TELEMATIC SCHOOLS PROJECT

2023 SUBJECT WORKBOOK
Grade 11

LIFE SCIENCES

A joint initiative between the Western Cape Education Department and Stellenbosch University.

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BROADCAST SESSIONS

GRADE 11

LIFE SCIENCES

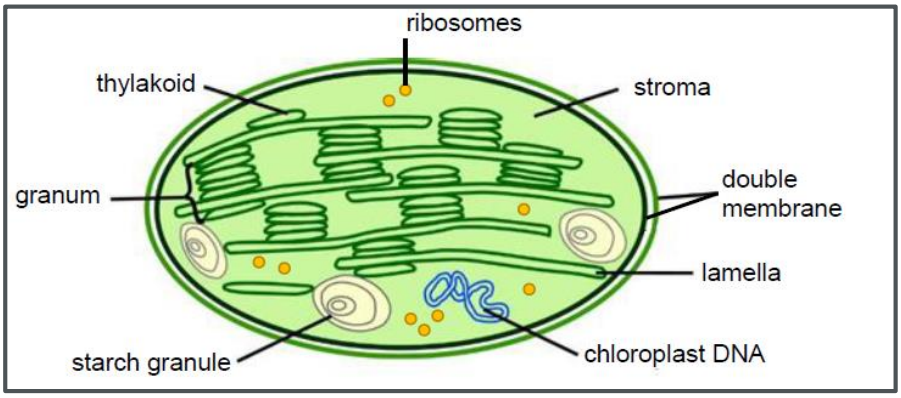
Session	Date	Time	Topic
1	**19/04/2023**	**15h00-16h00**	**Photosynthesis**
2	25/04/2023	16h00-17h00	Cellular respiration
3	**16/10/2023**	**16h00-17h00**	**Animal nutrition**

SESSION 1 | PHOTOSYNTHESIS

- **Photosynthesis** is the process by which *chlorophyll* in the chloroplasts of green plants absorbs *radiant energy* from the sun, *carbon dioxide* from the atmosphere and *water* from the soil to produce *carbohydrates (e.g., glucose)* which is stored in the plant.
- *Oxygen* is released into the atmosphere during the process. Enzymes in the cell are also needed for the process. Excess glucose is converted into starch in the plant.

$$\text{Carbon dioxide } (CO_2) + \text{water } (H_2O) + \text{radiant energy} \xrightarrow[\text{enzymes}]{\text{chlorophyll}} \text{glucose} + \text{oxygen } (O_2)$$

- Photosynthesis takes place in the **chloroplasts** of plant cells.



The process of photosynthesis occurs in two phases:

- ❑ **Light phase**: light is required.
- ❑ **Dark phase**: no light is required.

LIGHT PHASE

- The light phase of photosynthesis takes place in the **grana** of chloroplasts.
- Radiant energy from the sun is absorbed by chlorophyll in the grana and transformed into chemical energy.
- Chemical energy is used to split water molecules (H_2O) into energy -rich hydrogen atoms (H) and oxygen atoms (O). The process is known as **photolysis.**
- Energy rich hydrogen atoms are transferred to the dark phase.
- Oxygen is released into the atmosphere.
- Radiant energy also causes the energy carrier ATP to be formed which will be used in the dark phase.

DARK PHASE

- The dark phase of photosynthesis takes place in the **stroma** of chloroplasts.
- Carbon dioxide is absorbed from the atmosphere and combines with the energy-rich hydrogen atoms from the light phase using the energy that is released from ATP.
- Energy-rich carbohydrates (glucose) are formed.
- Excess glucose is stored as starch.

IMPORTANCE OF PHOTOSYNTHESIS

- Photosynthesis keeps the oxygen concentration in the atmosphere and water constant. Oxygen is needed by living organisms for **cellular respiration**.
- Photosynthesis keeps the level of carbon dioxide constant in the atmosphere and water. Carbon dioxide is released by organisms during cellular respiration.
- Photosynthesis provides food for heterotrophic organisms.

EFFECTS OF VARIOUS AMOUNTS OF LIGHT, CARBON DIOXIDE AND TEMPERATURE ON THE RATE OF PHOTOSYNTHESIS

Light intensity

- At low light intensity, the rate of photosynthesis is low.
- As light intensity increases, the rate of photosynthesis also increases. This will happen up to a certain point.
- If light intensity increases above the optimum, the rate of photosynthesis will remain constant.
- Factors such as carbon dioxide become limiting factors which reduces the rate of photosynthesis.

Carbon dioxide (CO_2) concentration

- At a low carbon dioxide concentration, the rate of photosynthesis is low.
- As the carbon dioxide concentration level increases, the rate of photosynthesis also increases. This will happen up to a certain point.
- If the carbon dioxide concentration is higher than the optimum amount, then photosynthesis will remain constant.

Temperature

- When temperature is low, the rate of photosynthesis is low.
- As temperature increases, the rate of photosynthesis also increases.
- If the temperature is higher than the optimum amount, then the rate of photosynthesis will decrease. This is because the enzymes used in the process will denature at high temperatures and will no longer function.
- At low temperatures enzymes become inactive.

THE ROLE OF OPTIMUM LIGHT, TEMPERATURE AND CARBON DIOXIDE IN A GREENHOUSE TO IMPROVE CROP YIELD

- Optimum light intensity and temperature increases the rate of photosynthesis and stimulates the growth of plants.
- Carbon dioxide levels in a greenhouse decreases because of photosynthesis.
- Carbon dioxide gas can be pumped into a greenhouse to increase the rate of photosynthesis of the plants.

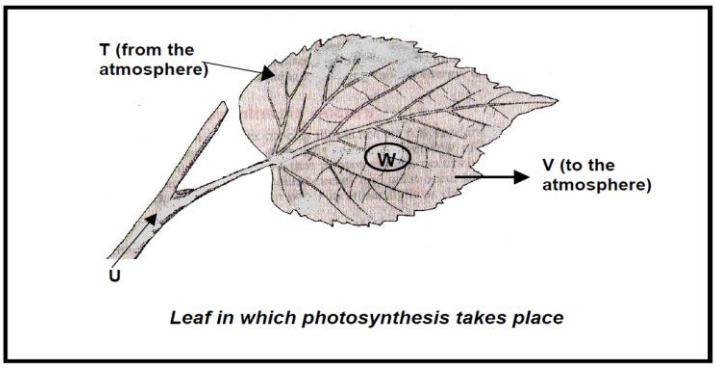
ATP AS ENERGY CARRIER IN CELLS

- When a cell needs energy, ATP is broken down and the energy is released.
- Cells use this energy to produce important molecules such as proteins, fats etc.
- Muscle cells need energy provided by ATP to contract.
- Energy provided by ATP is needed to move substances across cell membranes.

SESSION 1 | PHOTOSYNTHESIS (QUESTIONS AND ANSWERS)

QUESTION 1

1.1 Study the following diagram of a leaf in which the process of photosynthesis takes place.



Leaf in which photosynthesis takes place

1.1.1 Identify the products of photosynthesis represented by
- (a) **V** (1)
- (b) **W** (1)

1.1.2 Identify the inorganic substances
- (a) **T** and (1)
- (b) **U** that are needed for photosynthesis (1)

1.1.3 Name the process by which inorganic substance **T** is absorbed into the leaf. (1)

1.1.4 Draw a labelled diagram of an organelle present in the leaves of plants where photosynthesis takes place. (5)

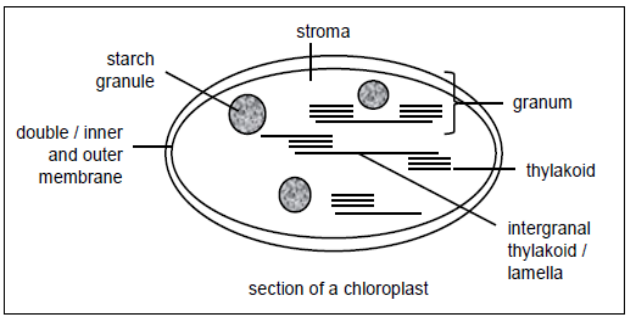
ANSWERS:

1.1.1 (a) V- oxygen✓
(b) W – Starch✓/glucose/carbohydrates

1.1.2 (a) T - Carbon dioxide✓
(b) U – Water✓

1.1.3 Diffusion✓

1.1.4



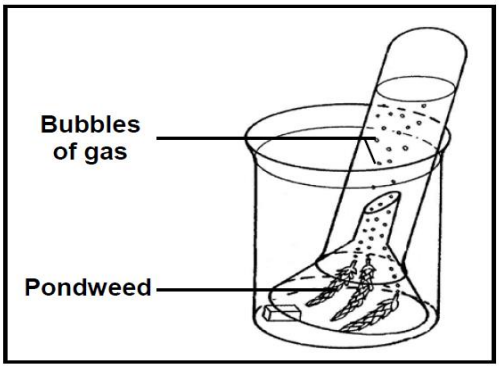
Caption – 1 mark
Correct drawing – 1 mark
Labels (any three) – 3 marks

QUESTION 2

2.1 When light shines on pondweed, *Elodea Sp*, bubbles of gas are released. The rate at which bubbles of gas are produced can be used to measure the rate of photosynthesis.

An investigation was carried out to study the effect of different colours of light on the rate of photosynthesis in the pondweed.

- The pondweed was exposed to one colour of light and left for 5 minutes before measurements were taken.
- The time taken for the release of 20 bubbles was recorded.
- The procedure was repeated using light of a different colour of equal intensity.
- The apparatus was set up as shown in the diagram below.



The results are shown in the table below.

COLOUR OF LIGHT	TIME TAKEN TO RELEASE 20 BUBBLES (SECONDS)
Violet	80
Blue	40
Green	160
Yellow	140
Red	70

2.1.1 State the:

(a) Independent variable (1)
(b) Dependent variable (1)

2.1.2 Calculate the average time taken for the release of 20 bubbles for all colours. Show all working. (3)
2.1.3 Express bubble production under violet, blue and green light as a ratio. (1)
2.1.4 Without modifying the apparatus, state ONE way how the reliability of the investigation could be increased. (1)
2.1.5 Draw a bar graph of the results shown in the table. (6)

SESSION 1 | PHOTOSYNTHESIS (QUESTIONS AND ANSWERS)

ANSWERS

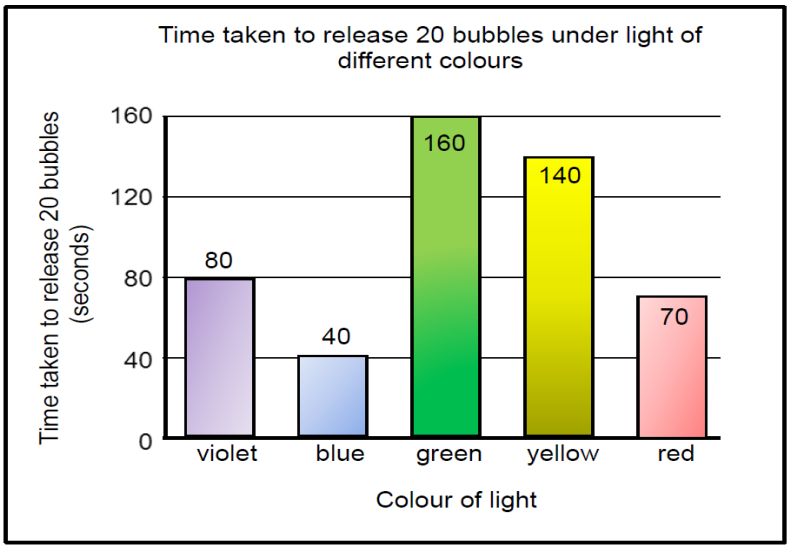
2.1.1 (a) Different colours of light✓
(b) Rate of photosynthesis✓

2.1.2 $\frac{80 + 40 + 160 + 140 + 70}{5}$ ✓
= 98✓ seconds✓

2.1.3 2:1:4✓

2.1.4 Repeat the investigation✓/Take more readings for light of each colour.

2.1.5



Guidelines for assessing graph:

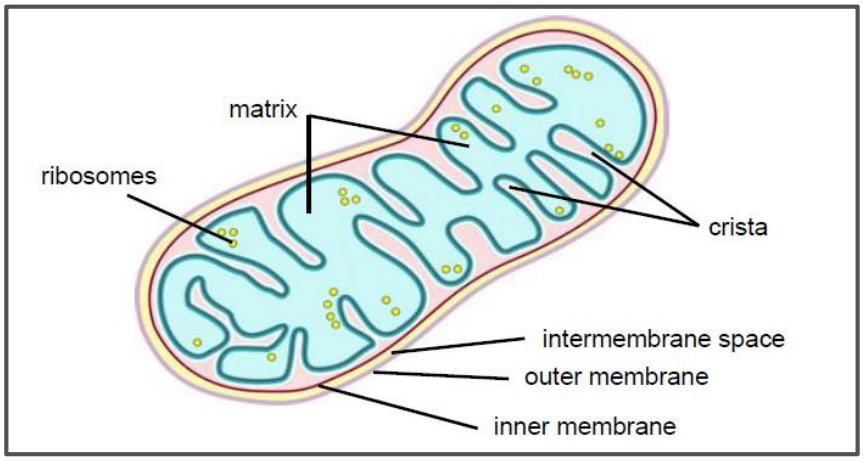
CRITERIA	ELABORATION	MARK
Correct type of graph	Bar graph drawn	1
Caption of graph	Both variables included	1
Axes labels	X-and Y axes correctly labelled Correct unit on Y-axis	1
Scale for X-and Y-axes	Equal space between bars and width of bars Correct scale for Y-axis	1
Plotting of bars	1- 4 bars plotted correctly All 5 bars plotted correctly	1 2

SESSION 2 | CELLULAR RESPIRATION

- Cellular respiration is the chemical process where glucose is broken down gradually, in the **presence** of oxygen (aerobic respiration) or in the **absence** of oxygen (anaerobic respiration), to release **energy**.

$$\text{Glucose + oxygen } (O_2) \xrightarrow{\text{enzymes}} \text{Carbon dioxide } (CO_2) + \text{water } (H_2O) + \text{ATP}$$

- Aerobic respiration occurs in the presence of oxygen in the cytoplasm and the **mitochondria** of cells.



STAGES OF AEROBIC RESPIRATION

Glycolysis

- Glycolysis occurs in the cytoplasm of the cell outside the mitochondrion.
- Glucose is broken down into pyruvic acid .
- Energy-rich hydrogen atoms are given off and move into the mitochondrion..
- ATP is formed during glycolysis.

Krebs cycle

- The Krebs cycle is a series of cyclic reactions that takes place inside the mitochondrion.
- Pyruvic acid that entered the mitochondrion is broken down into energy-rich hydrogen atoms and carbon dioxide.
- The carbon dioxide is released and given off as a gas.

Oxidative phosphorylation

- Oxidative phosphorylation takes place in the mitochondrion.
- The energy from the hydrogen atoms is used to form energy-rich ATP.
- The hydrogen atoms combine with oxygen to form water.

ANAEROBIC RESPIRATION

- Takes place in the absence of oxygen
- Glucose is only partially broken down and less energy is released.
- **Lactic acid fermentation**– anaerobic respiration that occurs in muscle cells. Pyruvic acid is converted into lactic acid.
- **Alcoholic fermentation –** anaerobic respiration that occurs in yeast cells. Carbon dioxide and alcohol(ethanol) is formed.

ROLE OF ANAEROBIC RESPIRATION IN THE INDUSTRY

- Yeast and other fungi respire anaerobically and are used to produce alcoholic beverages such as beer and wine.
- Yeast cells are also used to cause bread to rise during the baking process.
- The fermentation process is also used to produce cheese.

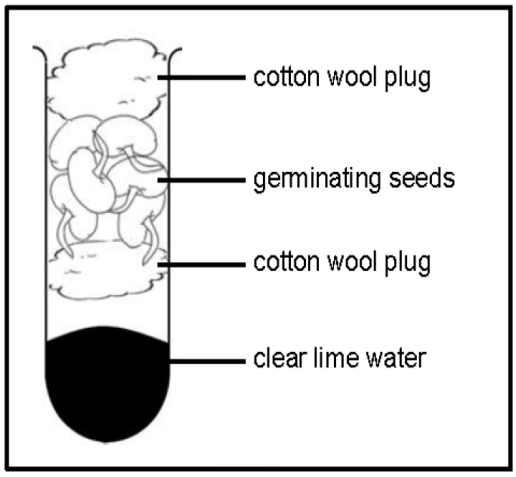
COMPARISON BETWEEN AEROBIC AND ANAEROBIC RESPIRATION

AEROBIC RESPIRATION	ANAEROBIC RESPIRATION
Occurs in the presence of oxygen	Occurs in the absence of oxygen
Products are carbon dioxide and water	Products are lactic acid (animals) or carbon dioxide and ethanol (plants/yeast cells)
A large amount of energy is released	A small amount of energy is released

SESSION 2 | CELLULAR RESPIRATION

QUESTION 1

1.1 A group of grade 11 learners set up an investigation as shown in the diagram.



1.1.1 State the aim of the investigation. (2)

1.1.2 Give ONE reason why the seeds were sterilised before they were used. (1)

1.1.3 State ONE way how the learners could ensure the validity of the investigation (1)

1.1.4 State a suitable conclusion for the investigation above. (2)

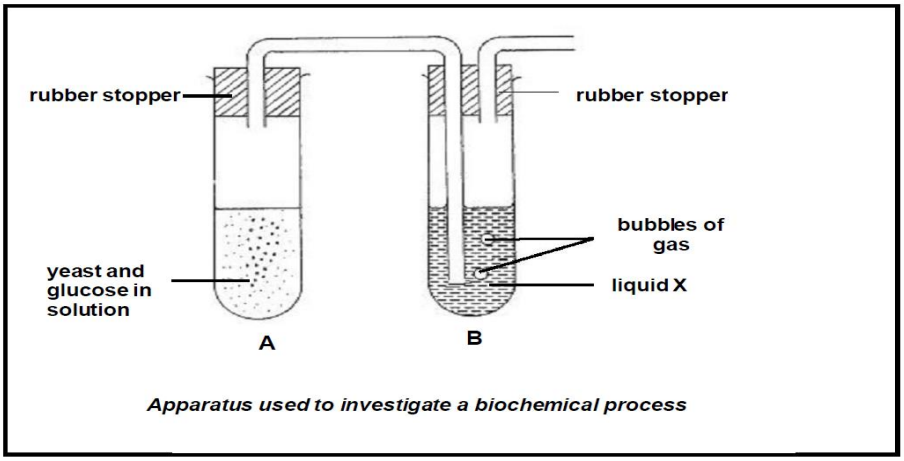
1.1.5 Explain how they would set up a control for this investigation. (2)

ANSWERS

1.1.1 To determine if carbon dioxide is produced/ released ✓during cellular respiration✓
1.1.2 To ensure all microorganisms are killed✓
1.1.3 By controlling variables e.g., using same type of seeds✓, same amount of lime water✓, same size of test-tube✓
1.1.4 Clear lime water turns milky in the presence of carbon dioxide✓ ✓
1.1.5 The apparatus would be set up in the exact same way✓ except by using no seeds✓/seeds that were boiled to ensure that the changes observed in the investigation were caused by cellular respiration/germinating seeds✓

QUESTION 2

2.1 Study the diagram below.



Apparatus used to investigate a biochemical process

2.1.1 State ONE function of the rubber stopper in tube A. (1)

2.1.2 Name:

(a) The biochemical process that is taking place in tube A (1)

(b) The bubbles of gas in tube B (1)

(c) Liquid **X** in tube B (1)

2.1.3 What is the source of the food / substrate for the process mentioned in QUESTION 2.1.2 (a)? (1)

2.1.4 Name TWO ways in which the process illustrated in the diagram is economically important. (2)

2.1.5 State ONE reason why it would have been better to use a thermos flask instead of a test tube. (1)

ANSWERS

2.1.1 Prevent atmospheric air to enter/escape from the test tube ✓ / make test tube airtight

2.1.2 (a) anaerobic respiration ✓ /fermentation

(b) carbon dioxide ✓

(c) lime water ✓

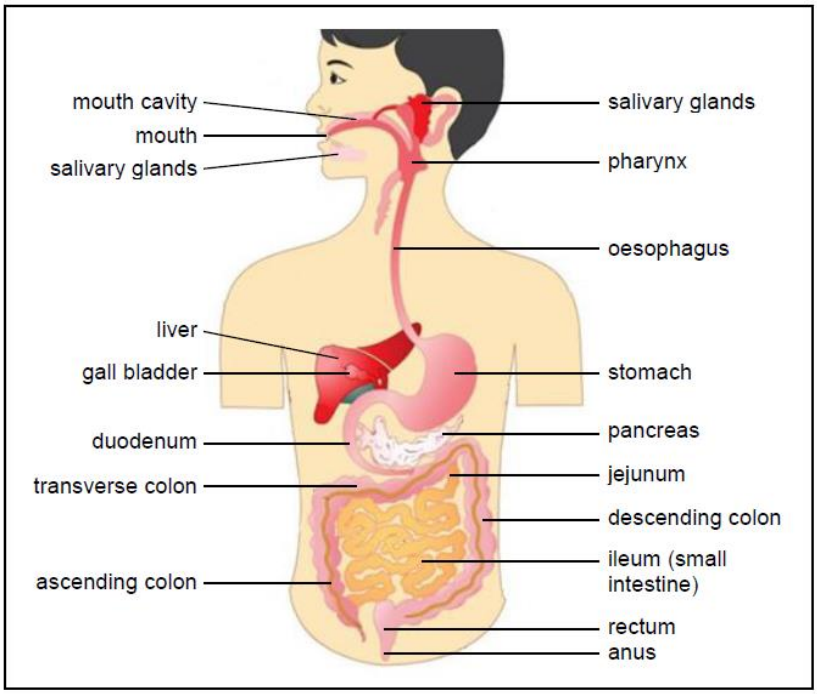
2.1.3 Glucose ✓

2.1.4 Beer/wine making ✓

baking ✓

2.1.5 To keep temperature constant ✓

- The human digestive system is made up of an alimentary canal (tube from mouth to anus) and accessory organs (e.g. liver, pancreas) that aid in the digestive process.



MECHANICAL DIGESTION

- During mechanical digestion food is broken down into smaller particles.
- Mechanical digestion includes:

❑ The **chewing** process (mastication) – food is broken down by the teeth and tongue.
❑ **Bolus formation** – chewed food is mixed with saliva and rolled into a ball by the tongue. The tongue pushes the bolus down to the oesophagus.
❑ **Churning movements** – this takes place by the contraction and relaxation of the muscles of the stomach wall. Food is broken down further and mixed with gastric juice.
❑ **Peristaltic movements** – rhythmic contraction and relaxation of the muscles in the wall of the alimentary canal. It helps to move food particles forward.

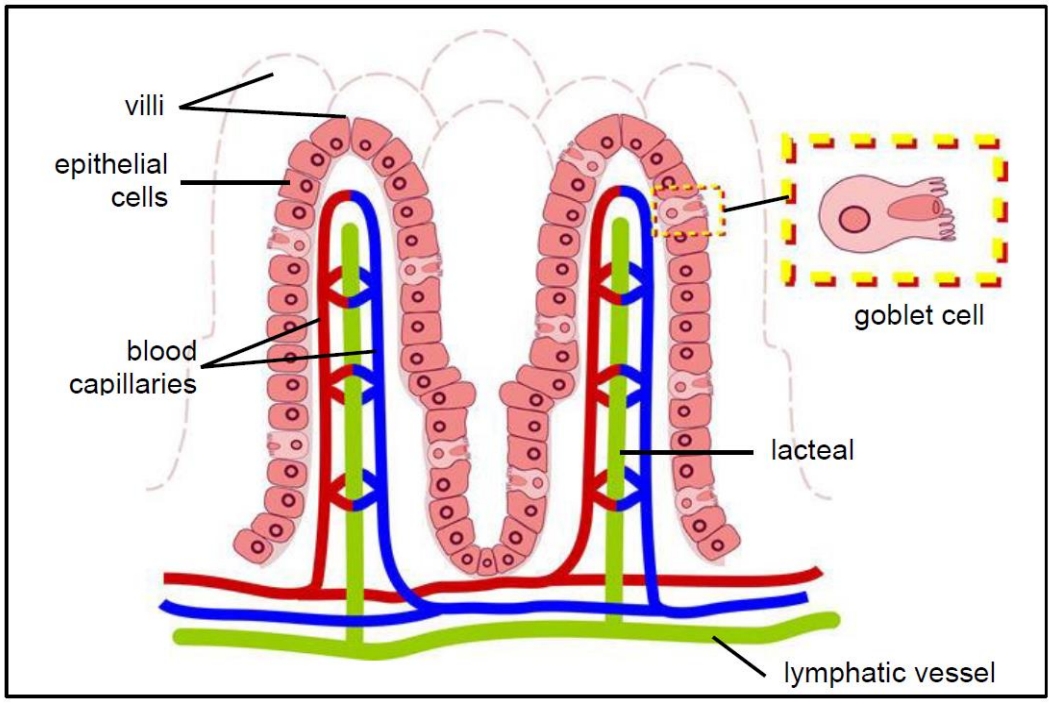
CHEMICAL DIGESTION

- Chemical digestion is the breaking down of large, insoluble molecules in food into smaller, soluble molecules by the addition of water.

SUBSTRATE	ENZYMES	END PRODUCT OF DIGESTION
Carbohydrates	Carbohydrases e.g. salivary amilase (produced in mouth), Pancreatic amylase (produced in pancreas), Maltase, Sucrase, Lactase (produced in small intestine)	Glucose
Proteins	Proteases e.g. pepsin and renin (produced in stomach) and trypsin (in pancreas)	Amino acids
Lipids	Lipase (produced in pancreas and small intestine)	Glycerol and fatty acids

ABSORPTION

- The end products of digestion i.e. glucose, amino acids, fatty acids and glycerol as well as vitamins, mineral salts and water are absorbed by the **villi** in the small intestine.



TRANSPORT AND ASSIMILATION OF ABSORBED NUTRIENTS

- Glucose, amino acids, vitamins, mineral salts and water are absorbed through the blood capillaries in the villi.
- The capillaries join to form large veins that eventually open into the **hepatic portal vein.**
- The hepatic portal vein transports the absorbed nutrients to the liver where most of the glucose is converted into glycogen and stored.
- Excess amino acids undergo **deamination** in the liver to form **urea** and **glucose**. The urea is transported to the kidneys and excreted as part of urine
- The remaining glucose and amino acids leave the liver through the **hepatic veins** and are transported to the heart and to the rest of the body.
- The body cells absorb the required nutrients. This process is known as **assimilation**.

EGESTION

- All undigested materials are transported through the colon where most water and mineral salts are absorbed.
- The undigested material is temporarily stored in the rectum until it is excreted. through the anus.
- The undigested waste is then referred to as faeces.

HOMEOSTATIC CONTROL - THE HORMONAL CONTROL OF BLOOD SUGAR LEVELS

When the glucose levels in the blood increases above the normal level:

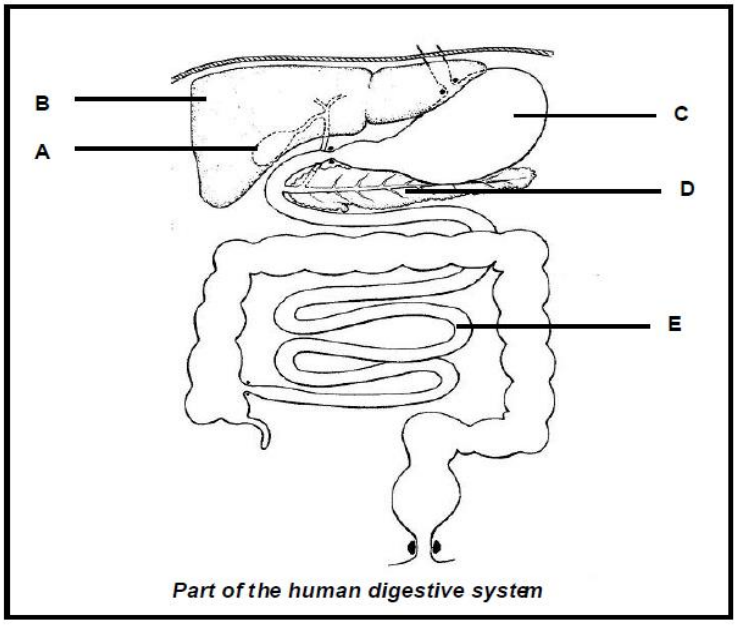
- The pancreas is stimulated to secrete **insulin** into the blood.
- Insulin is transported to the liver by the blood.
- In the liver and muscles, the **insulin** stimulates the conversion of excess **glucose** into **glycogen.**
- Insulin also stimulates the absorption of glucose from the blood into the body cells.
- Glucose is removed from the blood and the glucose concentration in the body decreases.

When the glucose levels in the blood decreases below the normal level:

- The pancreas is stimulated to secrete **glucagon** into the blood.
- Glucagon is transported to the liver by the blood.
- In the liver and muscles, the **glucagon** stimulates the conversion of **glycogen** into **glucose.**
- Glucose is released into the blood and the glucose concentration in the body increases.

QUESTION 1

1.1 The diagram below shows parts of the human digestive system and its associated organs.



Part of the human digestive system

1.1.1 Identify parts **B**, **C**, and **E** respectively. (3)
1.1.2 Name TWO functions of part **B** that are related to nutrition. (2)
1.1.3 Describe the relationship between **B** and **D** in controlling the blood glucose level. (6)
1.1.4 Explain THREE structural adaptations of **E** for digestion. (6)

ANSWERS

1.1.1 B Liver✓

C Stomach✓

E Small intestine/Jejunum/ileum✓

1.1.2 The liver cells secrete bile✓
The liver is able to convert glucose to glycogen✓
The liver is able to convert glucose to fat✓
and stores fat✓
The liver serves as a storehouse for minerals such as iron✓
Important vitamins such as A, D and B12 are stored in the liver✓
The liver is able to deaminate excess amino acids✓
The liver is able to detoxify certain harmful substances✓

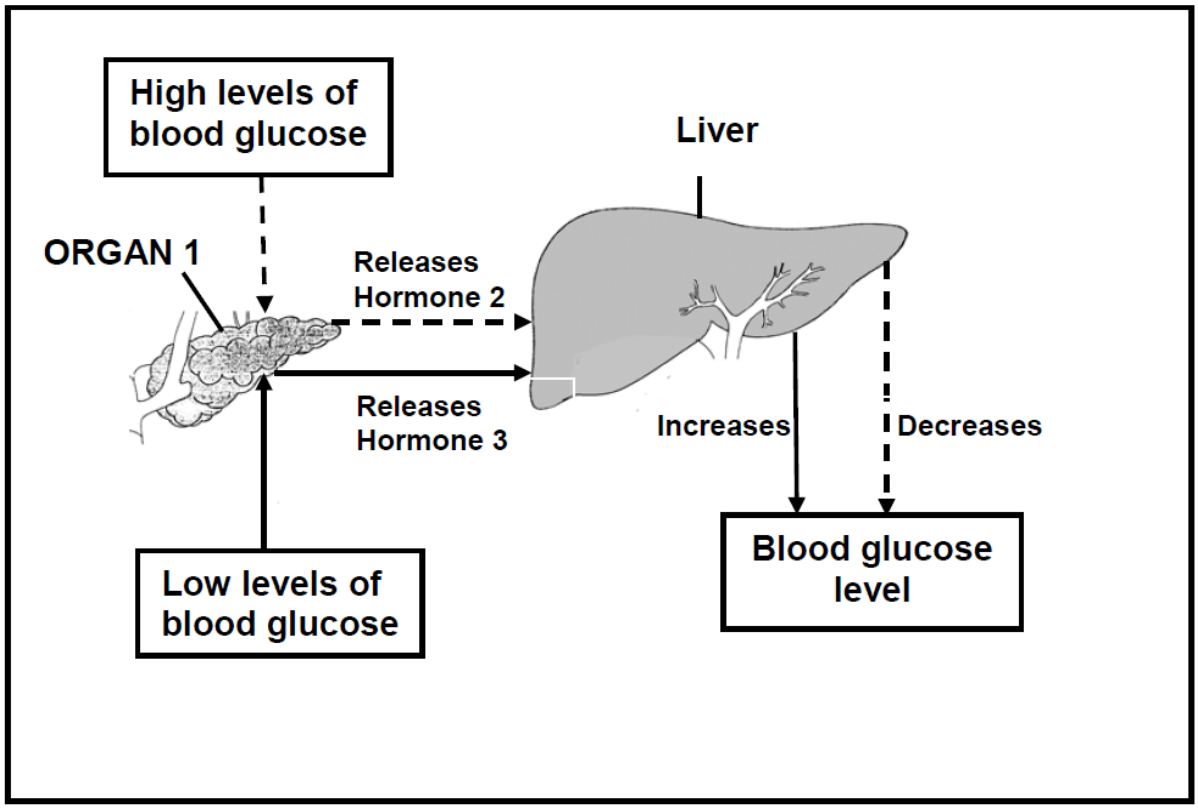
1.1.3 If the blood sugar level is high✓:
- ❑ The Islets of Langerhans found in the pancreas secrete insulin✓
- ❑ which is then transported to the liver where it converts excess glucose into glycogen✓

If the blood sugar level is low✓:
- ❑ The Islets of Langerhans found in the pancreas secrete glucagon✓
- ❑ which is then transported to the liver where it converts glycogen into glucose✓

1.1.4 Contains intestinal glands ✓which secrete intestinal juice which contain enzymes✓ for digestion
The length✓ increases the surface area✓ for maximum digestion
The folds/villi /microvilli ✓ increase the time/slows down the food✓ for maximum digestion

QUESTION 2

Study the flow diagram below.



2.1.1 Identify

(a) Organ **1** (1)

(b) Hormone **2** (1)

(c) Hormone **3** (1)

(d) The disorder caused when organ **1** fails to release sufficient amounts of hormone **2** (1)

(e) The mechanism that controls the levels of glucose in the body. (1)

ANSWERS

2.1.1 (a) Pancreas ✓

(b) Insulin ✓

(c) Glucagon ✓

(d) Diabetes ✓ mellitus

(e) Negative feedback ✓

LINKS TO ONLINE RESOURCES

TOPIC	LINK AND QR CODE
Photosynthesis, Cellular respiration and Animal nutrition video	https://bit.ly/3VABbeS (Note it is the last video in the series of videos)
Photosynthesis, Cellular respiration and Animal nutrition slides	https://bit.ly/3CEgxlE