7.1 Production of energy through cellular espiration

- two types of metabolic reaction, which are anabolism and catabolism.
- Both of these reactions involve energy.
- The catabolism process releases energy.
- The anabolism process uses energy

THE MAIN SUBSTRATE IN ENERGY PRODUCTION

- Cellular respiration is carried out to generate the energy needed by all living cells
- Cellular respiration is the oxidation process of organic molecules through several stages to release energy. The main substrate for cellular respiration is glucose
- Tenaga kimia yang terdapat di dalam glukosa dibebaskan untuk menghasilkan tenaga yang diperlukan oleh sel .
- In humans and animals, glucose is obtained through the digestion of carbohydrates from the food eaten.
- In green plants, light energy can be trapped by chlorophyll for the photosynthesis process to produce glucose

TYPES OF CELLULAR RESPIRATION

- There are two types of cellular respiration, which are aerobic and anaerobic respiration
- Aerobic respiration occurs in the presence of oxygen.
- Anaerobic respiration occurs in the absence of oxygen.
- Fermentation is an alternative pathway of obtaining energy besides cellular respiration
- In fermentation, the breakdown of glucose is incomplete in conditions of limited oxygen or without oxygen..

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7.2 Aerobic Respiration

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- Aerobic respiration is the breakdown of glucose involving oxygen to produce chemical energy.
- Oxygen is used to oxidise glucose to produce carbon dioxide, water and energy.
- Theprocess begins with the glycolysis process.
- Glycolysis means the breakdown of glucose by enzymes.
- This process occurs in the cytoplasm.
- One glucose molecule is broken down into two pyruvate molecules.
- The following process occurs in the mitochondrion
- Pyruvate produced from glycolysis is then oxidised through a series of reactions to produce carbon dioxide, water and energy.
- A large amount of this energy is used to produce adenosine triphosphate (ATP) molecules

Glycolysis

Glucose → Pyruvate

(Occurs in the cytoplasm)

Oxidation of Pyruvate

→ Carbon dioxide + water + energy

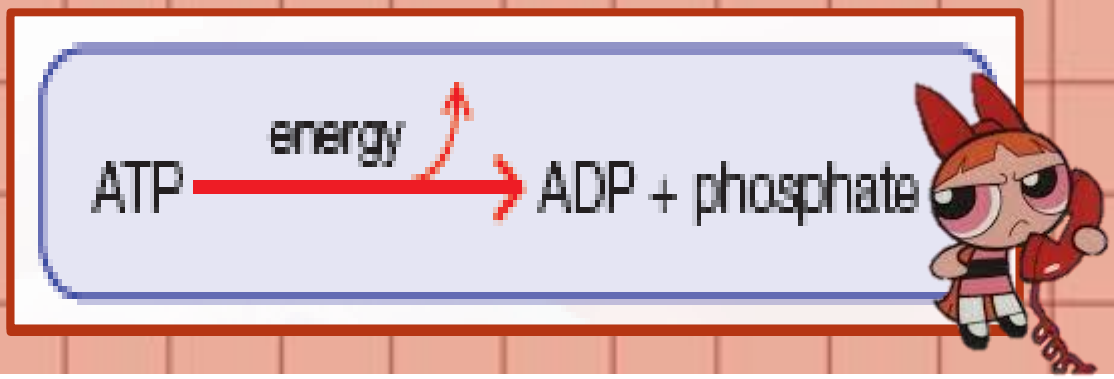
(Occurs in the mitochondrion)

The aerobic respiration

ATP molecules are produced when a group of non-organic phosphate is added to adenosine diphosphate (ADP

ADP + phosphate —energy→ ATP

- **ATP molecules have weak phosphate links.**
- **When the phosphate links on ATP molecules are broken, the energy released is supplied to cells to help us carry out our daily activities**



The complete process of glucose oxidation

Word equation:

Glucose + oxygen → Carbon dioxide + water + energy (2898 kJ)

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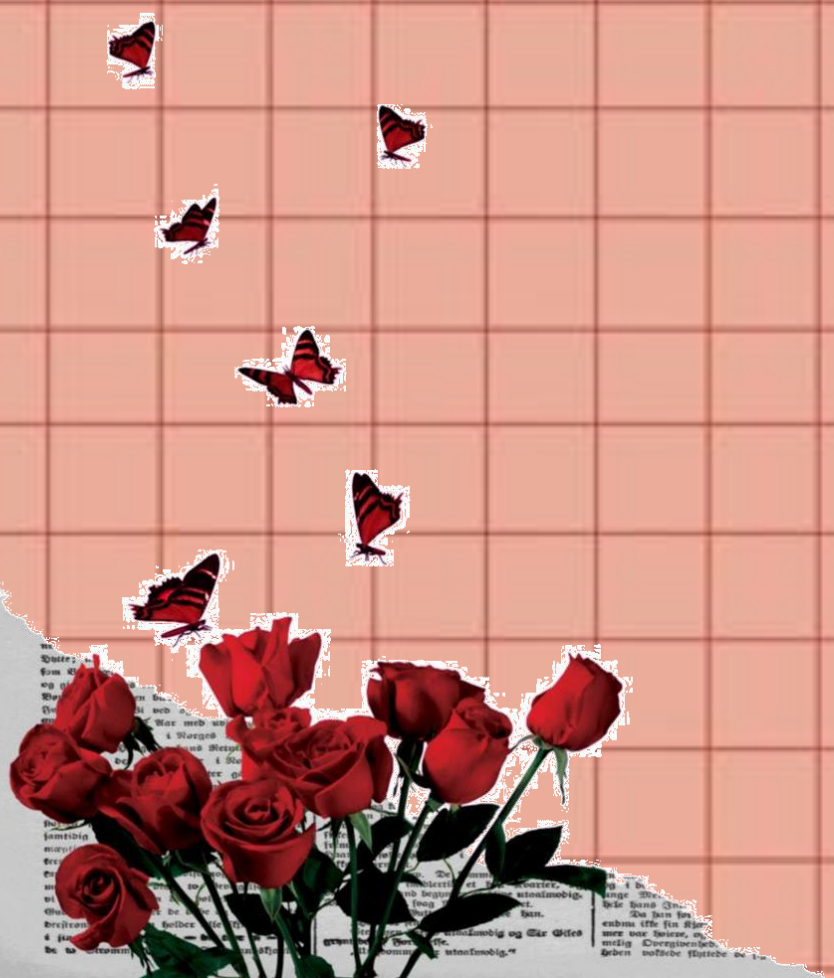

7.3 Fermentation

- Fermentation is the incomplete breakdown of glucose in conditions of limited oxygen or without oxygen
- Fermentation is different from aerobic respiration in its metabolic pathway after the glycolysis stage.
- After glycolysis, the pyruvate produced will undergo either alcohol fermentation or lactic acid fermentation.

FERMENTATION

The incomplete breakdown of glucose in limited or no oxygen conditions.

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ALCOHOL FERMENTATION

The incomplete breakdown of glucose to ethanol, carbon dioxide and energy.

Glucose → Ethanol + carbon dioxide + energy (210 kJ)

YEAST

- Ethanol is used in the making of beer and wine.
- The released carbon dioxide makes bread dough rise.

PLANTS

- Paddy plants that grow in waterlogged areas with less oxygen are able to carry out alcohol fermentation.
- Ethanol produced in the tissues during the fermentation process is toxic to most plants but the cells of paddy plants have a higher tolerance for ethanol compared to other species.
- Paddy plants produce plenty of alcohol dehydrogenase enzymes that can break down ethanol molecules into non-toxic carbon dioxide..

LACTIC ACID FERMENTATION

The breakdown of glucose into lactic acid and energy

Glucose ⟶ Lactic acid + energy

LACTOBACILLUS

- The bacteria Lactobacillus carries out milk fermentation to produce yoghurt.
- Lactobacillus acts on the lactose (milk sugar) and turns it into lactic acid.
- The lactic acid will then coagulate casein (milk protein) to produce yoghurt.
- Lactic acid is the source of a sour taste in yoghurt.

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HUMAN MUSCLE CELLS

- This process is carried out by the muscle cells during vigorous training.
- During vigorous training, the rate of oxygen used exceeds the oxygen supplied by the blood circulatory system.
- The muscle is in an oxygen-deficiency state and is said to undergo oxygen debt.
- During this process, glucose cannot break down completely. For each glucose molecule that is broken down, only two ATP molecules or 150 kJ energy will be produced.
- The produced lactic acid accumulates until it reaches a level of concentration that can cause fatigue and muscle cramps.
- Once the vigorous activity stops, the intake of excess oxygen will oxidise the lactic acid into carbon dioxide, water and energy. When all the lactic acid has been expelled, the oxygen debt is repaid.

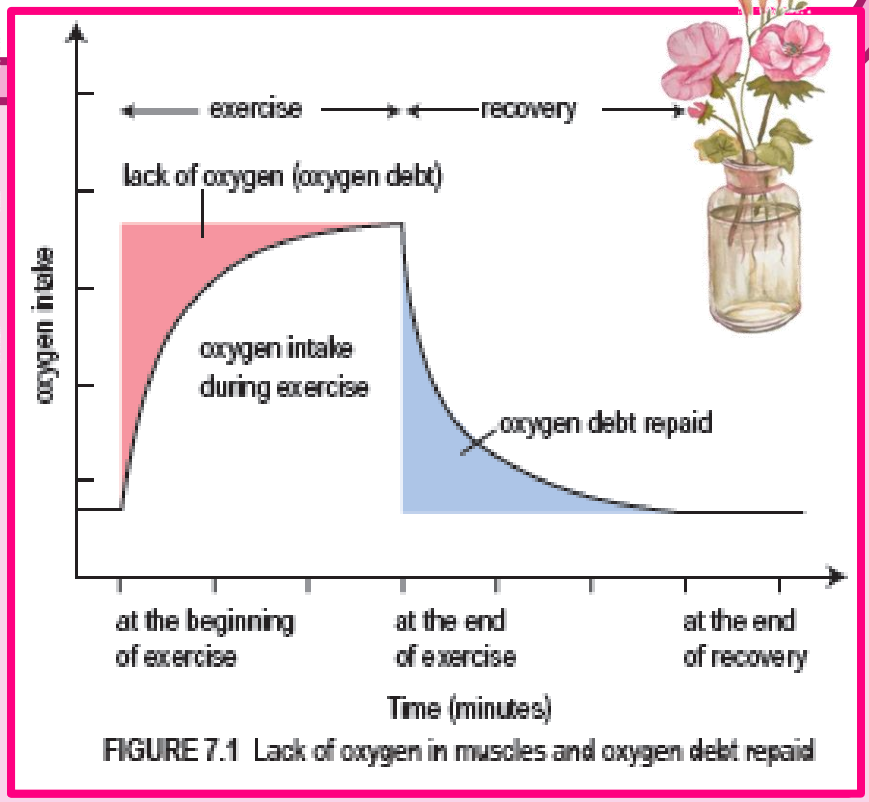

FIGURE 7.1 Lack of oxygen in muscles and oxygen debt repaid

COMPARISON BETWEEN AEROBIC RESPIRATION AND FERMENTATION

SIMILIRITIES

- The breakdown process of glucose and its conversion to chemical energy
- The process begins in the cytoplasm
- Occurs in yeast , bacteria , animals and plants
- Produces chemical energy in the form of ATP
- The process begins with glycolysis when glucose is converted to pyruvate

DIFFERENCES

Aerobic Respiration

- The breakdown process of glucose is completed in the presence of oxygen.
- Occurs in cytoplasm and mitochondrion.
- Produces water
- Glucose is oxidised completely into carbon dioxide and water
- One molecule of glucose generates 2898kJ of energy

Fermentasi

- The breakdown process of glucose is incomplete without oxygen or in limited oxygen conditions.
- Occurs in cytoplasm.
- Does not produce water.
- Glucose is not oxidised completely into ethanol and carbon dioxide or lactic acid.
- One molecule of glucose generates 210 kJ (alcoholic fermentation) or 150 kJ (lactic acid fermentation) of energy

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