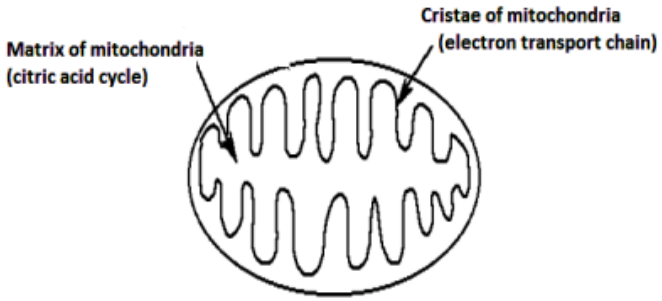
7. Respiration

Stages of respiration

1. Glycolysis (**cytoplasm**)
2. Citric Acid Cycle (Kreb Cycle) (**matrix of mitochondria**)
3. Electron Transport Chain (**cristae/inner mitochondria membrane**)

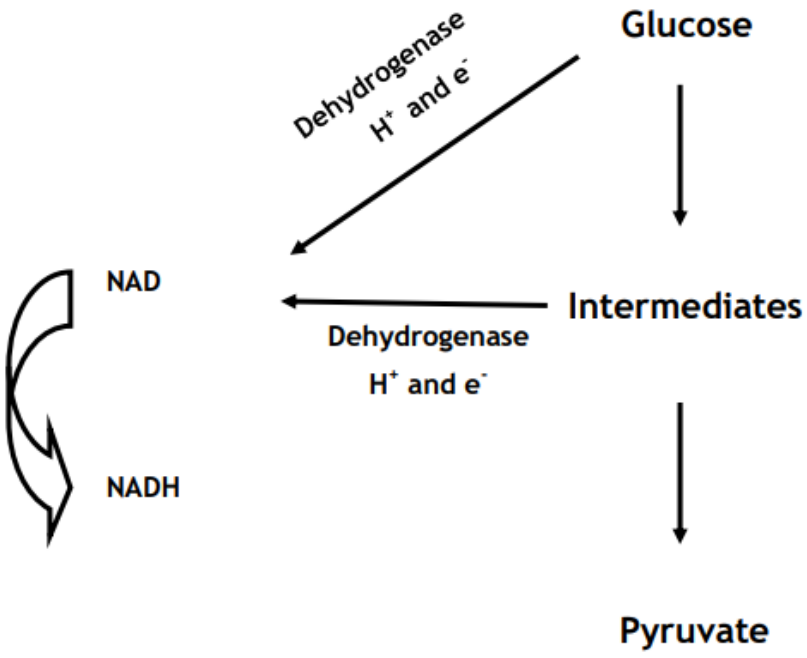


ATP production

The majority of the ATP is produced during the **electron transport chain** although **ALL stages** generate some ATP.

Glycolysis

Location—cytoplasm Process does **not require oxygen** **Net** gain **of 2ATP**



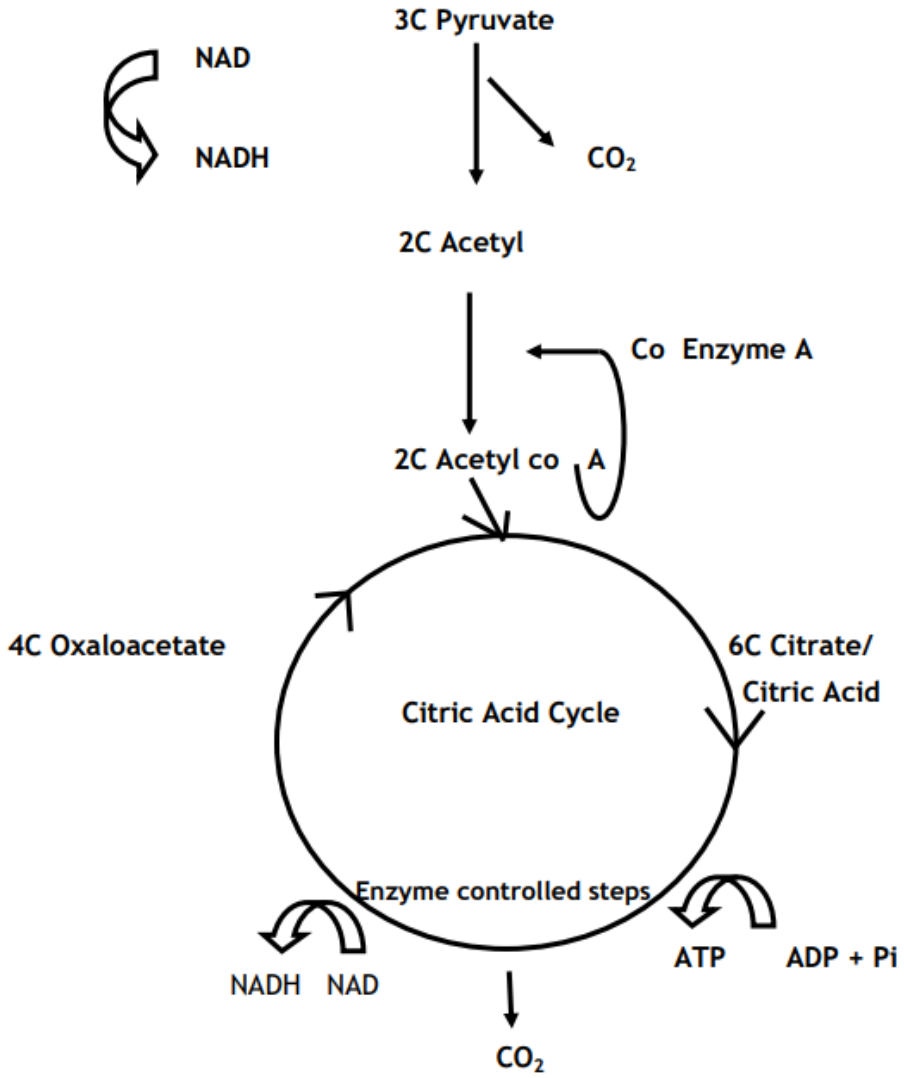
1. **Energy Investment Stage**
   2 ATP IN to phosphorylate glucose & intermediates

2. **Energy Payoff stage**
   4 ATP produced after 2 ATP in
   = Net gain of 2 ATP

7. Aerobic Respiration

Aerobic Stage of Respiration

Process **requires oxygen** to move beyond pyruvate and is **controlled by enzymes** called **dehydrogenases**.



Summary of steps

1. In aerobic conditions, **pyruvate** is broken down to an **acetyl group**.
2. Acetyl combines with recycled coenzyme A forming **acetyl coenzyme A**.
3. In the citric acid cycle, the **acetyl group** from acetyl coenzyme A combines with **oxaloacetate** to form **citrate**.
4. During a series of **enzyme-controlled steps**, **citrate** is gradually **regenerated** back into **oxaloacetate.**
5. **ATP, NADH and CO_2** are all produced during these enzyme-controlled steps.

7. Dehydrogenases and Co enzymes

Role of dehydrogenase

Removes hydrogen ions and electrons from substances and **passes to coenzyme** NAD to form NADH.

Location—**Glycolysis and Citric Acid Cycle**.

Role of Co enzymes

Accepts hydrogen ions and electrons and **takes them to the electron transport chain** on inner mitochondrial membrane.

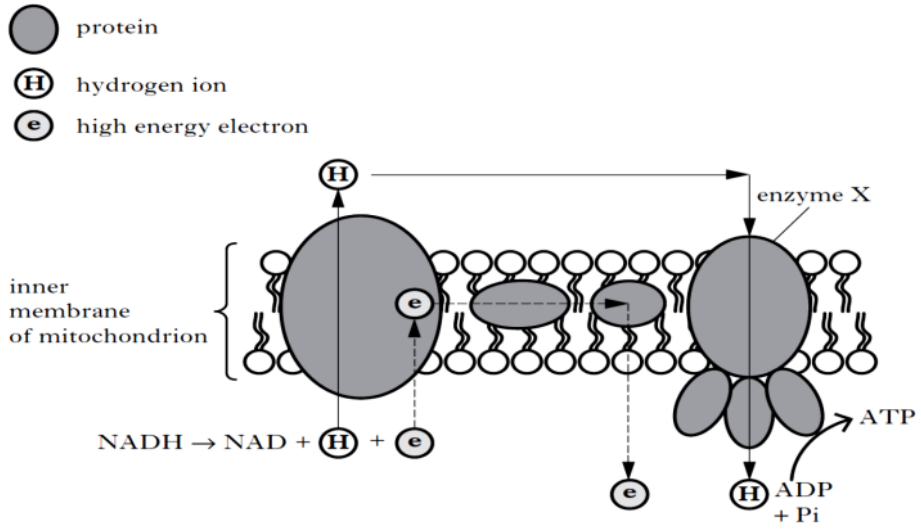
Location—**Glycolysis, Citric Acid Cycle and Electron Transport Chain**

7. Electron Transport Chain

Electron Transport Chain

The electron transport is a series of **carrier proteins** attached to the **inner mitochondrial membrane.**

Location—Inner membrane of mitochondria (Cristae).



Summary of Process

1. The co enzyme NADH **releases electrons and hydrogen ions** in the inner mitochondrial membrane.
2. **Electrons pass along** the electron transport chain and **release energy**.
3. The energy released by electrons pumps H ions across the membrane by active transport.
4. **H diffuses back across ATP synthase** causing it to rotate to **make ATP** from ADP + Pi.
5. Oxygen is the **final hydrogen ions and electron acceptor** forming **water.**
1. **Most of the ATP** produced during respiration occurs during this stage.

High/Low Cristae

Lots of folds in the inner mitochondrial membrane are needed for **active cells** as they need lots of ATP e.g. muscle/brain/sperm cells.

More folds/cristae mean **more electrons pass down chain/more H is released & more ATP is produced by ATP synthase.**

Lots Cristae/ High surface area
Lots ATP produced

Less Cristae/ Less surface area
Less ATP produced

8. Energy systems in muscles

Vigorous exercise

Muscle cells get **insufficient oxygen** to support the **electron transport chain**.

The oxygen debt is **repaid** when **exercise stops.** This allows respiration to provide the energy to **convert the reverse reaction of**

lactate ⟶ **pyruvate** + **glucose** (liver)

Types of Skeletal muscle fibres

1. Slow-twitch muscle fibres

Contract relatively slowly, but can sustain **contractions for longer.**

Rely on **aerobic respiration** to generate ATP.

For **endurance** activities such as **long-distance running, cycling or cross-country skiing**

Features of slow twitch muscle fibres

(a) **Many** mitochondria

(b) Large blood supply

(c) High concentration of myoglobin (O_2 storing protein).

8. Muscle Fibres

2. Fast- Twitch Muscle Fibres

Fast-twitch muscle fibres **contract relatively quickly**, over **short** periods.

Generate ATP through **glycolysis only**

Useful when **sprinting** or **weightlifting**

Features of Fast-Twitch Muscle Fibres

(a) **Fewer** mitochondria
(b) **Lower** blood supply compared to slow-twitch muscle fibres.
(c) **Lower** concentration of myoglobin
(d) **Glycogen** is major storage fuel

Muscle Fibre Composition

Most human muscle tissue contains a **mixture** of both slow & fast-twitch muscle fibres.

Athletes show **distinct patterns** of muscle fibres that **reflect their sporting activities**.