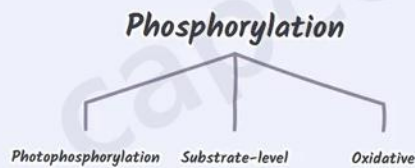


glycolysis to the electron transport chain: how one glucose molecule is turned into ATP

Respiration and Phosphorylation

- respiration: a catabolic process, oxidises a complex organic substrate to simple components
- releases biological energy, runs as anaerobic or aerobic respiration
- phosphorylation is ATP formation, in three forms (see table)
- ATP hydrolysis releases the energy that drives metabolic activity when needed



three ways a cell makes ATP, split by what supplies the energy

Three Forms of Phosphorylation

Type	Energy source	Where
Photophosphorylation	light	chloroplasts
Substrate-level	direct Pi transfer, substrate to ADP	cytoplasm, mitochondrial matrix
Oxidative	oxidising NADH+H ⁺ and FADH ₂	inner mitochondrial membrane only

Glycolysis, the Common First Step *

- breaks one glucose molecule down to two pyruvic acid molecules
- happens in the cytoplasm, common to both anaerobic and aerobic respiration
- ten steps in two phases
- preparatory phase (first 5 steps): glucose phosphorylated twice, costs 2 ATP
- forms fructose-1,6-bisphosphate, splitting into isomers glyceraldehyde-3-phosphate (G3P) and dihydroxyacetone phosphate (DHAP)
- DHAP isomerises to a second G3P, giving two G3P total
- pay-off phase (last 5 steps): both G3P convert to 1,3-bisphosphoglycerate
- oxidation plus Pi phosphorylation, then further steps to two pyruvic acid
- releases energy that makes 4 ATP by substrate-level phosphorylation
- net: $\text{Glucose} + 2\text{ATP} + 2\text{P}_i + 4\text{ADP} + 2\text{NAD}^+ \rightarrow 2\text{Pyruvate} + 2\text{ADP} + 4\text{ATP} + 2\text{NADH} + \text{H}^+ + 2\text{H}_2\text{O}$
- a net gain of 2 ATP and 2 NADH+H⁺