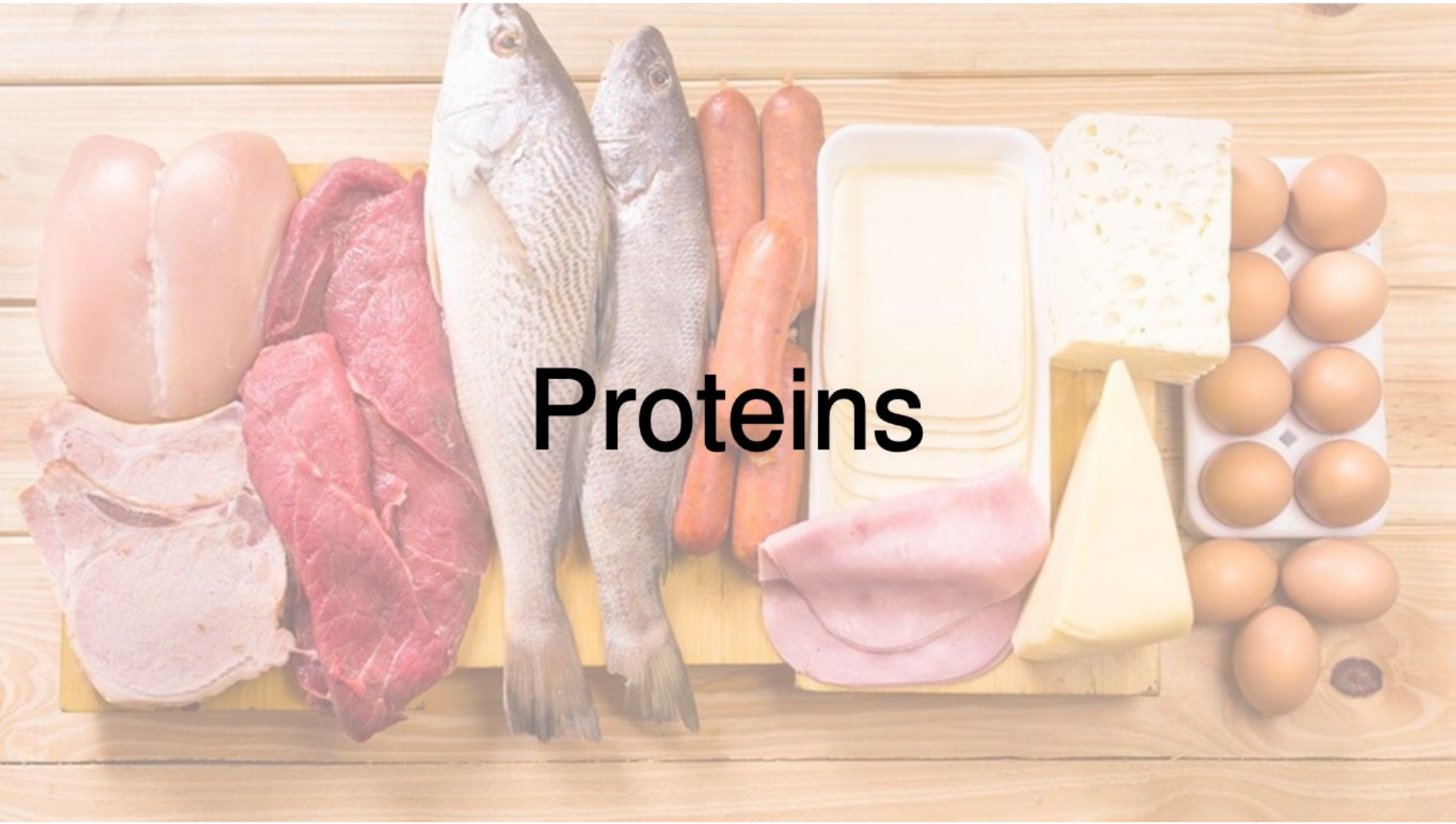
Classifications of Amino acids

c) Based on dietary importance, divided into 2 typesa	
(i) Essential amino acids	• They are not synthesized inside body. • Example: Leucine, Isoleucine, Lysine, Methionine, Threonine, Valine, Phenylalanine and Tryptophane (8 amino acids). • Arginine and Histidine is essential for babies. So, essential amino acids for babies are 10 in number.
(ii) Non-essential amino acids	• These can be synthesized in the body. • 12 in numbers. • 10 in case of babies.

Poll Question-02

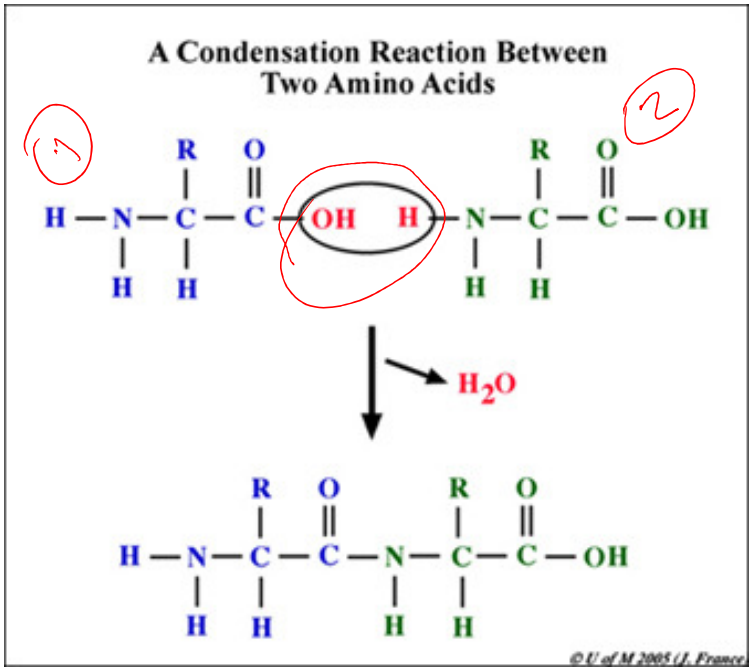
How many amino acids are obtained from protein?

(a) 8
(b) 20
(c) 26
(d) 64


Proteins

Proteins

- **Naming:** G. Mulder
- 100 or more amino acids form protein by peptide bond
- Protein is 50% of dry weight of animal body
- **Peptide:** An amino acid chain bound with peptide bonds
- **Polypeptide:** Must have amino acids more than 50
- Smallest protein (insulin) can have 75 amino acids whereas the largest protein can have 40,000 amin acid residues



Characteristics of Proteins

- It is composed of carbon, hydrogen and nitrogen. It also contains sulphur, iron and copper.
- Protein is colloid type
- Many physical and chemical process can change nature of protein.
- Protein is soluble in water
- Amino acids are found in hydrolysis of protein.
- Protein coagulates in presence of acid. Molecular structure is changed in this process.

Simple Proteins

Name	Water solubility	Heat Coagulation	Source
Albumin	+	+	Albumin in egg white, lactalbumin in millk, blood serum
Globulin	-	+	Egg yolk, serum globulin (blood plasma), muscle (myosin globulin).
Histone	+	-	More seen in nucleus and nucleic acid.

Simple Proteins

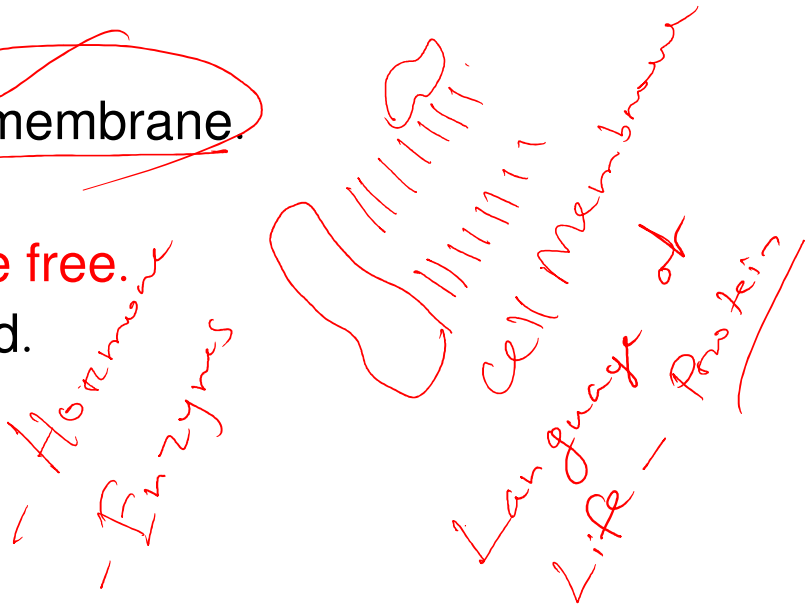
Name	Water Solubility	Heat Coagulation	Source
Prolamine	-	-	Zain
Protamine (Smallets protein)	+	-	Sperm of salamin fish
Glutelin	-	-	wheat, rice
Scleroprotein	-	-	Collagen of bone and skin, keratin of nail, skin etc. and tenon of bone

Conjugated Proteins

Has a non-protein part (prosthetic group).	
Classification	
(i) Nucleoprotein	• Found in chromosome.
(ii) Glycoprotein/mucoprotein	• Found in cell membrane.
(iii) Lipoprotein	• Plasma protein of human blood.
(iv) Chromoprotein	• Cytochrome, biliprotein, carotenoid, chlorophyll, hemoglobin.
(v) Metalloprotein	• Has Fe, Mg, Mn, Zn etc; this type of protein is seen in siderophilin and celoplasimin.
(vi) Phosphoprotein	• Found in caesinogen of milk and vitelin of egg.
(vii) Flavoprotein	• Remains attached to FAD.

Functions of Proteins

- Proteins act as stored food in cell
- formation of different organelles and cell membrane.
- Regulates reaction of body as enzymes
- Creates antibody and keeps body disease free.
- Histone activates nuclues and nucleic acid.
- snake venom protein
- Hemoglobin
- Defensive protein
- Interferon is cellular protein.
- Hormones required for animal body are produced. Such as- insulin, STH, LTH.



Poll Question-03

Which one is the smallest simple protein?

(a) Protamine
(b) Prolamine
(c) Globulin
(d) Albumin

Poll Question-04

Which one is not a simple protein?

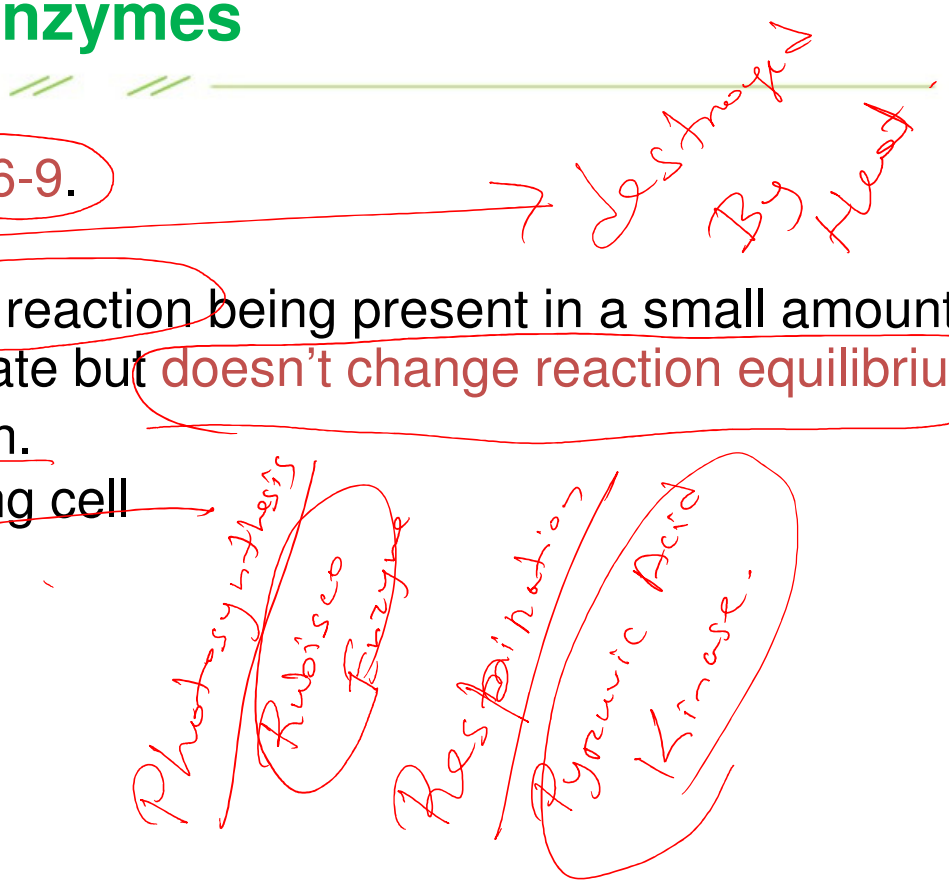
(a) Albumin
(b) Glycoprotein
(c) Protamine
(d) Globulin

Enzymes


Catalyst
Doesn't Alter Equilibrium of Reaction
Formed by Protein
Increase Rate of Reaction
Boost Up Reaction Acceleration
After Reaction Unchanged

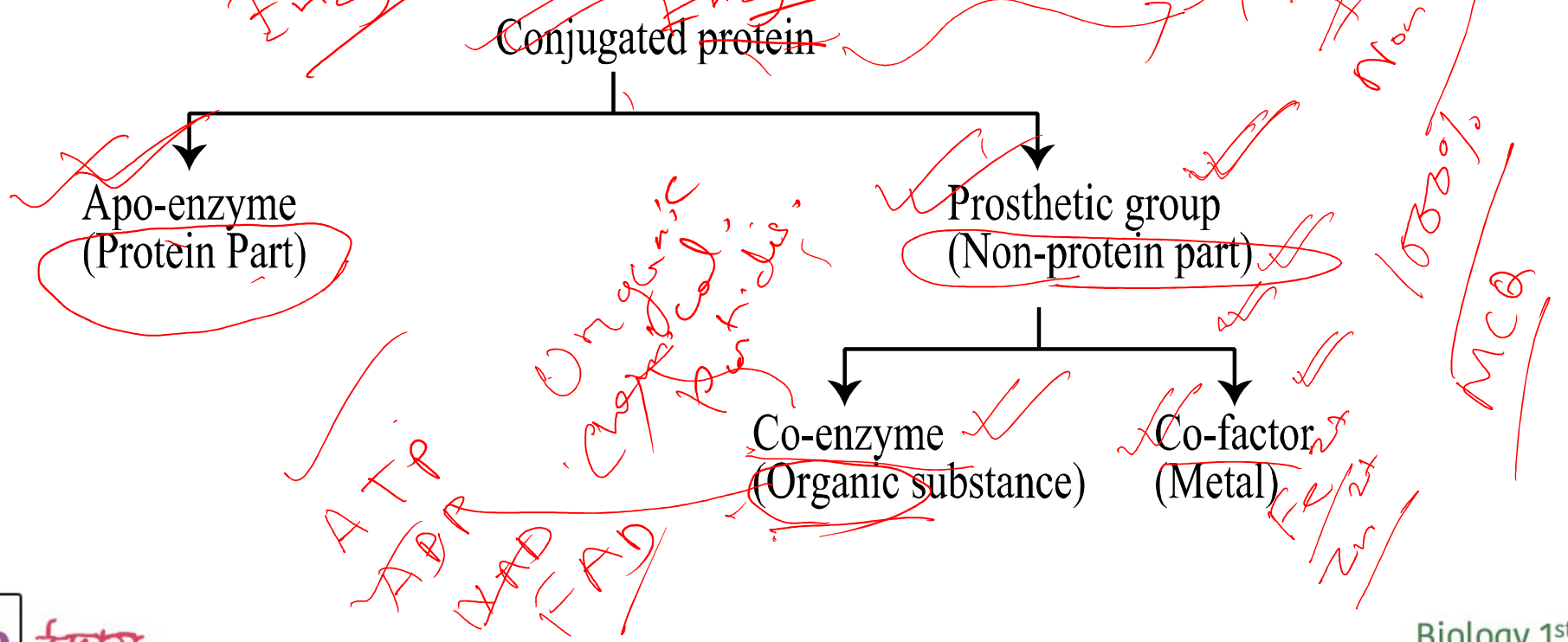
Enzymes

- Enzyme is protein. Optimum pH : 6-9.
- These are heat labile,
- Enzyme can accelerate the rate of reaction being present in a small amount.
- Enzyme only speeds up reaction rate but doesn't change reaction equilibrium.
- Enzymes are specific in their action.
- Enzymes are only produced in living cell
- water is required for their activity.



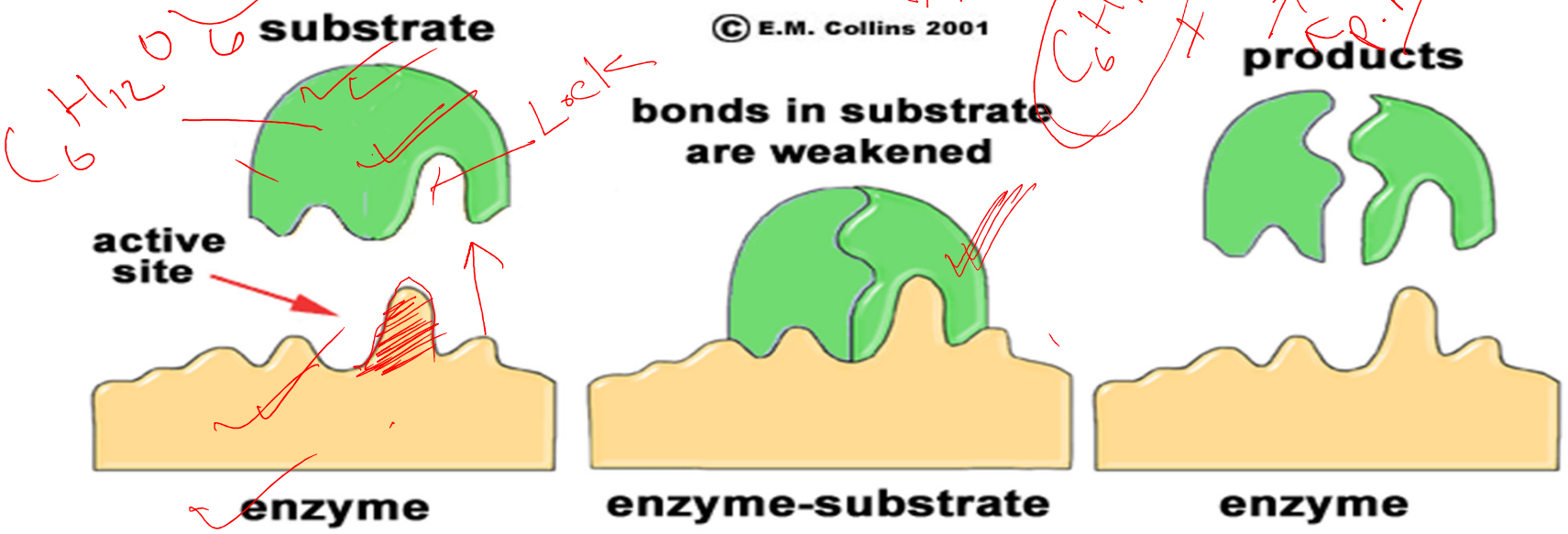
Classifications of Enzymes

(i) Simple Enzymes	**• (only proteins)**
(ii)Conjugated Proteins	• (have non protein groups)



Mechanism of Enzyme function

1. Lock and key theory • **Proponent is Emil Fischer.**



Factors effecting enzyme's mechanism

❒ Temperature

Rate of enzyme activity is the most between 35°C and 40°C. This temperature is called "absolute temperature".

❒ pH

In case of most enzymes, favorable pH is between 6-9

Optimum pH of different enzymes are:

Pepsin → 2.0

Invertase→ 4.5

Cellobiase → 5.0

Urease → 7.0

Trypsin → 8.0

Factors effecting enzyme's mechanism

- **Metal**

  Mg^{++}, Mn^{++}, Co, Ni increases enzyme activity

  Ag, Zn, Cu can decrease enzyme activity

- **Water**
- **Concentration of substrate, enzyme and product**
- **Activator and inhibitor can alter the reactions**

Uses of enzymes

❒ **Cellulase**

• Cellulase enzyme is used in coffee processing.

• It is also used in pharmaceuticals.

❒ **Zymase**

• The enzyme found in yeast that ferments sugar to ethyl alcohol and carbon dioxide is called zymase.

• Zymase enzyme extracted from yeast is used to cure maldigestion.

❒ **Urobilase**

• Used to melt clotted blood of brain and artery.

❒ **Trypsin**

• American ophthalmologist Dr. Joseph Spina has done operation of cataract by using trypsin.

❒ **Pectin**

• Removes muddy state of fruit juice.

Poll Question-05

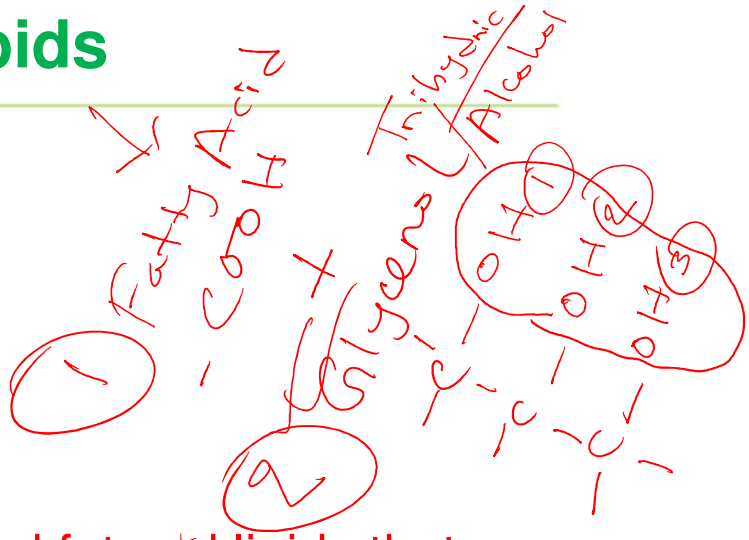
Which one is a component of enzyme?

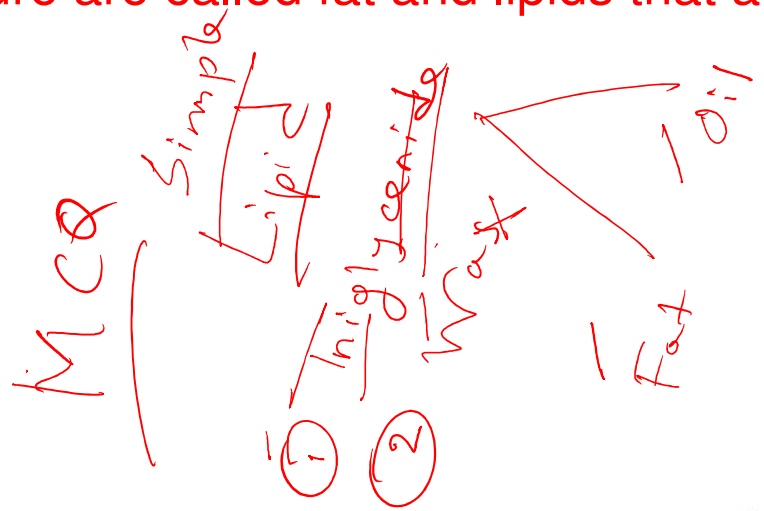
(a) Lipid
(b) Monosaccharide
(c) Protein
(d) Glycoprotein


Lipids

Characteristics of Lipids

- Colorless, tasteless and odorless.
- Lipid is converted to fatty acid and glycerol.
- Insoluble in water.
- Lighter than water, so floats on water.
- Its melting point rises with its molecular weight.
- Lipids that are solid at room temperature are called fat and lipids that are liquid are called oil.
- Lipid has no specific melting point.





Classifications of Lipids

(a) Simple lipid	Fat, oil, wax.
(b) Compound lipid	Phospholipid, glycolipid, sulpholipid etc.
(c) Derived lipid	Steroid, terpenes, rubber etc.

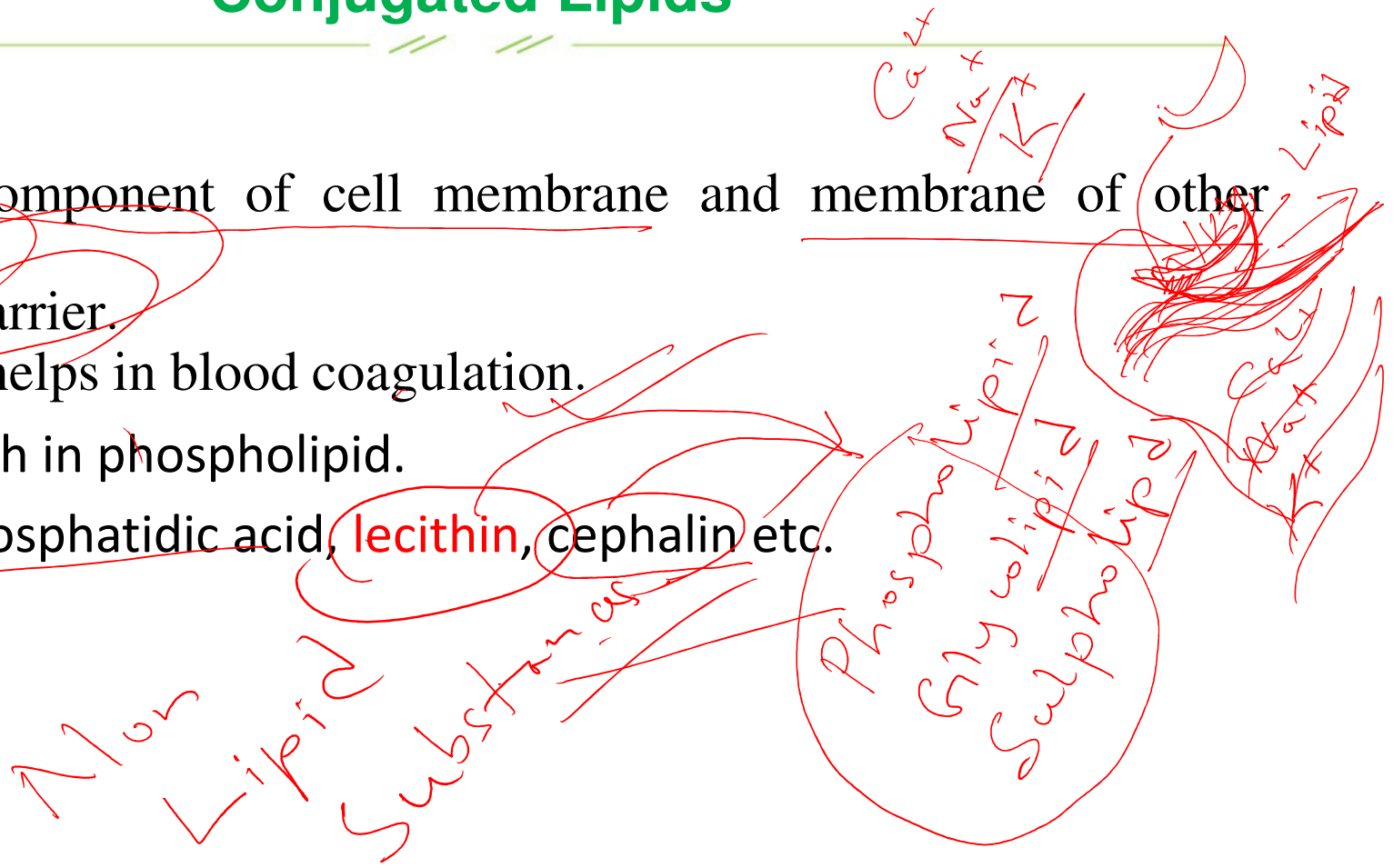
Simple Lipids

(i) Fats and oils	· Two types- fats and oils. · Stored as food in fruit and seed. · Provides energy and food for growing tree during germination of seed.
(ii) Wax	· 24-36 carbon atoms are present in one molecule of wax. · Soluble in water, made of unsaturated fatty acid. · Chemically inert; because, they have no double bonds in hydrocarbon chain.

Conjugated Lipids

Phospholipid:

- ✓ Structural component of cell membrane and membrane of other organelles.
- ✓ Acts as ion carrier.
- ✓ Phospolipid helps in blood coagulation.
- ✓ Plant oil is rich in phospholipid.
- ❒ Example: phosphatidic acid, lecithin, cephalin etc.



Conjugated Lipids

Glycolipid:

- ✓ Plays role in the formation of photosynthetic organelle.
- ✓ Helps in photosynthesis.
- ✓ Glycolipid has been detected in the seed of sunflower and cotton.
- ✓ Glycolipid is more in plant chloroplast.

Lipoprotein:

- ✓ Mainly acts as structural component of cellular organelles.
- ✓ Involved in electron transport system of mitochondria to help in production of energy.
- ✓ Mitochondria, microsome, nucleus, lamelle of chloroplast, plasma protein of human blood.

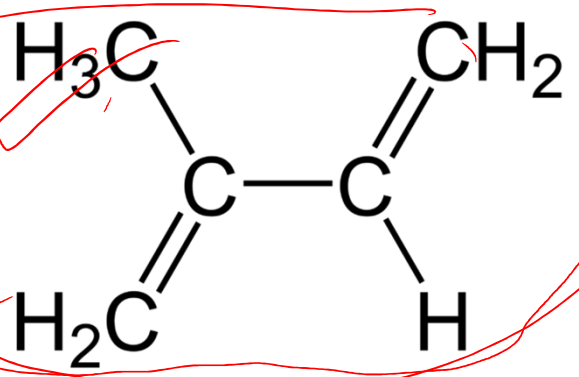
Lipid derivatives

Steroid:

- ❒ These are isoprenoid compound 27-29 carbon atoms.
- ❒ Steroids that have one or more hydroxyl group are called sterol.

Example: Cholesterol, stigmasterol, ergosterol, β sistosterol, digitalin.

- ✓ Much of the cholesterol is found in animal body.
- ✓ But purple yum (chupri alu) has the highest amout of cholesterol.
- ✓ Ergosterol is found in yeast and *Neurospora*.
- ✓ Digitalin is used in the treatment of heart.



Derived Lipids

Cholesterol:

- Produced in liver.
- Normal level in blood is $0.15 - 1.20\%$

Importance:

✓ High amount of cholesterol in human blood is harmful. Possibility of heart disease (coronary thrombosis) increases if cholesterol level is high.

✓ Excess amount of cholesterol in blood can block the lumen of artery.

✓ Female has more HDL than male.

✓ High HDL in blood is not bad, but high LDL is very dangerous.

Two types of Cholesterol

(i) **Low-density lipoprotein or LDL, normal level:** < $100\ mg/dl$

(ii) **High-density lipoprotein or HDL, normal level:** > $40\ mg/dl$

Derived Lipids

Terpenes:

- Composed of 10-40 isoprenoid units.
- Used in barnish and production of aromatic cosmetics.
- Found In Tulsi/Holy Basil and Mint

Rubber:

- Composed of 3,000-6,000 isoprene units.
- **Source**: *Ficus elastic* is a natural rubber plants.
- Rubber is used to manufacture different rubber materials (tire).

Importance of Lipids

- ✓ Lipid remains as stored food in animals.
- ✓ Fat preserved under animal skin acts as heat insulator.
- ✓ Phospholipid and glycolipid are structural components of cell membrane.
- ✓ Lipid soluble vitamins are A, D, E and K.
- ✓ Some lipids such as lipoprotein, hormone and cholesterol are synthesized from lipid.
- ✓ Phospholipid also acts as an ion carrier.
- ✓ Terpene-like lipids produce aroma in plants.

Poll Question-06

Which creates fragnance in plant?

(a) Terpinoid
(b) Glycolipid
(c) Triglyceride
(d) Steroid

Poll Question-07

Which one is not an example of simple lipid?

(a) Fat
(b) Oil
(c) Rubber
(d) Wax

লেগে থাকো সৎ ভাবে,
স্বপ্ন জয় তোমারই হবে।