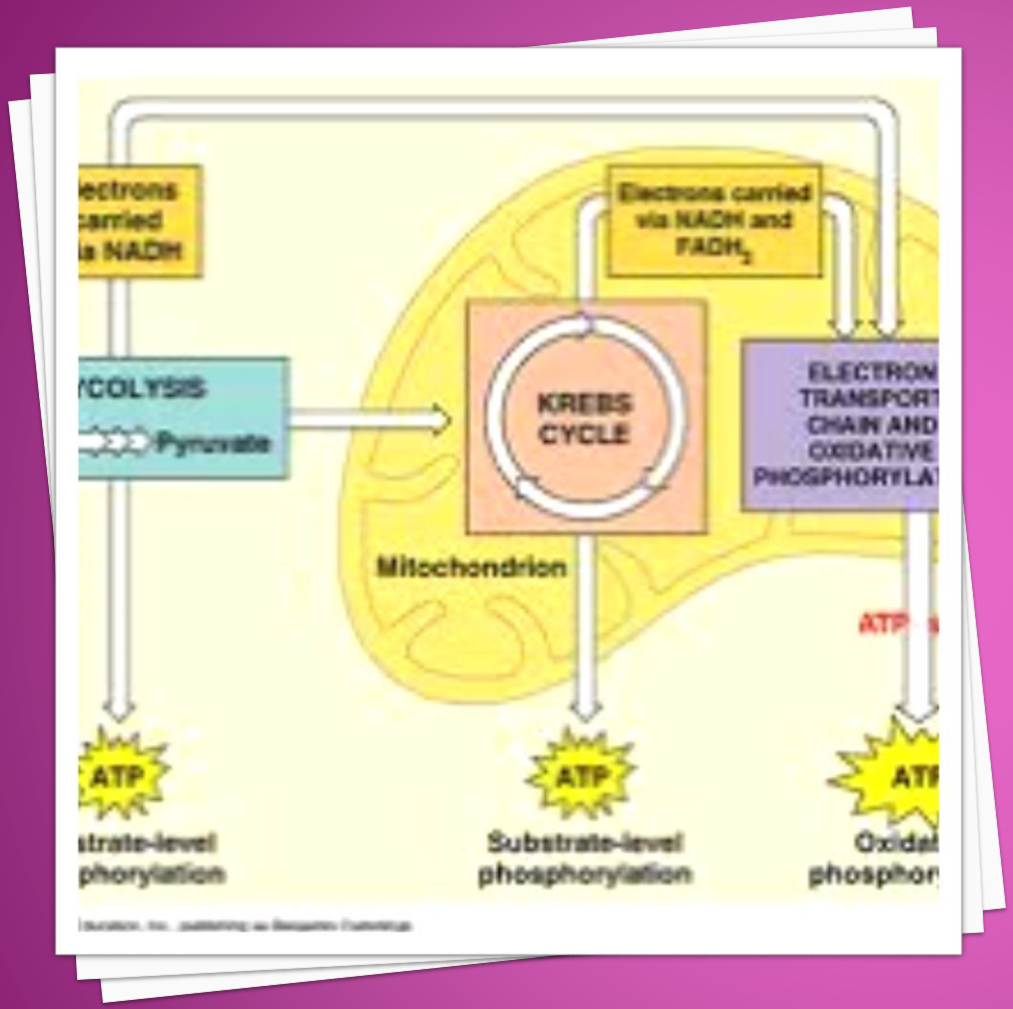


LIFE SCIENCES GRADE 11 CAPS

STRUCTURED, CLEAR, PRACTICAL - HELPING TEACHERS UNLOCK THE POWER OF NCS

KNOWLEDGE AREA:
Life Process in Plants and Animals.

TOPIC 4:

Cellular respiration

Sangari SouthAfrica
THINK. DO. LEARN.

GAUTENG
PROVINCIAL GOVERNMENT

SUMMARY OF THE PRESENTATION:

- Introduction
- Uses of Energy
- Energy as ATP
- The Process of Cellular Respiration
- Aerobic Respiration
- Anaerobic Respiration
- Anaerobic Respiration in Micro-organisms
- Similarities between Aerobic and Anaerobic Respiration
- Differences between Aerobic and Anaerobic Respiration

INTRODUCTION:

- In **plants food** is **made** in the **form of glucose by the process of photosynthesis**.
- When **consumers feed** on **these plants** the **starch** is **digested** into its **simplest form-glucose**.
- The **glucose** is then **taken into the cells** where it is **broken down to release energy**.
- This **energy** is **released** during the process of **cellular respiration**.
- The **energy is released** in the **form** of a **compound called ATP**.

INTRODUCTION:

- **Cellular respiration** is the **process** during which **glucose is broken down** to **release energy** in the form of **ATP**.
- **Oxygen** is usually **required** for **cellular respiration**, though it **may not always be a requirement**.
- The **by-products** of **cellular respiration** are **water and oxygen**.

USES OF ENERGY:

- Energy is required in the body for **5 main purposes**.

- These are:

1. Growth
2. Movement
3. Cell division
4. Maintaining body temperature
5. Active transport

USES OF ENERGY:

1. **Growth:**

- **Energy** is used to make large **molecules** such as **smaller polysaccharides, enzymes, proteins, fats and glycogen**.
- Some of these **molecules** are then **used to make cell components**.
- These **cell components** are then **used to make material needed for growth**.

USES OF ENERGY:

2. **Movement:**

- Remember that **movement** is **brought** about by the **contraction** and **relaxation** of the **muscles**.
- **Energy is required** for the **contraction** and **relaxation of muscles**.
- Examples of **movement** in the **human body** is **contraction** and **relaxation** of the **heart muscles,** of the **muscles** of the **blood vessels** or even **peristalsis**.

USES OF ENERGY:

3. **Cell division:**

- **Energy** is **required during cell division** for **DNA replication** and **movement** of the **chromosomes**.

4. **Maintaining the body temperature**:

- The **heat energy** that is **released during chemical reactions** is used by **endothermic organisms to maintain** their **body temperature**.

SOMETHING FOR YOU TO DO:

What is an endothermic organism?

SOLUTION:

- It is an organism whose body temperature is constant irrespective of changes in the environmental temperature.

USES OF ENERGY:

5. **Active Transport:**

- Remember when **substances** are **absorbed against a concentration gradient energy** is **required**.

ENERGY AS ATP:

Energy that is released during cellular respiration is used in the following way.

- **Most** of the **energy** is given off **as heat**.
- **Some of the energy** is used to make the **compound ATP**.
- ATP is an **energy rich compound**.
- ATP stands for **Adenosine Triphosphate**.
- The **formation** and **breakdown of ATP** is referred to a as the **ATP/ADP cycle**.
- During the ATP/ADP cycle **ATP (Adenosine Triphosphate)** is formed from **ADP (Adenosine diphosphate)**.

ENERGY AS ATP:

- The **energy** that is released during **cellular respiration** is used to **combine** a **phosphate molecule** to **ADP** to form the **ATP**.
- When the **energy** is required **chemical bonds** are broken to release **a phosphate molecule** to form **ADP**.
- **34kJ of energy** is **required** to form **ATP**.

Can you predict then how much energy is released when ATP becomes ADP?

ENERGY AS ATP:

34 kJ

- These **ATP molecules** move **freely**.
- Therefore they are able to **move** to any **part** of the **cell** and **supply** **the** **energy for any process** **that might need it**.
- **All cells** use the **ATP to store the energy** and as **a source of energy**.

THE PROCESS OF CELLULAR RESPIRATION:

- **Cellular respiration** occurs in **both plant and animal cells**.
- There are **2** **types of cellular respiration**.
- They are:

1. Aerobic respiration
2. Anaerobic respiration.

THE PROCESS OF CELLULAR RESPIRATION:

- **Aerobic respiration** is **respiration** that occurs in the **presence** of **oxygen**.
- **Anaerobic respiration** occurs in the **absence** of **oxygen**.

AEROBIC RESPIRATION:

Site of Cellular Respiration:

- **Cellular respiration occurs** in the **cytoplasm** of the cell and in the **mitochondrion**.
- Therefore we will look briefly at the structure of the mitochondrion:

AEROBIC RESPIRATION:

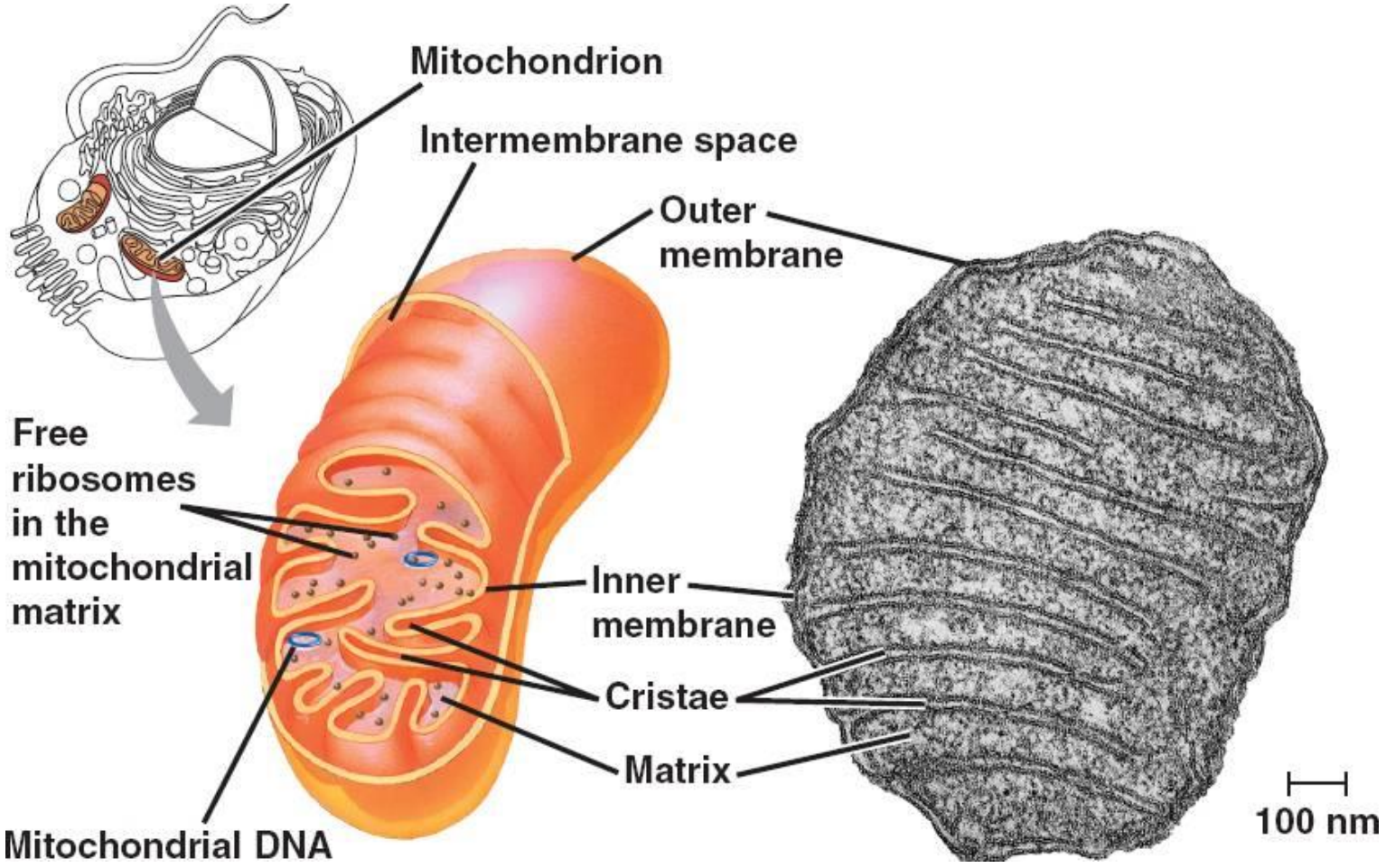
Structure of the Mitochondrion:

- This is a **cigar shaped organelle** found in **both** the **plant and animal cell**.
- It is surrounded by a **double membrane**.
- The **outer membrane** is **permeable** to allow **oxygen and pyruvic acid** to **enter**.
- The **inner membrane** is **folded** to form **finger like projections**.
- These projections are called **cristae**.
- These **cristae increase the surface area** for the process of **cellular respiration**.

AEROBIC RESPIRATION:

- Within the membrane lies a **ground substance** called the **matrix**.
- Found in the matrix are the **DNA, ribosomes and enzymes**.
- The **ribosomes manufacture** the **enzymes** that are required for **respiration**.
- The **enzymes** help with the **process of respiration**.

AEROBIC RESPIRATION:



Structure of Mitochondrion

AEROBIC RESPIRATION:

- The **number of mitochondrion present** in the cell is an **indication of how much energy** is **required by that cell**.

AEROBIC RESPIRATION:

Adaptations of the Mitochondrion for the process of Cellular Respiration:

1. **Smooth outer membrane** to enable **easy movement** around the cell.
2. **Outer membrane** is **permeable** to allow **oxygen and pyruvic acid** to **enter** the **mitochondrion** for **Krebs's cycle and oxidative phosphorylation**.
3. The **inner membrane** is **folded** to form the **cristae** to **increase the surface area** for the process of **respiration**.
4. **DNA and ribosomes** are **present** for the **manufacture of enzymes** that are required for respiration.

AEROBIC RESPIRATION:

The Process of Aerobic Respiration:

- This process is **dependent on oxygen**.
- Occurs in **3 phases**.
- These 3 phases are:

1. Glycolysis
2. Kreb's Cycle
3. Oxidative Phosphorylation

AEROBIC RESPIRATION:

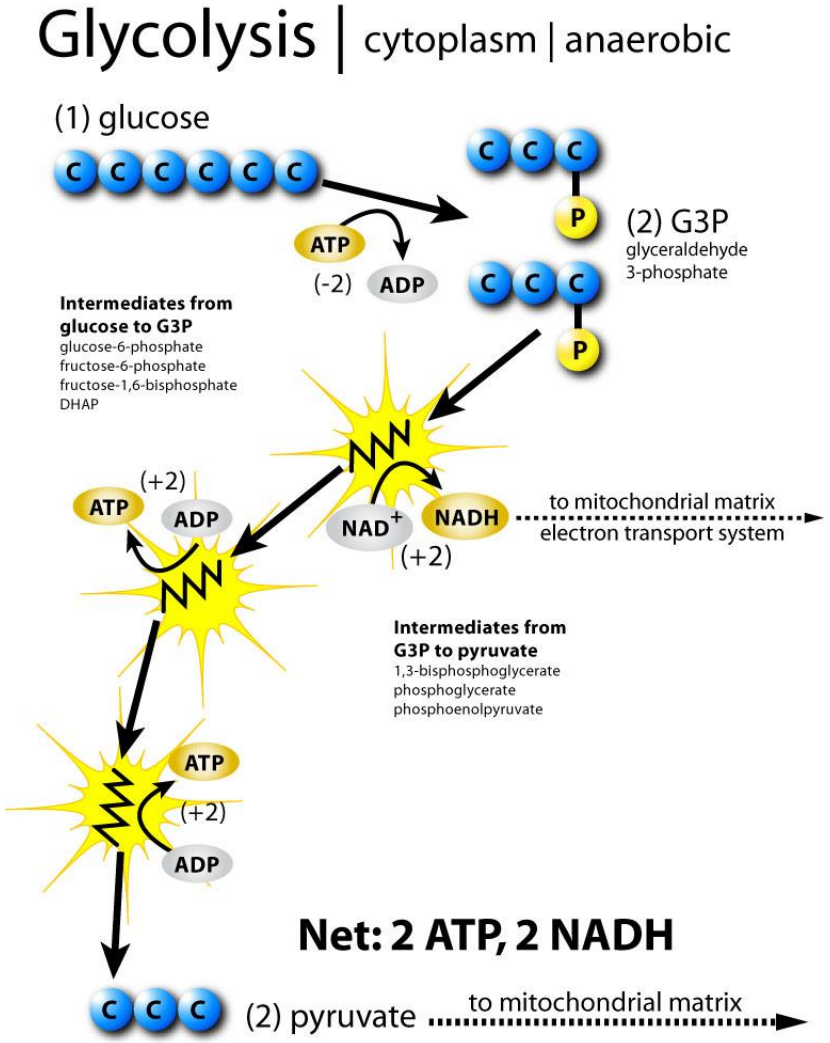
Glycolysis:

- **Glycolysis** occurs in the **cytoplasm**.
- This reaction **requires energy**.
- The **energy** comes from **ATP**.
- It involves **phosphorylation** which is the **addition of phosphate** to the **glucose** with the **addition of energy**.

AEROBIC RESPIRATION:

Glycolysis:

- It starts with an **energy rich 6 carbon molecule**.
- This **carbon molecule** is **broken down step wise** to form **two 3 carbon molecules**.
- These **3 carbon molecules** are called **pyruvic acid**.
- During the process **energized hydrogen atoms** and **energy** is **released**.



AEROBIC RESPIRATION:

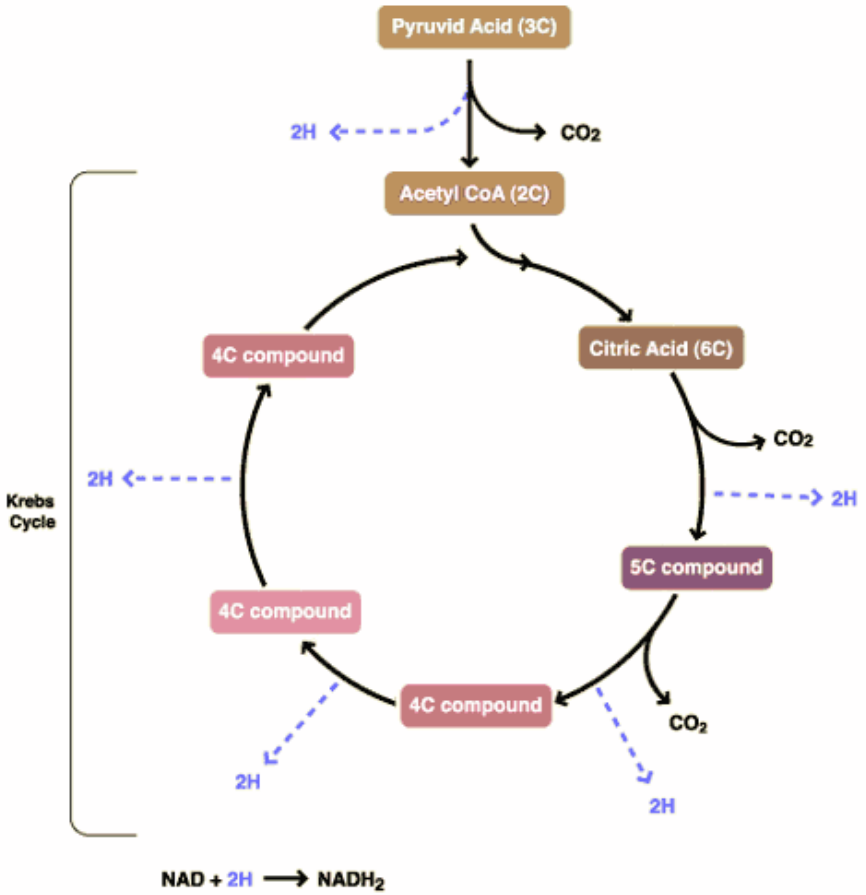
- The **energy** that is **released** is **used** to form **ATP**.
- **Each step** of the reaction is **catalyzed** by an **enzyme**.

Kreb's cycle:

- This stage is **dependent on oxygen**.
- Now lets look at this stage.

AEROBIC RESPIRATION:

- The **2 pyruvic acids enters** the **mitochondrion**.
- The **pyruvic acid** is now **used** in a **cyclic series** of **reactions**.
- During these reactions **energized H atoms** and **carbon dioxide** are **released**.
- The **hydrogen atoms** are transferred by **co-enzymes**.



AEROBIC RESPIRATION:

Oxidative Phosphorylation:

- This phase also **occurs** in the **mitochondrion**.
- The **energized H atoms** that were produced during **glycolysis** and **Kreb's cycle** are **involved** in a **series of reactions**.
- These **H atoms** are **transferred** from **1 co-enzyme to another**.
- At **each transfer** the **energized H atom gives off** a **little energy**.
- This **continues** until **all the energy** is **released** from the **H atoms**.

AEROBIC RESPIRATION:

- The **energy** that is **lost by the H atoms** are **used** to combine:

  ADP + P to form ATP

- The **H atom** then **combines with oxygen** to from **water**.

ANAEROBIC RESPIRATION:

- **Anaerobic respiration** is also known as **fermentation**.
- This type of respiration occurs in the **absence of oxygen**.
- During **anaerobic respiration** the **glucose** is **not completely broken down** into **carbon dioxide** and **water**.
- The **glucose** is **instead broken down** into **intermediate substances** that are **alcohol or lactic acid**.
- **Anaerobic respiration** also **releases very little energy**, **net gain of 2 ATP**, compared to **net gain of 36 ATP**, produced during **aerobic respiration**.
- This is so because the **glucose is not completely broken down**.

SOMETHING FOR YOU TO DO:

Explain the differences between aerobic and anaerobic respiration.

SOLUTION:

1. It occurs in the absence of oxygen.
2. The glucose is not completely broken down into carbon dioxide and water.
3. The glucose is instead broken down into intermediate substances that are alcohol or lactic acid.
4. Anaerobic respiration also releases very little energy, net gain of 2 ATP, compared to net gain of 36 ATP, produced during aerobic respiration.
5. This is so because the glucose is not completely broken down.

ANAEROBIC RESPIRATION:

- **Anaerobic respiration** begins with **glycolysis**.
- **Glycolysis occurs** in the **cytoplasm**.
- During this process **phosphorylation** of the **glucose molecule occurs**.
- This means that **energy** from the **ATP molecule** is **added** to the **6 carbon glucose molecule**.
- The **glucose** is then **broken down** into **two 3-carbon molecules** called **pyruvic acid**.
- During this process **energized H atoms** and **energy** is **released**.

ANAEROBIC RESPIRATION:

- The **energy** is **used** to form **ATP**.
- Each step of this process is **catalyzed by enzymes**.
- The process that follows is slightly different is plant and animal cells.

In a plant cell…

- The **pyruvic acid** is **converted** into **ethanol and carbon dioxide**.
- **Energy** is **released** as **ATP**.

ANAEROBIC RESPIRATION:

In animal cells…

- The **pyruvic acid** is converted into **lactic acid**.
- **Energy** is also **released** as **ATP**.

ANAEROBIC RESPIRATION:

Anaerobic Respiration in Humans:

- During **strenuous physical activity larges amount of energy is required**.
- This **energy** is **first supplied** by **aerobic respiration**.
- Since **large amounts of energy is required**, the **breathing rate and heart rate** needs to **increase**.
- This occurs to ensure there is **enough oxygen entering the body** and this **oxygen** is **carried fast enough to the cells**.
- This **increases** the **supply of oxygen** to the **cells**.

ANAEROBIC RESPIRATION:

- Eventually is an **oxygen debt occurs**.
- **Oxygen debt** occurs when the **available oxygen cannot meet the energy demands**.
- The **anaerobic respiration** must **occur**.
- Remember that in **animal cells lactic acid** is **produced** as a **by-product** during **anaerobic respiration**.
- This **lactic acid collects** in the **muscle tissue**.
- If the **lactic acid** reaches **very high levels**, then it causes **muscle cramps**.
- These **cramps prevent** the **muscle** from **contracting any further**.

ANAEROBIC RESPIRATION:

- Therefore the **person cannot continue** with the **activity**.
- The person then **collapses**.
- After the **activity has stopped** the **breathing rate** and **heart beat remain high**.
- This is to **ensure** that the **oxygen debt** is **paid off** by **more oxygen** being **taken into the cells**.
- The oxygen is used in **2 ways**.
- Some of it is used to **convert some lactic acid** into **carbon dioxide and water**.
- **Some oxygen** is also used to **convert some lactic acid into glucose**.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

- **Micro-organisms** undergo **anaerobic respiration**.
- This **type** of **anaerobic respiration** is called **fermentation**.
- **An example** of an **organism** that undergo **fermentation** is the **yeast cell**.
- During **fermentation, yeast cells** produce **energy**.
- Then **carbon dioxide and alcohol** are produced as **by-products**.
- These by-products are used in industry.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

- In **industry** the **yeast** is used **to produce carbon dioxide and alcohol in large quantities**.
- This field is called **biotechnology**.
- **Biotechnology** refers to the **process** during which **biological processes** are used **for production.**

Yeast:

- **Yeast** is used in **wine and bread making**.
- During fermentation, the **product** that is produced is **dependent** on the **sugar** that is used during **anaerobic fermentation**.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

- If **apple juice** is the **sugar source** then, **cider** is made.
- When **wine** is made the source of **sugar** is **grapes**.
- If it is **beer** that needs to be made then the **sugar** used is a **malt extract from germinating barley**.

Wine is made in the following way…

1. The **grapes** are **crushed**.
2. Then the **crushed grapes** together with the **juice** is placed in a **fermentation vat.**

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

3. Then **yeast** is **added** to the **vat**.
4. **Fermentation** now **occurs** at a **controlled temperature**.
5. **Alcohol and carbon dioxide** is **released** during the **fermentation process**.
6. This results in the **formation of wine**.

Bread-making:

- **Bread** is also **dependent** on the **fermentation process**.

Bread is made in the following way:

1. Yeast is added to the flour.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

2. Then water is added to make a dough.
3. Remember the flour has starch. The starch in the flour is broken down into maltose when water is added to it. Maltose is a type of sugar.
5. As the yeast undergoes respiration is breaks down the sugar to release energy.
6. Together with the energy it also releases carbon dioxide and alcohol.
7. The alcohol is burnt off during baking.
8. The carbon dioxide causes the bread to rise.
9. When the bread is cooked the high temperatures kill the yeast.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

Bacteria:

- **Bacteria** is used in the making of **cheese and yoghurt**.
- The **type of bacteria** that is used in making these **dairy products** is called **lactic acid bacteria**.
- During **anaerobic respiration** this **type of bacteria releases lactic acid**.
- The **lactic acid turns** the **milk or cream sour**.
- This **lowers the pH** of the **milk or cream**.
- The **acidic pH prevents** other **types of bacteria from growing**.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

Cheese is made in the following way:

1. Lactic acid bacteria is added to the milk.
2. This bacteria undergoes anaerobic respiration to release lactic acid.
3. Then a protease enzyme, called rennin, is added to the milk.
4. Rennin causes the milk protein to coagulate.
5. The milk curdles into solid curd.
6. The curd is cut into slabs and a liquid is drained away after the curdling process.
7. This liquid is called whey.

ANAEROBIC RESPIRATION IN MICRO-ORGANISMS

8. The curd is compressed into blocks.
9. They are then placed on shelves to ripen.
10. The ripen process occurs as a result of action by other micro-organisms.
11. The longer the cheese is left to ripen the sharper its taste.
12. The flavour or texture of the cheese is dependent on the strains of bacteria used in their production.

SIMILARITIES BETWEEN ANAEROBIC AND AEROBIC RESPIRATION:

Anaerobic and aerobic respiration are similar in the following ways:

1. In both processes glucose is a requirement.
2. In plants, both aerobic and anaerobic respiration release carbon dioxide and alcohol as by-products.
3. The main product of both types of respiration is energy in the form of ATP.

DIFFERENCES BETWEEN AEROBIC AND ANAEROBIC RESPIRATION:

- The table below shows the differences between the 2 types of respiration.

Differences between aerobic and anaerobic respiration:

Aerobic respiration	**Anaerobic respiration**
1. Dependent on oxygen	1. Independent of oxygen.
2. Releases more energy, net gain of 36 ATP.	2. Releases less energy, net gain of 2 ATP.
3. By products released are carbon dioxide and water.	3. By products are carbon dioxide and alcohol.

TERMINOLOGY:

- **Cellular respiration**: is the process during which glucose is broken down to release energy.
- **ATP**: stands for Adenosine Triphosphate and is an energy rich compound.
- **Aerobic respiration**: is respiration that occurs in the presence of oxygen.
- **Anaerobic respiration**: occurs in the absence of oxygen.
- **Cristae**: these are finger like projections that increase the surface area for the process of cellular respiration.

TERMINOLOGY:

- **Phosphorylation**: is the addition of phosphate to the glucose with the addition of energy.
- **Pyruvic acid**: these are 3 carbon molecules.
- **Oxygen debt**: occurs when the available oxygen cannot meet the energy demands of the body.
- **Fermentation**: is a type of anaerobic respiration that occurs in some micro-organisms.
- **Biotechnology**: refers to the process during which biological processes are used for production.
- **Rennin**: is a protease enzyme that causes the milk protein to coagulate.

QUESTION 1

The energy rich compound associated with respiration is…

A. ATP

B. ADP

C. P

D. None of the above

QUESTION 2

The processes that requires energy in the body are…

A. Growth, passive transport and cell division

B. Mitosis, meiosis and passive transport

C. Growth, mitosis and meiosis

D. Both A and C

QUESTION 3

The organelle in which cellular respiration occurs is…

A. Chloroplast

B. Nucleus

C. Mitochondrion

D. Golgi apparatus

QUESTION 4

The mitochondrion contains the following components…

A. DNA, stoma, crista

B. Nucleus, crista, stroma

C. DNA, crista, nucleus

D. DNA, crista, matrix

QUESTION 5

The phase of respiration that occurs in the mitochondrion is…

A. Kreb's cycle

B. Glycolsis

C. Oxidative phosphorylation

D. Both A and C

QUESTION 6

The phase of respiration that occurs in the cytoplasm is…

A. Kreb's cycle

B. Glycolsis

C. Oxidative phosphorylation

D. Both A and C

QUESTION 7

The energy released from the energized hydrogen atom during oxidative phosphorylation is used to…

A. Combine ADP + P to form ATP

B. Produce pyruvic acid

C. Break down pyruvic acid

D. Break down glucose

QUESTION 8

Energized hydrogen atoms and carbon dioxide is released during…

A. Glycolysis

B. Kreb's cycle

C. Oxidative phosphorylation

D. Both B and C

QUESTION 9

Energized hydrogen atoms are transferred from one co-enzyme carrier to the next during…

A. Glycolysis

B. Kreb's cycle

C. Oxidative phosphorylation

D. Both B and C

QUESTION 10

The 6 carbon molecule undergoes a step wise break down to form two pyruvic acids during…

A. Glycolysis

B. Kreb's cycle

C. Oxidative phosphorylation

D. Both B and C

QUESTION 11

_____ is an adaptation that increases the surface area for respiration.

A. Smooth outer membrane

B. Permeable outer membrane

C. Presence of cristae

D. Presence of DNA and ribosome

QUESTION 12

_____ is an adaptation that allows oxygen and glucose to enter the mitochondrion for respiration.

A. Smooth outer membrane

B. Permeable outer membrane

C. Presence of cristae

D. Presence of DNA and ribosome

QUESTION 13

_____ is an adaptation that allows for easy movement of the mitochondrion around the cytoplasm.

A. Smooth outer membrane

B. Permeable outer membrane

C. Presence of cristae

D. Presence of DNA and ribosome

QUESTION 14

_____ is an adaptation that allows for the production of enzymes for respiration.

A. Smooth outer membrane

B. Permeable outer membrane

C. Presence of cristae

D. Presence of DNA and ribosome

QUESTION 15

During anaerobic respiration in plants the products are…

A. ATP, carbon dioxide and water

B. ATP, alcohol and carbon dioxide

C. ATP, lactic acid and carbon dioxide

D. ATP, alcohol and water

QUESTION 16

During aerobic respiration the products formed are…

A. ATP, carbon dioxide and water
B. ATP, alcohol and carbon dioxide
C. ATP, lactic acid and carbon dioxide
D. ATP, alcohol and water

QUESTION 17

During fermentation in bacteria the products formed are…

A. ATP, carbon dioxide and water
B. ATP, alcohol and carbon dioxide
C. ATP, lactic acid and carbon dioxide
D. ATP, alcohol and water

QUESTION 18

The enzyme that is used to curdle milk is…

A. Called rennin

B. An example of a protease

C. Used during the production of alcohol

D. Both A and B

QUESTION 19

Bread is able to rise when baked because of…

A. Anaerobic respiration

B. Aerobic respiration

C. The presence of alcohol

D. Both A and C

QUESTION 20

A similarity between aerobic and anaerobic respiration is that…

A. Both require oxygen

B. Both release alcohol

C. Both release water

D. Both require glucose

SOLUTIONS FINAL ASSESSMENT QUESTIONS

1. A
2. C
3. C
4. D
5. D
6. B
7. A
8. B
9. C
10. A
11. C
12. B
13. A
14. D
15. B
16. A
17. C
18. D
19. A
20. A