08/06/18

AGRICULTURAL BIOCHEMISTRY

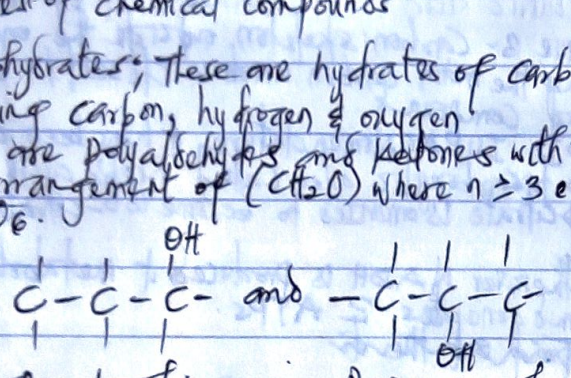
- Stoichemistry
- Lipids
- Proteins
- Vitamins & Minerals
- Enzymes & Hormones
- Carbohydrate

* The study of chemical reactions that influences life or responsible for life is called bio-chemistry i.e the chemistry of life.

* Stoichemistry (structural chemistry); This is the aspect of chemistry that studies nature and the structures of chemical compounds

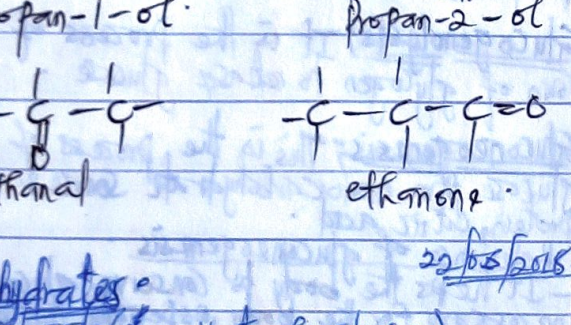
* Carbohydrates; These are hydrates of carbon containing carbon, hydrogen & oxygen. They are polyalcohols and ketones with the ratio arrangement of (CH_2O) where $n \geq 3$ e.g $C_6H_{12}O_6$.

e.g i)



Propan-1-ol. Propan-2-ol

ii)



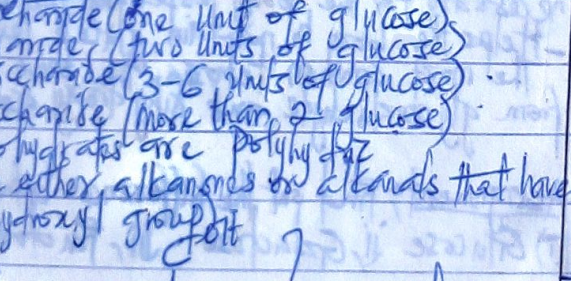
ethanal ethanone

22/06/2018

Carbohydrates

Monosaccharide (one unit of glucose)
Disaccharide (two units of glucose)
Oligosaccharide (3-6 units of glucose)
Polysaccharide (more than 2 glucose)

Carbohydrates are polyhydroxy. They are either alkanones or alkanals that have a whole hydroxyl group OH



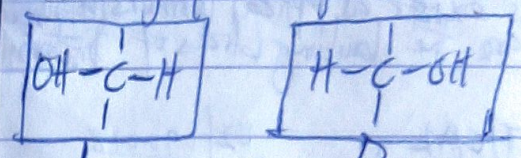
Glyceraldehyde Dihydroxyacetone

Functional isomers

Geometric isomers are based on position e.g. Alkanone & Alkanal.

3 carbon atom (Triose)
4 Carbon atom (Tetrose)
5 carbon atom (Pentose)
6 Carbon atom (Hexose)
7 Carbon atom (Heptose)

If the hydroxyl group (OH) is on the same side with the functional group C=O, it is "D". But when it is at the other side "L". Chemistry of carbohydrates is called stereoisomerism



L D

Left side – L (levo)
Right side – D (dextro). } by Emil Fisher

Ketose sugar forms 4 rings
Aldose sugar forms 6 rings.

Monosaccharides links together to form disaccharide. 2 monosaccharides links to form oligosaccharide. The bonds in glucose could usually be formed by an α 1-4 linkage.

* Maltose (Carbon 1-4) the nature is α. When it is connected in such a way that OH is up, it is called alpha (α). But when it is connected below, it is ~~called~~ called beta called β (beta).

The differences between glucose & cellulose is the branching.

Common types of polysaccharides are;
- Glycogen
- Starch
- Cellulose
- Dexrins.

Starch is a mixture of unbranched amylose (glucose residue) joined by

Types of Starch; Amylose (1-4 α bonds) no branching
Amylopectin (up branching up to 6)

Glycogen is the form in which glucose is stored in animals

Starch is the form in which glucose is stored in plants. The glucose unit are bonded α 1-4 and the branches are also α 1-6. But the final structure is not the same.

Cellulose; They are formed by β1-4 linkages and highly branched. The branches are also 1-6 linkages.

Dexrins; They have α 1-6 bonds but the branches occur at α 1-2, or 1-3, or 1-4.

Carbohydrates can bond to proteins (This is called glycoproteins).

Lipoprotein = fat + proteins.

When they are bonded to lipids, they form "glycolipids"

Carbohydrates + phosphate = ATP
ADP, AMP

Glucose + little phosphate = ADP
Glucose + phosphate = AMP.

ATP, ADP, AMP as battery that powers biochemical reactions.

* Carbohydrates exists as optical isomers (polymer)
* Amino acid are the building blocks of protein

PRACTICAL

02/07/2018

Test for Carbohydrates:
1) Molisch test
2) Benedicts test.

Apparatus: Four test tubes, ~~four~~ three carbohydrates (Glucose, Sucrose, Dextrin)

Glucose → Addition of 2 drops of Molisch's reagent (10% solution of α naphthol in alcohol)

Observation: 3 layers (The first or upper layer) Light purple
Second layer → Black
Third layer → ~~Brown~~ Yellow.

Test B → Sucrose and two drops of
Observation: It is dark in colour. (In excess)

Test D → Dextrin
Observation: 1st layer → Brown.
2nd layer → Brown.

After the dilution of glucose.
Observation: - A hot test tube
- Red-violet purple colour.
- 2 layers.

Maltose
Sucrose (in excess
Galactose)
Glucose)
Add benedicts solution 2 drops
Conc. H_2SO_4 is the last to be added.
Glucose changes to orange (1st)
Galactose changes to pale orange (2nd)
Sucrose changes to brown (third)
Maltose didn't change colour, it remained sea blue in colour.

06/07/2018

Metabolism of Carbohydrates.

Glycolysis:- This is the metabolic pathway in which one molecule of glucose is broken down into two molecules of pyruvate

- The process of making alcohol where glucose is with anaerobic condition for plant cell is fermentation

- The process of converting pyruvate is acetyl CoA is called oxidative decarboxylation of pyruvate
* It involves the removal of CO_2

⇒ Citric acid cycle because most of the compounds have 3-Carbon skeleton, except the one containing the main carbon which is closest to citric acid compounds
⇒ In IUPAC Nomenclature, it has been changed to tricarboxylic also called Krebs cycle.
⇒ Citrate isomerises to become iso-citrate.

Whenever NADH is produced it metabolizes to and generates 2 ATPs.
~~Fumarate then~~

Glucogenolysis: It is the process of breaking down of glycogen to release glucose.

Gluconeogenesis: This is the process of synthesis glucose from monocarbohydrate sources eg fat, protein, citric acid.

Relevance of gluconeogenesis
- It helps the body to conserve glucose which is necessary for the body especially the brain.
- Helps the body to maintain glucose level.
- The most common tetroses, the ones formed from glyceraldehyde and dihydroxyacetone.

Assignment: Find out the differences between:
(i) Glucose ii, Galactose iii, Fructose.

PROTEINS

13/07/18

* Body of animals / plants is 80% protein
Protein is often deconstructed from the macro to minute level.

Any – Arginine
Little – Lysine
Help – Histidine
In –

Learning –
Ten –
Tiny –
molecules –
Proves –
Valuable –

Essentially, proteins are polymers of amino acids. Only 20 amino acids are used to synthesize proteins.

Amino acid – This is any organic compound in which the alpha carbon atom helps to affect it e.g carbonyl group, alkyl group, ammonic group.

Classification of amino acid → [Reactivity, Structure, Nutritional Importance]

Reactivity ⇒ (Neutral, acidic, alkaline)

Acidic – Tyrosine, Aspartic acid, Glutamic acid

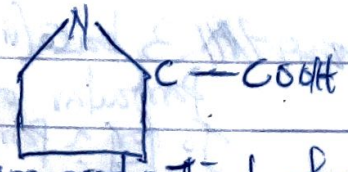
Alkaline – Histidine, Lysine, Arginine

N.B; When there is a carboxylic group in an amino acid, it becomes acidic

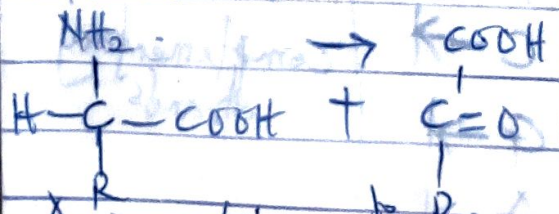
Structure ⇒ Aliphatic amino acid (straight chain)
Aromatic amino acid (Ring)

– Proline, synthesizes proteins, that's why its part of the 20 amino acids

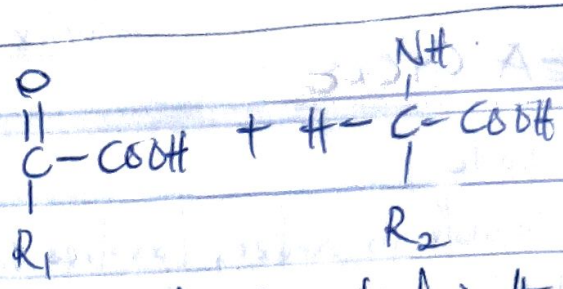
Structure;



– Transamination acid; This involves the transfer of an amino group from one amino acid to keto acid.

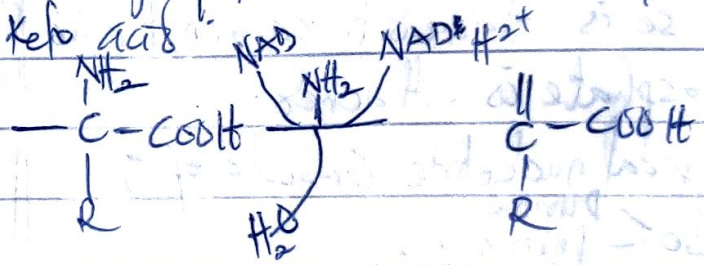


Amino acid transferred to keto acid



* Amino acid is important in the body because, it dissolves the acid in the body using the mechanism to synthesize the acids that are non-essential.

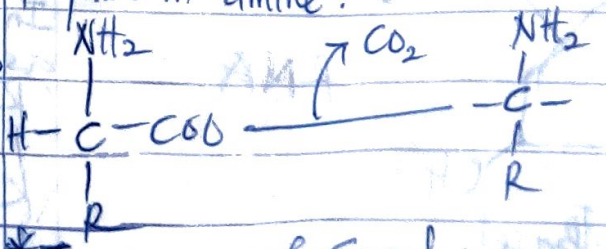
– Deamination; This involves the removal of amino group from an amino acid to form a keto acid.



NAD role is to pick up the hydrogen and the oxygen is supplied from H_2O

N.B; The body does this reaction when we consume excess protein in the body. The body uses this acid to generate energy

– Oxidative carboxylation of amino acid; It involves the removal of carbondioxide from amino acid to form an "amine".



* The process of converting ammonia NH_3 into Urea is called Urea cycle.

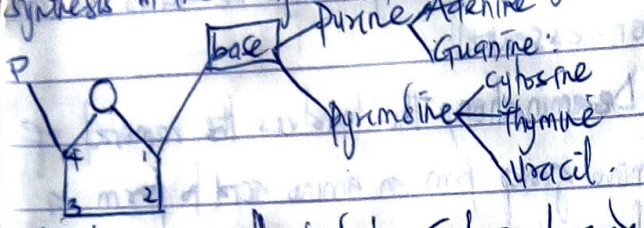
20/07/18

UREA CYCLE

* Genetic Code

- Urea is soluble in water, dissolves water in the kidney and is passed out as urine.

Protein Synthesis; Everything about protein synthesis in the body is controlled by genes.



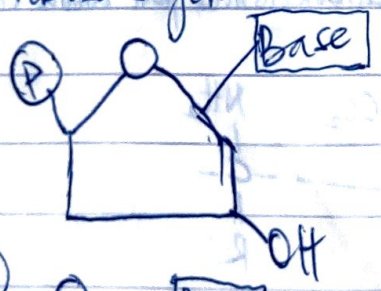
The base is attached to carbon 1 and the phosphate is attached.

A typical nucleotide consists of;

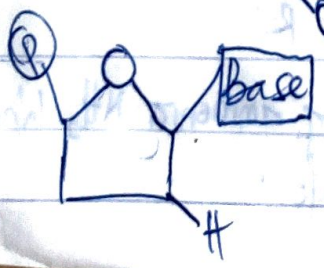
- Base — Purine / Pyrimidines
- Ribose sugar
- Phosphate.

Differences between RNA and DNA.

(1) When the nucleotide structure has an OH group it is called RNA and if it has a H it is called DNA at the carbon 2 of the ribose sugar.

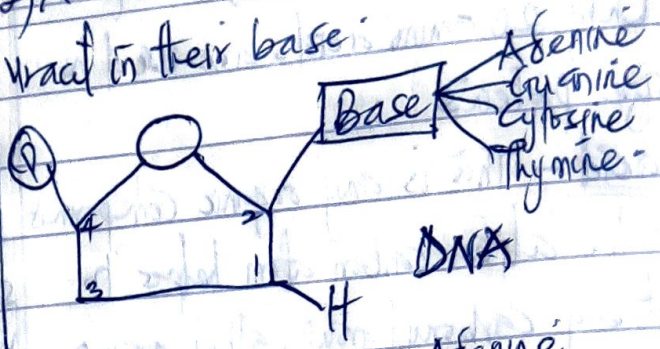


RNA.

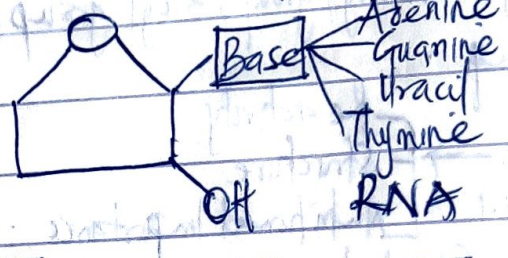


DNA

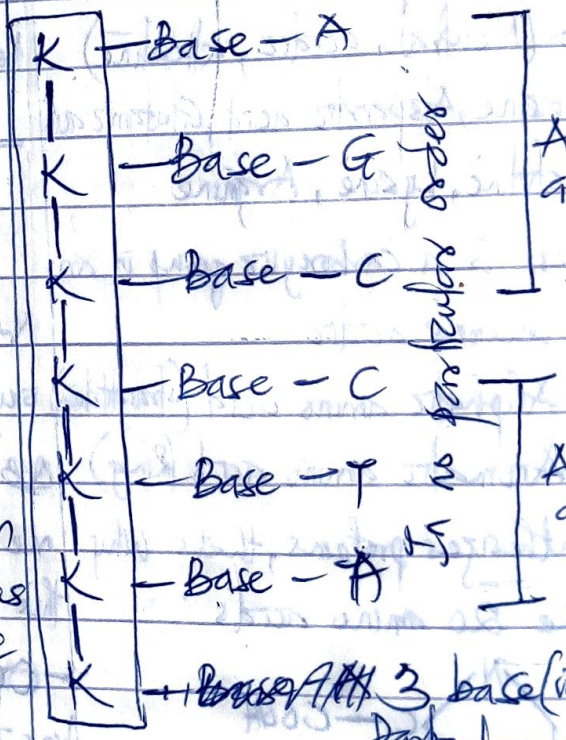
2) A DNA has cytosine, while RNA has uracil in their base.



DNA

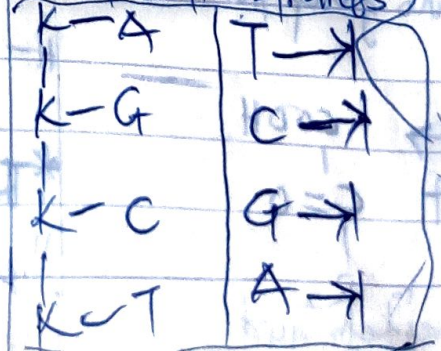


RNA



3 base (in no particular order) can go for a particular amino acid.

In eukaryotic organisms, DNA appears as double strands.



DNA → A G T C G A C T T

K – K – K – K – K – K – K – K – K

Complementary or opposite

RNA → T U A G U T G A A

Here Cytosine is Uracil.

Three consecutive base of an RNA codes for a particular amino acid is called the genetic code or make up.

DNA → RNA → Amino Acid.

DNA will code for RNA, RNA will code or determine the amino acid.

* Nonsence Codons does not code for any genetic makeup or code.

Rules: 1) gene is responsible for one protein

1) To terminate polymerization

2) To Indicate where one gene starts & ends.

The Process of protein synthesis involve 5 major process.

1) Transcription – This involves using DNA to produce RNA

2) Translation – This simply means converting the code of RNA in a particular amino acid.

DNA → mRNA → tRNA

mRNA = Messenger RNA

tRNA = transport RNA.

3) Initiation of polymerization – This is done by Initiator Codon (AUG) (methionine).

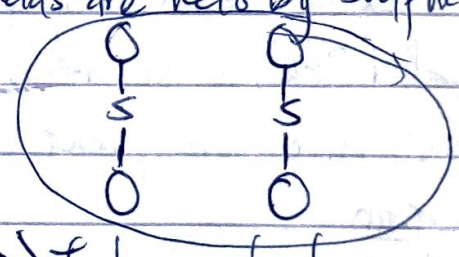
4) Elongation

5) Termination

(1) Primary structure of the protein after RNA. Single straight chain

Amino acid

2) Secondary structure is when the primary straight chain forms into a ring where amino acids are held by sulphide groups.



3) Tertiary structure

4) Quaternary structure.

Protein Quality

1) Crude protein; This is the measure of the nitrogen content in the food × 6.25.

Crude protein = N × 6.25

It is an estimate. It is not the real protein.

2) Digestible crude protein; It is the quantity

of protein in the food that is actually digestible by the body.

$$\frac{\text{Protein Intake} - \text{Protein in faeces}}{\text{Protein Intake}} \times 100$$

3) True protein:

TPV = CP − NPN

Crude protein, Non protein nitrogen

i) How to chemically store a food matrix to check how much essential amino acid are in the food, it is called ESSENTIAL AMINO ACID INDEX (EAAI).

2) Egg protein is 100% and so we score other protein based on how they look or are close to egg protein using protein as a model.

3) Protein efficiency ratio (PER) is the protein actually used for growth and development

$$PER = \frac{\text{Weight gain}}{\text{Protein Consumed}}$$

As you grow, the PER decreases and can never be equal to 1 must occur as a fraction.

27/07/18

LIPIDS

Lipids:
- Simple Lipids
- Compound
- Special lipids.

Simple lipids on hydrolysis yield only fatty acids and glycerol.

Compound lipids are lipids that produces lipoprotein and glycolipid.

Special lipids includes steroid, waxes, terpenes

Functions of lipids

1) They are components of cell membrane. Greater part of the cell membrane is made of lipids.

2) They are the major reservoirs of energy

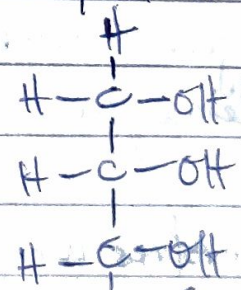
3) They are sources of energy.

4) They provide insulation ie helps in regulating body temperature.

5) Many soluble vitamins are lipids.

6) Like steroids, they serve as hormones in the body.

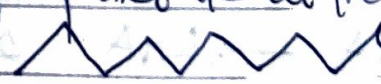
7) Fats & oil are esters of fatty acid & glycerol



Glycerol is a trihydric alcohol of propane.

Glycerol (propan-1,2,3-triol)

Fatty acids are simple hydrocarbons that have a carboxylic group as the only functioning group and its at the terminal position



Fats and oil = Fatty acid + Glycerol
(ester bond)

When fatty acid forms an ester bond with glycerol, the result is fats and oil.

(no double bond) – Saturated fatty acid → Fats

(Double bond) → Unsaturated fatty acid → oils

Fatty acids – Fatty acids are long chain hydrocarbon with usually C_{16}. But others that have short carbon chains are called volatile fatty acid. They do not form fats and oils and cannot combine with glycerol e.g Acetic acid, propanoic acid, Butyric acid

Fatty acids are named based on;

1) No of carbon atoms they have
2) Degree of saturation (no of double bonds)
3) position of the double bond.

Palmitic acid – C_{16}.

Stearic acid – C_{18} octadecanoic acid

Oleic acid – $C_{18}:1$ octadecenoic acid

Linoleic acid – $C_{18}:2$

Linolenic acid – $C_{18}:3$

Arachidonic acid – $C_{20}:4$ (Found in groundnut)

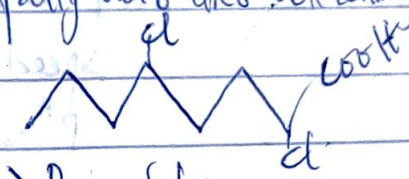
In naming fatty acids that have the presence of double bond, we name using a code depending on the number of carbon carrying the double bond e.g

C_{18} $2\Delta^2$

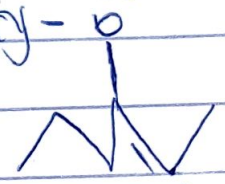
The higher the double bond, the lower the melting and boiling point.

Metabolism of fatty acids:

1) Halogenation – When halogens combine with fatty acid and attaching itself to the double bond



2) Rancidity –

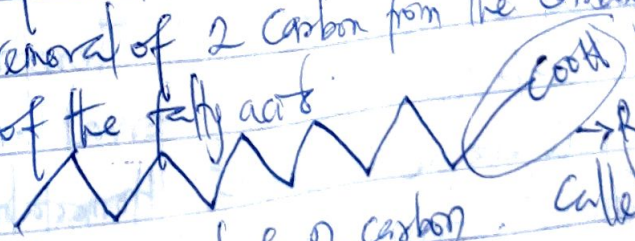


This happens when free peroxides / oxygen attacks the double bonds in the fatty acid forming ketone body, the oil is said to be rancid with disagreeable odour and flavour.

3) Oxidation – This is when oxygen adds to carbon on the fatty acid. If its at carbon 1, it is called α oxidative carbon.

Carbon 2 = β oxidative carbon.

Beta oxidation of fats is simply that series of reactions that results in the breakdown or removal of 2 carbon from the carboxylic end of the fatty acid



→ Removal is called β oxidation

Note: Removal of 2 carbon from the carboxylic end of chain

It is usually through the process of beta oxidation that energy is tapped from fatty acids when it is needed. It starts in the cytoplasm and ends in the mitochondria.

Reactions involved are;

1) Activation reaction - It occurs in the cytoplasm. The fatty acid combines with CoA to form Acyl CoA

$RCOOH + CoA \rightarrow RCO-CoA$

Acyl CoA requires 2 moles of Acyl CoA ATP.

In the mitochondrion, 4 reaction occurs

a) Oxidation of acyl CoA to enoyl CoA.

b) Hydration of enoyl CoA will give 3 hydroxyacyl CoA

c) Oxidation

d) Thiolysis is the breakdown of 3 keto acids CoA to acetyl CoA and another acyl CoA rise by 2 carbon atoms.

09/08/18

HORMONES & ENZYMES.

Hormone is a chemical messenger. Enzyme is a biological catalyst.

Mineral is a co-factor

Vitamin is a co-enzyme component.

Ductile; Two duct hormones E.g Insoluble glagagline, Paracrine hormone

Enzymes major work is to regulate metabolism. They include anabolism, catabolism and excretion. Control of metabolism is done by enzymes because regulation is done by hormones.

- Enzymes have cofactors.
- Enzymes need to react with minerals and vitamins

Speed of reaction = 10^{23}/sec is necessary

pH^{+} ranges observed in human being is 4-7.5. The least is 7.8. It is neither acidic or neutral.

6.9 → Acidic

Mineral ⇒ Micro/macro element.

They are transformed into ions.

- They operate as organic and inorganic

Micro nutrient (nutrient); They are nutrients needed in small quantity while macro are components of ion.

Fatty acid { B, D, A, K

Hormonal control of metabolic pathway; Carbohydrates and fats. Metabolic pathways are dependable and share some intermediate metabolic substrate.

Therefore, they infuse precise homeostatic control (Normal body activity (Homostatic control)

Homostatic is the normal working of the body control. The amount of substrate available and it triggers

amount of hormone.

Depolarization is the establishment of [illegible] potential.

Hormones of plants & their functions.

- Glycogen is the animal starch whose end product is glucose.

Glucose transporters; carries sugar from the extra-cellular spleen to the intra-cellular spleen (blood) & liver (performs so many metabolism) It is the major organ of metabolism. Insulin aids glucose transportation

- Glycolysis is anaerobic (works without oxygen)
- Lypogenesis is the formation of fat from glucose.
- The pathway will not take place without zyme, co-enzyme and co-factor.

ATP → Glucose
ADP ↓
Glucose 6 phosphate.
↓
Glyceraldehyde 3 phosphate.
↓
1,3 Bisphosphoglyceraldehyde.

$Mg \rightarrow Mg^{2+} - 2e \rightarrow Mg$.
$Mg - 2e \rightarrow Mg^{2+}$ (forming Mg ion in electron)

Enzymes; These are extraordinary catalytic power. Enzymes are proteinous in nature, governed by bonds. They can be in the primary unit of proteins with only one sub-unit of protein forming structure of protein.

- protein secondary structure.
- protein where they have co-values

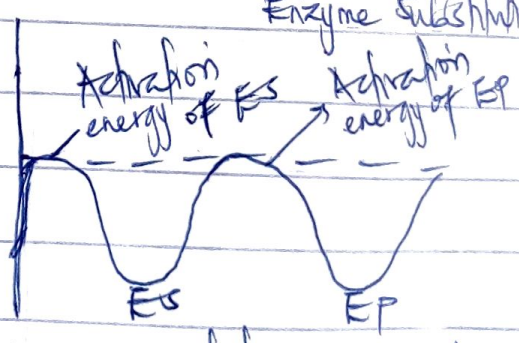
Covalent bond — Involving sharing of electrons while electrovalent bond transfers electron from one metal to another.

The enzymes functions in aqueous solution under temperature and pH change. In pH, the function below 7 and above 6.

Features of enzymes catalyze reaction. It can be represented by enzyme product.

$E + S \rightleftharpoons ES \rightleftharpoons EP \rightleftharpoons E + P$

↓ Enzyme substitution.



For enzyme catalyze there must be two mountain and two valleys.

Y axis → reaction
x axis → Intersection of component.

IEC → International enzyme Classification
Enzyme Commission; (1) Oxidoreductases - 1:1