



Ministry of Education
and Sports

HOME-STUDY LEARNING

SENIOR
3

BIOLOGY

August 2020





Published 2020

This material has been developed as a home-study intervention for schools during the lockdown caused by the COVID-19 pandemic to support continuity of learning.

Therefore, this material is restricted from being reproduced for any commercial gains.

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FOREWORD

Following the outbreak of the COVID-19 pandemic, government of Uganda closed all schools and other educational institutions to minimize the spread of the coronavirus. This has affected more than 36,314 primary schools, 3129 secondary schools, 430,778 teachers and 12,777,390 learners.

The COVID-19 outbreak and subsequent closure of all has had drastically impacted on learning especially curriculum coverage, loss of interest in education and learner readiness in case schools open. This could result in massive rates of learner dropouts due to unwanted pregnancies and lack of school fees among others.

To mitigate the impact of the pandemic on the education system in Uganda, the Ministry of Education and Sports (MoES) constituted a Sector Response Taskforce (SRT) to strengthen the sector's preparedness and response measures. The SRT and National Curriculum Development Centre developed print home-study materials, radio and television scripts for some selected subjects for all learners from Pre-Primary to Advanced Level. The materials will enhance continued learning and learning for progression during this period of the lockdown, and will still be relevant when schools resume.

The materials focused on critical competences in all subjects in the curricula to enable the learners to achieve without the teachers' guidance. Therefore effort should be made for all learners to access and use these materials during the lockdown. Similarly, teachers are advised to get these materials in order to plan appropriately for further learning when schools resume, while parents/guardians need to ensure that their children access copies of these materials and use them appropriately. I recognise the effort of National Curriculum Development Centre in responding to this emergency through appropriate guidance and the timely development of these home study materials. I recommend them for use by all learners during the lockdown.



Alex Kakooza
Permanent Secretary
Ministry of Education and Sports

ACKNOWLEDGEMENTS

National Curriculum Development Centre (NCDC) would like to express its appreciation to all those who worked tirelessly towards the production of home-study materials for Pre-Primary, Primary and Secondary Levels of Education during the COVID-19 lockdown in Uganda.

The Centre appreciates the contribution from all those who guided the development of these materials to make sure they are of quality; Development partners - SESIL, Save the Children and UNICEF; all the Panel members of the various subjects; sister institutions - UNEB and DES for their valuable contributions.

NCDC takes the responsibility for any shortcomings that might be identified in this publication and welcomes suggestions for improvement. The comments and suggestions may be communicated to NCDC through P.O. Box 7002 Kampala or email admin@ncdc.go.ug or by visiting our website at <http://ncdc.go.ug/node/13>.



Grace K. Baguma
Director,
National Curriculum Development Centre

ABOUT THIS BOOKLET

Dear learner, you are welcome to this home-study package. This content focuses on critical competences in the syllabus.

The content is organised into lesson units. Each unit has lesson activities, summary notes and assessment activities. Some lessons have projects that you need to carry out at home during this period. You are free to use other reference materials to get more information for specific topics.

Seek guidance from people at home who are knowledgeable to clarify in case of a challenge. The knowledge you can acquire from this content can be supplemented with other learning options that may be offered on radio, television, newspaper learning programmes. More learning materials can also be accessed by visiting our website at www.ncdc.go.ug or ncdc-go-ug.digital/. You can access the website using an internet enabled computer or mobile phone.

We encourage you to present your work to your class teacher when schools resume so that your teacher is able to know what you learned during the time you have been away from school. This will form part of your assessment. Your teacher will also assess the assignments you will have done and do corrections where you might not have done it right.

The content has been developed with full awareness of the home learning environment without direct supervision of the teacher. The methods, examples and activities used in the materials have been carefully selected to facilitate continuity of learning.

You are therefore in charge of your own learning. You need to give yourself favourable time for learning. This material can as well be used beyond the home-study situation. Keep it for reference anytime.

Develop your learning timetable to cater for continuity of learning and other responsibilities given to you at home.

Enjoy learning



S3 BIOLOGY SELF-STUDY MATERIALS

COVID-19 is a disease caused by the corona virus. The symptoms include: dry cough, sneezing/running nose, fever and difficulty in breathing. The virus is transmitted through droplets when an infected person coughs or sneezes. A person can also get infected by touching surfaces contaminated with the virus and then touching their face (eyes, nose or mouth). The spread of COVID-19 can be slowed down or prevented by following:

- Clean your hands often. Use soap and water, or an alcohol-based hand rub.
- Avoid overcrowded places. Maintain a safe distance (at least one meter) from anyone, more particularly one who is coughing or sneezing.
- Wear a mask when physical distancing is not possible.
- Don't touch your eyes, nose or mouth.
- Cover your nose and mouth with your bent elbow or a tissue when you cough or sneeze.
- Stay home if you feel unwell.
- If you have a fever, cough and difficulty breathing, seek medical attention and get tested.

All the best as you continue to study using these materials.

Topic 1: Respiration

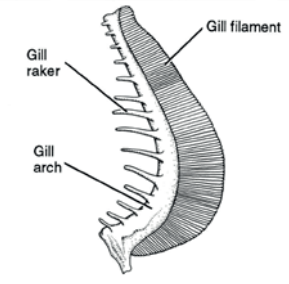
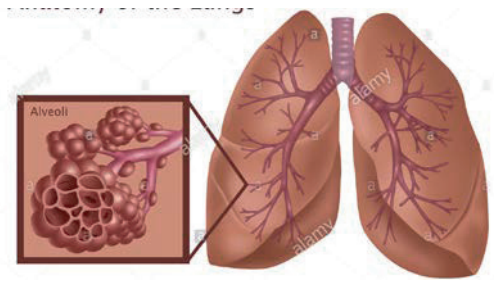
Lesson 1: Characteristics of Efficient Gas Exchange Surfaces

By the end of this lesson, you should be able to explain why gas exchange surfaces need to be moist.

INTRODUCTION

Gas exchange is a physical process by which gases move passively (without use of energy) by diffusion across a surface. Gas exchange surfaces are the sites where gas exchange takes place in the body of the organism.

The table below shows examples of gas exchange surfaces and the corresponding organs in different animals. Fill in the correct answers in the blank spaces

Organism	Respiratory organ	Gas exchange surface
Fish	Gill	 <p>Gill filament</p>
Toad/frog	Alveoli 
Bird	Lung
Human
Insect	Tracheal system	tracheole
Tadpole	Gill

Ask yourself this question: *What essential characteristics do these surfaces have in common?* This lesson shall focus on one of these characteristics.

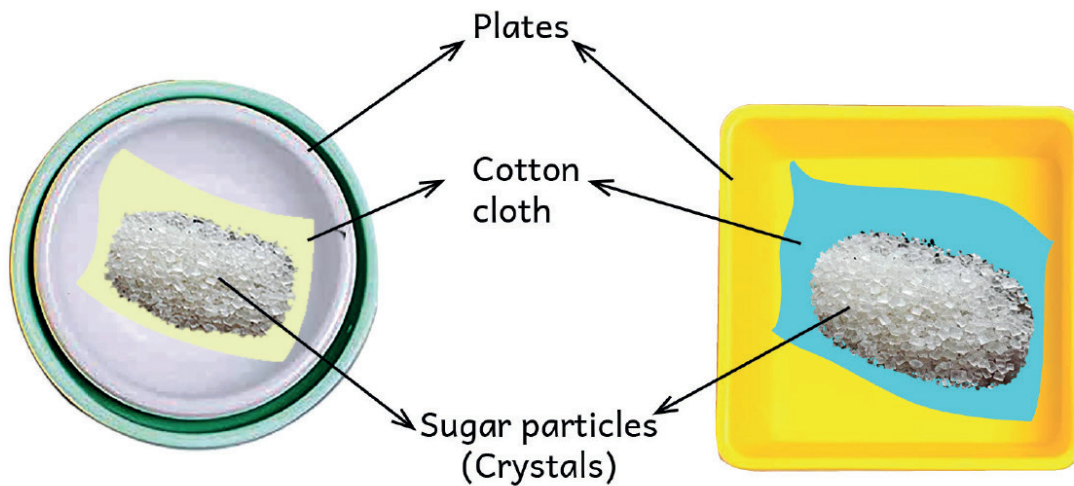
Activity 1.1: Experiment to demonstrate the effect of wetness on a gas exchange surface using a cloth

Materials you will need

Two small dry pieces of cotton cloth, water, sugar, two plates

Procedure

- i) Cut two small pieces of cotton cloth about the size of your palm, label one cloth A and the other B.
- ii) Put cloth A on a dry plate placed on a flat surface.
- iii) Deep cloth B in water and immediately transfer it onto another dry plate placed on a flat surface.
- iv) Take a small pinch of sugar using your thumb and fore fingers and sprinkle over cloth A.
- v) Take another pinch of sugar and sprinkle over cloth B.



- vi) Leave the cloths for about 10 minutes.

Questions

1. State your observation after the ten minutes.
2. What could have caused the observation given above?
3. If the cloths represent gas exchange surfaces, what does the sugar represent?

4. Which of the two cloths represents an efficient gaseous exchange surface?
5. Briefly explain your answer in (4) above.

LESSON SUMMARY

Effective gas exchange surfaces must be moist/wet. The film (thin layer) of water on the surface dissolves the oxygen so that it can be able to diffuse across the surface.

Application

One of the severe symptoms of covid-19 is suffocation. This is due to a thick mucus layer over the surface of the lungs that reduces the rate at which oxygen is taken up into blood by the lungs.

Lesson2: Surface Area of a Gas Exchange Surface

By the end of this lesson, you should be able to;

- i) state how gas exchange surfaces attain large surface area.
- ii) explain why gas exchange surfaces should have large surface area.

INTRODUCTION

In lesson 1, we learnt that gas exchange surfaces should be moist to allow easy diffusion of gases. Let us look at another essential feature of gas exchange surface.

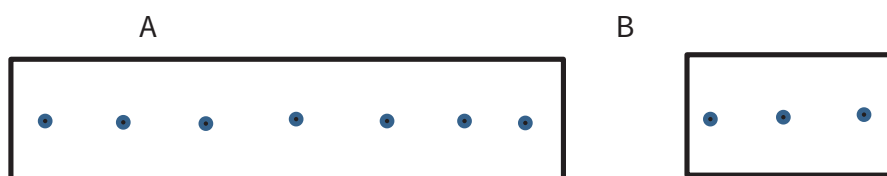
Activity 2.1: To demonstrate the effect of surface area on gas exchange surfaces using paper model

Materials you will need

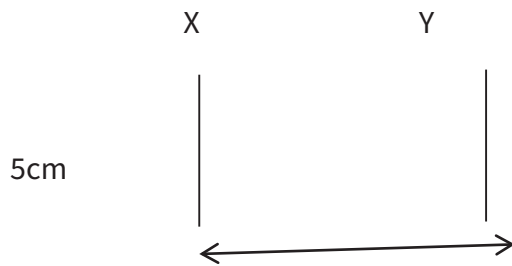
White paper, pencil/pen and a ruler

Procedure

- i) Cut two rectangular pieces A and B from the white paper with A measuring 15cm long and 2cm wide, and B measuring 5cm long and 2cm wide.
- ii) Using a pen/pencil, write dots on A and B along the middle length of each such that each dot is 1cm from the other as shown below.



- iii) Draw two parallel vertical lines X and Y on a flat surface, that are 5cm apart as shown below



- iv) Fit paper A between the lines X and Y. Ensure that the shorter sides of the paper lie on lines X and Y.
 v) Remove A from X and Y lines, and put it aside.
 vi) Fit paper B between the lines X and Y. Ensure that the shorter sides of the paper lie on lines X and Y.

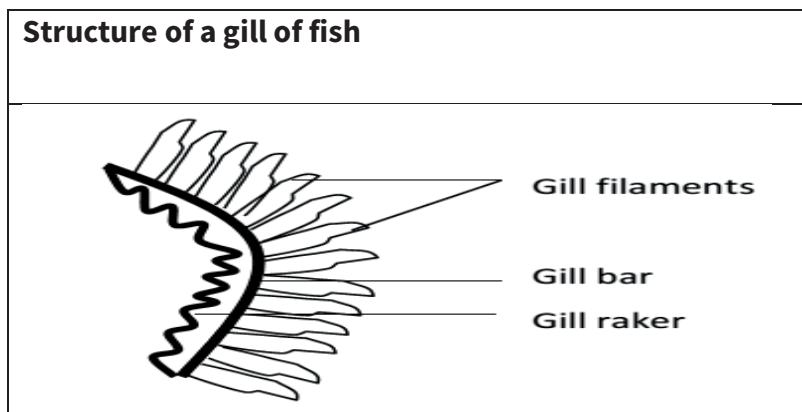
Questions

1. On which paper were you able to write the bigger number of dots?
2. What makes the paper you have chosen in (1) above to have the bigger number of dots?
3. How were you able to fit paper B between X and Y lines?
4. If we consider the pieces of paper to represent gas exchange surfaces and the dots to represent a diffusing gas,
 - i) Which paper represents a more efficient gas exchange surface?
 - ii) How can a gas exchange surface achieve large surface area and still occupy a smaller space?
 - iii) Why is it important for a gas exchange surface to have a large surface area?

SUMMARY

In Activity 2.1, you noticed that paper A has got a larger surface area than paper B and therefore carries more dots. You might have realized that paper A cannot fit in the same space as paper B unless it is folded.

In the same way, efficient gas exchange surfaces have large surface area to enable diffusion of gases in large amounts. This is achieved by folding or branching of structures to form numerous structures. For example, numerous alveoli in lungs, gill filaments in the gills and tracheoles in insects.



Basing on only what you can observe from the figure above, how is the gill adapted for gas exchange?

Lesson 3: Thinness of a Gas Exchange

By the end of this lesson, you should be able to explain the importance of thinness of a gas exchange surface.

INTRODUCTION

In lesson 2, we found out that gas exchange surfaces have a large surface area to enable a large amount of gases to be exchanged. During this lesson we will look at another essential feature of gas exchange surface.

Activity 3.1: To demonstrate the effect of thinness of a gas exchange surface on rate of diffusion of a gas using rectangles of different widths

Materials you will need

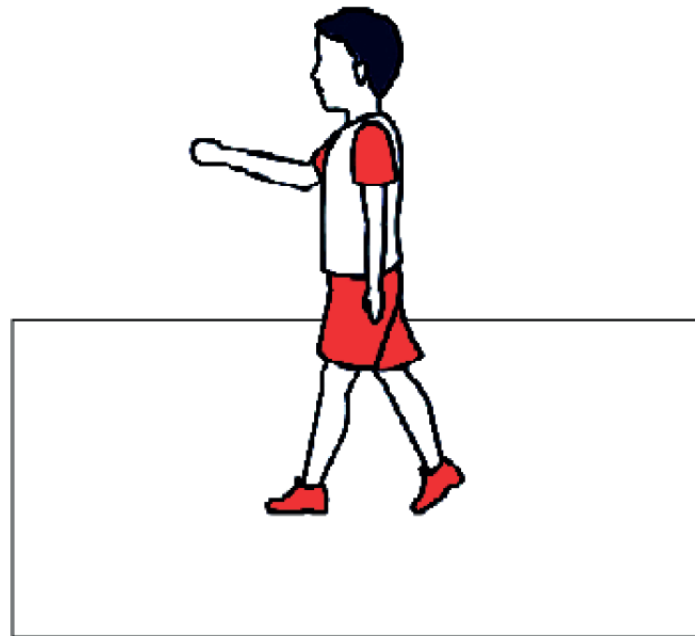
Stick/ piece of charcoal

Procedure

- i) In your compound, draw two rectangles P and Q on the ground using a stick or piece of charcoal. Rectangle P should be about 5 meters wide and 7 meters long while rectangle Q should be about 1-meter-wide and 7 meters long.

Note: You can use long steps (strides) to measure the lengths, or ask an adult to assist you. Each stride is about one meter

- ii) Walk gently across the width of P, from one line up to the other.



- iii) Repeat procedure (2) above with rectangle Q. Try as much as you can to walk at the same speed as you did in (2) above. Take notice of how long it takes to cross each rectangle.

Questions

1. In which rectangle did you take more time to walk across?
2. Why do you think it took you more time in the rectangle mentioned in (1) above?
3. Consider;
 - i) rectangles P and Q to represent gas exchange surfaces.
 - ii) the person walking through the rectangles(you) to represent the diffusing gas.
 - iii) the widths of the rectangles to represent thickness of gas exchange surfaces.
4. Which of P and Q represents an efficient gas exchange surface? Explain your answer.

In Activity 3.1, you might have realised that you take a longer time to cross a wide area than a thin area. In the same, way respiratory gases (oxygen and carbon dioxide) diffuse faster across thin surfaces compared to thick surfaces. Therefore, efficient gas exchange surfaces should be thin walled to reduce on the distance over which diffusion has to take place.

They are normally one cell thick.

Other characteristics of efficient gas exchange surfaces include:

- i) A good network of blood capillaries for rapid transportation of gases to the respiring tissues hence maintaining the diffusion gradient.
- ii) They are well ventilated to maintain a high concentration gradient that favours diffusion of gases.
- iii) They are permeable and therefore gases can pass through them.

Note: Unlike animals, plants do not have a special gas exchange surface, (apart from a few exceptions). They actually do not need these special gas exchange surfaces. Plants use simple pores that is stomata of the leaves and lenticels of the stems for gas exchange. Gases circulate in the plant by simple processes of diffusion due to abundant large intercellular spaces that make diffusion faster.

Question

In plants, oxygen is used in respiration and carbon dioxide is released as a product while carbon dioxide is used in photosynthesis and oxygen released as a product. Basing on that fact, explain why plants do not need special gas exchange surfaces.

Lesson 4: Tissue Respiration

By the end of this lesson, you should be able to;

1. define tissue respiration.
2. state the substrate and products of chemical oxidation of food in a cell.

INTRODUCTION

Just like a radio needs electric power to “speak”, all living organisms need energy to live. Even if you choose to do nothing in a day, energy is still required to keep your heart beating, to breathe and run many other processes in your body cells.

Where does this energy come from? We shall be able to answer this question in this lesson.

Exercise

Mention at least five activities or processes that occur in your body that need energy to take place.

Activity 4.1: To demonstrate the process of combustion in living organisms using dry grass/leaves

Materials you will need

Dry grass/leaves and a match box/fire source

CAUTION: Carry out the activity in an open space for safety.

Procedure

- i) Make a small heap of dry grass/leaves in an open place.
- ii) Using a match box or any other fire source, set the dry grass/leaves on fire.
- iii) Carefully observe the burning and answer the following questions.

Questions

1. Identify at least two forms of energy produced from the above process.
2. Where is this energy coming from?
3. Which substance in air supports the process above?

In a similar way, when food (glucose) is burnt (chemically oxidized) in the body, energy is released. This process is called respiration/tissue respiration. It occurs inside our body cells and involves the action of enzymes.

Glucose is the main type of food burnt during respiration. All other foods are first converted to glucose before they are respired. Unlike the burning of grass, respiration can occur in the presence of oxygen (aerobic respiration) or in absence of oxygen (anaerobic respiration).

Exercise

1. Define tissue respiration.
2. Which type of respiration in particular is represented by burning of grass in activity 4.1 above?

SUMMARY

Tissue respiration is a process through which energy is released from chemical oxidation of glucose. The energy released is stored in form of molecules called Adenosine Triphosphate (ATP) which can be used later when energy is needed. Heat is also produced. Carbon dioxide and sometimes water are usually given off as products.

Lesson 5: Aerobic Respiration

By the end of this lesson, you should be able to demonstrate that oxygen is used during aerobic respiration.

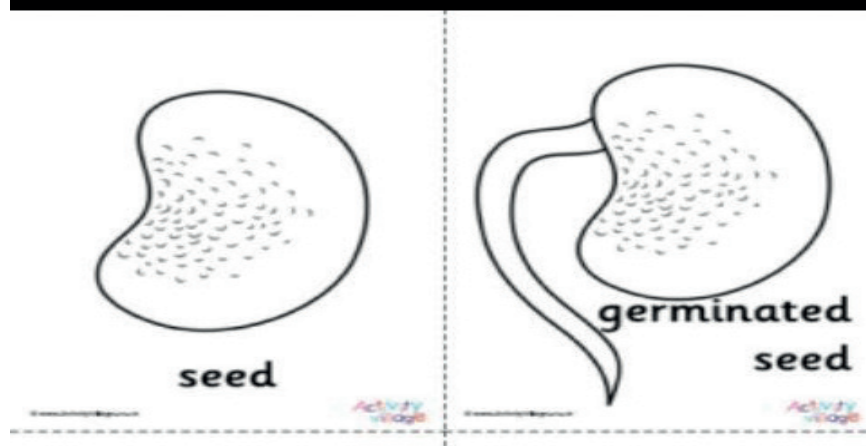
Activity 5.1: Experiment to demonstrate that oxygen is required in aerobic respiration using germinating seeds

Materials you will need

Germinating seeds, water, two identical soft bodied plastic mineral water bottles, wood ash, small stones, cotton cloth (the size of a big exercise book)

Procedure

- i) prepare germinating bean seeds using the steps below:
 - a) Soak bean seeds (about 50) in clean water within a bowl/container for about 12 hours.
 - b) Wet a piece of cotton cloth with water, squeeze out any excess water.
 - c) Remove the seeds from water in the bowl, transfer them onto a wet cloth and make sure the seeds are at least 1cm apart.
 - d) Roll or fold the wet cloth over the seeds, place them in a container, where possible keep them in a warm place to speed up germination.
 - e) Wait for two days, then check seeds daily for germination



- ii) Add a full cup of ash in a container/ basin and add 2 thirds of a cup of water, and stir with a stick in order to form a paste(suspension).
- iii) Add the ash-water mixture to each mineral water bottle to a quarter the total volume of the bottle. Label one bottle A and the other B.
- iv) Add small stones (about 2cm in diameter) in each bottle until they reach the level of the ash-water mixture.
- v) Boil half of the germinating bean seeds, and leave the other half fresh.
- vi) Put the fresh germinating bean seeds onto the stones in bottle A, and the boiled beans onto the stones in bottle B.
- vii) Cover the bottles tightly such that no air enters or leaves the bottle.
- viii) Leave the setup to stand for about 4 hours.

Questions

1. What is your observation after the 4 hours?
2. What could be the purpose of ash-water mixture?
3. Why were the germinating seeds in B, boiled?
4. What evidence in the activity above proves that oxygen is required during aerobic respiration?
5. Explain your answer in (4) above.

SUMMARY

In bottle A, the oxygen is absorbed by the germinating seeds during respiration and carbon dioxide is released back into the bottle. The carbon dioxide is absorbed by solution in the ash-water mixture. This reduces the amount of air and thus pressure inside the bottle reduces, since external pressure becomes higher than pressure inside the bottle, the walls of the bottle shrink(fall) in wards. This proves that oxygen is used during aerobic respiration.

Note: Ash water contains potassium hydroxide which can absorb carbon dioxide.

The word **aerobic** means that oxygen is needed for this chemical reaction. The food molecules are combined with oxygen. The process is called **oxidation** and the food is said to be **oxidized**. All food molecules contain carbon, hydrogen and oxygen atoms.

The process of oxidation converts the carbon to carbon dioxide (CO₂) and the hydrogen to water (H₂O) and, at the same time, sets free energy, which the cell can use to drive other reactions.

Aerobic respiration can be summed up by the equation

glucose + oxygen \longrightarrow carbon dioxide + water + energy

Self-check question

One student said “keeping plants in our rooms is good because they provide for us oxygen at night.”

- i) Which process in plants is responsible for producing oxygen?
- ii) At what time (day/night) does the process you have mentioned in (i) above take place?
- iii) Do you think the statement the student made is correct? Give a reason for your response

Lesson 6: Anaerobic Respiration

By the end of this lesson, you should be able to;

- i) state the importance of anaerobic respiration.
- ii) demonstrate fermentation in yeast.

INTRODUCTION

In the previous lesson, we learnt that respiration takes place in the presence of oxygen. Body activities that need a lot of energy in a short time, like running/sprinting cannot depend on aerobic respiration alone. *Why is it so?* The rate at which oxygen is taken up by the body is lower than what is required.

Therefore, some energy has to be produced in absence of oxygen. This is called anaerobic respiration. In this process, energy is still released from food by breaking it down chemically but the reactions do not use oxygen and they often produce carbon dioxide.

Anaerobic respiration occurs in plants and microorganisms as well. A common example is the action of yeast on sugar solution to produce alcohol.

Activity 6.1: Demonstrating anaerobic respiration using fermentation of sugar in presence of millet

Materials you need

Millet flour, two mineral water bottles with covers, sugar/sugar cane

Procedure

- i) Add about four tea spoons of sugar in half a cup of water.
- ii) In case you have no access to sugar, you can as well use sugar cane. First soften it and then squeeze out the juice into a cup. Do this until you collect half a cup of sugar cane juice. Divide the solution into two equal parts.
- iii) Pour each part of the sugar solution into a bottle.
- iv) Add a handful of millet flour in a clean cup, followed by an equal volume of warm water and stir. (Do not use hot water)
- v) Pour the millet paste into the sugar solution in one bottle and label that bottle A, label the other bottle B.
- vi) Seal the two bottles tightly using their covers.
- vii) Keep the two bottles in a warm place or you can wrap them in a dry thick cloth.

- viii) Leave the bottles for two days. After the two days, open each bottle starting with bottle B and then A.

Questions

1. State your observation in the two bottles after the 2 days.
2. In which bottle did fermentation take place?
3. What evidence is there to support your answer in (2) above?
4. What made fermentation possible in the bottle mentioned in (2) above?
5. What are the products of fermentation of sugar?

Fermentation occurred due to anaerobic respiration of microorganisms such as yeast in the millet. The sugar is converted into glucose which is then broken down in absence of oxygen to form ethanol(alcohol) and carbon dioxide.

SUMMARY

During fermentation of sugar, alcohol and carbon dioxide are produced. This explains why the bottle in which fermentation took place, swells.

Note: Anaerobic respiration in animals produces lactic acid instead of ethanol like in plants.

Applications

- Because yeast respire anaerobically, it is widely used in brewery companies to make alcohol. Remember alcohol is used to make sanitizers which are being used worldwide in the fight against COVID-19.
- Yeast is also used in baking factories to make bread, cakes, etc.

Topic 2: Excretion and Homeostasis

Lesson 7: Excretion in Animals

By the end of this lesson, you should be able to;

1. define excretion.
2. describe the structure of mammalian kidneys.
3. explain how kidneys function in getting rid of waste products from the body.

INTRODUCTION

In a home, various activities take place on a daily basis. *What are these activities?* Most of those activities such as cooking produce wastes which, if left to accumulate in the house, may to diseases and other health problems to arise.

How do you get rid of wastes from your house/home?

In the same way, many chemical reactions take place inside the cells of an organism in order to keep it alive. Some products of these reactions are poisonous and must be removed from the body. For example, the breakdown of glucose during respiration produces carbon dioxide which is toxic if left to accumulate in the body. It is therefore carried away by blood into the lungs where it is breathed out/excreted.

Using the information above, how can you define excretion?

EXCRETORY ORGANS

In the table below, fill in the excretory organs that correspond to the excretory products given. You may pick answers from the box below.

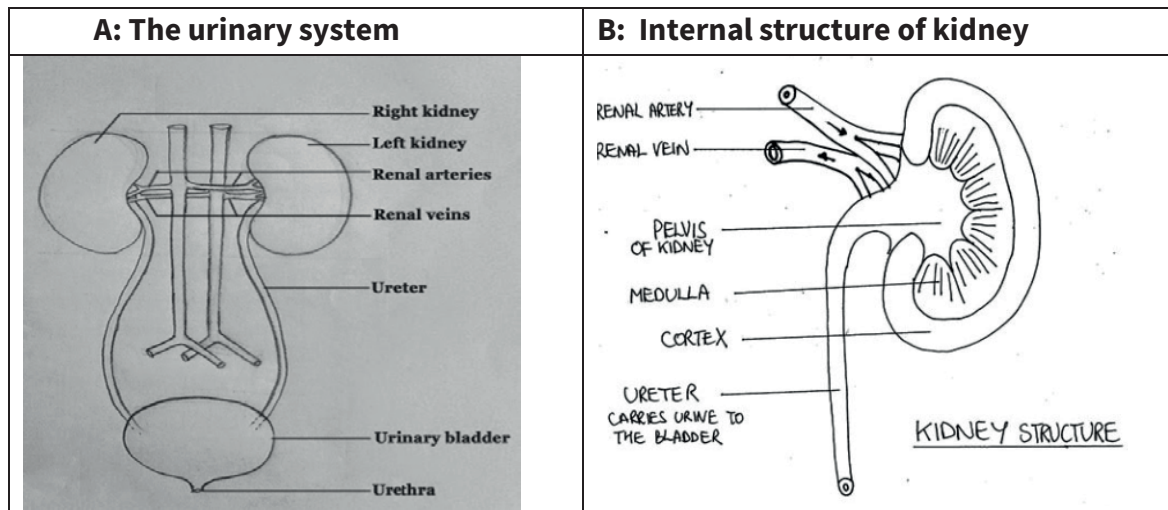
Lungs	Skin	Malpighian tubules	Kidney	Liver
-------	------	--------------------	--------	-------

Excretory organ	Excretory product
.....	Bile pigments
.....	Carbon dioxide and water
.....	A lot of Urea, excess salts and excess water
.....	Excess water, excess salts and some urea
.....	Uric acid

Structure of the Kidney

Activity 7.1: The kidney structure

In this activity, you are to study the kidney structure. Use the activity to fill the blank spaces in the sentences that follow.



1. According to figure A, we have two kidneys that are shaped.
2. The blood vessel that carries oxygenated blood with all food nutrients to the kidney is.....
3. The..... carries filtered blood from the kidney.
4. The..... is a narrow tube arising from hilum of each kidney. It transports urine from the kidney to the urinary bladder.
5. The..... is a thick-walled elastic sac-like structure which stores urine.
6. The passage for urine to the outside of the body is.....

Role of kidney in excretion

Activity 7.2: Experiment to demonstrate the role of the kidney

Materials you will need

Tea leaves, water, a clean piece of cloth, sugar, cup, mineral water bottle

Note: Make sure the cloth and bottle are clean.

Procedure

- i) Prepare a cup of tea with sugar in it. (Add sugar and tea leaves to hotwater)
- ii) You can taste a little. Pour the rest of the tea in a mineral water bottle.
- iii) Put the cloth over the mouth of the bottle, tightly tie the cloth using a thread along the neck of the bottle.
- iv) Invert the bottle over an empty cup so that what is in the bottle can pass through the cloth.
- v) You can gently press the walls of the bottle to quicken the process.
- vi) If you used a clean cloth and bottle, you can taste the solution collected in the cup.

Questions

1. Which components of tea were able to pass through the cloth?

Tick the correct answer(s)		
Sugar	tea leaves	water

2. Which components were not able to pass through the cloth?

Tick the correct answer(s)		
Sugar	tea leaves	water

3. Explain why some components were not able to pass through the cloth.
4. What name do we give to the process where smaller particles pass through a surface and larger particles fail to pass through?
5. Why do substances pass through the cloth faster when you press the walls of the bottle?

In a similar way, blood goes to the kidneys to be filtered. The main aim is to remove wastes, that is urea, excess salts and excess water from blood. Blood going to the kidneys mainly contains blood cells, water, plasma proteins, glucose, salts and urea.

Like in the Activity 7.2 above, small sized particles (water, glucose, salts and urea) in blood pass through the filter and big particles (blood cells and plasma proteins) are retained in blood. However, those substances that the body still needs such as glucose are reabsorbed from the filtrate back into the blood. The wastes are lost as urine.

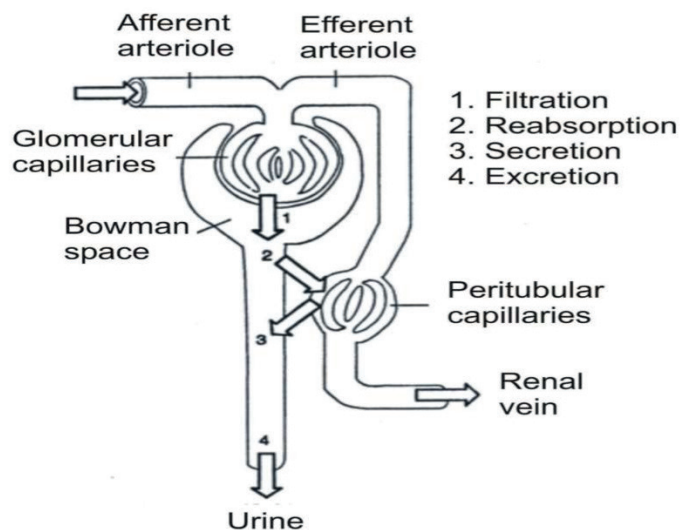
The filter in the kidney are special capillaries called glomerulus found in the nephron. The nephron is the structural and functional unit of a kidney. They are over a million nephrons in a single kidney.

Activity 7.3: The process of urine formation

In this activity, you are required to fill in the blank spaces in the passage below in order to come up with a meaningful description of the process of urine formation. Use the words in the box provided. **Note:** Each word should be used only once

blood plasma, water, too big, ultrafiltration, renal capsule, glucose, concentration, body, urea, urine, selective reabsorption

The figure below shows the structure of a nephron, use it to help fill in the gaps.



The blood pressure in a glomerulus causes part of theto leak through the capillary walls. The red blood cells and the plasma proteins areto pass out of the capillary, so the fluid that does filter through is plasma without the protein.

The fluid thus consists mainly ofwith dissolved salts, glucose, urea and uric acid. The process by which the fluid is filtered out of the blood by the glomerulus is called.....

The filtrate from the glomerulus collects in the..... and moves down the renal tubule. As it does so, the capillaries that surround the tubule absorb those substances which the body needs back into the blood.

First, all the..... is reabsorbed, with much of the water. Then some of the salts are taken back to keep the correct..... in the blood. The process of absorbing back the substances needed by the body is called.....

Salts not needed by the..... are left to pass on down the kidney tubule together with the..... and uric acid. So, these nitrogenous waste products, excess salts and water continue down the renal tube into the pelvis of the kidney. From here the fluid, now called....., passes down the ureter to the bladder.

SUMMARY

Excretion is the removal of toxic materials and substances in excess of requirements from the body of an organism. The kidney excretes urea, excess water and excess minerals. This is done through ultrafiltration followed by selective reabsorption. This occurs in the nephron which is the structural and functional unit of a kidney.

KEYWORD

Ultrafiltration; a form of filtration that is aided by pressure, for example in the glomerulus

Lesson 8: Homeostasis

By the end of this lesson, you should be able to;

- i) define homeostasis.
- ii) explain the concept of osmoregulation.

Activity 8.1: Defining homeostasis

In this activity, you are to study the figure below and use it to define homeostasis.



How is the man in the picture able to walk on a rope?

Well, there are forces pulling him to fall on either side of the rope. To avoid getting hurt, he has to resist falling and so he has to balance along the rope. In a similar way, there are factors that tend to pull conditions inside our bodies away from the normal. However, the body has a way of resisting these changes through homeostasis.

Questions

1. What does the path on the rope represent in terms of homeostasis?
2. How can you define homeostasis?

The internal environment of the body is composed of tissue fluids, which surround cells. Homeostasis involves balancing the blood sugar level, salt level, water level, temperature and carbon dioxide concentration. *Why is it important to maintain these conditions constant?*

Why is it important to maintain a constant internal environment?

Osmoregulation

Activity 8.1: Demonstrating the concept of osmoregulation using a cup of tea

Materials you need

Sugar, cup, clean water, tea spoon

What to do

- i) Pour clean water into a cup up to a quarter the volume of the cup. Taste the water.
- ii) Add half spoonful of sugar into the water and stir. Taste again, how does the solution taste now?
- iii) Add more clean water to the cup until it is full. Taste the solution again.
- iv) Add some sugar little at time while steering until the solution tastes like it was in step (2) above.

Questions

1. What can you do to increase the concentration of sugar in tea?
2. If the concentration of sugar in tea is too high, how do you lower it down?

Just like in Activity 8.1 above, the concentration of salts and sugars in blood has to be maintained at a normal level. When blood concentration is low, more salts or sugars are taken into blood, or excess water is lost.

When blood concentration is too high, the blood has to be diluted either by removing some sugars and salts, or taking up more water. This is achieved through the process of osmoregulation.

Questions;

1. How can you define osmoregulation?
2. Briefly explain how osmoregulation is related to homeostasis?

SUMMARY

Homeostasis is the maintenance of a constant internal environment of the body. Most of the cell processes are driven by enzymes whose performance is greatly affected by changes in pH, temperature, etc. It is therefore important to keep these conditions within the optimum levels.

Osmoregulation is the process by which blood concentration is maintained constant. it is an example of homeostasis.

Key words

1. **Tissue fluid**; a colourless liquid that surrounds/bathes body cells. It arrives to cells through blood capillaries and it is removed by lymphatic system.
2. **Internal environment**; the immediate surrounds outside body cells.

Lesson 9: Blood sugar regulation

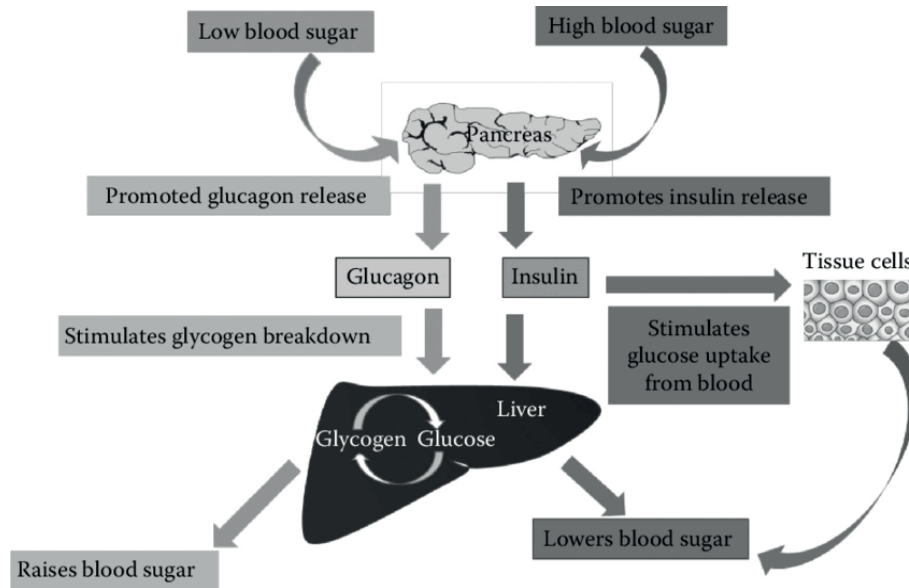
By the end of this lesson, you should be able to;

- Explain how the liver regulates blood sugar level in the human body.

Introduction

Regulation of blood sugar is an example of osmoregulation in the body. It takes place in the liver; The pancreas plays a big role as well in this process. Why is blood sugar regulation so important? Remember glucose is the main source of energy in the body (through respiration). Regulation of blood glucose prevents cells from running short of glucose in case its level drops. However, high glucose levels increase blood concentration and this results in excessive movement of water out of body cells.

Activity 9.1; in this activity, you are required to study the figure below about blood sugar regulation, and then answer the questions that follow.



- a) The two endocrine hormones, insulin and glucagon are produced by the.....
- b) Which of these hormones is released during low blood sugar levels?
- c) Which of these hormones causes the liver cells to convert glucose to glycogen.
- d) What is the effect of insulin in
 - i) Tissue cells
 - ii) The liver
- e) With reference to the figure above, Complete the following passage by filling in the words provided in the box below, so as to come up with a meaningful description of blood sugar regulation.

Liver cells, glucose, glycogen, raises, high,

When blood sugar level is, for example after eating a heavy carbohydrate meal, the pancreas releases a hormone called.....into blood. When this hormone reaches the liver, it stimulates..... to take up glucose, convert it to glycogen and store the glycogen. It also increases uptake of glucose in all

tissue cells to be used in respiration. The blood sugar reduces thus restoring it back to normal

When blood sugar level is low for example during fasting, the pancreas releases Instead of On reaching the liver, glucagon stimulates liver cells to convert some of their stored into glucose. This blood sugar thus restoring it back to normal levels

Summary

If the level of sugar in the blood falls, the islets release glucagon into the bloodstream. Glucagon acts on the cells in the liver and causes them to convert some of their stored glycogen into glucose and so restore the blood sugar level. Insulin has the opposite effect to glucagon. If the concentration of blood sugar increases, insulin is released from the islet cells. When the insulin reaches the liver it stimulates the liver cells to take up glucose from the blood and store it as glycogen. Insulin has many other effects; it increases the uptake of glucose in all cells for use in respiration; it promotes the conversion of carbohydrates to fats and slows down the conversion of protein to carbohydrate.

Self-Check questions

1. The term antagonistic hormones is used to describe two hormones having opposite effects in the body, briefly explain why insulin and glucagon may be termed as antagonistic hormones.
2. Briefly Describe the homeostatic events that take place;
 - after eating a heavy meal of posho and beans.
 - during a prolonged period of fasting
3. A Patient of diabetes mellitus faces a problem of blood sugar balance, his/her body is unable to produce insulin. Externally made Insulin is normally given to him/her in form of injections.
 - a). Which organ in the body is likely to malfunction as a result into diabetes mellitus.
 - b). Explain to a patient of diabetes mellitus why he/she needs to take the insulin injection 15 to 30 minutes before eating a meal.

Key words.

1. **Endocrine hormone;** a chemical substance released into blood and has effect on activity of cells in a particular organ/tissue
2. **Islets cells;** also known as islets of Langerhans, these cells are located in the pancreas and responsible for secretion of insulin and glucagon
3. **Insulin;** a hormone produced from beta cells of islets of langerhans in the pancreas
4. **Glucagon;** a hormone produced by alpha cells of islets of Langerhans in the pancreas

Lesson 10: The mammalian skin

By the end of this lesson you should be able to

- List the parts of a mammalian skin.
- Describe the functions of the skin.

Introduction

The skin is the most extensively distributed tissue all over the body of mammals. Your entire body is covered up the skin.

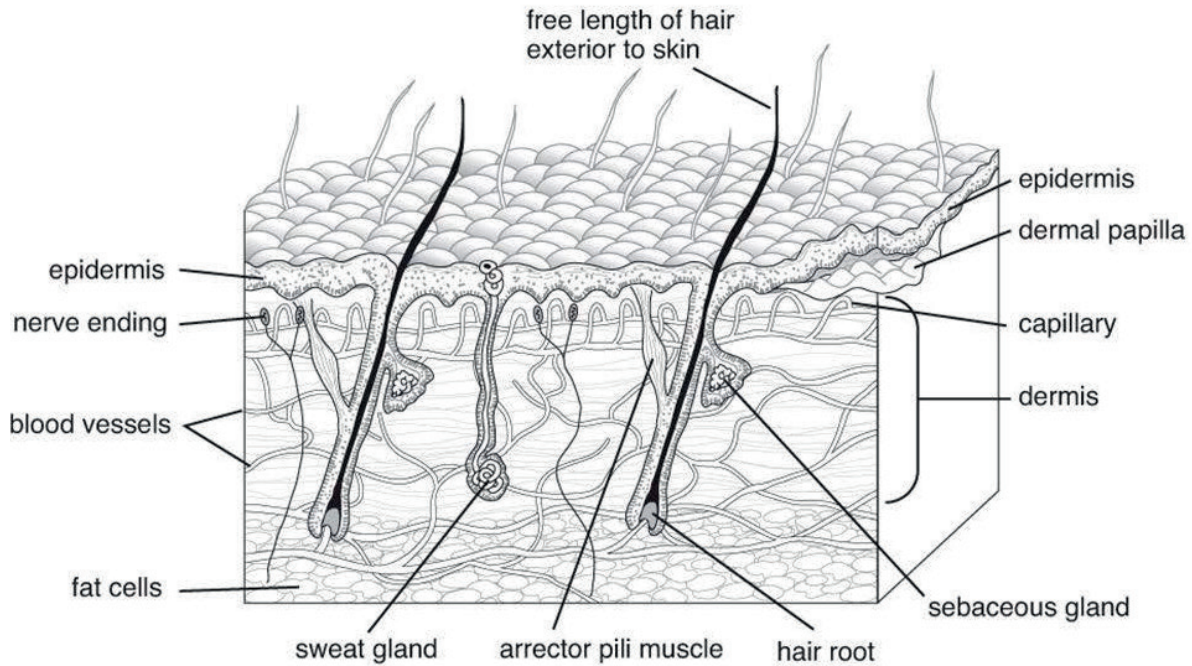
Structure of the mammalian skin.

Take a close look at your skin on one of your hands.

Which structures can you observe?

Activity 10.1; Study the figure below and answer the questions that follow.

Mammalian Skin



Adapted from Romer, A. S., and Parsons, S. T. *The Vertebrate Body*. Saunders, 1977.

a) The skin consists of two main layers. Can you identify them? The thin outer layer called..... and the inner thick layer called the

The epidermis is made up of three sub layers; Malpighian, granular, and cornified layers.

b). Identify the structures found in the dermis layer

c). Complete the following sentences by filling in the most suitable word in order to form a meaningful sentences. Choose a suitable word from the figure given above.

i) The extend from the dermis through the epidermis. They arise from hair follicles in the dermis.

ii) The..... secretes an oily substance called sebum which softens the cornified layer and prevents it from cracking. The oil also provides water proofing to the skin.

iii) The..... perceive external stimuli and transport impulses to the central nervous system.

iv). The..... are coiled tubular glands located in the dermis. They excrete sweat, which is released out of the skin through the

Functions of the skin

Activity 10.2; In this activity, match each feature of the skin in box A, with a corresponding skin function in box B, that feature is involved in. A statement in each box may be used more than once.

Box A; Features of skin
A. Cornified layer composed of dead cells
B. Presence of sweat gland in the dermis
C. Has erector pili muscles which can contract or relax to adjust position of hairs
D. Contains a pigment called melanin which absorbs sunlight
E. Presence of fat layer under the skin
F. Presence of nerve endings in the dermis
G. Cornified layer is covered with oily substance called sebum

Box B; functions of skin
1. To protect the tissue below it from mechanical damage, bacterial and viral infections.
2. It prevents excess loss of water from the body.
3. It acts as a sense organ and it is sensitive to pain, touch and heat and this helps the organism to be aware of its environment.
4. It helps to keep the body temperature of endothermic organisms constant.
5. It synthesizes vitamin D in presence of sunlight.
6. It acts as an excretory organ. It excretes sweat, which contains urea, water and excess salts
7. insulates the body against excessive heat loss

Temperature regulation by the mammalian skin.

Temperature regulation is a process of maintaining the temperature of the organism within narrow ranges, which favour body activity, and ensures optimum activity of body enzymes.

Organisms that can maintain a constant body temperature irrespective of the changes in environment are called endothermic/Homoithermic animals. Those that are not able to do so, and their temperature changes with that of the environment are called ectothermic/poiklothermic animals. All mammals are endothermic animals

During cold weather; the erector pili muscles contract, this causes hairs on the skin surface to stand upright and trap a layer of air between them, this layer of air insulates the body thus reducing heat losses to the surrounding.

During hot weather, the erector pili muscles relax, causing hairs to lay flat along the skin surface, no air layer is trapped as a result. This reduces insulation thus more heat is lost to the surrounding.

Sweat is secreted and released by sweat glands through sweat ducts, the sweat evaporates along the skin surface. The heat required to evaporate the sweat is removed from the body, thus resulting in cooling of the body.

Note; temperature regulation is not done by the skin alone; many other events occur in the body to ensure that temperature is maintained generally constant.

Other events that occur during temperature regulation include

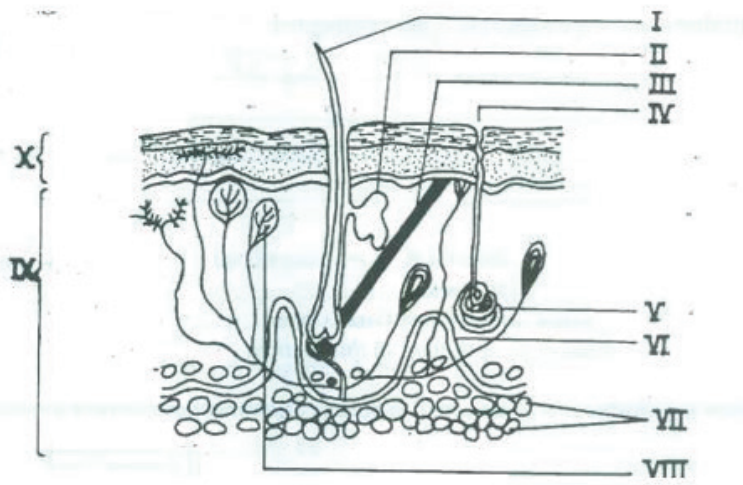
- a) In cold weather
 - The metabolic activity of the liver increases to produce energy in form of heat.
 - Shivering. This is the rhythmic contractions of the skeletal muscles. It results into production
 - Blood vessels near the skin constrict in the process called vasoconstriction to reduce on the blood reaching the skin. This reduces heat loss.
 - sweat product stops/reduces to minimize heat losses through evaporation
 - Small animals like the mouse undergo hibernation where they dig holes and live deep in them to reduce heat loss of heat energy.
- b) in hot weather;
 - The metabolic rate of the body reduces to reduce on the amount of heat produced.
 - Vessels dilate(vasodilation) and allow more blood to reach the skin surface in order to lose heat to the surroundings by radiation.

Exercise

1. Describe how the skin is suited to perform its functions.

2. What is the function of sebum in the skin

3. The figure below shows a section through the mammalian skin,



- a). Name the parts labelled I to IX
- b) Briefly describe what happens parts I and III during cold weather.
- c) Name the part that;
 - i). enables you to feel pain
 - ii) secretes sweat during hot weather
 - iii) Insulates the body to reduce heat losses

Summary

The mammalian skin is mainly made up of two layers; the epidermis and the dermis. The epidermis is further divided in three layers, the cornified layer, granular layer and Malpighian layer. The dermis contains, blood vessels, capillaries, nerve endings, hair follicles, sweat glands, sebaceous glands. A layer of fat is normally found under the dermis of the skin.

Functions of the skin include;

- protection of the tissue below it from mechanical damage, bacterial and viral infections.
- prevention of excess loss of water from the body.
- It is a sense organ
- synthesis of vitamin D in presence of sunlight.
- It acts as an excretory organ. It excretes sweat, which contains urea, water and excess salts.
- it helps in regulating body temperature

CORONAVIRUS (COVID-19) PREVENTION



WASH HANDS WITH SOAP

20 SEC



USE A MASK



USE HAND SANITIZER



SNEEZE INTO ELBOW



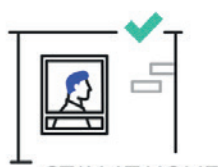
AVOID TRAVELLING



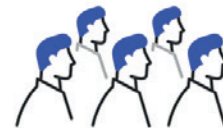
KEEP OBJECTS CLEAN



AVOID CONTACT



STAY AT HOME



AVOID CROWD PLACES



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