SUB-TOPIC: Types of teeth

OBJECTIVES:

- Using a diagram, students will correctly draw the structure of a tooth and label the parts of a tooth

CONTENT

- Types of teeth

Most people start adulthood with 32 teeth, not including the wisdom teeth. There are four types of teeth, and each plays an important role in how you eat, drink, and speak.

<table>
<thead>
<tr>
<th>Types of human teeth</th>
<th>Incisor</th>
<th>Canine</th>
<th>Premolar</th>
<th>Molar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position in mouth</td>
<td>Front</td>
<td>Either side of incisors</td>
<td>Behind canine</td>
<td>Back</td>
</tr>
<tr>
<td>Description</td>
<td>Chisel-shaped (sharp edge)</td>
<td>Slightly more pointed than incisors</td>
<td>2 parts (cups), 3 or 2 roots</td>
<td>4 or 5 cups, 2 or 3 roots</td>
</tr>
<tr>
<td>Function</td>
<td>Biting of pieces of food</td>
<td>Similar function to incisors</td>
<td>Tearing and grinding food</td>
<td>Chewing and grinding food</td>
</tr>
</tbody>
</table>

Figure 1 Showing the types of teeth
Figure 2 Showing the internal structure of a tooth

- **Functions of the parts of a tooth**

The root is the part of the tooth that extends into the bone and holds the tooth in place. It makes up approximately two-thirds of the tooth.

It’s made up of several parts:

- **Root canal**: The root canal is a passageway that contains pulp.

- **Cementum**: Also called cement, this bone-like material covers the tooth’s root. It’s connected to the periodontal ligament.

- **Periodontal ligament**: The periodontal ligament is made of connective tissue and collagen fiber. It contains both nerves and blood vessels. Along with the cementum, the periodontal ligament connects the teeth to the tooth sockets.

- **Nerves and blood vessels**: Blood vessels supply the periodontal ligament with nutrients, while nerves help control the amount of force used when you chew.
- **Jaw bone:** The jaw bone, also called the alveolar bone, is the bone that contains the tooth sockets and surrounds the teeth’s roots; it holds the teeth in place.

The neck, also called the dental cervix, sits between the crown and root. It forms the line where the cementum (covers the root) meets the enamel.

It has three main parts:

- **Gums:** Gums, also called gingiva, are the fleshy, pink connective tissue that is attached to the neck of the tooth and the cementum.
- **Pulp:** The pulp is the innermost portion of the tooth. It’s made of tiny blood vessels and nerve tissue.
- **Pulp cavity:** The pulp cavity, sometimes called the pulp chamber, is the space inside the crown that contains the pulp.

The crown of a tooth is the portion of the tooth that’s visible.

It contains three parts:

- **Anatomical crown:** This is the top portion of a tooth. It’s usually the only part of a tooth that you can see.
- **Enamel:** This is the outermost layer of a tooth. As the hardest tissue in your body, it helps to protect teeth from bacteria. It also provides strength so your teeth can withstand pressure from chewing.
- **Dentin:** Dentin is a layer of mineralized tissue just below the enamel. It extends from the crown down through the neck and root. It protects teeth from heat and cold.
• **Tooth Decay**

Tooth decay is the softening of your tooth enamel and refers to the damage of the structure of the tooth caused by acids that are created when plaque bacteria break down sugar in your mouth. If this loss of mineral from the enamel is left untreated, a cavity, or hole in the tooth, can eventually occur. Without treatment, these holes can grow larger over time and may even destroy the whole tooth.

Taking good care of your teeth is an important part of maintaining your overall health and wellness, and that includes preventing the dreaded dental cavity. A dental cavity is one of the most common results of tooth decay and could be a sign of poor oral health and hygiene.

![Figures 3 and 4 Tooth decay](image)

**Causes of tooth decay**

- **Poor Oral Hygiene**: Not brushing your teeth regularly allows plaque to build up and attack the tooth enamel.
- **Plaque Formation**: When not removed on a regular basis, plaque adheres to your teeth and builds up over time. In the presence of sugar, plaque produces acid which attacks the enamel of your tooth and eventually can cause holes in your teeth, otherwise known as cavities.
- **Dry Mouth**: Saliva helps wash plaque from the teeth and buffer the acid. If you have a dry mouth with a very little saliva, plaque and tooth bacteria may build up more quickly.
- **Plaque Bacteria and Acid**: While most people don’t like to think about it, bacteria naturally live in your mouth and on your teeth. When these bacteria digest the food particles that linger on your
teeth and in your mouth, they produce acids. These acids will then tend to dissolve minerals inside the tooth through a process known as demineralization.

**How to prevent tooth decay**

- Brush with fluoride toothpaste after eating or drinking.
- Rinse your mouth.
- Visit your dentist regularly.
- Consider dental sealants.
- Drink some tap water.
- Avoid frequent snacking and sipping.
- Eat tooth-healthy foods.
- Consider fluoride treatments.

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**Figures 5 and 6 Showing how to care the teeth**

[How to use an electric toothbrush - AJ Hedger - Bing video](#)

[Types of Teeth and Structure of a Tooth - YouTube](#)
WORK SHEET 1                                                                       WEEK 1

INSTRUCTIONS – Answer all questions

1. Label the parts of the tooth.

2. State the functions of any ANY five structure of the tooth.

3. State three ways of how tooth decay can be caused.
4. Suggest THREE ways to prevent tooth decay.
WEEK: 2

LESSON: 2

TOPIC: Digestion and enzymes

GRADE 10

OBJECTIVES:

- Using a flow diagram, students will correctly define the term enzymes and state the importance of enzymes in the human digestive system.
- Using a diagram, students will correctly draw the human digestive system, label the parts of the human digestive system and state the adaptation of the small intestine in absorption.

CONTENT:

Chemical digestion could not take place without the help of digestive enzymes. An enzyme is a protein that speeds up chemical reactions in the body. Digestive enzymes speed up chemical reactions that break down large food molecules into small molecules.

<table>
<thead>
<tr>
<th>Digestive juices and enzymes</th>
<th>Substance digested</th>
<th>Product formed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Saliva</strong></td>
<td>Starch</td>
<td>Maltose</td>
</tr>
<tr>
<td>Amylase</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gastric juice</strong></td>
<td>Proteins</td>
<td>Partly digested proteins</td>
</tr>
<tr>
<td>Protease (pepsin) and hydrochloric acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pancreatic juice</strong></td>
<td>Proteins</td>
<td>Peptides and amino acids</td>
</tr>
<tr>
<td>Proteases (trypsin)</td>
<td>Fats emulsified by</td>
<td>Fatty acids and glycerol</td>
</tr>
<tr>
<td>Lipases</td>
<td>bile</td>
<td></td>
</tr>
<tr>
<td>Amylase</td>
<td>Starch</td>
<td>Maltose</td>
</tr>
<tr>
<td><strong>Intestinal enzymes</strong></td>
<td>Peptides</td>
<td>Amino acids</td>
</tr>
<tr>
<td>Peptidases</td>
<td>Sucrose (sugar)</td>
<td>Glucose and fructose</td>
</tr>
<tr>
<td>Sucrase</td>
<td>Lactose (milk sugar)</td>
<td>Glucose and galactose</td>
</tr>
<tr>
<td>Lactase</td>
<td>Maltose</td>
<td>Glucose</td>
</tr>
<tr>
<td>Maltase</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bile from the liver</strong></td>
<td>Fats globules</td>
<td>Fat droplets</td>
</tr>
<tr>
<td>Bile salts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 showing enzymes, substance digested and products formed
- Amylase is produced in the mouth. It helps break down large starch molecules into smaller sugar molecules.
- Pepsin is produced in the stomach. Pepsin helps break down proteins into amino acids.
- Trypsin is produced in the pancreas. Trypsin also breaks down proteins.
- Pancreatic lipase is produced in the pancreas. It is used to break apart fats.
- Deoxyribonuclease and ribonuclease are produced in the pancreas. They are enzymes that break bonds in nucleic acids like DNA and RNA.

Bile salts are bile acids that help to break down fat. Bile acids are made in the liver. When you eat a meal, bile is secreted into the intestine, where it breaks down the fats. Enzymes are affected by changes in pH. The most favorable pH value - the point where the enzyme is most active - is known as the optimum pH.

![Figure 1: Effect of pH on reaction rate](image)

**Figure 1 Effect of pH on reaction rate**

Extremely high or low pH values generally result in complete loss of activity for most enzymes. The pH is also a factor in the stability of enzymes. As with activity, for each enzyme, there is also a region of pH optimal stability. Temperatures higher than 40 °C generally cause enzymes to be denatured.
- The Digestive System

The digestive system is the body system that breaks down food and absorbs nutrients. It also gets rid of solid food waste. The digestive system is mainly one long tube from the mouth to the anus, known as the gastrointestinal tract (GI tract). The main organs of the digestive system include the esophagus, stomach and the intestine. The intestine is divided into the small and large intestine. The small intestine has three segments. The ileum is the longest segment of the small intestine, which is well over 10 feet long. The large intestine is about 5 feet long.

Figure 2 Showing human digestive system.

Digestion is the process of breaking down food into nutrients. There are two types of digestion, mechanical and chemical. In mechanical digestion, large chunks of food are broken down into small pieces. Mechanical digestion begins in the mouth and involves physical processes, such as chewing. This process continues in the stomach as the food is mixed with digestive juices. In chemical digestion, large food molecules are broken down into small nutrient molecules. This is a chemical process which also begins in the mouth as saliva begins to break down food and continues in the stomach as stomach enzymes further digest the food.

Absorption is the process that allows substances you eat to be taken up by the blood. After food is broken down into small nutrient molecules, the molecules are absorbed by the blood. After
absorption, the nutrient molecules travel in the bloodstream to cells throughout the body. This happens mostly in the small intestine. However, some substances in food cannot be broken down into nutrients, and they remain behind in the digestive system after the nutrients are absorbed. Any substances in food that cannot be digested and absorbed are pass out of the body as solid waste. The process of passing solid food waste out of the body is called egestion.

- **Mouth**

The mouth is the beginning of the digestive tract. After you start eating, you chew your food into smaller pieces to make them more easily digestible. Your saliva mixes with the food to begin to break it down into a form your body can absorb and use. When you swallow, your tongue passes the food into your throat.

- **Esophagus**

Located in your throat near your trachea (windpipe), the esophagus receives food from your mouth when you swallow. The epiglottis is a small flap that folds over your windpipe as you swallow to prevent you from choking (when food goes into your windpipe). A series of muscular contractions within the esophagus called peristalsis delivers food to your stomach. But first, a ring-like muscle at the bottom of your esophagus, called the lower esophageal sphincter, has to relax to let the food enter. The sphincter then contracts and prevents the contents of the stomach from flowing back into the esophagus.

- **Stomach**

The stomach is a hollow organ that holds food while it is being mixed with stomach enzymes. These enzymes continue the process of breaking down food into a usable form. Cells in the lining of the stomach secrete a strong acid (HCl) and powerful enzymes (pepsinogen, gastric lipase) that are responsible for the breakdown process. When the contents of the stomach are processed enough, they are released into the small intestine.
- **Small intestine**

The small intestine is made up of three segments the duodenum, jejunum, and ileum. The small intestine is a 22-foot long muscular tube that breaks down food using enzymes released by the pancreas and bile from the liver. Peristalsis also works in this organ, moving food through and mixing it with digestive juices from the pancreas and liver. The duodenum is the first segment of the small intestine. It is mostly responsible for the continuous breaking-down process. The jejunum and ileum lower in the intestine are mainly responsible for the absorption of nutrients into the bloodstream.

Contents of the small intestine start as a semi-solid, and end in a liquid form after passing through the organ. Water, bile, enzymes and mucus contribute to the change in their consistency. Once the nutrients have been absorbed, and the leftover-food residue liquid has passed through the small intestine, it then moves on to the large intestine, or colon.

- **Pancreas**

The pancreas secretes digestive enzymes into the duodenum that break down protein, fats and carbohydrates. The pancreas also makes insulin, passing it directly into the bloodstream. Insulin is the chief hormone in your body for metabolizing sugar.

- **Liver**

The liver has many functions, but its main job within the digestive system is to process the nutrients absorbed from the small intestine. Bile from the liver secreted into the small intestine also plays an important role in digesting fat and some vitamins. The liver is the body's chemical "factory." It takes the raw materials absorbed by the intestine and makes all the various chemicals the body needs to function. The liver also detoxifies potentially harmful chemicals. It breaks down and secretes many drugs that can be toxic to the body.

- **Gallbladder**

The gallbladder stores and concentrates bile from the liver, and then releases it into the duodenum in the small intestine to help absorb and digest fats.
- Colon (large intestine)

The large intestine, or colon, is responsible for processing waste so that emptying the bowels is easy and convenient. It is a 6-foot long muscular tube that connects the small intestine to the rectum. The large intestine is made up of the cecum, the ascending (right) colon, the transverse (across) colon, the descending (left) colon, and the sigmoid colon, which connects to the rectum. Stool, or waste left over from the digestive process, is passed through the colon by means of peristalsis, first in a liquid state and ultimately in a solid form. As stool passes through the colon, water is removed. The stool is stored in the sigmoid (S-shaped) colon until a "mass movement" empties it into the rectum once or twice a day.

It normally takes about 36 hours for stool to get through the colon. The stool itself is mostly food debris and bacteria. These “good” bacteria perform several useful functions, such as synthesizing various vitamins, processing waste products and food particles and protecting against harmful bacteria. When the descending colon becomes full of stool, or faeces, it empties its contents into the rectum to begin the process of elimination (a bowel movement).

- Rectum

The rectum is a straight, 8-inch chamber that connects the colon to the anus. The rectum's job is to receive stool from the colon, let you know that there is stool to be evacuated (pooped out) and to hold the stool until evacuation happens. When anything (gas or stool) comes into the rectum, sensors send a message to the brain. The brain then decides if the rectal contents can be released or not.

If they can, the sphincters relax and the rectum contracts, disposing of its contents. If the contents cannot be disposed of, the sphincter contracts and the rectum accommodates so that the sensation temporarily goes away.

- Anus

The anus is the last part of the digestive tract. It is a 2-inch long canal consisting of the pelvic floor muscles and the two anal sphincters (internal and external). The lining of the upper anus can detect
rectal contents. It lets you know whether the contents are liquid, gas or solid. The anus is surrounded by sphincter muscles that are important in allowing control of stool. The pelvic floor muscle creates an angle between the rectum and the anus that stops stool from coming out when it is not supposed to. The internal sphincter is always tight, except when stool enters the rectum. This keeps us continent (prevents us from pooping involuntarily) when we are asleep or otherwise unaware of the presence of stool.

- **Assimilation**

Assimilation is the movement of digested food molecules into the cells of the body where they are being utilized. Assimilation of nutrients happens in the small intestine. Your small intestine is equipped with tiny projections called microvilli on the surface of the cells lining the intestine, called epithelial cells. These important cells take nutrients from the intestine and pump it into your blood, where it can be distributed to the body.

- **The villi**

The villi (one is called a villus) are tiny, finger-shaped structures that increase the surface area. They have several important features:

- the wall just one cell thick - ensures that there is only a short distance for absorption to happen by diffusion and active transport.

- the network of blood capillaries - transports glucose and amino acids away from the small intestine in the blood.

- the internal structure called a lacteal - transports fatty acids and glycerol away from the small intestine in the lymph.

The hepatic portal vein transports absorbed food from the small intestine to the liver.
Figures 3 and 4 Showing the structure of a villus

HUMAN DIGESTIVE SYSTEM Made Easy- Gastrointestinal System - Bing video

Biology- What are the enzymes of the digestive system? - Bing video

Structure of Villi | Absorption and Assimilation | Villus - Bing video
• **Role of liver in the metabolism of glucose and amino acids**

Excess glucose in the blood arriving at the liver is converted into glycogen (animal starch) for storage, or broken down through respiration, producing energy for other purposes.

Amino acids cannot be stored in our body, so any that is excess has to be dealt with in the liver. Some amino acids are transaminated to produce a different amino acid. The rest are deaminated to produce ammonia (NH₃) and a keto acids.

**Role of liver in the breaking down of alcohol and other toxins**

• Breaking down any toxins absorbed from the alimentary canal, including drugs such as alcohol. Cells in the liver are able to convert many toxins to harmless substances that can be transported in the blood and excreted from the body.

**Role of fat as an energy storage substance**

Fatty acids and glycerol pass into the lymphatic system and then the bloodstream. Once in the blood nutrients are carried to all cells of the body. Some are oxidised to produce energy and others are used to repair the cell, build new cells. Fat is a good storage compound because it releases twice as much energy as carbohydrates when respired, and act as insulation in the skin. Some nerve cells form a myelin sheath from fat, to prevent electrical impulses from leaking out.
The process involves removing undigested waste products food from the body of the organism.

Discharged materials are Undigested food and other toxic substances leftover from digestion.

Egestion mainly happens through the anus or the mouth. (animals such as jellyfish use their mouth to both consume and discharge wastes).

Only animals undergo egestion.

<table>
<thead>
<tr>
<th>Egestion</th>
<th>Excretion</th>
</tr>
</thead>
<tbody>
<tr>
<td>The process involves removing undigested waste products food from the body of the organism</td>
<td>The process involves removing wastes from the cells of organisms</td>
</tr>
<tr>
<td>Discharged materials are Undigested food and other toxic substances leftover from digestion</td>
<td>Discharged materials are Metabolic wastes such as carbon dioxide or oxygen</td>
</tr>
<tr>
<td>Egestion mainly happens through the anus or the mouth. (animals such as jellyfish use their mouth to both consume and discharge wastes)</td>
<td>Excretion happens through the nose, skin and the urethra</td>
</tr>
<tr>
<td>Only animals undergo egestion</td>
<td>Excretion happens in both plants and animals</td>
</tr>
</tbody>
</table>

**Table 2 Showing the differences between egestion and excretion**
INSTRUCTION – Answer all questions

1. (i) The breaking down of food into small, simple pieces is called _________.

   (ii) Stomach, food pipe, small intestine and large intestine are parts of your _________
   system.

   (iii) The digestive juices present in the mouth is _________.

   (iv) The food pipe takes the food to the _________.

   (v) Digestion is completed, and food is absorbed into the blood in the _________________.

   (vi) Water is absorbed from the undigested food in the _________________.

   (vii) The undigested food is thrown out of the body through the _________.

2. Name four organs of your digestive system, which make digestive juices.

3. How is saliva useful in swallowing the food?

4. What happens to the food in the small intestine?

5. What happens to the undigested portion of food?
Label each of the parts of the digestive system in the image below.

Complete the chart below with the function of each the structure you labeled above.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophagus</td>
<td></td>
</tr>
<tr>
<td>Large Intestine</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
</tr>
<tr>
<td>Oral cavity</td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td></td>
</tr>
</tbody>
</table>
WEEK: 3 LESSON: 3

TOPIC: Respiration

SUB-TOPIC: Types of respiration

OBJECTIVES:

- After reading hand out, students will define the term respiration and differentiate between the two types of respiration.

CONTENT:

This is the process in which organisms break down glucose from food to create a usable form of energy called adenosine triphosphate (ATP). When the cell needs to perform work, it removes a phosphate from ATP, releasing energy and changes to adenosine diphosphate (ADP). During cellular respiration, the cell can reattach a phosphate onto the ADP molecule, making a new ATP.

Types of Respiration

- Aerobic respiration: can only occur in the presence of oxygen. It involves reacting oxygen and glucose to produce carbon dioxide, water and ATP. It occurs in the mitochondria of cells in both plants and animals

- Anaerobic Respiration: can only occur when oxygen is not present. It involves the release of ATP from glucose and lactic acid or ethanol.

➤ Aerobic respiration

*Word equation for aerobic respiration*

\[
\text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water}
\]

Reactants  Products

*Balanced chemical equation*

\[
\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}
\]

Reactants  Products
- **Anaerobic Respiration**

Anaerobic respiration happens in muscles during vigorous exercise:

**Word equation for aerobic respiration in animals**

Glucose $\rightarrow$ lactic acid

**Balanced chemical equation in animals**

\[
C_6H_{12}O_6 \rightarrow 2C_3H_6O_3
\]

Glucose is not completely broken down, so less energy is released in anaerobic respiration than during aerobic respiration. There is a build-up of lactic acid in the muscles during vigorous exercise. The lactic acid needs to be oxidized to carbon dioxide and water later. This causes oxygen debt (a temporary oxygen shortage in the body tissues arising from exercise) that needs to be ‘repaid’ after the exercise stops. This is why we keep on breathing deeply for a few minutes after we have finished exercising.

**Anaerobic respiration also happens in plants and yeast**

Anaerobic respiration in yeast is used during brewing and bread-making:

**Word equation for aerobic respiration in plants and yeast**

Glucose $\rightarrow$ ethanol + carbon dioxide

**Balanced chemical equation in plants and yeast**

\[
C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2
\]

Ethanol is the type of alcohol found in alcoholic drinks like beer and wine. In bread-making, bubbles of carbon dioxide, resulting from anaerobic respiration, gas expand the dough and help the bread rise.
<table>
<thead>
<tr>
<th>Reactant/Product</th>
<th>Aerobic</th>
<th>Anaerobic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>Needed</td>
<td>Not needed</td>
</tr>
<tr>
<td>Glucose</td>
<td>Complete</td>
<td>Incomplete</td>
</tr>
<tr>
<td>The end product(s)</td>
<td>Carbon dioxide and water</td>
<td>- Animal cells: lactic acid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Plant cells and yeast: carbon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dioxide and ethanol</td>
</tr>
<tr>
<td>Amount of energy released</td>
<td>Relatively large amount</td>
<td>Relatively small amount</td>
</tr>
</tbody>
</table>

Table 1 Showing the differences between aerobic and anaerobic respiration.

WORKSHEET 3

INSTRUCTIONS: Answer the following questions.

1. Which equation best represents aerobic respiration?
   a) $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 + \text{energy}$
   b) $\text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}$
   c) $\text{C}_6\text{H}_12\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2 + \text{energy}$
   d) $\text{C}_6\text{H}_12\text{O}_6 + \text{energy} \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$

2. Which releases energy to do the work in a cell?
   a) Conversion of ATP to ADP
   b) Conversion of ADP to ATP
   c) Release of oxygen from ADP
   d) Combination of oxygen and ADP

3. State three differences between aerobic and anaerobic respiration

4. Write a balanced equation for the process for anaerobic respiration in
   (i) plants
   (ii) animals
WEEK: 4 LESSON: 4

TOPIC: Respiration

SUB-TOPIC: Structure of the respiratory system

OBJECTIVES:

- After reading handout, students will state the importance of breathing and relate the structures of the respiratory system to the functions of the various parts.
- Students will list and discuss the features of the respiratory surface that make it adapted for gaseous exchange to occur.

CONTENT:

The importance of breathing in humans

Breathing is the process in which air moves in and out of the lungs. Breathing uses chemical and mechanical processes to bring oxygen to every cell of the body and to get rid of carbon dioxide. Our body needs oxygen to obtain energy to fuel all our living processes. Carbon dioxide is a waste product of that process. The respiratory system brings air from the environment into the lungs and facilitates gas exchange in both the lungs and within the cells.
Figure 1 The human respiratory system

Structures of the Respiratory System and their function

- The function of the nasal cavity is to warm, moisturize, and filter air entering the body before it reaches the lungs. Hairs and mucus lining the nasal cavity trap dust, mold, pollen and other environmental contaminants before they can get to the inner portions of the body.
- The one advantage of breathing through the mouth is that its shorter distance and larger diameter allows more air to enter the body quickly.
- The main function of the trachea is to provide a clear airway for air to enter and exit the lungs.
- The main function of the bronchi and bronchioles is to carry air from the trachea into the lungs.
- The lungs are involved in the important process of breathing. The oxygen inhaled from the outside environment enters into the blood, and the carbon dioxide leaves the blood. The lungs facilitate inhalation and exhalation.
Path of air through the Respiratory System

Air then enters the trachea, and this connects the larynx to the bronchi (singular bronchus). The air passes from the trachea and into the right and left bronchi. The bronchi continue to get smaller and smaller until they form the bronchioles. At the end of the bronchioles are small cup-shaped structures called alveoli (singular alveolus). Capillaries surround each alveolus, and when the air (rich in oxygen) reaches the alveoli, they diffuse across the thin walls and into the capillaries; which eventually distributes it to all parts of the body by the circulatory system. In the meanwhile, carbon dioxide is being diffused from the capillaries, into the alveoli and out the respiratory tract as expired air. In humans, gaseous exchange occurs in the alveoli which are found in the lungs.

Characteristics of Respiratory Surfaces

- Large surface area
- Thin walls
- Moist walls
- Permeable walls
- Extensive blood supply
- A large diffusion gradient

Figure 2 An alveolus
The respiratory surface of fish - Gill

1. The gill lamellae are delicate structures
2. Gills are continuously bathed in water, keeping them wet.
3. The numerous lamellae increase the surface area of the gills.
4. The gills of a freshly caught fish are bright red. Each lamella has a network of blood vessels.

Figure 3 Showing the structure of a gill

Additional resources:

Anatomy and physiology of Respiratory system - Bing video
RESPIRATION - AEROBIC VS ANAEROBIC RESPIRATION - OXYGEN DEBT - Bing video
Gas exchange - Bing video
INSTRUCTIONS: Answer the following questions.

1) Name the parts of the respiratory system indicated on the diagram.

2) Which of the following part is involved in gas exchange in the human respiratory system?
   a) Trachea
   b) Bronchioles
   c) Branch
   d) Alveoli

3) Air going into the lungs travels through
   a) Trachea and bronchioles
   b) Gullet and veins
   c) Nose and stomach
   d) Trachea and gullet

4) The blood vessel surrounding the alveoli are?
   a) Nerve
   b) Veins
   c) Arteries
   d) Capillaries
State whether the following are **true or false**.

5) The ribcage protects the lungs. ______

6) Inhalation is breathing in and out._______

7) The brain controls the amount of oxygen we breathe in. ______

8) When we exercise, our breathing rate increases. ______

9) The respiratory surface in man is the alveoli. ______

10) The respiratory surface in fishes are fins. _________

11) The chest moves upwards and outwards when we inhale. _________

12) The volume of lungs decreases when we exhale. _________

13) Breathing and respiration is the same thing._______
Transpiration is a physiological process. In this process, plants lose water in the form of water vapour through their aerial parts mainly through the leaves. So it may be defined as the loss of water in the form of water vapour from leaves and other aerial parts. The plant absorbs water through their roots. This water conducted to all aerial parts like stem branches and leaves (Fig. 1).

Fig. 1  The process of transpiration  
Source: Importance of Transpiration in Plants - QS Study
Water moves through the xylem vessels in a continuous **transpiration stream**:

\[
\text{Root} \rightarrow \text{Stem} \rightarrow \text{Leaf}
\]

Transpiration produces tension or ‘pull’ on the water in the xylem vessels by the leaves. Water molecules are cohesive, so water is pulled up through the plant.

The transpiration stream has several functions. These include:

- transporting mineral ions
- providing water to keep cells turgid to support the plant
- providing water to leaf cells for photosynthesis
- keeping the leaves cool by evaporation

Source: [Transpiration stream - Transport in plants - GCSE Biology (Single Science) Revision - BBC Bitesize](https://www.bbc.co.uk/bitesize/guides/z3j8jq9/revision/11)

**Transpiration serves some essential roles:**

- **Gaseous exchange**

  Transpiration is necessary for the life of land plants. It helps to absorb carbon dioxide from the atmosphere during photosynthesis through the stomata in the day and facilitate gaseous exchange.

- **Movement of water and nutrients**

  Movement of minerals up from the root (in the xylem) and sugars (products of photosynthesis) throughout the plant (in the phloem).

**Transpiration is helpful to plants in many ways.**

- It helps in the exchange of gases and provides coolness to the plant body.
- It helps in sending out excessive water absorbed by plants and transport of mineral salts in plants.
- It helps in the development of the plant body by absorption and distribution of water in plants.
- Transpiration maintains an osmotic balance of the cell.
- It provides the water needed for food manufactured by photosynthesis in the leaves.
- The water transported upwards from the roots to the leaves also contains dissolved mineral salts used to produce a diversity of materials such as proteins in the plant.

A transpiration pull could be simply defined as a biological process in which the force of pulling is produced inside the xylem tissue. This force helps in the upward movement of water into the xylem vessels. This biological process is carried out in all higher plants and trees as their stems are surrounded by bundles of fine tubes made from a woody material known as xylem.
Measuring Transpiration

A potometer is used to measure how much water is being taken up by the plant and the rate at which it does so (Fig. 1).

Using a simple potometer
1. The potometer is filled with water.
2. A leafy plant is connected to it underwater through a rubber tube at one end of the potometer.
3. A bubble of air passes up the potometer when held upright and then placed back into the water.
4. The bubble is observed, and the distance travelled by the bubble over a period is measured.
5. The faster the bubble moves, the greater the rate of water uptake, and so the greater the rate of transpiration.

Source: Understand Transpiration Worksheet - EdPlace
Environmental factors affecting transpiration

- Light
- Humidity
- Temperature
- Wind speed

**Light:** Stomata close in darkness and open in light. As most water vapour diffuses out of leaves through stomata, their width is a major factor in determining how much transpiration occurs.

**Humidity:** The air inside leaves is fully saturated with water vapour. The humidity of the surrounding air determines the concentration gradient for water vapour. There is less transpiration in humid conditions because the concentration gradient for water is less steep than in dry air.

**Temperature:** Warm conditions increase the rate of evaporation inside the leaves. This is because warmer air holds more water vapour than cooler air.

**Wind speed:** In still air, water vapour remains near the leaves reducing the concentration gradient. In windy conditions, water molecules are blown away from the leaf surface, increasing the concentration gradient's steepness.

**Adaptations of plants to obtain and conserve water**

Many plants live in places where high transpiration rates and/or water are in short supply. They have special features, which allow them to obtain sufficient water and retain it rather than losing it in transpiration.

- Deep roots that extend to great depths
- Extensive, shallow roots that cover a wide area
- Thick, waxy cuticles over the stems and leaves to reduce the water loss through the upper and lower epidermis
- Thick leaves and/or stems to store water, plants like this are called succulents.

(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)
WORKSHEET 1

INSTRUCTIONS – Answer all questions

1. Explain the process of transpiration in plants

2. Discuss THREE adaptations of plants to obtain and conserve water

3. List and explain ANY three factors that affect the rate of transpiration.

4. Explain how to measure transpiration using a potometer.
WEEK: 5

TOPIC: Excretion

CONTENT:

Excretion is an essential process in which waste products are removed from the body. Without excretion, waste products build up in the body and can cause serious health issues. Urea is a mixture of nitrogenous wastes that damage the body if not removed by the excretory system. Blood is important to the excretory system. It carries waste from cells through the bloodstream to the excretory organs for removal from the body. The excretory system consists of many parts and organs that work as a unit. It rids the body of metabolic waste, which contains salts, carbon dioxide and urea.

The lungs remove carbon dioxide, absorbing and eliminating waste while providing oxygen to the body. The skin is part of the excretory system and helps rid the body of contaminants through perspiration. Perspiration removes urea from the body in a water-based liquid excreted from sweat glands located in the skin.

The urinary system is comprised of the kidneys, the urethra, the ureters and the bladder. The kidneys filter contaminants from the bloodstream and remove them from the body as urine. The kidneys also serve to diffuse any useful substances that pass through the urinary system, sending them back into the bloodstream to be utilized.

In humans, this function is performed through kidneys, lungs and skin. In animals, the main excretory products are:

- Ammonia
- Carbon Dioxide
- Urea
- Uric Acid

<table>
<thead>
<tr>
<th>Organ</th>
<th>Excretory function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lungs</td>
<td>Help in removing a large amount of carbon dioxide and water from our body through the air that we expire.</td>
</tr>
<tr>
<td>Skin</td>
<td>Sweat, a watery fluid containing lactic acid, urea, sodium chloride etc., is secreted from the sweat glands and cooling of the body.</td>
</tr>
<tr>
<td>Kidney</td>
<td>Kidneys help in the elimination of wastes from the body in the form of urine.</td>
</tr>
<tr>
<td>Liver</td>
<td>Bile pigments are produced by the breakdown of haemoglobin in the worn-out red blood cells in the liver. These are eliminated from the body, and the organ thus helps in excretion. Urea is formed in the liver, which is eliminated through kidneys.</td>
</tr>
</tbody>
</table>

Table 1 The organs of excretion and their functions
Excretion in plants

Elimination of toxic and waste products from the body is called excretion. Organisms like animals have an advanced and specialized system for excretion. But plants lack a well-developed excretory system like that in animals. They do not have special organs for excretion. Thus, excretion in plants is not so complex.

Excretory products

The cellular respiration, photosynthesis, and other metabolic reactions produce a lot of excretory products in plants. Carbon dioxide, excess water produced during respiration and nitrogenous compounds produced during protein metabolism are the major excretory products in plants.

Plants produce two gaseous waste products, i.e. oxygen during photosynthesis and carbon dioxide during respiration. Excretion of gaseous waste in plants takes place through stomatal pores on leaves. Oxygen released during photosynthesis is used for respiration while carbon dioxide released during respiration is used for photosynthesis. Excess of water is also excreted from the plant body through the stomatal pores and from the surfaces of fruits and stems. The process of elimination of water is called transpiration.

Other than gaseous wastes, metabolism in plants also generates organic by-products. These wastes are stored in different forms in different parts. The gums, oils, latex, resins etc, are some waste products stored in plant parts like barks, stems, leaves etc. Eventually, plants shed off these parts. The oil produced from orange, eucalyptus, jasmine, latex from the rubber tree, papaya tree, and gums from acacia, are different forms of stored waste products. Sometimes they even excrete into the soil. Excretion in aquatic plants takes place through diffusion.

Fig. 2  Excretion in plants
Source: excretion in plants - Bing images
Egestion

- The process involves removing undigested waste products food from the body of the organism
- Discharged materials are Undigested food and other toxic substances leftover from digestion
- Egestion mainly happens through the anus or the mouth. (animals such as jellyfish use their mouth to both consume and discharge wastes)
- Only animals undergo egestion

Excretion

- The process involves removing metabolic wastes from the cells of organisms
- Discharged materials are Metabolic wastes such as carbon dioxide or oxygen
- Excretion happens through the nose, skin and the urethra
- Excretion happens in both plants and animals
INSTRUCTIONS – Answer all questions

1. What are the different methods of excretion in animals.
2. Distinguish between egestion and excretion.
3. Are the lungs part of the excretory system? If so, what do they excrete?
4. List the main excretory products in humans.
5. Explain the importance of excretion in plants and animals.
TOPIC: Excretion

SUB-TOPIC – THE KIDNEY

CONTENT:

Structure and function

The kidneys are a pair of bean-shaped organs present in all vertebrates. They remove waste products from the body, maintain balanced electrolyte levels, and regulate blood pressure. The primary role of the kidneys is maintaining homeostasis. This means they manage fluid levels, electrolyte balance, and other factors that keep the body's internal environment constant and comfortable.

The kidneys are at the back of the abdominal cavity, with one sitting on each side of the spine. The right kidney is generally slightly smaller and lower than the left, to make space for the liver. Each kidney weighs 125–170 g in males and 115–155 g in females. A tough, fibrous renal capsule surrounds each kidney. Beyond that, two layers of fat serve as protection. The adrenal glands lay on top of the kidneys.

Inside the kidneys are many pyramid-shaped lobes. Each kidney consists of an outer renal cortex and an inner renal medulla. These are the urine-producing structures of the kidneys. Blood enters the kidneys through the renal arteries and leaves through the renal veins. The kidneys are relatively small organs but receive 20–25 % of the heart’s output. Each kidney excretes urine through a tube called the ureter that leads to the bladder.

Fig. 1 The excretory system
- **Renal capsule**: The outer membrane that surrounds the kidney; it is thin but tough and fibrous
- **Renal pelvis**: A basin-like area that collects urine from the nephrons, it narrows into the upper end of the ureter
- **Calyx**: An extension of the renal pelvis; they channel urine from the pyramids to the renal pelvis
- **Cortex**: The outer region of the kidney; extensions of the cortical tissue, contains about one million blood filtering nephrons
- **Nephron**: These are the filtration units in the kidneys
- **Medulla**: Inner region of the kidney contains 8-12 renal pyramids. The pyramids empty into the calyx.
- **Medullary pyramids**: Formed by the collecting ducts, inner part of the kidney
- **Ureter**: Collects filtrate and urine from the renal pelvis and takes it to the bladder for urination
- **Renal artery**: Branches of the aorta bringing waste-filled blood into the kidney for filtering in the nephrons; the renal artery is further subdivided into several branches inside the kidney. Each minute, the kidneys receive 20% of the blood pumped by the heart. Some arteries nourish the kidney cells themselves.
- **Renal vein**: Removes the filtered blood from the kidneys to the inferior vena cava

Source: Kidney Anatomy, Parts & Function, Renal Cortex, Capsule, Nephron, Calyx, Pyramids [healthpages.org]
1. Label the parts (A-L) of the kidney.

2. State the functions of ANY five (5) parts of the kidney.

3. State the primary function of the kidney.
WEEK: 6

TOPIC: Excretion

SUB-TOPIC – The kidney and nephron

CONTENT:

The Kidneys

They serve the body as a natural filter of the blood and remove wastes excreted through the urine. They are also responsible for the reabsorption of water, glucose, and amino acids, and will maintain the balance of these molecules in the body. The renal circulation is an important part of the kidney’s main function of filtering waste products from the blood. Blood is supplied to the kidneys via the right and left renal arteries.

Each renal artery carries blood with waste products into the kidney. The renal artery branches into increasingly smaller arteries within the kidney that extend through the renal columns between the renal pyramids. These arteries, in turn, branch into arterioles that penetrate the renal pyramids. Blood in the arterioles passes through nephrons, the structures that filter the blood. After blood passes through the nephrons and is filtered, the clean blood moves through a network of venules that converge into small veins. Small veins merge into increasingly larger ones and ultimately into the renal vein, which carries clean blood away from the kidney to the inferior vena cava.

The tubules are divided into four segments. The filtrate passes through each of these segments before reaching the ureter (Fig. 1).

1. **Proximal convoluted tubule**: Highly coiled, drains Bowman’s capsule and where almost complete absorption of nutritionally essential substances occurs.
2. **The loop of Henle**: Thin loop-like long structure, reabsorbs water and ions from the urine and plays a role in urine concentration.
3. **Distal convoluted tubule**: Regulates potassium, sodium and pH and where further, dilution of the urine occurs.
4. **Collecting tubule**: Joins with several tubules to collect the filtrate and where final sodium regulation takes place.
Blood enters the nephron through an arteriole called the afferent arteriole. Some of the blood next passes through the capillaries of the glomerulus. Blood that doesn’t pass through the glomerulus and blood after it passes through the glomerular capillaries continues through an arteriole called the efferent arteriole. The efferent arteriole follows the nephron's renal tubule, where it continues to play roles in nephron functioning (Fig. 1).

**Filtration**

As blood from the afferent arteriole flows through the glomerular capillaries, it is under pressure. Because of the pressure, water and solutes are filtered out of the blood and into the space made by Bowman’s capsule. This is the filtration stage of nephron function. The filtered substances, called filtrate, pass into Bowman’s capsule and from there into the proximal end of the renal tubule. At this stage, filtrate includes water, salts, organic solids such as nutrients, and waste products of metabolism such as urea.

**Reabsorption and secretion**

As filtrate moves through the renal tubule, some of the substances it contains are reabsorbed from the filtrate back into the blood in the efferent arteriole (via peritubular capillaries). This is the reabsorption stage of nephron function. About two-thirds of the filtered salts and water and all of the filtered organic solutes (mainly glucose and amino acids) are reabsorbed from the filtrate by
the blood in the peritubular capillaries. Reabsorption occurs mainly in the proximal convoluted tubule and the loop of Henle.

At the distal end of the renal tubule, some additional reabsorption generally occurs. This is also the tubule region where other substances from the blood are added to the filtrate in the tubule. The addition of other substances to the filtrate from the blood is called secretion. Both reabsorption and secretion in the distal convoluted tubule are primarily controlled by endocrine hormones that maintain homeostasis of water and mineral salts in the blood. These hormones work by controlling what is reabsorbed into the blood from the filtrate and what is secreted from the blood into the filtrate to become urine. For example, the parathyroid hormone causes more calcium to be reabsorbed into the blood and more phosphorus to be secreted into the filtrate.

**Collection of urine and excretion**

By the time the filtrate has passed through the entire renal tubule, it has become the liquid waste known as urine. Urine empties from the distal end of the renal tubule into a collecting duct. From there, the urine flows into increasingly larger collecting ducts. As urine flows through the system of collecting ducts, more water may be reabsorbed from it. This will occur in the presence of antidiuretic hormone from the hypothalamus. This hormone makes the collecting ducts permeable to water, allowing water molecules to pass through them into capillaries by osmosis while preventing the passage of ions or other solutes. As much as three-fourths of the water may be reabsorbed from urine in the collecting ducts, making the urine more concentrated.

Urine finally exits the largest collecting ducts through the renal papillae. It empties into the renal calyces and finally into the renal pelvis. From there, it travels through the ureter to the urinary bladder for eventual excretion from the body. The darker the colour, generally the more concentrated the urine is.

**Osmoregulation**

Osmoregulation is a process that regulates the osmotic pressure of fluids and electrolytic balance in organisms. In animals, this process is brought about by osmoreceptors, which can detect changes in osmotic pressure. Humans and most other warm-blooded organisms have osmoreceptors in the hypothalamus.
**Water reabsorption** (Fig. 2)
- As the collecting duct passes through the medulla, the hypertonic conditions of the medulla will draw water out by osmosis
- The amount of water released from the collecting ducts to be retained by the body is controlled by antidiuretic hormone (ADH)
- ADH is released from the posterior pituitary in response to dehydration (detected by osmoreceptors in the hypothalamus)
- ADH increases the permeability of the collecting duct to water, by upregulating production of aquaporins (water channels)
- This means less water remains in the filtrate, urine becomes concentrated, and the individual urinates less (i.e. anti-diuresis)
- When an individual is suitably hydrated, ADH levels decrease, and less water is reabsorbed (resulting in more dilute urine)

**Kidney failure**
The kidneys can become damaged and no longer able to filter metabolic wastes from the blood adequately. This is due to ailments, such as high blood pressure. Treatments options include kidney transplant or artificial filtration of the blood, using a dialysis machine where the blood is filtered externally through the machine.
Additional resources (videos):

- [HUMAN DIGESTIVE SYSTEM Made Easy - Gastrointestinal System - Bing video](#)
- [Biology - What are the enzymes of the digestive system? - Bing video](#)
- [Structure of Villi | Absorption and Assimilation | Villus - Bing video](#)
INSTRUCTIONS – Answer all questions

1. label the parts (A-J) of the nephron below:

   a_____________________________                             f________________________
   b______________________________                           g________________________
   c______________________________                            h______________________
   d _____________________________                            i_______________________
   e______________________________                                j________________________

2. Explain how the nephron filter blood.
3. What are the two main parts of the nephron?
4. Where are the nephrons located?
5. What is the cup-shaped structure surrounding the renal corpuscle called?
6. Explain the role of the kidney in osmoregulation in humans.
TOPIC: Movement

CONTENT:

Movement is an action by organisms or part of an organism that changes its position or place. Plants are fixed in one position and have spreading bodies that absorb light, carbon dioxide, water and mineral ions. Some plant movement occurs quite fast: the leaves of mimosa and the Venus flytrap are examples. When plants reproduce, they make pollens that move from one plant to another. Their seeds are dispersed from the parent plant to colonise new areas and reduce competition.

Most plant movements are due to growth and are slow. Shoots grow towards a light to expose their leaves to as much light as possible to photosynthesise efficiently (Fig. 1). Roots grow downwards towards sources of water.

Most animals are not fixed in one place. They move their whole body, which is known as locomotion (Fig. 2). Movement in animals is brought about by muscle contraction.

Locomotion is necessary to:

- find food
- hide and escape from predators
- migrate to avoid harsh conditions or in search of food
- find mates
- find nesting sites and make a nest

Some animals are fixed and only move part of their bodies, for example, coral polyps, sea anemones and barnacles. Part of their body moves to gain food and defend themselves.

(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)

Fig. 1 Movement in plant

Fig 2 Movement in animal
The human skeletal system (Fig. 3)

Functions:
- **Support:** The presence of a strong bony skeleton gives posture and shape to the entire human body. These muscles provide a framework for the whole body. It provides a rigid surface to attach the muscles to the tendons. It mainly assists the body in the locomotion.

- **Protection:** It protects fragile internal organs such as the spinal cord, the human brain, and the lungs.

- **Blood cell production:** The bone marrow's central part contains the bone marrow, the primary site for blood cell production in adult humans. There are two types of bone marrow, red bone marrow (containing stem cells and supportive tissue) and yellow bone marrow (made of fat).

- **Production of other cell types:** Lymphocytes are also produced in the bone.

- **Storing minerals:** The bones of the skeletal system act as a storehouse for calcium ions.

- **The skeletal system helps in the movement** of the sternum and the ribs, thus helping in breathing.

- **Breathing:** The skeletal system also assists with breathing by moving the rib cage to either create more pressure to expel air or to create more volume in the lungs to take in air.
Fig. 3 The human skeleton
1. Label the figure below:

Source: the human skeleton - Bing images
2. Complete the below word puzzle:

![Skeletal System Word Puzzle](image)

CARTILAGE  RADIUS
CLAVICLE  RIB
COMPACT  RICKETS
CRANIUM  SCAPULA
EXTERNAL  SKELETON
FEMUR  STERNUM
FIBULA  TENDON
HUMERUS  TIBIA
INTERNAL  ULNA
JOINT  VERTEBRAE
LIGAMENT  VITAMIN D

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3. List and explain ANY three functions of the skeleton system.

4. State five reasons why animals move.

5. Explain movement in plants.
**WEEK: 6**

**LESSON: 3**

**TOPIC: Movement**

**SUB – TOPIC – Types of joints**

**CONTENT:**

**Joints**

Locomotion involves the skeleton, joints between the bones and the skeletal muscles. The place where two bones meet is a joint. There are two types of joint:

- A fixed joint where there is no movement, e.g. between the bones of the cranium
- A movable (or synovia) joint where there is movement

**Two types of moveable joints are:**

- Hinge joint in which movement occurs in one plane, e.g. at the elbow and the knee
- A ball and socket joint where movement occurs in all three planes, e.g. at the shoulder and the hip

(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)

In addition to bones, the skeleton also consists of **cartilage** and **ligaments**:

- **Cartilage** is a type of dense connective tissue, made of tough protein fibres, that provides a smooth surface for the movement of bones at joints. Therefore, cartilages are found between bones. They are also found where more flexibility is required such as the ear, the nose, elbow, the knee, the ankle and the intervertebral discs. Cartilage connective tissue is important because it provides support, but is less rigid than bone. It also allows for some flexibility of movement but has more stability than muscle. **Cartilage** is thin, avascular, flexible and resistant to compressive forces. **Bone** is highly vascularized, and its calcified matrix makes it very strong.

- **A ligament** is a band of fibrous connective tissue that **holds bones together** and keeps them in place (Fig. 1).

- **Tendon**: a flexible but inelastic cord of strong fibrous collagen tissue **attaching a muscle to a bone** (Fig. 1).
Muscles only contract, they do not expand. To move about or to move part of your body, muscles contract and shorten and pull on a bone. Muscles cannot push the bone to move it back to where it
started. To get a bone to move to the back, another muscle is needed. For example, two muscles move the forearm, and they form an antagonistic pair. They are the biceps and triceps (Fig 2).

Contractions and shortening of the biceps muscle raise the forearm. This type of movement is called flexion, and the biceps is the flexor muscle. When this happens the antagonistic muscle, the triceps relaxes and is pulled to become longer. Contractions and shortening of the triceps muscle lower the forearm. This type of movement is called extension, and the arm is now extended. This triceps is the extensor muscle. When this happens the antagonist muscle, the biceps, relaxes and is pulled to become longer (Fig. 2).
1. The figure below shows a hinge joint. Label the parts of the joints.

Fig. 1 Hinge joint
Source: worksheet on synovial joint - Bing images

2. Four types of joints are listed below. Match the joint type with its example by looking at the table below: Write only the letters of the correct answer.

_______________1. Pivot joint
_______________2. Ball and socket joint
_______________3. Immovable joint
_______________4. Hinge joint
3. Four types of joints are listed below. Match the type of joints with its description by looking at the table below: Write only the letter of the correct answer.

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>These joints only allow a very small range of motion</td>
</tr>
<tr>
<td>B.</td>
<td>These joints allow the bones to have a circular motion</td>
</tr>
<tr>
<td>C.</td>
<td>These joints allow a large vertical and</td>
</tr>
<tr>
<td>D.</td>
<td>These joints join two bones together, but there is little or no movement possible</td>
</tr>
</tbody>
</table>

4. The following groups of muscles are antagonistic pairs:

- Biceps
- Triceps
- Hamstrings
- Quadriceps
- Gluteals
- Hip flexors
- Gastrocnemius
- Tibialis anterior
- Pectoralis major
- Latissimus dorsi
TOPIC: Irritability

SUB-TOPIC – Stimulus and response

CONTENT:

In order to survive in their habitat, each organism needs to sense changes in its environment and make suitable responses. A stimulus is a change in the environment. A response is a change in an organism's position or behaviour due to a stimulus. Irritability, also known as sensitivity, is the ability to detect stimuli and respond to them.

(CXC Study Guide , Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)

Fig. 1 Shoot respond towards light while
Source: Growing Plants and Gravity - Bing images
Fig. 2 The Venus flytrap capture flies

Source: respond of venus fly trap - Bing images

A stimulus could be an external event, such as:

- Change in the direction of light
- Change in light intensity or change in temperature
- Internal events include:
  - the arrival of food in the stomach
  - changes in blood glucose level
  - the entry of foreign organisms in the body or change in water content of cells

Some changes can be:

- positive or advantageous
- unfavourable or harmful
- unimportant

Response

The response can be through:

- the movement of the whole animal, e.g. earthworm moving away from light
- the movement of part of the animal, e.g. closing of the pupil of the eye to bright light
Some responses include:

- secretion of enzymes in response to food
- production of antibodies in response to foreign organisms
- secretion of hormones in response to changes in blood glucose levels
- an increase in heart rate in response to a rise in the CO₂ content of the blood

Importance of response

Response to stimuli is important for the survival of organisms since:

- shoots of green plants grow toward the light to make food
- roots grow in the direction of gravity. They grow towards moisture and provides stability for the plant
- animals to avoid unsuitable conditions by moving to suitable ones. Hunted animals avoid predators when they see, hear or smell their approach
- a male moth is attracted to a female moth by being able to detect and respond to chemical signals released by the female
- this response ensures that reproduction takes place and the species survives
- The sensitive plant (*Mimosa pudica*) folds its leaves quickly when touched. This makes it more difficult for animals who eat them to see them.

Response in plants:

Like all organisms, plants detect and respond to stimuli in their environment. Unlike animals, plants can’t run, fly, or swim toward food or away from danger. They are usually rooted in the soil. Instead, a plant’s primary means of response is to change how it is growing. Plants also don’t have a nervous system to control their responses. Instead, their responses are generally controlled by hormones, which are chemical messenger molecules.

- **Plant Tropisms**
  
  Plant roots always grow downward because specialized cells in root caps detect and respond to gravity. This is an example of a tropism. A tropism is a turning toward or away from a stimulus in the environment.

  - Growing toward gravity is called geotropism.
  - Plants also exhibit phototropism or growing toward a light source. This response is controlled by a plant growth hormone called auxin. As shown in Fig. 3 below, auxin stimulates cells on the dark side to grow longer. This causes the plant to bend toward the light.
Invertebrates

Climate change can have a plethora of effects on organisms above and below the ground in terrestrial ecosystems. Given the tremendous biodiversity in the soil and the many ecosystem functions governed by soil organisms, soil biodiversity drivers have received increasing attention.

Various climatic factors like temperature, precipitation, soil moisture, and extreme climate events like drought and flood have been shown to alter the composition and functioning of communities in the soil.

Earthworms are important ecosystem engineers in the soils of temperate and tropical climates and play crucial roles for many ecosystem services, including decomposition, nutrient cycling, and crop yield. Earthworm activity, abundance, and biomass increase with increasing temperature at sufficiently high soil water content, while climate extremes like drought and flooding have harmful effects.

Changing climate conditions may facilitate the invasion of earthworms at higher latitudes and altitudes, while dryer and warmer conditions may limit earthworm performance in other regions of the world.

Effectors and Receptors

The receptor receives information that something in the environment is changing. The control centre or integration centre receives and processes information from the receptor. The effector responds to the commands of the control centre by either opposing or enhancing the stimulus.

While muscles, glands and sense organs help humans to detect and respond to changes, plants respond to changes using:

- Leaves
- Petiole
- Apical meristem
WORKSHEET 1

INSTRUCTIONS – Answer all questions

1. Define the term stimulus and response.
2. Explain how plants respond to stimuli.
3. Explain why the response to stimuli is important to the survival of a named organism.
4. With the use of diagrams, explain the term phototropism and geotropism.
TOPIC: Irritability

SUB-TOPIC – The nervous system

CONTENT:

The nervous system is a complex collection of nerves and specialized cells known as neurones that transmit signals between different parts of the body. Structurally, the nervous system has two components: the central nervous system and the peripheral nervous system. The central nervous system is made up of the brain, spinal cord and nerves. The peripheral nervous system consists of sensory neurones, ganglia (clusters of neurones), and nerves connected and the central nervous system.

Nerves are cylindrical bundles of fibres that start at the brain and central cord and branch out to every other part of the body. Neurones send signals to other cells through thin fibres called axons, which cause chemical known as neurotransmitters to be released at a junction called synapses. There are over 100 trillion neural connections in the average human brain.
Summary

- The nervous system is divided into two main parts:
  - The central nervous system
  - The peripheral nervous system

- The central nervous system consists of two parts:
  - The brain
  - The spinal cord.

- The peripheral nervous system is divided into two major parts:
  - The somatic nervous system
  - The autonomic nervous system.
WORKSHEET 2

WEEK 7

INSTRUCTIONS – Answer all questions

LESSON 2

1. State the differences between the central nervous system and the peripheral nervous system.

2. Draw Diagram to show the central nervous system and the peripheral nervous system.

3. Indicate whether the following parts of the nervous system are part of the central nervous (CNS) or the peripheral nervous system (PNS).

- Brain .............................................
- Autonomic nervous system .....................
- Spinal nerves .....................................
- Spinal cord ......................................
- Cranial nerves ...................................
WEEK: 7

LESSON: 3

TOPIC: Irritability

SUB-TOPIC – Types of neurones

CONTENT:

Neurones
The nervous system is made up of neurones. A neuron is a cell, responsible for the generation and transmission of neuronal impulses through electrical and chemical signals. They are found in the brain, spinal cord and the peripheral nerves. A neuron is also known as the nerve cell. There are three main types of neurones – sensory neurones, motor neurones, and relay neurones (Fig. 1). A group of neurones form a nerve.

Fig. 1 Types of neurones

Sensory neurones
Sensory neurones are the body’s electrical wiring for incoming information. Messages from sense organs can either trigger a reflex action or reach the brain where a decision is made about what to do in response to the signal (Fig. 2).
Fig 2 Sensory neurone

In the example above, a pin piercing the skin causes a sensory receptor to signal the central nervous system via a **sensory neurone**. The sensory neuron passes the signal on to a relay neuron in the spine, which passes the signal to a motor neurone, which delivers the signal to muscles. The muscles contract/expand to move the hand from the pin (Fig. 2)

**Motor neurones**

Motor neurones are the nerve cells that control muscle and gland activity. The muscles and glands are known as effectors. Motor neurones carry signals from the CNS to the effectors to get a response, such as contracting a muscle to move a limb or releasing a hormone from a gland to make the kidneys retain more water in the body.
In this example, a pain receptor in a finger sends an impulse via a sensory neurone to a relay neurone in the spinal cord. The relay neurone transfers the impulse to a **motor neurone**, which in turn transfers it to an arm muscle, causing the arm muscle to contract and bend the arm, moving the finger away from whatever is causing the pain (Fig. 3)

**Relay neurones**

Some relay neurones located in the spine are involved in reflex actions. In the diagram below, someone’s finger feels the heat of a flame. Receptors pick up the heat in the skin. The signal from the receptors travels along sensory neurones to the spine (Fig. 4). The signal is then transferred to the relay neurone (interneurone), and from there to the motor neurone, which carries the signal to the effector (in this case a muscle). The muscle performs the required action, moving the arm away from the flame.
Parts of a Neurone (Fig. 6)

Neurones have a characteristic elongated shape and consist of three main parts:

- **Nerve cell body**: Consists of the eukaryotic cell components like the nucleus, endomembrane system, and organelles.
- **Dendrites**: Tiny projections branching out at the neurone’s receiving end, of the nerve cell body. They act like tiny antennas that pick up signals from other cells.
- **Axon**: A long, thin fiber that extends from the nerve cell body. It branches at its tips to end in synaptic terminals that are marked by swellings called synaptic knobs. Many axons happen to be insulated by a fatty myelin sheath formed by cells called Schwann cells. Between the Schwann cells, one finds small gaps in insulation called the nodes of Ranvier.
Fig. 6 Structure of a neurone
WORKSHEET 3

INSTRUCTIONS – Answer all questions

LESSON 3

1. Label the parts of the neurone in the diagram below:

![Neurone Diagram]

1. _____________
2. _____________
3. _____________
4. _____________
5. _____________
6. _____________

2. There are three different kinds of neurones or nerve cells. Match each kind with its function.

<table>
<thead>
<tr>
<th>Kind of neurone</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor neurone</td>
<td>The cell that carries nerve impulses from a sense receptor to the brain or spinal cord</td>
</tr>
<tr>
<td>Sensory neurone</td>
<td>The nerve cell that connects sensory and motor neurones</td>
</tr>
<tr>
<td>Relay neurone</td>
<td>The nerve cell that transmits impulses from the brain or spinal cord to a muscle or gland</td>
</tr>
</tbody>
</table>

3. Match the description in the table with the terms in the list.
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The long fibre that carries the nerve impulses</td>
<td></td>
</tr>
<tr>
<td>2. A bundle of axons</td>
<td></td>
</tr>
<tr>
<td>3. The connection between adjacent neurones</td>
<td></td>
</tr>
<tr>
<td>4. The chemical secreted into the gap between neurones at the synapse</td>
<td></td>
</tr>
<tr>
<td>5. Rapid automatic response to a stimulus</td>
<td></td>
</tr>
<tr>
<td>6. The branching filament that conducts nerve impulses towards the cell</td>
<td></td>
</tr>
</tbody>
</table>
WEEK: 8

LESSON: 1

TOPIC: Irritability

SUB-TOPIC – Reflex action

CONTENT:

The synapse

The function of the synapse (Fig. 1) is to transfer electric activity (information) from one cell to another. The transfer can be from nerve to nerve (neuro-neuro), or nerve to muscle (neuro-myo).

- Neurones communicate with one another at junctions called synapses. At a synapse, one neuron sends a message to a target neuron—another cell.

- Most synapses are chemical; these synapses communicate using chemical messengers. Other synapses are electrical; in these synapses, ions flow directly between cells.

- At a chemical synapse, an action potential triggers the presynaptic neuron to release neurotransmitters. These molecules bind to receptors on the postsynaptic cell and make it more or less likely to fire an action potential.

Fig. 1 A synapse
The Mechanism of Reflex Action

When you touch a hot object or when a pin pricks your finger, you remove your hand away from the source of pain, either the hot object or a pin. In situations like these, your reactions are always immediate, involuntary and sudden. They happen without much of a thinking process. In scientific terms, this action is called the reflex action. Here the spinal cord has a major role to play. The reflex arc shows the pathway through which the reflex action occurs.

Reflex action

A reflex action is an involuntary action in response to impulses initiated by a stimulus. The whole mechanism of reflex action occurs in such a fashion that there is no conscious control of the brain. Stimulation occurs through the peripheral nervous system, and the response to this peripheral nerve stimulation is involuntary. In a reflex action, the spinal cord and the brain stem are responsible for the reflex movements.

Examples of reflex actions

- When light acts as a stimulus, the pupil of the eye changes in size
- Sudden jerky withdrawal of hand or leg when pricked by a pin
- Coughing or sneezing, because of irritants in the nasal passages
- Knees jerk in response to a blow or someone stamping the leg
- The sudden removal of the hand from a sharp object
- Sudden blinking when an insect comes very near to the eyes

**Components involved in a reflex action**

- receptor organs
- sensory neurones
- nerve centre
- associated neurones
- motor neurones
- effector neurones

**The Eye**

These are the visual sensory organs in the body. These are sensitive to light images. The eyes vary in colour depending upon the amount of melanin present. It helps in the sense of sight by detecting and focusing on the light images.

**Control of light entering the eye**

**The pupil reflex**

The pupil size is smaller in bright light and larger in dim light. This is a reflex action that controls the amount of light entering the eye. In bright light, circular muscles in the iris contract, enlarging the iris and reducing the pupil size. In the dim light, radial muscles contract to make the iris smaller and enlarge the pupil (Fig. 3).

![Fig. 3 Pupil reflex](source: Pupil Reflex - The Human Eye (weebly.com))
Reaction to a painful stimulus

The Knee Jerk Reflex

The knee jerk reflex is a spinal reflex. However, this reflex does not make use of the relay neuron. The stimulus passes directly from the sensory to the motor neuron.

How does the knee jerk reflex works?

To test your knee jerk reflex, a doctor or nurse practitioner raps a small hammer on the tendon below your kneecap. A split second later, you kick the person with the hammer, it's because the lightning-quick knee jerk reflex occurred within the spinal cord. The kick simply indicates that a section of your spinal cord, and the nerves extending from it, are working properly. When the hammer hits the knee, the tendon below your kneecap connects to the quadriceps muscle on top of your thigh. The hammer's rap on the tendon slightly stretches the muscle. Sensory nerves in the muscle are stimulated by the stretching and send an impulse to the spinal cord (Fig. 4). Motor nerves in the spinal cord then conduct the impulse right back to the quadriceps, triggering a muscle contraction that makes you kick.

![Knee Jerk Reflex Diagram](image)

The receptor organs perceive the stimuli. They are situated on the sense organs. The afferent neurones or the sensory neurones carry the stimuli from receptors to the spinal cord. The ganglion of the spinal cord has sensory neurones.

The spinal cord is the nerve centre, where synaptic connections are formed. The associated neurones are present in the spinal cord. The ventral horn of the spinal cord has the motor neurones. Effector organs are the glands and muscles that behave in response to the stimuli.
Cranial Reflex Action

The cranial nerves provide the pathways to and from the central nervous system for reflexes utilizing the muscles of the head, such as those controlling movements of the eyeball, face, and tongue. The nerve cells giving rise to the cranial motor nerve fibres lie in clusters (nuclei) in the brain stem; they represent an upward extension of the homologous groups of nerve cells in the spinal cord. Examples of reflexes involving the cranial nerves are the closure of the eyelids when the cornea is stimulated, or gagging when the back of the throat is irritated.

Types of actions

1. **Voluntary actions**
   Voluntary actions are responses to stimuli that are consciously controlled or coordinated by the brain, and these actions are taken deliberately. These are actions such as movements, which you decide to do. For a voluntary action to occur, a nerve impulse has to be started in the brain. Your own thoughts initiate the action; for example: if you decide to start walking. Alternatively, you may receive a stimulus, as when somebody calls your name and you decide to reply. For voluntary actions, the brain decides whether or not to respond. If so, the impulse passes down the white matter of the spinal cord. It will leave the spinal cord along a motor neuron near to the effector muscle that will act to bring about your desired (voluntary) action.

2. **Involuntary actions**
   These actions are not controlled by conscious decisions. An involuntary action is one which occurs without the conscious choice of an organism. If it occurs specifically in response to a stimulus, it will be known as a reflex. These actions are the opposite of voluntary actions that occur because of choice. Some involuntary actions include breathing, digestion, heart beating, eye reflexes etc.
INSTRUCTIONS – Answer all questions

1. Define the term reflex action.
2. Using a well-labelled diagram explain the pupil reflex.
3. Distinguish between voluntary and involuntary actions.
WEEK: 8                                   LESSON: 2

TOPIC: Irritability

SUB-TOPIC – Structure of the brain

CONTENT:

Functions of the parts of the brain

**Cerebrum:** The cerebrum is the largest portion of the brain and contains tools responsible for most of the brain's function. It is divided into four sections: the temporal lobe, the occipital lobe, parietal lobe and frontal lobe. The cerebrum is divided into a right and left hemisphere connected by axons that relay messages from one to the other (Fig. 1). This matter is made of nerve cells which carry signals between the organ and the nerve cells which run through the body.

**Frontal Lobe:** The frontal lobe is one of four lobes in the cerebral hemisphere. This lobe controls several elements including creative thought, problem-solving, intellect, judgment, behaviour, attention, abstract thinking, physical reactions, muscle movements, coordinated movements, smell and personality.

**Parietal Lobe:** Located in the cerebral hemisphere, this lobe focuses on comprehension. Visual functions, language, reading, internal stimuli, tactile sensation and sensory comprehension will be monitored here.

**Sensory cortex:** The sensory cortex, located in the front portion of the parietal lobe, receives information relayed from the spinal cord regarding the position of various body parts and how they are moving. This middle area of the brain can also be used to relay information from the sense of touch, including pain or pressure affecting different portions of the body.
**Motor cortex:** This helps the brain monitor and control movement throughout the body. It is located in the top, middle portion of the brain.

**Temporal lobe:** The temporal lobe controls visual and auditory memories. It includes areas that help manage some speech and hearing capabilities, behavioural elements, and language. It is located in the cerebral hemisphere.

**Occipital lobe:** The optical lobe is located in the cerebral hemisphere in the back of the head. It helps to control vision.

**Cerebellum:** This is commonly referred to as "the little brain," and is considered to be older than the cerebrum on the evolutionary scale. The cerebellum controls essential body functions such as balance, posture and coordination, allowing humans to move properly and maintain their structure.

**Hippocampus:** This portion of the brain is used for learning memory, specifically converting temporary memories into permanent memories stored within the brain. The hippocampus also helps people analyze and remember spatial relationships, allowing for accurate movements. This portion of the brain is located in the cerebral hemisphere.

**Hypothalamus and thalamus:** The hypothalamus region of the brain controls mood, thirst, hunger and temperature. It also contains glands which control the hormonal processes throughout the body. The thalamus is located in the centre of the brain. It helps to control the attention span, sensing pain and monitoring input that moves in and out of the brain to keep track of the body's sensations.

**Brain Stem:** All basic life functions originate in the brain stem, including heartbeat, blood pressure and breathing. In humans, this area contains the medulla, midbrain and pons. This is commonly referred to as the simplest part of the brain, as most creatures on the evolutionary scale have some form of brain creation that resembles the brain stem. The brain stem consists of midbrain, pons and medulla.

**Midbrain:** The midbrain, also known as the mesencephalon, comprises the tegmentum and tectum. These parts of the brain help regulate body movement, vision and hearing. The anterior portion of the midbrain contains the cerebral peduncle, which contains the axons that transfer messages from the cerebral cortex down the brain stem, which allows the voluntary motor function to take place.

**Pons:** This portion of the metencephalon is located in the hindbrain, and links to the cerebellum to help with posture and movement. It interprets information that is used in sensory analysis or motor control. The pons also creates the level of consciousness necessary for sleep.

**Medulla:** The medulla or medulla oblongata is an essential portion of the brain stem which maintains vital body functions such as the heart rate and breathing.
1. The diagram below shows the structure of the human brain. Label the diagram below:

2. State the function of ANY five parts of the brain
TOPIC: Irritability

SUB- TOPIC – The eye

CONTENT:

Parts of the eye and their function (Fig. 1)

- **Lens:** It is a transparent, biconvex, and an adjustable part of an eye. The lens with the help of the cornea refracts light focused on the retina, therefore creating images on it.

- **Retina:** It is the layer present at the back of the eye where all the images are formed. The retina functions by converting the light rays into impulses and sending the signals to the brain through the optic nerve.

- **Optic nerve:** The optic nerve is mainly responsible for carrying all the nerve impulses from the photoreceptors to the human brain.

- **Aqueous humour:** It is a watery fluid that is present in the area between the lens and the cornea. It is responsible for the nourishment of both the lens and the cornea.

- **Vitreous humour:** It is a semi-solid, transparent, jelly-like substance that covers the interior portion of the eyes. It plays an important role in maintaining the shape of the eye and also causes refraction of light before it reaches the retina.

- **Iris:** The iris is the Pigmented area of the eye that decides the colour of eyes. Its muscles contract and relax to alter the size of its central hole or pupil. If it is too bright, the iris will shrink the pupil so that the eye can focus more effectively. It controls how much light enters the pupil. This allows the eye to take in more or less light, depending on how bright it is around you.

- **Conjunctiva glands:** These glands are the layers of mucus which help keep the outside of the eye moist. If your eye becomes dry, then it causes itchy and painful. If the conjunctiva glands infected, the patient will face a problem of pink eye. Keep eyes moist and save from itchy and pain.

- **Cornea:** The Cornea is the second structure that light strikes. The clear, transparent front part of the eye covers the iris, pupil, and anterior chamber and provides most of an eye’s optical power. It needs to be smooth, round, clear, and tough. It is like a protective window. The function of the cornea is to let light rays enter the eye and converge the light rays.
• **Sclera.** The sclera is the opaque, fibrous, tough, protective outer layer of the eye directly continuous with the cornea in front and with the sheath covering the optic nerve behind. The sclera provides protection and form.

![Fig. 1 Structure of the human eye](image)

**Formation of an image on the retina**

Light enters the eye through the transparent cornea, passes through the aqueous humour, the lens, and the vitreous humour, where it finally forms an image on the retina. The retina is made up of rods and cones (called photoreceptors). When these photoreceptors are stimulated by light, they produce electrical signals that are transmitted to the brain via the optic nerve. The image on the retina is formed the wrong way up (upside down). The brain interprets the image so that it is the right way up.

**Cones:** The cones are the light-sensitive retinal receptor cell that provides the sharp visual acuity (detail vision) and colour discrimination; most numerous in the macular area. Function under bright lighting.

**Rods:** The light-sensitive, specialized retinal receptor cell works at low light levels (night vision). The rods function with movement and provide light/dark contrast. It makes up peripheral vision.
INSTRUCTIONS – Answer all questions

1. The figure below shows the structure of the human eye. Label the parts (A-L) of the eye.

![Diagram of the human eye with labels A to L]

Source: The Eye and Vision Anatomy Worksheet Answers or Ausgezeichnet Anatomy and Physiology Human Eye Bilder (semesprit.com)

For question two to ten, fill the blanks.

2. Light rays are first refracted by the ____________________.

3. Surrounding the cornea is an opaque white tissue called the ____________________.

4. Light enters the eye through an opening in the centre called the ____________________.

5. The__________________ is the fluid that nourishes the cornea since it does not have a blood supply of its own.

6. The____________ is the coloured circle of muscle surrounding the pupil. It controls the amount of light entering the eye.

7. Light then passes through the flexible, convex____________ which can change its shape.

8. Once the lens refracts light, it is focussed on__________ the at the back of the eye, where an image is formed.
9. Light-sensitive cells detect the image and an electric message is sent to the brain through the____________.

10. The______________ is the fluid found between the lens and the retina and provides support for the eyeball.
TOPIC: Irritability

SUB-TOPIC – The eye

Accommodation: is the focusing of light on the retina by changing the shape of the lens. To view near objects, the ciliary muscles contract, causing the lens to become more convex in shape. The opposite occurs when viewing distance objects.

Fig. 1 Image formation on the retina

Fig. 2 Viewing far and near objects
**Viewing far object**

The ciliary muscles relax. The fluid's pressure inside the eye pulls the sensory ligaments tightly, so the lens is pulled into an elliptical (thin) shape. Light rays are refracted as they pass through the lens and focus on the retina. The distant object is in focus. The lens does not need to focus much as the light rays from each point are nearly parallel when entering the eye (Fig. 2 {a}).

**Viewing near object**

The ciliary muscles contract to counteract the pressure inside the eye. The suspensory ligaments are not pulled and become slack. This lets the elastic tissues around the lens recoil, so the lens becomes more spherical (thicker). Light rays are refracted more than they were when looking at the distant object. The near object is in focus. The lens needs to do more focusing as the light rays are diverging as they enter the eye (Fig. 2 {b}).

(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)

**Causes and correction of sight defects**

Defects in the vision where objects cannot be clearly seen can be made better by using glasses.

- **Long-sightedness** (hypermetropia) occurs when near objects cannot be focused because the diverging rays of light are not sufficiently refracted. A short eyeball or weak lens may cause long sight (Fig. 3 {d}).
  - *Correction for hyperopia*: A **convex lens** in glasses will refract the light sufficiently to focus the diverging rays from near objects onto the retina (Fig. 3{f}).

- **Short-sightedness/near sight** (myopia) makes distant objects appear blurred because parallel light rays are refracted too much and focus in front of the retina. A long eyeball causes short sight (Fig. 3 {c}).
  - *Correction for myopia*: A **concave lens** that will diverge the light rays will allow the eye to refract them onto the retina (Fig. 3 {e}).
Fig. 3 Causes and correction of sight defects

- **Astigmatism:** This occurs when the cornea becomes uneven, resulting in distorted vision; parallel vertical or longitudinal bars appear to bend.
  - **Correction:** Corrective lenses (that means glasses or contacts)

- **Glaucoma:** Caused by an increase in pressure in the aqueous humour, due to its increase secretion in front of the lens. It results in poor vision, weeping and inflamed and painful eyes. Severe pressure may damage the optic nerve, causing blindness so that myopia, a stroke and some other diseases may cause it.
  - **Correction:** Eye drops may help

- **Cataracts:** the lens becomes opaque. Reduced vision, then blindness, occurs as it slowly develops.
  - **Correction:** laser surgery is used to remove the lens and spectacles, or contact lenses, are used to compensate for their loss.
Pupil reflex

Move from a very bright well – lit place and walk into somewhere dark. For a while, you cannot see much. Now think about the reverse going from a dark place and entering somewhere very bright. For a moment, you are almost blinded by the light until your eyes adjust. These adjustments are made by muscles in the iris. Circular muscles in the iris contract to decrease the diameter of the pupil; radial muscles contract to increase its diameter. A simple reflex controls them. Sensory neurones transmit impulses from the retina to the brain along the optic nerve; motor neurones transmit impulses to the iris muscles along with another one of the cranial nerves.

(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)
INSTRUCTIONS – Answer all questions

Complete the sentences by filling in the blank

Our eyes adjust to looking at different objects, far or near, bright or dim.

1. The ______________ controls the size of the ______________ in looking at bright or dim objects.
2. When we look at a __________ object, our ______________ become smaller. Less light will enter our eyes.
3. The thickness of the _____________ changes for looking at far or near objects.
4. When we look at a __________ object, our __________ become thinner. The light from the object will be focused onto the ________.
5. Discuss ANY two types of eye defects and how it can be corrected.
TOPIC: Irritability

SUB- TOPIC  Structure of the skin

CONTENT:

The skin is the largest organ in the human body and plays important roles in the interactions between our bodies and our surroundings.

Fig. 1 Structure of the human skin

Parts of the skin

- **Epidermis**: Is made of layers of squamous cells filled with tough fibrous protein keratin; these cells provide mechanical protection against injury and are gradually rubbed away.

- **A layer of stem cells**: these cells divide by mitosis to replace cells lost from the surface on the epidermis.

- **Melanocytes**: These cells are between the stem cells and make melanin, which absorbs ultraviolet light protecting the body from its harmful effect.

- **Hair**: Provides some insulation on the head

- **Sweat glands**: Secrete sweat which travels up sweat ducts to sweat pores; sweat evaporates to loose heat.

- **Arterioles**: Control flow of blood capillaries which lose heat to the surrounding
• **Sensory nerve endings and sensory cells:** Detect changes in temperature, pressure and pain

• **Sensory neurones:** Conduct nerve impulses to the CNS

• **Motor neurones:** Conduct nerve impulses to instruct the hair muscles to contract and raise the hairs

• **Fat:** Store of energy and a thermal insulator

**Temperature control**

No matter what the weather is like, your body temperature stays at 37°C, unless you have a fever. Sensors in the skin detect changes in the air temperature. Receptors in the spinal cord and hypothalamus detect changes in the temperature of the blood. If the temperature of the blood flowing through the hypothalamus in the brain increases, it sends nerve impulses to the skin to promote heat loss. Arterioles widen so more blood flows through the capillaries and loses heat to the surrounding by convection and radiation. Sweat glands produce sweat by filtration from the blood plasma. The heat of the body causes the sweat to evaporate having a cooling effect.

When we feel cold and our blood temperature decreases, the hypothalamus sends nerve impulses to the skin to reduce heat loss by stimulating. Arterioles to contract so reducing blood flow through the capillaries. Sweat glands to stop producing sweat. If the blood temperature continues to fall, the hypothalamus stimulates heat production in the liver and sends impulses to the skeletal muscles to contract to release heat by shivering. Blood flowing through the liver and muscles is warmed and distributes heat to the rest of the body.

All people, whatever their skin colour, are at risk of developing skin cancer. Melanin in the skin protects against ultraviolet light, which causes cancer. Creams and lotions are available to protect against UV light. These products absorb and/or deflect to the UV light. The higher the sun protection factor (SPF), the more protection is provided.

The ingredients of some skin bleaching products have severe effects. Some products contain hydroquinone which is banned in the European Union as it is thought to be carcinogenic.

The skin is an organ of protection

The primary function of the skin is to act as a barrier. The skin protects from mechanical impacts and pressure, variations in temperature, micro-organisms, radiation and chemicals.

*(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)*
1. The diagram below shows the structure of the skin. Labels the parts of the skin.

Fig. 1 The structure of the skin

Source: skin structure diagram worksheet - Bing images
Match the following part of the skin with its function.

Sweat Glands, Nerves Hair, Erector muscles, Sebaceous gland, Arterioles and capillary network

<table>
<thead>
<tr>
<th>Part of the skin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Help regulate body temperature</td>
</tr>
<tr>
<td>3.</td>
<td>Muscle contract causing hair to stand upright. This generates heat when the body is cold</td>
</tr>
<tr>
<td>4.</td>
<td>Secrete sweat which travels up sweat duct to sweat pores. Heat is lost when sweat evaporates from the skin</td>
</tr>
<tr>
<td>5.</td>
<td>Detect changes in temperature, pressure and pain</td>
</tr>
<tr>
<td>6.</td>
<td>Secrete sebum which helps protect, soften, moisturize and hydrate the skin</td>
</tr>
</tbody>
</table>
WEEK: 9

TOPIC: Growth

SUB- TOPIC Structure of a dicotyledonous seed

CONTENT:

Growth

Growth of a multicellular organism is a permanent increase in its size due to a rise in the number of cells and the organisms' mass. Flowering plants begin their growth from seeds, each containing a multicellular embryo with stores of energy-rich compounds.

Parts of a Seed

![Diagram of a seed and its parts]

Fig. 1 External and internal structure of a dicotyledonous seed

Functions of the parts of a seed

- **Testa:** It is the outer coat of the seed that protects the embryonic plant.
- **Micropyle:** It is a tiny pore in the testa that lies on the opposite of the tip of the radicle. It permits water to enter the embryo before active germination.
- **Hilum:** Is a scar left by the stalk which attached the ovule to the ovary wall before it became a seed.
- **Cotyledon:** In some plants, this contains high quantities of starch and will provide a source of food for the developing embryo prior to germination, in other plants this role is performed by an endosperm. In monocotyledons, there is just one cotyledon whereas in dicotyledons there are two. Depending on the type of germination (epigeous or hypogeous) the cotyledons may remain below ground or be pulled above ground.
- **Radicle:** This is the embryonic root which will develop into the primary root of the plant. It is usually the first part of the embryo to push its way out of the seed during germination.

- **Plumule:** This is the embryonic shoot. It appears as a bud, giving rise to the shoot and the remaining structures in the plant.

- **Endosperm:** In many plants, a separate part for starch storage develops, called the endosperm. It is seen in maize and wheat.
1. Describe the structure of a seed.
2. Draw labelled diagrams to show the internal and external structure of a dicotyledonous seed.
3. State the function of the hilum.
Germination

Germination is the process by which a seed changes to a seedling. Conditions necessary for germination include:

- **Water**: Water is of primary importance in germination. A water-soaked seed will germinate, actual submergence may be harmful. When protoplasm absorbs the water, seed resumes vigorous physiological activities - the embryo bursts through the seed coats softened by water imbibition.

- **Oxygen**: In germinating, seed respiration and other physiological activities are more vigorous; hence oxygen is essential.

- **Suitable Temperature**: Seeds usually germinate between 0°C to 50°C, and the optimum usually lies between 25°C to 30°C.

Germination Process

The process of germination is as follows:

1. **Environmental conditions are favourable**: For germination to occur, the environmental conditions must be favourable to support the growing plant. The soil depth, amount of water, and temperature are all critical conditions that must be met for the process of germination to be initiated. Typically, the soil must be moist and warm.
2. **Water imbibition**: When environmental conditions are optimal, germination is initiated by a process termed water imbibition. The seed absorbs water through the micropyle, which induces swelling of the seed until it splits open.
3. **Root and Shoot formation**: Once the seed has ruptured, the radicle (primary root) and plumule (shoot) can emerge from the seed. This process is initiated by specific enzymes that become activated when the seed is exposed to water. The roots grow downwards, and the shoot grows upwards towards the soil surface.
4. **A seedling is formed**: Once the shoot emerges from the soil surface, the cotyledons become fully unfolded and expand, eventually forming the first leaves. Once this occurs, the plant is ready to initiate photosynthesis and is considered a seedling (Fig. 1).
Measuring growth

Growth of plants can be measured in many different ways:

- Linear increase, e.g. in the length of root and shoot
- Area increase, e.g. in surface area of the leaf
- Numerical increase, e.g. in number of leaves
- Mass increase, e.g. using wet (fresh) mass and dry mass

One of the best indicators of growth is dry mass since this measures the new organic compounds produced as a result of photosynthesis and absorption of mineral ions. Unfortunately, this involves killing the organism concerned to remove all the water. This can be done by dividing some seeds or seedlings into batches harvesting each batch at different intervals.

(CXC Study Guide, Biology for CSEC by Richard Fosbery, Charmaine Foster and Allison Peart.)
1. Define the term germination.

2. List and explain the conditions necessary for germination.

3. Describe what happened to seed during germination.

4. Draw the stages of germination.
Reproduction means to reproduce. It is a biological process by which an organism produces an offspring who is biologically similar to the organism. Reproduction enables and ensures the continuity of species, generation after generation. It is the main feature of life on earth.

Types of reproduction

- Sexual reproduction
- Asexual reproduction

Asexual reproduction

Asexual reproduction refers to the type of reproduction in which only a single organism gives rise to a new individual. Asexual reproduction does not involve the fusion of gametes, and therefore, the offspring produced are genetically identical to the parent. The organisms produced by asexual reproduction are less diverse. This type of reproduction is practised widely by unicellular organisms.

The process involves rapid population growth, and no mate is required. However, a lack of genetic diversity makes the organisms more susceptible to diseases and nutrition deficiencies.

Asexual reproduction is further divided into:

1. **Binary Fission**: In this, the cell splits into two each cell carrying a copy of the DNA from the parent cell, e.g. amoeba (Fig. 1).
2. **Budding**: In this, a small bud-like outgrowth gives rise to a new individual. The outgrowth remains attached to the organism until it is fully grown. It detaches itself as lives as an individual organism, e.g. yeast (Fig. 2).
3. **Fragmentation**: In this, the parent organism splits into several parts, and each part grows into a new individual, e.g. Planaria
4. **Sporogenesis**: In this type of reproduction, a new organism grows from the spores, e.g. the fungi. These can be created without fertilization and can spread through wind and animals.


Page 73 of 81
Fig. 1 Asexual reproduction in the Amoeba – Binary fission

Source: What is asexual reproduction Describe the asexual reproduction class 12 biology CBSE (vedantu.com)

Fig. 2 Asexual reproduction in the yeast - budding

Sexual reproduction

Sexual reproduction is a type of reproduction that involves the production of an offspring by the fusion of male and female gametes.

Fig. 3 Sexual reproduction - human
In sexual reproduction, male and female gametes are formed to produce an offspring. These gametes are either formed by the same individual or by different individuals of the opposite sex (Fig. 3). This process is usually slow and complex compared to asexual reproduction. The organisms so produced are genetically diverse. Thus, they can evolve along with the changing climatic conditions. Humans and many multicellular organisms exhibit a sexual mode of reproduction.

WORKSHEET 2

INSTRUCTIONS – Answer all questions

1. Define the term reproduction.
2. List the types of reproduction.
3. Asexual reproduction occurs in the amoeba. Explain asexual reproduction in the amoeba.
TOPIC: Reproduction

SUB- TOPIC – The male reproductive system

CONTENT:

The male reproductive system

The primary role of a man in human reproduction is to produce large numbers of gametes and position them in the female reproductive system, but ideally, he should also invest time and care in supporting and bringing up this child once it is born.

![Fig. 1 The male reproductive system](image-url)
The male reproductive system

Functions of the male reproductive system

The male reproductive system comprises organs that make up a man’s reproductive and urinary systems. These organs do the following jobs within your body:

- They produce, maintain and transport sperm (the male reproductive cells) and semen (the protective fluid around the sperm).
- They discharge sperm into the female reproductive tract.
- They produce and secrete male sex hormones.

The penis consists of the root (attached to the lower abdominal structures and pelvic bones), the visible part of the shaft, and the glans penis (the cone-shaped end). The urethra (the channel that transports semen and urine) is located at the tip of the glans penis. The base of the glans penis is called the corona. In uncircumcised males, the foreskin (prepuce) extends from the corona to cover the glans penis (Fig 1).

The scrotum is the thick-skinned sac that surrounds and protects the testes. The scrotum also acts as a climate-control system for the testes because they need to be slightly cooler than body temperature for normal sperm development. The cremaster muscles in the scrotum wall relax to allow the testes to hang farther from the body to cool or contract to pull the testes closer to the body for warmth or protection.

The testes are oval bodies that average about 1.5 to 3 inches (4 to 7 cm) in length and 2 to 3 teaspoons (20 to 25 ml) in volume. Usually, the left testis hangs slightly lower than the right one. The testes have two primary functions:

- Producing sperm (which carry the man’s genes)
- Producing testosterone (the primary male sex hormone)

The epididymis consists of a single coiled microscopic tube that measures almost 6 m in length. The epididymis collects sperm from the testis and provides the environment for sperm to mature and acquire the ability to move through the female reproductive system and fertilize an ovum. One epididymis lies against each testis.

The vas deferens is a firm tube that transports sperm from the epididymis. One such duct travels from each epididymis to the back of the prostate and joins with one of the two seminal vesicles. In the scrotum, other structures, such as muscle fibres, blood vessels, and nerves, also travel along with each vas deferens and form an intertwined structure, the spermatic cord.

The urethra serves a dual function in males. This channel is the part of the urinary tract that transports urine from the bladder and the part of the reproductive system through which semen is ejaculated.
The prostate lies just under the bladder and surrounds the urethra. Walnut-sized in young men, the prostate enlarges with age. When the prostate enlarges too much, it can block urine flow through the urethra and cause bothersome.

The seminal vesicles, located above the prostate, join with the vas deferens to form the ejaculatory ducts, which travel through the prostate. The prostate and the seminal vesicles produce fluid that nourishes the sperm. This fluid provides most of the volume of semen, the fluid in which the sperm is expelled during ejaculation. Other fluid that makes up a minimal amount of the semen comes from the vas deferens and Cowper’s glands in the urethra.

In the male reproductive system, sperm is produced in the testes. The sperm travel from the testes through the epididymis, to the penis in the sperm duct, and secretions are added from the seminal vesicles and the prostate gland to produce semen.

During sexual arousal, blood floods into the erectile tissue, so the penis becomes larger and firmer. This makes it possible for it to be inserted into the female reproductive system. At the peak of sexual arousal (orgasm), muscular contractions in the penis cause semen to be ejaculated from the end. The semen travels along the urethra. This also at other times, carries urine from the bladder to the outside world, but the sphincter makes it impossible for urine and semen to pass out of the penis at the same time.
1. The figure below represents the male reproductive organ of human. Label the parts 1-11

![Male Reproductive Organs Diagram](bio_1(25).jpg (1136×1200) [proprofs.com])

2. Match the following organ with their function:

<table>
<thead>
<tr>
<th>Organ</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Located at the top of the testes, this is where sperm is matured and stored</td>
</tr>
<tr>
<td>2.</td>
<td>A large gland which adds fluid to the sperm to create semen</td>
</tr>
<tr>
<td>3.</td>
<td>Tightly coiled tubes within the testes where sperm are created</td>
</tr>
<tr>
<td>4.</td>
<td>A tube which carries both urine and semen through the penis and out of the body</td>
</tr>
<tr>
<td>5.</td>
<td>Oval shaped organs that produce testosterone and is where sperm is produced and mature</td>
</tr>
<tr>
<td>6.</td>
<td>A tube which transfers sperm from the testes to the urethra</td>
</tr>
<tr>
<td>7.</td>
<td>A sac made of skin which holds the testicles and keeps them at a cooler temperature than the body</td>
</tr>
</tbody>
</table>
WEEK: 11

TOPIC: Reproduction

SUB- TOPIC – The Female reproductive system

CONTENT:

The female reproductive system

The role of a woman in human reproduction is to produce a relatively small number of large gametes or ova, to provide the developing embryo with food, oxygen, removes its waste products and, after delivering a baby into the world, to provide it with a continued supply of food for a period of time.

Fig. 1 The female reproductive system, side and front view
Parts of the female reproductive system (Fig. 1)

- **Vagina** - the area between the lower part of the womb (the cervix) and the outside of the body. The vagina receives the penis during sexual intercourse and is a passageway for childbirth.

- **Womb (uterus)** - a hollow, pear-shaped organ that is the home to a developing fetus. The uterus is divided into two parts: the cervix, which is the lower part that opens into the vagina, and the main body of the uterus, called the corpus. The corpus can easily expand to hold a developing baby. A channel through the cervix allows sperm to enter and menstrual blood to exit.

- **Ovaries** - there are two ovaries, small, oval-shaped glands that are located on either side of the uterus. The ovaries produce eggs (ova - an ovum is one egg, ova means multiple eggs.) The ovaries also produce the main female sex hormones which are released into the bloodstream.

- **Uterine (Fallopian) tubes** - narrow tubes that are attached to the upper part of the uterus. They serve as tunnels for the ova to travel from the ovaries to the uterus. The fertilisation of an egg by a sperm (conception) normally occurs in the uterine tubes. The fertilised egg then moves to the uterus, where it implants into the lining of the uterine wall.
WORK SHEET 1

WEEK 11

INSTRUCTIONS – Answer all questions

LESSON 1

1. The diagram below is the female reproductive system. Label the parts of the female reproductive system.

Label the different parts of the female reproductive system

![Diagram of female reproductive system]

O
U
C
V

2. Fill in the following table with the words from the list below. (You may need to use some words more than once).

A. Ovary, B. Vulva, C. Fallopian tube, D. Cervix, E. Vagina, F. Uterus

<table>
<thead>
<tr>
<th>Word</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Chamber that houses the developing</td>
</tr>
<tr>
<td>U</td>
<td>Canal that receives the penis during</td>
</tr>
<tr>
<td>C</td>
<td>Usual site of fertilization</td>
</tr>
<tr>
<td>V</td>
<td>Duct through which the ovum travels to reach the uterus</td>
</tr>
<tr>
<td>D</td>
<td>A sphincter muscle between the uterus and the vagina</td>
</tr>
</tbody>
</table>

Source: Microsoft Word - reproduction worksheet (mrgscience.com)
CHEMICAL CONTROL BY HORMONES IS VITAL IN THE FEMALE REPRODUCTIVE SYSTEM. HORMONES CONTROL THE WHOLE PROCESS OF MENSTRUATION AND PREGNANCY. THE MENSTRUAL CYCLE IS A SEQUENCE OF EVENTS WHICH TAKE PLACE APPROXIMATELY EVERY FOUR WEEKS THROUGHOUT THE FERTILE LIFE OF A WOMAN, FROM THE AGE OF PUBERTY TO AROUND 50 YEARS OF AGE.

A baby girl has two ovaries full of immature ova, but they do nothing until after puberty. Then, once a month a surge of the hormone FSH (follicle stimulating hormone) from the pituitary gland in the brain start a few of the ova developing. FSH also affects the ovary itself, which starts making the female hormone oestrogen. This stimulates the uterus to build up a thick, spongy lining with lots of blood vessels ready to support a pregnancy. About 14 days after the ova start ripening, one of them bursts out its follicle. This is called ovulation, and when it happens, the hormone levels from the pituitary begin to drop dramatically.

After ovulation, the remains of the follicle from the corpus luteum (which means ‘yellow body’ because it is filled with a yellowish fat) and this secretes the hormone progesterone. Progesterone ensures that for some days, the uterus lining stays thick and spongy and stimulates the growth of more blood vessels, ready to receive a fertilized ovum. If pregnancy occurs, the embryo will immediately get a rich supply of food and oxygen. But most months the ovum is not fertilized, and the woman does not become pregnant.

About 10 days after ovulation (when no pregnancy has occurred) the ovary reduces the levels of the both oestrogen and progesterone. As the he chemical messages change again the blood vessels
which are supplying the thick spongy lining of the uterus close down (Fig. 1). The lining detaches from the wall of uterus and is lost through the vagina as the monthly period or bleeding.

However, if the ovum has been fertilized it will reach the uterus and sink into the thick, spongy lining, attach itself and starts to develop (implantation).

---

**Fig. 1 The menstrual cycle**

**The hormones of the menstrual cycle**

To summarize, there are four hormones which have an effect on the female reproductive system and between them control the menstrual cycle and female fertility.

Produced by the pituitary glands in the brain:

- **FSH (follicle stimulating hormone)** stimulates the development of a follicle in the ovary, and within the follicle, the eggs mature and ripens. FSH also stimulates the ovaries to produce the hormone oestrogen.
- **LH (luteinizing hormone)** stimulates the release of the egg from the ovary in the middle of the menstrual cycle and also affects the ovary so that it produces another hormone progesterone, to keep the uterus lining in place.

Produced by the ovaries:

- **Oestrogen** stimulates the lining of the uterus to build up in preparation for pregnancy. It also affects the pituitary glands. As the oestrogen levels rise, the production of FSH by the pituitary gradually falls, which in turn means the oestrogen levels fall. The rise in oestrogen levels has the opposite effect on the levels of the other pituitary hormone, LH. As oestrogen rises, the production of LH goes up. When LH reaches its peak in the middle of the menstrual cycle, it stimulates the release of a ripe egg from the ovary.

- **Progesterone** maintains the thickened lining of the uterus. It stimulates the growth of the blood vessels in the lining to prepare for pregnancy, and if a fertilized ovum arrives in the uterus, progesterone helps maintain the pregnancy. By the end of the cycle, when the menstrual bleeding is about to start, all of the hormones are at a low ebb.

Because the ovaries only contain a limited number of ova, women do not have periods throughout their lives. Eventually, the ova in the ovaries run out. The hormone levels drop, the ovaries and uterus shrink, and the woman stops having periods. She is no longer fertile. This change, which takes place around the age of 50, is known as the menopause.
WORKSHEET 2  WEEK 11

INSTRUCTIONS – Answer all questions  LESSON 2

1. Define the term menstruation

2. List and state the role of ANY four hormones in the menstrual cycle.

3. Using a well-labelled diagram, explain the menstrual cycle.

Multiple Choice questions

I. Which of the following statements is TRUE about menstruation?
   a) In a normal 28 day menstrual cycle you would expect menstruation to last approximately 13-15 days.
   b) During menstruation, the entire endometrium is shed
   c) During menstruation, only the functional layer of the endometrium is shed, with the basal layer remaining intact
   d) Absence of menstruation always indicates an active pregnancy

II. At which stage of the uterine cycle does the menstrual phase occur?
   a) Cycle days 10-15  c) Cycle days 5-14
   b) Cycle days 1-5    d) Cycle days 14-28

III. Where are luteinizing hormone (LH) and follicle-stimulating hormone (FSH) produced?
   a) Hypothalamus  c) Posterior pituitary
   b) Anterior pituitary  d) Adrenal glands

IV. Which hormone is the corpus luteum responsible for producing?
   a) Oestrogen  c) Follicle-stimulating hormones
   b) Progesterone  d) Luteinizing hormone

V. At which point in the menstrual cycle is a woman most fertile?
   a) Cycle days 1-6  c) Cycle days 17-20
   b) Cycle days 9-16  d) Cycle days 22-28

VI. ___________ is a shedding of the inner lining of the uterus.
   a) Menstruation  c) The luteal phase
   b) Ovulation  d) The follicular phase
CONTENT:

Fertilisation

Fertilization is the fusion of the male gamete fuses and female gamete to produce a zygote. After sperm are deposited in the vagina, some swim through the mucus in the cervix into the uterus and then to the oviduct. Many sperm cells do not survive this difficult journey. A man produces huge numbers of sperm cells to increase the chances of success.

If there is an egg in the oviduct, a sperm cell may succeed in fertilizing it. First enzymes are released by the tip of the sperm to digest a pathway through the jelly cot around the egg. The cell membrane of the sperm fuses with the membrane around the egg, and the sperm nucleus enters the egg cytoplasm. A membrane immediately forms around the fertilized egg or zygote to stop other sperm cells from entering. Only one sperm is successful. The two nuclei fuse together to form the zygote nucleus. Sperm can stay alive for two or three days, so if intercourse happens just before ovulation, the sperm can fertilise an egg, if it is released during this time.

Implantation

After fertilization, the zygote divides by mitosis to form a two-celled embryo. Then it continues dividing. After a few hours, the embryo is a hollow ball of cells, which moves down the oviduct. The embryo is moved by cilia on the epithelial cells along the oviduct and muscular contraction, similar to peristalsis in the gut.

It may take several days for the embryo to reach the uterus. The embryo embeds into the soft lining of the uterus. This is called implantation. The uterus lining is thick with many glands and blood vessels, which provide food and oxygen to the embryo by diffusion. Carbon dioxide and chemical wastes diffuse out of the embryo. Once the embryo has developed organs and is recognizable, it is known as a foetus.
Amnion
Structure – Thin layer of cells and fibrous tissue
Function – Encloses foetus in a watery fluid- the amniotic fluid, which protects against mechanical damage

Placenta
Structure- Disc of tissue that has many villi giving a large surface area
Function –Exchange of substances between foetal blood and maternal blood

Umbilical cord
Structure-Rubbery cord, containing an artery and two veins
Function – Dey oxygenated blood flows to the placenta
          Oxygenated blood returns to the foetus
WORKSHEET 3

INSTRUCTIONS – Answer all questions

1. Explain the process of fertilization in humans.
2. Explain what is meant by the term implantation.
3. State the functions of the following parts of the embryo
   I. Amnion
   II. Placenta
   III. Umbilical cord
WEEK: 12

TOPIC: Reproduction

SUB- TOPIC: Birth control methods

CONTENT :

Birth control

Birth control is any method that prevents the birth of a baby. This involves methods to prevent fertilization or implantation, removing the embryo or foetus at some stage during pregnancy.

<table>
<thead>
<tr>
<th>Birth control methods</th>
<th>Details</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier: condom</td>
<td>- Prevents sperm from reaching the egg in the oviduct</td>
<td>Protecting against transmission of STIs</td>
<td>Can split during intercourse</td>
</tr>
<tr>
<td></td>
<td>- Fits over the penis to prevent the release of semen into the vagina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diaphragm and cervical cap</td>
<td>Fits over the cervix to prevent the entry of sperm into the uterus</td>
<td>The woman is in control</td>
<td>Does not protect against STIs</td>
</tr>
<tr>
<td>Hormonal pill</td>
<td>Contains oestrogen and /or progesterone - prevents the development of follicles in the ovary</td>
<td>Very low failure rate</td>
<td>Not all women can use this method: some women are at risk of developing blood clots</td>
</tr>
<tr>
<td>Surgical vasectomy</td>
<td>Sperm duct is cut and tied; prevents sperm from being ejaculated</td>
<td>No other form of contraception is necessary</td>
<td>Do not protect against STDs</td>
</tr>
</tbody>
</table>
WORKSHEET 1  

INSTRUCTIONS – Answer all questions  

1. Define the term birth control  
2. List four methods of birth control  
3. Discuss the advantages and disadvantages of various birth control methods.
WEEK: 12
LESSON: 2

TOPIC: Reproduction in plants

SUB- TOPIC: Structure of a flower

CONTENT:

The flower

The flower is the part of the plant that is responsible for sexual reproduction. A flower is a reproductive organ of a plant.

Structure of a flower

![Diagram of a flower](image)

**Fig. 1 Parts of a flower**

Source: Functions of the parts of a flower - Google Search

Sepal

Sepals are the exterior parts of a flower that protect the interior flower while it emerges. Sepals are typically green and leaf-like, as they are modified leaves, but it is possible for them to be almost any colour depending on the type of plant. The sepal is the first part of the flower to grow, forming at the uppermost end of a stem. The sepal creates a bud around the emerging flower, and its key responsibilities are to protect the flower as it grows and prevents it from drying out.

Petals

Petals exist to draw pollinators to the flower. For this reason, they are often brightly coloured, showy, and of interesting patterns and sizes. The petals together form what is known as the corolla.
of the plant. Petals are probably the part of the flower with the most variation from plant to plant. Not only do they differ in colour, size, and shape, but some petals form in several layers to create very full-looking flowers, while others appear not to have separate petals, but instead are one solid petal.

**Stamens**

The stamen is the male reproductive organ of a flower. Each stamen contains two main parts. The filament is the long cylindrical tendril part of the stamen, while the anther is a sac that sits at the top of the filament. The function of the filament is simply to hold up the anther, extending it up to an accessible part of the flower for pollinators reach, or for the wind to disperse the pollen.

**Carpel**

The carpel, which is also sometimes called the pistil, is the female reproductive structure of a flower. Each carpel is usually bowling pin-shaped and features a sac at its base in the centre of a flower, and this sac is the ovary that produces and contains developing seeds or ovules. Moving upward, the ovary extends to support a style, that is a tube-like structure leading up to the stigma at the very top.

**Filament**

The filament is the thin tubular part of the stamen that extends and supports the pollen sac at the top.

**Ovary**

The ovary produces and contains unfertilized seeds. It sits centrally inside the flower at the base of the carpel. Once fertilized, it is the ovary that develops into the fruit of the plant.

**Ovule**

Ovules are contained within the ovary, and in the event of successful pollination, they will become the seed of the fruit.

**Anther**

The anther sits at the top of the filament of a stamen and produces and contains the pollen.
The female part of the flower

The female part of the flower is called the carpel or pistil. The pistil is comprised of three parts: the stigma, style and ovary. Flowers can have male parts, female parts or both; those with only female parts are called carpellate or pistillate flowers.

![Fig. 2 Structure of a Pistil](source: Parts of a Flower | Flower Parts | Flower Structure | Science Lessons (k8schoollessons.com))

Male Reproductive Parts of a Flower

Collectively, the male parts of the flower are called the stamen. Individually, the male reproductive parts are called the anther and the filament. The filament, which resembles a hair, holds a round pouch on top of it called the anther. The anther produces pollen, which is held in the small round pouches that sit on top of the filament.
Fig. 3 Structure of a Stamen

Source: Parts of a Flower | Flower Parts | Flower Structure | Science Lessons (k8schoollessons.com)
1. The diagram below shows the structure of a flower. Label the parts of a flower.

**Question 1:**
Label the following:

A

B

a) Name the structure labelled as:
1. A: ______________________
2. B: ______________________

b) Why do you think the petals of a flower have to be colourful and small nice?

______________________________________________________________

(c) What is another name for carpel?

______________________________________________________________

d) What is fertilization?

______________________________________________________________

Source: flower-parts-and-its-functions-5-638.jpg (638×903) (slidesharecdn.com)
Pollination is when pollen grains from an anther, the male portion of a flower, are transferred to a female part in the flower, known as the stigma. In order for pollination to be successful, the pollen grains transferred must be from a flower of the same species.

**Types of Pollination**

- Self-pollination
- Cross-pollination

**Self-pollination** is the more basic type of pollination because it only involves one flower. This type of pollination occurs when pollen grains from the anther fall directly onto the stigma of the same flower of the same plant. Although this type of pollination is simple and quick, it does result in a reduction in genetic diversity because the sperm and egg cells of the same flower share genetic information (Fig. 1).

![Self-pollination](source)

**Fig. 1 Self-pollination**

Source: self pollination - Bing images
**Cross-pollination** is a more complex type of pollination that involves the transfer of pollen from the anther of one flower to the stigma of a different flower. This type of pollination results in an increase in genetic diversity because the different flowers are sharing and mixing their genetic information to create unique offspring (Fig. 2).

![Cross-pollination diagram](image)

**Fig. 2 Cross-pollination**

Source: cross pollination diagram - Google Search

**Agents of pollination**

1. Insects such as bees, butterflies, moths, beetles, and flies
2. Birds
3. Bat
4. Wind
5. Water
Fig. 3 Bees as Pollinators
Source: agents of pollination - Bing images

Fig. 4 Birds as Pollinators
Source: agents of pollination - Bing images

Fig. 5 Butterflies as Pollinators
Source: agents of pollination - Bing images
INSTRUCTIONS – Answer all questions  

LESSON 3

1. Define the term pollination
2. List and explain the types of pollination.
3. List three agents of pollination.
CONTENT:
Fertilisation follows pollination. Pollination is completed when pollen grains land on the female stigma. The male nucleus is now transferred to the female gamete inside the ovule so that fertilisation can occur.

If a pollen grain lands on a ripe stigma of the same species, it produces a pollen tube which grows down the style to the ovary. As it grows, it gains nutrition from the tissues of the style and carries the male gamete nucleus. When it reaches the ovary, the tube grows through the micropyle – the small hole at the entry to the ovule. The tip of the tube breaks down to allow the male gamete nucleus to enter the ovule and fuse with the female gamete nucleus. This is fertilisation in which the zygote is formed by the fusion of the two nuclei.

After Fertilisation
The zygote divides by mitosis and grows into the embryo. The ovule forms the seed with the embryo inside it. After fertilisation, many of the parts of the flower are not needed any more, so the sepals, petals and stamens wither and fall off. They have completed their functions. The ovary swells to form the fruit with seeds inside it. The central part of the ovary is the placenta that contains xylem and phloem to provide water and nutrients to the growing seeds. Some fruits only have one or a few seeds and are disperse together. Other fruits contain many seeds and split open to release them.

Double fertilization is a process of fertilization characterized by the fusion of a female gametophyte with two male gametes. In this mechanism, one sperm cell fuses with the egg-producing zygote, and the other fuses with the two polar nuclei to make the endosperm. All angiosperm plants undergo double fertilization process.

After fertilization, the petals, the stamen, and the stigma fall off. The ovules become the seeds. The ovary becomes the fruit.
Fig. 1 Double fertilisation in plants

Source: fertilisation in plants - Bing images
1. Define the term fertilization.

2. Using a well-labelled diagram, explain the process of fertilization in plants.

3. Explain what happens to the ovary and ovules after fertilization.
WEEK: 13

TOPIC: Reproduction in plants

SUB- TOPIC: Differences between wind and insect-pollinated flowers

CONTENT:

Wind- pollinated flowers

These flowers are much smaller and less conspicuous than those of insect-pollinated flowers. They are often green in colour. Often the individual flowers are grouped closely together in an inflorescence, which grows above the rest of the plant. This is to ensure that the pollen is blown away from the plant and into the air so that it can be spread far and wide. Anthers are large and lightly attached to the filament, so they shake in the wind to release their pollen. Stigmas are large and feathery to trap pollen grains (Fig. 1).

![Fig. 1 Flowers pollinated by wind](source: wind pollinated flowers - Bing images)

Insect – pollinated flowers

These flowers are often large and conspicuous to insects, which are attracted by bright colours, scent and the prospect of nectar and pollen. Nectar is a liquid rich in sucrose, and pollen is a good source of protein.
Fig. 2 Insect pollinated flowers
Source: insect pollinated flowers - Bing images
INSTRUCTIONS – Answer all questions

1. State three characteristics between insect and wind-pollinated flowers

2. Draw diagrams to show the differences between an insect and wind-pollinated flower.
Dispersal of seeds

Seed Dispersal is an adaptive mechanism in all seed-bearing plants, participating in the movement or transport of seeds away from their parent plant to ensure the germination and survival of some of the seeds to adult plants. There are many vectors to transport the seeds from one place to another. There are different ways in which seeds from its parent plant is dispersed. These include:

Seed Dispersal by Wind

The wind is the natural and fundamental means of seed dispersal in the plant kingdom. This dispersal process is mainly seen in those plants that bear very light seeds. The orchid plant seeds, dandelions, swan plants, cottonwood tree, hornbeam, ash, cattail, puya, willow herb, are all examples of plants whose seed are dispersed by the wind.

![Seed dispersal by wind](seed dispersal by the wind - Bing images)
Seed Dispersal by Water

In this method of seed dispersal, seeds float away from their parent plant. These are mainly seen in those plant which lives in water or nearby the water bodies like beaches, lakes, ponds etc. Coconut, palm, mangroves, water lily, water mint, are a few examples of plants whose seed are dispersed by the water.

![Seed dispersal by water](seed dispersal by water - Bing images)

Seed Dispersal by Animal and Birds

There are different ways in which animals and birds disperse the seeds. Few animals and birds are attracted to bright and colourful fruits. They eat the entire fruit, and only the juicy part is digested by their system, and the seed are excreted out in the form of their dropping, which forms into new plants. Blackberry, cherry, tomato and apple seeds are dispersed in this way (Fig. 3).

A few species of squirrels collect nuts from different plants like acorns and bury them under the soil as they store food for the winter season and often forget the place where they have previously buried them, and the seeds grow into new trees.

There are a few plants which bear seeds with hooks. Burdock plant is an example of this type of plant species. The seed of these plants catches on the fur of animals and are carried away to different places, far from their parent plants.
Dates, rambutan, sea grapes, sea holly, tamarind, raspberry, sunflower, tomatoes are a few examples of plants whose seeds are dispersed by animals and birds.

**Seed Dispersal by Gravity**

Gravity is a force of attraction among all the objects in the universe. As the fruits from the tree fall on the ground due to the force of attraction, they sometimes roll down to some smaller distance, get buried in the soil after a few days and germinate into a new plant. In some instances, fruits which do not have tough seed coat may crack and open after falling from a height, which leads to a better dispersion of seeds. In some cases, the fallen fruit is carried by other agents like water, wind, birds or animal and helps in the dispersion of seeds. Apples, Commelina, canna, coconuts, calabash, passion fruit are a few examples of plants whose seeds are dispersed by gravity.

**Seed Dispersal by Explosions**

Explosions in fruits refer to bursting with all its energy. In this case, as the fruits get ripened, it shoots out its seeds into the external environment. This type of seed dispersal is mainly seen in those plants having pods. Okra, Lupins, gorse, and broom are a few examples of plants whose seeds are dispersed by Explosions. Pea and bean plants also have pods, and the seeds burst out when they ripen, and pod has dried (Fig. 4).
Fig. 4 Seed dispersal by explosion

Source: seed dispersal by explosive mechanism - Bing images
WORKSHEET 3

INSTRUCTIONS – Answer all questions

1. Define the term dispersal
2. List five means of seed dispersal of seeds
3. Using examples and pictures explain THREE means of seed dispersal.
A disease can be defined as a condition or illness that affects the body resulting in an abnormal condition in the body that negatively affects the structure or function of all or part of an organism. They are often known as medical conditions that are associated with specific symptoms and signs.

Categories of disease

There are many ways to classify the disease into different categories:

1. Pathogenic
2. Deficiency
3. Hereditary
4. Physiological

<table>
<thead>
<tr>
<th>Category and cause</th>
<th>Examples</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pathogenic:</strong> disease-causing organisms or pathogens</td>
<td>HIV, influenza, Yellow fever, Tetanus, tuberculosis (TB), gonorrhoea, Ringworm, thrush</td>
<td>Virus, Bacterium, Fungus</td>
</tr>
<tr>
<td><strong>Deficiency:</strong> Lack of a nutrient in the diet</td>
<td>Night blindness, Scurvy, (iron – deficiency) anaemia</td>
<td>Lack of vitamin A, C, iron</td>
</tr>
<tr>
<td><strong>Hereditary:</strong> inheritance of a mutant allele</td>
<td>Sickle cell anaemia, Haemophilia</td>
<td>A mutant of the gene for haemoglobin, A mutant allele of the gene for blood clotting factor</td>
</tr>
<tr>
<td><strong>Physiological:</strong> malfunction of organs or organ system</td>
<td>Diabetes, Hypertension</td>
<td>Inability to produce insulin or of tissue to respond to it, Cause (in most case unknown)</td>
</tr>
</tbody>
</table>
Treatment and control of disease

Pathogenic disease is treated with drugs:

- antibiotics, such as penicillin and amoxicillin, are used to treat bacterial infections; they are not suitable for treating viral and fungal diseases
- antifungal drugs, such as clotrimazole for treating thrush and ringworm.

Vaccination is an effective control measure for many infectious diseases. It has been used to eradicate smallpox and polio. Deficiency diseases are treated by providing dietary supplements. Hereditary and physiological diseases are treated in different ways, depending on the cause and its effect.

The concentration of glucose in the blood is maintained within narrow limits. Tissues in the pancreas detect changes in the concentration. Insulin stimulates cells in the liver and muscles to absorb glucose and convert it to the storage compound glycogen. If the concentration of glucose decreases, the pancreas secretes glucagon, which stimulates liver cells to break down glycogen to glucose.

Diabetes mellitus (most often just called diabetes) occurs when the body stops producing insulin to the target cells in the liver and muscles stop responding to it. Diabetes type I usually starts in childhood or adolescence. The cells that make insulin in the pancreas are often destroyed, so no insulin is produced.

Diabetes type II usually starts later in life. There is a very high risk of developing this form of diabetes if there is a genetic predisposition, a diet high in fat and refined sugar and not enough fibre. Obesity, high blood pressure and high blood cholesterol concentration also increase the risk of developing this disease.

Insulin is used to treat diabetes, and this has to be injected into the blood at regular intervals to stimulate the storage of glucose as glycogen so that it is not excreted in the urine. People with hypertension have high blood pressure and are often unaware of the fact as there are few, if symptoms. It is one of the best indicators that a person is a risk of heart disease or stroke. Various drugs are prescribed for hypertension, including beta-blockers that reduce the effects of stress that increase the heart rate and blood pressure.
The roles of diet and exercise

Rather than pay for expensive drugs, it is better to prevent physiological diseases developing in the first place. Eating a balanced diet, taking exercise, not smoking, and drinking alcohol in moderation are simple ways in which people can avoid developing many of these diseases.

A balanced diet provides all the nutrients needed for good health and prevention of deficiency diseases. It also means that people do not have more energy in their diet than they spend on daily activities. This reduces the risk of storing excess fat and becoming overweight or obese.
WORKSHEET 1

INSTRUCTIONS – Answer all questions

1. Define the term disease.
2. List the types of disease.
3. Using a flow diagram explain the causes and treatment of the types of disease
4. Explain how diet and exercise play an important role in reducing the risk of developing a disease.
The life cycle of a mosquito

Knowing the different stages of the mosquito's life will help you prevent mosquitoes around your home and also help you choose the right pesticides for your needs if you decide to use them. All mosquito species go through four distinct stages during their life cycle:

- Egg - hatches when exposed to water.
- Larva - (plural: larvae) lives in water; molts several times; most species surface to breathe air.
- Pupa - (plural: pupae) does not feed; stage before emerging as adult.
- Adult - flies a short time after emerging and after its body parts have hardened.

The first three stages occur in water, but the adult is an active flying insect. Only the female mosquito bites and feeds on the blood of humans or other animals.

- After she obtains a blood meal, the female mosquito lays the eggs directly on or near water, soil and at the base of some plants in places that may fill with water. The eggs can survive dry conditions for a few months.
- The eggs hatch in water and a mosquito larva or ‘wriggler’ emerges. The length of time to hatch depends on water temperature, food and type of mosquito.
- The larva lives in the water, feeds and develops into the third stage of the life cycle called, a pupa or ‘tumbler’. The pupa also lives in the water but no longer feeds.
- Finally, the mosquito emerges from the pupal case after two days to a week in the pupal stage.
- The life cycle typically takes up two weeks, but depending on conditions, it can range from 4 days to as long as a month.
Diseases transmitted by mosquitoes

Mosquitoes can transmit diverse infectious pathogens and parasites that cause dengue, Zika, Chikungunya, West Nile fever, or malaria. Therefore, the mosquitoes are so-called disease vectors. In order to do so, a mosquito must bite an infected human first, thereby infecting itself with the pathogen. After some time (usually around ten days), the mosquito itself becomes infectious. However, not every mosquito can transmit every pathogen. For example, the malaria pathogen can only be transmitted by the *Anopheles* species of mosquitoes, whereas tiger mosquitoes are the dengue fever vectors. Naturally, the specialization in different hosts has an influence on the diseases that a mosquito species can transmit. For example, the yellow fever mosquito, *Aedes aegypti*, is strongly specialized in humans and their surroundings. That is why it is a highly efficient vector of various diseases affecting humans: yellow fever, dengue, chikungunya, and Zika are among these.

**Yellow fever**

Yellow fever is caused by the yellow fever virus, which is transmitted by mosquitoes. They feed on infected animals in the forest, then pass the infection to humans when they feed on them. The
most significant risk of an epidemic occurs when infected humans return to urban areas and are
fed on by *A. aegypti*, which transmits the virus to other humans

**Dengue**

A virus transmitted by mosquitoes causes dengue fever. This disease is increasing across the world,
including the Caribbean. Epidemics tend to occur after heavy rains when the population of
mosquitoes increases.

Malaria is a disease caused by a parasite. The parasite is transmitted to humans through the bites
of infected mosquitoes. People who have malaria usually feel very sick, with a high fever and
shaking chills. Each year, approximately 210 million people are infected with malaria, and about
440,000 people die from the disease. Most of the people who die from the disease are young
children in Africa.

While the disease is uncommon in temperate climates, malaria is common in tropical and
subtropical countries. World health officials are trying to reduce malaria incidence by distributing
bed nets to help protect people from mosquito bites as they sleep. Scientists around the world are
working to develop a vaccine to prevent malaria.

**Control of mosquitoes**

Mosquitoes are controlled by:

- Reducing the number of places where they can lay eggs
- Covering the surfaces of water with oil or polystyrene beads, so larvae cannot breathe
- Stocking large bodies of water with fish that eat mosquito larvae
- Spraying insecticide in the houses and on breeding sites.

**Homework:**

Discuss the social, environmental and economic implications of disease to plants and animals.
WORKSHEET 2

INSTRUCTIONS – Answer all questions

1. Define the term vector
2. Draw and identify the stages in the life cycle of a mosquito
3. Discuss how mosquitoes transmit diseases
4. Discuss four ways to control mosquitoes.
CONTENT:

DNA

Genetic information is passed from one generation to the next. This is called heredity and why we resemble our parents. The genetic information itself is contained in a complex molecule called DNA. Scientists worked out the structure of DNA in the 1950s. Rosalind Franklin made ‘X-ray diffraction’ images of DNA. James Watson and Francis Crick used information from one of her images to work out a model for the structure of DNA. Work by Maurice Wilkins, a colleague of Franklin, supported their model.

Watson and Crick were able to work out how DNA was arranged and the tiny distances between its different features. They worked out that in a DNA molecule:

- there are two strands
- the strands are twisted around each other to form a double helix
- the strands are held together by bonds between base pairs

![Simple DNA structure](image)

**Fig. 1 Simple DNA structure**

The DNA in all of your cells is approximately two metres long, except red blood cells which have none and sperm or eggs which only have about one metre. Because it is so long, it is very thin and coiled into structures called chromosomes. The chromosomes are found in the nucleus of each cell.
Human body cells each contain 23 pairs of chromosomes, half of which are from each parent. So, human gametes (eggs and sperm) each have 23 chromosomes. When a sperm fertilises an egg, it becomes a cell with 23 pairs of chromosomes. This is why children resemble their parents – half of their chromosomes and DNA come from their mother and half from their father.

Fig. 2 Collection of human chromosomes

A gene is a unit of inheritance. It consists of a specific DNA sequence that codes for a unique molecule of RNA. This RNA molecule will either be directly involved in the synthesis of a
polypeptide or indirectly involved in regulating the production of a polypeptide. Genes occur in a linear sequence along a chromosome, and a single chromosome may contain hundreds of genes. Because chromosomes occur in pairs, genes also occur in pairs. An inherited trait is determined by at least one pair of genes. There may be two or more alternate forms of a gene controlling the expression of a particular trait. These alternate forms are called alleles, and each allele affects the expression of a trait differently. So, in the simplest case, a trait is determined by one pair of alleles present in a person’s cells. If the two alleles for a trait are identical, the person is homozygous for that trait; if they are different, the person is heterozygous for that trait.

The length of DNA is a chromosome is divided into segments known as genes. Each gene is an instruction for assembling amino acids to make specific protein, such as catalase or amylase. DNA is composed of four bases: adenine (A), thymine (T), guanine (G), and cytosine (C). A sequence of these bases codes that are used to make proteins. The nucleotides are joined to one another in a chain by covalent bonds (known as the phospho-diester linkage) between the sugar of one nucleotide and the next phosphate, resulting in an alternating sugar-phosphate backbone. The nitrogenous bases of the two separate polynucleotide strands are bound together, according to base-pairing rules (A with T and C with G), with hydrogen bonds to make double-stranded DNA.
WORKSHEET 3

INSTRUCTIONS – Answer all questions

1. Define the term gene.
2. Define the term chromosomes. Draw diagram to show the homologous pair of a chromosome.
3. Distinguish between a gene and an allele.
CONTENT:

Cell division is the driving process of reproduction at the cellular level. Most eukaryotic cells divide in a manner where the ploidy or the number of chromosomes remains the same, except in the case of germ cells where the number of chromosomes is halved.

Mitosis is the phase of the cell cycle where the nucleus of a cell is divided into two nuclei with an equal amount of genetic material in both the daughter nuclei. Cell division gives rise to genetically identical cells in which the total number of chromosomes is maintained. Mitosis is essential for the growth of the cells and the replacement of worn-out cells. Abnormalities during mitosis may alter the DNA, resulting in genetic disorders.

Features of Mitosis

1. In each cell division cycle, two daughter cells are formed from the parent cell.
2. The cell is also known as equational cell division because the chromosome number in the parent cell and daughter cell is the same.
3. In plants, mitosis leads to the growth of vegetative parts of the plant like root tip, stem tip, etc.
4. Segregation and combination do not occur in this process.

Stages of Mitosis

Before prophase, the cell spends most of its life in the interphase, where preparations are made before the beginning of mitosis (the DNA is copied). However, since the actual process involves the division of the nucleus, prophase is technically the first stage of this process.
Prophase
Prophase immediately follows S and G2 phase of the cycle. It is marked by condensation of the genetic material to form compact mitotic chromosomes composed of two chromatids attached at the centromere.

The completion of prophase is characterised by the initiation of the assembly of the mitotic spindle, the microtubules, and the proteinaceous components of cytoplasm that help in the process. The nuclear envelope starts disintegrating.

Metaphase
At this stage, the microtubules start pulling the chromosomes with equal force, and the chromosome ends up in the middle of the cell. This region is known as the metaphase plate. Thus, each cell gets an entire functioning genome.

Anaphase
The splitting of the sister chromatids marks the onset of anaphase. These sister chromatids become the chromosome of the daughter nuclei. The chromosomes are then pulled towards the pole by the fibres attached to the kinetochores of each chromosome. The centromere of each chromosome leads at the edge while the arms trail behind it.

Telophase
The chromosomes that cluster at the two poles start coalescing into an undifferentiated mass, as the nuclear envelope starts forming around it. The nucleolus, Golgi bodies and ER complex, which had disappeared after prophase start to reappear. Telophase is followed by cytokinesis, which denotes the division of the cytoplasm to form two daughter cells. Thus, it marks the completion of cell division.
As a result of mitosis, each daughter cell has the same number of chromosomes as the original parent cell. As the DNA in the chromosomes is copied by a reliable system, they are genetically identical to one another and to the parent cell.

Mitosis occurs in:

- **Growth** – this starts with the first division of the zygote and then throughout the body of a plant or animal embryo; later it is restricted to certain places, such as meristems in plants and growing regions in long bones of animals.
• Tissue and wound repair- for example, stem cells at the base of the epidermis divide to repair wounds in the skin.

• Replacement of cells – cells wear out and die, such as red blood cells, which only live for a short time as they do not have a nucleus and cannot divide.

• Asexual reproduction- occurs in fungi and plants, but is rare in the animal kingdom. Identical twins are a clone as they are formed from the same embryo that splits into two.
WORKSHEET 1

INSTRUCTIONS – Answer all questions

1. Define the term mitosis

2. Describe the importance of mitosis

3. Using a well-labelled diagram, describe the stages of mitosis.

4. Explain the importance of mitosis in asexual reproduction.
CONTENT:

Meiosis

Meiosis is a division of a germ cell involving two fissions of the nucleus and giving rise to four gametes, or sex cells, each possessing half the number of the original cell chromosomes. The process of meiosis is characteristic of organisms that reproduce sexually. Such species have in the nucleus of each cell a diploid (double) set of chromosomes, consisting of two haploid sets (one inherited from each parent). These haploid sets are homologous, that is they contain the same kinds of genes, but not necessarily in the same form. In humans, for example, each set of homologous chromosomes contains a gene for blood type, but one set may have the gene for blood type A and the other set the gene for blood type B.

Before meiosis, each of the chromosomes in the diploid germ cell has replicated and consists of a joined pair of duplicate chromatids. Meiosis begins with the contraction of the chromosomes in the nucleus of the diploid cell. Homologous paternal and maternal chromosomes pair up along the midline of the cell. Each pair of chromosomes—called a tetrad, or a bivalent—consists of four chromatids. At this point, the homologous chromosomes exchange genetic material by the process of crossing over. The homologous pairs then separate, each pair being pulled to opposite ends of the cell, which then pinches in half to form two daughter cells. Each daughter cell of this first meiotic division contains a haploid set of chromosomes. The chromosomes, at this point, still consist of duplicate chromatids (Fig. 1).
In the second meiotic division, each haploid daughter cell divides. There is no further reduction in chromosome number during this division. It involves separating each chromatid pair into two chromosomes, which are pulled to the opposite ends of the daughter cells. Each daughter cell then divides in half, thereby producing four different haploid gametes. When two gametes unite during fertilization, each contributes its haploid set of chromosomes to the new individual, restoring the diploid number (Fig. 2).
Fig. 2 Stages of meiosis
INSTRUCTIONS – Answer all questions

1. Define the term meiosis
2. Explain the role of meiosis
3. List and explain the stages of meiosis
4. State four differences between mitosis and meiosis
In biology, a gene is a section of DNA that encodes a trait. The precise arrangement of nucleotides (each composed of a phosphate group, sugar and a base) in a gene can differ between copies of the same gene. Therefore, a gene can exist in different forms across organisms. The exact fixed position on the chromosome that contains a particular gene is known as a locus. A diploid organism either inherits two copies of the same allele or one copy of two different alleles from their parents. If an individual inherits two identical alleles, their genotype is homozygous at that locus.

However, if they possess two different alleles, their genotype is classed as heterozygous for that locus. Alleles of the same gene are either autosomal dominant or recessive. An autosomal dominant allele will always be preferentially expressed over a recessive allele. The subsequent combination of alleles that an individual possesses for a specific gene is their genotype.

**Genotype examples**

Let’s look at a classic example – eye colour.

- A gene encodes eye colour.

- In this example, the allele is either brown, or blue, with one inherited from the mother, and the other inherited from the father.

- The brown allele is dominant (B), and the blue allele is recessive (b). If the child inherits two different alleles (heterozygous), they will have brown eyes. For the child to have blue eyes, they must be homozygous recessive (bb) for the blue eye allele.

**What is the definition of a phenotype?**

The sum of an organism’s observable characteristics is its phenotype. A key difference between phenotype and genotype is that, whilst genotype is inherited from an organism’s parents, the
phenotype is not. Whilst a phenotype is influenced the genotype, genotype does not equal phenotype. The phenotype is influenced by the genotype and factors including:

- Epigenetic modifications
- Environmental and lifestyle factors

**Phenotype examples**

Environmental factors that may influence the phenotype include nutrition, temperature, humidity and stress. Flamingos are a classic example of how the environment influences the phenotype. Whilst renowned for being vibrantly pink, their natural colour is white – the pink colour is caused by pigments in the organisms in their diet.

A second example is an individual's skin colour. Our genes control the amount and type of melanin that we produce; however, exposure to UV light in sunny climates causes the darkening of existing melanin and encourages increased melanogenesis and thus darker skin.

A dominant allele will result in a dominant phenotype. This is regardless of whether there are one or two copies of the allele present. In other words, one copy of the dominant allele is enough for it to manifest itself as a trait. This means that it can come from just one parent—think about brown-eyed children of brown-eyed mothers (brown eyes are based on a dominant allele, while blue eyes are recessive). A recessive allele results in a recessive phenotype only if a person carries two copies of it. This means that someone who has a dominant allele and a recessive allele will have the dominant phenotype. However, these individuals are still considered to be carriers of the recessive allele.

The concepts of dominant and recessive are practical in the prediction of inheritance of a certain trait. This is especially useful when it comes to certain disorders. However, these used to be confusing before the scientific community knew how to determine the underlying DNA. Still, it is important to point out that there is no specific way by which dominant and recessive genes behave. The term ‘dominant’ does not literally indicate dominance or repression. Rather, it all depends on the behaviours of the proteins that these genes code for.
Common Recessive Traits

There are also fairly common recessive traits within the human population, and some examples are listed below.

**Colour Blindness**

The gene that codes for red-green colour blindness resides on the X-chromosome, and it codes for a protein in the eye that is responsible for detecting specific colours of light. In the case of a defect within the gene, the eye is not able to distinguish between the colours green and red. Since two copies of the defective form of the gene are needed for an individual to be colour blind, females need to inherit each copy from both the parents. In contrast, males who inherit their copy from the mother will always be colour blind. As such, colour blindness affects males a lot more than females.

**Definition of Co-Dominance**

In the co-dominance, both traits are equally expressed. Thus the resultant phenotype will express more than one character. Co-Dominance is closely related to the Incomplete Dominance where both the alleles are expressed in heterozygotes.

An example of Co-Dominance is seen in the patient suffering from sickle cell disorder. This disorder results in the abnormal shape of red blood cells. As we know in the normal case, the shape of the red blood cell is disc-like and biconcave, containing the protein called haemoglobin. This haemoglobin plays the major role in transporting oxygen to the cells and other parts of the body. But due to certain mutations in the haemoglobin gene result in the sickle cell.
INSTRUCTIONS – Answer all questions

1. Define the term genotype and give examples
2. Explain the term phenotype and give examples
3. Explain what is meant by the term dominance and co-dominance

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