The Human Body

About the Course Team

Laura Sibanda has worked in hairdressing & beauty therapy for 13 years. She holds an Advanced Diploma in Hairdressing & Beauty Therapy & a Diploma in Education & Training. Laura taught at Gaborone Technical College for 4 years before joining FCTVE. She is an experienced BTEP assessor.

Writer: Laura Sibanda
Peer Reviewer: One Mazhani
Course Coordinator: Joanna Collymore
Instructional Design Editor: Jan Deurwaarder
Distance Education Adviser: Alison Mead Richardson
Language Editor: Aubrey Ramatau Pale
Desktop Publisher: Antony Okuku
Illustrator: Lebogang Thompson

This course is dedicated to Laura Sibanda who was taken from us in 2013. It is a testament to her work and her dedication to her students.
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## Glossary

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Structure & function of the human body

You know already that this BTEP unit is all about the structure and function of the human body. It is about the different parts of the human body and how they work. It is important for a beauty therapist to have a very sound knowledge of the human body before learning to carry out any treatments.

What is in this Module?

There are 6 topics in this module:

- **Topic 6** The Digestive System
- **Topic 7** The Excretory System
- **Topic 8** The Nervous System
- **Topic 9** The Endocrine System
- **Topic 10** The Reproductive System
- **Topic 11** The Integumentary System

Learning outcomes

The two learning outcomes from the BTEP Unit, The Human Body, are partly covered in this module:

1. Describe the structure and composition of the human body
2. Explain the functions of the main body systems

In this module we will cover the body systems shown above. Module 1 covered the body systems about the skeletal, muscular, respiratory and circulatory systems.

Assessment

There are 2 tutor marked assignments (TMAs) for this module. You should have received TMA 3 with this module. TMA 4 will be given to you when you come for the first unit assessment.

You should complete TMA 3 after you have completed your study of Topic 8. It covers the digestive, excretory and nervous systems. TMA 4 will cover the topics on endocrine, reproductive and Integumentary systems.
The TMAs are very important because they prepare you for the unit assessments. Check in your study timetable for the dates of the unit assessments.
Topic 6  The Digestive System

Do you remember Topic 1 in Module 1 on the characteristics of life? We said that one of the characteristics of life was the ability to take in food. In this topic we are going to look at the way in which humans take in and use food. The digestive (say die-JES-tif) system is the body system responsible for changing the food we eat into a form the body can use.

Have you ever wondered what happens to your food once it gets into your mouth? It is going to be digested. Digestion starts when your mouth waters as you smell that tasty chicken from KFC!

You know that our bodies become weak if we go for a long time without food. Food is needed to give our bodies energy as well as to allow the body to grow and be able to repair itself when it is damaged. For the body to be able to use the food you eat, that food needs to be broken down into small pieces and absorbed.

In this topic, we are going to explore the human digestive system. We will look at which organs are involved and how they work together to perform the function of digesting food. You will also find out about the different processes involved in the system of digestion.

What is in this Topic?

In this topic there are 4 sections:

Section 1  The food we eat
Section 2  The digestive system
Section 3  The accessory glands
Section 4  The process of digestion

Learning Objectives

By the time you have completed this topic, you should be able to:

- Describe the different types of food that we eat
- Identify the organs and glands of the digestive system
- Describe how food passes through the digestive system
- Describe how food is broken down mechanically and chemically
- Explain the processes involved in digestion

Study Time

It will take you between 6 and 8 hours to study this topic on digestion.
Section 1  The Food We Eat

The digestive system is about the breakdown of the food that you eat into a form that your body can use. Large and complex food molecules need to be broken down into smaller, simple ones. These can then be carried around the body in your blood to supply nutrients to all the cells.

What you eat can only help your body to be strong and healthy after it goes through the process of digestion. Before we look at the organs of the digestive system and their function let’s look at the things we eat.

What did you eat today? Write down all the food (solid or liquid) you have eaten today.

Your list might be long or short. This is my list for today: brown bread, cheese, raisin cake (muffin), cups of coffee, glass of fruit juice, roast chicken and noodles. Your list will be different from mine. We have a different diet. Diet is the food you eat every day. The list you made is your diet for today. Tomorrow’s list will be different.

It is important for you as a beauty therapist to learn about food. The food a person eats has an impact on the health of the body in general but on the skin and the hair in particular.

Why do you need food?

Can you write down 4 things that your body uses food for? Write in this space.

Your body uses food for energy, growth, repair and to stay healthy.

Energy - your body needs energy to make your muscles move and all other systems in your body work. This energy comes from the food you eat.
Growth – the human body grows until adulthood. The body increases in size which means new cells are needed throughout the body. In adults there are still body parts that grow all the time, for example your hair and nails. So, again, new cells are needed for this to happen. New body cells are built from food.

Repair – the body needs new cells to replace old ones. Blood cells are continuously broken down and need to be replaced; the top layer of your skin flakes continually and skin cells need to be formed. Damages to your body – a cut, a burn, destroy cells and these need to be replaced.

Staying healthy - to stay healthy your body needs vitamins and minerals. You have to ensure that you supply your body with these nutrients through your food.

**What is in the food you eat?**

To stay healthy you need seven different types of food. These are

- Carbohydrates
- Proteins
- Fats
- Vitamins
- Minerals
- Water
- Roughage

A diet that contains all these things in the correct amounts is called a **balanced diet**. It is a balanced diet which keeps the human body healthy.

It is important for you to understand the difference between the types of food and to be able to give examples of each. Let’s look at the seven types of food in more detail.

**Carbohydrates**

These are sugary and starchy foods for example sweet fruits (apples, bananas), honey, jam, bread, cakes, cereals, potatoes, rice, pasta, biscuits, chocolate and noodles. Carbohydrates are your main energy supply – the fuel for your body. Sugars are carbohydrates. The digestive system breaks down the complex carbohydrates (for example starch) into the most simple sugars (called mono-saccharides say SAK-rides). The simple sugar used as fuel in your body is called glucose. Later in this topic you will learn where in the digestive system this process takes place and which digestive organs are involved.
To speed up the breakdown of complex carbohydrates into glucose the body uses **enzymes**. Enzymes are substances that speed up the rate of breakdown of food without being changed themselves.

**Proteins**

These are mainly the foods which build the body although protein can be used as an energy nutrient, but only when other stores have run out. You need protein foods for growth and repair. The simplest proteins are called **amino acids**. There are 20 amino acids. Ten of these are essential for growth, repair and fighting disease. The other ones your body can make if needed. The amino acids are the building blocks for new body cells. Foods that are rich in proteins are, for example meat, egg white, liver, fish and beans. Animal protein contains all the ten essential amino acids.

Enzymes are proteins made by your body that are needed for different processes. Digestive enzymes are needed for the breakdown of food. Later in this topic you will learn how the digestive system breaks down the protein we eat into amino acids which the body can use.

**Fats**

Fats and oils are important energy nutrients; they are a source of energy for the body. You find them, for example, in butter, olive oil, fatty meat, whole milk, chocolate, egg yolk, and margarine. The fats you eat are complex and are broken down into simple ones called glycerol and fatty acids. The body stores some fat as reserves. If the body requires a lot of energy some of the fats in the body will be used (burning your fat!). Fat is stored in different places in the body. Much of it forms a layer just below the skin. The amount of fat and the part of the body where it is stored give people their ‘characteristic shape’.

There are two types of fats, fats that come from animals (saturated fats) and fats that come from plants (unsaturated fats). If you eat too much saturated fat it sticks to the inside of your blood vessels and builds up. This makes your blood vessels narrower and the heart has to work harder to pump the blood through your body. This increases the risk of a heart attack.

You will learn where and how fats are broken down in the digestive system later in this topic.
Carbohydrates, proteins and fats are needed by your body in relatively large quantities compared to the amount of vitamins and minerals. But even though very small amounts of vitamins and minerals are needed, they are still essential for the healthy functioning of your body.

**Vitamins**

Vitamins are essential substances but they have no energy value. Your body needs 13 vitamins. The main ones are:

- **Vitamin A** – for good eyesight – found in fruit and vegetables (especially carrots.)
- **Vitamin B** – a group of vitamins which support the nervous system and help your body make energy. Found in meat, fish, beans, eggs, milk and green vegetables.
- **Vitamin C** - for healthy cells, especially in the skin and blood vessels. Foods rich in vitamin C are citrus fruit (oranges, lemons) and vegetables. Vitamin C also strengthens the immune system which helps to protect the body from disease.
- **Vitamin D** is needed by the body to absorb calcium from the food. It helps to keep your bones strong. Lack of Vitamin D causes rickets (see calcium below). Vitamin D is found in fish oils, milk and egg yolk. Vitamin D can also be made by the body itself in the skin using sunlight.

**Minerals**

Like vitamins, minerals have no energy value but you need them to stay healthy. You need small amounts of about 15 different minerals. The major ones are iron, calcium and potassium, but you need all 15 to stay healthy. Lack of any of these minerals leads to a deficiency disease.

- **Iron** is needed to make the red blood cells (haemoglobin). Lack of iron causes anaemia, which makes a person feel weak and tired. Good sources of iron are meat, fish, eggs and beans.
- **Calcium** is needed by growing bones and teeth. Lack of calcium causes rickets in which the leg bones cannot support the weight of the body and therefore get bent. We get calcium from milk. Cheese & yoghurt, fish and green, leafy vegetables.
- **Potassium** is needed to balance the amount of water in your cells so it is important in all body systems. Bananas and beans are rich in potassium.

**Water**

The chemical reaction that takes place in your body (metabolism) happens between substances dissolved in water. Water is essential for the body. You need about 1.7 litres of water every day to replace the water you lose through your skin during perspiration, as urine from your kidneys, in faeces and by evaporation from the lungs during breathing.
Roughage or dietary fibre

Roughage or fibre cannot be digested. It passes through the digestive system from mouth to anus. The digestive system, in order to function well, needs stimulation. Roughage keeps the digestive system in good working order and prevents constipation. Food sources for roughage are the cellulose cell walls in fruit and vegetables, husks of cereal grains as found in wholemeal bread and brown (not white) rice.

The table summarises the information we have just given.

<table>
<thead>
<tr>
<th>Food</th>
<th>Why it is needed</th>
<th>Foods that contain it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Energy nutrient</td>
<td>Bread, cakes, biscuits, rice, pasta, honey, sugar, jam</td>
</tr>
<tr>
<td>Proteins</td>
<td>Growth and repair</td>
<td>Meat, fish, egg white, milk, cheese, beans, peas</td>
</tr>
<tr>
<td>Fats</td>
<td>Energy</td>
<td>Butter, lard, oil, margarine, fat meat, peanuts, chocolate</td>
</tr>
<tr>
<td>Vitamins</td>
<td>Staying healthy</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>eyesight</td>
<td>carrots, green vegetables, liver</td>
</tr>
<tr>
<td>B group</td>
<td>nervous system</td>
<td>mat, fish, eggs, dairy, beans, green vegetables</td>
</tr>
<tr>
<td>C</td>
<td>Healthy skin and body tissues</td>
<td>Citrus fruits, raw vegetables, potatoes, tomatoes</td>
</tr>
<tr>
<td>D</td>
<td>Helps body to absorb calcium from food</td>
<td>Butter, egg yolk, milk. Made by skin using sunlight.</td>
</tr>
<tr>
<td>Minerals</td>
<td>Staying healthy</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>For bones and teeth</td>
<td>Milk, cheese, bread, green vegetables</td>
</tr>
<tr>
<td>Iron</td>
<td>For making haemoglobin</td>
<td>Liver, egg yolk, meat, cocoa</td>
</tr>
<tr>
<td>Potassium</td>
<td>to balance water in the cells</td>
<td>Bananas, green vegetables, potato skins, beans</td>
</tr>
<tr>
<td>Water</td>
<td>To replace water loss</td>
<td>Water, fruits, juices</td>
</tr>
<tr>
<td>Roughage / dietary fibre</td>
<td>To enhance digestion</td>
<td>Whole wheat bread, brown rice, fruits, vegetables, bran cereals</td>
</tr>
</tbody>
</table>

Now complete Activity 1 to check that you learned and understood the information on the food you eat.
Activity 1: The food you eat

1. Complete the table

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Used in the body for</th>
<th>Some foods that contain the nutrient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>Building bones and teeth</td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td></td>
<td>carrots, green, leafy vegetables</td>
</tr>
</tbody>
</table>

2. Complete the table

<table>
<thead>
<tr>
<th>Food type</th>
<th>Why you need it</th>
<th>Some foods that contain the food type</th>
</tr>
</thead>
<tbody>
<tr>
<td>To produce energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>For energy</td>
<td></td>
</tr>
<tr>
<td>Minerals and vitamins</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Why do you need roughage or fibre in your diet?

Feedback

The activity will help you check your understanding of nutrition, the types of food you eat and where it is used in the body. Check your answers against ours at the end of the topic. If you did not get all the answers correct then chek the information again. Make sure you practice spelling of new words.
Section 2  The Digestive System

The digestive system changes food into a soluble form, so that it can be used by the cells of the body. When the food is soluble the body can use the nutrients found in the food. The digestive system is made up of a number of organs whose function is to get nutrients into the body. Look at Figure 1 which shows the main organs of the digestive system.

The digestive system has 2 parts:

- the organs of the alimentary canal
- the accessory organs or glands

We will first look at the organs of the alimentary canal. The accessory glands will be covered in Section 2.

The Alimentary Canal

The alimentary canal – is a long tube that begins at the mouth and ends at the bottom or anus. It is approximately 10 metres long. The organs which are part of the alimentary canal are:

- mouth
- pharynx
- oesophagus
- stomach
- small intestines
- large intestine

These are the main organs of the digestive tract. Do you remember what you learned in Topic 1 about the body cavities?
Can you say which cavities the alimentary canal passes through? Write your ideas in this space.

You can see from Figure 1 that the digestive tract starts in the mouth and then goes through the thoracic cavity before passing into the abdominopelvic cavity and then out of the body.

There are also 4 accessory organs or glands that work with the main organs to aid digestion. Their main function is to produce digestive enzymes to help break down and use food. The accessory organs are:

- salivary glands
- liver & gall bladder
- pancreas

We will first look at the structure and function of each of the main digestive organs in more detail. In Section 2 we will look at the structure and function of the accessory organs.

**Mouth**

Digestion begins in the mouth. When we see, smell, taste, or even imagine a tasty meal, our salivary glands, which are located under the tongue and near the lower jaw, begin producing saliva (say sa-LIE-vah). Saliva is a watery substance which contains enzymes or chemicals which help to break down carbohydrates. This flow of saliva is started by a brain reflex that is triggered when we sense food or think about eating (you will learn more the brain and reflexes later in Topic 8 on the nervous system). In response to this sensory stimulation, the brain sends impulses or messages through the nerves that control the salivary glands, telling them to prepare for a meal.

As you know, your mouth also contains your teeth and they also have an important part to play in digestion. The teeth tear and chop the food – we call this mechanical digestion. Then saliva is added to make the food more liquid for easy swallowing which is one of the forms of chemical digestion. The tongue helps by pushing the food around while the teeth are chewing. A digestive enzyme in the saliva starts to break down the carbohydrates (starches and sugars) in the food even before it leaves the mouth. Food is chewed with the teeth, made wetter by saliva and formed into a small ball called a bolus (say bow-lus).
Digestive functions of the mouth

There are 4 things that happen in the mouth as part of the digestive process:

- food is mixed with saliva from the salivary glands
- the teeth chop up food – mechanical digestion
- certain types of food (carbohydrates) start to break down because of the action of enzymes in the saliva
- food is formed into a small ball – **bolus** – by the muscular action of the tongue
- From the mouth, the food is moved into the pharynx.

Now try Activity 2 to check your understanding of the digestive tract and the function of the mouth in the digestive system.

**Activity 2: The digestive system & the mouth**

1. What is the main function of the digestive system?

2. The diagram shows 7 organs of the digestive system. Label each organ and say which one is an accessory organ.
Feedback

If you have read the text carefully then you will be able to answer these questions correctly. Check your answers against ours at the end of the topic.

We will now continue with our study of the other organs of the digestive tract.
Pharynx

What causes food to move out of your mouth and down your throat? It is swallowing. Once the food is formed into a bolus, the muscles of the tongue and mouth move the food into the throat, or, pharynx in an action we call swallowing. You know from your study of the respiratory system in Module 1 that the pharynx is the passageway in the throat for food and air. Do you also remember from your study of the respiratory system that there is a flexible flap of tissue called the epiglottis (say eh-pee-GLOT-iss) which closes over the wind pipe (larynx) when we swallow food so that we do not choke?

Digestive functions of the pharynx

- passage of food from the back of the throat to the oesophagus
- epiglottis makes sure the food enters the oesophagus and not the windpipe

Oesophagus

Look at Figure 3 again. From the pharynx or throat, food travels down a muscular tube in the chest called the oesophagus (say ess-OFF-a-gus). Why do you think it is a muscular tube? Write your ideas in this space.

The oesophagus needs to be made of muscle to be able to move food along towards the stomach. The muscles of the oesophagus contract in a wave-like motion to force food down through the oesophagus to the stomach. This movement is called peristalsis (say pear-ee-STAL-sis). A person normally is not aware of the movements of the oesophagus, stomach, and intestines that take place as food passes through the digestive tract. This is because the muscles are involuntary and we do not have to think about them moving – remember what you learned about different muscles in Topic 3?

Digestive function of the oesophagus

- action of peristalsis moves food down the oesophagus to the stomach
Module 2: The Human Body

Stomach

At the end of the oesophagus, a muscular ring or valve called a sphincter (say sf-INK-ter) allows food to enter the stomach and then squeezes shut to keep food or liquid from flowing back into the oesophagus.

The stomach is a muscular sack or bag which can be bigger or smaller according to how much is inside it! That is why your trousers sometimes do not fit around the waist after a big meal! Look at Figure 4 to see the position of the stomach (coloured) in the digestive tract.

In the stomach, large proteins are broken down into smaller proteins called amino acids. This is done by hydrochloric (say hi-dro-KLOR-ic) acid which is released from the stomach wall. Stomach muscles churn and mix the food with acids and enzymes.

The acids and enzymes break the food down into a thick liquid. The liquid form of the food is called chyme (say kime). This is known as chemical digestion. It is different from the mechanical digestion which takes place in the mouth. The gastric juices also help to kill some bacteria that might be in the food so that it does not make us sick.

Most substances in the food we eat need further digestion and must travel into the intestine for this to happen. There is another sphincter (ring of muscle) at the bottom end of the stomach. This allows the food to pass into the small intestine but not come back into the stomach. See Figure 5.
Digestive functions of the stomach

- food storage - the stomach is a place where food is held while the process of digestion takes place and then releases the food into the rest of the digestive tract
- digestive vessel - gastric juices are released in the stomach to breakdown proteins (chemical digestion)
- food mixer – the muscles layers of the stomach churn the food with the digestive juices to enable process of mechanical digestion
- sterilization – harmful bacteria are killed by stomach acid

Now try Activity 3 to check your understanding of the role of the pharynx, the oesophagus and the stomach in digestion.

Activity 3: The pharynx, oesophagus and stomach

1. What is the function of the pharynx in digestion?

2. What is the other name for the pharynx?

3. What is the name for the movement of food in the oesophagus?

4. Describe the structure of the stomach.

5. What are the functions of the stomach?
Feedback

You have studied the second part of the digestive tract. If you answered the questions correctly, you are ready to move on to the next part. Check your answers against ours. If you feel you did not get the answers quite right then you should read about the stomach again before moving on.

Activity 3: The pharynx, oesophagus and stomach

6. Where in the stomach are the sphincters found?

7. What is the function of the sphincters?

8. Where does food pass to after leaving the stomach?

Small intestine

Food, in the form of chyme, is slowly squeezed out of the stomach and into the small intestine. This is where much of the digestion of food takes place. The small intestine is a very long tube – about 3.5 m – which is specially formed to take nutrients out of the food and pass them into the body through the bloodstream and lymphatic system.

Look at Figure 6 to see the position of the small intestine in relation to the other organs of the digestive tract.

Figure 6: Position of small intestine (coloured) in digestive tract
Absorption of nutrients

Most of the absorption of nutrients happens in the small intestines. Food is slowly passed along the small intestines taking 2 – 3 hours to reach the large intestines. This allows plenty of time for absorption to take place. The surface area of the small intestine is increased by millions of tiny finger-like projections called villi (say vil-EYE) that contain a network of capillaries and lymph vessels called lacteals. This huge surface area absorbs nutrients into the blood and lymph vessels. See Figure 7.

Absorption of the various nutrients occurs as follows:

- **Amino acids**, water, soluble vitamins and minerals are all absorbed into the blood capillaries where they dissolve into the blood, and are carried away to other parts of the body.
- Glucose is used immediately for energy or is converted to glycogen and stored in the liver and muscles.
- **Glycerol** and **fatty acids** are absorbed into the lacteal where they recombine to form fats, which mix with the lymphatic fluid. They then pass around the body in the lymphatic system and join the blood circulation as insoluble fat. They are converted to soluble fat in the liver.
- The fat soluble vitamins (such as Vitamin A from carrots) are absorbed with fats and are taken to the liver.

The pancreas and gall bladder are accessory organs in the digestive system and they all do their work on the food in the small intestine. The main thing they do is to release digestive juices and enzymes to further break down the food. We will explain their role in the process more fully in Section 3.

**Digestive functions of the small intestines**

- onward movement of its content through peristaltic movement
- completion of the chemical break down of proteins, fats and carbohydrates by bile (produced in the liver) and pancreatic juices released in the small intestines
- absorption of nutrient materials such as amino acids, water, vitamins and minerals
Large intestines

From the small intestines, undigested food in a liquid form, moves into the large intestines through another muscular ring or sphincter that prevents food from returning to the small intestine. By the time food reaches the large intestine, the work of absorbing nutrients is nearly finished. The main function of the large intestine is to remove water from the undigested matter and form solid waste that can be expelled from the body.

Look at Figure 8 to see the position of the large intestine in relation to the other main organs of the digestive tract.

The large intestine is made up of three main parts:
- the caecum
- the colon
- the rectum

The caecum

The caecum (say seek-hum) is a sac like enlargement at the beginning of the large intestine – see Figure 9. It is here that the size of the intestine increases, allowing food to travel from the small intestine to the large intestine.

The caecum is also where we find the appendix (say uh-PEN-dix). The appendix is a small, finger-like pouch found at the end of the caecum. The function of the appendix is to break down a substance called cellulose which is what plants are made of. It is not very important in human beings and sometimes can become infected and cause great pain. It is one part of the human body which can be removed with no ill-effects. You may know someone who has had their appendix removed?
The colon

The colon (say koh-lon) extends from the caecum up the right side of the abdomen, across the body and down the left side, finally connecting to the rectum. Bacteria in the colon help to digest the remaining food products.

The colon is also in three parts:

- the ascending colon goes up the right side of the body
- the transverse colon crosses the body just below the rib cage
- the descending colon goes down the left side of the body and holds the resulting waste.

- Look at Figure 10 to understand the different parts of the colon.

![Figure 10: Parts of the colon](image)

The rectum (say rek-tum) is where waste matter, called faeces (fee-SEES) is stored until it leaves the digestive system through another double sphincter muscle to the anus (say ay-nus).

Digestive functions of the large intestine

- Ascending and transverse colon – absorbs mainly water and salts
- descending colon – holds waste matter (faeces) and passes it to the rectum
- rectum – passes waste matter (faeces) from the colon to the anus
- anus – moves waste matter (faeces) out of the body

Now complete Activity 4 to check your understanding of how the large and small intestines work.
Activity 4: The small and large intestines

1. What digestive processes take place in the small intestine?

2. Explain the function of the villi.

3. On the diagram, name the parts of the large intestine labelled A – E.

4. What are the names of the organs labelled F – H?

5. What is the function of the appendix?

6. What does the rectum do?

Feedback

Check your answers against ours at the end of the topic. Did you get them all correct? If you missed some, do not worry. Read the section again carefully.

You have now completed your study of the organs of the digestive tract.
Section 3  Accessory organs of the digestive system

You have now learned about the main organs in the digestive tract – how they are structured and what their functions are and how they work together to digest food. This has given you the overall picture of how the digestive system works. However, there are some additional organs which you need to know about which will give you more detail on the process of digestion.

Do you remember that we told you what the accessory organs are at the start of Section 1? They are the:

- salivary glands
- liver with gall bladder
- pancreas

Salivary glands

The salivary glands are found in the mouth and their job is to produce saliva, a watery substance that mixes with the food in your mouth and starts to break it down. There are 3 salivary glands in the mouth.

Digestive functions of the salivary glands

- Makes food wet to make it easier to swallow
- Starts the chemical process of digestion of carbohydrates

Liver

If you remember the diagram of the digestive system – Figure 1, we included the liver. The liver is found under the rib cage in the right upper part of the abdomen. Figure 11 shows the position of the liver in the body.

The liver is a gland – the largest gland in the body. A gland is an organ which produces a substance, which the body needs for different processes. There are many glands in the human body but the liver is the largest.

The function of the liver in the digestive system

The liver has many functions and the main function in connection with...
digestion is the production of a substance called **bile**. The bile produced in the liver is stored in the **gall bladder** which is a small muscular sack it then passes through a duct into the small intestine when it is needed. Bile is important to help the body to digest fats which mainly takes place in the small intestine. Bile works like a detergent – it breaks up fat into small droplets (this is called emulsifying). This allows enzymes in the small intestine to work on the food and further digest it. The liver has also the function of storing, processing and inactivating nutrients. It plays a major role in the handling and processing of nutrients.

Figure 12 shows the liver and the detail of the gall bladder.

The liver is part of the **circulatory** system because it ‘purifies’ the blood. Old red blood cells are removed and broken down. It also filters **toxins** from the blood (like alcohol and drugs). The liver is part of the **excretory** system because the waste products formed by the breakdown of the red blood cells, and other chemicals removed from the blood, are excreted in the bile. This is why the liver is part of the excretory system.

### Digestive functions of the liver

- produces bile which helps in the digestion of fats
- stores and distributes glucose and other nutrients to the body

### Pancreas

The pancreas (say pan-KREE-ass) is another gland which assists in the digestive process. It is found beneath the stomach and next to the liver – you can see the position and detail of the pancreas in Figure 13.
The pancreas produces enzymes that help digest proteins, fats, and carbohydrates. The enzymes pass into the small intestines along the same tube as the bile coming from the gall bladder.

**Digestive functions of the pancreas**

- produce enzymes that help digest proteins, fats, and carbohydrates

Activity 4 will help you check that you fully understand the role of the accessory glands in the digestion process.

### Activity 4: Accessory organs

1. Complete the table on the accessory organs. Describe where each one is found in the digestive system, giving the other parts of the system which it is connected to. Then describe the function of each accessory organ.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Where found</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. What is the function of the gall bladder?

3. What is a gland?

**Feedback**

*Check to see if you got the same answers as ours at the end of the topic.*
Section 4   The Process of Digestion

In your study of the organs of the digestive tract, you have learned that food is broken down in 2 ways. Can you say what they are, here?

Food is broken down mechanically when the teeth bite into it and chew it and when it is churning in the stomach. Food is broken down chemically when different glands in the digestive system release juices and enzymes to work on it.

During the digestive process, large particles of protein, carbohydrate and fat are reduced in size and converted into simpler substances.

The breakdown of nutrients into smaller, simpler substances means they can be absorbed through the walls of the digestive organs and into the blood.

In talking about the organs of the digestive system, we have mentioned several terms which may be new to you. These terms describe the processes of digestion. We will now explain these terms in more detail.
The processes of the digestive system

The processes of the digestive system are:
- ingestion
- propulsion
- digestion
- absorption
- assimilation
- egestion

Ingestion
This involves taking food and liquids into the mouth. It is just another word for eating.

Propulsion
This is how food moves through the digestive tract. Most of the system, especially the oesophagus, stomach and intestines, have strong muscular walls which move to create the process of peristalsis – squeezing food through. The alternating contraction and relaxing of the smooth muscle walls of the digestive tract, squeeze the food through.

Digestion
This is the process of breaking down food mechanically or chemically into smaller, simpler substances to allow them to pass into the blood.

Absorption
This is the passage of nutrients from the digested food through the epithelial lining of the stomach and small intestine into the blood and lymph circulation systems.

Assimilation
This is the conversion of absorbed simple nutrients into the complex substances which make up the human body.

Egestion
This is the process by which waste, indigestible substances, bacteria and cells that have been rejected by the digestive tract leave the body through the anus. You will learn more about the elimination of waste matter from the body in Topic 7 on the Excretory System.

Now complete Activity 5 to test yourself on the processes of digestion.
Activity 5: The process of digestion

1. Draw lines between the terms in the columns to link the name of the process and the meaning.

<table>
<thead>
<tr>
<th>Process</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>passage of nutrients from the digested food through the epithelial lining of the stomach and small intestine into the blood</td>
<td>absorption</td>
</tr>
<tr>
<td>taking food and liquids into the mouth</td>
<td>egestion</td>
</tr>
<tr>
<td>the conversion or incorporation of absorbed simple food into the complex substances constituting the body.</td>
<td>propulsion</td>
</tr>
<tr>
<td>breaking down of food into smaller components to enable absorption</td>
<td>ingestion</td>
</tr>
<tr>
<td>how food moves through the digestive tract</td>
<td>digestion</td>
</tr>
<tr>
<td>waste, indigestible substances, bacteria and cells that have been rejected by the digestive tract leave the body through the anus</td>
<td>assimilation</td>
</tr>
</tbody>
</table>
Activity 5: continued

2. You should be able to explain the path that food takes through the digestive system of the body.

Look at the table below which lists organs or parts of the digestive system. Write number 1 next to the organ or part where the process of digestion starts. Write number 2 next to the organ or part when the food next passes and so on.

<table>
<thead>
<tr>
<th>Organ/Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>pharynx</td>
</tr>
<tr>
<td>stomach</td>
</tr>
<tr>
<td>mouth</td>
</tr>
<tr>
<td>small intestine</td>
</tr>
<tr>
<td>anus</td>
</tr>
<tr>
<td>oesophagus</td>
</tr>
<tr>
<td>large intestine</td>
</tr>
<tr>
<td>rectum</td>
</tr>
<tr>
<td>liver &amp; gall bladder</td>
</tr>
<tr>
<td>appendix</td>
</tr>
</tbody>
</table>

Feedback

Well done – this is the last activity in the topic on digestion. Check your answers against our at the end of the topic. Then move on to the summary of this topic.
**Topic Summary: The digestive system**

We started this topic by looking at the different types of food which we need to eat if we are to be healthy. We first identified the 4 things the body uses food for: energy, growth, repair and to stay healthy.

We moved on to explain the 7 different types of food that the human body needs. These were proteins, carbohydrates, fats, vitamins, minerals, water and roughage.

**Proteins** are the foods which build the body such as meat, fish, egg white and beans. Protein is broken down into amino acids – the form the body can use in the stomach and the small intestines. The juice produced by the stomach lining, and enzymes from the pancreatic juice and the lining of the intestine are all involved in the digestion of proteins.

**Carbohydrates** are mostly sweet and starchy foods like bread, potatoes, sugar, honey and rice. The process of digestion breaks carbohydrates down into simple sugars called mono-saccharides. This starts in the mouth and continues in the stomach and the small intestines. Saliva and pancreatic juice and an enzyme in the lining of the small intestines play a part in the chemical break down of carbohydrates.

**Fats** are needed – in the right proportions – to maintain a healthy body and also to give energy. Fats are found in oily fish, milk, butter, cheese. When fats are digested they break down to glycerol and fatty acids. Fats are mainly broken down in the small intestines by juices produced by the liver (bile, stored in the gall bladder) and pancreatic and intestinal enzymes produces by the pancreas and lining of the intestines.

Vitamins, minerals, roughage and water are all important elements of a balanced diet to keep us healthy. **Vitamins** and **minerals** are chemical substances, found in foods, which help all the different body processes to work as they should. They are absorbed through the small intestines. They are not ‘foods’ and do not give us energy. **Roughage** (fibre) is needed to keep the digestive system healthy. It is indigestible and moves through the digestive tract without being broken down by enzymes.

**Water** is important because a large proportion of the human body is made of water and if we do not drink enough, we become dehydrated (too dry). Water is absorbed from our food in the small and large intestines.

We then moved on to explain that the human digestive system is a complex series of **organs** and **glands** that processes food. In order to use the food we eat, the body has to break the food down into smaller molecules that it can use; during the process, it makes waste.

Most of the digestive organs (like the stomach and intestines) are tube-
like and hold the food as it makes its way through the body. The digestive system is essentially a long, twisting tube that runs from the mouth to the anus, plus a few other organs (like the liver and pancreas) that produce or store digestive chemicals.

**The start of the process - the mouth:** The digestive process begins in the mouth. Food is partly broken down by the process of chewing (mechanical digestion) and by the action of salivary enzymes (chemical digestion). These enzymes are produced by the salivary glands and break down carbohydrates into smaller molecules.

**On the way to the stomach: the oesophagus** - After being chewed and swallowed, the food enters the oesophagus. This is a long tube that runs from the mouth to the stomach. It uses rhythmic, wave-like muscle movements (called peristalsis) to force food from the throat into the stomach. This muscle movement gives us the ability to eat or drink even when we’re upside-down.

**In the stomach - the stomach** is a large, sack-like organ that churns the food and mixes in a very strong acid (gastric acid). Food in the stomach that is partly digested and mixed with stomach acids is called chyme.

**In the small intestine** - After being in the stomach, food enters the **duodenum**, the first part of the small intestine. In the small intestine, bile (produced in the liver and stored in the gall bladder), enzymes from the **pancreas** and other digestive enzymes produced in the small intestine help in the breakdown of food.

**In the large intestine** - after passing through the small intestine, food passes into the large intestine. Here, some of the water and chemicals like sodium are removed from the food. The bacteria in the large intestine help in the digestion process. The first part of the large intestine is called the **caecum** (the appendix is connected to the caecum). Food then travels upward in the **ascending colon**. The food travels across the abdomen in the **transverse colon**, goes back down the other side of the body in the **descending colon**, and into the rectum.

**The end of the process** - solid waste is then stored in the **rectum** until it is egested via the **anus**.

Congratulations! You have now reached the end of Topic 6 on the human digestive system. We hope that you have found it interesting. It is a good idea to look again at the learning objectives for this topic and make sure that you have achieved them all. When you are happy that you fully understand the digestive system then you should move on to Topic 7. In the next topic, you will learn about the human excretory system – which we have already touched on in this topic.
Answers to Activities

Activity 1: The food you eat

1. Complete the table

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Used in the body for</th>
<th>Some foods that contain the nutrient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>To make red blood cells</td>
<td>Liver, egg yolk, meat, cocoa.</td>
</tr>
<tr>
<td>Calcium</td>
<td>Building bones and teeth</td>
<td>Milk, cheese, bread, green vegetables</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Healthy skin and body tissues</td>
<td>Citrus fruits, raw vegetables, potatoes, tomatoes</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Good eyesight</td>
<td>carrots, green, leafy vegetables</td>
</tr>
</tbody>
</table>

2. Complete the table

<table>
<thead>
<tr>
<th>Food type</th>
<th>Why you need it</th>
<th>Some foods that contain the food type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fats</td>
<td>For storage of energy</td>
<td>Butter, lard, oil, margarine, fat meat, peanuts, chocolate</td>
</tr>
<tr>
<td>Protein</td>
<td>Growth and repair</td>
<td>Meat, fish, egg white, milk, cheese, beans, peas</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>For energy</td>
<td>Bread, cakes, biscuits, rice, pasta, honey, sugar, jam</td>
</tr>
<tr>
<td>Minerals and vitamins</td>
<td>Keeps the body healthy</td>
<td>meat, eggs, milk, green vegetables and fruits.</td>
</tr>
</tbody>
</table>

3. Roughage or fibre is needed in the diet to aid the passage of food through the digestive system. It gives the muscles of the small and large intestine something to work on.
Activity 2

1. The main function of the digestive system is to change food into a soluble form, so that it can be used by the cells of the body.

2. [Diagram of the digestive system]

The liver is the accessory organ.

3. The alimentary canal passes through the thoracic and abdominopelvic cavities.

4. Saliva is produced in the salivary glands.

5. The function of saliva is to help break down food. Digestive enzymes in the saliva start to chemically break down carbohydrates in the food.

6. The function of the teeth is to chop food into smaller particles. We call this mechanical digestion.

7. The tongue pushes the food around the mouth while the teeth are chewing and helps to form small balls of food (bolus) that are then pushed to the back of the mouth where it is swallowed.

8. A bolus is a small ball of food which has been chewed (broken up mechanically) and made wet with saliva.

9. Carbohydrates (sugars and starches) start to be broken down in the mouth.

10. After leaving the mouth, food passes into the pharynx.
Activity 3

1. The function of the pharynx in digestion is to pass food from the mouth to the oesophagus. The epiglottis makes sure the food enters the oesophagus and not the windpipe.
2. The other name for the pharynx is the throat.
3. The name for the movement of food in the oesophagus is peristalsis.
4. The stomach is a muscular sack or bag.
5. The digestive functions of the stomach are
   - food storage - the stomach is a place where food is held while the process of digestion takes place and then releases the food into the rest of the digestive tract
   - digestive vessel - gastric juices are released in the stomach to breakdown proteins (chemical digestion)
   - food mixer – the muscles layers of the stomach churn the food with the digestive juices to enable process of mechanical digestion
   - sterilization – harmful bacteria are killed by stomach acid
6. The sphincters are found at the top and bottom of the stomach.
7. The function of the sphincters is to prevent food from flowing back into the system.
8. After leaving the stomach food passes into the small intestine.

Activity 4

1. digestive function of the small intestine are:
   - onward movement of its content through peristaltic movement
   - completion of the chemical break down of proteins, fats and carbohydrates by bile (produced in the liver) and pancreatic juices released in the small intestines
   - absorption of nutrient materials such as amino acids, water, vitamins and minerals
2. The function of the villi is to increase the surface area of the small intestine to allow for nutrients to be absorbed.
3. On the diagram, the names of the parts A – E. are
   A: appendix
   B: caecum
   C: ascending colon
   D: transverse colon
   E. descending colon
5. The function of the appendix is to break down cellulose but it is not very important in the human body because we do not eat a lot of cellulose.
6. The rectum holds the waste matter or faeces until it is pushed out of the body through the anus.

**Activity 5**

1. | Organ          | Where found                                      | Functions                                                                 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary glands</td>
<td>Mouth – connected to pharynx</td>
<td>Produces saliva which mixes the food and starts breaking down of carbohydrates</td>
</tr>
<tr>
<td>Liver</td>
<td>Under the rib cage on right side of body</td>
<td>Stores and distributes nutrients in the body</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Beneath the stomach and next to the liver</td>
<td>Produces enzymes that help to break down carbohydrates, fats and protein in food</td>
</tr>
</tbody>
</table>

2. The function of the gall bladder is to store bile.

3. A gland is a small organ which produces and secretes substances into the body to assist in different processes.

**Activity 6**

- Absorption: Passage of nutrients from the digested food through the epithelial lining of the stomach and small intestine into the blood.
- Egestion: Taking food and liquids into the mouth.
- Propulsion: Breaking down of food into smaller, simpler substances.
- Ingestion: How food moves through the digestive tract.
- Digestion: The conversion of absorbed simple food into complex substances which make up the body.
- Assimilation: Elimination of waste, indigestible substances, bacteria and cells that have been rejected by the digestive tract from the body.
2. The order in which food pass through or by the organs of the digestive tract is:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>pharynx</td>
</tr>
<tr>
<td>4</td>
<td>stomach</td>
</tr>
<tr>
<td>1</td>
<td>mouth</td>
</tr>
<tr>
<td>5</td>
<td>small intestine</td>
</tr>
<tr>
<td>10</td>
<td>anus</td>
</tr>
<tr>
<td>3</td>
<td>oesophagus</td>
</tr>
<tr>
<td>8</td>
<td>large intestine</td>
</tr>
<tr>
<td>9</td>
<td>rectum</td>
</tr>
<tr>
<td>6</td>
<td>liver &amp; gall bladder</td>
</tr>
<tr>
<td>7</td>
<td>appendix</td>
</tr>
</tbody>
</table>
Topic 7  The Excretory System

Do you remember in Topic 1 you studied the characteristics of life? You learned that there are seven characteristics of living things. Write them down here:

1. Reproduction
2. Growth
3. Metabolism (using energy)
4. Nutrition (eating)
5. Homeostasis (maintaining constant internal conditions)
6. Response to stimuli
7. Excretion

Did you remember them all? The characteristics are reproduction, growth, metabolism (using energy), nutrition (eating), homeostasis (maintaining constant internal conditions), and response to stimuli, reproduction and excretion.

In this topic you will learn more about the last of these characteristics: excretion. Excretion is the removal of waste products from your body such as carbon dioxide, water and salts and used hormones, in order to keep the body balanced and healthy.

Do you know any of the organs which are involved in the excretory system? Write them down here:

There are four organs involved in the excretory system - did you write any of these? The lungs remove carbon dioxide and water vapour. The kidneys remove excess water, urea and other salts. The liver (and large intestines) excrete chemical waste in the form of bile. The skin removes urea, salts, excess water (as sweat). Do not worry if you don’t understand some of these terms, we will explain them later.

The main excretory organs are the kidneys. Your kidneys remove excess water and waste products from the blood. Do you know that your blood passes through your kidneys 300 times a day and that your blood is ‘cleaned’ every 45 minutes?

You should not confuse this process with the removal of undigested food. Faeces are not really an excretory product because it was not taken into the cells of the body, but it is a waste product of the body. Excretory
products are the waste products produced by the chemical processes in your body cells during metabolism.

In this topic you will learn about the excretory system. The removal of waste products from metabolism in the body ensures that the internal environment of the body remains constant (homeostasis). Without the excretory system the waste products would become harmful to the body. They would poison your body.

What is in this topic?

In this topic there are 2 sections:

- Section 1  The organs of the excretory system
- Section 2  The urinary system
- Section 3  Removing waste products from the body

Learning Objectives

By the time you have completed this topic, you should be able to:

- describe the main organs of the excretory system
- describe the function of each of the excretory organs
- describe the main parts of the urinary system
- explain how the kidneys remove waste products from the blood

Study Time

We expect it will take you 5 – 6 hours to complete this topic and all the activities. But do not worry if it takes you more or less time than this, we do not all work at the same pace.
Section 1 The organs of the excretory system

Excretion is the name given to the process of removing waste made in the cells of the body. We call this metabolic waste. By removing waste products the excretory system regulates the amount and the make-up of the body fluids. That is the main function of the excretory system: keeping a constant internal environment in your body.

The waste products which are removed are the products produced by the chemical reactions taking place in your body cells. For the body to function properly it must have the correct amounts of water, salts and nutrients. If there is too much or too little – the body will not function and it could even be poisoned. Your excretory system ensures your body has the right amount of water, salts and nutrients and is not poisoned by waste products.

Why we need an excretory system

Your body takes nutrients from food and uses them to maintain all bodily functions. After your body has taken what it needs from the food, waste products are left behind in the blood and in the colon.

The urinary system works with the lungs, skin, and intestines—all of which also excrete waste—to keep the chemicals and water in your body balanced. Excretion is important to the health of your body because the waste products are poisonous. If the waste builds up and are not removed from the body, they can cause serious problems.

You know that carbon dioxide and water vapour are removed by the lungs. Other waste products, namely urea, uric acid, various salts, and nitrogenous wastes are removed by the kidneys and sweat glands.

The excretory organs

In this section we will look at which organs are involved in excretion. The main organs involved are:

- the lungs
- the liver
- the large intestine
- the skin
- the urinary system consisting of:
  - the kidneys
  - the ureters (say: you-REE-ters),
  - the urinary bladder (say: YOU-ree-nar-ee BLA-der)
  - the urethra (say: you-REETH-rah)

We will now look in more detail at the organs of the excretory system and see how they work together.
The lungs

The lungs are the major organs in the respiratory system, but they are also part of the excretory system. The lungs are the excretory organ that removes carbon dioxide and water vapour from your body. See Figure 14 to remind yourself of the shape and position of the lungs.

In the cellular respiration process energy is produced along with the waste products, carbon dioxide and water.

The liver & large intestine

The liver is the largest internal organ in your body. It has several functions and is part of 3 different body systems - the circulatory, digestive and excretory systems.

The liver is part of the circulatory system because it ‘purifies’ the blood. Old red blood cells are removed and broken down. The liver also removes potentially harmful chemicals from the blood.

The liver is part of the digestive system. Proteins and nitrogenous compounds are broken down in the liver. The liver produces bile that is released in the small intestines to help in the breakdown of fats.

The liver is part of the excretory system because the waste products formed by the breakdown of the red blood cells, and other chemicals removed from the blood, are excreted in the bile. This is why the liver is part of the excretory system. These waste products leave the body with the faeces formed in the rectum. This makes the large intestines part of the excretory system.
One of the waste products formed after protein has been broken down, is called urea (say you-REE-ah). Urea is excreted to the kidneys. This is why the liver is part of the excretory system.

The skin

Can you give a reason why your skin is part of the excretory system? Write your idea in this space.

The skin is part of the excretory system because, if you are very hot, sweat or perspiration, comes out of the pores in your skin. Sweat is a mixture of water, salts and urea.

If you are sweating, two things are happening:

- your body is cooling down
- metabolic waste products are excreted

It is because the skin excretes metabolic waste products that it is an organ of the excretory system.

Now complete Activity 7 to check how much you have understood so far about the organs of the excretory system.
Activity 7: The Organs of the Excretory System

1. What is the main function of the excretory system?

2. Name the four main organs of the excretory system.
   a. 
   b. 
   c. 
   d. 

3. Describe the difference between faeces and excretory products.

4. Which of the following is NOT a correct description of excretion?
   A. removal of metabolic waste
   B. removal of undigested food
   C. removal of heat through sweating
   D. removal of carbon dioxide when breathing out

5. Explain why the liver is part of three different body systems.

6. Explain why the large intestines (colon) is part of the excretory system.

7. Explain why the skin is an excretory organ.

Feedback
If you have read this section carefully then you will have no problem in answering these questions. Check your answers against ours at the end of the topic. If you did not manage to get them all correct, then you may need to read the section again.
Section 2  The Urinary System

The urinary system is responsible for removing a type of waste called urea from your blood. Urea is produced in the liver when foods containing protein, such as meat, chicken, and certain grains, are broken down. Urea is carried in the bloodstream to the kidneys.

The main organs of the urinary system are the kidneys, which form urine (pronounced: YUR-in). The other parts of the system are the ureters, the urinary bladder and the urethra. These parts of the system do not help to make urine they just transport it from the kidneys to the outside of the body. Look at Figure 16 to see how the urinary system is formed.

The main function of the urinary system is to control the amount of body fluids and what is contained in the body fluids. The urinary system gets rid of waste products that are formed as a result of cellular metabolism. The urinary system helps your body to maintain a constant internal environment (homeostasis).

The kidneys

The kidneys are bean-shaped organs about the size of your fists. They are near the middle of your back, just below the rib cage. The kidneys remove urea, which has been produced in the liver, from your blood through tiny filtering units called nephrons (say: NEFF-rons). See Figure 17.

Look at Figure 18 to see what a kidney looks like inside and the detail of the nephron.
In Figure 18, the nephron has been made much bigger in relation to the kidney than it really is so that you can see what it looks like. In reality, the nephron is very small. You have about 1.25 million nephrons in each kidney!

Each nephron is made of a ball formed of small blood capillaries, called a **glomerulus** (say: glom-ERR-yoo-lus), and a small tube called a renal tubule (say: TOOB-yool). Urea, together with water and other waste substances, forms the urine as it passes through the nephrons and down the renal tubules of the kidney. The function of the kidneys is to

- remove liquid waste from the blood in the form of urine
- keep a stable balance of salts and other substances in the blood

You will learn how the kidneys work in Section 3.

**The ureters**

The ureters are thin tubes that carry urine from each kidney to the urinary bladder. Each ureter measures about 25 to 30 centimetres in length. The ureters are very thin and measure only about half a centimetre across.

Urine drains through the ureters to the urinary bladder by gravity, but the smooth muscular walls of the ureters also help move urine along. They compress in a series of wavelike contractions (an action known as peristalsis) that move the urine through the ureters in only one direction. Do you remember that you learned about peristalsis in Topic 6 on the digestive system? It is the same muscular movement which helps to move things through the body. When urine has entered the urinary bladder, it is prevented from flowing back into the ureters by small, valve-like folds of membrane that flap over the ureter openings.
The urinary bladder

The urinary bladder is a hollow, collapsible, muscular sac that stores urine temporarily. See Figure 19. It is found in the pelvis behind the pelvic bones, and is held in place by ligaments. In women, the bladder is behind the uterus; in men, it is above the prostate gland. You will cover these organs in Topic 10 on reproduction.

The size of the urinary bladder varies depending on the amount of urine it contains. When it is empty, it is about 5 – 7 centimetres long and the walls are thick and heavily folded. As it begins collecting urine, the muscular walls of the urinary bladder, stretch and expand, and it moves higher in the abdominal cavity. A urinary bladder that is moderately full measures about 13 centimetres in length and holds just over half a litre of urine. When completely full, the urinary bladder can contain more than 1 litre of urine.

The muscular walls of the urinary bladder contract to expel urine out of the bladder into the urethra. A ring of muscle surrounding the opening to the urethra controls the flow of urine. This is an involuntary muscle, meaning you cannot consciously control its workings.

The urethra

The urethra is a thin-walled tube that carries urine from the urinary bladder to the outside of the body. The length and function are different for females and males.

In females, the urethra measures about 3 – 4 centimetres in length. Its external opening lies in front of the vaginal opening. The only purpose of the urethra in females is to conduct urine outside of the body.

In males, the urethra serves a dual purpose. It transports semen and urine to the body exterior, but never at the same time. Thus, it serves both the reproductive and urinary systems. In men, the urethra extends from the urinary bladder through the prostate gland to the tip of the penis, a distance of 15 to 20 centimetres.

In both sexes, the urethra contains a ring of skeletal muscle that forms the external urethral sphincter as the urethra passes through the floor of the pelvis. A person is normally able to control the opening and closing of this sphincter. When the sphincter is voluntarily relaxed, urine flows into the urethra, emptying the urinary bladder. However, when the bladder fills with urine and becomes stretched beyond normal, it is no longer possible to control the sphincter voluntarily.
Activity 8  The Urinary System

1. Name the 4 parts of the urinary system.
   1.
   2.
   3.
   4.

2. What is the ureter?
   A. The thin tube that connects the bladder to the outside of the body.
   B. The tube that leads from each of the kidneys to the bladder
   C. The inner lining of the bladder.

3. What is the urethra?
   A. The thin tube that connects the bladder to the outside of the body.
   B. The collective name for the thousands of nephrons contained in each kidney.
   C. The main vein that transports clean blood from the kidney back to the heart.

4. Which is the correct pathway for the removal of urine?
   A. kidney, ureter, bladder, urethra
   B. kidney, urethra, bladder, ureter
   C. kidney, bladder, ureter, urethra

5. What are the functions of the urethra in a man?

6. Describe the main features of the kidney as an excretory organ.
Feedback

You might have met some new words in this section that are not so easy to remember and to spell correctly. Do not worry - with some practice you will get them all right. Check your answers against ours at the end of the topic. If you did not manage to get them all correct, then you may need to read the section again.

You have now finished learning about the different organs which are involved in the excretory system. You should now know the 4 main human excretory organs, their function and excretory products. Read through the main points of the section again. As you read through, make sure you have understood the work covered before you go to the next section. In the next section you will learn how the different waste products are removed from the body.
Section 3  Removing waste products from the body

Now that you know what the excretory system does and the structure of the major organs, we are going to look at how waste products are removed. You already know about some of the waste products as you learned about them in Topic 5 on the respiratory system and in Topic 6 on the digestive system and we have mentioned them earlier in this topic.

Can you name the waste products which are excreted from the body? Write your ideas here.

You probably mentioned sweat and urine. In fact, there are 4 metabolic waste products:

1. Water
2. Carbon dioxide (formed in cells when molecules are broken down to release energy)
3. Salt
4. Urea (formed when protein is broken down)

Now we will look at the way these different waste products are excreted via the organs of the excretory system.
Carbon dioxide

The lungs remove carbon dioxide from the blood. Carbon dioxide is formed by the metabolic processes which take place in the cells of the body. You remember from your study of the respiratory system in Module 1, Topic 5, that you learned that the body needs oxygen in every cell. The oxygen is taken into the body through the lungs and it is in the alveoli of the lungs that the oxygen is exchanged for carbon dioxide and then exhaled from the body.

Urea & bile pigments

You learned in Section 1 that the liver forms part of the digestive system and the circulatory system but also plays a part in the excretory system. Urea is formed in the liver during the breakdown of protein. The urea is taken by the blood to the kidneys.

From your study of the digestive system can you remember the name of the substance produced in the liver to help with the breakdown of fats?

Did you remember that this substance is called bile? Bile is produced in the liver and stored in the gall bladder. From the gall bladder it is released into the small intestines to break down fats.

Bile also contains pigments that are waste products of the red blood cells which have been broken down in the liver. The bile pigments are removed from the body with faeces (undigested food). That is why we also include the large intestines as part of the excretory system, as it removes the waste products of the red blood cells.
Heat

Heat is a waste product that is removed from the body by the process of sweating. Figure 20 shows a diagram of the skin with the sweat gland lying below the surface of the skin and the sweat being able to leave the body via the pore.

![Figure 20: A sweat gland in the skin](image)

The sweat gland is a tubular structure with small blood vessels (capillaries) all around it. Waste products in the blood (salts, urea) or excess water can easily move from the blood into the sweat gland. If the body temperature goes up the fluid (sweat) is released from the gland and moves through the tube (duct) to reach the skin surface through small openings ( pores).

Water and salt

The kidneys are the main excretory organ. They function to balance the levels of water and salt in the body. You need to understand the detail of how they work.

How the kidneys work

As blood circulates around the body, it enters each kidney through the renal artery. This is the blood carrying waste products. The artery branches into capillaries that surround the nephrons. The nephron is the functional part of the kidney that purifies and filters the blood.
**Filtration in the glomerulus**

Look at Figure 21. As the blood goes into a nephron, in the glomerulus part of the nephron, it is at high pressure. This pressure causes everything that is dissolved in the blood (waste products, food) to be pushed out of the blood into the kidney. This process removes both waste products and essential nutrients from the blood, including:

- water
- urea (the nitrogen-containing breakdown product of protein)
- salts
- glucose
- amino acids, the building blocks of proteins
- yellow bile compounds from the liver
- other trace substances from the blood

**Re-absorption**

The fluid filtered from the blood by the glomerulus then travels down a tiny tube-like structure called a tubule. As this fluid moves through the long, looped tubule, the water and anything else the body needs goes back into the blood. It is reabsorbed into the blood to be reused by the body to maintain normal body functions.
Removal of excess products and waste products

The rest of the dissolved waste products (urine) keep moving through the tubule into the ureters, the tubes that carry urine to the bladder. The bladder then collects the urine. When the bladder is emptied, the urine passes out of the body through the urethra.

The filtered blood (which now has all the waste products removed) leaves the kidney through the **renal vein** and flows back to the heart.

In summary – how the urinary system works

- If there is too much water in the blood, then it is removed in the kidneys and is excreted as urine.
- If there is not enough water in the blood, the kidneys will not remove it.
- If there is too much urea or other substances in the blood, the kidneys will remove these.
- By regulating the amount of substances and water in the blood, the kidneys maintain homeostasis in the body.

Now try Activity 9 to make sure you fully understand how excretion works.

**Activity 9: Excretion**

1. List three excretory organs that remove excess water from your body.

2. Why is the liver an excretory organ?

3. Describe how the skin acts as an excretory organ.
Activity 9: ...

4. Use the diagram to describe how the kidneys work to ‘clean’ the blood.

Feedback

It is important that you are able to describe how the four waste products of metabolism are removed from the body. Check your answers against ours at the end of the topic.
**Topic Summary: The Excretory System**

You have now finished this topic about the excretory system. Read through the summary to make sure you understand each point. If there is any part of this unit you are unsure about you can re-read the section, look it up in a textbook or ask your tutor for help, **do not just leave it**.

Excretion is the removal of metabolic waste products from the body in order to keep the amount and composition of the body fluids constant (homeostasis). Excretion does not include the removal of waste material from the digestive track through the anus. This is called **egestion**.

The metabolic waste products are:
1. Water
2. Carbon dioxide (formed in cells when molecules are broken down to release energy)
3. Salt
4. Urea (formed when protein is broken down)

The four main human excretory organs are
1. the lungs
2. the liver / large intestines (colon)
3. the skin
4. the kidneys (the urinary system)

The table lists the excretory organs, the waste excreted by them and where the waste was produced.

<table>
<thead>
<tr>
<th>Excretory organ</th>
<th>What waste is excreted</th>
<th>Where waste is made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lungs</td>
<td>Carbon dioxide and water vapour</td>
<td>In all cells during metabolism</td>
</tr>
<tr>
<td>Kidneys</td>
<td>Urea and other nitrogen compounds</td>
<td>Liver cells</td>
</tr>
<tr>
<td>Skin</td>
<td>Excess water; small amounts of salts and urea (as sweat)</td>
<td>Liver and body cells</td>
</tr>
</tbody>
</table>
| Liver           | Urea waste product of breakdown of nitrogenous products in the liver.  
                  | Bile pigments resulting from breakdown of red blood cells | Liver cells                                      |
| Intestines      | Bile pigments resulting from breakdown of red blood cells   | Liver cells                                      |
You have learned that the urinary system rids the body of waste materials and regulates the amount of water in the blood. The main organs of the urinary system are the kidneys and the other parts are the ureters, urinary bladder, and urethra.

The functional units of the kidney are the nephrons. It is here that the blood is ‘filtered’ and urine is formed. The kidneys carry out a process of filtering all substances in the blood (except the red blood cells and blood plasma) and then reabsorbing only the essential nutrients back into the blood. The waste products – as urine - are then transported via the ureters from the kidney to the urinary bladder.

The urinary bladder is a temporary storage vessel for urine. The urethra is the final passageway for the flow of urine which is controlled by an involuntary internal urethral sphincter and voluntary external urethral sphincter.

This completes your work on the excretory system in Topic 7. It is a good idea to check the learning objectives again and make sure you have covered them all. Once you are happy you have mastered this topic then move on to the next on which is all about the nervous system.
Answers to Activities in Topic 7

Activity 7: The Organs of the Excretory System

1. The main function of the excretory system is to remove metabolic waste products in order to keep a constant internal environment in the body – to maintain homeostasis.

2. The four main organs of the excretory system are:
   - lungs
   - liver / large intestines (colon)
   - skin
   - kidneys (urinary system)

3. The difference between faeces and excretory products is that excretory products are waste formed during metabolism in the cells of the body. Faeces are undigested food – a product of digestion. Excretory products such as urea, salt and water are a result of cell metabolism.

4. B. removal of undigested food is NOT a form of excretion.

5. The liver is part of three different body systems because:
   - In the circulatory system – it ‘cleans’ the blood
   - Digestive system – produces bile for digestion of fats
   - Excretory system
     - produces bile pigments (waste of breakdown of red blood cells)
     - produces urea (waste product of breakdown of nitrogenous molecules)

6. The large intestines (colon) is part of the excretory system because it excretes bile pigments, the waste product of the breakdown of red blood cells.

7. The skin is an excretory organ because it excretes sweat (perspiration) containing water, salts and urea which are the waste products of metabolism in the cells.
Activity 8: The Urinary System

1. The 4 parts of the urinary system are:
   1. Urethra
   2. Ureter
   3. Urinary bladder
   4. Kidneys

2. What is the ureter?
   A. The slender tube that connects the bladder to the outside of the body.
   B. The tube that leads from each of the kidneys to the bladder
   C. The inner lining of the bladder.

3. What is the urethra?
   A. The slender tube that connects the bladder to the outside of the body.
   B. The collective name for the thousands of nephrons contained in each kidney.
   C. The main vein that transports clean blood from the kidney back to the heart

4. Which is the correct pathway for the removal of urine?
   A. kidney, ureter, bladder, urethra
   B. kidney, urethra, bladder, ureter
   C. kidney, bladder, ureter, urethra

5. What is the function of the urethra in a man?
   Transport of semen and urine.

6. Describe the main features of the kidney as an excretory organ
   The kidneys are bean-shaped organs about the size of your fists. The main features of the kidneys are the tiny filtering units called nephrons. Each nephron consists of a ball formed of small blood capillaries, called a glomerulus, and a small tube called a renal tubule.
Activity 9: Excretion

1. Three excretory organs that remove excess water from your body:
   - kidneys
   - skin
   - lungs

2. The liver is an excretory organ because it excretes
   - bile pigments
   - urea

3. Describe how the skin acts as an excretory organ
   Waste products in the blood (salts, urea) or excess water move from the blood into the sweat gland. If the body temperature goes up the sweat gland fluid (sweat) moves through the tube (duct) to reach the skin surface through the small openings (pores).

4. Use the numbers in the diagram to describe how the kidneys work to ‘clean’ the blood.

   - (1). blood containing metabolic waste products enters each kidney through the **renal artery**
   - The artery branches into capillaries (2) that surround the **nephrons** (3).
   - In the glomerulus part of the nephron (3), metabolic waste products from the blood are removed.
   - The fluid filtered from the blood by the glomerulus then travels down a tiny tube-like structure called a **tubule** (5) As this material moves through a long, looped tubule, the water and anything else the body needs goes back into the blood (is re-absorbed)
   - The rest of the dissolved waste products (urine) keep moving through the tubule into the ureters (4), the tubes that carry urine to the bladder.
   - Filtered blood leaves the kidney through the **renal vein** (6) and flows back to the heart.
Welcome to this topic on the nervous system. We are sure that you have already realised that all the body systems you have covered so far, link with each other. That is why it is important that you understand them fully before you move on to the next topic. We are building up on, and expanding, your knowledge of the human body from Topic 1, the characteristics of life.

For a human body to live without being in danger it needs to sense, feel, touch, smell and see its surroundings. If you think back to the characteristics of life, you will remember that one of the 7 characteristics of life is to respond to stimuli, these can come from outside (externally) or from inside (internally) the body. In this topic we are going to talk about how the body gets to sense, feel, respond etc with the help of the nervous system.

The brain is like a central computer that controls all the functions of your body, and the nervous system is like a network or a set of connections that sends messages to and from different parts of the body. The brain controls not only what you think and feel, how you learn and remember, the way you move and talk, but also many things you’re less aware of - such as the beating of your heart, the digestion of your food.

The main purpose in studying the nervous system is to understand the effects various facial services have on the nerves, skin and face, and on the body as a whole. You will need this background knowledge in later units.

**What is in this topic?**

In this topic there are 2 sections:
- Section 1  What forms the nervous system?
- Section 2  Response mechanism

**Learning Objectives**

By the time you have completed this topic, you should be able to:
- describe the main parts of the nervous system
- explain how the nervous system works
- describe the sensory organs of the human body
- explain the difference between a voluntary and a reflex action.
Study Time

We expect it will take you 4-6 hours to complete this topic and all the activities. But do no worry if it takes you more or less time than this, we do not all work at the same pace.
Section 1 What forms the nervous system?

The nervous system is responsible for controlling and coordinating the functions of all the other body systems and makes them work together in harmony. In this section we are going to look at how the nervous system is formed – which parts of the body are involved in the nervous system. It is a very complex system in the body, and has many different parts.

The nervous system is divided into 2 main systems:

1. the central nervous system (CNS)
2. the peripheral nervous system (PNS)

1. The central nervous system (CNS)

The spinal cord and the brain make up the central nervous system. See Figure 22. Its main job is to get information from the body and send out instructions. The information it gets from the body is provided through the 5 senses. Can you say what these are? Write in this space.

1
2
3
4
5

We will learn more about the 5 senses in Section 2. They are sight, touch, smell, taste and hearing. First we will find out more about the brain and spinal cord.

Figure 22: The central nervous system (CNS)

The brain

We are sure that you are aware of the importance of the brain in the functioning of the whole human body. But what protects the brain from injury? Write your answer here.

Remember in Topic 1 Section 4, we said that the brain is located in the cranium or head and the bones of the skull protect the brain. The brain controls all of the body systems and organs. The brain also allows us to
think, feel, remember and imagine. It is the brain that makes us behave as human beings.

The brain is the main communication centre of the nervous system. It communicates with the rest of the body through the spinal cord and the nerves. They tell the brain what is going on in the body at all times. This system also gives instructions to all parts of the body about what to do and when to do it.

The brain is a very complex organ but at this stage, you only need to know about the structure and function of 3 main areas:

- the cerebrum
- the cerebellum
- the medulla oblongata (brain stem)

Look at Figure 23 to see these parts of the brain. You need to imagine that you are looking inside the skull from the side of a person who is facing to the left.

The Cerebrum

The cerebrum is formed in 2 halves called the left and right hemispheres. These are the main functional units of the brain. The function of the cerebrum is to control voluntary movement, to receive and interpret signals from the rest of the body (sensory perception) and to coordinate higher mental activities such as memory, thinking, reasoning, learning. Figure 24 shows how the brain looks from above. You can clearly see the right and left hemispheres or halves.

The left hemisphere controls the right side of the body and the right hemisphere controls the left side of the body. If you are holding this study guide in your right hand, it is the left hemisphere which is telling your hand to do so.
The cerebrum is covered by the cerebral cortex, the outer layer of which is known as "gray matter". Information collected by the five senses comes into the brain from the spinal cord to the cortex. This information is then directed to other parts of the nervous system for further processing. For example, when you touch the hot stove, not only does a message go out to move your hand but one also goes to another part of the brain to help you remember not to do that again. The cerebrum controls voluntary movement and higher functions such as memory & intelligence.

Hypothalamus

There are lots of different parts of the cerebrum which you do not have to know about, except one, the hypothalamus (say hi-poe-thal-a-mus). This is located in the centre at the base of the brain. It forms a link between the nervous system and the endocrine system (see next section) by controlling the pituitary gland (which produces hormones). It also controls involuntary processes such as the pulse, thirst, appetite and sleep patterns. These are the things that happen automatically in our bodies without us having to think about them. The hypothalamus also plays an important role in motivation and emotion, including feelings of pleasure, fear and anger.

The Cerebellum

The cerebellum sits underneath the back end of the cerebrum. The cerebellum is sometimes called the "little brain" because it looks like a small version of the cerebrum. It is located below and behind the cerebrum and is responsible for muscular coordination and balance.
The Medulla Oblongata

The medulla oblongata is also called the **brainstem**. The brainstem takes in, sends out, and coordinates all of the brain's messages. It works like a relay station. It controls many of the body’s **autonomic functions**, like breathing, heart rate, blood pressure, swallowing, digestion, and blinking. It connects the brain and the spinal cord. You can see this in Figure 25.

![Figure 25: Spinal cord connecting to the brain at the medulla oblongata](image)

Now complete Activity 10 to check how much you have learned about the brain and the central nervous system.
Activity 10: The Brain

1. What is the function of the nervous system?

2. Name the divisions of the nervous system.

3. What is the function of the brain?

4. Name the 3 main parts of the brain by labelling the diagram.

5. Complete the table by adding the name of the part of the brain against each function.

<table>
<thead>
<tr>
<th>Function</th>
<th>Part of the Brain</th>
</tr>
</thead>
<tbody>
<tr>
<td>controls muscular co-ordination and balance</td>
<td>controls voluntary movements and carries out higher functions like memory &amp; intelligence</td>
</tr>
<tr>
<td>controls automatic functions – like the working of the heart and lungs.</td>
<td>controls voluntary movements and carries out higher functions like memory &amp; intelligence</td>
</tr>
</tbody>
</table>
The Spinal Cord

The spinal cord is an extension of the brain stem and extends from the base of the skull down to the lower extremity of the trunk. The spinal cord is protected from damage by certain bones. Which bones protect the spinal cord? You learned this in Module 1. Write your answer here.

The spinal cord is protected by a set of ring–shaped bones called the spinal column, vertebrae or vertebral column.

The spinal cord is a thick bundle of nerves, connecting the brain to the rest of the body. Nerves divide many times as they leave the spinal cord so that they may reach all parts of the body. The thickest nerve is 2.5cm thick and the thinnest is thinner than a human hair. Each nerve is a bundle of hundreds or thousands of neurons (nerve cells) remember we mentioned this in Topic 1 on the types of cells. The function of the spinal cord is to relay impulses to and from the brain.

The spinal cord is the centre for reflex actions. A spinal reflex provides a fast automatic response to external or internal stimuli and does not involve the brain. Some examples are a knee jerk, dropping a hot object, or the iris of the eye responding to light changes. On these occasions you will notice that the body has often responded before you are conscious of any sensation.

2. The Peripheral Nervous System (PNS)

The peripheral nervous system (PNS) connects the brain and spinal cord – the CNS – to the rest of the body. It is made up of nerve cells or neurons that are "wired" together throughout the body. Neurons carry messages in the form of electrical impulses. The messages move from one neuron to another to keep the body functioning.

Neurons have a limited ability to repair themselves. Unlike other cells, nerve cells cannot be repaired if they are damaged due to injury or disease.
The function of the peripheral nervous system is to carry messages to and from the central nervous system. Messages come from the body to the CNS. Messages are carried from the CNS to the muscles and glands of the body.

There are two types of cells in the peripheral nervous system.
- The cells that carry information TO the central nervous system (CNS) are called the **sensory nervous cells or sensory neurons**
- The cells that carry information FROM the central nervous system (CNS) are called the **motor nervous cells or motor neurons**.

The sensory nervous cells send information TO the CNS from internal organs or from external stimuli through the 5 body senses.

Motor nervous cells carry information FROM the CNS to organs, muscles, and glands.

**Structure of the peripheral nervous system**

The peripheral nervous system has 2 parts:
- the somatic nervous system
- the autonomic nervous system
The somatic nervous system

The somatic nervous system controls skeletal muscle as well as external sensory organs such as the skin, nose, eyes, etc. Somatic motor nerves go to muscles attached to the skeleton. This system is said to be voluntary because the responses can be controlled consciously. Reflex reactions of skeletal muscle however are an exception. These are involuntary reactions to external stimuli. A reflex action is an automatic, involuntary reaction to a stimulus. It happens very quickly because, as we explained in the section on the spinal cord – it is the spinal cord which is the centre for reflex actions.

The autonomic nervous system

The autonomic nervous system controls internal organs. It is the part of the nervous system which directs involuntary muscles, such as smooth and cardiac muscle and glands. You will remember from Topic 3 in Module 1 on the muscular system that smooth and cardiac muscles are responsible for such processes as digestion and respiration and the heart beating. This system is also called the involuntary nervous system. The autonomic nervous system is what keeps our heart beating, our lungs breathing and our digestive system moving food through the body. You cannot control these action and they take place without even knowing about them. Autonomic motor nerves travel to cardiac muscle, smooth muscle and to glands.

The autonomic nervous system can also be divided into two parts:

- the sympathetic system – which is concerned with mobilising body’s energy during times of stress. It is involved in the fight or flight response.
- the parasympathetic system – concerned with the conservation of the body’s energy. It slows down or relaxes the body and regulates the involuntary activity of glands, smooth muscle and cardiac muscle.

These two subsystems work together but in opposition to each other. The sympathetic nervous system prepares the body for sudden stress. The ‘fight or flight’ response is what happens when a person is scared for their safety. Have you ever been really frightened by something and noticed what happens to your body? The things you might have noticed are that your heart beats faster, your blood pressure increases, your digestion slows down and you breathe more heavily.

What you don’t know is happening is that the sympathetic nervous system sends an instant message to release the hormone adrenalin which causes the body to be ready to either have a fight with someone or run away- fight or flight!
This response goes back to when stone-age man lived in caves and chased animals for food. When he met a woolly mammoth when out hunting, the cave man would be very frightened and had to decide very quickly whether to try to kill the animal for food or to run away to avoid being killed himself!

The **parasympathetic nervous system** does the exact opposite. It prepares the body for rest and regulates the involuntary essential body functions.

Luckily we no longer have to fight animals for food but we still have the same response when we get very scared. Here is a table which shows how the sympathetic system works and how the parasympathetic system works in opposition.

<table>
<thead>
<tr>
<th><strong>Sympathetic</strong></th>
<th><strong>Parasympathetic</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepares body for the fright or flight response</td>
<td>Conserves and restores body’s energy</td>
</tr>
<tr>
<td>Increases adrenaline secretion from adrenal gland above kidney</td>
<td>Slows down the body’s actions and functions</td>
</tr>
<tr>
<td>Slows down process of digestion in intestines – non essential activity</td>
<td>Returns intestines to normal function</td>
</tr>
<tr>
<td>Speeds up heart beat – to provide more blood to the lungs and muscles</td>
<td>Slows down heart rate</td>
</tr>
<tr>
<td>Speeds up respiratory process – to provide more oxygen to body cells</td>
<td>Returns respiration to normal</td>
</tr>
</tbody>
</table>
Dilates (makes bigger) the pupils to make eye sight better

Constricts (makes smaller) the pupils back to normal

This has been a lot to take in – the human nervous system is not simple! Try the questions in Activity 11 to see how much you have understood about the peripheral nervous system.

**Activity 11: The Peripheral Nervous System**

Circle the correct answer

1. The components of the peripheral nervous system are:
   a. spinal nerves, brain and spinal cord
   b. sensory nerves, motor nerves, somatic and autonomic nervous system
   c. cerebrum, cerebellum, medulla oblongata

2. Two types of cells found in the peripheral nervous system are:
   a. Sensory nerves and motor nerves
   b. Somatic and autonomic nerve cells
   c. Voluntary and involuntary nerves

3. What is the other name for the autonomic nervous system?
   a. the voluntary nervous system
   b. the somatic nervous system
   c. the involuntary nervous system

4. Reflex actions are controlled by the spinal cord, not the brain. T F

5. Cells which carry messages from the CNS are sensory nervous cells T F

6. The spinal cord joins the brain at the medulla oblongata T F

7. A motor nerve cell carries information from the CNS to the organs muscles and glands. T F

8. The function of the PNS is to connect the CNS to the body. T F
Feedback

Think carefully before you answer these questions – they are not as straightforward as you first think. It is important that you are clear about the names of the different parts of the nervous system. Check your answers against ours at the end of the topic.

You have completed your work on the structure and main functions of the CNS & the PNS. Now we are going to look at how the human body responds to stimulus.
Section 2  Response mechanism

In the previous sections you learned about how the nervous system is formed and how it works. Can you recall what the main function of the nervous system is? Write it down here.

Did you remember that the main function of the nervous system is to control and coordinate the functions of all the body systems? To do this it has to collect information about the external and internal environment of your body. The nervous system needs special cells to collect and send out this information.

The cells receiving this information are called receptors. This information, which is collected through the sense organs and glands (the receptors) is sent to your brain or spinal cord. In your brain or spinal cord the information is interpreted and the brain makes a decision and sends impulses out to the organs (the effectors) to make the appropriate responses to meet the body’s needs. The nervous system coordinates rapid responses to mainly external stimuli.

In a flow diagram it looks like this:

![Flow diagram](image)

In this section we are going to have a closer look at what actually happens and what is involved during the transmission of these messages. We will look at how the response mechanism functions.

Body Reflexes

What do you do if your hand by mistake touches a hot burner on a stove? Without thinking you will very quickly remove your hand. You move your hand before “knowing why” you are doing it. Why are you doing that?

For you to see clearly in different light conditions the amount of light entering your eye is controlled – it is automatic, you cannot control it with your will. This is called the iris or pupil reflex.

These are examples of what we call a reflex arc. When a response is involuntary it is called a reflex reaction. Reflex reactions are extremely fast as it does not involve conscious ‘thinking’ about how to react. Reflexes protect the human body. They happen very quickly so you will not harm yourself.
The diagram illustrates what happens when a receptor cell is activated. For example you stab your finger with a pin.

In a reflex arc

1. A **stimulus** is detected by receptor cells. They send a message (an impulse) to the central nervous system. The message is sent along sensory neurons.

2. The sensory neuron carries the impulse from the receptor cell to the central nervous system (the brain or the spinal cord) where it is passed to a motor neurone through an inter or relay neuron.

3. The motor neurone carries the nerve impulse to an effector (for example a muscle) telling it what to do.

4. The effector responds with the appropriate action (muscle contracts, gland secretes hormone, etc).

The reflex arc can be represented by a flow diagram:

Let’s follow the flow chart for the above diagram

1. The stimulus is the pain, the prick of the pin.
2. The receptor / sensory cells in your finger sense the pain and stimulate the sensory neurone.
3. The impulse travels along the sensory neuron to the spinal cord (CNS).
4. If the impulse is strong enough the sensory neuron via a **synapse** send the impulse to the inter or relay neuron.
5. In the spinal cord or brain, a message is given to a motor neuron.
6. The impulse from the motor neuron stimulates the effector organ – the muscle in this case.
7. The muscle contracts (the response) moving the finger away from the pain causing object, protecting the body from danger and harm.

The reflex action occurs before you know about it. The relay neuron does send a message to the brain so it knows what is going on but this message arrives later, after you have already moved your finger from the danger. Reflex actions are quick because only a few nerves are involved (like in the example only three) and reflex actions need no conscious control.

Of course, you are in control of your body. If you are strong willed you can control the automatic reflex in some cases. You can hold your hand on a hot stove burner and ignore the withdrawal reflex, but most of us do not have that kind of willpower.

**Receptors**

You have several receptors that can detect changes in your external environment. The stimulus or sensory input is through your five senses. Can you remember your five senses from Section 1?

Write them down in this table.

<table>
<thead>
<tr>
<th>Sense</th>
<th>Organ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>

Did you remember them all? The eyes are the receptors for the sense of vision. The nose is the receptor for the sense of smell. The ears have a dual role – they are the receptors for hearing and for balance. The tongue is the receptor for taste and the skin is the receptor for pain, temperature, texture and pressure.

Look at Figure 29 to see the receptors and their organs.
Now we will find out more about each of the receptors:

**Eyes**

The receptor cells in the human eye respond to change in the brightness of light. If a bright light is shone in your eye (the stimulus), the receptor cells in your eye send an impulse (along the sensory neurons) to the central nervous system (your spine cord in this case). From the central nervous system an impulse is sent to the motor neurons. The motor neurons bring the information to the muscles (the effectors) in the eye and the pupil of your eye becomes smaller allowing less light to enter. This protects the eyes from getting harmed by the bright light.

**Nose**

There are receptors cells in the moist lining of the nose. These react to chemicals in the air. The information is relayed to your brain through the sensory neurons. The brain interprets the information as “smell”. You can detect a very wide range of different smells, about 50 different ones.

**Tongue**

You have three types of receptors (called taste buds) on your tongue.
Look at Figure 30. At the front you can taste sweet and salty things. At the side of your tongue you have taste buds for sour things and at the back for bitter tasting food or drinks. There is also a meat-like taste the taste buds detect.

![Taste receptors](image)

*Figure 30: Taste receptors*

But altogether this makes only five different tastes and we can distinguish between many different foods – we say that they “taste” different. This is not because we have many different taste buds but because the taste receptors and the smell receptors work together. The sense of smell and taste are closely related. Both are reacting to chemicals found in food (taste) or in the air (smell). The chemicals in food or drinks dissolve in the saliva and can then activate the taste buds. The impulses are sent to the central nervous system and our brain tells us the “taste”.

**Ears**

The ear has two different types of receptor cells. There are the receptor cells that respond to sound vibrations and the receptor cells responding to change in movement and the position of the body.

How do we hear a sound? To understand this, you need to know more about the anatomy of the inner ear. Look at Figure 31.

![Inner ear anatomy](image)

*Figure 31: The outer and inner ear*
How we hear

Stimulus

Sound waves enter the ear canal, travel down the ear canal and set the ear drum vibrating.
The ear drum transmits the vibrations to ear bones in the middle ear.
The ear bones pass the vibrations to the inner eardrum (oval window).
The oval window causes the fluid in the cochlea (say COCK-lee-ar) of the ear to move.

Receptor

Tiny sensory hair inside the cochlea are set vibrating by the movement of the fluid.
The vibrating hair sends sensory nerve impulse to central nervous system (the brain)

Coordinator

The brain receive the impulses and interprets them as ‘sound’

Do you notice the difference from a reflex arc? Hearing is not a reflex arc. The receptors (the hairs in the cochlea) communicate with the brain and there we make sense of the information – experiencing it as sound.

The ear is also the organ that contains receptors that monitor your movement and your position. Just above the cochlea there are three semi-circular canals filled with fluid. As in the cochlea, the canals are lined with sensory hairs (receptors) that are sensitive to, and can detect, movement of the fluid in the canals. If you move or change position the liquid in the semi-circular canals will move. Then the receptors (the sensory hairs) detecting the movement will send an impulse to the central nervous system (spinal cord / brains). The central nervous system will coordinate the action – if necessary. In some cases it will just make you aware of having changed your position e.g. you are aware that you stand up from your chair. But in some instances it might result in a reflex reaction – if you trip over something, in a reflex you will try to regain your balance or put out your hand to hold on to something.

Skin

In your skin there are many receptors with slightly different functions. We listed them in Figure 29. They are:

- touch or texture
- pressure
- pain
- temperature
You can feel (with your eyes closed) whether a material is soft or hard, rough or smooth, hot or cold, wet or dry. Different sensory receptors detect these things and transmit the information to the central nervous system. These are texture receptors.

Your skin has also receptors that react to pressure – which allow you to know the approximate weight of something in your hand. You know that you also can find out about the shape of something you are holding – with your eyes closed! Again there are specific receptor cells in your skin that are sensitive to this and can send a message to your brain where it is interpreted.

Do you know that lots of things happen when you are feeling cold?

There are temperature receptors in your skin and they cause three reflex actions:

1. You start shivering – this produces heat which warms you up
2. The blood capillaries near the skin surface contract – this allows less blood to reach your skin and so less heat is lost from your body
3. You get goose pimples – a reaction to the body hairs moving into a vertical position, this traps a layer of air close to the skin. This layer acts as a blanket – an insulating cover. You may also react to cold voluntarily and decide to put on a coat or sweater.

We have covered a lot of ground in explaining how the human body responds to different stimuli. Now it is time to complete Activity 12 to check how much you have understood.
### Activity 12: Response mechanism

1. Complete the table on stimulus and response.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin prick to the hand</td>
<td></td>
</tr>
<tr>
<td>Bright light shining in your eye</td>
<td>Eye lids blink</td>
</tr>
<tr>
<td></td>
<td>Sweating</td>
</tr>
<tr>
<td>Sight of food</td>
<td></td>
</tr>
<tr>
<td>Feeling cold (give THREE responses)</td>
<td>Eat food</td>
</tr>
</tbody>
</table>

2. Give THREE examples of involuntary responses / reflex actions by listing both the stimulus and the response.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>
Activity 12: .../ cont

3. Give THREE examples of voluntary responses by listing both the stimulus and the response.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

4. Explain what happens at each of the labelled points in the diagram.

- at A
- at B
- at C
- at D

Feedback

If you understood this section well you should not have had problems in answering the questions. You can check your answers at the end of this topic. If your answers to question 2 and 3 differ from the suggested ones YOUR answer may still be correct as there are many possible correct answers to these questions. If you are not sure about the correctness of your responses to these questions check with your facilitator. If you missed out on some points carefully go over the information again.
Voluntary responses

In section 2 of this topic you learned about the peripheral nervous system (PNS). Do you remember the two parts of this system? Write them down here.

The two parts of the peripheral nervous system are the voluntary or somatic nervous system and autonomic or involuntary nervous system. The voluntary system allows you to react consciously to environmental changes. If you drop your pen you can either pick it up or not — it is up to you. You have to make a conscious decision. If somebody is asking you a question, it is up to you decide whether or not to respond and if you respond what your response will be. These things do not happen automatically.

The signals / impulses from the receptors when reaching the central nervous system are, in the case of voluntary action, transmitted to the higher centres of your brain and you decide whether and how to react.

This is different from the reflex action which we explained earlier. If the safety of your body is at stake a very quick response is needed. There is no time to start thinking what you will do. The signal from the receptors is immediately relayed (from the sensory neuron through the relay neuron) to the motor neuron for immediate, unthinking action.
**Topic Summary: The Nervous system**

In this topic you have learned that the nervous system is the main communication system of the body. It receives and interprets information from both inside and outside the body. The nervous system works with the endocrine system to help regulate body’s actions and maintain homeostasis.

The nervous system has two main parts.
- The **central nervous system** (CNS) comprising the brain and the spinal cord
- The **peripheral nervous system** (PNS) consisting of all the nerves connecting the spinal cord and brain to all other parts of the body (sensory nerves and motor nerves)

There are 3 main parts of the brain that you need to know:
- cerebrum
- cerebellum
- medulla oblongata

The **cerebrum** is formed in 2 halves or hemispheres which are the main functional units of the brain. The function of the cerebrum is
- to initiate and control **voluntary movement** (muscle contraction)
- to receive and interpret sensory perceptions (pain, temperature, touch, sight, hearing, smell and taste)
- to carry out higher mental activities: memory, intelligence, thinking, reasoning, moral sense, etc.

The **hypothalamus** is located in the cerebrum and this is the centre which controls some involuntary processes such as hunger and thirst and forms the link between nervous and endocrine system.

The **cerebellum** is responsible for **muscular coordination, posture and balance**.

The **medulla oblongata** coordinates all the messages to and from the brain. It controls **autonomic body functions** such as breathing, blinking and digestion. It is at the medulla oblongata that the brain joins the spinal cord.

The spinal cord consists of masses of nerve cells with fibers running upwards and downwards. It originates in the brain stem and extends down to the lower extremity of the trunk or abdomen. It is enclosed and protected by the spinal column.

There are two types of cells in the PNS:
- **Sensory cells** which send information TO the CNS from internal organs or from external stimuli.
• **Motor cells** which carry information FROM the CNS to organs, muscles, and glands.

The Peripheral Nervous System has two parts:

• **Somatic Nervous System** which controls skeletal muscle as well as external sensory organs.

• **Autonomic Nervous System** which controls involuntary muscles, such as smooth and cardiac muscle.

The autonomic nervous system is further divided into two parts which work in opposition to each other:

• The **sympathetic** nervous system – is responsible for activities that control the increase of energy expenditures; ready for the fight or flight response.

• The **parasympathetic** nervous system - controls activities that conserve energy expenditures.

We explained how the sympathetic nervous system acts on different organs of the body to prepare it for action. The parasympathetic nervous system works in exactly the opposite way to return the body to rest.

Response mechanism comes about when we sense certain things within our environment. All senses depend upon the working of the nervous system. Our sense organs start to work when something stimulates special nerve cells called receptors in a sense organ. We have five main sense organs. They are the eyes, nose, ears, tongue, and skin. Once stimulated, the receptors send nerve impulses along sensory nerves to the brain. Your brain makes a decision and tells an organ which is the effector to make an appropriate response.

It works something like this:

A reflex arc is a function of nervous system capable of receiving a stimulus and producing a response. The response produced by the reflex arch is called a reflex. It is an automatic response to a stimulus that occurs without a conscious thought, you cannot control it. It is there to protect you. In a reflex arc this is what happens:
We have different receptors in our bodies. The receptor cells detect changes to the environment and this happens through our 5 senses – touch, smell, sight, taste and hearing/balance.

The eyes respond to light/dark; the nose responds to smell; taste is detected on the tongue; the ears help us to hear and maintain balance and the skin is the receptor for touch, temperature and pressure. So the ears, eyes, skin, nose and tongue are the organs that respond to a change of environment.

This is the end of your work on the nervous system for this unit. This has been a difficult unit. You should be pleased with your efforts if you have worked hard and achieved the learning objectives. In Topic 9 you will learn about the endocrine system.
Answers to Activities

Activity 10: The Brain

1. The function of nervous system is to control and coordinate the functions of all the other systems and makes them work harmoniously by sensing changes, analysing the change and acting on the change.

2. The two main parts of the nervous system are the Central Nervous System and the Peripheral Nervous system.

3. The function of the brain is to coordinate the body functions to maintain life.

4. ![Diagram of the brain with labels cerebrum, cerebellum, medulla oblongata]

5. | Structure         | Function                                           |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>cerebellum</td>
<td>responsible for muscular coordination, posture and balance</td>
</tr>
<tr>
<td>medulla oblongata</td>
<td>controls autonomic functions of the body – such as the working of the heart and lungs.</td>
</tr>
</tbody>
</table>
| cerebrum          | Functions are
                      • to initiate and control voluntary movement (muscle contraction)
                      • to receive and interpret sensory perceptions (pain, temperature, touch, sight, hearing, smell and taste)
                      • to carry out higher mental activities: memory, intelligence, thinking, reasoning, moral sense, etc |

Activity 11: The Peripheral Nervous System

1. The components of the peripheral nervous system are:
   a. spinal nerves, brain and spinal cord
   b. sensory nerves, motor nerves, somatic and autonomic nervous system
   c. cerebrum, cerebellum, medulla oblongata
2. Two types of cells found in the peripheral nervous system are:
   a. sensory nerve and motor nerve
   b. somatic and autonomic nerve cells
   c. voluntary and involuntary nerves

3. What is the other name for the autonomic nervous system?
   a. the voluntary nervous system
   b. the somatic nervous system
   c. the involuntary nervous system

4. Reflex actions are controlled by the spinal cord, not the brain. T

5. Cells which carry messages from the CNS are sensory nervous cells F

6. The spinal cord joins the brain at the medulla oblongata T

7. A motor nerve cell carries information from the CNS to the organs, muscles and glands. T

8. The function of the PNS is to connect the CNS to the body. T

Activity 12: Response mechanism

1. Complete the table on stimulus and response.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin prick to the finger</td>
<td>Muscle contracts to withdraw finger</td>
</tr>
<tr>
<td>Bright light shining in your eye</td>
<td>Pupils get smaller</td>
</tr>
<tr>
<td>Moving an object suddenly towards the eyes</td>
<td>Eye lids blink</td>
</tr>
<tr>
<td>Feeling hot</td>
<td>Sweating</td>
</tr>
<tr>
<td>Smell of food</td>
<td>Salivary glands produce saliva</td>
</tr>
<tr>
<td>Feeling cold (give THREE responses)</td>
<td>• start shivering – muscular contractions warm you up &lt;br&gt; • blood capillaries near the surface of the skin contract – prevents heat from leaving the body &lt;br&gt; • you get goose pimples – the hairs of your skin stand up and trap air close to the skin.</td>
</tr>
<tr>
<td>You feel hungry</td>
<td>Eat food</td>
</tr>
</tbody>
</table>
2. Give THREE examples of involuntary responses / reflex actions by listing both the stimulus and the response.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. bright sunlight shining in the eyes</td>
<td>pupils become smaller</td>
</tr>
<tr>
<td>2. dust or pepper in the nose</td>
<td>sneezing</td>
</tr>
<tr>
<td>3. smell of good food cooking</td>
<td>salivate</td>
</tr>
</tbody>
</table>

3. Give THREE examples of voluntary responses by listing both the stimulus and the response.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. drop your pen</td>
<td>bend down and pick it up</td>
</tr>
<tr>
<td>2. feel cold</td>
<td>put on a coat</td>
</tr>
<tr>
<td>3. bright sunlight</td>
<td>put on sunglasses</td>
</tr>
</tbody>
</table>

Did you notice the INVOLUNTARY response to feeling cold (in question 3) is quite different from the reflex responses to feeling cold which are describes in question 1?

4. Explain what happens at each of the labelled points in the diagram.

At A – a **stimulus** – the pin prick – is detected/felt by the **receptor cells** in the finger.

At B – a **sensory neuron** carries a message from the receptor cell to the **CNS** (spinal cord).

At C – connecting (relay) neuron carries impulse from the sensory to the motor neuron.

At D – a **motor neurone** takes the message to withdraw (pull away) to the **effector cells** in the finger.

At E – the finger pulls away from the stimulus (pin prick).
In the topic on the nervous system you learned about receptors, organs that react to stimuli, and effectors, muscles or glands that respond to impulses from the central nervous system. The nervous system is one of the two systems, and the fastest, to send messages from receptors cells (you smell food cooking) to effectors (your salivary glands produce saliva). The message is communicated through the nerve cells.

The chain of events in the above example is:

1. **Stimulus**
   - (change in environment - change in odour)

2. **Receptor**
   - (cell detecting the change - smell cells in nose)

3. **Communication**
   - (change is communicated, message transmitted and processed - nervous system)

4. **Effector**
   - (organ, tissue reacting to the message - saliva glands)

5. **Response**
   - (reaction of effector - production of saliva)

In this topic you will learn about another body system that can send messages from receptors to effectors. It is slower than the nervous system. The messages in this system are carried through chemical substances called hormones (pronounced: hor-moanz). Hormones are produced in special organs called endocrine glands (pronounced: en-duh-krin). Endocrine glands release the hormones directly into the blood, not through a tube or duct. That is why these glands are called ductless glands.
The system consisting of all these glands is called the **endocrine system**. This system is rather different from the other body systems you have studied. The systems you have already learned about are formed by organs that work together and are physically linked to perform a special task in your body. For example the digestive system consists of all the organs which are linked together to break down the food you eat so it can be used in your body.

The endocrine system is different because the glands are separated from each other with no anatomical link. Each has a very specific task. They are still called a system as all glands produce hormones that are directly released into the bloodstream. Some of the endocrine glands have non-endocrine parts that have a function other than hormone secretion. For example the pancreas has a major part that produces enzymes as part of the digestive system as well as producing insulin in the endocrine system. The ovaries release eggs in the reproductive system and hormones in the endocrine system.

**What is in this topic?**

In this topic there are 2 sections:

- **Section 1** The endocrine glands
- **Section 2** How the endocrine system works

**Learning Objectives**

By the time you have completed this topic, you should be able to:

- name the glands that form the endocrine system
- indicate the place in the body where the endocrine glands are found
- describe the function of the different glands of the endocrine system
- name the main hormone secreted by the endocrine glands
- describe the target organ of the hormone produced by each of the endocrine glands

**Study Time**

We expect it will take you 3 - 4 hours to complete this topic and all the activities. But do no worry if it takes you more or less time than this, we do not all work at the same pace.
Section 1 The Endocrine Glands

The endocrine system is a collection of endocrine glands that produce and secrete chemical messages – called hormones. In this section, you will learn the names of the glands that make up the endocrine system, the hormones they secrete, where they are found in the body and their main function (target organ). The endocrine system, along with the nervous system, is a messenger system that regulates and coordinates your body activities. It ensures that the internal environment of your body is stable.

You will learn the basics of what the endocrine system does and how it works. Like most body systems the endocrine system is a rather complex system. There are a good number of new words and terms in this topic you have to learn. Practice pronouncing and writing these words. It does not look good if you make spelling errors in an assignment. You can avoid it – but it needs some practise.

What forms the endocrine system?

Figure 34 shows the name of each of the endocrine glands and its place in the body.

endocrine gland
body organ which makes and secretes hormones into the bloodstream
You learned about the **hypothalamus** (say: hi-poe-THAL-ah-mus) in Topic 8 on the nervous system. It is a collection of specialized cells that are located in the lower central part of the brain. It is not a gland but is grouped together with the endocrine glands because of the important role it plays in the endocrine system. It controls the main endocrine gland which is also located in the brain. The **pituitary** (say: pit-YOU-it-are-ee) gland is located at the base of the brain just beneath the hypothalamus.

The **thyroid** (say: thie-royd) is located in the front part of the lower neck – see Figure 36. It is known as the “Adam’s apple”. The thyroid secretes a hormone called **thyroxin** which is involved in growth and metabolism.

The **pancreas** (say: pan-kree-ass) is found in the abdominal cavity below the stomach. The pancreas is also part of the digestive system where it is attached to the small intestine. The endocrine part of the pancreas is many small clusters of cells called islets of Langerhans. These cells produce 3 different endocrine products – the most important being **insulin** which assists in the regulation of blood glucose levels.

The body has two triangular **adrenal** (pronounced: ah-DREE-nal) **glands**, one on top of each kidney in the abdominal cavity. The hormone secreted by the adrenal glands is **adrenalin** which you know from Topic 8, helps the body to deal with stress.

The **gonads** are the main source of sex hormones and are located in the pelvic cavity. They are part of both the endocrine and the reproductive systems. You will learn about the reproductive system in the next topic. The male gonads are located in the scrotum – which hangs below the pelvic cavity. They are called the **testes** (say: tes-teez). The main hormone secreted by the testes is **testosterone**.

The female gonads, the **ovaries** (say: o-vuh-reeez), are also found in the pelvic cavity. They are joined to the uterus or womb as part of the reproductive system. There are 2 main hormones secreted by the ovaries – **oestrogen** and **progesterone**.
Ducted and ductless glands

Glands such as sweat glands, salivary glands, digestive glands and mammary glands (breasts) are not part of the endocrine system. These glands secrete products through ducts, or tubes, to the surface of the body or to organs. Glands that have ducts are called **exocrine glands** (say: ek-soh-kreen). The secretions of exocrine glands reach their target by travelling through a duct (tube).

The endocrine glands do not have ducts to carry their product to a surface. They are called ductless glands. **Endocrine glands** release more than 20 major hormones directly into the bloodstream where they can be transported to target cells in other parts of the body.

Now check how much you have learned so far by trying Activity 13.

**Activity 13: The Endocrine Glands**

1. Name the glands labelled in the diagram below:
   (NB: A should have 2 names!)

   ![Diagram of the human body showing various glands]

2. Explain what is meant by receptors and effectors. Give an example of receptors and effectors which work together.
Activity 13: The Endocrine Glands (cont)

3. What are the main messenger systems in the body?

4. What is a hormone?

5. Describe the difference between exocrine and endocrine glands.

6. Give 3 examples of endocrine and three examples of exocrine glands.

<table>
<thead>
<tr>
<th>Endocrine glands</th>
<th>Exocrine glands</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
</tr>
</tbody>
</table>

Feedback

If you have studied Section 1 carefully then you will have no problem in answering the questions in the activity. Check your answers against ours at the end of the topic. If you did not manage to get them all correct, do not worry, just read the part that gave you problems again. But make sure that in the end you feel confident to answer the above questions and similar ones.

A good way to help you to learn is while you are reading you set your own questions and answer them after you completed the paragraph. Ask yourself “what question could possibly be asked on this part?”
Section 2 How the endocrine system works

You now know that the endocrine system is made up of glands that produce and secrete hormones. Hormones are chemical messengers that transfer information from one group of cells to another to coordinate the functions of the body. Hormones regulate, for example, growth, sexual development and metabolism.

The endocrine system works like a thermostat regulating the temperature in the room or oven. The thermostat in the system is the hypothalamus – the centre in the brain which controls many bodily functions. It receives information such as, whether the body needs more water or glucose, whether there is need for extra energy to be released etc. This information is processed and messages are then sent to the endocrine glands to release (or hold) a specific hormone. The release of the hormone – the chemical messenger – is then controlled. Here the hormone acts as an effector – it effects action in the target cells.

Once a hormone is secreted, it is released directly into the bloodstream, it then travels from the endocrine gland through the bloodstream to the cells designed to receive its message. These cells are called target cells. The target cells have receptors that latch only on to specific hormones. Each hormone has its own receptor, so that it will communicate only with the specific target cells that have receptors for it. Look at Figure 41.

This is sort of lock and key mechanism. If the key fits the lock, then the door will open. If a hormone fits the receptor site, then there will be an effect. If a hormone and a receptor site do not match, then there is no reaction.

When the hormone reaches its target cell, it locks onto the cell’s specific receptors and these hormone-receptor combinations transmit chemical instructions to the inner workings of the cell. Action is taken by the target organ / tissue as per instruction e.g. “liver produce more glucose” or “kidneys absorb less water”, etc. The thermostat (hypothalamus) keeps monitoring the internal state of the body and reverses processes if needed (e.g. “kidneys absorb more water now”).
The flow chart below illustrates how the endocrine system works.

![Flow Chart Image]

Now we will look at each part of the endocrine system in more detail.

**Hypothalamus**

The hypothalamus is the primary link between the endocrine and nervous systems. Nerve cells in the hypothalamus control the pituitary gland by producing chemicals (7 different hormones) that either stimulate or suppress hormone secretions from the pituitary. The hypothalamus maintains homeostasis in the body. Do you remember what homeostasis is? You should know this from your study of Module 1. Write down the meaning here.

The hypothalamus maintains homeostasis (constant internal conditions) by monitoring the internal environment of the body (examples: heart rate, body temperature, water balance, and the secretions of the pituitary gland). If changes are needed it will send “release hormone” or “stop release hormone” messages to the glands. It mainly deals with the pituitary gland.
**Pituitary gland**

The pituitary gland is considered the most important part of the endocrine system. It’s often called the “master gland” because it makes hormones (8 different ones) that control several other endocrine glands.

The hypothalamus communicates the information received by the brain (such as body temperature, light levels, and feelings) to the pituitary gland.

The pituitary gland produces hormones that:

- control the growth of a person.
- in females - control the release of eggs from the ovaries and activate milk production when breast feeding
- control the amount of water in the body
- reduces the sensitivity to pain (you might know the name of this chemical as it is used in many painkillers: **endorphin** (say: en-DOR-fin))

**Thyroid**

The thyroid gland is attached to your windpipe (trachea). It produces hormones that control the speed of chemical reactions in your body cells, the rate of **metabolism**. The hormones control how fast the nutrients are burned in the cells to give you energy. If the level of these hormones in the blood increases so will the speed of metabolism.

**Pancreas**

The pancreas produces a hormone that may be known to you: **insulin** (pronounced: IN-sue-lin). It also produces another less well known hormone called glucagon (pronounced: gloo-kah-gon). The two hormones work together to keep a constant level of glucose (sugar) in the blood. The target organ is the liver.

Persons that produce too little insulin in their body suffer from a condition called diabetes. They have to take insulin by injection everyday to control the level of glucose in their blood.
The adrenal glands

The adrenal glands produce a hormone called adrenalin. Did you ever hear somebody saying to another person “You have too much adrenalin in your blood”? The person is saying that (s)he feels that the other person is too exited or aggressive. You know from your study of the nervous system that adrenaline is sometimes called “the fight or flight hormone”. It is produced when you are angry or frightened. It prepares you for action – to fight or to run away.

An increased level of adrenaline might cause you to notice some of the following in your body:

- Your heart beats faster
- You start breathing faster
- You become pale in the face
- You get funny feelings in your stomach

If your heart beats goes up and you are breathing faster more blood and oxygen goes to your muscles, to give you more energy – for fight or flight.

At the same time less blood is sent to the skin and stomach so all your energy can be focused on the threatening situation (e.g. the lion that is about to attack you).

Ovaries (in females)

In the ovaries the female sex hormones are produced – oestrogen (say: EES-trow-jen) and progesterone (say: pro-JESS-ter-own). The ovaries also contain the ova – the eggs. These hormones regulate the development of the female sex organs and gives girls their female features such as breasts, accumulation of body fat around hips and thighs, and a female voice. The female sex hormones play an important role in pregnancy and regulate the menstrual cycle. You will learn more about this in Topic 10 on the reproductive system.

Testes (in males)

The testes make the male sex hormone – testosterone (say: test-OST-er-own) and also produce the male sex cells (sperm). The male sex hormone regulates the development of the male sex organs. It also controls the development and maintenance of the male secondary sexual characteristics giving boys their male features such as deeper voices and more body hair (beard growth) than females.
Here is a table showing the hormones produced by the main endocrine glands.

<table>
<thead>
<tr>
<th>Gland</th>
<th>Hormone and influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>hypothalamus</td>
<td>Part of the brain - does not secrete hormones but monitors homeostasis in the body and controls the pituitary gland</td>
</tr>
<tr>
<td>pituitary</td>
<td>8 different hormones – the main one is endorphin which helps the body to cope with pain. Controls other glands.</td>
</tr>
<tr>
<td>thyroid</td>
<td>Thryoxin – controls growth and metabolism</td>
</tr>
<tr>
<td>pancreas</td>
<td>Insulin – controls blood glucose levels</td>
</tr>
<tr>
<td>adrenal</td>
<td>Adrenalin – helps the body deal with stress</td>
</tr>
<tr>
<td>ovaries</td>
<td>Progesterone and oestrogen – controls female reproductive cycle</td>
</tr>
<tr>
<td>testes</td>
<td>Testosterone – controls male body characteristics</td>
</tr>
</tbody>
</table>

**Activity 14: The Endocrine System and Glands**

1. What is the name of the endocrine gland that controls the activity of most of the other endocrine glands?

2. What is the name of the endocrine gland which produces hormones to control the glucose level in your blood?

3. Describe how the endocrine system works

4. Why do the endocrine glands have a good supply of blood capillaries running through them?
Activity 14: The Endocrine system and glands (cont)

5. Complete the following table.

<table>
<thead>
<tr>
<th>Endocrine gland (hormone)</th>
<th>Target organs</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothalamus</td>
<td>Whole body</td>
<td>Controls metabolic rate</td>
</tr>
<tr>
<td>Adrenal gland (adrenaline)</td>
<td>Vital organs – eg. liver and heart</td>
<td></td>
</tr>
<tr>
<td>Pituitary gland (endorphin)</td>
<td>Nervous system</td>
<td></td>
</tr>
<tr>
<td>Pancreas (insulin / glucagon)</td>
<td>Liver and muscles</td>
<td></td>
</tr>
<tr>
<td>Ovaries (oestrogen)</td>
<td>Controls development of sex organs and secondary sexual characteristics during puberty. Controls the menstrual cycle.</td>
<td></td>
</tr>
<tr>
<td>Male reproductive organs</td>
<td>Controls development of sex organs and secondary sexual characteristics during puberty.</td>
<td></td>
</tr>
</tbody>
</table>

6. What is the main function of the hypothalamus?

Feedback

You had to go over a lot of information, so you might have missed a few points. Check your answers against ours at the end of the topic. For any response you did not get the correct answer turn to the page with the information and read it again careful. Make sure you are confident that you can answer any question on the endocrine system.
**Topic Summary: The Endocrine System**

You have come to the end of the topic on the endocrine system. Here is a summary of what you have learned.

- The endocrine system is a group of hormone producing glands.
- Its main function is to regulate many aspects of metabolism, growth, fluid balance and reproduction.
- Hormones are chemical message carriers to tell target organs / tissues as to what to do in order to maintain a balanced stable situation in the body (homeostasis).
- The endocrine glands release the hormones produced directly into the blood stream – no ducts or tubes are involved. These glands are therefore called ductless glands.
- Ducted glands have ducts / tubes that brings their product to a specific surface in the body. Examples are sweat glands, salivary glands, mammary glands.

The flow chart illustrates how the endocrine system works:

1. **Stimulus:** change detected in the environment (by hypothalamus)
2. Information sent to endocrine glands
3. Endocrine organ produces, or stops producing, hormone
4. Hormones, as message carriers, carried around the body by the blood
5. Hormone-sensitive tissue / organ – the target effector - responds to the message received
The table summarises the glands, their target organ / tissue and their action or function

<table>
<thead>
<tr>
<th>Endocrine gland (hormone)</th>
<th>Target organs</th>
<th>Action / function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothalamus</td>
<td>Pituitary gland</td>
<td>Links nervous system and endocrine system. Controls hormone production.</td>
</tr>
<tr>
<td>Thyroid gland</td>
<td>Whole body</td>
<td>Controls metabolic rate</td>
</tr>
<tr>
<td>Adrenal gland (andrenalin)</td>
<td>Vital organs – eg, liver and heart</td>
<td>Prepares body for action ('fight or flight')</td>
</tr>
<tr>
<td>Pituitary gland (endorphin)</td>
<td>Nervous system</td>
<td>Reduces sensitivity to pain</td>
</tr>
<tr>
<td>Pancreas (insulin / glucagon)</td>
<td>Liver and muscles</td>
<td>Controls blood sugar levels by increasing / decreasing uptake of glucose</td>
</tr>
<tr>
<td>Ovaries (oestrogen and progesterone)</td>
<td>Ovaries, uterus</td>
<td>Controls development of sex organs and secondary sexual characteristics during puberty. Controls the menstrual cycle. Maintains womb-lining</td>
</tr>
<tr>
<td>Testes (testosterone)</td>
<td>Male reproductive organs</td>
<td>Controls development of sex organs and secondary sexual characteristics during puberty.</td>
</tr>
</tbody>
</table>
Answers to Activities

Activity 13: The Endocrine Glands

1. Receptors: these are cells in your body sensitive to changes in your internal or external environment
   Effectors are organs or tissues that respond to a message

   Change in light intensity (stimulus) is detected by light sensitive cells in the eye (receptor). Message (“light intensity has changed”) is transmitted (and processed in the brain) through nervous system.

3. The main ‘messenger’ systems in the body are the nervous system and the endocrine system.

4. A hormone is a chemical produced in body glands which are released directly into the blood stream. Hormones coordinate body processes which affect different functions of our bodies.

5. The difference between exocrine and endocrine glands is that exocrine glands use tubes or ducts to release their products to a surface e.g., sweat glands produce sweat that is secrete through a small tube to your skin.
   Endocrine glands release their products (hormones) directly into the blood stream.

6. Endocrine glands  | Exocrine glands
   1. Adrenals     | 1. Sweat glands
   2. Thyroid      | 2. Saliva glands
   3. Testes       | 3. Digestive glands

(or any other endocrine / exocrine gland)
Activity 14: The Endocrine system and glands

1. The name of the endocrine gland that controls the activity of most of the other endocrine glands is the pituitary gland.

2. The name of the endocrine gland that produces hormones controlling the glucose level in the blood is the pancreas (islets of Langerhans).

3. The way the endocrine system works is as follows:

   First there is some form of stimulus – a change in the internal or external environment of the body. This changed is relayed to the hypothalamus in the brain which is the brain centre for the endocrine system.

   The hypothalamus sends the information to the appropriate endocrine gland.

   The gland changes the level of production and release of the hormone – depending on the conditions required.

   Hormones are carried around the body by the blood.

   The appropriate organ – which has receptors for that hormone – responds to the message received.

4. The endocrine glands have a good supply of blood capillaries running through them because they release hormones directly into the bloodstream to be carried around the body. The glands need easy access to the cardiovascular (blood) system for transport.

5.

<table>
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<tr>
<td>Testes (testosterone)</td>
<td>Male reproductive organs</td>
<td>Controls development of sex organs and secondary sexual characteristics during puberty.</td>
</tr>
</tbody>
</table>
6. The main function of the hypothalamus is to link the nervous system and the endocrine systems. It constantly checks that the body systems function well and the body has a stable internal environment (homeostasis). The outcome of this checking is communicated (mainly) to the pituitary gland. This gland will produce / release the hormones (the chemical messengers) to carry information to target organs and tissues. The target organs / tissues will respond to the input information (the message from the hormones).
Topic 10  The Reproductive System

One of the 7 characteristics of living things we mentioned in Topic 1 is reproduction. Can you remember what reproduction means? Write it down here.

We are sure that you know that reproduction is the production of offspring. Without the reproductive system, the human species would not survive and hereditary materials would not be passed on from one generation to the next generation. The reproductive system is responsible for the survival of humans. It is not of major importance to the beauty therapist, except for the effects of the sex hormones. You learned about those in the last topic on the endocrine system - do you remember what they are? Write them down in the space below.

The sex hormones are testosterone in males, oestrogen and progesterone in females. They are important to a beauty therapist because they affect some skin functions and hair growth patterns. You may want to remind yourself about these hormones by looking at Topic 9 again.

In Topic 9 you learned that the male and female gonads (testes and ovaries) produce sex cells (ova and sperm) and the hormones necessary for proper development, maintenance, and functioning of the organs of reproduction and other organs and tissue. They affect the development of males and females and cause them to develop different characteristics.

Most organ systems of the body show little difference between male and female. This is not the case with reproductive systems where the male system is much simpler than the female system. You will learn about the organs of both the male and female systems and how they work together to reproduce human beings.

What is in this topic?

In this topic there are 3 sections:

Section 1  Structure of reproductive system
Section 2  How the reproductive system works
Section 3  Effects of reproductive hormones
Learning Objectives

By the time you have completed this topic, you should be able to:

- describe the structure and function of the male reproductive organs
- describe the structure and function of the female reproductive organs
- describe how human reproduction takes place
- describe the sex hormones and the effects they have on the human body

Study Time

We expect it will take you 4 – 6 hours to complete this topic and all the activities. But do not worry if it takes you more or less time than this, we do not all work at the same pace.
Section 1  Structure of reproductive system

The human reproductive system consists of two systems because unlike all other body systems which are the same for males and females, the reproductive system of women is different from that of men.

Although the organs of the male and female look totally different, they are similar in some important ways. Some hormones are the same in males and females, even though they act in very different ways. We will look at each of the reproductive systems in turn, starting with the male system.

Male reproductive organs

Look at Figure 42 to see the different parts of the male reproductive system.

![Figure 42: Male reproductive system (seen from the side)](image)

You will notice that we have labelled some parts which you learned about in the excretory system. This is because the two systems both use the urethra. Can you remember what the urethra is used for in the excretory system? Write down the answer here.

In the excretory system, the urethra is used to transport urine from the urinary bladder out of the body. In the reproductive system, the same tube is used to transport sperm from the testicles or testes (say: test-EEZ).
The organs of the male reproductive system are:
- testes (testis single)
- a series of ducts
- accessory glands
- supporting structures

**Testes**
The testes are involved in both the endocrine and reproductive systems. The testes produce testosterone which is the hormone that causes boys to develop deeper voices, bigger muscles and facial hair. Testosterone is also responsible for stimulating the testes to produce sperm. The testes produce and store millions of tiny sperm cells which are needed for the reproductive system. Sperm production begins at puberty and continuous throughout the life of the male.

**Ducts**
The sperm produced in the testes needs to be transported to the outside of the body to join with the female reproductive system. It does this through two tubes or ducts. Sperm produced in the testes travel along the vas deferens. It mixes with fluid from the accessory glands to form semen. During ejaculation, semen passes through the urethra to the outside. Remember, the urethra is a passageway for both urine and reproductive fluids.

**Accessory glands**
These glands, which are also part of the endocrine system, include the seminal vesicle and the prostate gland. They produce hormones and seminal fluid. Seminal fluid, produced in the seminal vesicle, helps the sperm to ‘swim’ to meet the female egg.

**Supporting structures**
There are 2 supporting structures in the male system – the scrotum and the penis. The scrotum holds the testes. It is like a bag of skin hanging below the body. This is to control the temperature of the testes which need to be kept at a temperature slightly lower than normal body temperature to produce sperm.

We are sure that you know that the penis is a male organ of copulation through which sperms cells are transferred from the male to the female.

Now try this activity to check your knowledge of the male reproductive organs.
Activity 15: The male reproductive system

1. Label the diagram of the male reproductive system.

2. Complete these sentences:
   a. Sperm is produced in the _______________
   b. The two ducts in the system are called the _________ and __________
   c. The function of the scrotum is to ________________________________
   d. The functions of the urethra are to ________________________________
   e. The two glands in the system are called the _______ and _________

Feedback

You need a solid knowledge of the organs in the male reproductive system. Check your answers against ours at the end of the topic.
**Female reproductive organs**

The female reproductive organs are located within the pelvis between the urinary bladder and the rectum. They are protected by the pelvic bone which is shaped differently from the male pelvic bone in order to facilitate the birth of new offspring.

Look at Figure 45 which shows the position of the female reproductive organs in relation to the other organs.

The female reproductive system consists of 6 organs which are the:
- ovaries
- fallopian tubes (oviducts)
- uterus
- vagina
- cervix
- mammary glands (breasts)

Look at Figure 44 to see how the first 5 organs look from the front (anterior view).
Ovaries

Like the testes in the male system, there are 2 ovaries which are part of both the reproductive and endocrine systems. Ovaries produce ova or eggs. As the testes store sperm, the ovaries store eggs. Each month, an egg is released from an ovary. This is the start of the menstrual cycle. As part of the endocrine system ovaries secrete female sex hormones – progesterone and oestrogen.

Fallopian tubes or oviduct

These are the tubes or ducts which transport the eggs from the ovary to the uterus. There are two tubes – one from each ovary. It is here that the egg is fertilized by the male sperm.

Uterus or Womb

The uterus is a tube with muscular walls and a thick lining. Each month, an egg is carried here from the ovaries.

If the egg is fertilized the lining of the uterus develops and gets ready for the egg to be in it. Over the following 9 months the egg develops into a baby. If the egg is not fertilized it, then some of the lining of the uterus, is expelled from the body in the monthly menstrual cycle. This is called menstruation.

Vagina

This is the female organ of copulation. It is where the penis is inserted during sexual intercourse. It is also the lower part of the birth canal through which the baby is delivered after developing in the womb or uterus for nine months.
Cervix

The cervix is found at the lower end of the uterus. It is the opening where the uterus joins the vagina. During copulation, sperm enters the uterus through the cervix. It is lined with a mucous membrane, which makes it easy for the sperms to move through to reach the unfertilized egg. During labour (when the baby is about to be born) it is the cervix which holds the baby inside until it is ready to be born. Only when the cervix opens – or dilates – can the baby come out.

The Mammary glands or Breasts

The mammary glands are accessory glands of the female reproductive system. The function of the breast is the production and ejection of milk, commonly called lactation. The secretion of milk is controlled by the hormones from the endocrine system. Oxytocin (say : ox-EE-toe-sin) stimulates the release of milk in response to the stimulation of the nipple by the baby sucking.

Now check your understanding of the female reproductive system by completing Activity 16. Remember it is important that you answer the questions without looking back at the text if you can. You might want to read over the section again before attempting the questions. Look carefully at the diagrams and try to learn the names of each part of the system.
Activity 16: The female reproductive system

1. Label the diagram of the female reproductive system.

2. Complete these sentences:
   
a. The place where the baby develops is the _________________.
   
b. Fertilization takes place in the _________________.
   
c. The _________________ forms the lower birth canal.
   
d. The cervix has _________________ which helps the sperm to move easily to find the egg.
   
e. The _________________ secretes and ejects milk.
   
f. Female sex hormones – progesterone and oestrogen are produced in the _________________.

Feedback

We hope you have managed to answer these questions without looking at the text. Check your answers against ours at the end of the topic.
Section 2  How the human reproductive system works

In this section we will look at the process of reproduction and how human beings reproduce. For new life to develop a sperm and an ovum have to join. Reproductive cells (sperms and ova) – called gametes – are special. All the cells of your body contain 46 chromosomes arranged in 23 pairs. Gametes contain only 23 chromosomes, one from each pair. When an ovum and a sperm join (fertilisation) the fertilised egg (zygote) contains again 46 chromosomes, 23 from the mother and 23 from the father.

The Process of Reproduction

Reproduction can be seen as a step-by-step process although some of these steps are happening at the same time.

1. The release of the male sex hormone, testosterone in the testes, causes the production of sperm cells. This is a continuous process.
2. A change in the balance of female sex hormones, oestrogen and progesterone, causes the release of an egg (ovum) from the ovary. This change happens once each month. Remember, the female is born with eggs in the ovaries and this is the total number she will have in her life.
3. During each menstrual cycle, an egg is released from the female ovary.
4. At the same time, the lining of the uterus is stimulated by changes in female hormone levels to thicken and prepare for the egg.
5. During copulation, sperm cells are released from the testes, travel down the vas deferens, enter the urethra and through the penis are ejaculated into the vagina at the mouth of the cervix. There, they ‘swim’ up the vagina, through the cervix into the uterus and on into the fallopian tubes.
6. If a sperm finds an egg in the fallopian tube and is able to penetrate it, then the egg is fertilised. At this point a new human being is started. The fertilised egg, a single cell, is called a zygote and begins to divide.
7. The fertilized egg, or zygote, takes several days to reach the uterus. It continues to divided to form a ball of cells. It is now called an **embryo**. The embryo attaches to the soft lining of the uterus – this is called **implantation**.

Once the embryo has attained it basic form to develop into a human being (as from about the third month after fertilisation) it is called **foetus** (say FEET-us).

8. For the next 36 weeks the **foetus** grows and develops in the uterus. This period is called **gestation**. The muscular walls of the uterus stretch to accommodate the growing baby.

9. The lining of the uterus thickens and develops to form the **placenta** (say plah-SEN-ta). This is a blood-rich membrane which protects the growing foetus. The placenta is joined to the foetus by the umbilical cord. This is a cord with a lot of blood vessels which carry oxygen and nutrients from the mother to the growing foetus.

10. After approximately 36 weeks it is time for the baby to be born. Again, hormone action is involved. Hormone changes cause the cervix to open or dilate. The walls of the uterus are caused by hormones to start contracting to push the baby through the cervix and into the vagina. Remember, the vagina is also called the birth canal as it is through the vagina that the baby is born.

11. As soon as the baby is born (and not before) changes in the female hormone levels cause the mammary glands to start producing and secreting milk to feed the new born baby.

You can see that the male side of reproduction is very simple! However the female side involves the complex action of female sex hormones which cause the body to change in different ways at different stages of the process.

It is time to test your understanding of the process of reproduction. Complete Activity 17 to see how much you have learned. You may benefit from reading the section again before you attempt the activity.
Activity 17: The process of reproduction

1. Label the diagram according to the table below. Place the correct letter on the diagram at the area which the action described takes place.

   |   |   |
---|---|---|
A | egg is released from ovary |
B | lining of the uterus thickens in preparation for a fertilised egg |
C | sperm enters the uterus at the cervix |
D | sperm meets with egg in fallopian tube and fertilises it |
E | egg is implanted into lining of the uterus |

2. Explain what fertilisation is.

3. Explain what implantation is.

4. What is the placenta?

5. What is the cervix?

Feedback

It is important that you are clear about the stages in the process of reproduction. Check your answer against ours at the end of the topic.
Section 3  The effects of the sex hormones

You now know that there are different reproductive hormones for males and females. These hormones are present throughout the life of the individual and in males are fairly regular and constant. In females, there is a very delicate balance between the sex hormones which changes throughout the monthly cycle and cause different things to happen at different stages of the life cycle.

Can you remember the names of the three main sex hormones – one for males and two for females? Write them down here.

The hormones we want you to remember are oestrogen and progesterone in females and testosterone in males. We will look at each of them in turn.

Male sex hormones

The main male sex hormone is testosterone which is part of both the endocrine and reproductive systems.

When a baby boy is born, he has all the parts of his reproductive system in place but he is not able to reproduce until he reaches puberty (say : pyou-BER-tee) – around teenage years.

At puberty, the pituitary gland near the brain secretes hormones to stimulate the testes to produce testosterone. Figure 47 shows where the pituitary gland is found in the brain.
The increased level of testosterone causes several changes in males:
- the scrotum and testes grow larger
- the penis becomes longer and the seminal vesicles and prostate gland grow
- they develop deeper voices
- facial and body hair grows
- they have a sudden increase in the rate of growth to help them reach adult height and weight
- more oil is released from the sebaceous glands into the skin which leads to spots and in some cases acne
- the production of sperm begins.

**Female sex hormones**

The main female sex hormones are oestrogen and progesterone. However, the effects of the female sex hormones are much more complex than in the male.

The female reproductive hormones are also brought into action by the release of hormones from the pituitary gland. These hormones act on the ovaries and start the production of oestrogen and progesterone. The secretion of these hormones causes the female to grow into a mature woman capable of having babies. Several changes occur:
- the breasts get bigger
- the ovaries release eggs as part of the menstrual cycle
- the lining of the womb thickens to receive the egg but is expelled from the body during the monthly period if the egg is not fertilized
- more oil is released from the sebaceous glands into the skin which leads to spots and in some cases acne

The amount of oestrogen and progesterone released by the ovaries increases or decreases at different times during the monthly cycle. These changing hormone levels can cause different physical and emotional effects in women:
- more blemishes or spots on the skin
- bloating
- backache
- sore breasts
- headaches
- food cravings
- depression
- irritability

These different symptoms are known collectively as **premenstrual syndrome** as they tend to be more noticeable one week before the monthly period and disappear when the monthly period starts.

Now test your understanding of the effects of the male and female sex hormones in Activity 18.
Activity 18: The effects of sex hormones

1. Give 6 changes that take place in a male during puberty.

2. Give 4 changes that take place in a female during puberty.

3. What is the name of the male sex hormone?

4. Which 2 body systems is this hormone part of?

5. What are the two main female sex hormones?

6. Describe 4 effects of premenstrual syndrome.

7. State which of these effects are of most interest to a beauty therapist and why.
**Topic Summary: The Reproductive System**

In this Topic we described reproductive system as a system responsible for sustaining life and maintaining the continuation of human life, and in section 1 we said that the human reproductive system consists of two systems:

- the male reproductive system and
- the female reproductive system

We listed and described the male reproductive organs as:

- Testes - produce sperm and testosterone. Testosterone controls the development, growth and maintenance of the male sex organs.
- Ducts consists of vas deferens and urethra which transport the sperm
- Accessory glands include the seminal vesicle and the prostate gland. These secrete seminal fluid to help with the movement of the sperm
- Supporting structures are the scrotum and the penis. The penis ejaculates sperm into the vagina of a female during sexual intercourse. The scrotum holds the testes.

We also listed and described the female reproductive organs as:

- Ovaries –there are two ovaries and they produce eggs (ova) and secrete the female sex hormones progesterone and oestrogen
- The fallopian tubes are attached to each ovary. They transport the fertilised ova to the uterus where it develops into an embryo. If fertilization does not take place here the egg breaks down and is removed during menstruation
- The uterus is the womb, where the foetus develops. The lining of the uterus is removed during the monthly period (menstruation) if there is no fertilized egg.
- The vagina is a place where the penis is inserted during sexual intercourse. It is also the passage way for menstrual flow and the birth canal through which the baby is delivered.
- The cervix an opening at the end of vagina. It is lined with mucous membrane which enables the sperm to swim easily to reach the egg
- Mammary glands secrete and eject milk.

In Section 2 we talked about the process of reproduction. This section explained the process or stages that take place from sexual intercourse to the birth of the baby. In brief it happens in these stages:

During sexual intercourse the male sex hormones release testosterone, causing the production of sperm and the female sex hormones release oestrogen and progesterone causing the release of egg from the ovaries.
The male sperm swims through the vagina and attaches itself to the female egg (ova).
They join together in the **fallopian tube** and form a fertilized egg (**zygote**).
The fertilized egg continues on its way through the fallopian tube into the uterus. Implantation and development of a foetus takes place here.
The **placenta** and membrane then forms surrounding the embryo, in the uterus and allows substances to pass from the mother to the foetus through the umbilical cord.
The **foetus** continues to develop until it reaches the end of gestation period when the mother goes into labour and the baby is born.
The female hormones – oestrogen and progesterone – then trigger the mammary glands to produce and secrete milk to feed the new baby.
**Answers to Activities**

**Activity 15 : The male reproductive system**

1. The diagram of the male reproductive system.
   A: vas deference  
   B: seminal vesicle  
   C: urethra  
   D: testicle  
   E: penis  
   F: urinary bladder  
   G: prostrate gland

2.  
   a. Sperm is produced in the **testes**.  
   b. The two ducts in the system are called the **vas deferens** and **urethra**.  
   c. The function of the scrotum is to **hold the testes at a reduced temperature**.  
   d. The functions of the urethra are to **transport urine from the bladder to the outside of the body and to transport sperm from the testes**.  
   e. The two glands in the system are called the **seminal vesicle** & **prostrate**.

**Activity 16 : The female reproductive system**

1. The female reproductive system 
   A: fallopian tube  
   B: ovaries  
   C: uterus  
   D: vagina  
   E: cervix

2.  
   a. The place where the embryo develops is the **uterus**.  
   b. Fertilization takes place in the **fallopian tube**.  
   c. The **vagina** forms the birth canal.  
   d. The cervix has **mucous membrane** which helps the sperm to move easily to find the egg.  
   e. The **breast** secretes and ejects milk.  
   f. Female sex hormones – progesterone and oestrogen are produced in the **ovaries**.
**Activity 17: The process of reproduction**

1. 

![Diagram of reproductive system](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>egg is released from ovary</td>
</tr>
<tr>
<td>B</td>
<td>lining of the uterus thickens in preparation for a fertilised egg</td>
</tr>
<tr>
<td>C</td>
<td>sperm enters the uterus at the cervix</td>
</tr>
<tr>
<td>D</td>
<td>sperm meets with egg in fallopian tube and fertilises it</td>
</tr>
<tr>
<td>E</td>
<td>egg is implanted into lining of the uterus</td>
</tr>
</tbody>
</table>

2. Fertilisation takes place when a sperm penetrates an egg in the fallopian tube. It is at this point that a new human being is created.

3. Implantation is the process when the embryo is embedded into the soft lining of the uterus and starts to develop into a foetus.

4. The placenta is the thickened lining of the uterus. It is a blood-rich membrane which protects the growing foetus. The placenta is joined to the foetus by the umbilical cord.

5. The cervix is the opening between the uterus and the vagina. It is here that the sperm are ejaculated from the male to the female.

**Activity 18: The effects of sex hormones**

1. You could have given any 6 of these changes that take place in a male during puberty.
   a) facial and body hair grows
   b) boys develop deeper voices
   c) more oil is released from the sebaceous glands into the skin which leads to spots and in some cases acne
   d) they have a sudden increase in the rate of growth reaching adult height and weight
   e) the penis becomes longer and the seminal vesicles and prostate gland grow
   f) the scrotum and testes grow larger
   g) the production of sperm begins.
2. The 4 main changes that take place in a female during puberty are:
   a) more oil is released from the sebaceous glands into the skin which leads to spots and in some cases acne
   b) the breasts get bigger
   c) the lining of the womb thickens to receive the egg but is expelled from the body during the monthly period if the egg is not fertilized
   d) the ovaries release eggs as part of the menstrual cycle

3. The name of the male sex hormone is **testosterone**.

4. Testosterone is part of the **reproductive and endocrine systems**.

5. The two main female sex hormones are **oestrogen and progesterone**.

6. You could have chosen any 4 of these effects of premenstrual syndrome.
   a) more blemishes or spots on the skin
   b) bloating
   c) backache
   d) sore breasts
   e) headaches
   f) food cravings
   g) depression
   h) irritability

7. State which of these effects are of most interest to a beauty therapist and why.
   When women get facial spots and blemishes, they might go to the beauty salon for a facial. It is helpful if the therapist is aware that these blemishes might be as a result of premenstrual syndrome.
**Topic 11 The Integumentary System**

In your work as a beauty therapist you will often carry out treatments on the skin of clients.

Most people are very concerned about their skin. It is your facial skin that gives a first impression to others. So a good healthy looking facial skin is important to nearly everyone.

But it is not only for this reason that the skin is a very important organ in the body. Together with the hair and nails the skin forms the **integumentary system** (say: in-TEG-yoo-MENT-ah-ree) – which is a difficult word! It just means the covering system or the skin system of your body.

We talked about the skin in 2 earlier topics in this module. Can you remember the 2 other human body systems in which the skin plays an important role? Write the systems down here.

Did you remember that the skin is part of the excretory system and of the nervous system? As an excretory organ the skin removes waste products from the body when you are sweating. Can you remember the three substances excreted in sweat?

1. 
2. 
3. 

When you sweat your body removes urea, salts and excess water (the mixture of these we call sweat or perspiration.)

You learned in Topic 8 that the skin forms part of the nervous system. This is because your skin contains many receptors, or neuron endings, which are sensitive to pressure, pain, temperature and texture.

We are sure that you understand how important the **integumentary system** is to the work of a beauty therapist. The beauty therapist must have a sound knowledge of the structure and functions of the skin.
this topic you will learn about the organs and parts of the integumentary system and the important role they have in maintaining a healthy body.

What is in this topic?
In this topic there are two sections:

Section 1  What forms the integumentary system?
Section 2  How the integumentary system works

Learning Objectives
By the time you have completed this topic, you should be able to:

- describe the structure of the skin
- describe the structure of a hair
- explain how the integumentary system works

Study Time
We expect it will take you 3 – 4 hours to complete this topic and all the activities. But do not worry if it takes you more or less time than this, we do not all work at the same pace and we do not have all the same amount of knowledge about this topic from our previous learning and experiences.
Section 1  What forms the integumentary system?

In this section you will learn about the different parts that make up the integumentary system.

The main organ in the integumentary system is the skin. Also included are other parts, or appendages, which are associated with the skin:

- hair
- nails
- sweat glands
- sebaceous (say: sib-AY-shus) glands

The other parts of the integumentary system all come from the skin layers. In this topic we will study the skins and appendages except the nails – we are not going to include the nails in our study of the integumentary system as these will be covered in the unit on manicure and pedicure. We will also not cover the hair in great detail as this is explained fully in the unit on hair removal.

We will start by looking at the skin in more detail.

The skin

The skin is the largest organ of your body. The skin of an adult person covers about 2 m² and weighs approximately 4 kg. It is much bigger than the next largest organ in the body. Can you think which one is the next largest? The answer is at the bottom of the page.

There are two layers in the skin:

- the epidermis - (say: epp-ee-DUR-mis) – the top layer
- the dermis (say: DUR-mis) – the layer underneath

Answer: The liver is the second largest organ of the body after the skin.
**Epidermis**

This is the **top layer** of the skin. It is the protective outer layer covering the whole of the body. The thickness varies slightly, between a half and 3 millimetres. The skin is thick on the palms of the hand and soles of the feet and thin on, for example, the eyelids and lips.

The skin is made up of layers of cells. Over time, the cells on the surface layer of the skin die and flake off to be replaced by cells from below. All the cells in the skin are renewed in 3 to 4 weeks. This is how skin blemishes fade and small cuts heal – because the epidermis layer of the skin is constantly renewing itself. This process of renewal means that your skin stays healthy.

**Dermis**

The layer below the epidermis is the dermis. It is a tough and elastic layer. As you grow older the elasticity of your skin reduces and your skin becomes wrinkled and dry. In the dermis you will find many structures. Look at Figure 49 and identify where you can find:

- capillary blood vessels
- sweat glands and their ducts
- oil glands – called sebaceous glands
- hair follicles
- arrector pili (hair) muscle
- sensory nerve endings

---

**Figure 49 : Structure found in the dermis layer**
Now we will look at the structures found in the dermis layer of the skin.

**Blood vessels**

The dermis provides the **nutrients** for the skin. It has many blood capillaries that supply oxygen and nutrients. Beauty treatments that involve skin nourishment and stimulation will affect the dermis. Waste products are carried to the dermis layer of the skin by the blood capillaries to be excreted.

**Sweat glands**

You already know that sweat glands – as part of the excretory system – remove urea, salts and water from the body. They do this by moving these substances to the surface of the skin through ducts, or tubes, to the pores of the skin. Pores are tiny holes which allow the sweat to escape.

You might not really feel it, but you are sweating all the time. Sweat contains mainly water (99%), and some salts and small amounts of urea. There are also some anti-bacterial substances found in sweat which help to protect your body against infection.

Sweat glands are found all over the body but there are more on the forehead, palms of the hands and soles of the feet. They work in response to temperature changes, physical activity and emotional tension and are controlled by the nervous system.

**Subcutaneous layer**

Beneath the dermis you find a layer of fatty connective tissue. This layer is called the **subcutaneous layer**. The layer connects the skin to the underlying structures. The hypodermis is NOT taken as being a part of the skin, by most authors.

The layer contains capillary blood vessels, nerves and the sweat glands. It acts as a shock absorber, an insulator to preserve body heat and is responsible for body contours, which is more defined in the adult female body than the male. The fat cells may also be a source of energy in cases of lack of food.

Now try Activity 19 to see if you have understood the details of the structure of the skin.
Activity 19: The Skin

1. Name the parts of the integumentary system numbered in the diagram

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  

Diagram:

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  

Activity 19: The Skin .../cont

2. Your skin is constantly worn away how is it replaced?

3. What is a sweat gland?

4. What is sweat made up of?

5. Give 2 functions of sweat in the human body.

Feedback

Did you manage to answer the questions on the skin correctly? Check your answer against ours at the end of this topic. Also check your spelling of any new words so you get used to spelling them correctly. If you made some errors – do not worry – we learn from errors! They tell you what sections you may have to read again and/or what questions you want to ask your tutor. If something is not clear or well understood make a note of it and ensure you get it right and clear in your mind.
Hair

Hair grows all over your body except the palms of your hands, soles of your feet, between your fingers and toes, eyelids and lips. You can hardly see the soft fine hair covering your body. The places where you can see your hair very clearly are your hair and eyebrows and other body parts after puberty. This hair is called terminal hair and is usually thicker and darker in colour.

Even though you can hardly see the soft hair covering your body it still has an important role in the integumentary system. Let’s look at how the hair is formed.

Each terminal hair has two parts, the hair shaft and the hair root;

**The Hair shaft**

This is the part that projects out of the skin’s surface. The hair shaft is formed from the old and dead cells that are pushed out as new cells grow from the root. As the shaft is dead material it does not hurt when your hair is cut.

**The Hair root**

The root is the part of the hair in the skin. It extends from the epidermal surface into the dermis but in the scalp, it can extend into the subcutaneous layer.

At many places the top layer of your skin is folded inwards forming a sheath or sac. This is called a hair follicle (say: fah-lih-kul; follicle means - bag). It surrounds the hair root, from the follicle a hair grows. A person becomes bald if the scalp follicles become inactive and no longer produce new hair.

**The hair bulb and the Hair papilla**

The lower part of this bag has the shape of an onion and is called the hair bulb, the lower part of the hair root. The bottom of the ‘onion’ is indented by blood capillaries and nerve cells. It is called the hair papilla. It is here where the actual growth of hair is taking place. The blood capillaries in the papilla supply nutrients to the root of the hair. The hair is growing from the follicle – and this being tissue from the epidermis – hair grows from the skin (and NOT out of the skin!).

**The arrector pili muscles**

Each hair follicle is connected with muscle fibre to the upper regions of the dermis of the skin. The arrector pili (say: ah-RECK-tor pil-ee) muscles are involuntary muscles which contract to make the hair ‘stand on end’ in response to cold and fear. You might know this as ‘goose pimples’.
Sebaceous gland

Each hair follicle has a sebaceous gland opening from the side of it. These glands make an oily liquid, called sebum (say: SEE-bum). Sebum keeps the hair and skin soft and elastic. Sebum has also an antibacterial effect - it kills micro organisms that try to infect the skin. Mixed with sweat it forms a waterproof layer on the skin.

Sebaceous glands are found mostly in the skin on the face (nose and lips), neck, upper back, shoulders, and chest. They are not found at all on the hand palms and soles of the feet. Most of the time, the sebaceous glands make the right amount of sebum. During puberty hormones stimulate the sebaceous glands to make more sebum. Pores might become blocked by too much sebum and too many dead skin cells, this contributes to acne (pimples). Later in life, these glands produce less sebum, which contributes to dry skin as you may have noticed with old people.
Activity 20: Hair

1. In the diagram you will see the hair
   - ___ shaft
   - ___ follicle
   - ___ hair bulb
   - ___ papilla
   - ___ arrector pili
   - ___ sebaceous gland

Place the correct number in front of each part.
Feedback

It is important that you get the answers to this section on hair right. It is very important for your work as a beauty therapist. Check your answers against ours at the end of this topic. If you missed out on a question go over the text again and make sure you understand. If you have a problem or question you can not resolve yourself please write it down and contact your tutor.

Now let us move on to Section 2 and find out how the integumentary system works.

Activity 20: Hair .../cont.

2. Where on the body does not grow hair?

3. Describe what is
   a. the follicle
   b. terminal hair
   c. the hair shaft
   d. the hair root

4. a. What are sebaceous glands?
   b. Where on the body are NO sebaceous glands?

5. What is the function of the arrector pili muscle?
Section 2 How the integumentary system works

In this section we will discuss the function of the various parts of the integumentary system. We will explain how the integumentary system performs 6 functions. Can you think of any functions which the skin and hair perform in the human body? Write your ideas in this space.

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

You might have mentioned

- The skin protects the body from injury and bacterial invasion.
- The skin helps the body to regulate heat.
- The skin detects external changes. It can detect pressure, touch, pain, temperature change.
- The skin excretes excess water, some salts and urea when sweating.
- Sebum produced by the sebaceous glands helps to keep the skin soft and forms (with sweat) a waterproof layer on the skin.
- The skin absorbs certain beneficial substances, for example creams or oils which can help to keep the body healthy.

Let’s look at each of these functions in more detail.

1. **Protection**

The main function of the skin is to protect the body. The skin is the first barrier that **microbes** (a microscopic living organism) and other harmful substances will meet when trying to invade your body.

Skin forms a protective layer against **physical injury**. This might be an abrasion or bump. The skin protects the underlying tissues, organs and bones from damage.

As the skin is a waterproof barrier it prevents **excessive water absorption** when bathing or swimming. The protective film is a result of the mixture of sweat and sebum.

It provides protection from **ultra-violet light**. Excess ultraviolet light is harmful to the body and can cause skin cancer. When ultra violet radiation penetrates the epidermis it stimulates the production of a...
substance called melanin (say: MEL-ah-nin), a substance which makes skin get darker. Melanin enters the cells of the lower epidermis and will reach the top of the epidermis. Here the darkened skin becomes a "sunscreen" blocking out much of the harmful ultraviolet light.

The skin also forms a barrier for water and extracellular fluid to leave your body. It protects you against dehydration.

**Hair in protection**

At first, you may think that hair offers little protection to the human body – but you would be wrong! Hair stops harmful dust and other small particles entering your eyes, ears and nose. Nasal hair traps dust particles in the air, preventing them from entering into your lungs. Your eyelashes protect your eyes by decreasing the amount of light and dust that go into them. Even your ears have small hairs that prevent small objects going into the ear drum. Your eyebrows protect your eyes from sweat dripping down from your forehead.

The hair on your head protects the scalp burning from the heat of the sun.

**2. Regulates body temperature**

The skin is an important organ is keeping your body temperature around 37°C centigrade. You lose water from your skin all the time. This loss is not visible and you do not notice it because no drops of sweat are seen on your skin. In this way you lose about 1 litre of water a day. The rate of secretion of sweat and the rate of evaporation (changing liquid in to vapour) match each other in this case.

Sweat is produced as a response to external changes. If the rate of sweat production is higher than the rate of evaporation you will see the drops of sweat on your skin. This you feel, you are aware of it. Some of the receptors (nerve endings) in your skin are sensitive to changes in temperature. The change in temperature is a stimulus that activates the receptors. The receptors will communicate with the central nervous system where the impulses received are interpreted and reacted upon accordingly by sending messages to the effectors to take appropriate action.
This is what we called the stimulus – response cycle in the topic on the nervous system.

When it is found that the body temperature is too high a number of things happen in your skin.

- The capillary blood vessels (arteries) in the skin widen as a reaction to nerve impulses received from the central nervous system. This increases the flow of (warm) blood in the skin allowing loss of heat through radiation from the skin. Your sweat glands (the effectors) are stimulated through the impulses received from the central nervous system to produce more sweat (the response). The sweat passes through the sweat duct to the surface of your skin and evaporates (this means the liquid sweat changes to water vapour). Evaporation needs heat energy, so sweating cools down your skin.

When your body becomes too cold this is what happens in your skin:

- The capillary blood vessels in the skin narrow as a reaction to impulses received from the central nervous system. This reduces the blood flow to the skin keeping the warm blood away from the skin so less heat can be lost through radiation from the skin.
- Sweat production in the sweat glands decreases.
- The hairs on your skin stand up straight as the arrector muscles contract. A thin layer of air is trapped just above your skin acting as an insulator.

Shivering, an involuntary contraction of skeletal muscles due to nerve stimulation helps to generate body heat. This is the result of the breakdown or "burning" of glucose in the skeletal muscles.

**Hair in regulation of body temperature**

Although there is less hair on the human body than most animals, hair is still part of the temperature control system. It forms an insulating coat reducing the loss of heat from the warm blood in the skin by radiation.

When the human body gets cold the arrector pili muscles pull the hairs upright so that the air trapped between them acts as an insulating blanket. It helps to further reduce the loss of heat from the surface of your skin.

The hair on your head acts as an insulator on cold days. It reduces heat loss from the head.
3. **Detects external changes / sensory function**

In the skin there are millions of tiny nerve endings. The nerve endings (receptors) react to stimuli in the external environment such as touch, pressure, pain, temperature change. Have a look again at the diagram at the start of this topic to see the different types of receptors in your skin.

The skin is sensitive to touch and contain receptors that send messages to the central nervous system. The brain might get a message and interpret the information telling you whether what you are touching is smooth or rough, soft or hard. Temperature receptors allow you to tell if something is hot or cold.

Pressure receptors send messages about the pressure against the body like when you get pinched or place something heavy on your skin. You may remember that when the receptor detects something that is harmful to the body is reacts immediately without thinking. Do you remember the reflex arc?

It can be represented in a flow diagram like this:

![Reflex Arc Diagram]

The receptors work most of the time together. This allows you to detect more complex sensations such as burning, itching, and tickling. All of these receptors allow you to react to the changes detected in the external environment. Without these receptors you would never know if you touched something very hot, or cut your finger and your skin or body would be seriously damaged.

4. **Excretes perspiration**

The skin is an excretory organ. Excess water, salt and nitrogenous metabolic wastes are expelled from your body through the process of sweating. We discussed this already under the temperature regulation function of the skin.

5. **Secretes sebum**

The function of the sebaceous glands is to secrete sebum into the hair follicle. Sebum acts to protect and waterproof hair and skin and keep them from becoming dry, brittle and cracked. It prevents dehydration of the skin and hair. Sebum has also an antibacterial function; it prevents the growth of certain bacteria. These glands are all over the body where there is hair.
6. **Absorbs substances**

Although the absorption of creams is limited, some beauty cosmetics penetrate skin. The latest technology used in facial skin care such as electrotherapy machines has made it much easier for cosmetics to penetrate the skin and improve its texture. The penetration happens through the hair follicle and oil glands.

### Activity 21: The function of the integumentary system

1. List and shortly explain FOUR functions of the skin

2. Name TWO functions of the hair and shortly explain each of them.

### Feedback

You went over a lot of information on the functions of the integumentary system. If you forgot some it is not surprising. Check your answers against ours at the end of the topic. For any response you did not get correct turn to the page with the information and read it careful again. Make sure you can answer the question confidently. If you have met with problems or questions came to your mind you could not answer, please write them down and contact your facilitator for help.
**Topic Summary: The Integumentary System**

The integumentary system comprises of hair, nails and skin, sweat glands and sebaceous glands. In this topic we concentrated mainly on the skin, as hair and nails will be covered in detail in other units.

**Skin**

The skin is the largest organ of the body it covers our entire body, though its thickness varies from thin over the eyelids to thick on the soles of the feet.

**The layers of the skin.**

The skin is made up of two layers, the epidermis and the dermis.

- **The epidermis** which is the outer layer of the skin. The very top consists of dead cells which flake off and are replaced by cells lower in the epidermis. Cells are continuously moving up in the epidermis.

- **The dermis** below the epidermis is an elastic layer and contains:
  - Capillary blood vessels-supply the skin with nutrients and oxygen
  - Sweat glands and their ducts-excrete mainly water and some salts and urea from the body through the pores of the skin
  - Oil glands or sebaceous glands-secretes sebum which keeps skin and hair soft and elastic. Mixed with sweat it forms a water proof layer on the skin.
  - Arrector pili muscle-attached to a hair follicle and the upper region of the dermis. They contract (involuntary) in response to cold or fear
  - Sensory nerve endings-sensory nerves of the skin register pressure, pain, heat, itch and cold.

Below the dermis is a third layer called the subcutaneous layer, connecting the skin to the underlying structures. It contains mainly fat that serves as an energy store for the body; conserves body heat, acts as a cushion and gives the body shape.

**Hair**

Hair grows all over the body (except palms of hands, soles of feet, between fingers and toes and on lips and eye lids). The hair that you see is called terminal hair.
Parts of a hair:

- Shaft - the part of the hair above the skin.
- Root - the part of the hair in the skin. It is surrounded by the hair follicle: a sheath or sac formed from the epidermal layer by folding inward.
- Bulb - is the onion shaped lower part of the hair root
- Papilla - the bottom indented part of the root, at the end of the follicle filled with a knot of blood capillaries. The papilla supplies the hair with nutrients, hair growth takes place here.

The functions of the skin and hair are:

- Protection
  The skin protects the body from invasion of bacteria and from ultraviolet light. The skin acts as a water proof barrier preventing excess water absorption when swimming and bathing. Hair protects the body by trapping dust particles in the air preventing them from entering your lungs.
- Regulation of body temperature.
  The skin and hairs helps the body to regulate its temperature.
- Detection of external changes / sensory function.
  The sensory nerve endings in the skin detect external changes. They can detect pressure, touch, pain, temperature change.
- Excretory function
  The skin excretes excess water, some salts and urea when sweating.
- Secretion function
  Sebum produced by the sebaceous glands helps to keep the skin soft and forms (with sweat) a waterproof layer on the skin.
- Absorption.
  The skin can absorb beneficial substances, for example creams or oils which can help to keep the body healthy.
**Answers to Activities**

**Activity 19: The Skin**

1. The parts are:
   1. Epidermis
   2. Dermis
   3. Hair follicle
   4. Sebaceous gland
   5. Nerve endings
   6. Sweat Glands
   7. Hair bulb
   8. Subcutaneous layer

2. Your skin is constantly worn away how, is it replaced?
   - Cell at the very top of the epidermis are continually flaking off by friction and replaced by the cell lower in the epidermis. Cells in the epidermis are continually moving up. New cells formed at the bottom and moving to the top where they are “flaking of”

3. What is a sweat gland?
   A duct gland that produces perspiration (sweat).

4. What is sweat made up of?
   Sweat contains mainly water (99%) and some small amounts of salts and urea.

5. Give a function of sweat in the human body.
   The main function of sweating is to control the temperature of the body (for details go back to topic 8). As the water in the sweat evaporates it cools the body. Sweat has also contains an antibacterial substance that helps to protect the body against infection.

**Activity 20: Hair**

1. - _3_ shaft
   - _1_ follicle
   - _5_ hair bulb
   - _2_ papilla
   - _6_ arrector pili
   - _4_ sebaceous gland

2. No hair is found on the palms of your hand, the soles of your feet, between your fingers and toes and on your lips and eye lids.

3. Describe what is
   a. the follicle is **the bag shaped sheath of epidermal cells that surround the hair root**
   b. terminal hair is the hair that **is clearly visible** e.g: hair on your head, eyebrows and other parts of the body after puberty.
   c. the hair shaft **is the part of the hair above the skin**
   d. the hair root **is the part of the hair in the skin**
4. a. Sebaceous glands are glands attached to the hair follicle producing an oily substance (sebum).

   b. NO sebaceous glands are found on the palms of your hand and the soles of your feet

5. The arrector pili muscle contracts when you are feeling cold and make the hair ‘stand on end’ (goose pimples). When the hairs stand on end a thin layer of air is trapped between the hairs. This layer acts as a blanket reducing heat loss from your body.

**Activity 21: The function of the integumentary system**

1. **FOUR functions of the skin are**
   1. *Protects body*—forms a barrier for the invasion of bacteria and ultraviolet light, it also acts as a water proof barrier preventing excess water absorption when swimming and bathing.
   2. *Regulates body temperature*-when the outside temperature changes the skin adjust to warm or cool the body, we cool ourselves if sweat evaporates, dilation of blood vessels assists in cooling the body.
   3. *Detects changes*—sensory nerve endings in the dermis respond to touch, pain, cold, heat and pressure.
   4. *Secretion*-the natural oil (sebum) from the sebaceous glands secreted into the hair follicle. Sebum mixed with sweat forms a waterproof layer on the skin and hair. Sebum keeps hair and skin soft and elastic.
   5. *Absorption*—certain beauty creams and oils are absorbed through the skin pores
   6. *Excretion*-when sweating excess water, and some salts and urea are removed from the body.

2. **TWO functions of the hair**
   - Protection
     Hair protects by trapping dust and other particles in the air preventing them from entering your eyes, ear, nose.
     Hair on your scalp protects the scalp from burning in the hot sun.
   - Regulation of body temperature.
     Body hairs form an insulating layer on the body.
     Reducing the loss of heat from the blood in your skin through radiation.
     When cold the arrector pilli muscles pull the hair upright so air is trapped between the hairs forming a blanket that acts as an insulator.
## The Human Body

### Module 2 Glossary

<table>
<thead>
<tr>
<th><strong>a</strong></th>
<th><strong>b</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>absorption</strong></td>
<td>passage of nutrients from digested food through the epithelial lining of the stomach and small intestine into the blood and lymph circulation systems</td>
</tr>
<tr>
<td><strong>accessory organ</strong></td>
<td>an organ that helps or assists another organ</td>
</tr>
<tr>
<td><strong>acne</strong></td>
<td>inflammation of the skin as a result of the over activity of sebaceous glands – causing spots and pimples</td>
</tr>
<tr>
<td><strong>adrenalin</strong></td>
<td>“the fight or flight hormone”. It is produced when you are angry or frightened. It prepares you for action – to fight or to run away.</td>
</tr>
<tr>
<td><strong>alimentary canal</strong></td>
<td>long tube that begins at the mouth and ends at the bottom or anus – contains the organs of the digestive system</td>
</tr>
<tr>
<td><strong>amino acid</strong></td>
<td>simplest form of protein – known as the ‘building blocks’ of protein</td>
</tr>
<tr>
<td><strong>anus</strong></td>
<td>The opening of the rectum to the outside of the body</td>
</tr>
<tr>
<td><strong>appendix</strong></td>
<td>small, finger-like pouch attached to the caecum</td>
</tr>
<tr>
<td><strong>arrector pili muscle</strong></td>
<td>small involuntary muscles attached to each hair follicle – causing the hair to stand up as a response to cold</td>
</tr>
<tr>
<td><strong>assimilation</strong></td>
<td>conversion of absorbed simple nutrients into the complex substances which make up the human body</td>
</tr>
<tr>
<td><strong>autonomic functions</strong></td>
<td>body actions that happen without conscious thinking</td>
</tr>
<tr>
<td><strong>autonomic nervous system</strong></td>
<td>involuntary system which controls internal organs – part of the peripheral nervous system (PNS) concerned with involuntary actions</td>
</tr>
<tr>
<td><strong>bile</strong></td>
<td>substance produced in the liver to break down fats – it is stored in the gall bladder</td>
</tr>
<tr>
<td><strong>bile pigments</strong></td>
<td>waste product produced in the liver when it breaks down old red blood cells</td>
</tr>
<tr>
<td><strong>bolus</strong></td>
<td>small ball of food formed by chewing with the teeth</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>carbohydrate</td>
<td>sugary and starchy foods eg mealie meal, rice, sugar, cake – used by the body for giving energy</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>a colourless, odourless gas (CO₂) formed during respiration</td>
</tr>
<tr>
<td>caecum</td>
<td>a pouch at the start of the large intestine</td>
</tr>
<tr>
<td>central nervous system CNS</td>
<td>main part of the nervous system made up of the brain and spinal cord</td>
</tr>
<tr>
<td>cerebellum</td>
<td>part of the brain responsible for muscular coordination and balance</td>
</tr>
<tr>
<td>cerebral cortex</td>
<td>the outer layer of gray matter of the cerebral hemispheres, large responsible for higher brain functions</td>
</tr>
<tr>
<td>cerebrum</td>
<td>part of the brain which controls voluntary movement; formed into right and left hemispheres</td>
</tr>
<tr>
<td>cervix</td>
<td>the opening between the vagina and the uterus in the female reproductive system</td>
</tr>
<tr>
<td>chemical digestion</td>
<td>process of breaking down food by acids and enzymes, into chemical substances that can be absorbed into the blood</td>
</tr>
<tr>
<td>chyme</td>
<td>thick liquid form of partially digested food and stomach juices</td>
</tr>
<tr>
<td>colon</td>
<td>part of the large intestines that runs from the caecum to the rectum</td>
</tr>
<tr>
<td>copulation</td>
<td>to have sexual intercourse</td>
</tr>
<tr>
<td>dermis</td>
<td>lower layer of the skin</td>
</tr>
<tr>
<td>diet (balanced)</td>
<td>the food you eat regularly or everyday – a balanced diet contains the right amount of nutrients to meet all the needs of the body to be healthy</td>
</tr>
<tr>
<td>digestion</td>
<td>this is the process of breaking down food mechanically or chemically into smaller, simpler substances to allow them to pass into the blood</td>
</tr>
<tr>
<td>digestive enzymes</td>
<td>proteins which speed up the breakdown of food</td>
</tr>
<tr>
<td>duodenum</td>
<td>first part of the small intestines</td>
</tr>
<tr>
<td>effectors</td>
<td>cells in the muscles or glands that convert signals from the brain or spinal cord into some form of action</td>
</tr>
</tbody>
</table>
eigestion  process by which waste which has been rejected by the digestive tract leaves the body through the anus

endocrine system  a messenger system that regulates and coordinates body activities

endocrine gland  Body organ which makes and secretes hormones into the bloodstream

enzyme  protein produced in the body which helps in different body processes

embryo  a fertilised egg (zygote) that has started cell division up to about the eight week after fertilisation

epidermis  top layer of the skin

epiglottis  flexible flap of tissue which closes over the wind pipe (larynx) when we swallow food so that we do not choke

excretion  the process of removing metabolic waste products from the cells of the body.

exocrine gland  gland which secretes through ducts or tubes to reach the surface of the body

fallopian tubes (oviducts)  tubes which transport eggs released in the ovary to the uterus in the female reproductive system

fats  nutrients which provide energy for the body; e.g. butter, oil, fatty meat and whole milk

fatty acids  substance produced when fats are broken down to their simplest form for digestion

fertilisation  when the sperm nucleus fuses with the ovum in the fallopian tube

fibre (dietary)  substance in food that cannot be digested but which helps to keep the body healthy by preventing constipation and digestive problems

foetus  embryo that has developed to a stage to attain its basic form (from the 3rd to the 9th month after fertilisation)

gall bladder  storage vessel for bile which is produced in the liver

gametes  The male (sperm) or female (ovum) reproduction cells

gestation  the period of 9 months during which the foetus develops into a baby in the uterus

gland  a body organ which secretes chemical substances

glomerulus  a knot of capillaries found inside the nephron. They filter blood to form urine

glycerol  substance produced when fats are broken down to their simplest form for digestion
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>hair follicle</td>
<td>cells forming a bag which surrounds the part of a hair that is under the skin</td>
</tr>
<tr>
<td>homeostasis</td>
<td>maintenance of a constant internal environment in the body</td>
</tr>
<tr>
<td>hormones</td>
<td>chemicals produced in the glands which affect different body functions</td>
</tr>
<tr>
<td>hydrochloric acid</td>
<td>strong acid released in the stomach to help break down food</td>
</tr>
<tr>
<td>hypothalamus</td>
<td>part of the cerebrum in the brain which controls involuntary movement and links the nervous and endocrine systems</td>
</tr>
<tr>
<td>implantation</td>
<td>when the fertilised egg is embedded in to the lining of the uterus in the reproductive process</td>
</tr>
<tr>
<td>ingestion</td>
<td>taking food and liquids into the mouth (eating)</td>
</tr>
<tr>
<td>insulin</td>
<td>hormone produced in the pancreatic glands; it helps control levels of glucose in the blood</td>
</tr>
<tr>
<td>integumentary system</td>
<td>covering (skin) system of the human body</td>
</tr>
<tr>
<td>intestine (small)</td>
<td>food passes here after leaving the stomach. It is in the small intestine where much of the digestion of food takes place</td>
</tr>
<tr>
<td>inter neuron</td>
<td>A nerve cell found entirely within the central nervous system that acts as a link between sensory neurons and motor neurons</td>
</tr>
<tr>
<td>involuntary process</td>
<td>body process which you do not have to think about like breathing or heart beat</td>
</tr>
<tr>
<td>mammary glands</td>
<td>part of female reproductive system which provides nourishment (milk) to offspring. Also called the breasts</td>
</tr>
<tr>
<td>mechanical digestion</td>
<td>process of breaking down food in to smaller pieces by chewing (mouth) or churning (stomach, intestines)</td>
</tr>
<tr>
<td>medulla oblongata</td>
<td>part of the brain which controls and coordinates all the messages to and from the brain – also known as the brainstem</td>
</tr>
<tr>
<td>menstruation</td>
<td>the removal of unfertilized eggs from the uterus of a female</td>
</tr>
<tr>
<td>menstrual cycle</td>
<td>26 – 30 day cycle from release of egg to end of menstruation</td>
</tr>
<tr>
<td>metabolic waste</td>
<td>waste produced by the chemical reactions inside body cells</td>
</tr>
<tr>
<td>metabolism</td>
<td>chemical process by which cells are nourished and supplied with energy.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>minerals</td>
<td>Important inorganic substances needed for body functions but which have no energy or nutritive value e.g. iodine, calcium, iron</td>
</tr>
<tr>
<td>mono saccharide</td>
<td>Carbohydrates are broken down to form simple sugars called mono-saccharides</td>
</tr>
<tr>
<td>motor nervous cell</td>
<td>Carry information from the CNS to organs, muscles, and glands.</td>
</tr>
<tr>
<td>nephron</td>
<td>The part of the kidney which purifies and filters the blood</td>
</tr>
<tr>
<td>nervous system</td>
<td>The system of cells, tissues and organs that regulates the body's responses to internal and external stimuli</td>
</tr>
<tr>
<td>nutrients</td>
<td>Substances used by the body to grow, get energy, repair cells and stay healthy</td>
</tr>
<tr>
<td>oesophagus</td>
<td>Muscular tube which carries food from the pharynx to the stomach – part of digestive system</td>
</tr>
<tr>
<td>oestrogen</td>
<td>One of the main female reproductive hormones</td>
</tr>
<tr>
<td>offspring</td>
<td>The product of reproduction: children</td>
</tr>
<tr>
<td>ovum</td>
<td>Egg (singular) ova (plural)</td>
</tr>
<tr>
<td>ovary</td>
<td>Part of female reproductive system which stores eggs or ova. The ovaries also release hormones.</td>
</tr>
<tr>
<td>oviducts</td>
<td>See fallopian tubes</td>
</tr>
<tr>
<td>pancreas</td>
<td>Accessory organ in the digestive system which releases enzymes into small intestines to help break down food</td>
</tr>
<tr>
<td>parasympathetic</td>
<td>Part of the autonomic nervous system – it prepares the body to relax and rest</td>
</tr>
<tr>
<td>nervous system</td>
<td>Part of the nervous system which connects the brain and spinal cord to the rest of the body</td>
</tr>
<tr>
<td>peripheral</td>
<td></td>
</tr>
<tr>
<td>nervous system PNS</td>
<td></td>
</tr>
<tr>
<td>penis</td>
<td>Male sexual and reproductive organ</td>
</tr>
<tr>
<td>peristalsis</td>
<td>Muscular contractions of the walls of the digestive tract causing food to move along it</td>
</tr>
<tr>
<td>pharynx</td>
<td>Throat – used by the respiratory system for passing air to and from the lungs and by the digestive system for passing food to the stomach</td>
</tr>
<tr>
<td>pituitary gland</td>
<td>Master gland which controls other endocrine glands; located in the brain</td>
</tr>
<tr>
<td>placenta</td>
<td>A blood-rich membrane which protects the growing foetus</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>premenstrual syndrome</td>
<td>physical and emotional symptoms women might experience about a week before their monthly period</td>
</tr>
<tr>
<td>progesterone</td>
<td>female reproductive hormone</td>
</tr>
<tr>
<td>propulsion</td>
<td>process in the digestive system when food is moved along the digestive tract</td>
</tr>
<tr>
<td>protein</td>
<td>type of food which builds and repairs the body e.g. fish, meat, egg white and beans</td>
</tr>
<tr>
<td>receptors</td>
<td>group of cells that can detect changes in the internal or external environment of the body</td>
</tr>
<tr>
<td>rectum</td>
<td>the last part of the large intestines</td>
</tr>
<tr>
<td>reflex</td>
<td>an automatic response of the body to a stimulus</td>
</tr>
<tr>
<td>relay neuron</td>
<td>a nerve cell found entirely within the central nervous system that acts as a link between sensory neurons and motor neurons</td>
</tr>
<tr>
<td>renal artery</td>
<td>the main blood vessel that supplies blood to the kidney</td>
</tr>
<tr>
<td>response</td>
<td>any change in the body occurring as a result of a stimulus</td>
</tr>
<tr>
<td>roughage</td>
<td>whole wheat bread, brown rice, fruits, vegetables, bran cereals</td>
</tr>
<tr>
<td>saliva</td>
<td>watery substance produced in the mouth containing enzymes to break down food</td>
</tr>
<tr>
<td>sebaceous glands</td>
<td>small glands that release oily liquid onto the hair follicle to lubricate and soften the skin</td>
</tr>
<tr>
<td>seminal fluid or semen</td>
<td>The fluid mixture consisting of sperm cells and secretions from the accessory glands (seminal vesicles and prostate)</td>
</tr>
<tr>
<td>sensory neurons</td>
<td>cells that carry information to the central nervous system (CNS)</td>
</tr>
<tr>
<td>skin appendages</td>
<td>parts of the integumentary system which are associated with the skin</td>
</tr>
<tr>
<td>soluble</td>
<td>something which can be dissolved in water; opposite = insoluble</td>
</tr>
<tr>
<td>somatic nervous system</td>
<td>part of the peripheral nervous system concerned with voluntary actions</td>
</tr>
<tr>
<td>sphincter</td>
<td>ring like muscle that contracts to close an opening to control the flow of substances in only one direction</td>
</tr>
<tr>
<td>spinal cord</td>
<td>extension of the brain found inside the vertebral column – responsible for reflex actions</td>
</tr>
<tr>
<td><strong>stimulus</strong></td>
<td>changes in the internal or external environment of the body that can be detected (by sensory cells)</td>
</tr>
<tr>
<td><strong>sweat</strong></td>
<td>liquid made up of water, salts and urea which is excreted by the sweat gland through pores in the skin: helps with regulation of body temperature</td>
</tr>
<tr>
<td><strong>sweat gland</strong></td>
<td>gland which transports waste products such as salts and urea and excess water from the blood to the surface of the skin</td>
</tr>
<tr>
<td><strong>sympathetic nervous system</strong></td>
<td>part of the autonomic nervous system which prepares the body for stress</td>
</tr>
<tr>
<td><strong>synapse</strong></td>
<td>the junction between two neurons or a neuron and a body cell (e.g. a muscle cell) across which a nerve impulse is transmitted</td>
</tr>
</tbody>
</table>

| **t** |
| **testes** | part of male reproductive system where sperm is produced and the male sex hormone testosterone – also called testicles |
| **testosterone** | male sex hormone |
| **traverse** | going across |
| **toxins** | substances which are harmful to the body and can be poisonous |
| **tubule** | the last part of a long twisting tube that collects urine from the nephrons |

| **u** |
| **urea** | waste product formed in the liver from the breakdown of protein |
| **ureter** | tubes which transport urine from the kidneys to the urinary bladder |
| **urethra** | thin-walled tube that carries urine from the urinary bladder to the outside of the body in the excretory system. In the male reproductive system it carries sperm from the testes |
| **urine** | fluid formed by the kidneys from blood plasma |
| **uterus** | part of female reproductive system where the fertilized egg grows - also called the womb |

| **v** |
| **vagina** | female organ of copulation. Also the lower part of the birth canal in the female reproductive system |
| **vas deferens** | tube in male reproductive system which transports sperm from the testes to the penis |
| **villi** | small finger-like projections on the wall of the small intestine which increase the area of absorption |
| **vitamin** | important organic substances which the body needs to function but which have no energy or nutritive value |
 voluntary movement

body movement which you have to think about – like walking or waving your hand

zygote

a fertilised egg