Respiration in Plants

By P V Satish — PG Life Sciences, PGD Biotechnology · Updated 2026-07-23

CBSE 2027-28 weightage: Unit IV: 12 marks (shared)

NEET history: 3–4 questions per year

Overview

Respiration in Plants is essentially cellular respiration — glycolysis, Krebs cycle, electron transport chain — dressed for a botany chapter. The NCERT is beautifully written and the NEET questions are almost 100% predictable: net ATP yield, number of NADH/$FADH_2$ per glucose, respiratory quotient (RQ) for different substrates, and the site of each stage.

Memorise this one line: glycolysis (cytoplasm) → link reaction (mitochondrial matrix) → Krebs cycle (matrix) → ETC + oxidative phosphorylation (inner mitochondrial membrane). If you know where each step happens and the ATP yield of each, you can answer every question.

Key concepts

- Glycolysis (Embden-Meyerhof-Parnas pathway): occurs in cytoplasm. 1 glucose → 2 pyruvate + 2 ATP (net) + 2 NADH.
- Link reaction: pyruvate → acetyl CoA + CO_2 + NADH (in mitochondrial matrix). Enzyme: pyruvate dehydrogenase.
- Krebs cycle (TCA cycle): acetyl CoA → 2 CO_2 + 3 NADH + 1 $FADH_2$ + 1 GTP (ATP). Per glucose (2 acetyl CoA): 6 NADH, 2 $FADH_2$, 2 ATP, 4 CO_2.
- Electron transport chain (ETC): complexes I–IV on inner mitochondrial membrane. Final electron acceptor = O_2.
- Chemiosmosis (Mitchell hypothesis): proton gradient across inner mitochondrial membrane drives ATP synthesis via ATP synthase.
- Net ATP yield per glucose (aerobic): 36–38 ATP (varies with shuttle system).
- Fermentation (anaerobic): glucose → pyruvate → ethanol + CO_2 (yeast) OR lactic acid (muscle). Only 2 ATP net.
- Respiratory quotient (RQ) = CO_2 released / O_2 absorbed. Carbohydrates: 1.0. Fats: 0.7. Proteins: 0.9. Organic acids: >1. Anaerobic respiration: infinity (no O_2 absorbed).
- Amphibolic pathway: respiration involves both breakdown (catabolism) and building blocks for synthesis (anabolism) — hence amphibolic.

NEET high-yield one-liners

- 1 NADH gives 3 ATP; 1 $FADH_2$ gives 2 ATP (in the classical assumption).
- Enzymes of Krebs cycle are located in the mitochondrial matrix; only succinate dehydrogenase (complex II) is on the inner membrane.
- Anaerobic respiration in yeast: alcoholic fermentation. In muscle: lactic acid fermentation (Cori cycle).
- Pyruvate dehydrogenase requires 5 coenzymes: NAD, coenzyme A, TPP, FAD, lipoamide.
- Substrate-level phosphorylation: direct ATP production without ETC — occurs in glycolysis and Krebs cycle.
- Cyanide blocks cytochrome oxidase (complex IV) — halts ETC → no ATP → death.

Common NEET traps

- Assuming all ATP comes from ETC — 4 ATP come from substrate-level phosphorylation (2 in glycolysis + 2 in Krebs cycle).
- Placing Krebs cycle in cytoplasm — it is in the mitochondrial matrix.
- Believing plants only respire in leaves — every living plant cell respires 24/7.
- Confusing respiration with breathing — plants don't 'breathe' but respire cellularly.

Satish's study plan

Three sessions: (1) glycolysis (memorise number of ATP, NADH, and pyruvate), (2) link reaction + Krebs cycle (draw the wheel diagram from memory), (3) ETC + oxidative phosphorylation + fermentation + RQ. Make one ATP-yield summary sheet. Then solve 20 PYQs.

Frequently asked questions

How much ATP is produced per glucose in aerobic respiration?

The classical textbook answer is 38 ATP for prokaryotes (2 from glycolysis, 2 from Krebs, 34 from ETC using the malate-aspartate shuttle) and 36 ATP for eukaryotes (glycerol phosphate shuttle costs 2 ATP). NCERT uses 38 ATP — that is the NEET answer.

What is RQ and why does it vary?

Respiratory quotient (RQ) = volume of CO_2 evolved / volume of O_2 consumed. It varies with the substrate because different substrates have different C:H:O ratios. Carbohydrates give RQ = 1, fats (more reduced) give RQ ≈ 0.7, proteins ≈ 0.9, organic acids >1, and anaerobic respiration gives infinity (no O_2 consumed).

Why is respiration called an amphibolic pathway?

Respiration is not purely catabolic (breaking glucose into CO_2). Many intermediates — acetyl CoA, pyruvate, α-ketoglutarate — are also starting materials for the anabolic synthesis of fatty acids, amino acids, and other biomolecules. Because it serves both breakdown and buildup, respiration is amphibolic.

What is the difference between fermentation and aerobic respiration?

Fermentation is incomplete oxidation of glucose in the absence of oxygen — glycolysis + regeneration of NAD^+ by reducing pyruvate to lactate (muscle) or ethanol (yeast). Net yield: 2 ATP. Aerobic respiration is complete oxidation of glucose to CO_2 and water in the presence of O_2. Net yield: 36–38 ATP.