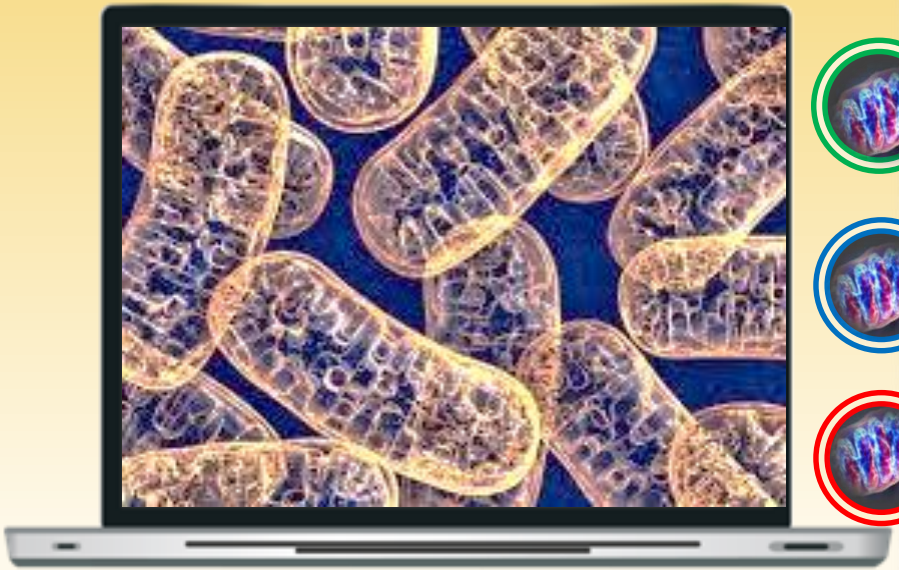
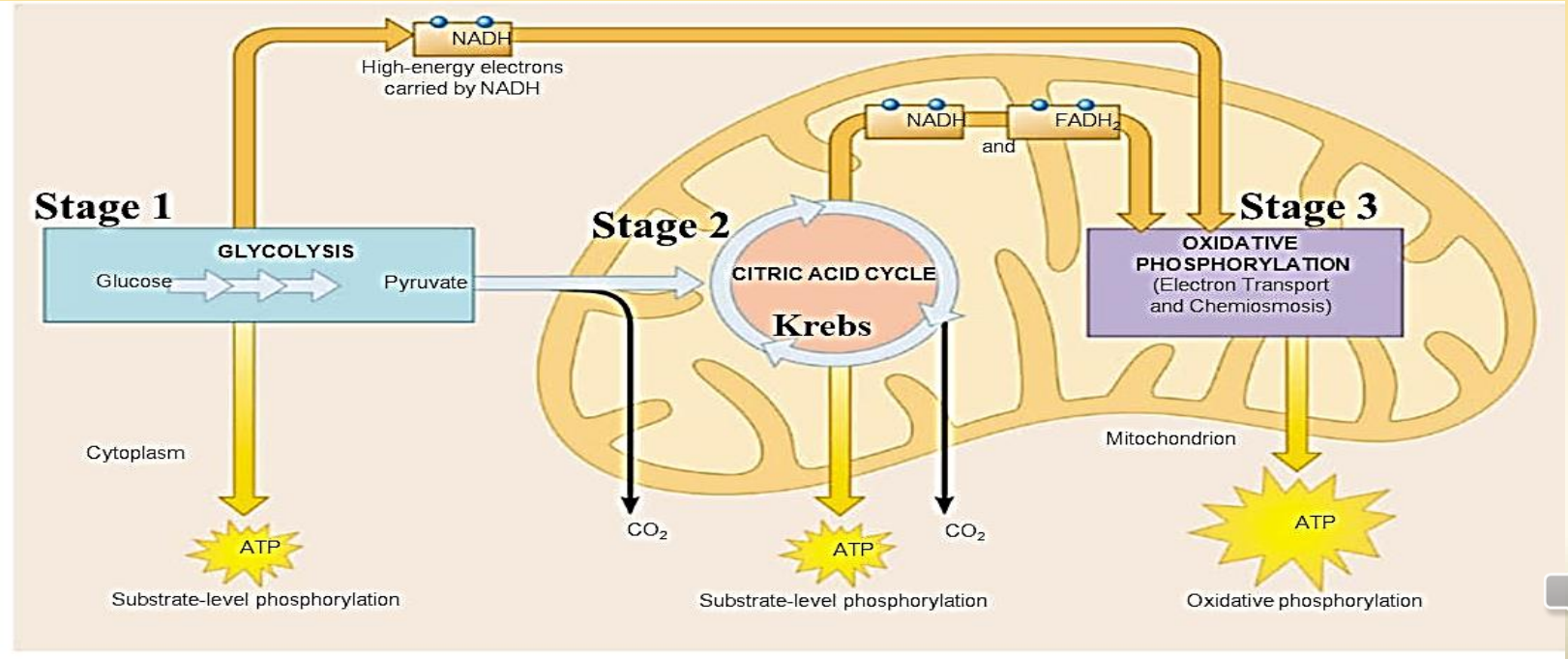
CELLULAR RESPIRATION AND FERMENTATION

5.1.3 Oxidative Phosphorylation: Electron Transport Chain and Chemiosmosis



- Illustrate to explain electron transport chain
- Explain chemiosmosis: Proton motive force
- Explain complete oxidation of one molecule of glucose in active cells

Food
e.g: Carbohydrate → Digestion → Glucose → (CELLULAR RESPIRATION) → Energy



5.1.3 Oxidative Phosphorylation: Electron Transport Chain and Chemiosmosis

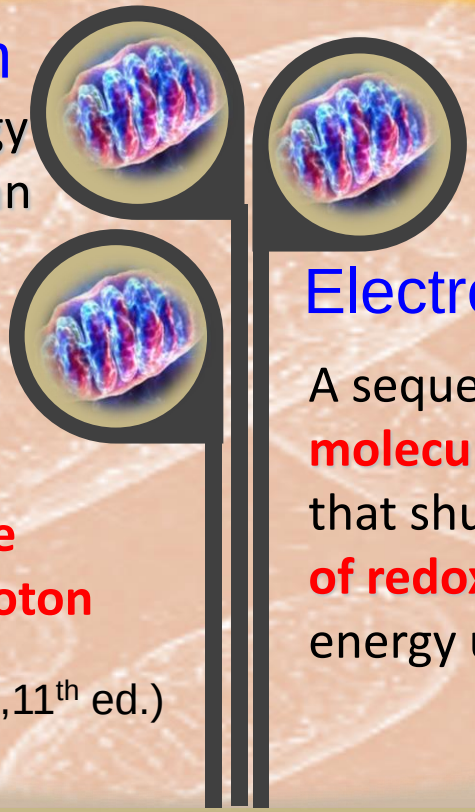
Oxidative Phosphorylation

The **formation of ATP** using energy derived from **redox reactions** of an **electron transport chain**

Chemiosmosis

The production of ATP via proton movement, through **ATP synthase** across a membrane, driven by **proton gradient.**

(Campbell, 11th ed.)

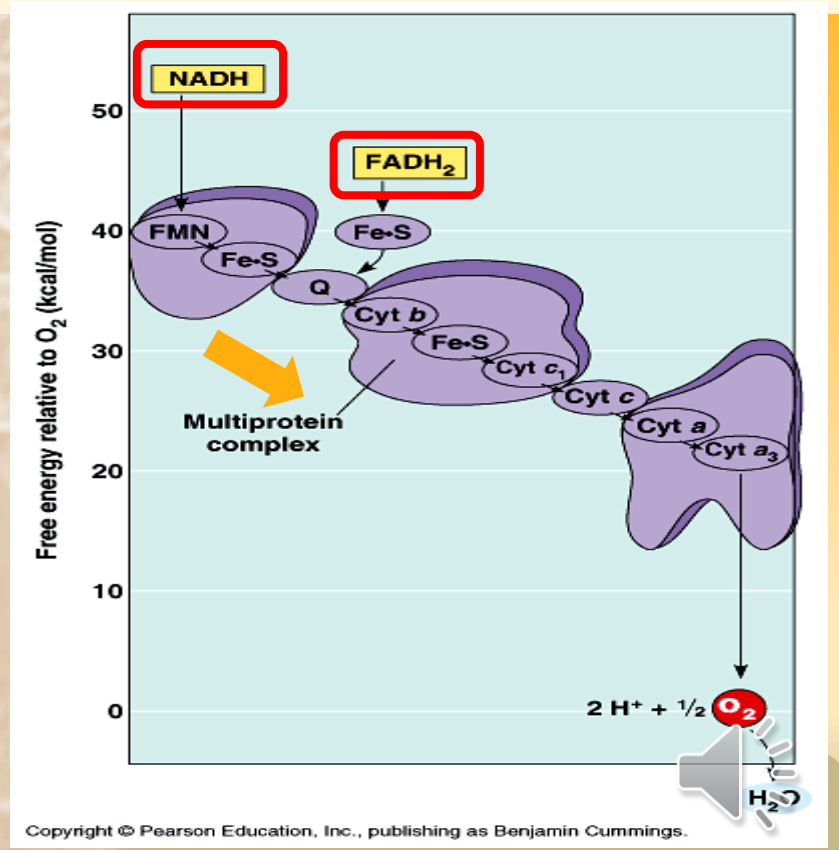


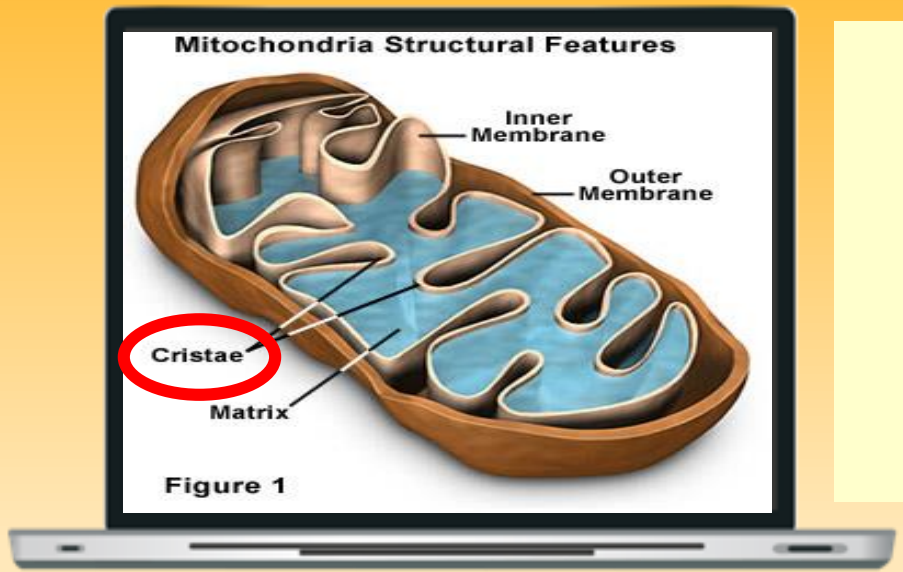
Electron Transport Chain

A sequence of **electron carrier molecules** (membrane proteins) that shuttle electrons down a **series of redox reactions** that release energy used to make ATP

Electron Transport Chain

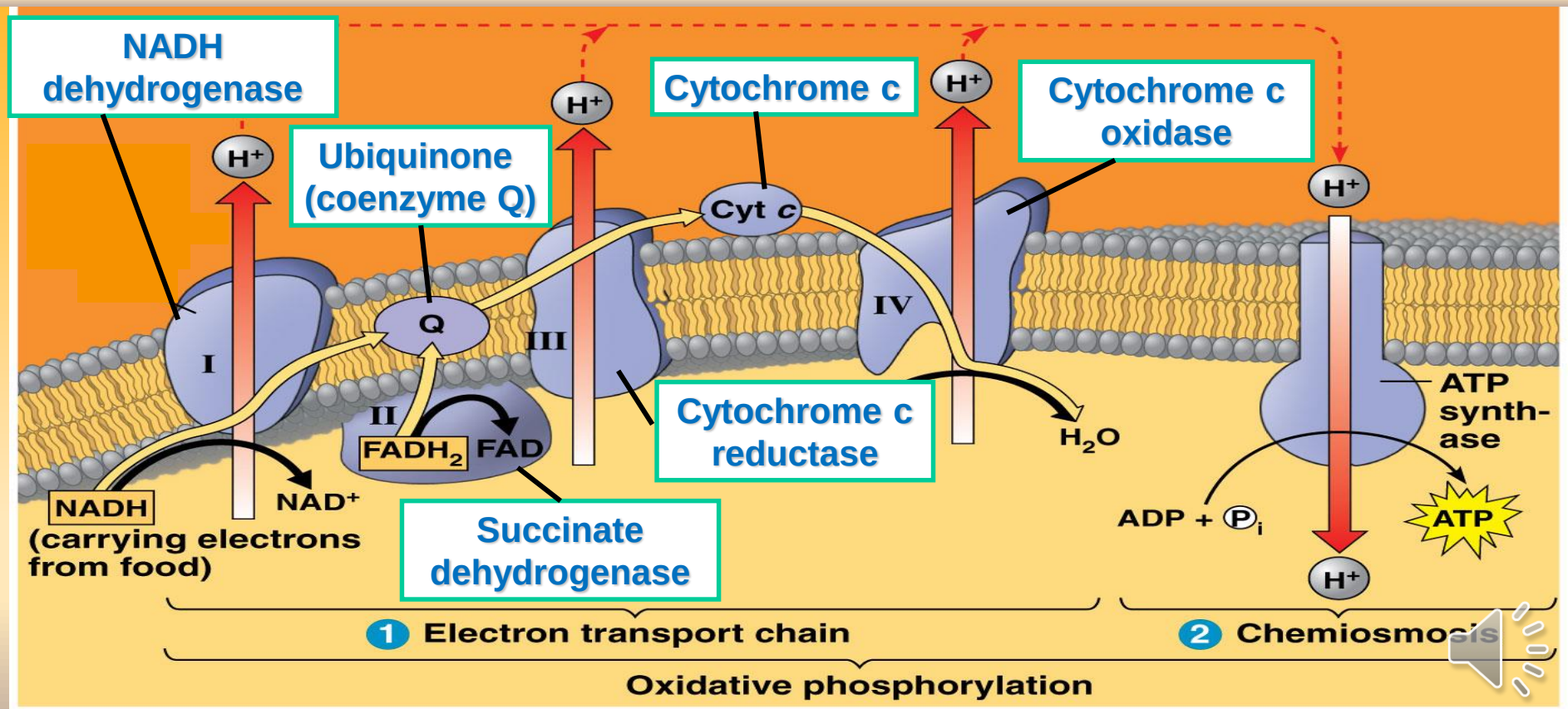
- NADH and $FADH_2$ are the **source of electrons**.
- NADH and $FADH_2$ **donate electrons** to the **electron transport chain**, which powers ATP synthesis via **oxidative phosphorylation.**

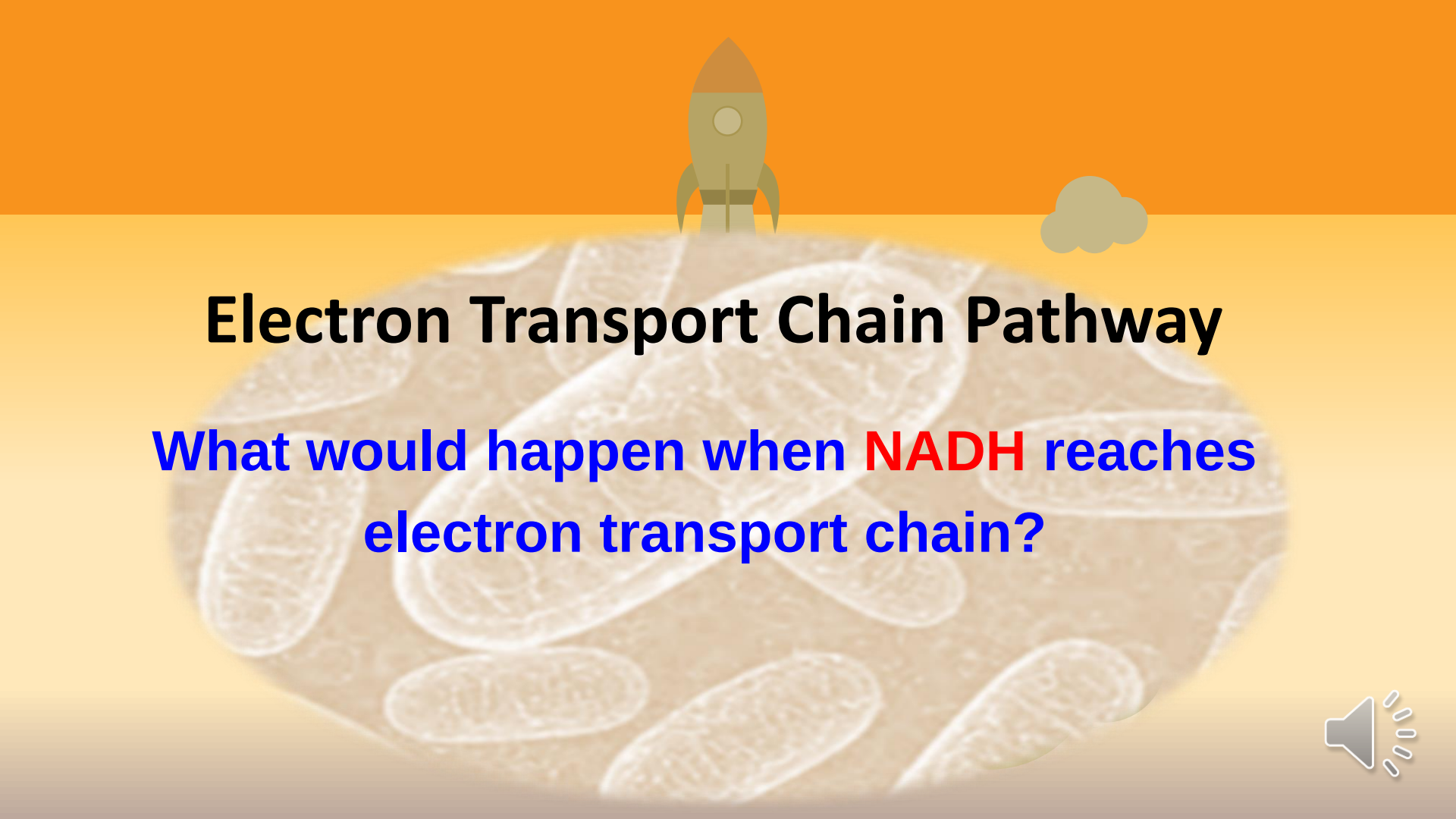




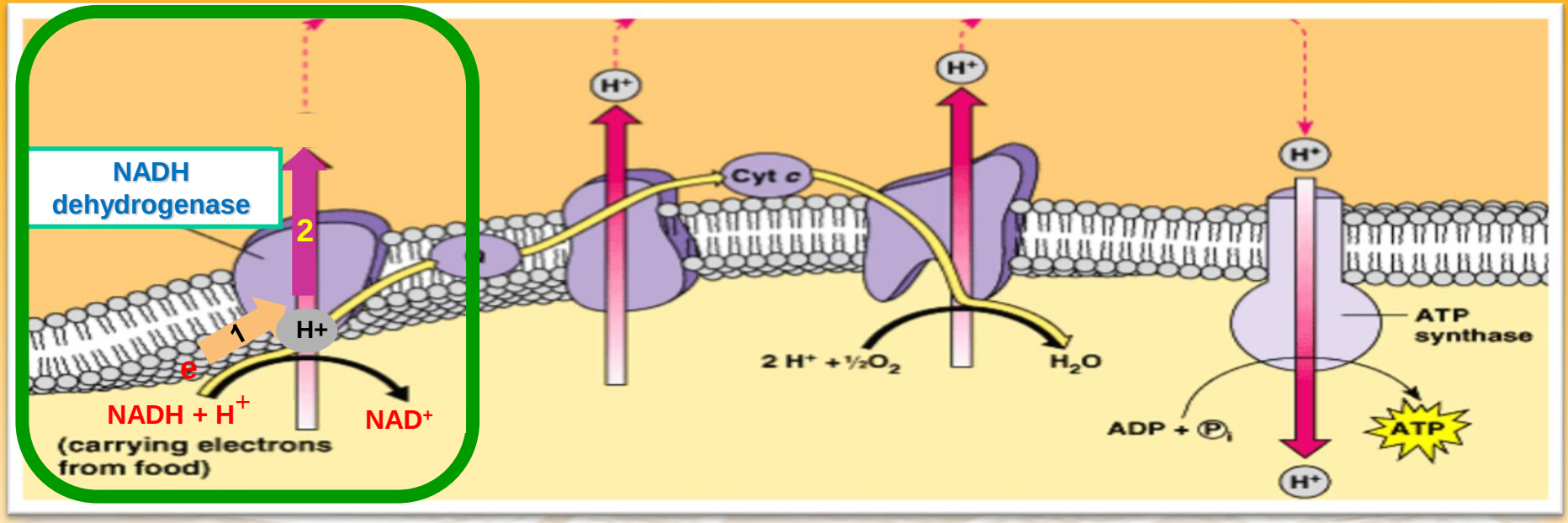
The electron transport chain is located at the cristae of the mitochondrion.

Components of Electron Transport Chain



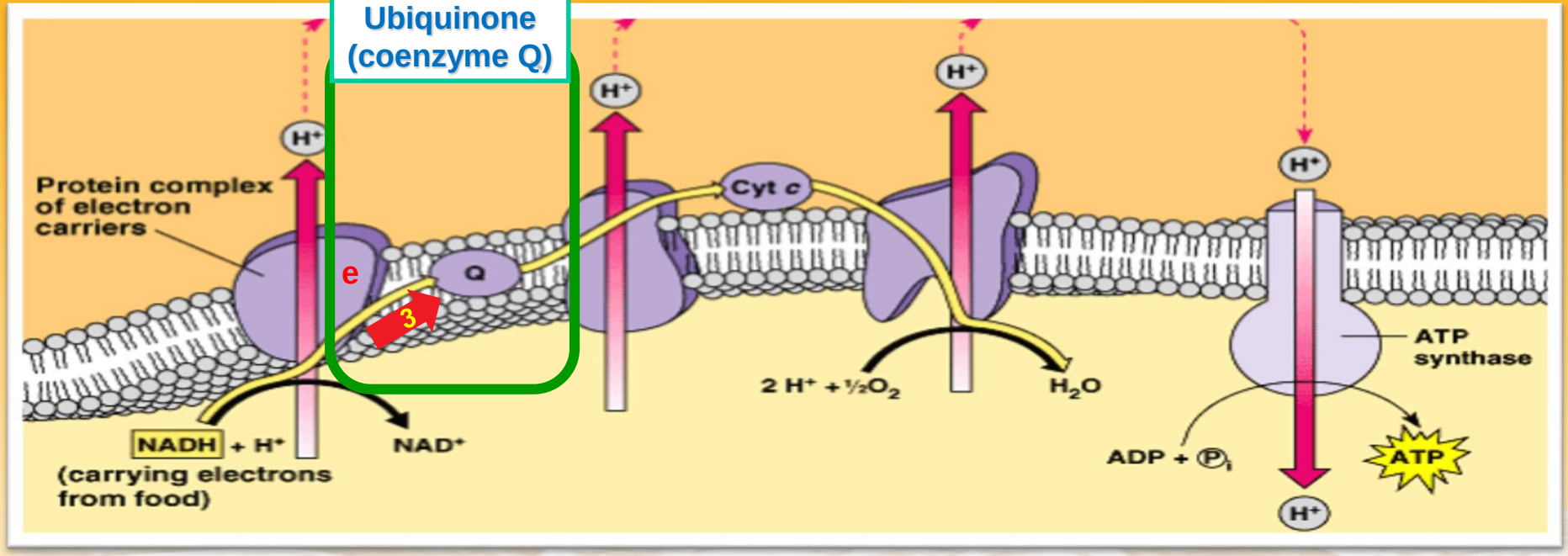

Electron Transport Chain Pathway
What would happen when NADH reaches electron transport chain?

Electron Transport Chain Pathway



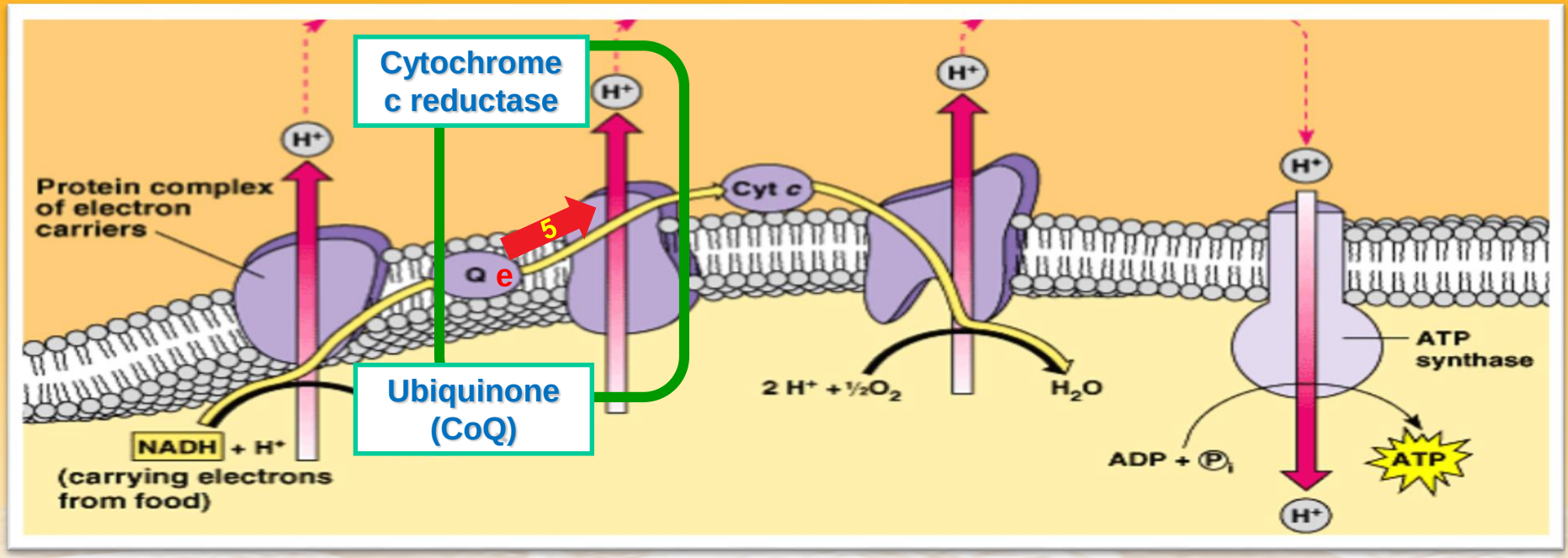
1. NADH is oxidized to form NAD^+. Electrons are transferred to NADH dehydrogenase.
2. As electron is transferred, some of the energy is harnessed to pump proton (H^+) out, into the intermembrane space of mitochondria

Electron Transport Chain Pathway



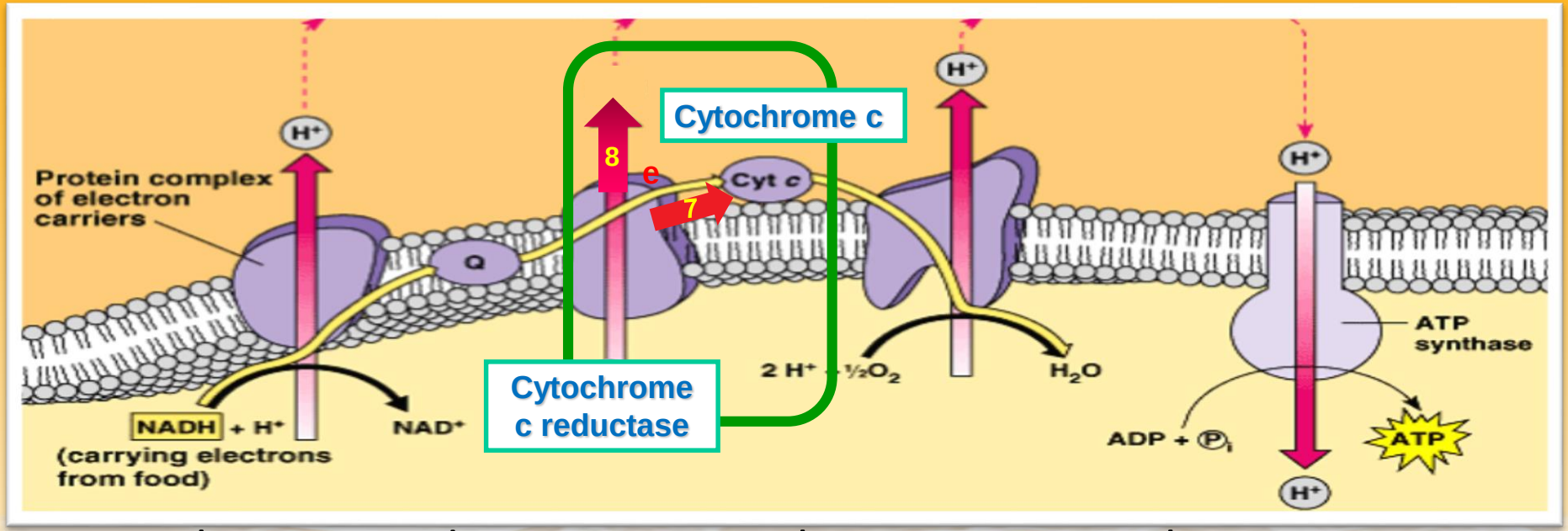
3. NADH dehydrogenase passes electrons to ubiquinone.
4. Ubiquinone molecule that receives electron is reduced, NADH dehydrogenase molecule which donated electron is oxidized

Electron Transport Chain Pathway



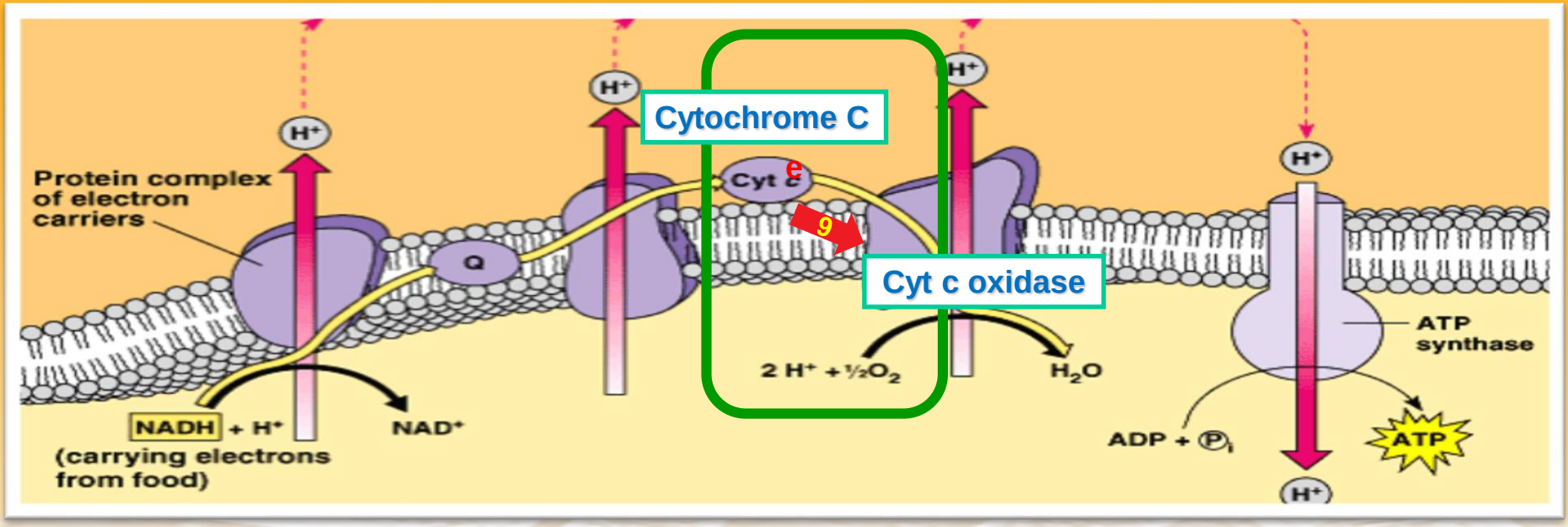
5. Ubiquinone (a mobile electron carrier) passes electrons to Cytochrome c reductase
6. Ubiquinone is oxidized, Cyt c reductase is reduced

Electron Transport Chain Pathway



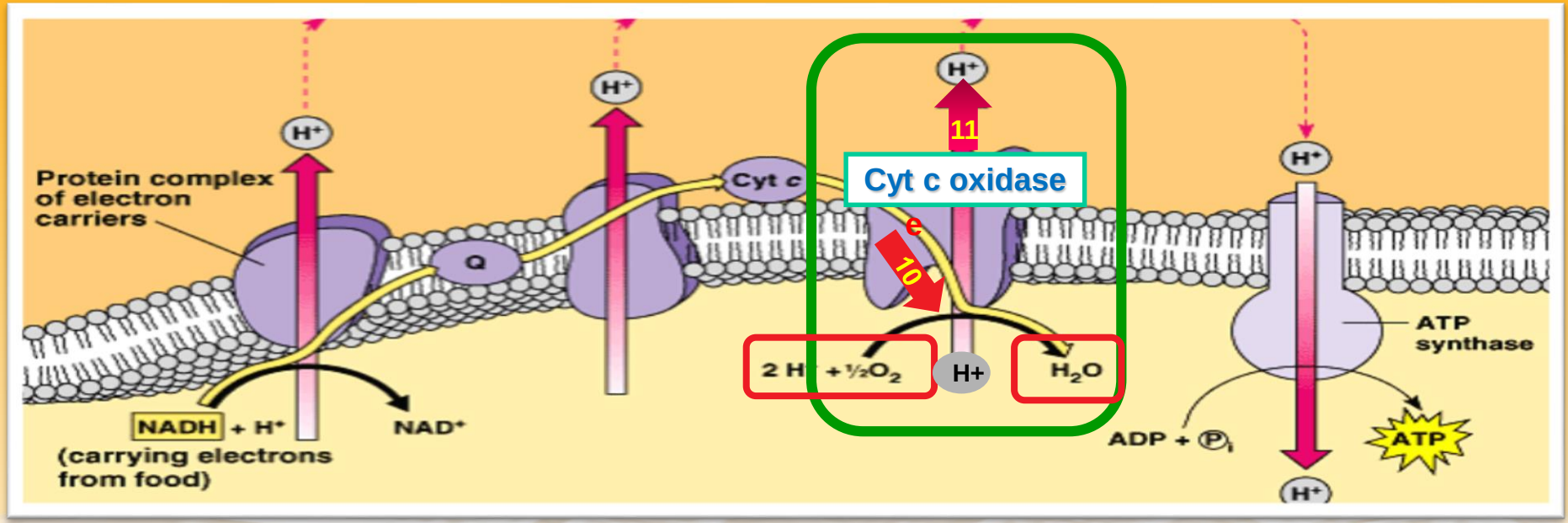
7. Cytochrome c reductase passes electrons to Cytochrome c.
   Cyt c reductase is oxidized, Cyt c is reduced.
8. As electron is transferred, energy is used to pump proton into the intermembrane space of mitochondria

Electron Transport Chain Pathway



9. Cytochrome c (a mobile electron carrier) passes electrons to Cytochrome c oxidase. Cytochrome c is oxidized, Cyt c oxidase is reduced.

Electron Transport Chain Pathway

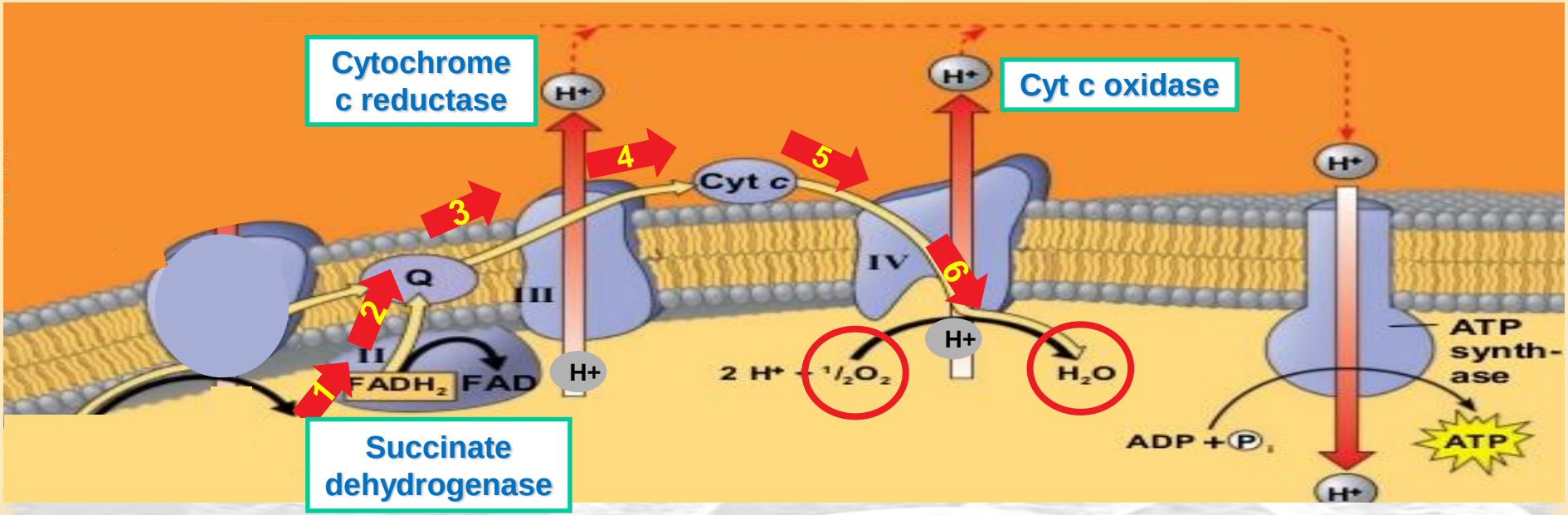


10. Cytochrome c oxidase passes electrons to oxygen (last electron acceptor). Water is produced.
11. As electron is transferred, proton is pumped into the intermembrane space of mitochondria

Electron Transport Chain Pathway

What would happen when $FADH_2$ reaches electron transport chain?

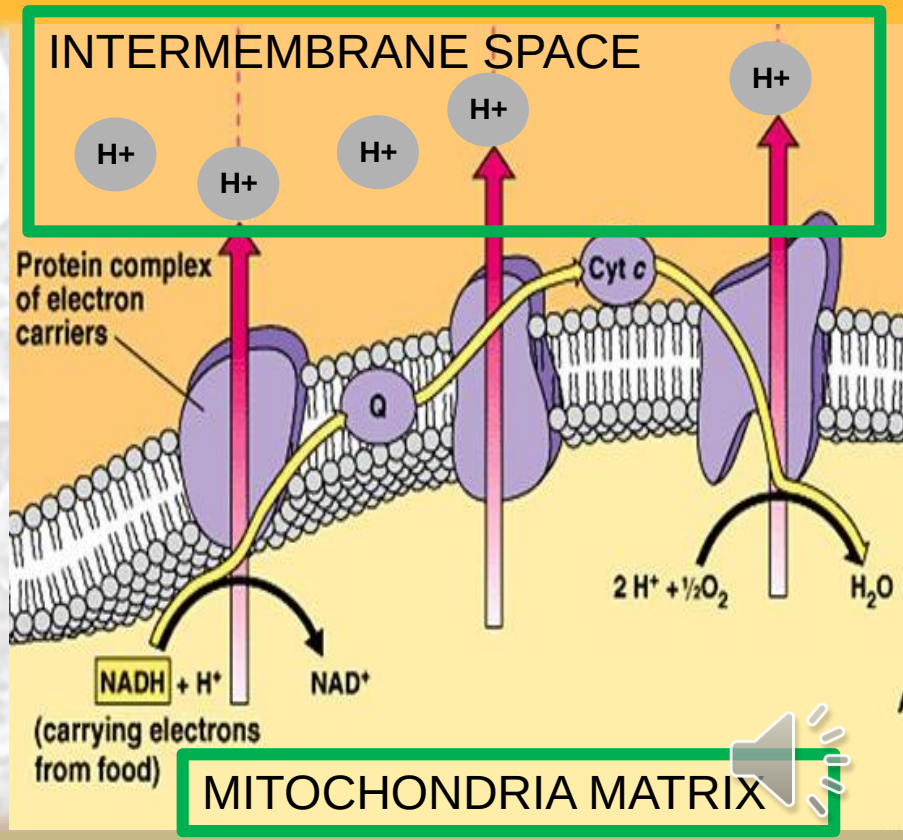
Electron Transport Chain Pathway



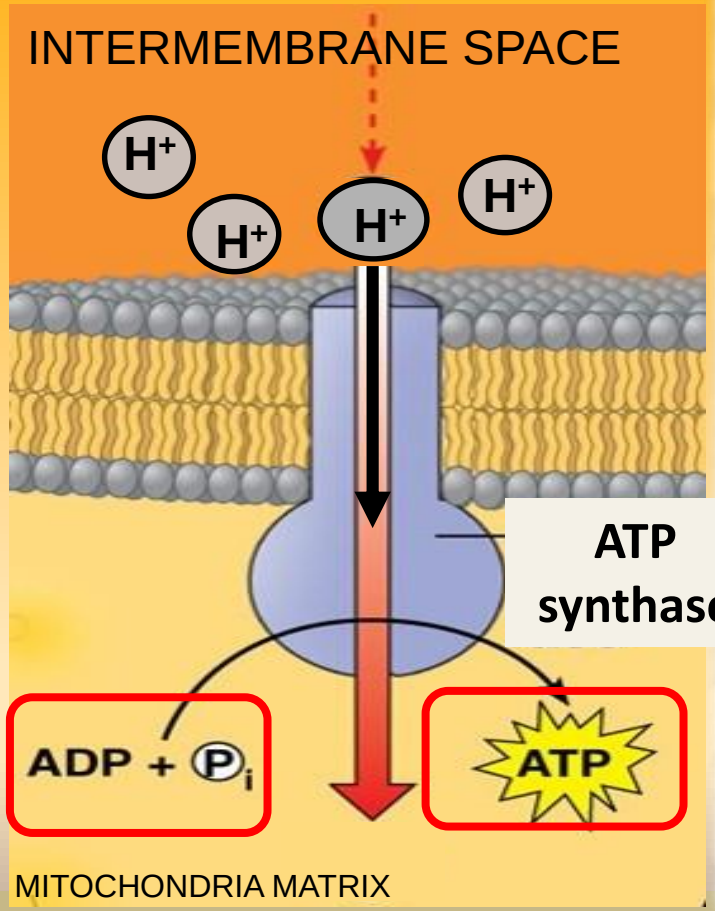
$FADH_2$ passes electrons to succinate dehydrogenase. The electron then will be passed to other electron carrier from ubiquinone, cytochrome c reductase, cytochrome c and lastly cytochrome c oxidase. Electron from cyt c oxidase will be passed to oxygen atom which act as final electron acceptor, forming water molecules.

Chemiosmosis

- The ETC uses the energy flow of electron to **pump H^+** from the **mitochondrial matrix** to the **intermembrane space of mitochondrion.**
- Results **higher concentration** of H^+ in the intermembrane space



Chemiosmosis

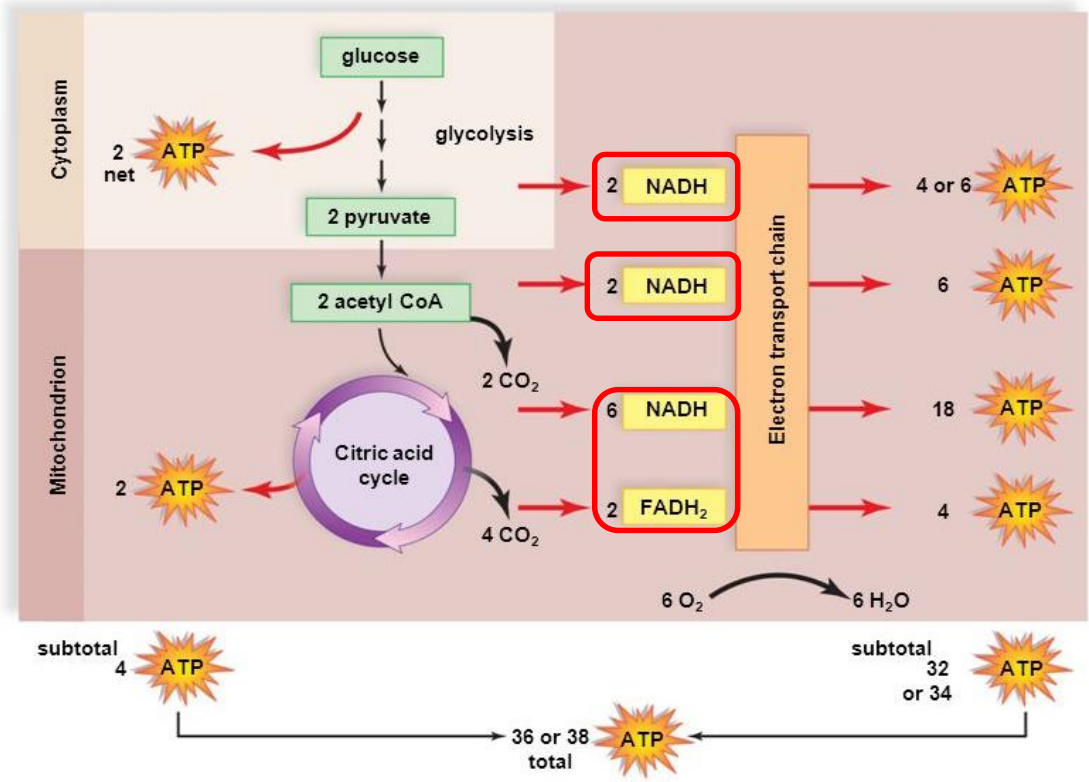


- Proton gradient across the inner membrane creates **proton-motive force**
- The force drives H^+ in the intermembrane space to **flow back** into mitochondrial matrix.
- Protons enter the mitochondrial matrix through the H^+ channel provided by **ATP synthase.**
- ATP synthase uses the energy of the **proton gradient** to catalyze the synthesis of ATP by phosphorylating ADP to ATP

Utilization of NADH & $FADH_2$

1 $FADH_2$ transfers a pair of electron generates 2 ATP.

1 NADH transfers a pair of electron generates 3 ATP



ATP yield from complete oxidation of glucose

Glycolysis: Glucose into pyruvate 2 NADH (Malate shuttle = 6 ATP) In Active Cells	 2 ATP 6 ATP
Link Reaction : Pyruvate (2) to acetyl CoA yield 2 NADH	6 ATP
Acetyl CoA (2) via Kreb cycle 2 GTP = 2 ATP, 6 NADH = 18 ATP, 2 $FADH_2$ = 4 ATP	24 ATP
TOTAL	38 ATP

5.2 Fermentation and its application

5.2 Fermentation and its application

LEARNING OUTCOMES:

(a) Explain lactate and alcoho
l fermentation

(b) State the importance of fe
rmentation in industry

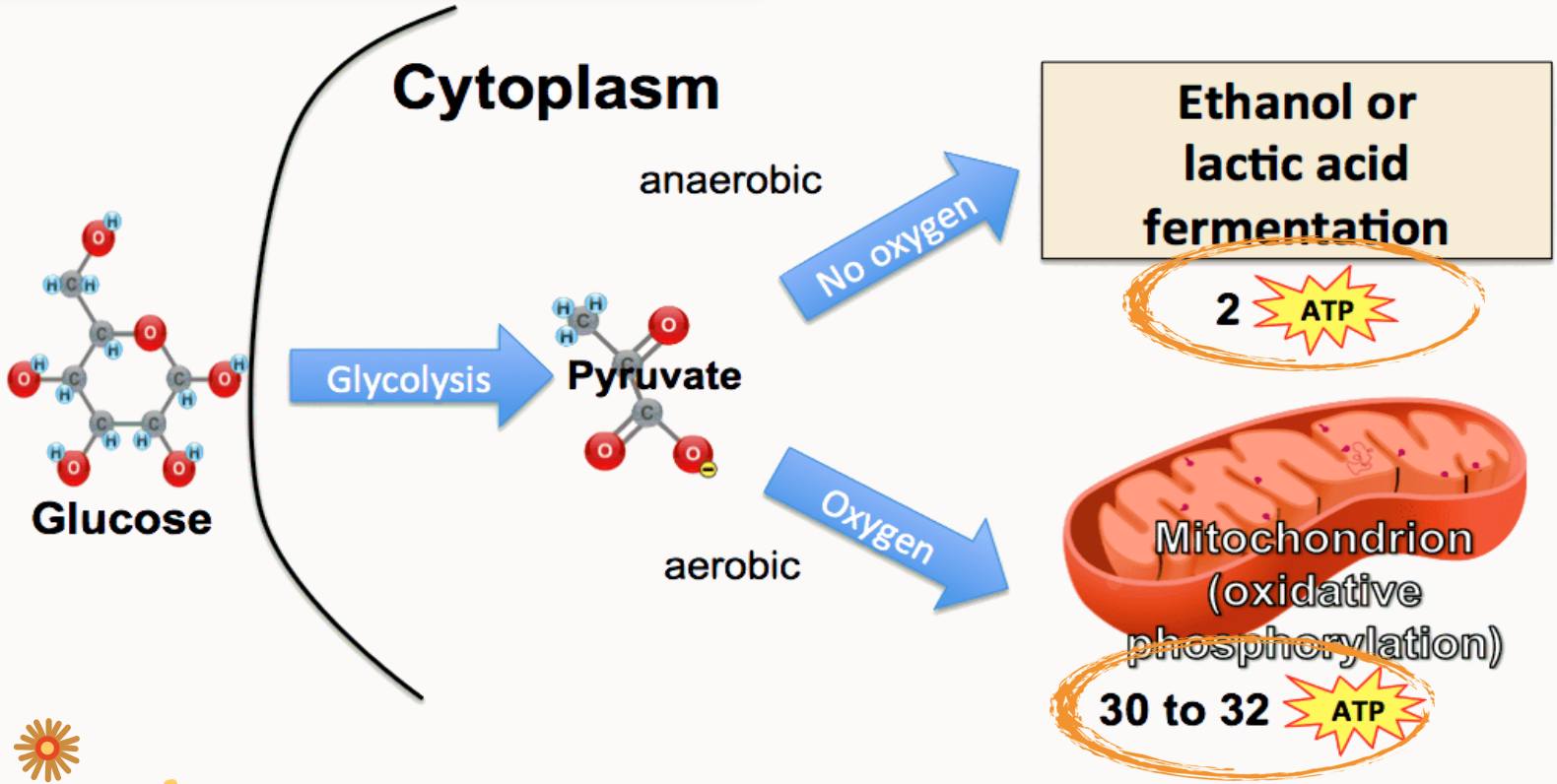
01
02
03
04
05
06

Fermentation

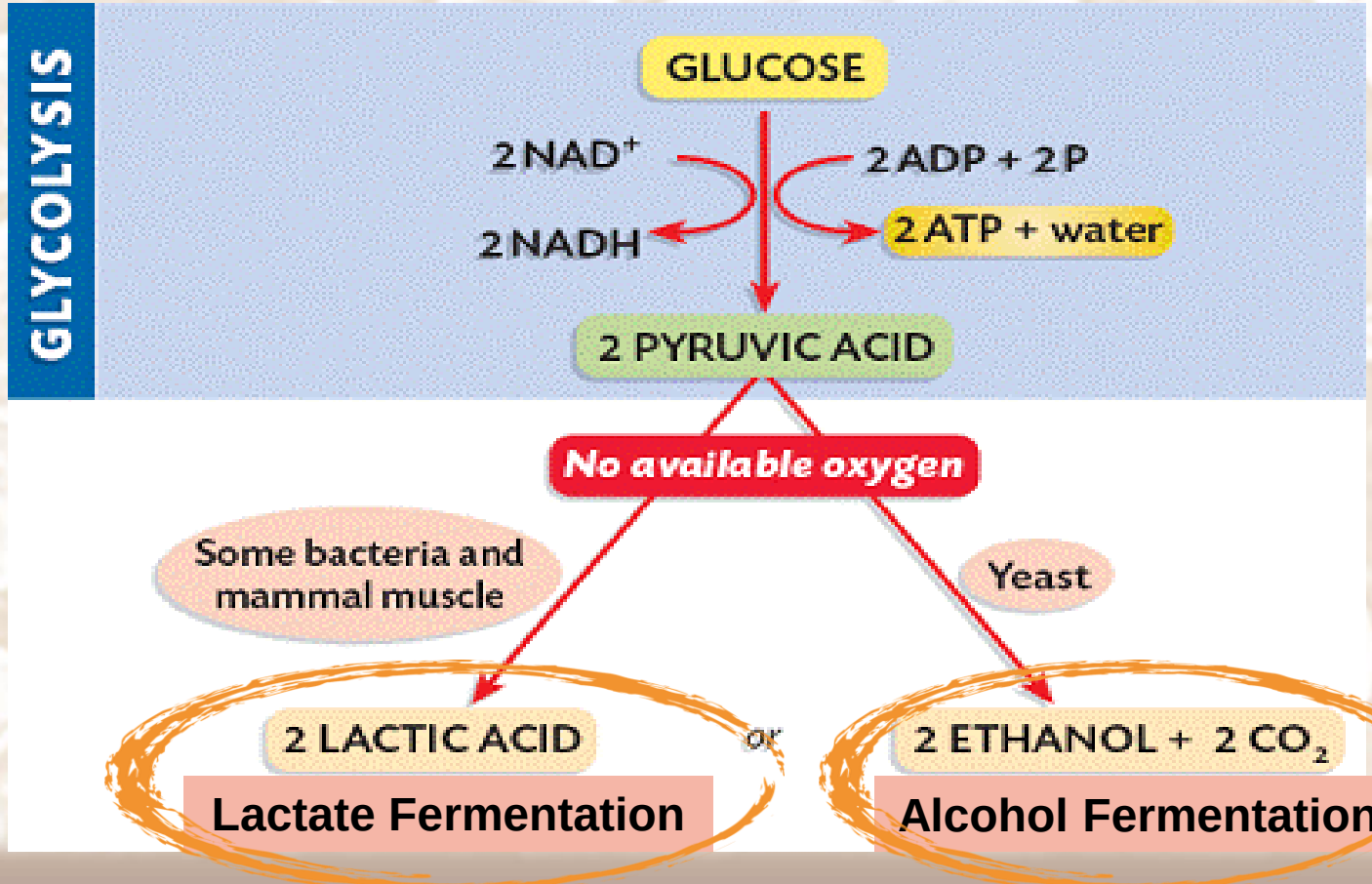
A catabolic process that makes a limited amount of ATP from glucose (or other organic molecules) without an electron transport chain and that produces a characteristic end product, such as ethyl alcohol or lactic acid.

(Campbell, 11th edition)

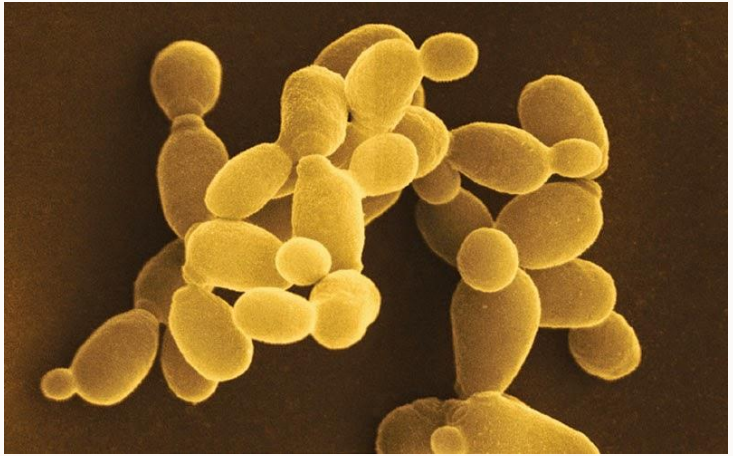
Fermentation



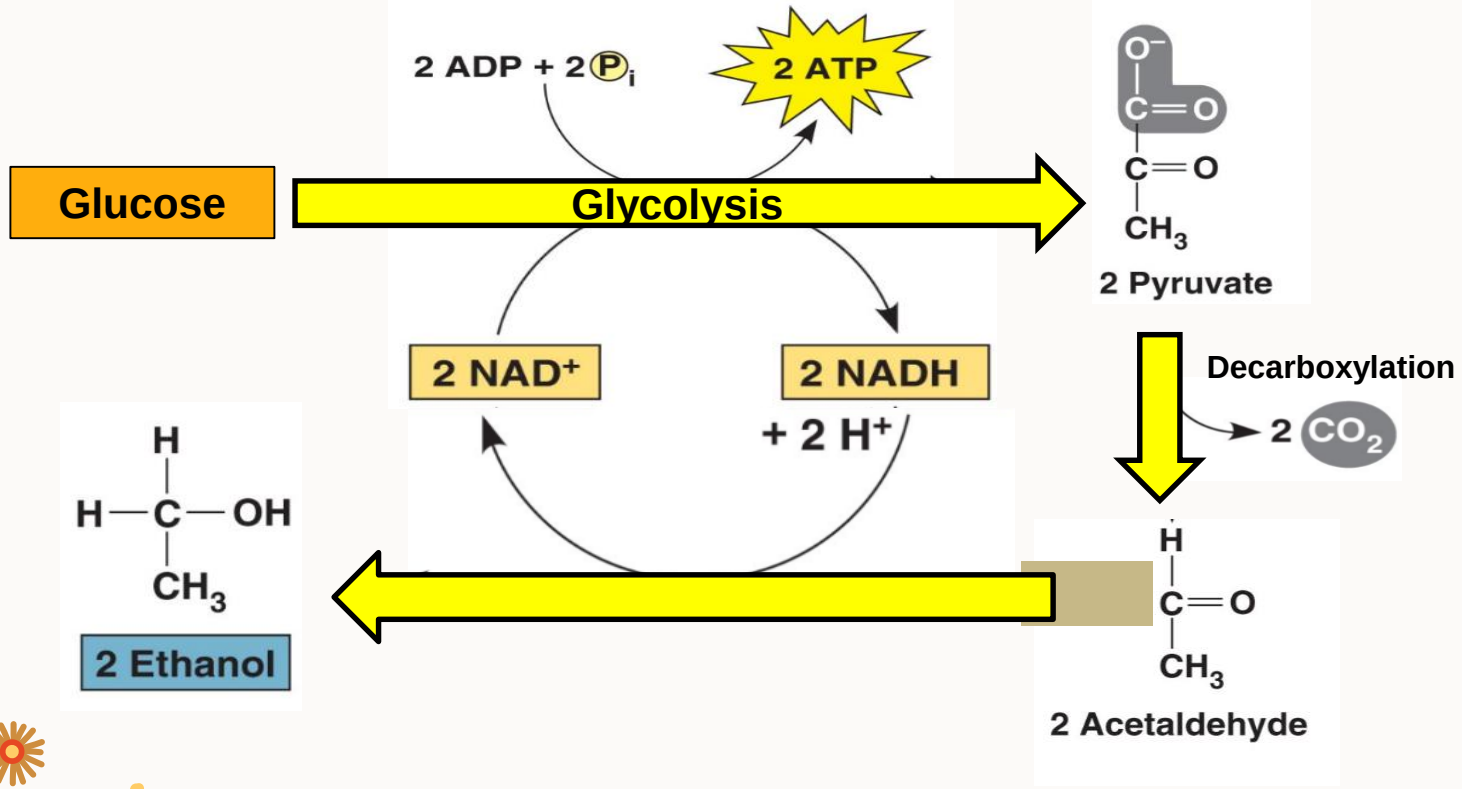
Types of Fermentation



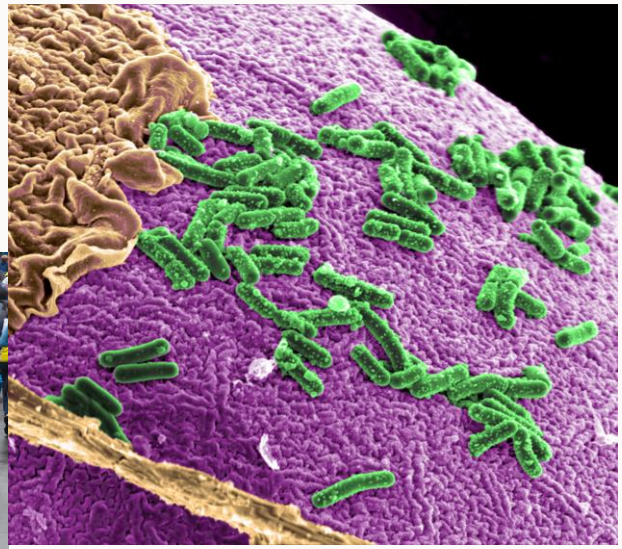
Alcohol Fermentation



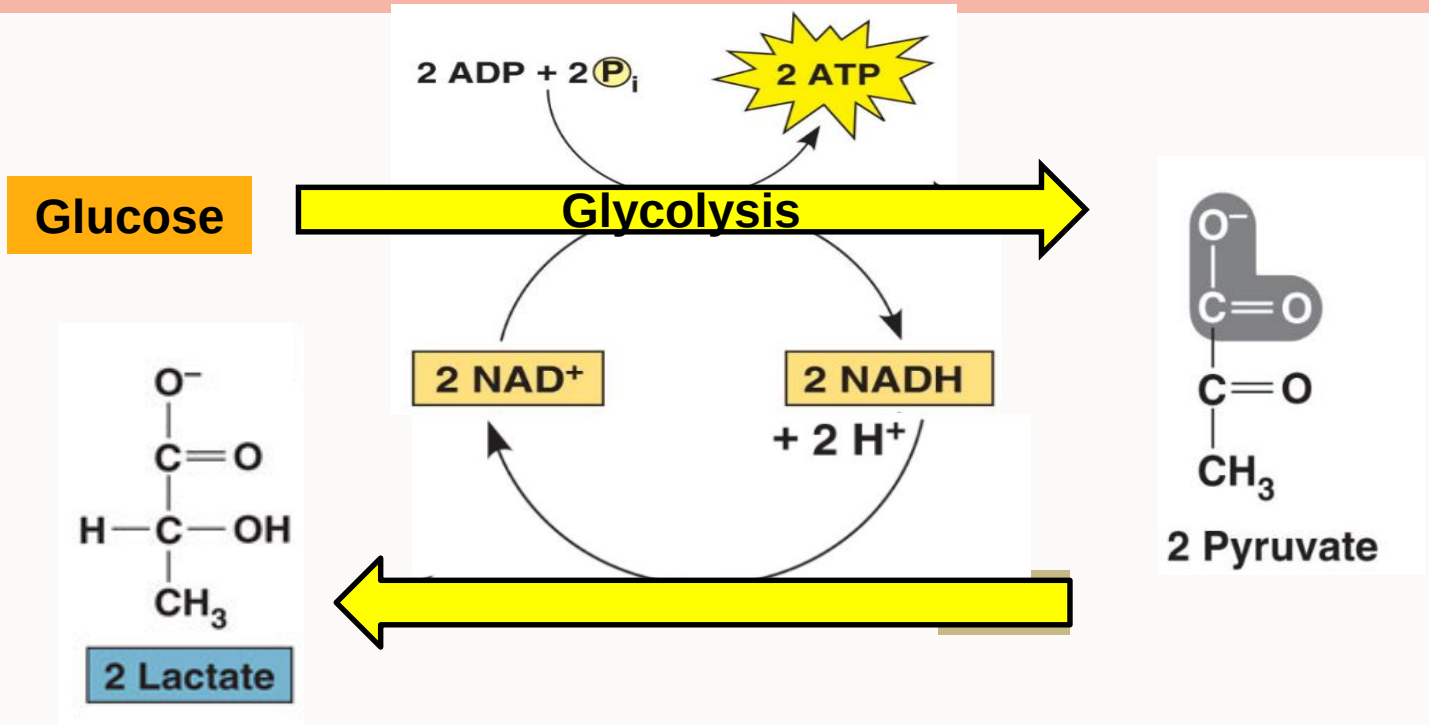
Alcohol Fermentation



Lactate Fermentation



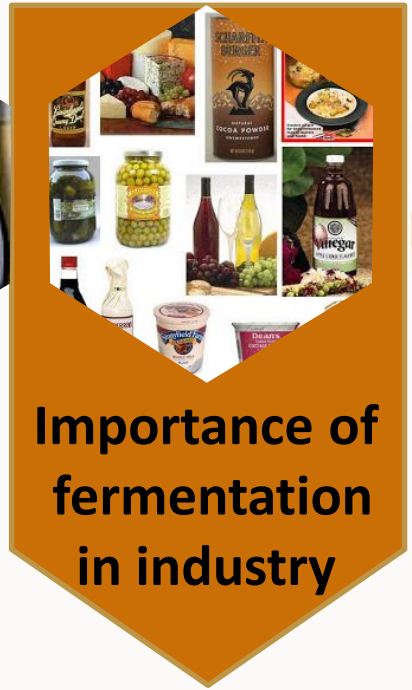
Lactate Fermentation



Importance of Fermentation in Industry

Bakery

Vinegar
Beverage &
Alcohol
production



Importance of fermentation in industry

Dairy
industry
Cheese
Yogurt

Local food-
Tempe,
Thosai,
Tapai