Chloroplast / Plastids.

Plastids occur only in plant cells. They contain pigments & may synthesize and accumulate various substances.

The Green coloured chromoplasts are called Chloroplasts. Chloroplast have Chlorophyll pigments and are involved in Photosynthesis.

What is photosynthesis? Synthesis of food by using light energy.

Light energy $\xrightarrow[\text{Chloroplasts}]{\text{Photosynthesis}}$ Chemical energy (Food)

↑ Plant cells

Chloroplasts have either round shape (or) oval shape (or) discoid shape. Chloroplasts are bounded by two membranes (Outer membrane, Inner membrane), both of which have no Chlorophyll pigments.

* Grana — is the main functional unit of chloroplast & are floated in the matrix, called stroma. Stroma contains a variety of photosynthetic enzymes & starch grains.

* Grana are stacks of membrane-bounded, flattened, discoid sacs, arranged like piles of coins. Grana are interconnected by inter granal membrane. Thylakids: Sac-like vesicles arranged as a membranous net work.

* Grana - is the site of light-rxn.

Sunlight $\xrightarrow{\text{photophosphorylation}}$ Chemical energy (NADPH & ATP)

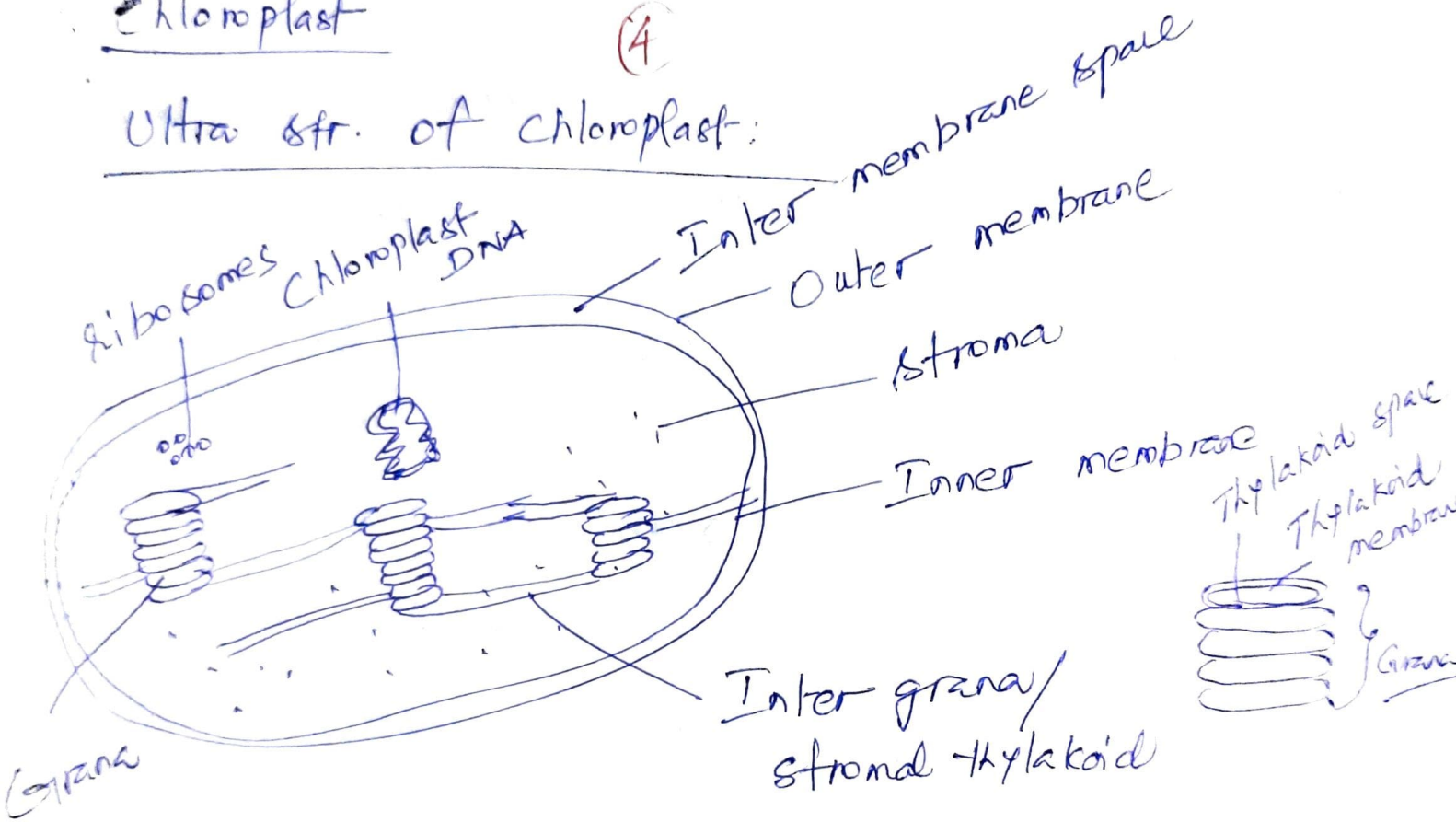
Stroma - is the site of dark reaction.

Atm CO_2 $\xrightarrow{\text{Calvin cycle}}$ Carbohydrates

* Chloroplast contains its own DNA, 70S Ribosomes.

Chloroplast

Ultra str. of Chloroplast:



Thylakoids : Stacked like a neat pile of coins, forming grana (or) unstacked called Stromal thylakoid.

Functions of the Chloroplast: Photosynthesis.

There are 2 reactions in Photosynthesis.

Photosynthesis

Light reaction / (Hill reaction) / Photochemical reaction.

* Light energy is trapped in the form of chemical energy (ATP, NADPH).
* During light reaction, Photolysis of water takes place

$$H_2O \xrightarrow{\text{Sunlight}} 2H^+ + \frac{1}{2}O_2$$

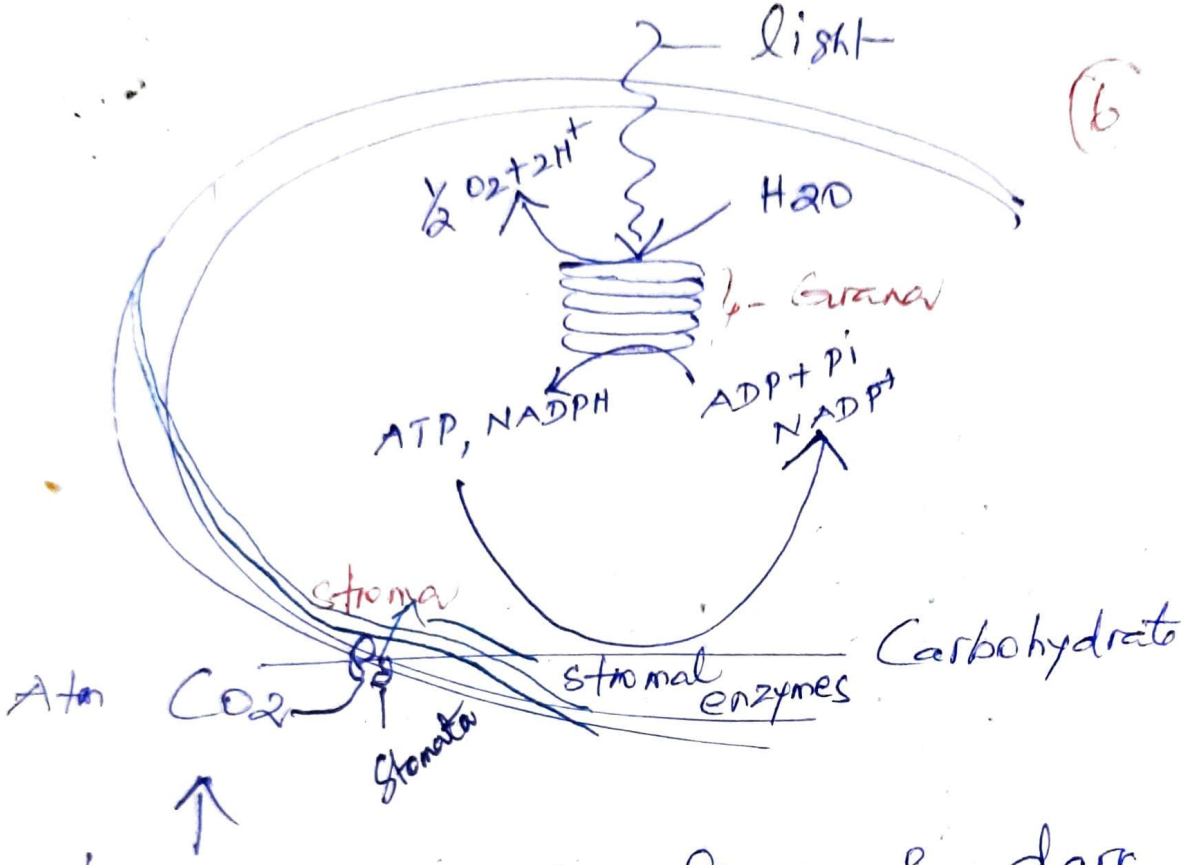
* Light rn occurs in thylakoid membrane.

Dark reaction / Calvin cycle / Photosynthetic Carbon reduction Cycle (PCR cycle)

In dark rn, the ATP & NADPH produced in light rn is utilized in the Conversion of CO_2 to Carbohydrate.

* Occurs in stroma.

$$CO_2 \xrightarrow{ATP/NADPH} \text{Carbohydrate}$$

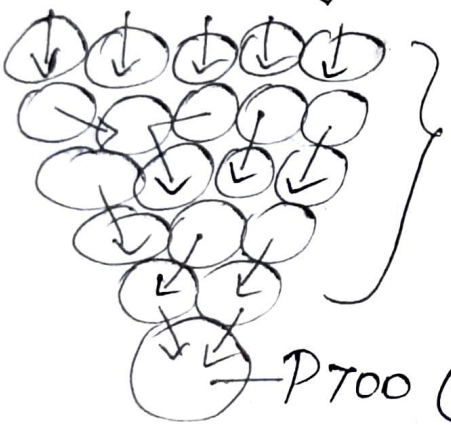


Localization of light & dark reactions of photosynthesi in chloroplast-

Chloroplasts as Semi Autonomous Organelle:

Like Mitochondria, the chloroplasts have their own DNA, RNA, Protein Synthesizing machinery. But chloroplasts depend on Nuclear genome for most of its functions. Hence called Semi autonomous organelle.

Chloroplast pigments: Chloroplast contains chlorophyll molecules which absorb sunlight & transfer the energy to the reaction centres, which are composed only of chlorophyll a.



The other pigments, are called Accessory pigments eg: Carotenoids, Xanthophylls etc. Functions: They trap & transfer the light energy to the reaction centre of Chl. a. & also prevent chlorophyll molecules from photooxidation.

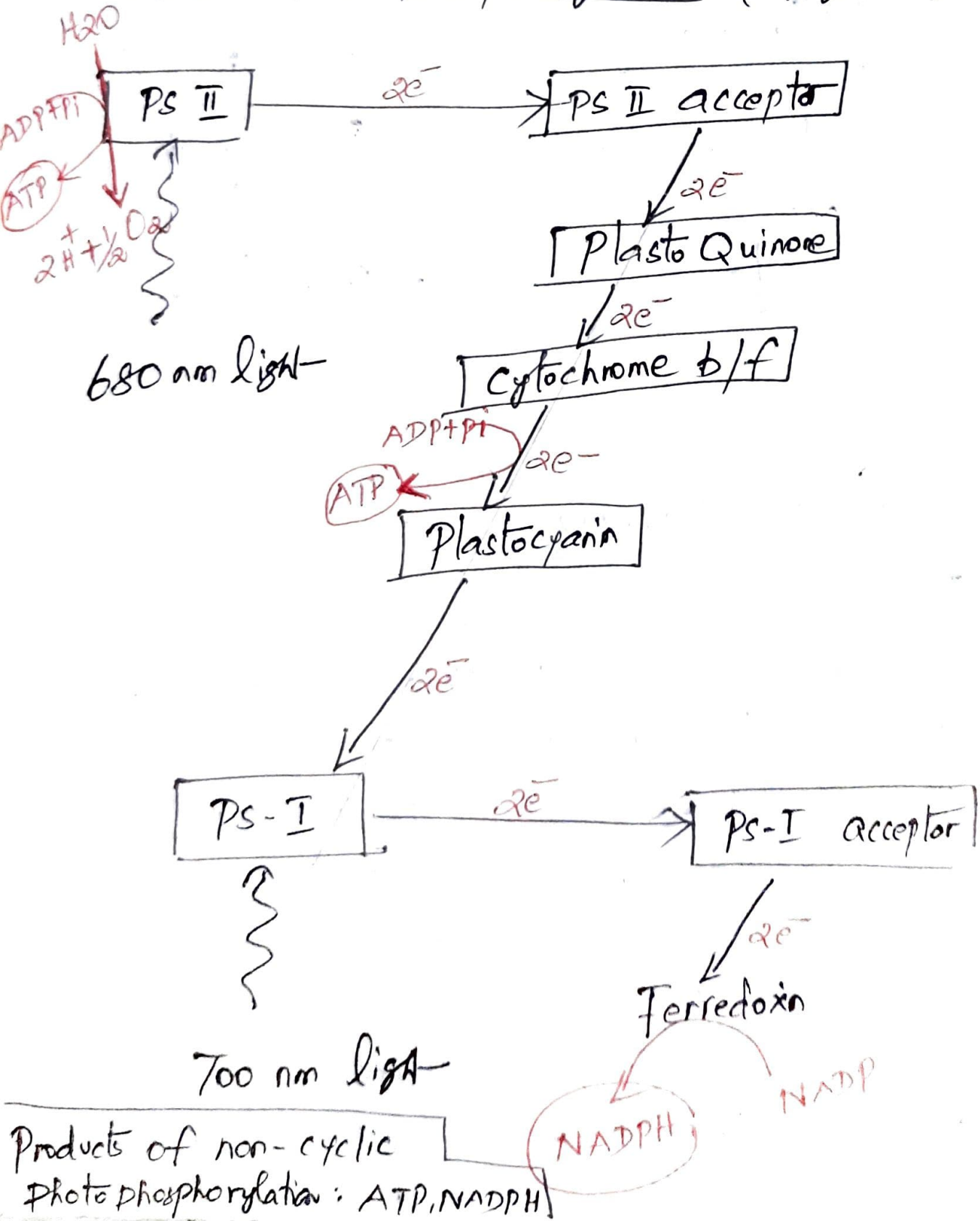
Photophosphorylation: Under light, chloroplast could synthesize ATP & NADPH. This is called photophosphorylation. In the Thylakoid membrane, the energy

is trapped by photosystem I & II.

Photophosphorylation (Light reaction)

- Cyclic
- non-cyclic (Z-scheme)

Non-cyclic photophosphorylation: (Efficient)

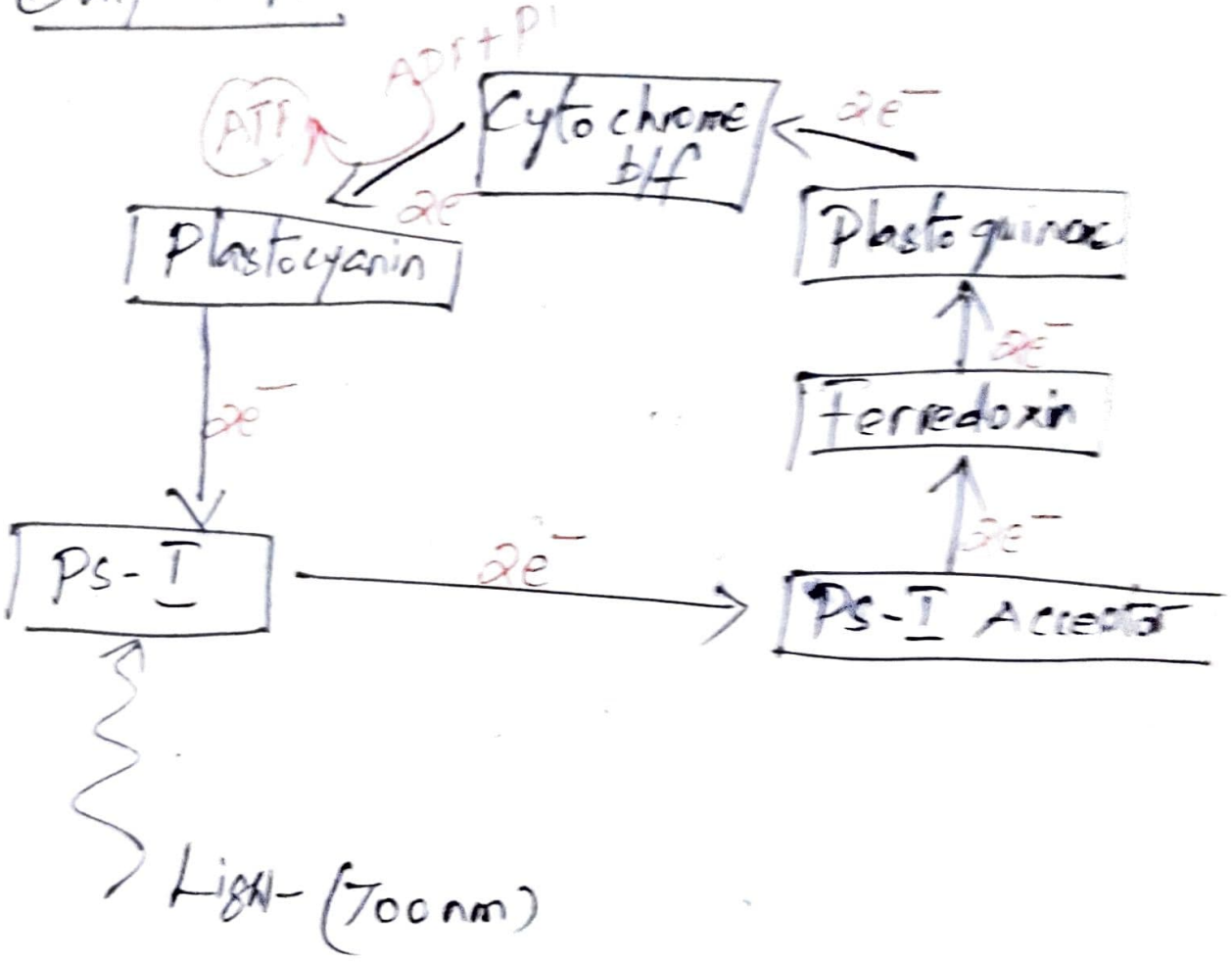


Products of non-cyclic photophosphorylation: ATP, NADPH

Cyclic ~~Photophosphorylation~~

Products of Cyclic photophosphorylation

Only ATP



Z-Scheme describes the flow of electron from water to NADP through two photosystems. The light is trapped by PS I & PS II. The reaction centres of PS I & PS II are excited by photons. The excited facilitates the transfer of $\bar{e}$s from donor to acceptor molecule. In PS II, the absorbed light energy causes photolysis of water & thereby the $\bar{e}$s are removed from it & transferred to PS II acceptor.

- The Primary e^- acceptor of PS I is Ferredoxin.

Cyclic pathway is used to supply the extra ATP.

Dark reaction: In the dark reaction NADPH & ATP, which are generated during light reaction, are used to reduce atm. CO_2 to Carbohydrates

$$CO_2 + NADPH + ATP \rightarrow (CH_2O)_n + NADP+ \; ADP+Pi$$

The Calvin cycle has 3 steps:

(i) Carboxylation (ii) Reduction of CO_2 (iii) Regeneration of RuDP.

Carboxylation:

$$RuDP + CO_2 \xrightarrow{\text{Rubisco}} 2\ PGA$$

Reduction of CO_2: requires energy; the Product is phosphoglyceraldehyde. This molecule can then be converted into starch within the Chloroplast (or) translocated out.

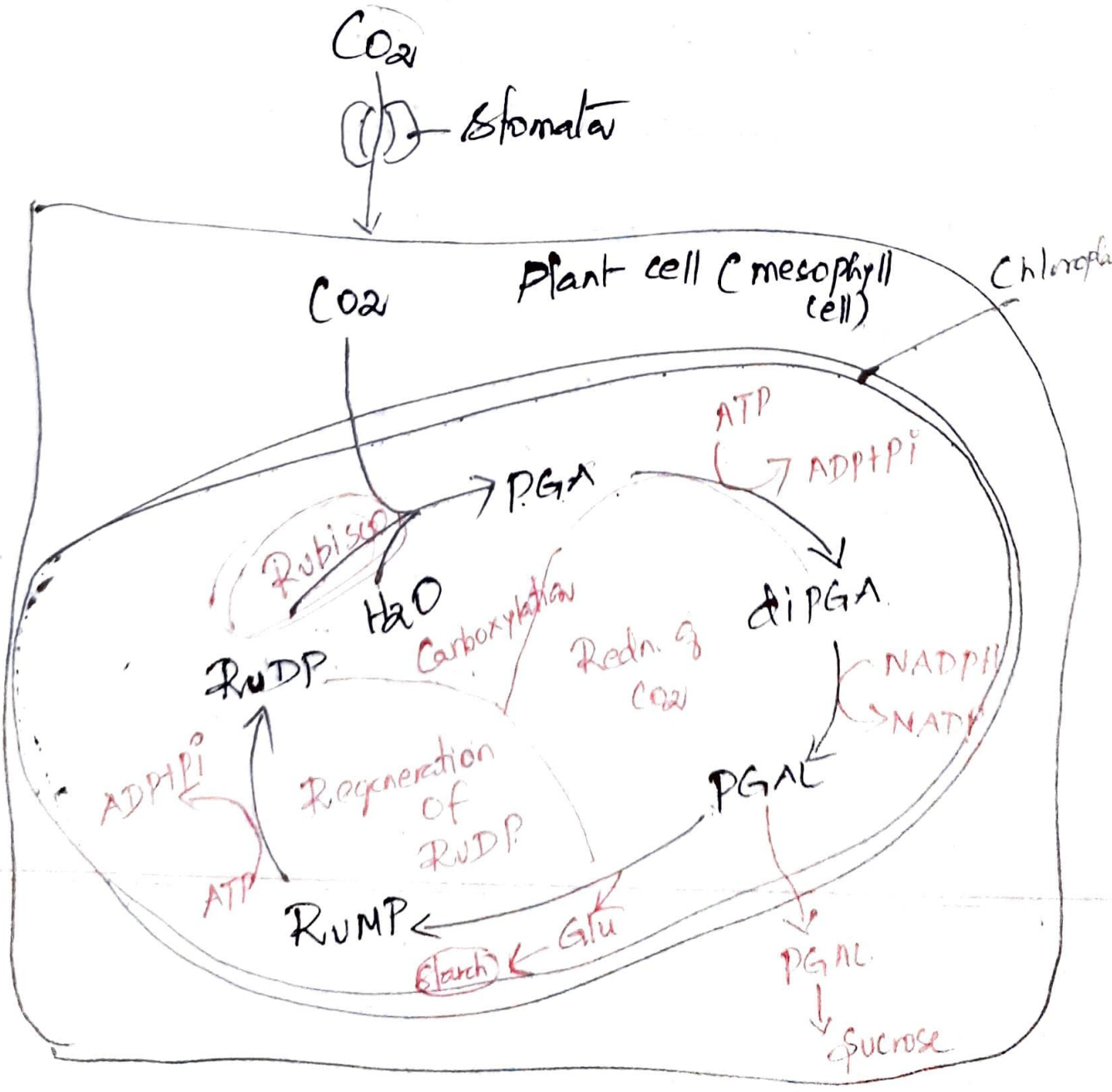
Regeneration of RuDP: $\frac{1}{6}$ of the phosphoglyceraldehyde is used for Sucrose

and starch synthesis. The remainder 5/6 is used for regeneration of RuDP.

The energy balance of photosynthesis is

$$6CO_2 + 12H_2O \xrightarrow{\text{Light energy}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

C3 cycle - Simplified view



Mitochondria (1)

- Robert Altmann (1890) found out Mitochondria
- Mitochondria is the power house of the Cells.
- Each mitochondria is bounded by 2 membranes. { Outer membrane / Inner membrane
- Mitochondria is a Complex Organelle.
- Outer membrane resembles the Plasma membrane in structure and Function.
- Inner membrane gives out finger-like Outgrowths (Cristae) towards the lumen of Mitochondria
- Cristae contains Tennis-racket shaped F_1 particles.

(4) Mitochondrial Matrix, which is liquid are encircled by the inner membrane, contains the soluble enzymes of Krebs cycle which completely Oxidize the Acetyl-CoA to CO_2, H_2O & H^+ ions. H^+ ions reduce the molecules of NAD & FAD, both of which pass on hydrogen ions to e^- transport chain where oxidative phosphorylation takes place. Oxidative phosphorylation generates energy-rich ATP molecules. The ATP produced is used for various functions.

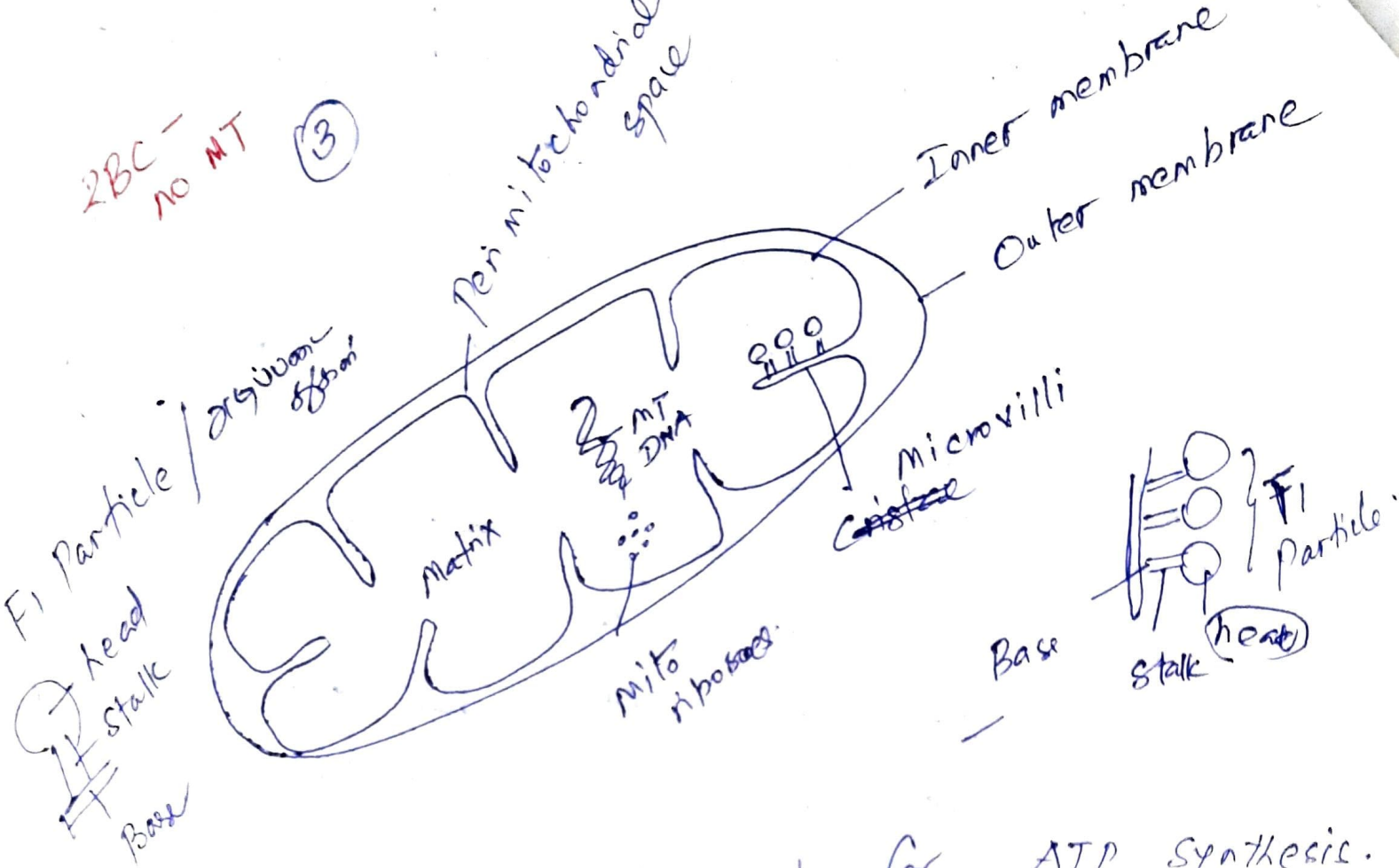
~~MT — are abundant in sperm tail, muscle cell~~
~~liver cell, microvilli,~~ (Contraction, motility; Biosynthesis of cell material, Active Transport- Transmission of impulses Bio-luminescence)

MT contains mt DNA & mitoribosomes (70S). MT depends on nuclear genome for 90% of its proteins & hence considered as semiautonomous organelle.

Flow of energy in MT:

Foodstuffs → citric acid cycle → Coenzymes → e^- transport-chain → ATP

2BC – NO NT (3)



F1 - particles are meant for ATP synthesis.

Glycolysis: Breakdown of Glucose to Pyruvic Acid, takes place in the Cytoplasm.

Oxidative decarboxylation: ~~Conversion~~ Degradation of Pyruvic acid to Acetyl CoA, takes place in MT.

Krebs cycle: takes place in MT.

Glucose

↓

Pyruvic acid

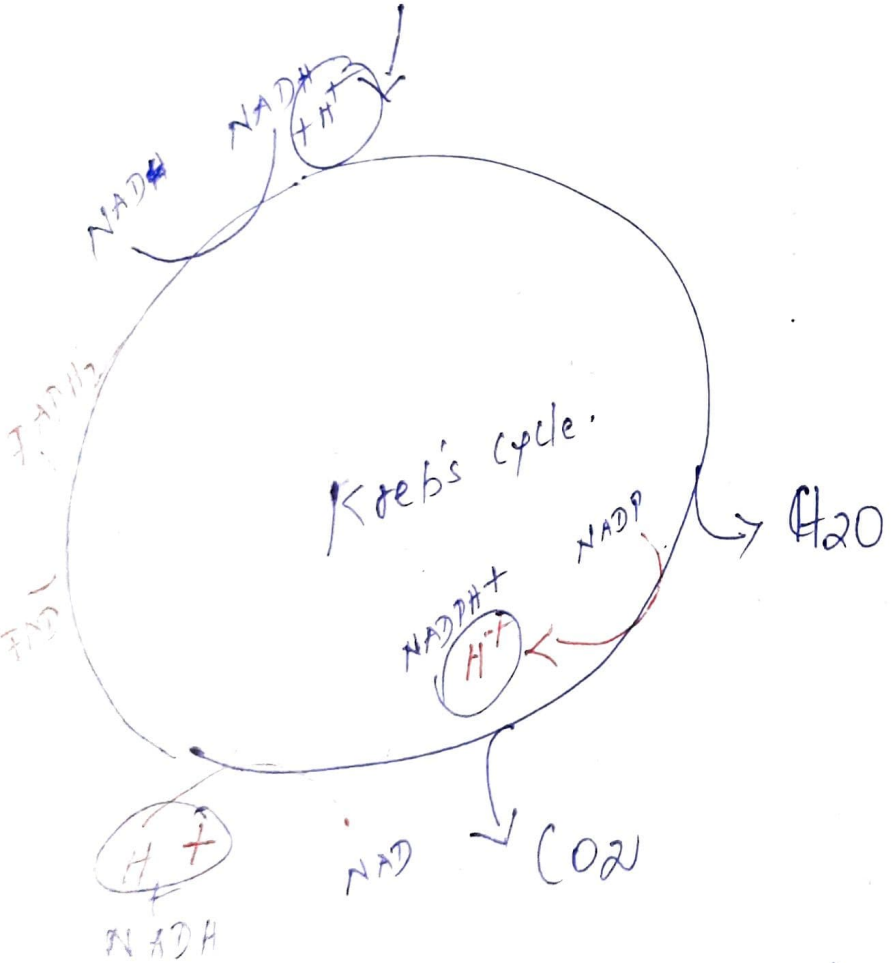
↓

Acetyl CoA

Functions of MT

(i) Respiration.

(ii) ATP synthesis.

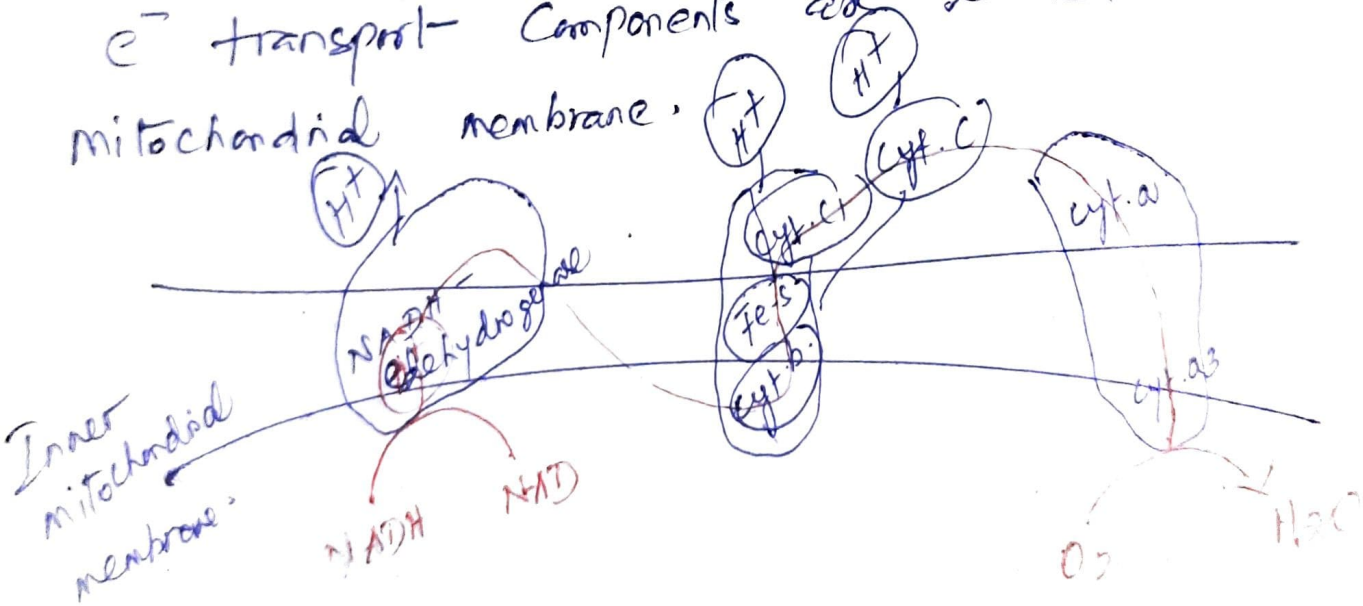


At each turn of Kreb's cycle, 4 pairs of hydrogen ions removed from the substrate & the H^+ ions

now enter into the respiratory chain. (n)

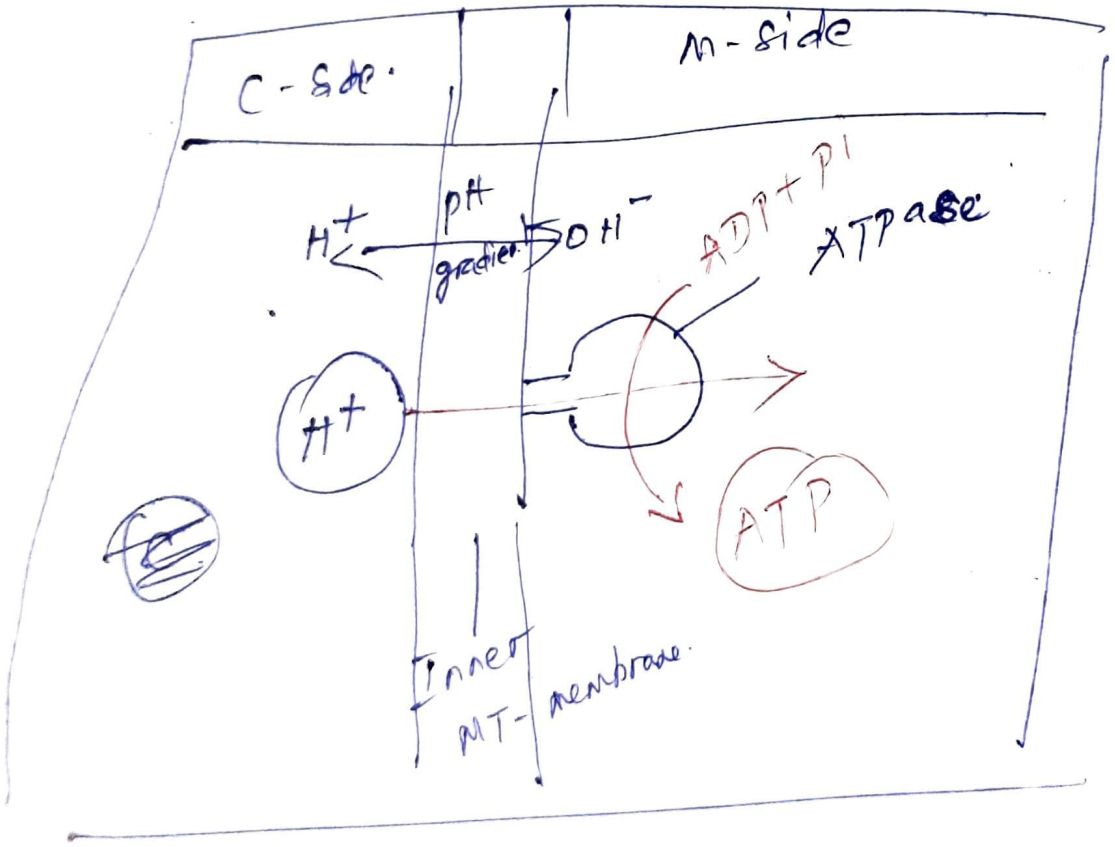
Oxidative phosphorylation:

2 mole. of $FADH_2$ & six molecules of NADH produced in Krebs cycle are oxidized by molecular O_2 in a respiratory chain, involving a series of enzymes & Co-enzymes. e^- transport Components are located in inner mitochondrial membrane.

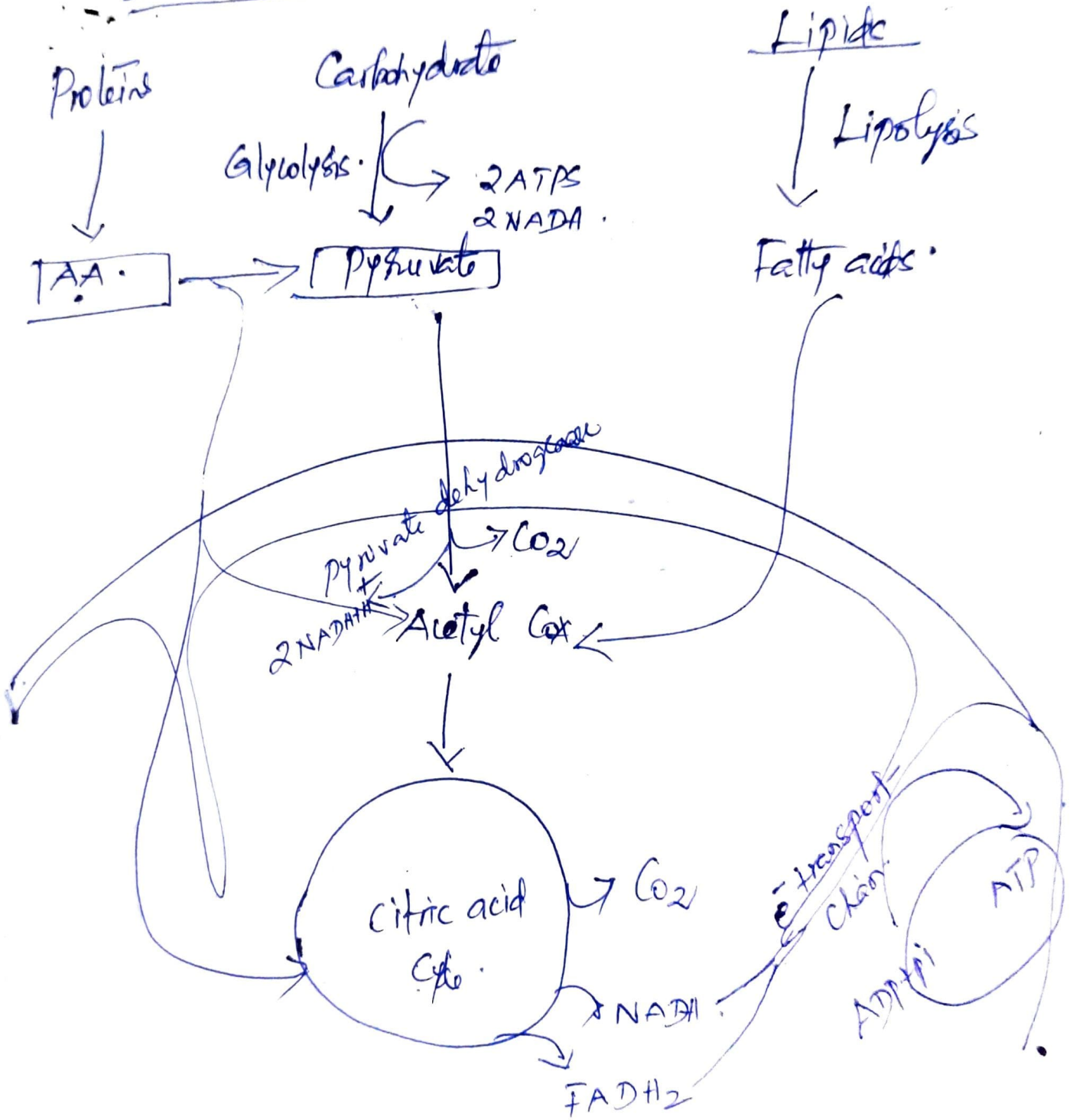


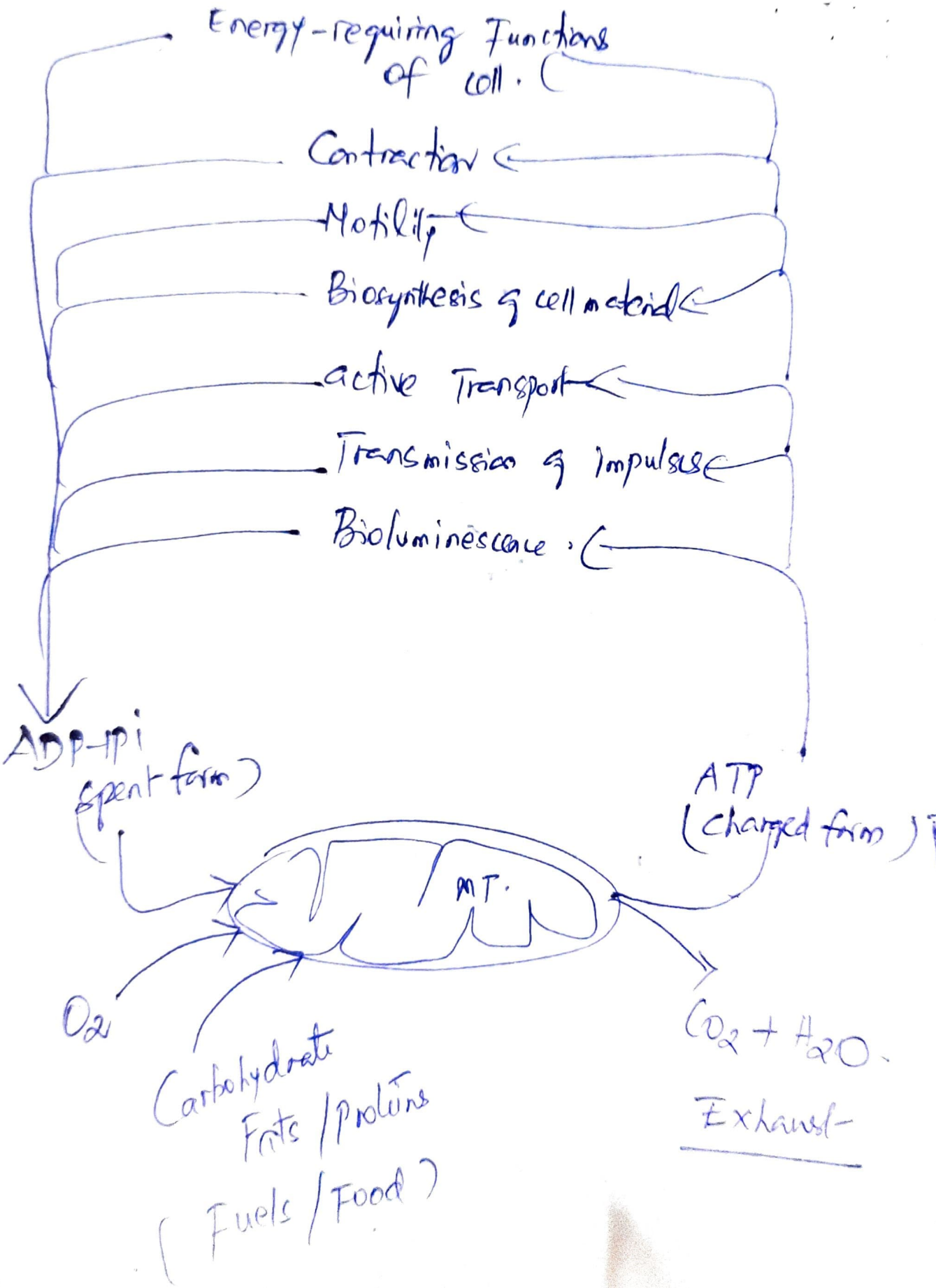
During e^- transfer, there will be an pH gradient (differences in H^+ ions Concen. between cytosolic (c side) &

Matrix side (M-side). This (b) gradient drives the protin pump of ATPase & ATP is synthesized from ADP + Pi.

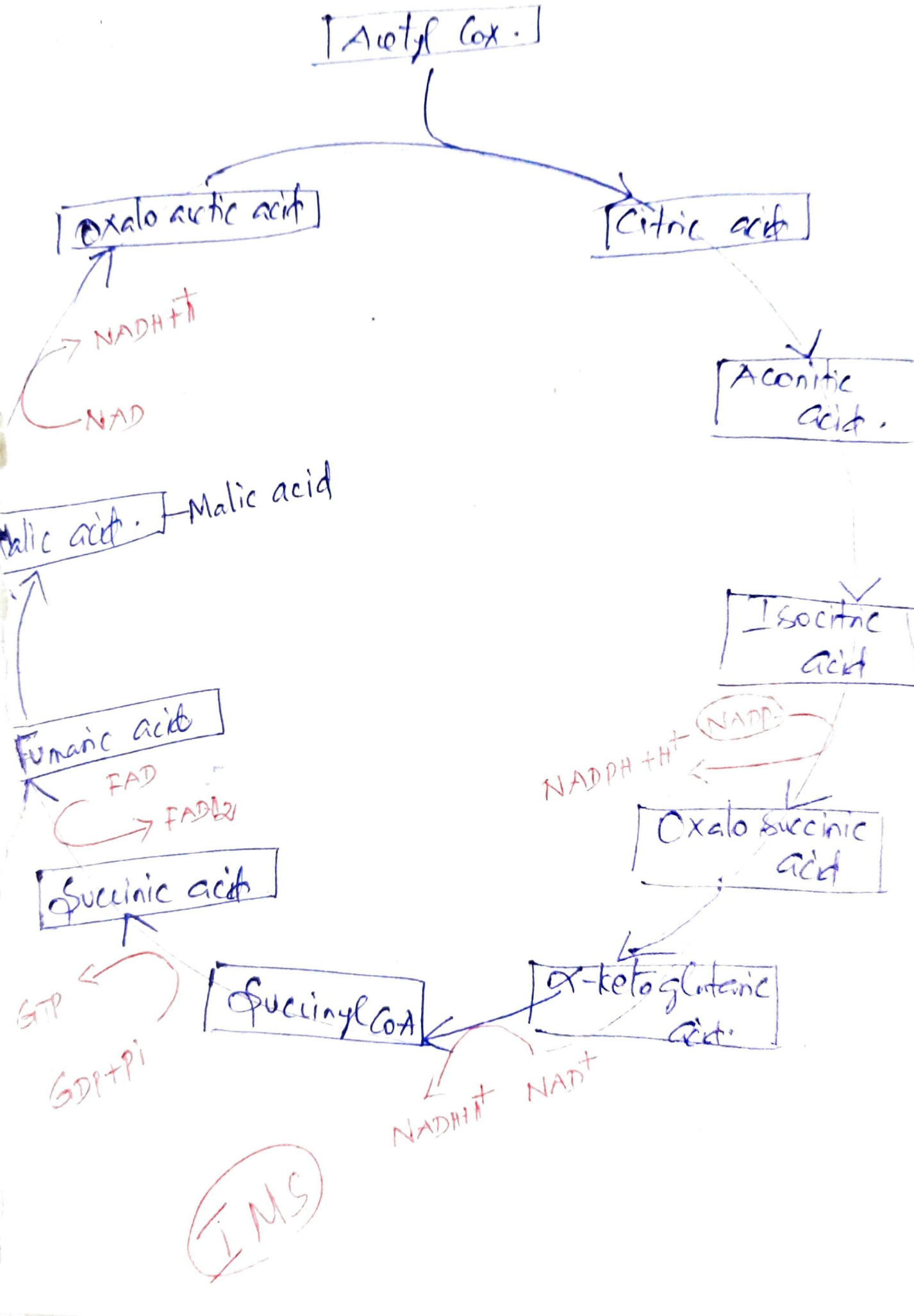


Overview of breakdown of fuels by MT

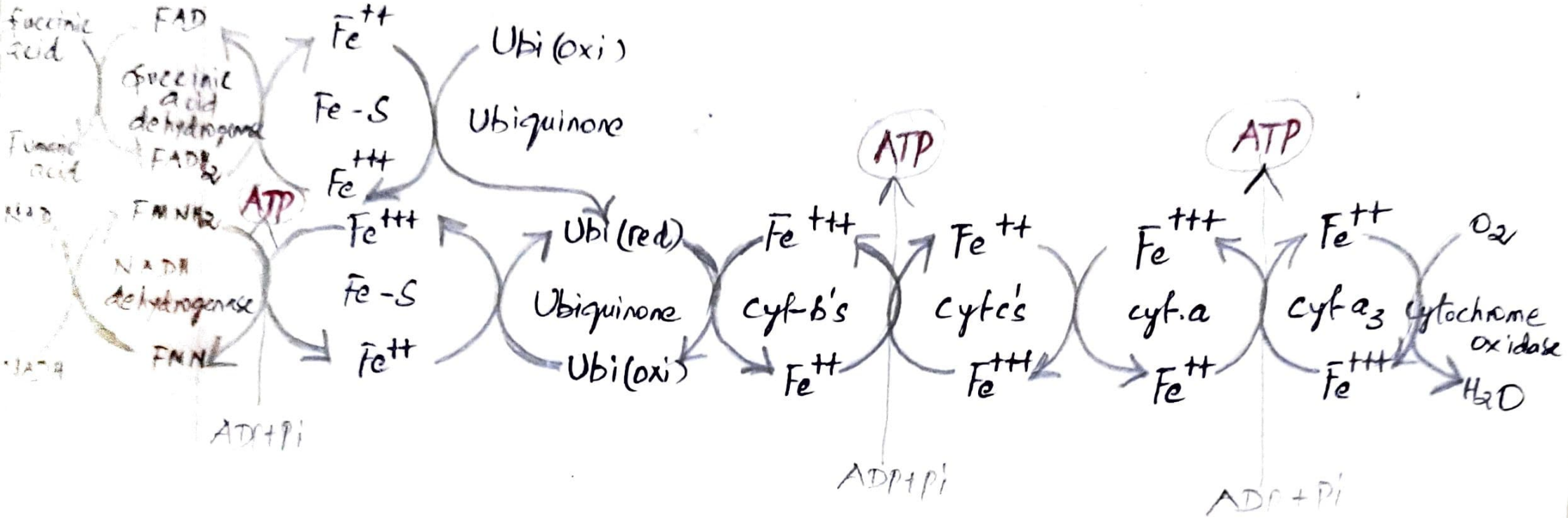



Energy-requiring Functions of cell.
Contraction
Motility
Biosynthesis of cell material
active Transport
Transmission of Impulses
Bioluminescence.
ADP-Pi (spent form)
ATP (charged form)
MT.
O_2
Carbohydrate Fats / Proteins (Fuels / Food)
$CO_2 + H_2O$.
Exhaust-

Krebs Cycle / Tri Carboxylic acid cycle.



A Schematic representation of the respiratory chain in Mitochondria of higher plants



(D)

Ribosomes

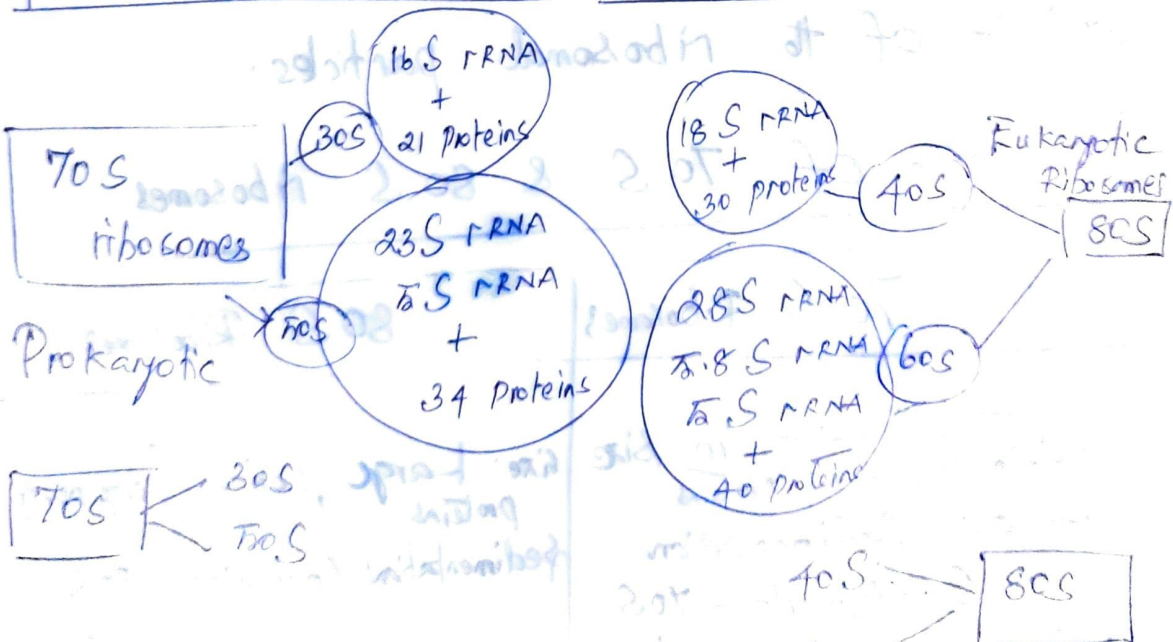
- Ribosomes are oblate spheroid structures of 150 - 200 Å in diameter.
- Ribosomes are 'Workbenches', where Proteins are synthesized.
- Ribosomes are not surrounded by a membrane, made up of insoluble proteins
- Ribosomes have remarkable self-assembling structures. Ribosomes were first observed by Palade in the electron microscope as dense particles (granules).
- R. Roberts called the granules as Ribosomes
- Electron microscopy reveals that they are composed of 2 non-identical subunits

Types of Ribosomes

- 70 S - found in Prokaryotic cells, Chloroplast & Mitochondria
- 80 S

are common in Eukaryotic cells.

Subunits of Ribosomes : & their Components



The Ribosomal subunits composed entirely of RNA & proteins.

- Ribosomes are small, dense, rounded and granular particles of Ribonucleoprotein.
- They remain either freely in the Mitochondria, Chloroplast & cytoplasm (or) remain attached with the membranes of the ER and Nucleus.
- The Ribosomes are usually isolated from the cell by differential Centrifugation method. The Sedimentation Co-efficient is expressed in the Svedberg Unit (S). The 'S' is related with the size & molecular weight of the ribosomal particles.

Comparison of 70S & 80S Ribosomes

70S Ribosomes	80S Ribosomes
- Smaller in size Contain, less no. of proteins - have Sedimentation Coefficient - 70S - Molecular weight - 2.7×10^6 Daltons	size: Large, contain large no. of proteins Sedimentation Coefficient: 80S Molecular Weight: 4.0×10^6 Daltons

- Occur in Prokaryotic cells & also in Eukaryotic Chloroplast & Mitochondria
- Biogenesis of 70S ribosomes takes place in cytoplasm
- have 3 rRNA molecules (16S, 23S
- RNA protein ratio is 2:1
- more sensitive to Chloramphenicol
- Each ribosome

Composed of 2 subunits subunit is larger like shape, while the is smaller in size the large subunit structure.

Both the subunits narrow cleft. remain united with Con. of Mg^{2+} ions. ions reduces, bot

Poly Ribosomes / Polysomes

many ribos

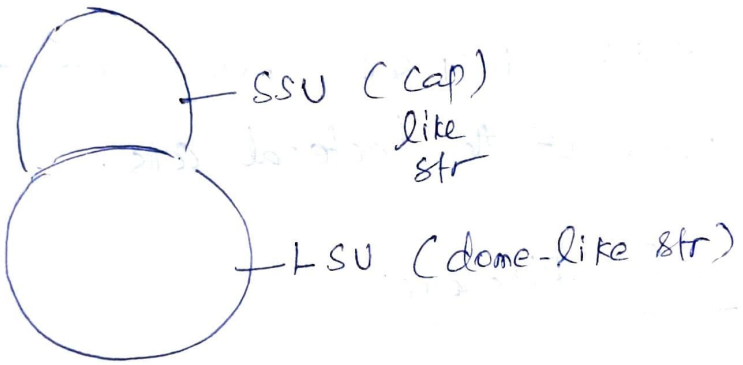
- Occur in Prokaryotic cells & also in Eukaryotic Chloroplast & Mitochondria.
- Biogenesis of 70S ribosomes takes place in cytoplasm.
- have 3 rRNA molecules (16S, 23S, 5S)
- RNA protein ratio is 2:1
- more sensitive to Chloramphenicol treatment
- Each Ribosome is Porous, hydrated and

Occur in Eukaryotic Cells.

Biogenesis of 80S ribosomes takes place in Nucleolus (18S, 28S, 5.8S, 5S have 4 types of rRNA)

RNA : Protein ratio is 1:1 less sensitive to Chloramphenicol treatment

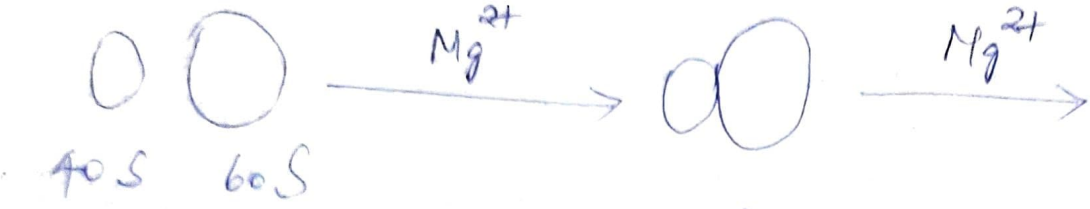
Composed of 2 subunits. One ribosomal subunit is larger in size & has a dome-like shape, while the other ribosomal subunit is smaller in size & occurring just above the large subunit & forming a cap-like structure.



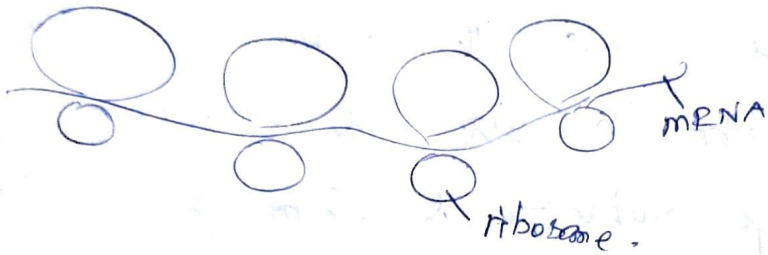
Both the subunits remain separated by a narrow cleft. The 2 ribosomal subunits remain united with each other due to the high Con. of Mg^{2+} ions. When the Concentration of Mg^{2+} ions reduces, both subunits get separated.

Poly ribosomes / Polysomes: During Protein Synthesis, many ribosomes are aggregated to a

Common mRNA & form Polyribosome.



Polysomes



- Ribosomes represent 25 % of the total mass of the bacterial cells.

Classes of Ribosomes

1. Cytoplasmic Ribosomes.
2. Ribosomes bound to ER
3. Mitochondrial & plastid Ribosomes.

Function of Ribosome:

- Translation / Protein Synthesis.

Ribosome translate the genetic information encoded in the mRNA into proteins

mRNA $\xrightarrow{\text{Translation}}$ Proteins

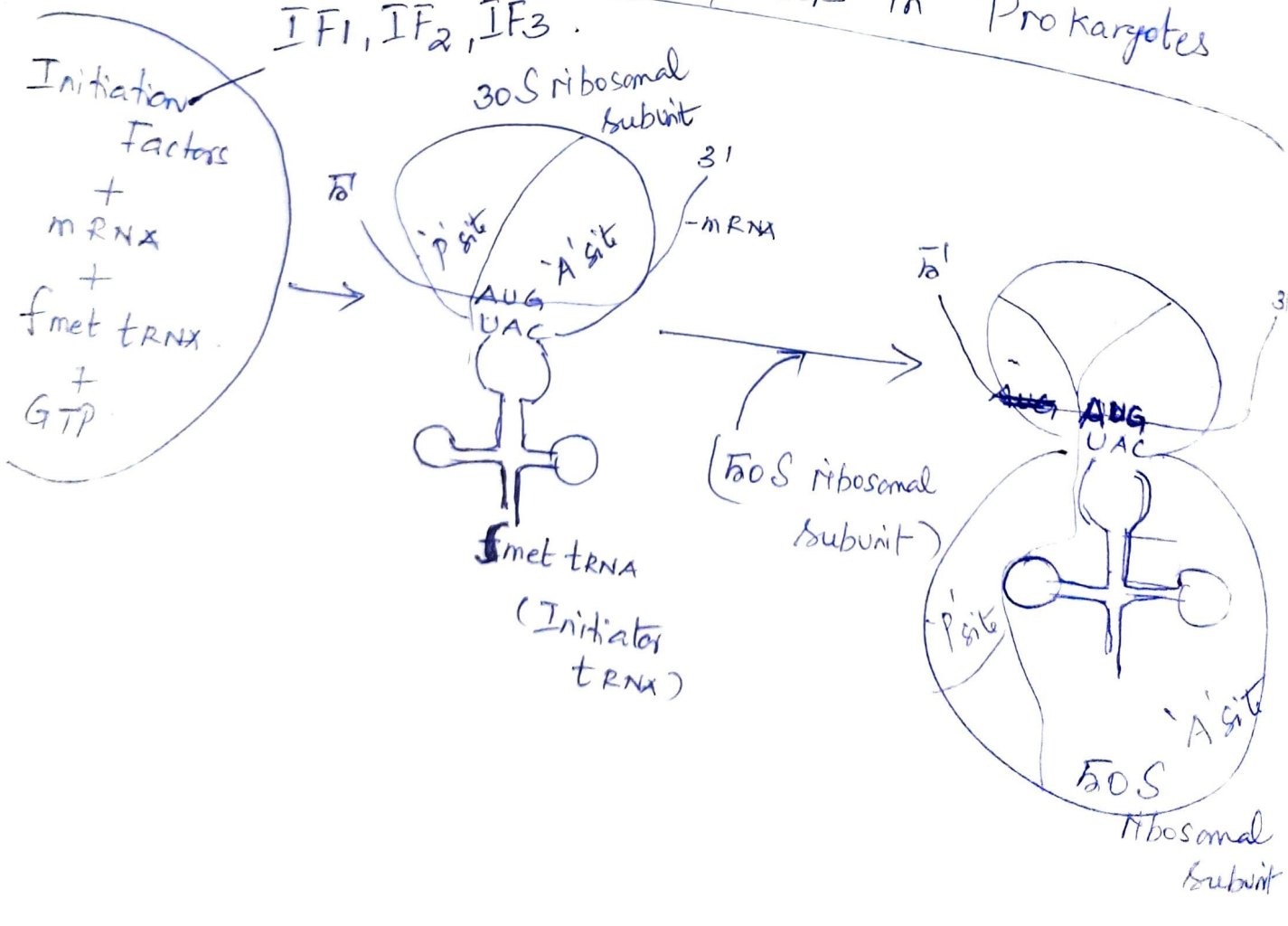
Initiation: involves formation of a complex between small ribosomal subunit, initiator tRNA & mRNA. The large subunit is then attached to the complex.

Initiator tRNA: 2 types $\begin{cases} tRNA^{met} \\ tRNA^{fmet} \end{cases}$

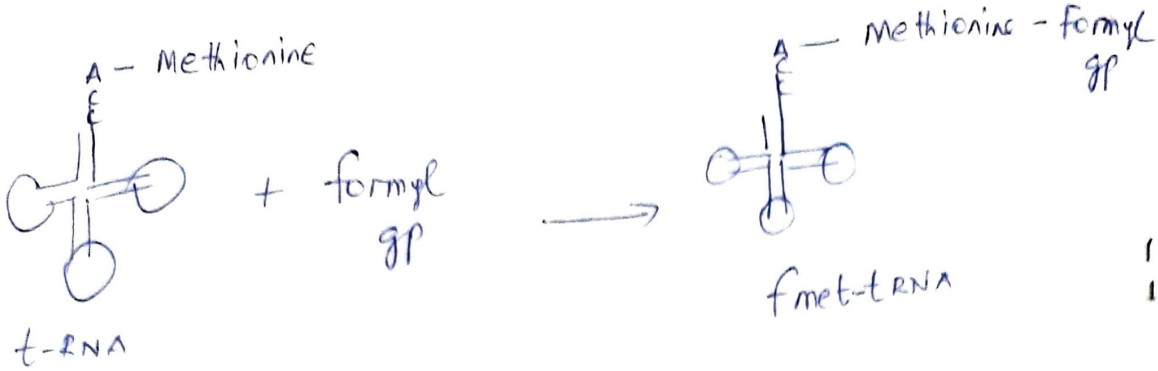
In Prokaryotes, $tRNA^{fmet}$ serves as an initiator tRNA that binds to the 'AUG' initiation codon of mRNA & begins Protein Synthesis

In Eukaryotes, $tRNA^{met}$ serves as an initiator tRNA.

Initiation of Protein Synthesis in Prokaryotes



Formation of fmet-tRNA complex.

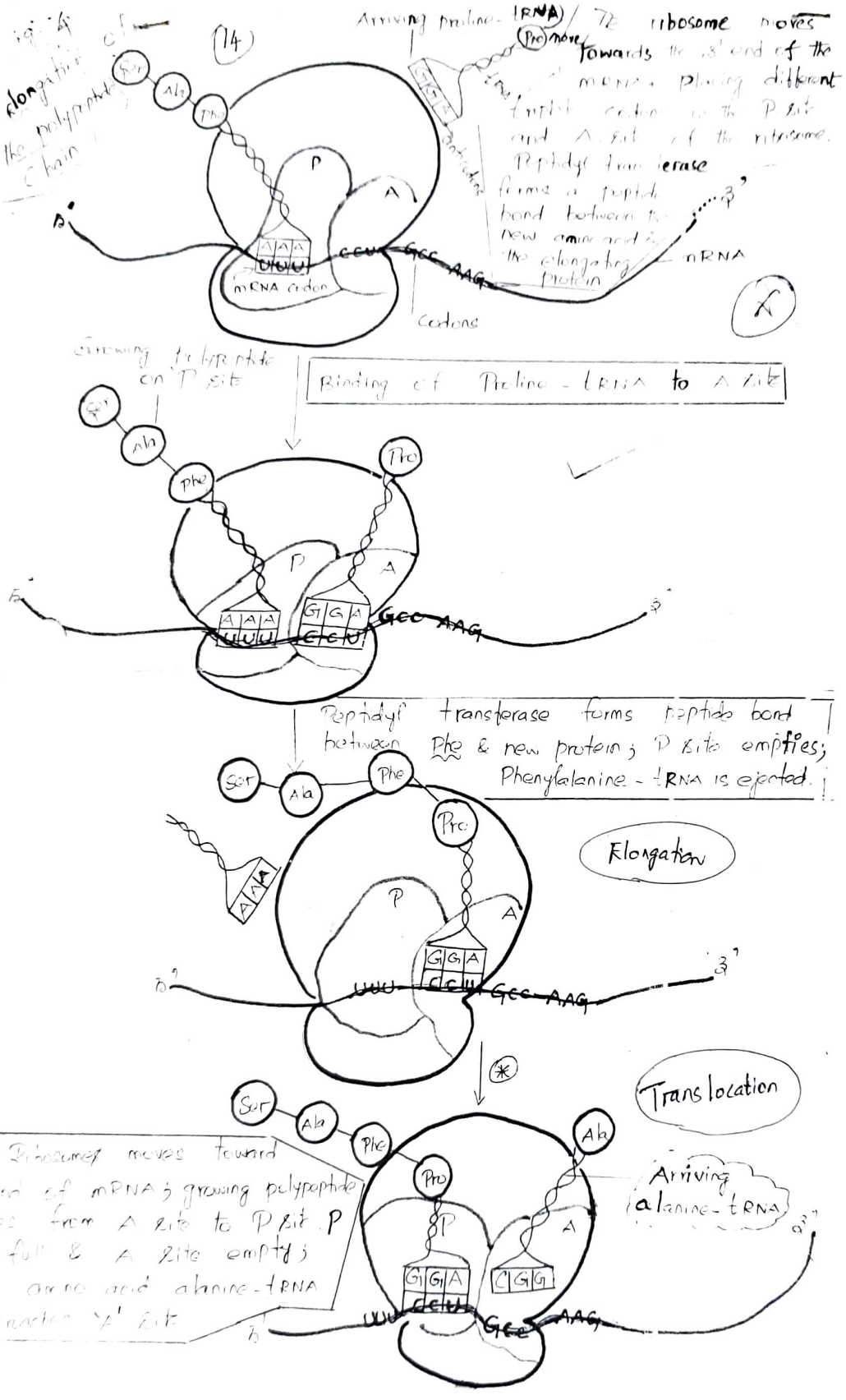


Translocation: Involves movement of Ribosome relative to mRNA, thereby exposing the second Codon to the Ribosome. Anticodon bearing tRNA brings appropriate Amino acid to the Ribosome & a peptide bond is formed to link the 2 amino acids. This occurs in a large ribosomal subunit. Elongation is followed by Translocation & this process is repeated until a termination Codon (for which there is no anticodon bearing tRNA) is reached.

There are 3 phases in Elongation:

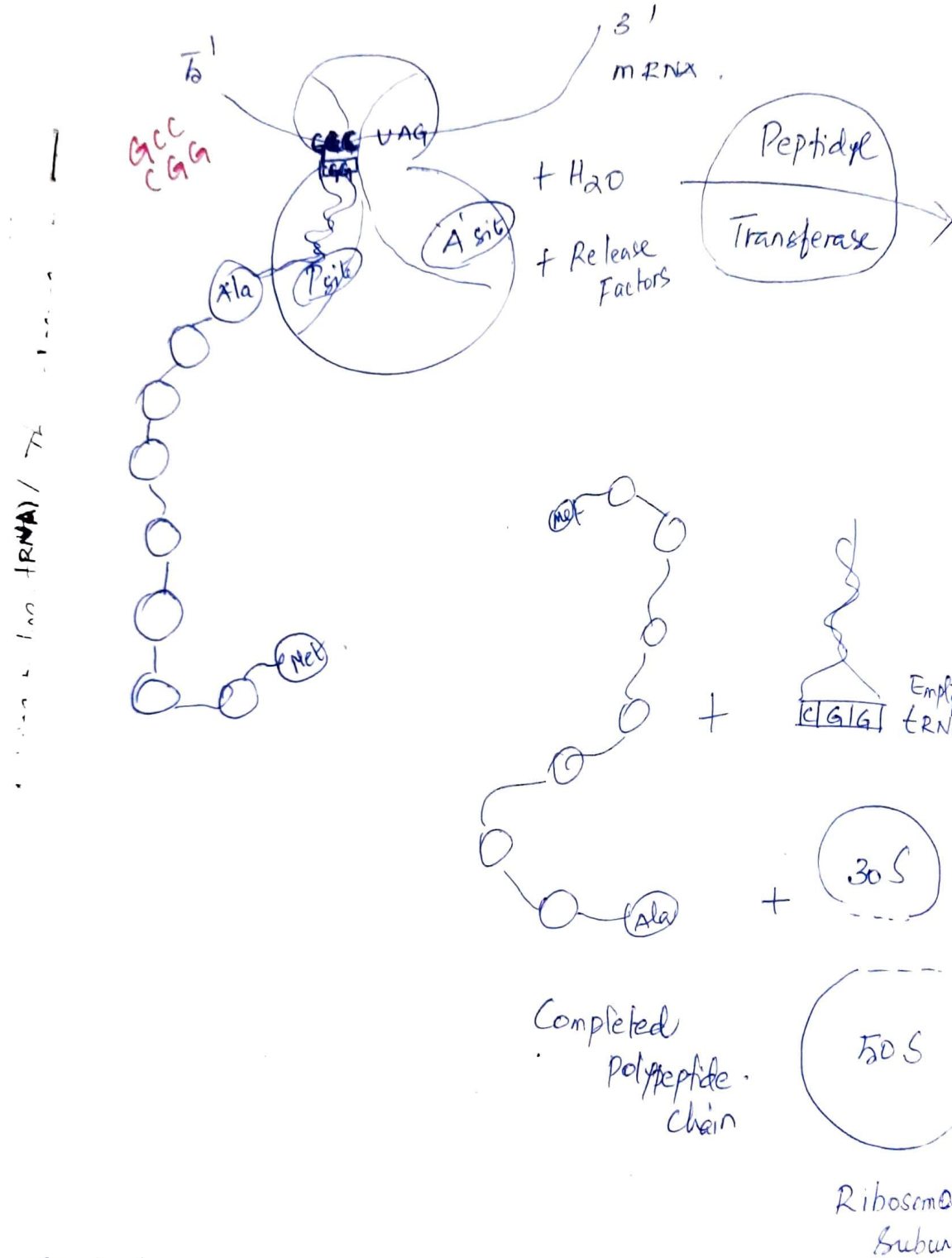
1. Binding of Aminoacyl-tRNA complex at 'A' site (Aminoacyl site).
2. Transpeptidation reaction. Peptidyl transferase forms Peptide bond between 2 amino acids.
3) Translocation to 'P' site (Peptidyl site). Peptidyl tRNA moves to 'P' site. Ribosome moves through mRNA from 5' ⟶ 3' end
⇒ Empty tRNA leaves 'P' site

Elongation of Polypeptide Chain



Elongation of Polypeptide chain

Termination of Protein Synthesis:



Arrival of a stop codon (UAG) at the 'A' site, release the Completed Polypeptide chain. This reaction is catalysed by 'Peptidyl transferase'. The 'tRNA' releases from the 'P' site. Ribosomal ~~Subunits~~ are

released from the mRNA.

- Ribosomes are dissociated into 30S & 50S subunits.
- There are 3 termination Codons: UAA, UAG, UGA

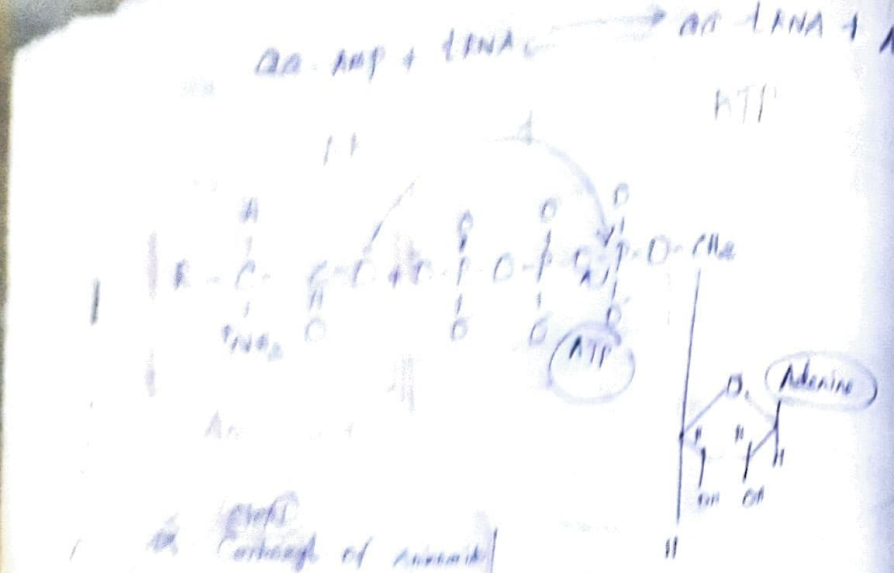
Amino acid Activation: refers to the attachment of an amino acid to its transfer RNA. Activation and charging of amino acids is a two-step process. The aminoacyl tRNA synthetases catalyze activation of amino acid and charging of amino acid to tRNA with the help of ATP. Both reactions carried out within active site of enzyme. The tRNAs carry activated aminoacids into the ribosome.

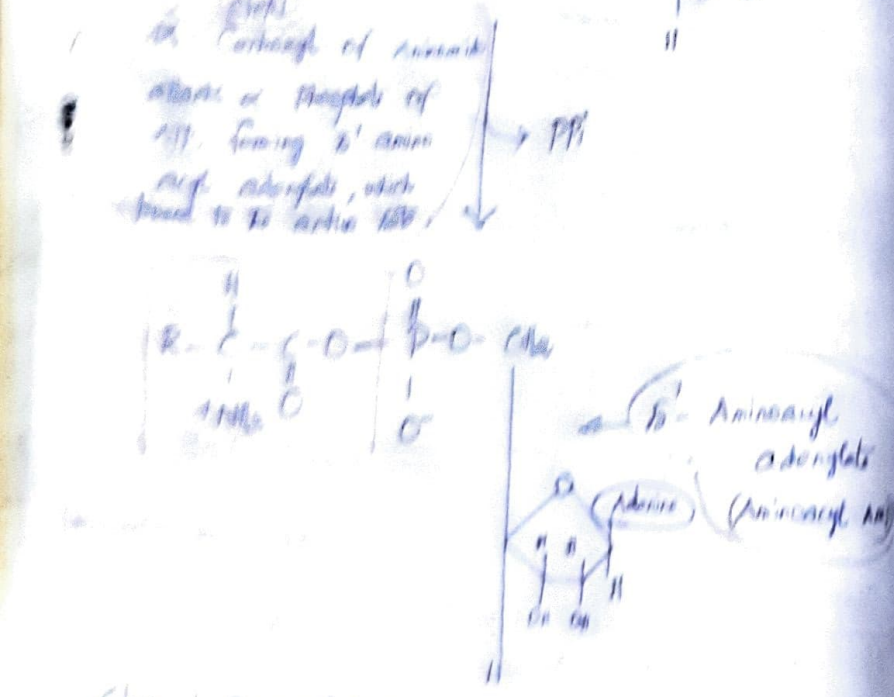
Step 1: Activation of Aminoacid, with the involvement of ATP.

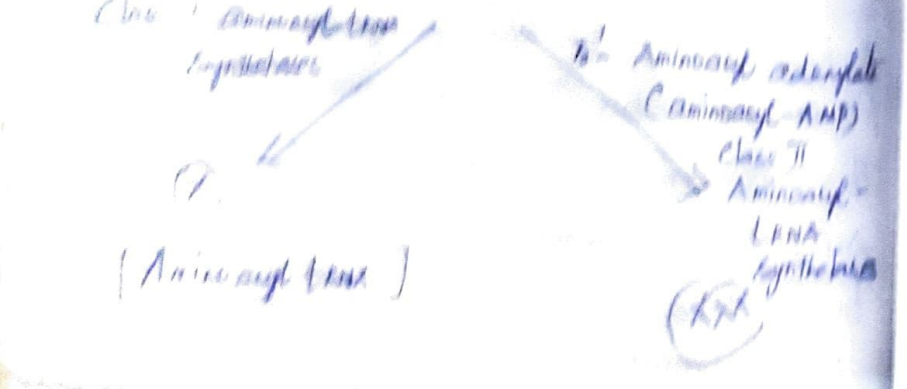
$$AA + ATP \rightleftharpoons AA\text{-}AMP + PPi$$

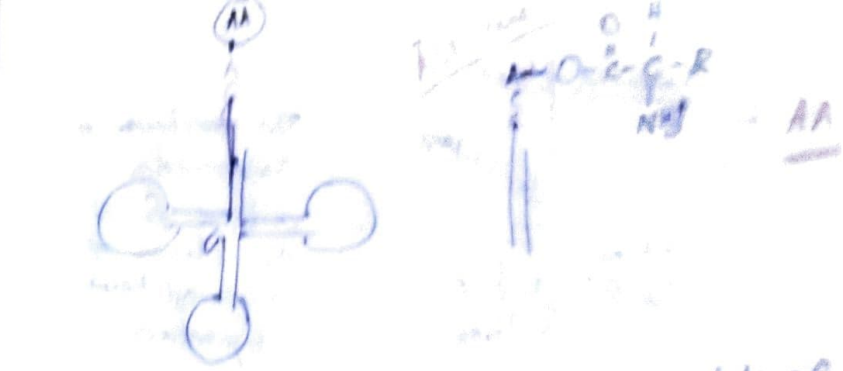
(Aminoacyl adenylate intermediate)

Step 2: Transfer of the aminoacyl group to the tRNA. Aminoacyl groups attached to the 2'-hydroxyl (or) 3'-hydroxyl group of the terminal ribose by class I enzymes and class II enzymes. This reaction is called as Aminoacylation. Amino acid attached to tRNA by high energy bond. In this reaction, one 'O' (oxygen) is removed from amino acid.

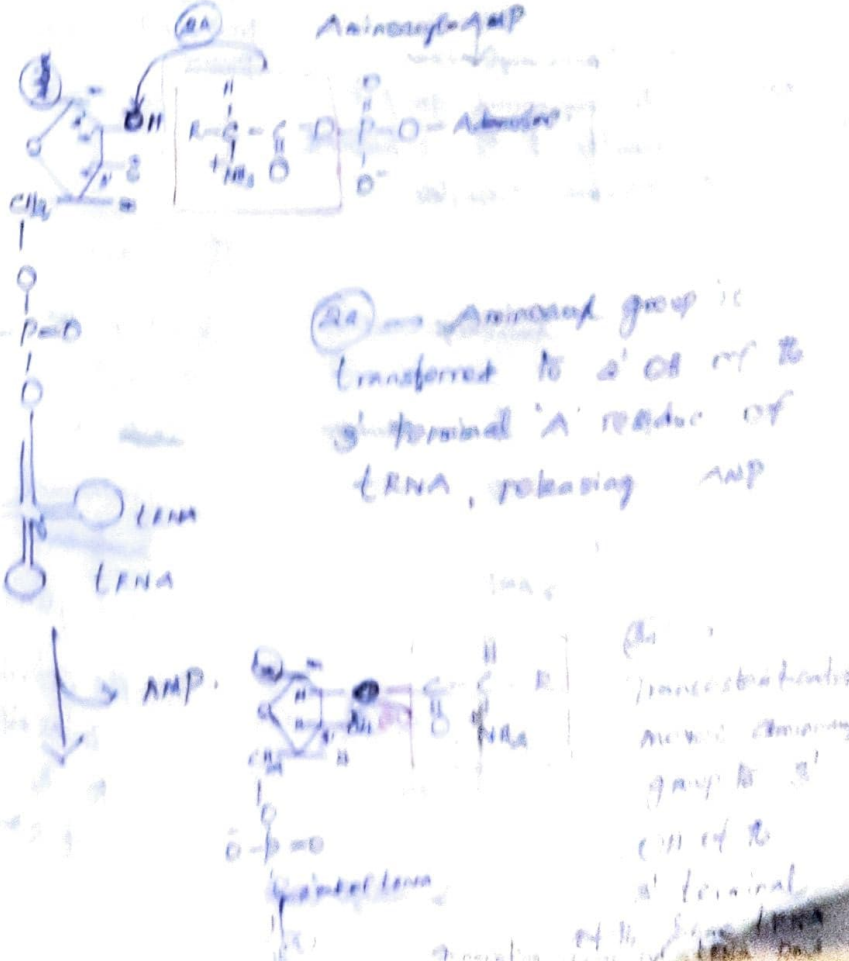








The charging of t-RNA with the help of ATP, in the presence of Amino acid is called as aminoacylation



Golgi apparatus

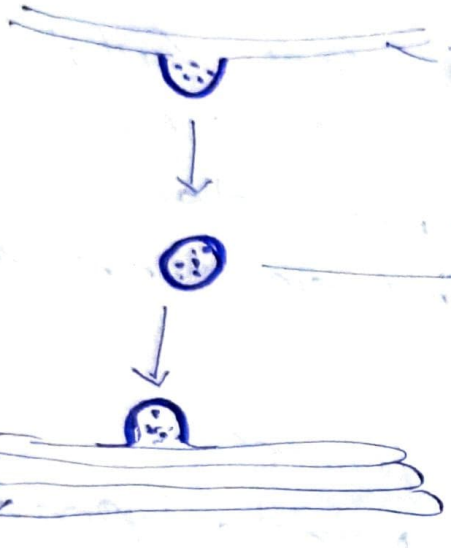
The Golgi apparatus was first observed in 1898 in the nerve cells of barn owls by the Italian cytologist Golgi. Electron microscopy showed that the Golgi apparatus, which occurs in all Eukaryotic cells, consists of a half dozen (or) more flattened sac-like structures that are stacked like dinner plates. They are made up of smooth membranes. Each sac-like structure is termed a Cisterna. Many of them form buds that pinch off from the larger ones. The ER membrane & Golgi membrane are not physically connected to one another. The Golgi apparatus is termed a 'Dictyosome' in Plants. The stack of cisternae has 2 different faces.

Cis-face of cisternae is nearer to the Nucleus and next to the specialized ER that lacks bound ribosomes & this ER is called transitional ER. The Trans-face of the 'Golgi' apparatus is at the opposite end.

~~Elements~~

'Diagram'

A model for the transport of proteins from the ER to the Golgi Complex

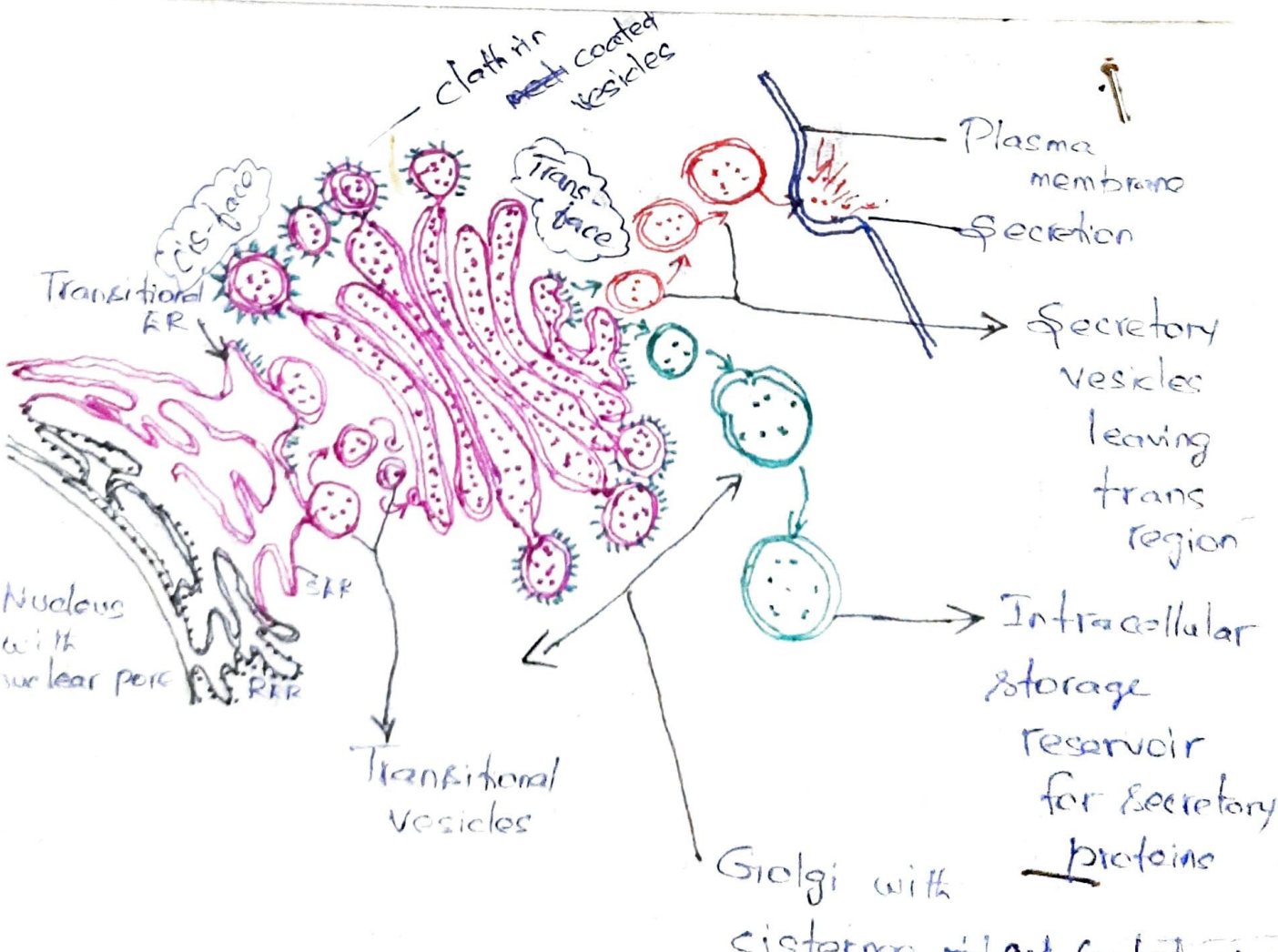


ER membrane – Vesicle buds off from the ER

Transport Vesicle

Vesicles fuses with the Golgi

Golgi



Vesicles which bud off from the ER (transitional vesicles) carry proteins synthesized in RER to the Golgi for further Processing. After processing, new vesicles containing the final product bud-off the other side of the 'Golgi'. They may fuse with plasma membrane & release the protein into the extracellular fluid.

Function: Elements of 'Golgi' apparatus participate in the secretion of cell product The Golgi apparatus is not a site of synthesis of secreted materials, but rather a collecting, modifying, sorting and packaging station. Proteins to be exported outside (secretory proteins) are transferred from the ER in little vesicles termed transitional vesicles' to they fuse with cis-face of cisternae. The Golgi' stack then process

cisternae. Some of these transport vesicles are termed 'coated vesicles'. The coated vesicles contain an outer shell composed largely of Protein 'clathrin'. Finally, vesicles filled with export products are processed into large secretory vesicles, which fuse with the Plasma membrane.

Secretory vesicles occur in specialized secretory cells like the Pancreatic cells, which secrete digestive enzymes and liver cells, which produce the albumin of the blood plasma. In such cells, many secretory vesicles are converted into intracellular storage reservoirs.

In addition, Golgi apparatus participates in the biochemical processing of some of the proteins made in the RER by adding sugar groups (glycosylation) to make glycoprotein and sulfur groups (sulfation) to make sulfo-proteins and phosphate groups (phosphorylation) to make phospho-proteins.

Lysosomes

The lysosomes are tiny, membrane-bounded, vesicular structures of the cytoplasm

- Lysosomes perform intra-cellular digestion of the cell.
- first reported by de Duve (1955).
- Lysosome is part of the cell's endo membrane system.
- possesses various digestive enzymes (60 different), which catalyse the hydrolysis of complex endocytosed proteins.
- play an important role in the recycling of cellular components.
- Participate in the digestion of food particles within cells.
- Usually occur in most of the animal cells and few plant cells.
- The animal cells, which are secretory in function, (for eg., Pancreatic cells, Leucocytes, liver cells, Spleen cells and kidney cells), contain large number of lysosomes.
- The lysosomes are numerous and large in Macrophages, which perform specific digestive functions.
- Lysosomes remain distributed evenly in the Cytoplasm.

Morphology: Lysosomes are generally spherical in shaped. Size usually ranges from 0.2 – 0.8 μ. In kidney cells, the size is extremely large (5 μ)

Lysosomes are round vacuolar structure, filled with Acid phosphatase. They are bounded by a single unit membrane of lipo prote. Acid phosphatase is most Concentrated in Lysosomes.

* Primary lysosomes are homogeneous, & dense whereas Secondary lysosomes are residual bodies & more heterogeneous.

* Lysosomal leakage leads to either Cancer (or) ageing (or) degenerative diseases.

The important functions of Lysosomes

(i) Digestion of large extracellular Particles of Phagosomes (Solid) (or) pinosomes (liquids).

(ii) Digestion of intracellular Stored food during Starvation.

(iii) Autophagy / Autolysis: In certain pathological Conditions, the lysosomes start to digest various organelles of the cells. (Continued)

(iv) The lysosomes of sperms discharge their enzymes outside, during fertilization. The lysosomal enzymes digest the membrane of Ovum & form penetration path in the Ovum

* Lysosomes initiate mitosis in certain Cells.

*

* Lysosomes are found in plant cells. In Seedlings, they are involved in the hydrolysis ~~and removal~~ of proteins and starch during germination.

* Missing of one (or) few hydrolases in lysosomes, leads to genetic diseases (Lysosomal storage diseases:

eg:	Disease	Enzyme deficiency
	Gaucher disease	B- glucosidase
	Pompe "	α - glucosidase

* Some parasites (Rickettsia parasite, Coxiella burnetii, which causes Q fever) also possess complex intracellular lysosomes.

* Lysosomes are also known as scavengers of cells.
* Break down excess cellular parts [illegible]
* Used to destroy invading viruses and [illegible]
* have acidic pH inside [illegible]
  allows the digestive [illegible]
* Role in Metamorphosis [illegible]

Keith Porter (1953) Endoplasmic reticulum (ER)

Porter observed an elaborate network of membrane-delimited channels. The ER consists of a system of interconnected tubules with the membranes, surrounding cisternal space. ER membrane - is the largest membrane of the cell. In most cases, the ER appears interconnected with other membrane-bound organelles.

[Types of ER]

- Rough ER (RER) [RER are studded on their outer membrane with numerous ribosomes]
- & smooth ER (SER) [SER lacks ribosomes on their outer surface].

RER: is a network of parallel inter-connected sheets, surrounding the Nucleus and radiating out toward the periphery of the cell.

RER is most abundant in active cells.

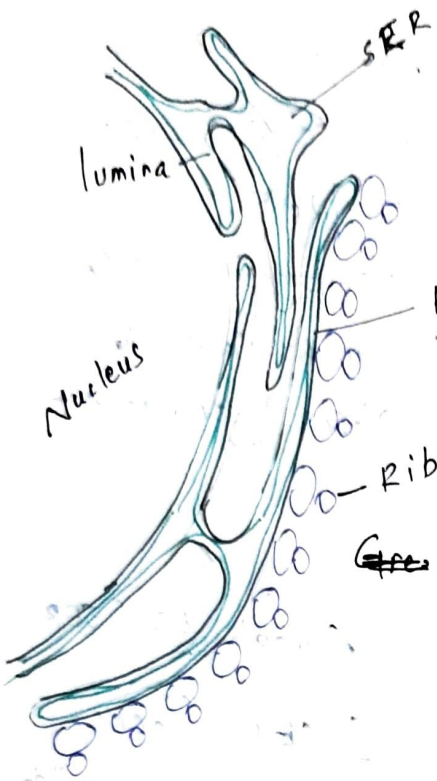
Components of ER:
The ER has the 3 main components.

(i) The nuclear envelop
(ii) The RER & SER and
(iii) the Golgi Complex.

Structure of ER membrane: The structure is similar to that of the Cell membrane. The membrane is a lipid bilayer with peripheral and Integral proteins. The ribosomes are bound by their large subunit (60S). In the RER, there are two proteins (Ribophorins I & II) that are absent-

in the SER.

Gree line - luminal face
Black line - Cytoplasmic face

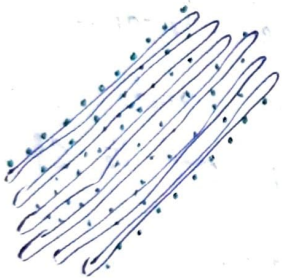


~~Various~~ faces
Two ~~phases~~ of Each membrane:

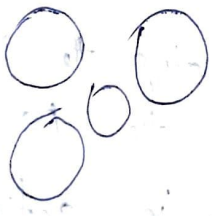
(i) Luminal ~~Etar~~ Face
(ii) Cytoplasmic face

Ribosomes are always on the cytoplasmic side.

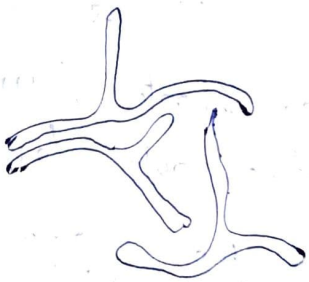
Various Components of ER:



- Cisternae



Vesicles



Tubules

Morphologically, the ER is composed of 3 kinds of structures. (i) Cisternae (ii) Vesicles. (iii) Tubules.

Cisternae: are long, flattened, sac-like, unbranched tubules, arranged parallelly in bundles studded with ribosomes

Vesicles: are ovd, membrane-bound vacuolar structures, remain isolated in the cytoplasm & occur in most cells.

Tubules: are branched, forming the reticular system along with cisternae & vesicles; occur in all the cells.

The ER membrane remains continuous with the plasma membrane, nuclear envelope & Golgi Complex.

Annulate lamellae: Usually, the ER has no pores; but in certain cases, has pores, are called annulate lamellae. The membranes of ER contain many important enzymes, which are needed for Biosynthetic activities.

Enzymes of ER: The enzymes of ER perform the following important functions.

1. Synthesis of glycerides
2. " " Fatty acids
3. " " Steroids
4. " " L-Ascorbic acid.
5. Metabolism of plasmologens, Carbohydrates
6. UDP-Uronic acid metabolism.
7. UDP-Glucose dephosphorylation. & others.

The ER acts as Secretory, Storage, circulatory and nervous System for the Cell.

Functions of ER.

1. The ER provides skeletal framework to the Cell & gives mechanical support to the matrix.
2. Exchange of molecules through the membranes.
3. The ER contain many enzymes & thereby Perform various Synthetic and metabolic activities.
4. ER acts as circulatory System.

Various Secretory products of RER are transported to various organelles.

RER → SER → Golgi → Lysosomes
Golgi → Secretory granules

to. The ER membranes conduct intra-cellular impulses.

6. The ER membranes form the new nuclear envelope after each nuclear division.

7. The ER membranes protect the Cell from the toxic effects of various substances.

8. RER Synthesizes new proteins according to the direction of the nuclear DNA. Proteins Synthesized by RER, transported to the exterior of the Cell via SER, Golgi & Secretory granules.

Specific Functions of RER:

Protein Synthesis, folding & Segregation and Transport-Targetting of Proteins via the RER:

The Synthesis of RER proteins begins on Cytoplasmic Ribosomes. These proteins Contain a Signal Sequence that is recognized by a Signal recognition particle (SRP). SRP binds with Signal Sequence which stops further translation. Docking Protein (integral protein of the ER membrane) also helps binding of SRP to Ribosome. Binding of SRP-Ribosome Complex to the SRP receptor is followed by binding of the ribosome to the membrane. This is followed by insertion of Signal Sequence into the membrane & release of

SRP. Release of SRP allow
to resume. After completion of
the signal sequence is cleaved b
signal peptidase. The newly syn
are glycosylated & are carrie
complex by vesicles, that bud
~~~~. The pores of ER me
polypeptides to pass through, as

Specific functions of SER:

→ Synthesis of lipids, ste
→ detoxification of harm
→ storage & metabolism
within the cell.
~~~~

Peroxisome.

Peroxisomes are organelles rich in Peroxidase, Catalase, D-amino acid oxidase and urate oxidase. They are abundant in the liver, kidney & in many other cell types of animals & Plants. They have 0.6 - 0.7 μm granules with a single membrane and a dense matrix. Many cells contain microperoxisomes, which are smaller & found in all cells. The enzymes of this organelle are synthesized in the cytosol & then transferred to Peroxisome.

The enzymes Urate oxidase, D-amino acid oxidase and α-hydroxylic acid oxidase, produce H_2O_2 & Catalase decomposes H_2O_2. These organelles are involved in β-oxidation of fatty acids & play a role in Thermogenesis.

In plants, Peroxisomes carry out the process of photorespiration, which involves the cooperation of chloroplasts & Peroxisomes. Glyoxysomes are special plant organelles involved in the metabolism of stored lipids.

Important Functions of Peroxisomes are

(1) Hydrogen Peroxide metabolism; They Protect the cellular organelles from the toxic

effect of H_2O_2.

2. Glycolate cycle (photorespiration). - α-Oxidation of FA

3. In Plants, they are involved in the synthesis of Glycine & Serine.

Peroxisomal oxidase Uric acid → allantoin

Functions of Glyoxysomes:

1. Fatty acid metabolism
2. Glyoxylate cycle
3. Glyoxysomes are found to Contain enzyme Urate Oxidase which Converts Uric acid to allantoin.

Microbodies are first described by Rhodin (1954) & are ubiquitous Components of all Eukaryotic cells. They are spherical with diameter ranging from 0.3 - 1.5 μm. They are enclosed by a membrane & have a granular matrix. The material inside the membrane is called 'matrix'. The matrix Contains a core, that shows a regular lattice (or) Crystalline structure. Urate Oxidase is found in many animal cells, whereas Catalase was found in plant cells. Microbodies are defined by their Catalase activity. This Organelle Contain enzymes that oxidize Organic Substances and ~~uses~~ use

Oxygen directly as an electron acceptor.

Classes of Microbodies are

(i) liver Peroxisomes

(ii) Leaf Peroxisome

(iii) Seed glyoxysome

Liver Peroxisome: A typical hepatocyte Contains approximately 1000 microbodies. peroxisomes Contain a wide variety of enzymes.

Electron Transport Chain of Peroxisome is different from the Mitochondria. The free energy lost on oxidation is not coupled to ATP Synthesis. ~~Instead~~ Instead the free energy is released as heat (Thermogenesis).

Most animals use Peroxisomal oxidase to Convert Uric acid to allantoin.

Uric acid $\xrightarrow{\text{Peroxisomal Oxidase}}$ Allantoin

The peroxisomes Contains enzymes for α-oxidation of fatty acids.

Leaf Peroxisomes: Peroxisomes are present in the photosynthetic cells of Green plants. especially in Palisade Cells of C_3 leaves & bundle sheath Cells of C_4 leaves.

The ratio of Microbodies to mitochondria to

Chloroplasts in plant cells is about 1:2

Peroxisomes plays an important role in photorespiration.

In C_3 plants, Rubisco can act as an Oxygenase, on a sunny hot day, & produce glycolate. The Peroxisome, with its enzymatic machinery can metabolize glycolate & convert glycolate to 'glycerate'.

Role of leaf Peroxisome in photorespiration:

Fig. 1

Enzyme content of leaf Peroxisome:

Catalase
Oxidase
Dehydrogenases
Aminotransferases.
NADH - Cytochrome 'C' reductase.

Photorespiration: Phosphoglycolate is dephosphorylated in the Chloroplast & the resulting glycolate diffuses out of this organelle & enter into the Peroxisome. Glycolate Oxidase Converts the glycolate into Glyoxylate. In this process, H_2O_2 is produced & this is then oxidized by catalase. Glyoxylate is Converted to Glycine, which leaves the Peroxisomes & enter into the Mitochondria. & then converted into Serine. This reaction

which releases CO_2 & thereby a major portion of fixed Carbon is lost (photo respiration). Serine is then converted to glycerate in the Peroxisome which can be used by the chloroplast to produce Hexose sugars.

Seed Glyoxysomes: are microbodies that occur for a brief time in plant life such as certain beans & nuts, which store fats as an energy reserve in their seeds. Matured, dry seeds does not contain these organelles. However, they appear in endosperm during seed germination. The appearance of Glyoxysomes correlates with a massive conversion of stored fats into hexose sugars. The Glyoxysomes contains the enzymes of fatty acid oxidation, & also glyoxylate cycle.

Enzymes of Glyoxysomes: Catalase, Oxidase, Dehydrogenase, B-oxidation enzymes, Aminotransferases, Glyoxylate cycle enzymes, NADH-cytochrome 'c'-reductase, Lipase. Isocitrate-lyase and malate synthetase are enzymes present only in Glyoxysomes.

Metabolic role of Glyoxysome:

Fig. 2 [Full page]

The net conversion of fat to Carbohydrate, a property of Glyoxysome, does not occur in mammalian cells.

Melanosomes: Melanin (Human skin colour) synthesis occurs in specialized cells, 'melanosomes'