CELLULAR RESPIRATION: Harvesting Chemical Energy

CHAPTER V

- Photosynthesis ends with the formation of hexose sugar.
- Hexose can also enter into the respiratory system of the cell where it is broken down to release energy.
- Important life processes such as synthesis of proteins, fats, and carbohydrates require a certain expenditure of energy.

RESPIRATION

- Respiration can make use of complex food materials like starch which are rich in stored energy (which holds the atoms together in the molecule) but should be converted into simpler carbohydrates like glucose.

Cellular respiration and fermentation are catabolic, energy-yielding pathways

CATABOLIC PATHWAYS- metabolic pathways that release stored energy by breaking down complex molecules.

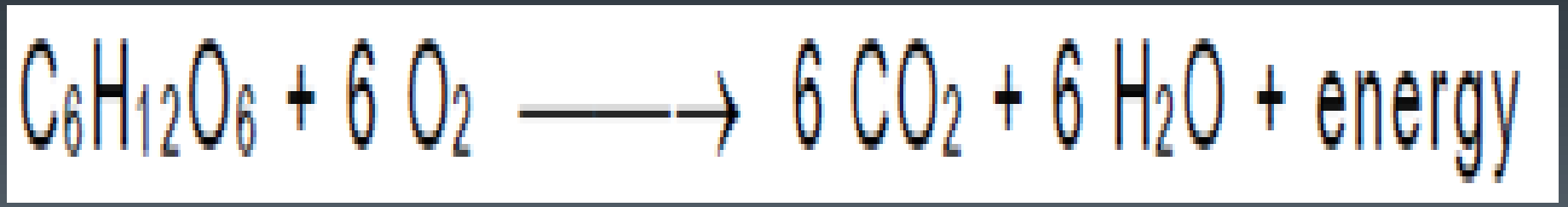
FERMENTATION involves no Oxygen!
CELLULAR RESPIRATION where Oxygen is a reactant.

AEROBIC VS. ANAEROBIC RESPIRATION

***Respiration** is termed **aerobic** when oxygen is utilized and **anaerobic** when oxygen is not utilized.*

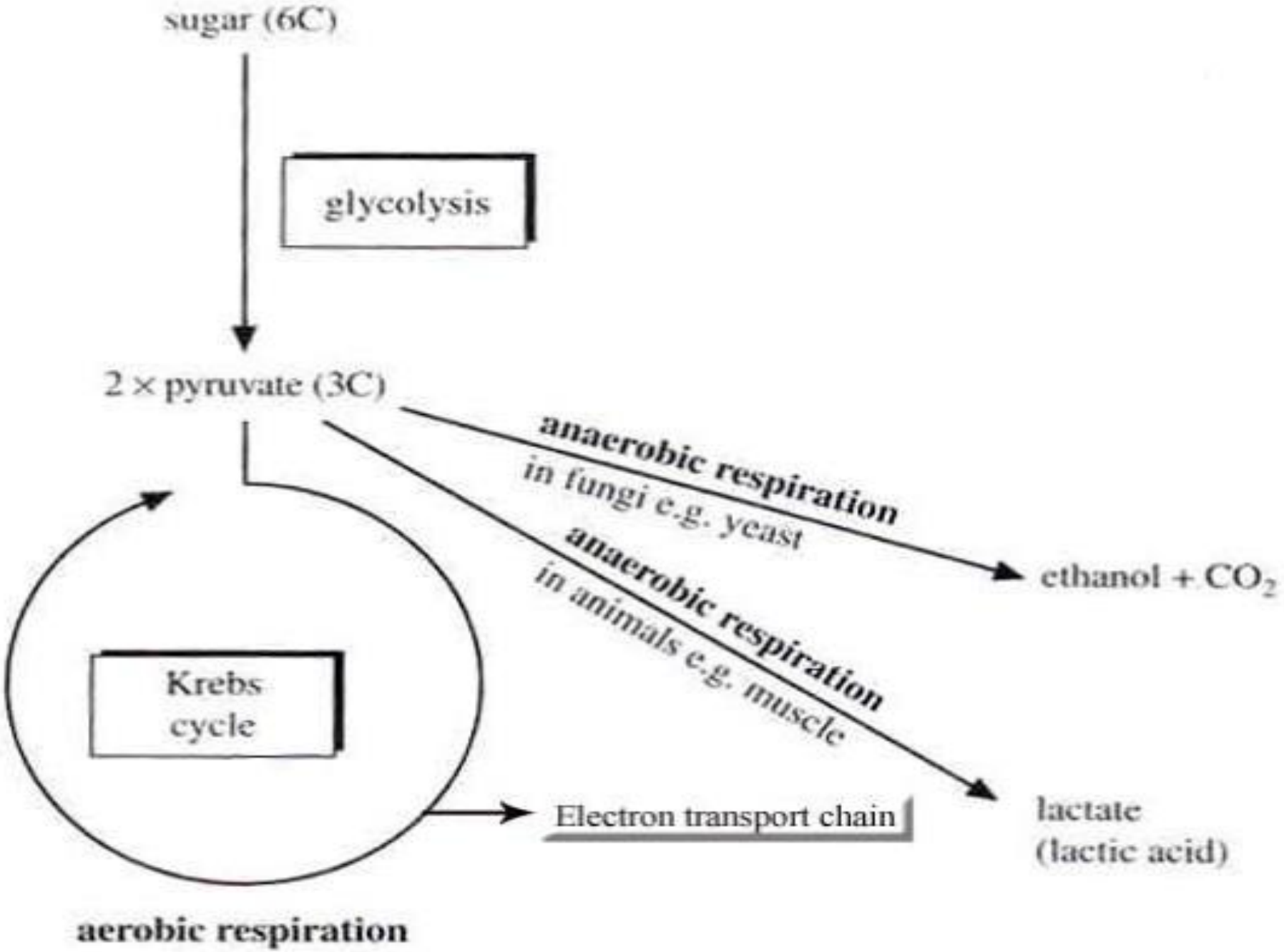
What is Cellular Respiration?

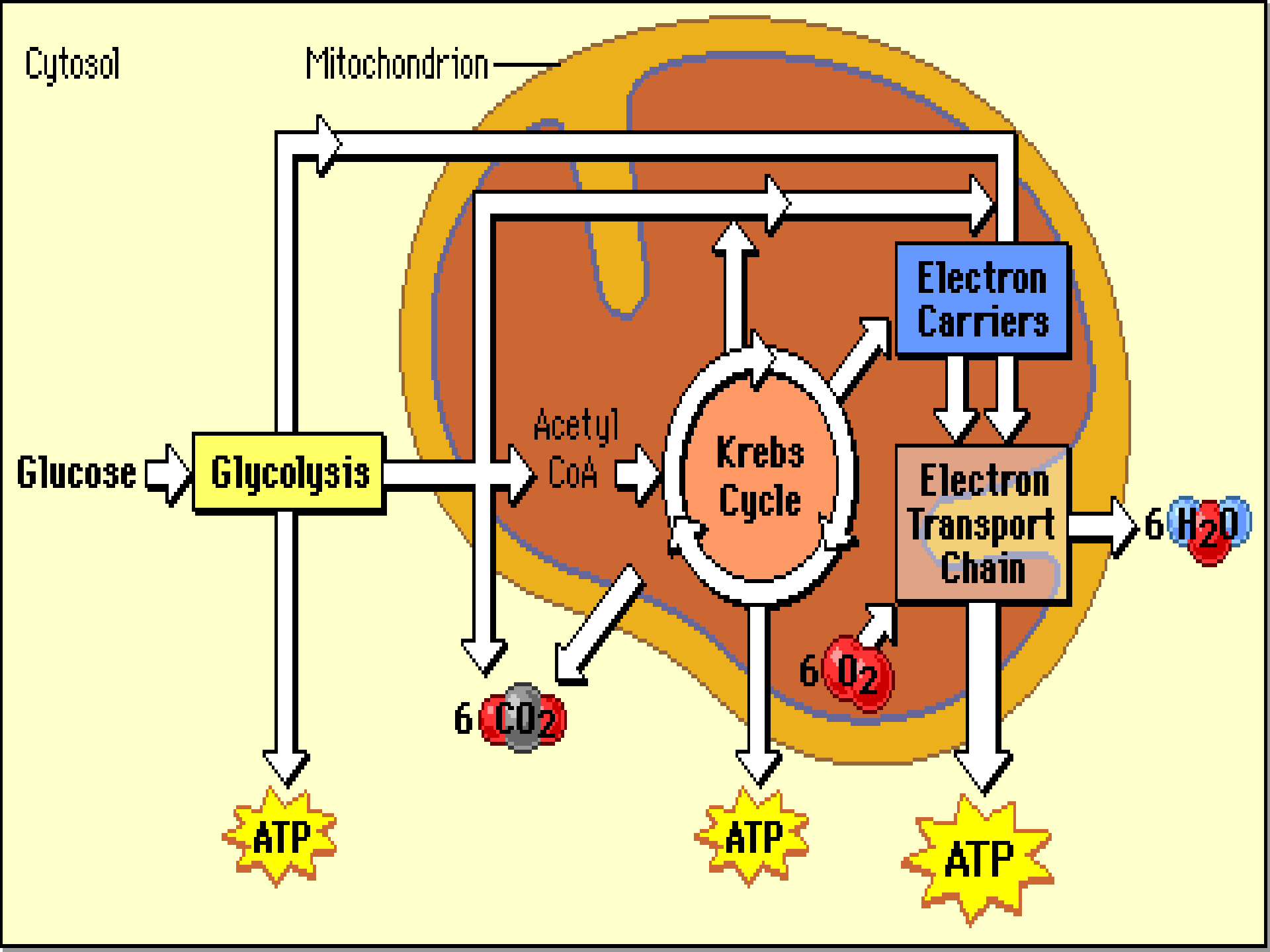
- Once the energy that was in sunlight is changed into chemical energy by photosynthesis, an organism has to transform the chemical energy into a form that can be used by the organism.
- Cellular respiration is the process that releases energy by breaking down food molecules in the presence of oxygen.



Describe Cellular Respiration…

- The biochemical process, which occurs within cells and oxidises food to obtain energy
- The breakdown of glucose molecules to release energy
- Takes place in all living things
- Is a step by step process
- Cellular respiration occurs in the mitochondria of living cells.
- Yields 38 ATP per glucose molecule.


sugar (6C)
glycolysis
2 × pyruvate (3C)
anaerobic respiration
in fungi e.g. yeast
ethanol + CO_2
anaerobic respiration
in animals e.g. muscle
lactate
(lactic acid)
Krebs
cycle
Electron transport chain
aerobic respiration


Cytosol
Mitochondrion
Glucose
Glycolysis
Acetyl CoA
Krebs Cycle
Electron Carriers
Electron Transport Chain
6 H_2O
6 O_2
6 CO_2
ATP
ATP
ATP

THE PROCESS OF CELLULAR RESPIRATION

- Glycolysis
- The Krebs Cycle
- The Electron Transport Chain

Glycolysis and Krebs Cycle are **CATABOLIC!** Why?

GLYCOLYSIS harvests chemical energy by oxidizing glucose to pyruvate: a closer look

GLYCOLYSIS: *a closer look…*

- Glycolysis means “splitting of sugar”.
- Glucose, a six-carbon sugar, is split into two 3-carbon sugars to form two molecules of pyruvate.

(Pyruvate is the ionized form of a 3-C sugar, pyruvic acid)

GLYCOLYSIS: *a closer look…*

- This is accomplished in 10 steps each catalyzed by a specific enzymes which can be divided into two phases: **ENERGY INVESTMENT PHASE and ENERGY PAYOFF PHASE.**
- In **ENERGY INVESTMENT PHASE**, the cell actually spends ATP to phosphorylate the fuel molecules.
- In **ENERGY PAYOFF PHASE**, ATP is produced by substrate-level phosphorylation and NAD+ is reduced to NADH. The net energy yield from glycolysis, per glucose molecule, is 2 ATP plus 2 NADH.

KREBS CYCLE

completes the energy-yielding oxidation of organic molecules: a closer look…

KREBS CYCLE: *a closer look*

- Glycolysis releases less than a quarter of the chemical energy stored in glucose: most of the energy are stored in the two molecules of pyruvate.
- If molecular oxygen is present, the pyruvate enters the mitochondrion, where the enzymes of the Krebs cycle complete the oxidation of the organic fuel.

KREBS CYCLE: *a closer look*

- The pyruvic acid (a 3- carbon chain) loses a carbon through oxidation to CO2 and forms the acetyl-CoA, a 2-carbon molecule.
- For every glucose membrane molecules (2 pyruvic acids) entering the mitochondrion, the Krebs cycle generate 6 NADH and 2 FADH2 and yield 2 ATP via substrate level phosphorylation.

The Inner Mitochondrial Membrane Couples ELECTRON TRANSPORT to ATP synthesis: a closer look…

ELECTRON TRANSPORT SYSTEM: *a closer look…*

- Occurs in the inner mitochondrial membrane
- NADH (from glycolysis and Krebs Cycle) and FADH2 (from Krebs cycle) are oxidized to yield ATP.
- 34 ATP is generated in ETS via oxidative phosphorylation.

FACTORS AFFECTING RESPIRATION

- **AGE AND TISSUE TYPE**
  - large, young tissues respire more strongly than old
  - developing tissues respire more than mature once
  - tissues undergoing metabolic processes respire more than resting tissues.

FACTORS AFFECTING RESPIRATION

- **TEMPERATURE**
  - **enzymes activity doubles for energy 10 degrees Celcius rise in temperature within certain limits.**
  - **more rapid breakdown of respiration as temperature increases above 35 degree Celcius due to destruction of enzymes by heat.**

FACTORS AFFECTING RESPIRATION

- **OXYGEN**
  - **Presence of oxygen is essential for oxidative metabolism**

- **CARBON DIOXIDE**
  - **high level (higher than normal temperature) inhibits respiration.**
  - **high concentration causes the stomata to close.**

FACTORS AFFECTING RESPIRATION

- **PHYSIOLOGICAL STATUS OF PLANT OR PLANT PARTS**
  - **Dormant state respire less than active parts of the plants.**

- **MOISTURE CONTENT OF TISSUES**
  - **Seeds with higher moisture content respire more than seeds with drier tissues.**

END OF PRESENTATION!