ATP Production in Cells

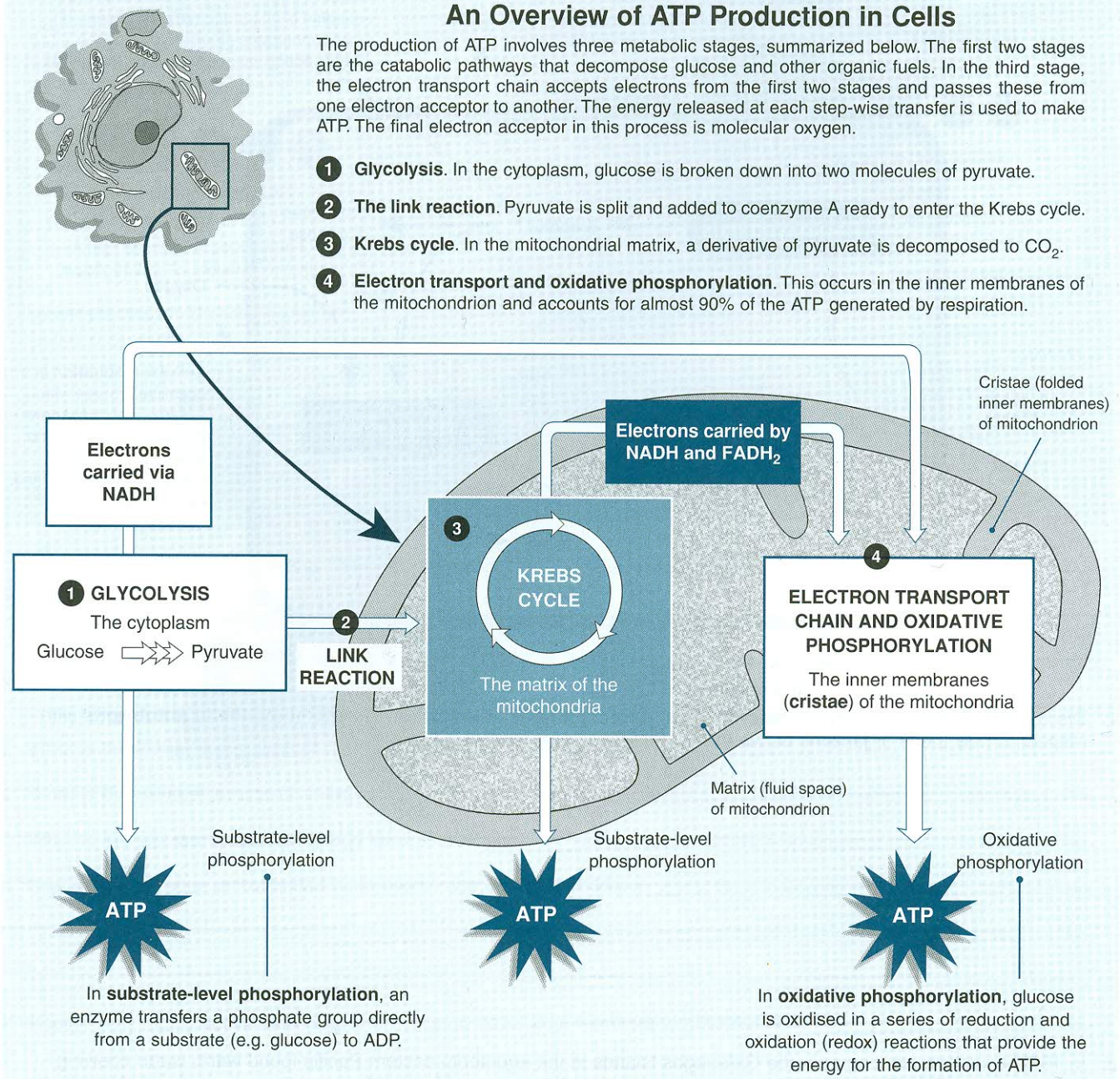
Name _____

Glycolysis and cellular respiration are the processes by which organisms break down energy rich molecules (e.g. glucose) to release the energy in a useable form (ATP). All living cells respire in order to exist, although the substrates they use may vary. **Aerobic respiration** requires oxygen. Some plants and animals can generate ATP using anaerobic pathways for short periods of time but the ATP yields from these pathways are low. Other organisms (bacteria) use only **anaerobic respiration** and live in oxygen-free environments. These organisms use some other final electron acceptor rather than oxygen (e.g. nitrate or Fe^{2+}).

An Overview of ATP Production in Cells

The production of ATP involves three metabolic stages, summarized below. The first two stages are the catabolic pathways that decompose glucose and other organic fuels. In the third stage, the electron transport chain accepts electrons from the first two stages and passes these from one electron acceptor to another. The energy released at each step-wise transfer is used to make ATP. The final electron acceptor in this process is molecular oxygen.

1. **Glycolysis**. In the cytoplasm, glucose is broken down into two molecules of pyruvate.
2. **The link reaction**. Pyruvate is split and added to coenzyme A ready to enter the Krebs cycle.
3. **Krebs cycle**. In the mitochondrial matrix, a derivative of pyruvate is decomposed to CO_2.
4. **Electron transport and oxidative phosphorylation**. This occurs in the inner membranes of the mitochondrion and accounts for almost 90% of the ATP generated by respiration.



In **substrate-level phosphorylation**, an enzyme transfers a phosphate group directly from a substrate (e.g. glucose) to ADP.

In **oxidative phosphorylation**, glucose is oxidised in a series of reduction and oxidation (redox) reactions that provide the energy for the formation of ATP.

1. Describe precisely in which part of the cell the following take place:

   (a) Glycolysis: _____

   (b) Krebs cycle reactions: _____

   (c) Electron transport chain: _____

2. How does ATP generation in glycolysis and the Krebs cycle differ from ATP generation via the electron transport chain?

   _____

   _____

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The Biochemistry of Respiration

Glycolysis and **cellular respiration** are catabolic, energy yielding pathways. The breakdown of glucose and other organic fuels (such as fats and proteins) to simpler molecules releases energy for the synthesis of ATP. All living cells respire in order to exist, although the substrates they use may vary. Glycolysis is the first stage of glucose catabolism and is anaerobic. The reactions of cellular respiration oxidize the end product of glycolysis (**pyruvate**) in multiple steps to produce ATP. ATP generation in respiration is coupled to the movement of hydrogen ions down their electrochemical gradient via the membrane-bound enzyme ATP synthase. The final electron acceptor in this electron transport pathway is oxygen.