

Fermentation and Cellular Respiration

1. Define:

Glycolysis – Glycolysis is a metabolic pathway allowing for the partial catabolism of glucose. During glycolysis, each glucose molecule is split into two pyruvic acid molecules with the associated production of two molecules of ATP and the reduction of two molecules of NAD to form NADH + H⁺ (also known as the Embden-Meyerhof-Parnas pathway).

Fermentation – Fermentation is the anaerobic decomposition of organic compounds (especially carbohydrates) that involves an organic compound (usually) as the final electron acceptor. For those examples used in class, pyruvic acid serves as the final electron acceptor, but some organisms use other compounds.

Heterofermentative – The term heterofermentative applies to organisms that produce a variety of end products (more than one) as the result of their fermentation activities. For example, *Saccharomyces cerevisiae* produces both ethanol and CO₂ during its fermentation activities, so is heterofermentative.

Krebs cycle – The Krebs cycle, also known as the tricarboxylic acid (TCA) cycle or citric acid cycle, is a cyclic series of chemical reactions that plays a central role in metabolism. When functioning catabolically, it involves the decarboxylation of organic acids (isocitric acid and α-ketoglutaric acid). The carboxyl groups removed form carbon dioxide, a waste gas. Most of the energy released during the cycle is captured in the form of reduced coenzymes (NADH + H⁺ and FADH₂). A small amount of energy is captured in the form of GTP or ATP. When functioning anabolically, the TCA cycle provides precursors for various biosynthetic pathways. In eukaryotic cells, the enzymes involved in this cycle are found in the matrix of mitochondria, while in prokaryotic cells they are found in the cytoplasm.

Cytochromes – Cytochromes are pigmented enzymes with iron (haem) prosthetic groups. They are found within or on the surface of membranes (cristae, thylakoids or cell membranes) and are involved in electron transfers and the transport of hydrogen protons across membranes to establish the proton motive force. The prosthetic groups of these enzymes can be alternately oxidized and reduced while passing electrons from one to the next. During cellular respiration, the last cytochromes in the series (electron transport chain) pass electrons to a final electron acceptor (e.g., oxygen). During photophosphorylation, the cytochromes pass electrons to pigment molecules.

2. Glycolysis
3. Pyruvic acid (two per glucose)
4. Kinase/ ATP
5. Glucose/ reduced
6. Phosphate
7. Kinase / isomerases

8. Some of the chemical reactions of glycolysis require enzymes that have coenzyme helpers (NAD). During glycolysis the NAD molecules pick up electrons, so are reduced. Since glycolysis requires NAD (the oxidized form), it is dependent upon additional reactions to oxidize the NADH + H⁺. This is accomplished by passing the electrons from NADH + H⁺ to a final electron acceptor (e.g., pyruvate or via an electron transport chain to oxygen). If the coenzymes required for glycolysis cannot be returned to their oxidized state, glycolysis will stop.
9. Fermentation/ homofermentative
10. Lactic acid
11. Two (2)/ substrate level/ pyruvic acid
12. Homofermentative/ *Lactococcus lactis* (formerly identified as *Streptococcus lactis*).
13. Heterofermentative/ *Saccharomyces cerevisiae*
14. Respiratory/ ATP
15. Cellular respiration/ glycolysis, the Krebs cycle and the electron transport chain
16. Acetyl-CoA
17. Carboxyl/ Coenzyme A/ pyruvate decarboxylate complex
18. Krebs cycle, TCA cycle, or citric acid cycle/ reduced coenzymes
19. Carbon dioxide (CO₂)
20. Acetyl-CoA
21. The catabolism of organic acids. Energy is released as carboxyl groups are removed from these organic acids, and much of this energy is eventually made available for use within the cell (in the form of ATP). / This pathway can also be used to synthesize organic acids. Many of the reactions of the Krebs cycle can be run in reverse, and the acids produced may be used to make amino acids or other organic compounds.
22. NAD (Nicotinamide Adenine Dinucleotide)/ niacin
23. Matrix of mitochondria/ cristae (inner folded membranes)
24. Cytochromes/ three/ two
25. Electron transport chain/ molecular oxygen (O₂)
26. Molecular oxygen/ water/ The function of the final electron acceptor is to pick up electrons that have been removed from coenzymes. Without the final electron acceptor, the coenzymes (NADH + H⁺ and FADH₂) could not be oxidized, and the reactions of glycolysis and the Krebs cycle would stop.

27. Oxidative/ hydrogen protons (H^+)/ 38
28. ATP synthase/ 3
29. Cytochromes/ proton motive force/ ATP synthase
30. Hydrogen protons (H^+)/ two molecules of ATP
31. Glycolysis/ β -oxidation/ acetyl-CoA
32. Deaminated/ amino acids