2024 Bi H2 Q7

Section: Metabolism and Survival

Topic: Cellular Respiration

Question Summary

This question tests knowledge of the electron transport chain (ETC) and ATP synthesis. Students identify the cellular location of the ETC, describe the role of NAD in ATP production, and explain how a mutation in a carrier protein affects energy yield.

Worked Solution

- (a) The electron transport chain is located on the inner membrane of the mitochondrion (the cristae).
- (b)(i) NAD acts as a hydrogen carrier: it accepts hydrogen (and electrons) from dehydrogenase enzymes during glycolysis and the citric acid cycle, becoming reduced NAD (NADH).
- (b)(ii) NADH then donates high-energy electrons to the first carrier protein in the ETC. As electrons pass along the chain, they release energy that pumps hydrogen ions (H+) across the inner membrane into the intermembrane space.
- This creates a hydrogen ion gradient across the membrane.
- H+ ions flow back through ATP synthase, driving phosphorylation of ADP to form ATP - this process is called chemiosmosis.

- (c) A mutation in a carrier protein may prevent electrons from passing efficiently along the chain, reducing proton pumping. This

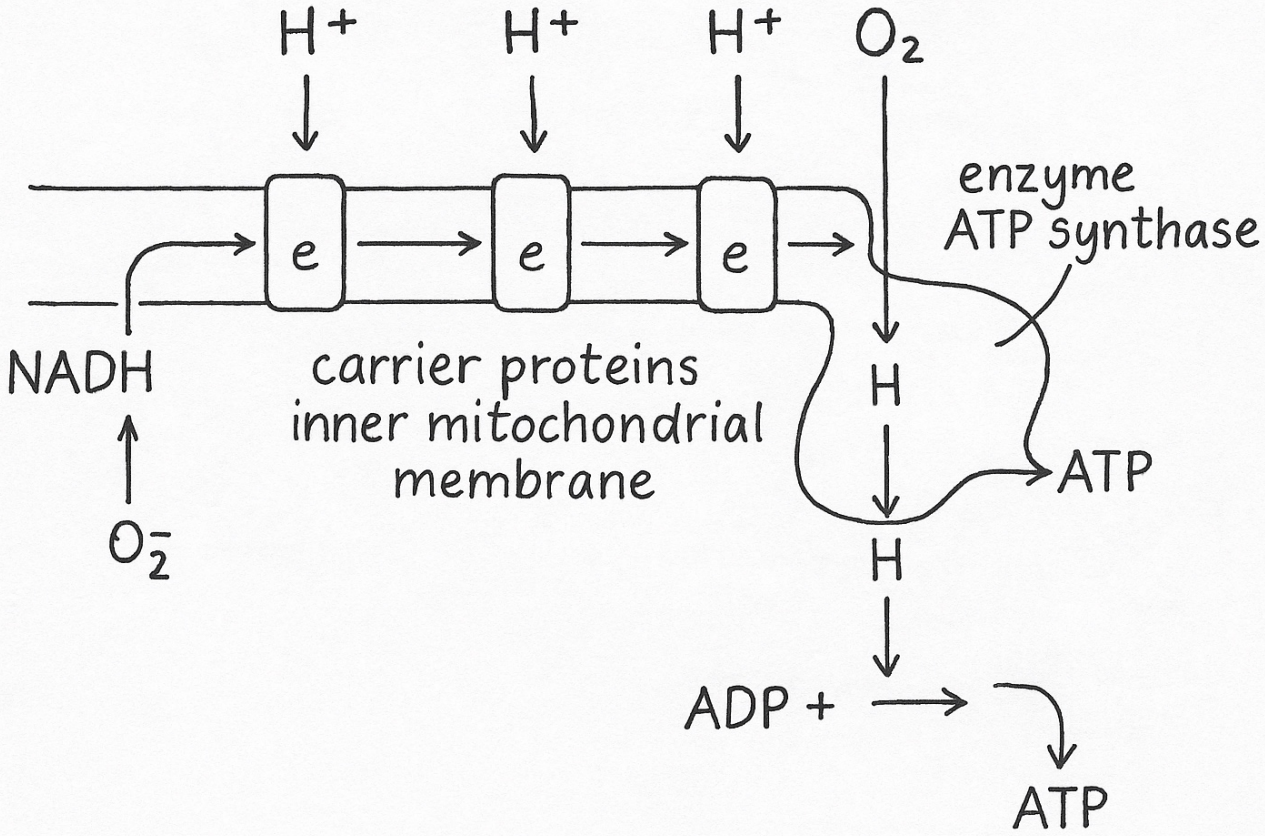
lowers the hydrogen ion gradient and hence reduces ATP yield. Some energy is released instead as heat, making the process less efficient.

Final Answer

-> (a) Inner mitochondrial membrane (cristae)
-> (b)(i) NAD carries hydrogen to the ETC
-> (b)(ii) Electrons release energy -> H+ pumped -> ATP by chemiosmosis
-> (c) Mutation reduces electron transfer and ATP yield

Revision Tips

- The ETC and ATP synthase are on the inner mitochondrial membrane.
- NAD and FAD carry hydrogen and electrons to the ETC.
- Energy from electrons pumps H+ ions -> gradient drives ATP synthesis.
- Any disruption to carriers or ATP synthase lowers ATP output.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