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Assignment

M.Sc. Zoology
Semester-II

Title of Assignment:

Student Name:

Roll Number:

Oxidative Phosphorylation –

The electron transport chain forms a proton gradient across the inner mitochondrial membrane, which drives the synthesis of ATP via chemiosmosis.

Why do we need oxygen?

→ The reason you need oxygen is so your cells can use this molecule during oxidative phosphorylation, the final stage of cellular respiration.

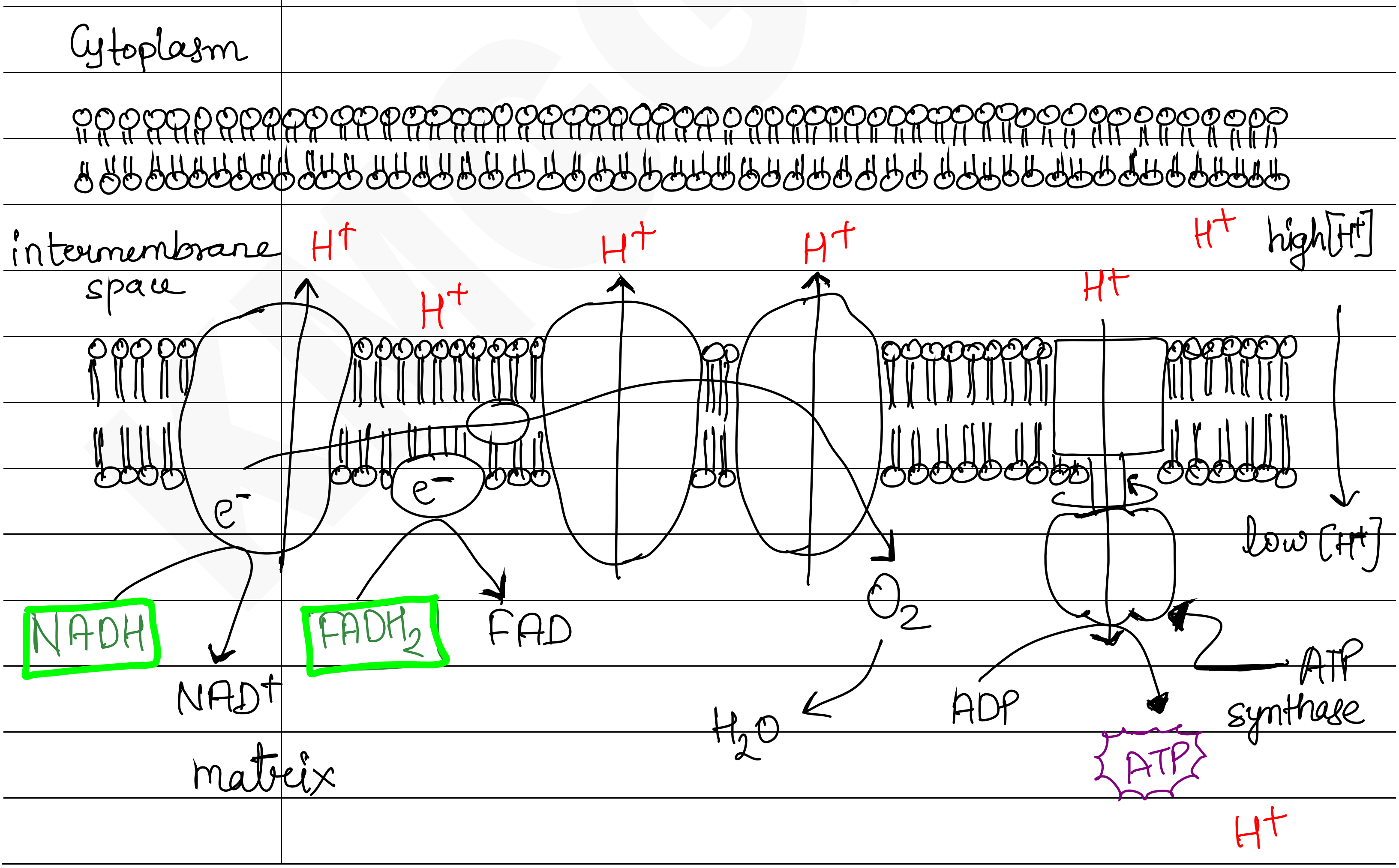
- Oxidative phosphorylation is made up of two closely connected components :–
  - The electron transport chain (ETC)
  - Chemiosmosis

- In the ETC, electrons are passed from one molecule to another, & energy released in these electron transfers is used to form an electrochemical gradient.
- In chemiosmosis, the energy stored in the gradient is used to make ATP.

- Oxygen sits at the end of the ETC, where it accepts electrons & picks up protons to form water. If oxygen isn't there to accept electrons, the ETC will stop running, and ATP will no longer be produced by chemiosmosis.

- Without enough ATP, cells can't carry out the reactions they need to function, &, after a long enough period of time, may even die.

Overview : Oxidative phosphorylation –



- The ETC is a series of proteins & organic molecules found in the inner membrane of the mitochondria.
- Electrons are passed from one member of the transport chain to another in a series of redox reactions.
- Energy released in these reactions is captured as a proton gradient, which is then used to make ATP in a process called chemiosmosis.
- Together, the ETC & chemiosmosis make up oxidative phosphorylation.

★ **Delivery of electrons by NADH & $FADH_2$ -**

Reduced electron carriers (NADH & $FADH_2$) from other steps of cellular respiration transfer their electrons to molecules near the beginning of the transport chain.
In this process, they turn back into NAD^+ & FAD, which can be reused in other steps of cellular respiration.

★ **Electron transfer & proton pumping -**

As e^- are passed down the chain, they move from a higher to a lower energy level, releasing energy. Some of the energy is used to pump H^+ ions, moving them out of the matrix & into the intermembrane space. This pumping establishes an electrochemical gradient.

★ **Splitting of oxygen to form water** – At the end of the ETC, electrons are transferred to molecular oxygen, which splits in half & takes up H^+ to form water.

★ **Gradient – driven synthesis of ATP** – As H^+ ions flow down their gradient & back into the matrix, they pass through an enzyme called ATP synthase, which harnesses the flow of protons to synthesize ATP.

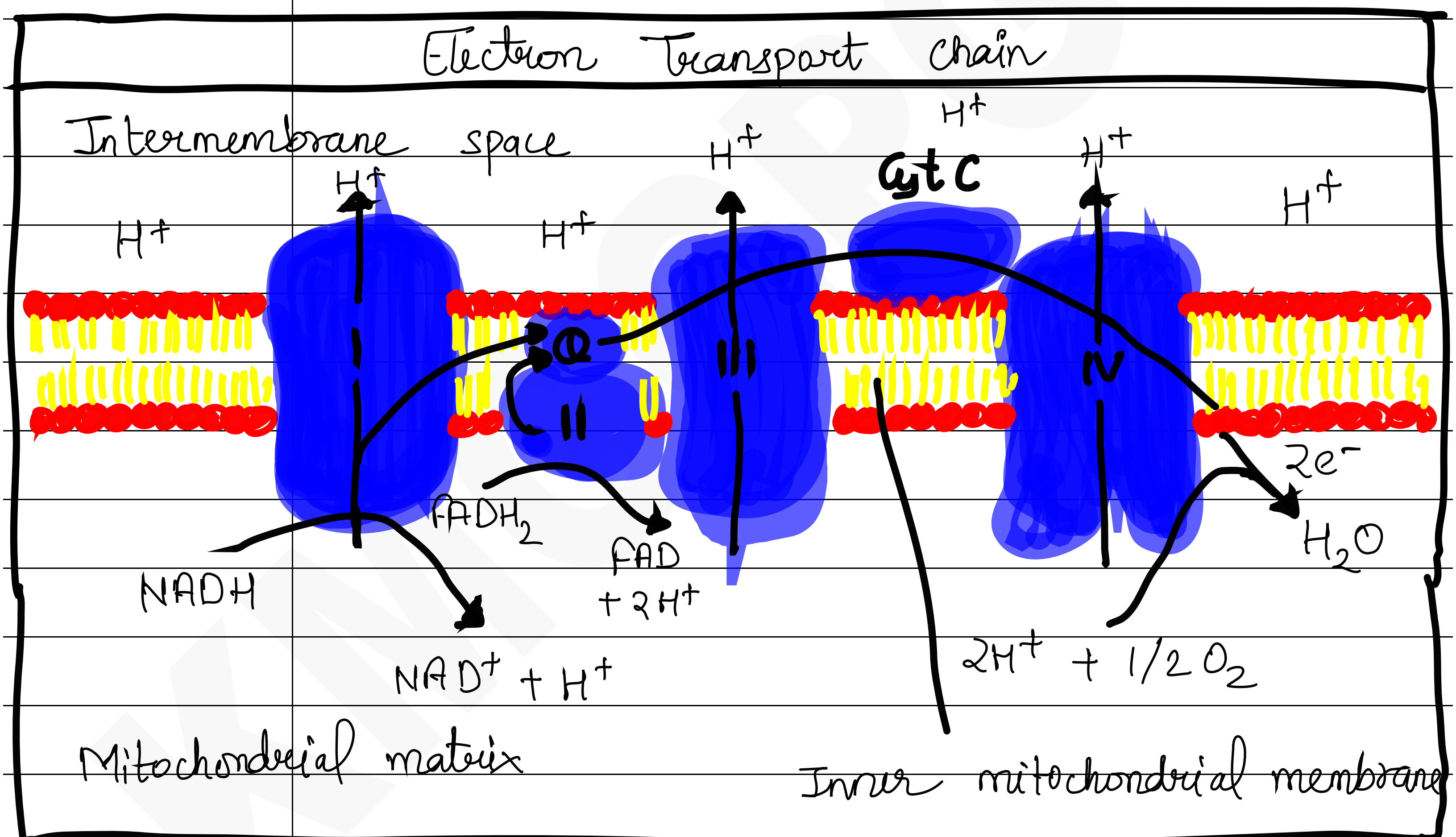
THE ELECTRON TRANSPORT CHAIN –

- The ETC is a collection of membrane – embedded proteins & organic molecules, most of them organized into four large complexes labeled I to IV.

– In eukaryotes → Molecules found in inner mitochondrial membrane.

- In prokaryotes → ETC found in plasma membrane.

- As the electrons travel through the chain, they go from a higher to a lower energy level, moving from less electron-hungry to more electron-hungry molecules.



- All of the electrons that enter the transport chain come from NADH & $FADH_2$ molecules produced during earlier stages of cellular respiration: glycolysis, pyruvate oxidation & the citric acid cycle.

- NADH is very good at donating e⁻ (its e⁻ are at a high energy level), so it can transfer its e⁻ directly to complex I, turning back into NAD^+.
- $FADH_2$ is not as good at donating e⁻ as NADH (its e⁻ are at a lower energy level), so it cannot transfer its e⁻ to complex I.

- Because of this "bypass", each $FADH_2$ molecule causes fewer protons to be pumped than an NADH.

- Beyond the first two complexes, e⁻ from NADH & $FADH_2$ travel exactly the same route.
- Both complex I & II pass their e⁻ to a small, mobile e⁻ carrier called ubiquinone (Q), which is reduced to form QH_2 & delivering the e⁻ to complex III.
- The e⁻ are ultimately delivered to another mobile carrier called cytochrome C (Cyt C).
- Cyt C carries the e⁻ to complex IV.
- Complex IV passes the e⁻ to O_2 which splits into two oxygen atoms.
- Four e⁻ reduce each molecule of O_2 & two water molecules are formed in the process.

Regenerate electron carriers –

NADH & $FADH_2$ pass their e^- to the ETC, turning back into NAD^+ & FAD. This is imp. b/z the oxidized forms of these e^- carriers are used in glycolysis & the citric acid cycle.

Makes a proton gradient –

The transport chain builds a proton gradient across the inner mitochondrial membrane, with a higher conc. of H^+ in the intermembrane space & a lower conc. in the matrix. This gradient represents a stored form of energy, & we'll see, it can be used to make ATP.

Chemiosmosis –

- Complexes I, III & IV of the ETC are proton pumps.
- In the inner mitochondrial membrane, H^+ ions have just one channel available: a membrane-spanning protein known as ATP synthase.
- As ATP synthase turns, it catalyzes the addition of a phosphate to ADP, capturing

energy from the proton gradient as ATP.

- This process, in which energy from a proton gradient is used to make ATP, is called chemiosmosis.
- For instance, chemiosmosis is also involved in the light reactions of photosynthesis.
- Although chemiosmosis accounts for over 80% of ATP made during glucose breakdown in cellular respiration, it's not unique to cellular respiration.

ATP yield –