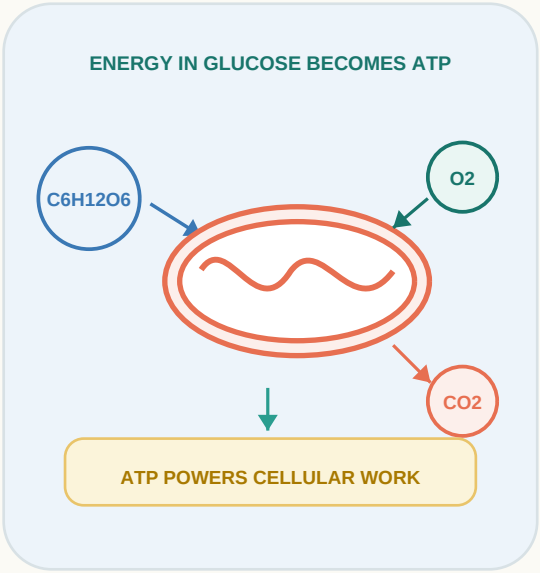
AP BIOLOGY | UNIT 3

TOPIC 3.5

Cellular Respiration

Cells transfer energy from biological molecules to ATP through glycolysis, the Krebs cycle, and oxidative phosphorylation.



THE CORE CAUSAL CHAIN

GLYCOLYSIS splits glucose → **KREBS CYCLE** loads carriers → **ETC** builds H+ gradient → **ATP SYNTHASE** produces ATP

BY THE END, YOU SHOULD BE ABLE TO...

1. Track carbon and energy through respiration pathways.
2. Explain how electron transport drives chemiosmosis.
3. Explain why fermentation lets glycolysis continue.

OVERALL TRANSFORMATION

Glucose + oxygen -> carbon dioxide + water + ATP. Energy is released in controlled steps and transferred to ATP, not released all at once.

1 From glucose to electron carriers

Respiration uses compartmentalized pathways to oxidize carbon molecules and transfer high-energy electrons to NADH and FADH2.

LOCATION ORGANIZES EACH STAGE

CYTOSOL

Glycolysis

Glucose becomes two pyruvate; ATP and NADH form.

MATRIX

Pyruvate oxidation

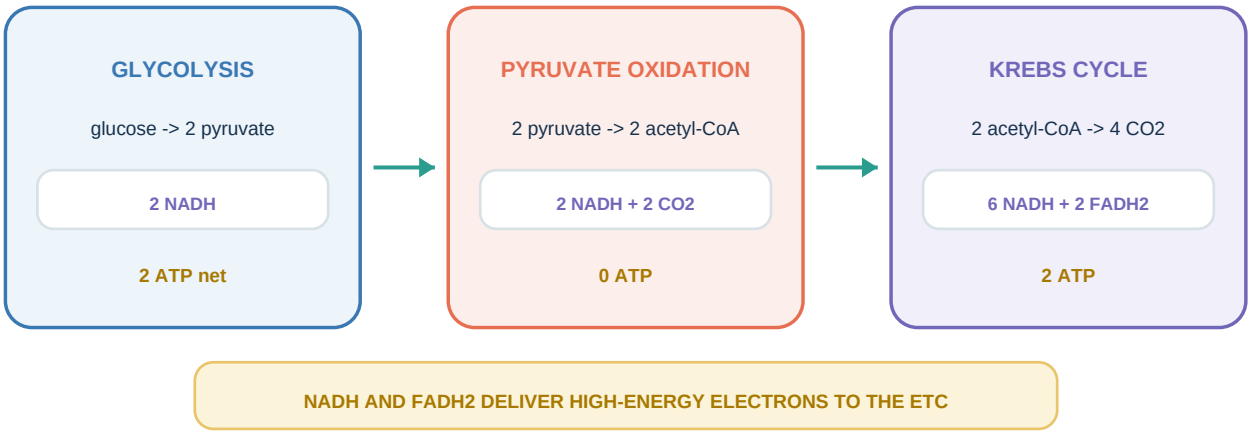
Pyruvate becomes acetyl-CoA; CO2 and NADH form.

MATRIX

Krebs cycle

Acetyl-CoA is oxidized; carriers and some ATP form.

CARBON FLOW AND ENERGY CAPTURE PER GLUCOSE



STAGE SUMMARY

STAGE	LOCATION	KEY OUTPUT	ATP PATTERN
GLYCOLYSIS	cytosol	pyruvate + NADH	some ATP directly
PYRUVATE + KREBS	matrix	CO2 + carriers	some ATP directly
OXIDATIVE PHOSPHORYLATION	inner membrane	H2O + ATP	most ATP

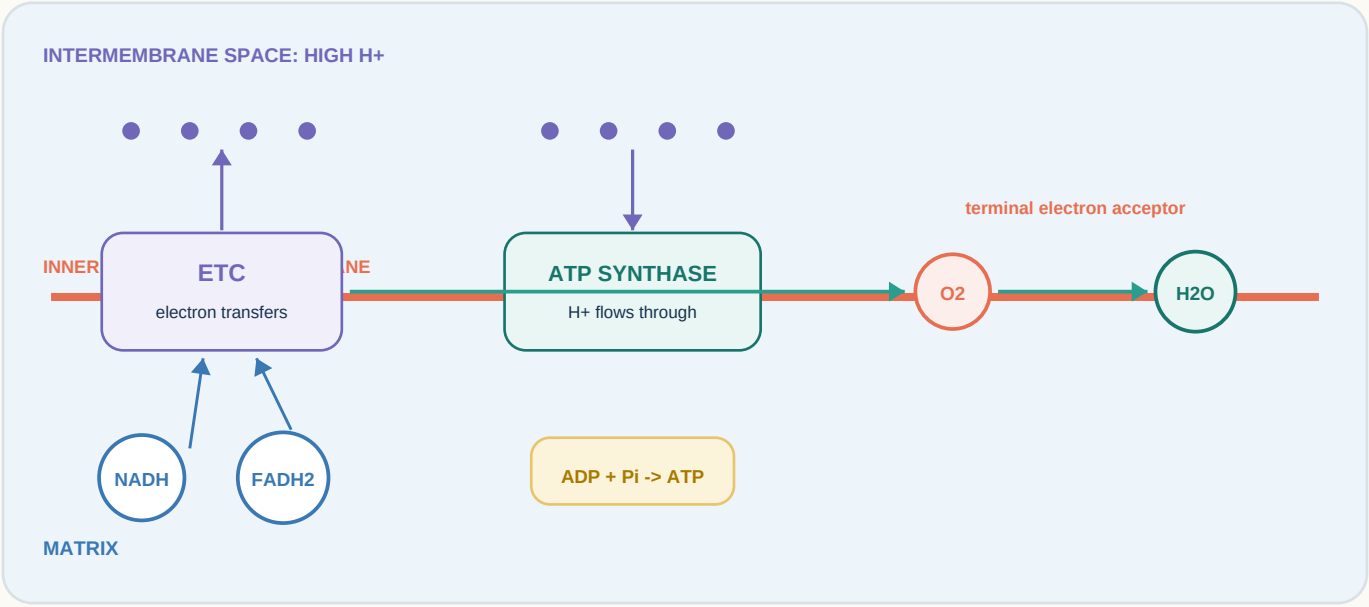
COMMON ERROR

The Krebs cycle makes only a small amount of ATP directly. Its main energy output is NADH and FADH2 for the electron transport chain.

2 Oxidative phosphorylation and fermentation

Electron transport converts carrier energy into a proton gradient; ATP synthase uses that gradient, while oxygen keeps electron flow possible.

CHEMIOSMOSIS ACROSS THE INNER MEMBRANE



ELECTRON FLOW -> H+ GRADIENT -> ATP SYNTHESIS

WHEN OXYGEN IS AVAILABLE OR ABSENT

AEROBIC RESPIRATION

OXYGEN AVAILABLE

The ETC passes electrons to O2, regenerating NAD+ and FAD while oxidative phosphorylation makes most ATP.

ETC RUNS; MOST ATP FORMS

FERMENTATION

OXYGEN UNAVAILABLE

Electrons from NADH are transferred to an organic molecule, regenerating NAD+ so glycolysis can continue.

NO EXTRA ATP BEYOND GLYCOLYSIS

ATP YIELD PATTERN

SUBSTRATE-LEVEL: SMALL DIRECT ATP YIELD

OXIDATIVE: MOST ATP

COMMON ERROR

Oxygen is not used directly by glycolysis or the Krebs cycle. It is the final electron acceptor in the ETC; without it, electron carriers cannot be recycled through aerobic respiration.