GRADE 9

SCIENCE

UNIT 3

OUR BODY

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SCIENCE

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IN THIS UNIT YOU WILL LEARN ABOUT:

TOPIC 1: SKELETAL AND MUSCULAR SYSTEM

TOPIC 2: CIRCULATORY SYSTEM

TOPIC 3: RESPIRATORY SYSTEM

TOPIC 4: EXCRETORY SYSTEM

Acknowledgement

We acknowledge the contributions of all Secondary Teachers who in one way or another have helped to develop this Course.

Our profound gratitude goes to the former Principal of FODE, Mr. Demas Tongogo for leading FODE team towards this great achievement.

Special thanks to the Staff of the Science Department of FODE who played active roles in coordinating writing workshops, outsourcing lesson writing and editing processes, involving selected teachers of Central Province and NCD.

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DIANA TEIT AKIS
PRINCIPAL

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SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is a part of the new Flexible, Open and Distance Education curriculum. The learning outcomes are student-centred and allows for them to be demonstrated and assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution, Government Policies and Reports. It is developed in line with the National Education Plan (2005 -2014) and addresses an increase in the number of school leavers affected by the lack of access into secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

- To facilitate and promote the integral development of every individual
- To develop and encourage an education system satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced to provide alternative and comparable pathways for students and adults to complete their education through a one system, many pathways and same outcomes.

It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all those teachers, curriculum writers, university lecturers and many others who have contributed in developing this course.

UKE KOMBRA, PhD

Secretary for Education

UNIT INTRODUCTION

Dear Student,

Welcome to Unit 3 of your Grade 9 Science Course! I hope that you enjoyed studying the earlier Units. I also hope that this Unit, Our Body, will be an interesting and enjoyable subject to study too.

In this Unit, there are 13 Lessons on four Topics. The four topics are:

- **Skeletal and Muscular System**
- **Circulatory System**
- **Respiratory System**
- **Excretory System**

There are five Lessons in the first Topic. The lessons will discuss about the skeletal and muscular system. It will also tackle the structure and functions of human body, skeleton, bones and cartilage. You will also learn from this Topic about the muscles and joints.

The second Topic is composed of three Lessons and will discuss about the circulatory system. You will also learn in this Topic the different types and functions of blood, blood vessels and heart and its functions.

In the third Topic, there are again three Lessons that will discuss about the respiratory system. It will also talk about the breathing process and digestive process.

The last Topic has only two Lessons. It will talk about the excretory system. You will also learn from this Topic the uses and functions of the skin and the kidneys.

Remember, you have to do all the activities and carry out the Practice Exercises after each lesson. Answers to Practice Exercises are at the end of each Topic.

If you have any problems in understanding any of the lessons in this Unit, please do not hesitate to inform the Science Department at FODE Headquarters. This will help the teacher to revise the lessons for the next edition.

You may study this Unit now following the Study Guide on the next page.

All the Best!

STUDY GUIDE

Follow the steps given below and work through the lessons.

Step 1 Start with Topic 1 and work through it in order. You may come across new terms in your lessons which are written in bold with an asterisk (*) For example in Lesson 1, you will come across **nerve endings*.** Words like this will require you to look up their meaning in the glossary section at the end of this book.

Step 2 When you study Lesson 1, do the given Activities. When you complete the Activities, check your work. The answers are given at the end of the Lesson. (Note: Short lessons may not have an activity.)

Step 3 You will also do a Practice Exercise at the end of each Lesson. After you have completed the Practice Exercise, correct your work. The answers are given at the end of each Topic.

Step 4 Then, revise and correct any mistake.

Step 5 When you have completed all of these steps, tick the check box for Lesson 1, on the Contents page, like this:

☑ Lesson 1: The Human Body

Then, go on to the next Lesson. Repeat this process until you complete all the Lessons on a Topic. When you have done this, revise using the Review Section.

Remember, as you complete each lesson; tick the box for that lesson on the Contents page. This will help you check your progress.

Assignment: Topic Tests and Unit Test

When you have completed all the lessons in a Topic, do the Topic Test for that Topic, in your Assignment Book. The Unit Book tells you when to do this. When you have completed all the Topic Tests for the Unit, revise well and do the Unit Test. The Assignment Book tells you when to do the Unit test.

When you have completed the entire Assignment Book, check and revise again before sending it to the Provincial Centre. If you have any questions, write them on the Student's page. Your teacher will advise you when he/she returns your marked Assignment.

The Topic Tests and the Unit Test in each Assignment will be marked by your Distance Teacher. The marks you score in each Assignment will count towards the final result. If you score less than 50%, you will repeat that Assignment.

Remember, if you score less than 50% in three consecutive Assignments, your enrolment will be cancelled. So, work carefully and ensure that you pass all Assignments.

TOPIC 1

SKELETAL AND MUSCULAR SYSTEM

In this topic you will learn about:

- **the human body**
- **the skeleton**
- **bones and cartilage**
- **the joints**
- **the muscles**

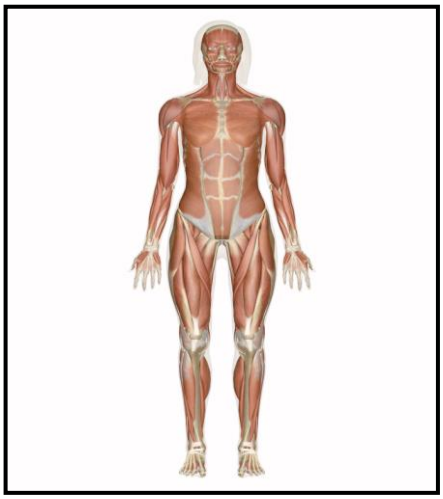
INTRODUCTION TO TOPIC 1: SKELETAL AND MUSCULAR SYSTEM

Skeletal system

People have skeletal systems made up of over 200 bones. In this topic we will learn about how these 206 bones in adults to be exact and other connective tissues are organized into skeletal system to give the body a rigid framework to which the softer tissues and organs of the body are attached. It provides the shape for our bodies in addition to supporting, protecting, allowing bodily movement, producing blood for the body, and storing minerals.

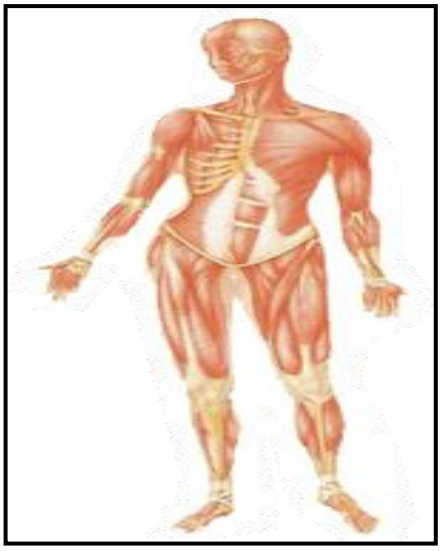
We will also talk about the muscular system and how the skeletal and muscular systems work together to allow a wide range of movements and physical capabilities in humans.

The muscular system makes up nearly half the weight of the human body, this is why when we train, sometimes we put on weight instead of losing it. We put on muscle weight. The main job of the muscular system is to provide movement for the body.



Muscular system

The skeletal and muscular systems work together to allow movement. Muscles are connected to bones by tendons. Bones are connected to each other by ligaments. Where bones meet one another is typically called a joint. Muscles which cause movement of a joint are connected to two different bones and contract to pull them together.



Musculo-skeletal system

Some questions will arise such as

- How are bones and cartilage important in our body?
- What are the different major skeletal muscles in our body?
- How do we mend broken bones? What are the reasons why bones break?

In this Topic, you will find the answers to these questions and other questions relating to the skeletal and muscular system.

Lesson 1: Human Body

Welcome to Lesson 1.The human body is made up of a head, neck, torso, two arms and two legs. The average height of an adult human is about 5 to 6 feet tall. The human body is made to stand erect, walk on two feet, use the arms to carry and lift, and has opposable thumps (able to grasp). For this lesson you will study the physical appearance of human body and its internal structures and functions.

Your Aims:

- describe humans as mammals
- define cells, tissues, organs and organ systems
- identify the parts and functions of the human body

Humans are Mammals

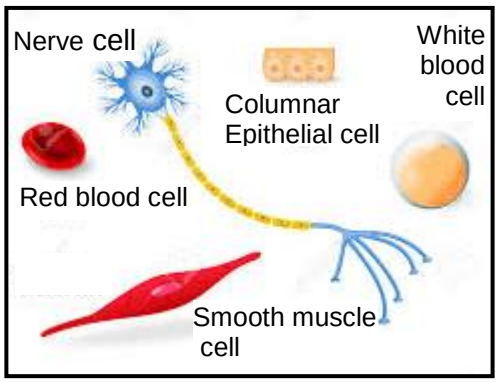
Human beings are the most complex organisms on this planet. We belong to a group of animals called mammals. They have a backbone, hair on the body and produce milk for their young. Babies are born alive and are looked after by their parents for a long time.

Humans are said to be the most highly developed of all animals. Your body, as a whole, is one organism. However, many, many parts make up that whole. The human body is a single structure but it is made up of billions of smaller structures of four major types.

1. **Cells**

The human body is made up of numerous cells, begins as a single, newly fertilized cell. The cells of the body are too small to be seen with the naked eye.

Cells are the smallest and simplest unit of living matter that can maintain life and reproduce themselves. Muscle cells, nerve cells, blood cells are examples of many types of cells found in the body.



Human cells

2. **Tissues**

Cells can be grouped together. A large number of similar cells with the same physical characteristics grouped together to perform same functions are called **tissues**. Covering tissues are thin layers of cells that cover or line the surfaces of the body. For example, the skin on the outside of your body and the inside of the blood vessels.

3. **Organs**

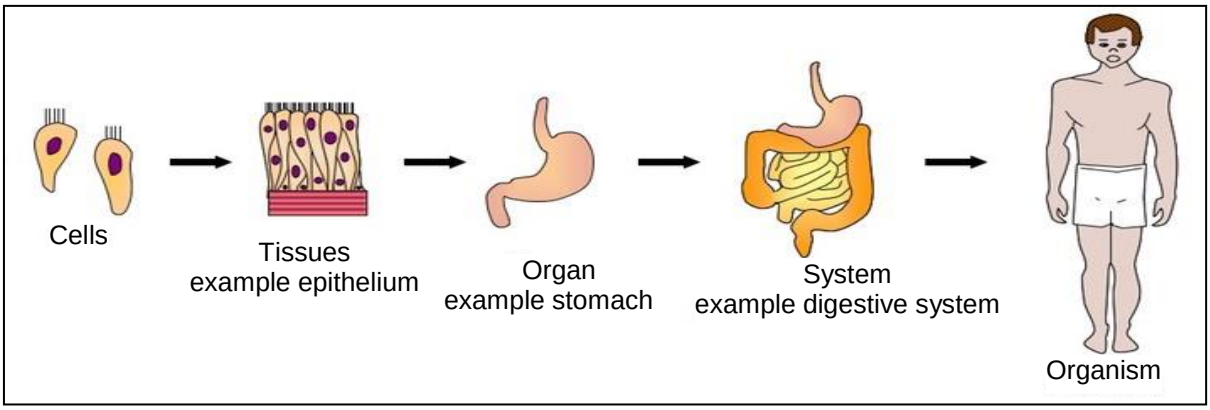
An organ is a collection of several different kinds of tissues so arranged that they can perform a special function. For example, the heart pumps blood and the stomach helps digest food. Each organ is made from a few different tissues. The stomach contains muscle and nerve tissue.

4. **Organ systems**

Organ systems are the most complex of the component units of the human body. Groups of organs are linked together to carry out important functions or jobs. A group of organs that work together is called an organ system. No system can exist alone due to specialization of cells.

For example, more than one organ is needed to digest food. The stomach does some of the work but the mouth and the intestines are other organs that help. The mouth, stomach and intestines form the digestive system.

Below is a sample diagram of the structures that make up the whole body from the simplest units which are the cells to most complex systems.



Cells are the basic units of life, which can join together to form tissues, while different groups of tissues join together to form organs. These organs are then connected together to form systems, such as the digestive system, which includes the stomach, oesophagus, intestines and other organs.

To summarize, in our body are different systems that perform important functions. Each system is an organization of different organs which work together for a particular system. Each organ is made up of various tissues and different tissues have number of cells, which is the smallest functional unit of the body.

Parts of the Human Body

The human body consists of bony skeleton and muscles. The human body refers to the entire structure of a human being and comprises the three main parts which are the **head**, **trunk** (which includes the thorax and abdomen) and the **limbs** (extremities, which include arms and hands, legs and feet)

The 3 main parts:

1. **Head** is composed of the cranium and facial parts. It contains the brain which controls the whole body. The cranium is partly covered with hair. The parts of the face are the forehead, the temples, the ears, the eyes with eyebrows, the cheeks, the nose, the jaw, the mouth and the chin. The main parts of the mouth are lips, the tongue, the teeth, the palate and the gums. The eyes are protected by eyelids and eyelashes. The eyes are the organs of sight. The nose of smell and the ears are the organs of hearing. The nerves of the skin are organs of touch. The five senses are: sight, hearing, smell, taste and touch. The head is attached to the trunk by the neck.

2. The **trunk** includes the chest (in front), the back, the shoulders and the abdomen. The internal organs which we cannot see are the heart, the lungs, the stomach, the liver with the gall-bladder, the pancreas, the spleen, the kidneys and the small and large intestines (bowels).

3. The arms and legs are called the **limbs**. The upper extremity (arm) consists of the upper arm, the elbow, the forearm, the wrist and the hand with four fingers and one thumb. The inner side of the hand is called the palm. The finger nails protect the finger tips. The lower extremity (leg) is attached to the pelvic girdle. It is composed of the thigh, the knee with patella, the shin, the calf, the ankle and the foot. Each foot has a heel, a sole and five toes

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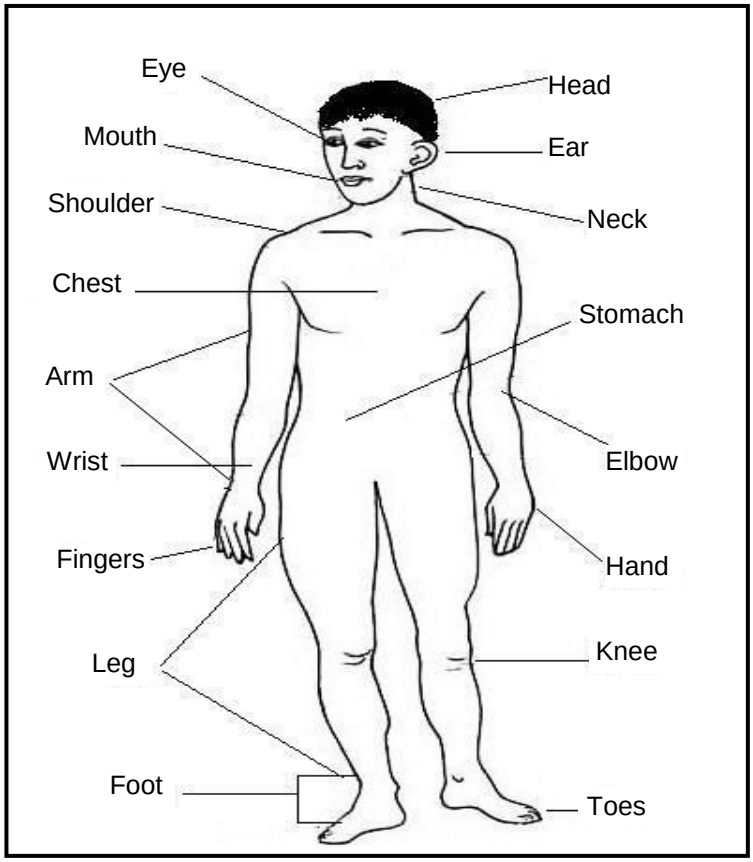


Parts of human body

Activity: Now test yourself by doing this activity.

A. **Define the following.**

a. Cells _____
b. Tissues _____
c. Organ _____
d. Organ system _____

B. **Describe humans as mammals.**

_____
_____
_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 1.

Summary

You have come to the end of lesson 1. In this lesson you have learnt that:

- humans belong to a group of animals called mammals.
- the human body is a single structure but it is made up of billions of smaller structures of four major types, cells, tissues, organs and organ systems.
- cells are the smallest and simplest unit of living matter that can maintain life and reproduce themselves.
- large number of similar cells with the same physical characteristics grouped together to perform same functions are called tissues.
- an organ is a collection of several different kinds of tissues so arranged that they can perform a special function.
- a group of organs that work together is called an organ system.
- the human body refers to the entire structure of a human being and comprises the three main parts which are the head, trunk (which includes the thorax and abdomen) and the limbs (extremities, which include arms and hands, legs and feet).

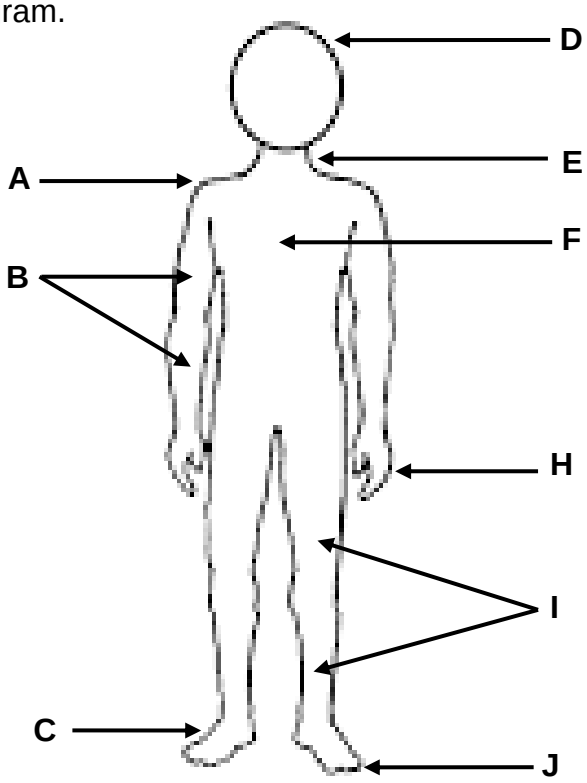
NOW DO PRACTICE EXERCISE 1 ON THE NEXT PAGE.

Practice Exercise 1

Answer the following questions:

1. Label the parts of the diagram.

A. _____
B. _____
C. _____
D. _____
E. _____
F. _____
G. _____
H. _____
I. _____
J. _____



2. What are the main parts of the human body?

_____
_____
_____

3. Describe the parts of the trunk, the upper and lower extremities.

_____
_____
_____
_____
_____
_____

4. Describe the parts of the head.

_____
_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT END OF TOPIC 1.

Answer to Activities

A.

a. Cells are the smallest and simplest unit of living matter that can maintain life and reproduce themselves
b. Tissues - a group of cells of the same type.
c. Organ - any part of the body with special job to do.
d. Organ system – are groups of organs linked together to carry out important jobs or functions.

B. Humans belong to a group of animals called mammals. They have a backbone, hair on the body and produce milk for their young. Babies are born alive and are looked after by their parents for a long time.

Humans are said to be the most highly developed of all animals. They are able to do many things that other animals cannot because they have developed a very complex brain and nervous system. Because of this, humans are able to read, write, talk and think.

Lesson 2: The Skeleton

From the previous lesson you have studied about the human body. You have described human as mammals and learnt its compositions. You also studied its different internal structures, parts and functions. For this lesson you will study the human skeleton.

Your Aims:

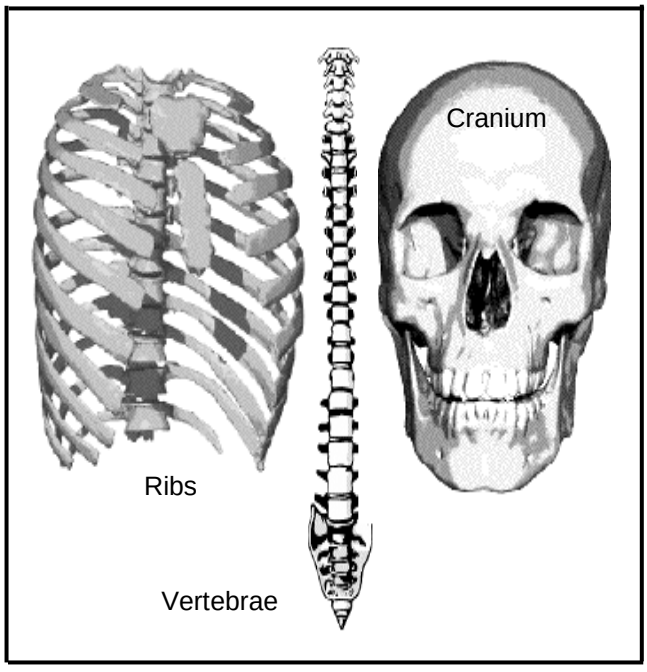
- define skeleton
- identify the parts and functions of human skeleton
- enumerate and describe vertebrate and invertebrate animals

What is a Skeleton?

A skeleton is the flexible inner framework of our body made of bone and cartilage. Bones are the hard material of a skeleton. A human skeleton generally forms about 206 separate bones out of cartilage as it develops to maturity.

Why is skeleton important?

The main job of the skeleton is to provide and support for our body. Without your skeleton your body would collapse into a heap. Your skeleton is strong but light. Without bones you would be just a puddle of skin and guts on the floor.



The skeleton maintains a body shape, protects vital organs, and provides a system of muscle controls that allow body movement.

Skeleton contains bone marrow, the blood-forming tissues of the body. Bone marrow stores needed minerals such as calcium and phosphorus and releases them into the blood.

Your skeleton also helps protect your internal organs that include brain, eyes, heart, lungs and spinal cord. Your cranium (skull) protects your brain and eyes, the ribs protect your heart and lungs and your vertebrae (spine, backbones) protect your spinal cord.

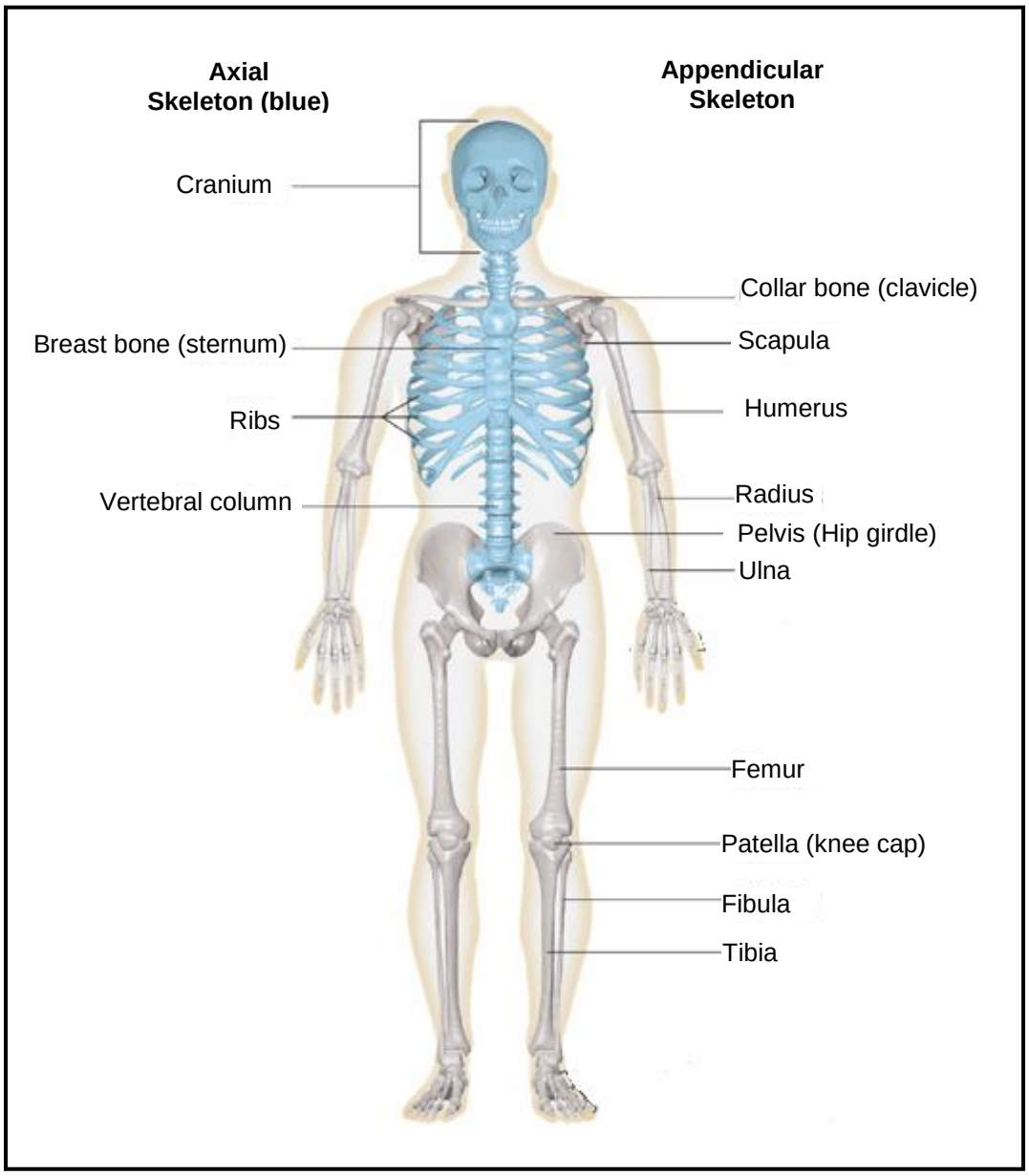
Divisions of the skeleton

The human skeleton is divided into two distinct parts; **axial** and **appendicular**.

The **axial skeleton** consists of bones that form the axis of the body and support and protect the organs of the head, neck, and trunk. This includes the skull, sternum, ribs and vertebral column.

The **appendicular skeleton** is composed of bones that anchor the appendages to the axial skeleton. This includes arms, hand, legs, feet, shoulder girdle and pelvic girdle.

The picture below shows the human skeleton with its different parts.



Parts of human skeleton

Parts and functions of human skeleton

Cranium is the box formed by bones of the skull. It encloses and protects the brain from damage and the other organs of sight, hearing and balance.

Collar bone supports the upper arm and scapula. It also serves to protect several important blood vessels and nerves that pass below the bone and travel into the arm.

Scapula is the movable bone to which most of the shoulder muscles are attached. It is attached to the back by other muscles. It serves as a broad plate for the strong anchoring of muscles of the upper arm.

Breast bone is a flat and an important bone due to its location; it protects the essential organs of the body, such as the heart, the lungs and the air passages.

The humerus bone serves as a connection between the scapula and the elbow, where it links to the two lower arm bones. It acts as an attachment site for the muscles around it.

The ribs or rib cage play a role in protecting the internal organs from damage particularly the heart and lungs, and also help you to breathe because it expands and contracts, thereby inflating and deflating the lungs.

The vertebral column support for the body's frame, keeping it standing upright. It connects the head to the rest of the body. It serves as protection for the spinal cord. The bony rings surround the sensitive spinal canal transmits the body's electrical transmissions from the brain to the rest of the body.

The pelvis, or pelvic girdle, is a muscle, bone, and connective tissue structure that provides a foundation for the legs and also supports a portion of the abdominal and pelvic cavities. It also helps to protect the bladder, the reproductive organs, and other visceral organs in the lower abdominal and pelvic regions.

The **radius** is the shorter of the two long bones of the lower arm that extends from the elbow to the wrist, and is the bone on the thumb side of the arm. It has a pivot joint at both ends and rotates over the ulna and enables the hand to rotate and be flexible.

The ulna is also located in the lower arm. The functions of the ulna include supporting movement of the hands and arms, creating insertion points for muscles, producing blood cells in bone marrow, and storing some minerals, such as calcium and phosphorus.

Femur is the thigh bone and it is the longest, heaviest, and strongest bone in the entire human body. All of the body's weight is supported by the femurs during many activities, such as running, jumping, walking, and standing. It also forms an attachment sight for the muscles that act to move the thigh and the knee joint.

The patella is the thick circular-triangular bone that forms the kneecap. It lies in front of the "knee-joint" between the femur and the tibia. The functions of the patella include increasing the force of the tendon of the large muscle in front of the thigh; maintaining the position of the tendon when the knee is flexed; and protecting the knee joint.

The fibula is an attachment point for muscles, located to the side of the tibia and between the patella and ankle. It is important because without a fibula we would have very short legs and it would be harder to walk.

Tibia is a bone in the lower leg that connects to the fibula and provides movement of the legs. The tibia makes your inner 'ankle' bone while the fibula is what makes your outer ankle bone. The main job of the tibia is to form a hinge joint with the femur, which allows you to walk, run, kick a ball, and generally have fun.

The skeleton supports and, or protects the softer body parts of a fish, bird, or human. These animals are called **vertebrates**. They all have a backbone. We are vertebrates and have a skeleton to keep us upright and to help us move.

What are vertebrates and invertebrates animals?
The animal kingdom is made up of 2 main groups.

ANIMALS WITH BACKBONES	ANIMALS WITHOUT BACKBONES
Animals with backbones are called **vertebrates**.	Animals without backbones are called **invertebrates**.
Some vertebrates are mammals, birds, reptiles, amphibians and fish	Some invertebrates are molluscs, worms, arthropods, echinoderms and coelenterates

---

Activity: **Now test yourself by doing this activity.**

Part A. **Circle the letter of the correct answer.**

1. How many bones are there in the skeletal system of the human body?

   A. 206 B. 256

   C. 306 D. 356

2. In the skeletal system, where would you find ulna and radius?

   A. Skull B. Humerus

   C. Lower arm D. Lower leg

3. Which of the following is formed from a group of bones that fused together in childhood?

   A. Pelvis B. Cranium

   C. Sternum D. Scapula

4. What is the longest bone in the human body?

A. Femur B. Fibula

C. Radius D. Humerus

5. The purpose of the rib cage is to protect the

A. stomach B. spinal cord

C. heart and lungs D. oesophagus and lungs

6. How many pair of ribs does a human have?

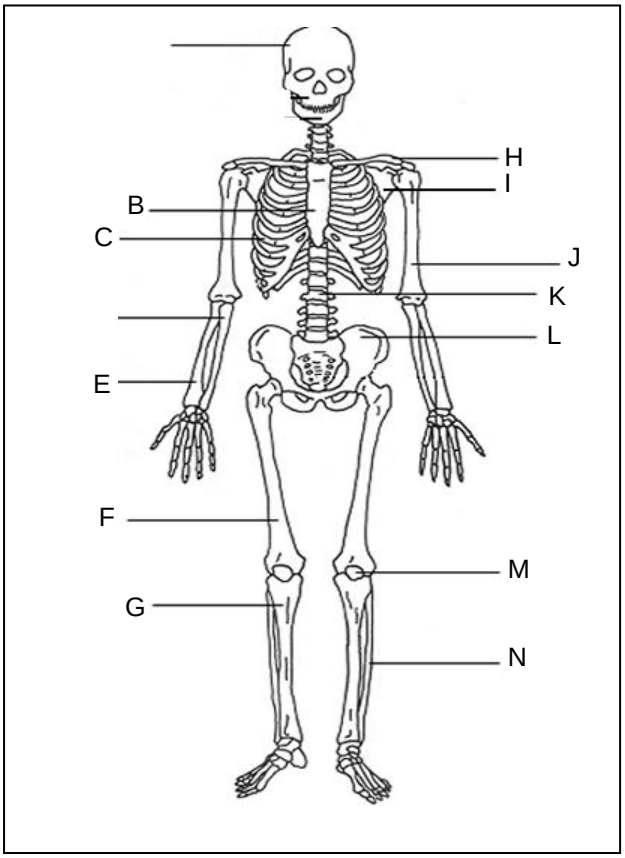
A. 8 B. 12

C. 14 D. 16

7. What is the skeletal system?

A. All the bones in the body
B. All the muscles and tendons
C. All the body's organs, both soft and hard tissue
D. All the bones in the body and the tissues that connect them

Part B. Identify the parts of the human skeleton.



Part C. Give the functions of the following.

1. Cranium

_____
_____
_____

2. Ribs or rib cage

_____
_____
_____

3. Vertebral column

_____
_____
_____

4. Humerus

_____
_____
_____

5. Femur

_____
_____
_____

CHECK YOUR WORK.ANSWERS ARE AT THE END OF LESSON 2.

Summary

You have come to the end of lesson 2. In this lesson you have learnt that:

- a skeleton is the flexible inner framework of our body made of bone and cartilage.
- the main job of the skeleton is to provide support for our body.
- the human skeleton is divided into two distinct parts; axial and appendicular.
- cranium is the box that encloses and protects the brain from damage and the other organs of sight, hearing and balance.
- collar bone supports the upper arm and scapula.
- scapula is the movable bone to which most of the shoulder muscles are attached.
- breast bone protects the vital organs of the body, such as the heart, the lungs, and the air passages.
- the humerus bone serves as a connection between the scapula and the elbow, where it links to the two lower arm bones.
- the ribs play a role in protecting the internal organs particularly the heart and lungs.
- the vertebral column support for the body's frame, keeping it standing upright. It connects the head to the rest of the body.
- the pelvis is a muscle, bone, and connective tissue structure that provides a foundation for the legs and also supports a portion of the abdominal and pelvic regions.
- the radius is the shorter of the two long bones of the lower arm that extends from the elbow to the wrist, and is the bone on the thumb side of the arm. It has a pivot joint at both ends and rotates over the ulna and enables the hand to rotate and be flexible.
- the ulna is also located in the lower arm. The functions of the ulna include supporting movement of the hands and arms, creating insertion points for muscles, producing blood cells in bone marrow, and storing some minerals, such as calcium and phosphorus.
- femur is the thigh bone and it is the longest, heaviest, and strongest bone in the entire human body. All of the body's weight is supported by the femurs during many activities, such as running, jumping, walking, and standing
- the patella is the thick circular-triangular bone that forms the kneecap.
- the fibula is an attachment point for muscles, located to the side of the tibia and between the patella and ankle.
- tibia is a bone in the lower leg that connects to the fibula and provides movement of the legs.
- animals with backbones are called vertebrates. Some vertebrates are mammals, birds, reptiles, amphibians and fish.
- animals without backbones are called invertebrates. Some invertebrates are molluscs, worms, arthropods, echinoderms and coelenterates.

NOW DO PRACTICE EXERCISE 2 ON THE NEXT PAGE.

Practice Exercise 2

Answer the following questions:

A. Define skeleton.

_____

_____

B. Match Column **A** with Column **B**
Write the letters only.

	Column A
1.	This is a bone in the forelimb that connects to the Fibula and provides movement of the legs.
2.	Animals with backbones
3.	This bone protects the vital organs of the body, such as the heart, the lungs, and the air ways.
4.	This is the bone of the forearm that extends from the lateral side of the elbow to the thumb side of the wrist.
5.	This is the lens-shaped "triangular" bone that forms the kneecap.
6.	This is the movable bone to which most of the shoulder muscles are attached.
7.	This bone is located in the lower arm and supports the movement of the hands.
8.	This is an attachment point for muscles, located to the side of the tibia and between the patella and ankle.
9.	This bone supports the upper arm and scapula.
10.	This is a muscle, bone, and connective tissue structure that provides a foundation for the legs.

	Column B
A	Patella
B	Ulna
C	Fibula
D	Pelvis
E	Scapula
F	Collar bone
G	Vertebrates
H	Tibia
I	Radius
J	Breast bone

C. Differentiate vertebrate from invertebrate animals and give examples.

_____
_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activities

A.

1.	A	4.	A	7.	D
2.	C	5.	C		
3.	B	6.	B		

B.

A.	Cranium	H.	Collar bone (clavicle)
B.	Breast bone (sternum)	I.	Scapula (shoulder blade)
C.	Rib	J.	Humerus
D.	Ulna	K.	Vertebral column
E.	Radius	L.	Pelvis
F.	Femur	M.	Patella (knee cap)
G.	Tibia	N.	Fibula

C.

1. Cranium is the box that encloses and protects the brain from trauma and the other organs of sight, hearing and balance.
2. The ribs play a role in protecting the internal organs particularly the heart and lungs.
3. The vertebral column support for the body's frame, keeping it standing upright. It connects the head to the rest of the body.
4. The humerus bone serves as a connection between the scapula and the elbow, where it links to the two lower arm bones.
5. Femur is the thigh bone and it is one of the biggest bones of the human body. All of the body's weight is supported by the femurs during many activities, such as running, jumping, walking, and standing.

Lesson 3: Cartilage and Bones

From the previous lesson you have studied about skeleton. You have described human skeleton and identified its different parts and functions. You also studied and described the difference between vertebrate and invertebrate animals. For this lesson you will study the human bones and cartilage.

Your Aims:

- define cartilage, bones and fracture
- explain how bones are formed
- explain how broken bones mend
- explain the different types of fractures

What is a Cartilage?

Cartilage is usually found in close association with bone in the body. It is a strong, flexible type of connective tissue found within a body. Cartilage is connective tissue that is less rigid than bone and less flexible than muscles.

The ground substance of cartilage consists mainly of protein material and cells and is covered by a dense fibrous membrane. No nerves or blood vessels are found in cartilage.

In mammal embryos, the skeleton first forms as cartilage tissue. Cartilage acts as a model and is gradually replaced by bone as the embryo grows. Such cartilage is known as **temporary cartilage**.

The process by which bone tissue follows the cartilage model and slowly replaces it, is known as **ossification**. It takes about 25 years for ossification to be completed.

Cartilage does not become ossified is known as **permanent cartilage** which is found in the tip of the nose, in the external ear and in the walls of the trachea and the larynx.

What are Bones?

You have learnt from the previous lesson that the skeleton of our body is made up of different types of bones. Bone is the main component of the skeleton in the adult human.

Like cartilage, bone is a specialised form of dense connective tissue. Bone gives the skeleton the necessary rigidity to function as attachment and lever for muscles and supports the body against gravity.

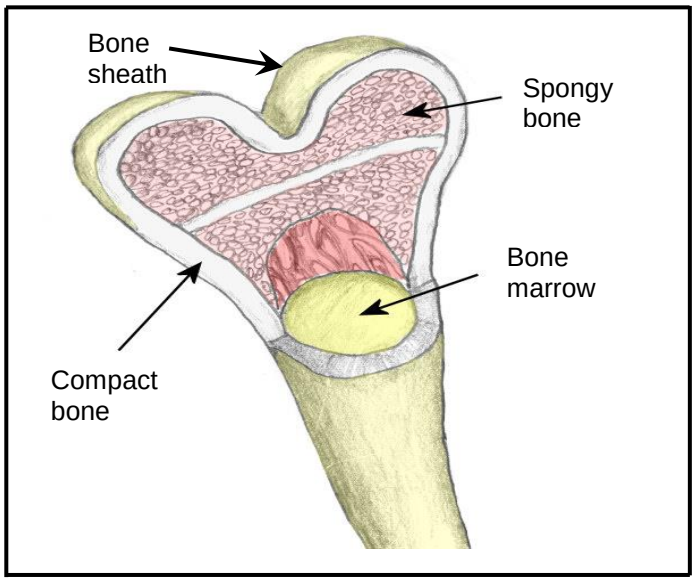
Diagram showing the cartilage and bone

What are the major functions of bones?

- Allow you to move and store important mineral
- Support your body against the constant pull of gravity
- Provide a strong barrier that protects the inner organs
- Produce blood cells (the marrow inside of bones produce blood cells)

What are bones made of?

If you have ever seen a real skeleton or fossil, you might think that all bones are dead. Although bones are dry, hard, or crumbly, the bones in your body are different. The bones that make up your skeleton are all very much alive, growing and changing all the time like other parts of your body. Almost every bone in your body is made of the same materials.



Bone structure

Bones are made of two types of tissue: **spongy** bone and **compact** bone.

- **Spongy bone** consists of delicate bars and sheets of bone which branch and intersects to form a sponge like network. It is lighter and less dense than compact bone. Within the compact bone are many layers which look a bit like a sponge. This is called a spongy bone. It is not quite as hard as compact bone, but it is still very strong. It gives extra strength to the bone without adding too much weight.

- **Compact or hard bone** has a hard outer layer and does not have any spaces or hollows in the bone that is visible to the eye. Compact bone forms the thick-walled tube of the shaft of long bones, which surrounds the marrow cavity. This part is smooth and very hard. It is the part you see when you look at a skeleton. It provides all the strength the bone needs.

Bone sheath

The outer surface of bone is called the bone sheath. It is a thin, dense membrane that contains nerves and blood vessels that nourish the bone. It makes new cells when bone breaks.

Bone marrow

In many bones, the spongy bone protects the innermost part of the bone, the bone marrow. Bone marrow is sort of like a thick jelly that fills the inside hollow of the large bone. Its main function is to make red blood cells. Blood vessels pick up these newly made red cells and carry them throughout the body.

How bones grow?

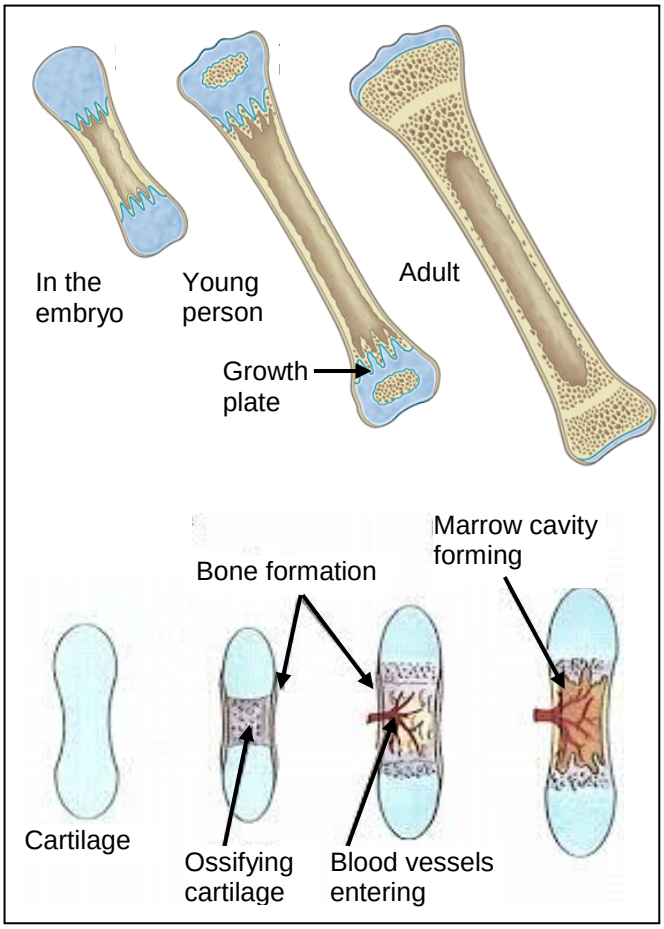
When you were a baby, you had tiny hands, tiny feet, and tiny everything. Slowly, as you grew older, everything became a bit bigger, including your bones.

A baby's body has about 300 bones at birth. These eventually grow together to form the 206 bones that adults have.

Some of a baby's bones are made entirely of a special material called cartilage.This cartilage is soft and flexible.

During childhood, as you are growing, the cartilage grows and is slowly replaced by bone, with the help from calcium. By the time you are about 25, this process will be complete.

After this happens there can be no more growth — the bones are as big as they will ever be. All of these bones make up a skeleton that is both very strong and very light.



The growth of long bones

What is a fracture?

Sometimes, too much pressure is applied to a bone that results in what is known as a fracture. A break in a bone is called a **fracture**. Fractures are more common in adults, especially aged people than children. The bones of the children are soft and resilient in nature while the adults have the bones much fragile which can receive fracture under certain conditions.

Fractures are commonly caused by a fall from a height or strike from an object, motor accidents, by twisting or bending of the bone or repetitive forces on the bone because of physical activities like running or weightlifting.

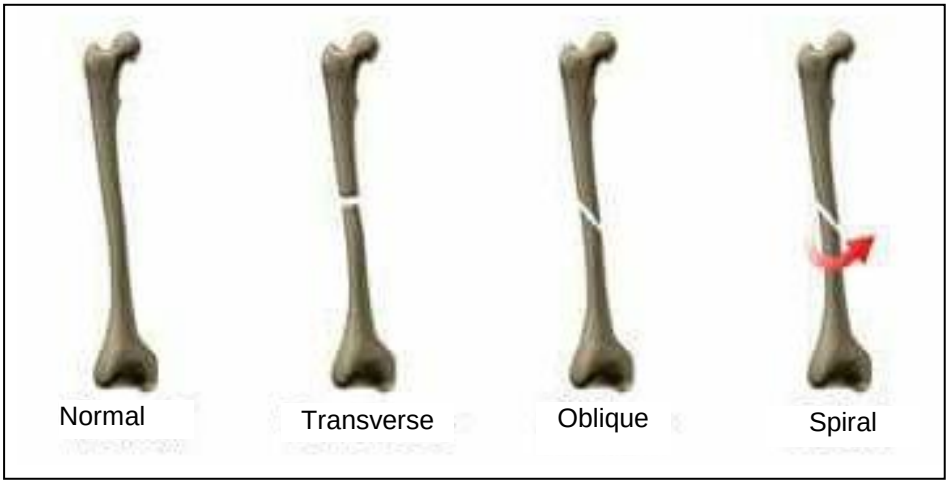
What are the main types of fracture?

A break can be complete or incomplete. When the bone is broken into pieces, doctors refer to it as a **complete fracture**. When the bone is only cracked or partially broken, doctors refer to it as an **incomplete fracture**.

There are so many different types of fractures characterized by their nature and intensity of damage done. Some of the different types of fractures are given below:

Simple fracture

A simple fracture is a complete fracture where the bone is broken into two fragments. This is a fracture in which the broken bones do not pierce the skin. This break can be transverse (which means straight across the bone), oblique (which means at an angle) and spiral (which means an angle that is twisted). Simple fractures are usually treated with immobilization with a cast or sometimes with pins, screws, and plates.



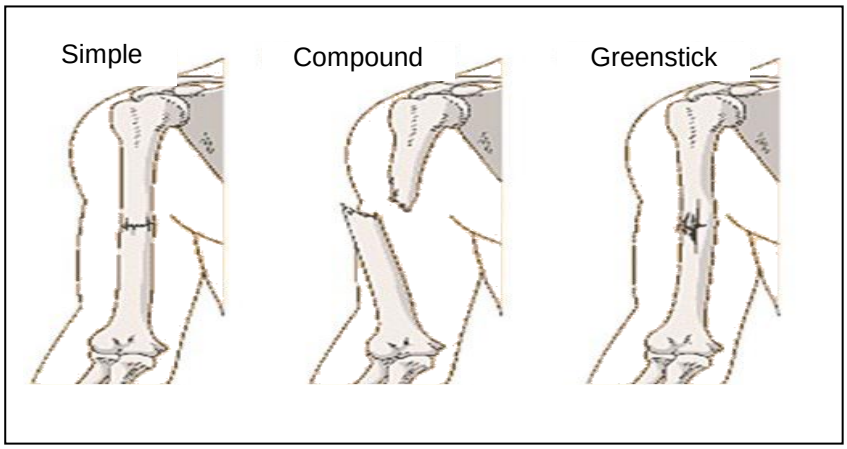
Simple fractures

Compound fracture

When bone breaks and penetrates through the skin it is known as a compound fracture. Compound fractures are usually caused by high impact injuries like sports injuries, heavy falls, car crashes, and so on. This is generally considered to be a more serious form of fracture, since it requires immediate treatment. Usually, an operation is required to quickly cleanse the area and realign the bone. In addition, because of the higher chances of infection, a compound fracture is more difficult to heal. It is important to seek early treatment. Emergency treatment generally involves the administration of antibiotics, the fracture site being cleansed, and the broken bones stabilized.

Greenstick Fracture

A child's bones are softer and more flexible than those of an adult, so they are more likely to bend than to break completely. This flexibility can result in a greenstick fracture. A greenstick fracture is an incomplete fracture wherein the bone cracks but does not break all the way through, like when you try to break a green stick of wood. Only one side of the bone breaks causing the bone to bend. A greenstick fracture can be difficult to diagnose, because it may not cause all the classic signs and symptoms of a broken bone. Greenstick fractures are usually treated by immobilization with a cast to allow it to mend so that the bone will grow back properly.



Types of bone fractures

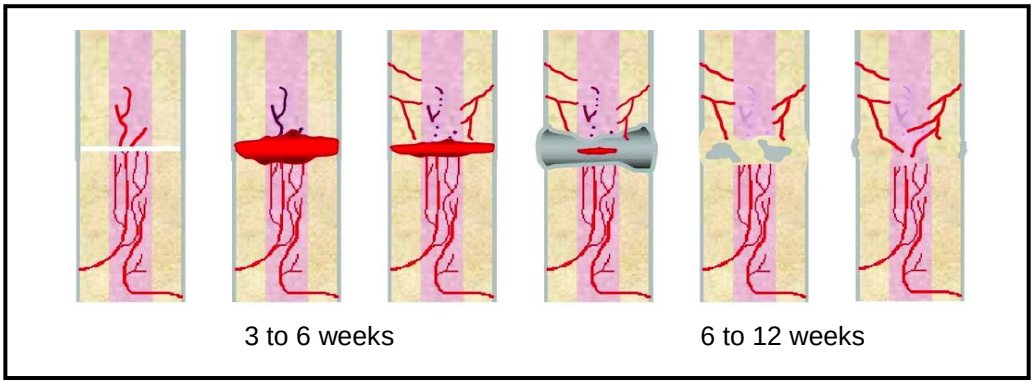
How do broken bones mend?

An amazing thing about bones is that they can mend themselves when they break. Bones can do this because they contain living cells that can grow, repair and replace themselves, and produce new bones. So, when a bone breaks, all that is needed is to hold the broken parts together. This is usually done with a plaster cast. The bone will begin to mend all by itself while in the cast as shown below.

Arm and neck on a plaster cast

Foot on a plaster cast

When a bone breaks, blood leaks out of the torn blood vessels on the surface of the bone. It forms a clot of solidified blood between the broken ends of the bone. Within a week, the cells in the bone sheath on the surface of the bone multiply to form new bone cells. By three to six weeks (3 – 6), the broken ends of the bone are joined by young bone. The young bone is replaced by stronger mature bone. After six to twelve weeks (6 – 12), the bone can be used again. Over the next year, the bone gradually regains its smooth outline in children. A slight bumps remains in adults.



Activity: **Now test yourself by doing this activity.**

Circle the letter of the correct answer.

1. Which of the following statements is false?

   A. Bone is a dry and a non-living tissue.
   B. Bone acts as a store house for minerals.
   C. Bone is where most white blood cells are made.
   D. Bone protects and supports the body and its organs.

2. What makes bones so strong?

   A. Silica
   B. Calcium
   C. Cartilage
   D. Blood and marrow

3. What is the difference between bone and cartilage?

   A. Bone is rubbery and cartilage is firm
   B. Cartilage is rubbery and bone is firm
   C. Bone is more primitive tissue than cartilage
   D. Bone is inside the body and cartilage is outside

4. The hollow space in the middle of bones is filled with

   A. air. B. blood.
   C. bone cells. D. bone marrow.

5. What is the difference between a compact bone and spongy bone?

   A. They have different bone marrow.
   B. They are made of different materials.
   C. They have different sizes of bone cells.
   D. They have different arrangement of bone cells.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 3.

Summary

You have come to the end of lesson 3. In this lesson you have learnt that:

- cartilage is a type of connective tissue which is tough, semi-transparent, elastic and flexible. No nerves or blood vessels are found in cartilage.
- bone is a specialised form of dense connective tissue and main component of the skeleton in the adult human. It gives the skeleton the necessary rigidity to function as attachment and lever for muscles and supports the body against gravity.
- spongy bone consists of delicate bars and sheets of bone which branch and intersects to form a sponge like network. It is lighter and less dense than compact bone.
- compact bone has a hard outer layer and does not have any spaces or hollows in the bone that is visible to the eye. Compact bone forms the thick-walled tube of the shaft of long bones, which surrounds the marrow cavity.
- bone sheath is the outer surface of the bone. It is a thin, dense membrane that contains nerves and blood vessels that nourish the bone. It makes new cells when bone breaks.
- bone marrow is sort of like a thick jelly that fills the inside hollow of the large bone. Its main function is to make red blood cells. Blood vessels pick up these newly made red cells and carry them throughout the body.
- a break in a bone is called a fracture. A break can be complete or incomplete. Fractures are commonly caused by a fall from a height or strike from an object or repetitive forces on the bone because of physical activities like running or weightlifting.
- a simple fracture is a complete fracture where the bone is broken into two fragments and the broken bones do not pierce the skin.
- when bone breaks and penetrates through the skin it is known as a compound fracture. Usually, an operation is required to quickly cleanse the area and realign the bone. In addition, because of the higher chances of infection, a compound fracture is more difficult to heal.
- a greenstick fracture is an incomplete fracture wherein the bone cracks but does not break all the way through, only one side of the bone breaks causing the bone to bend.
- bones can mend themselves when they break. Bones can do this because they contain living cells that can grow, repair and replace themselves, and produce new bones.

NOW DO PRACTICE EXERCISE 3 ON THE NEXT PAGE.

Practice Exercise 3

Answer the following questions:

1. Define the following.

   a. Cartilage

   _____
   _____

   b. Bones

   _____
   _____

   c. Fracture

   _____
   _____

2. Explain how bones formed.

   _____
   _____
   _____

3. Explain the different types of fractures.

   a. Simple fracture

   _____
   _____

   b. Compound fracture

   _____
   _____

   c. A greenstick fracture

   _____
   _____

4. Explain how broken bones mend.

   _____
   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity

1. A
2. B
3. D
4. D
5. C

Lesson 4: Joints

From the previous lesson you have studied about bones and cartilage. You have described bones and its different parts and functions. You also studied and described how bones formed and mend. For this lesson you will study the human joints.

Your Aims:

- define joints and ligaments
- describe the types of joints
- identify common joint injuries

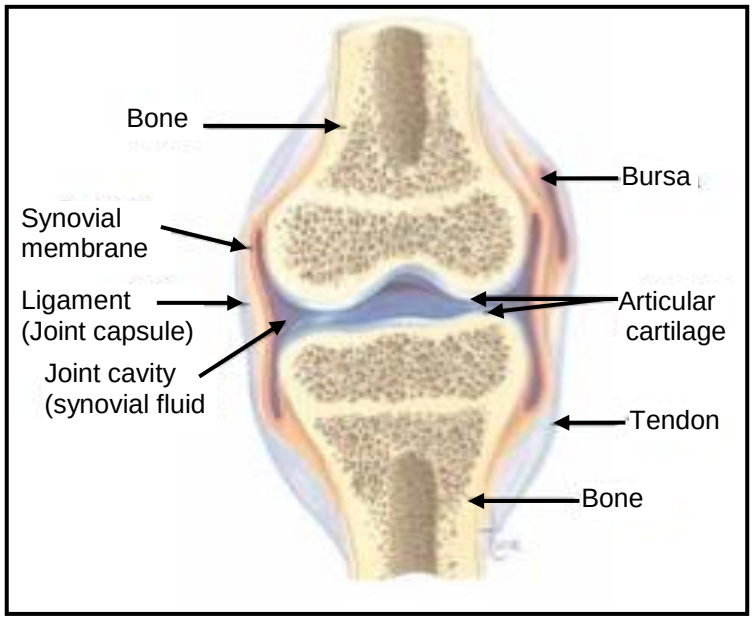
What is a Joint?

You know that an adult has 206 bones in his body. Bones are stiff and hard. They are held together by connective tissue. Our bodies move because of joints. A **joint** is the location where two or more bones meet. At a joint, bones do not directly come in contact with one other, but are connected and cushioned by tissues and fluid.

Parts of joints and their functions

Joints are constructed to allow movement and provide support, and are classified structurally and functionally. Joints consist of the following:

1. **Synovial membrane or synovial sac**
   Around each joint is the synovial sac which protects the joint and also secretes the synovial fluid. Synovial fluid serves to protect the joint, lubricate the joint and provide nourishment to the articular cartilage.
2. **Bursa**
   A bursa is a small sac that is not part of the joint but is near the joint. It contains a fluid that lubricates the movement of muscles as the muscle moves across muscle or as the muscle moves across bone. In some ways it is similar to the synovial sac.
3. **Muscle**
   Muscles are elastic tissues that have the ability to change length. By becoming shorter and longer, muscles allow for motion at the joints.
4. **Tendon**
   Tendons are fibrous connective tissues that attach muscles to the bones. Unlike muscles which change length (contract), the tendons are unable to change length. However, as the muscle moves, the tendon to which it is attached also moves. You can feel the tendons on the back of your hand or in the back of your knee.
5. **Articular cartilage**
   The end of each bone is covered with articular cartilage. This is a tough material that cushions and protects the ends of the bones. When it degenerates, arthritis develops.



Structure of a synovial joint

6. **Ligament**
Ligaments are tough band of white, fibrous and connective tissue that attach from bone to bone. Typically, ligaments are located around the joints. They provide for the stability of a joint and hold the adjacent bones in the proper alignment.

Different types of joints
There are many types of joints, including joints that do not move in adults, such as the **suture joints** in the skull. Joints that do not move are called **fixed**. Other joints may move a little, such as the vertebrae. In addition to their range of movement, joints may be classified based on the material present in them. These include **fibrous**, **cartilaginous** and **synovial**, which is the most common joint.

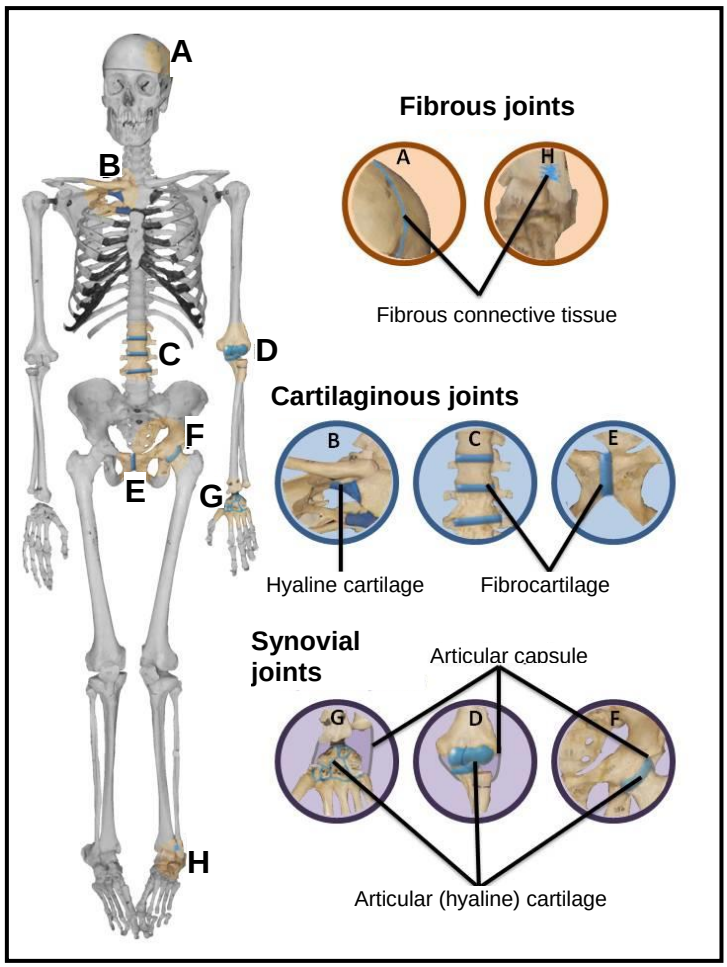
Fibrous (immoveable), Cartilaginous (partially moveable) and Synovial (freely moveable).

1. **Fibrous** - This type of joint is held together by only a ligament. Fibrous joints allow very little movement, and are composed of fibrous (dense) connective tissue. Examples are skull sutures and the connection between the tibia and fibula are fibrous joints.

2. **Cartilaginous -** Cartilaginous joints allow very little or no movement, and are characterized by a connection between adjoining bones made of cartilage. These joints occur where the connection between the articulating bones is made up of cartilage for example between vertebrae in the spine.

3. **Synovial** – These joints are by far the most common classification of joint within the human body. They are the most complex of the joint types and are highly moveable They are characterized by articular (hyaline) cartilage covering the ends of bones, a fibrous articular capsule (composed of fibrous connective tissue) lined with synovial membrane, a joint cavity containing

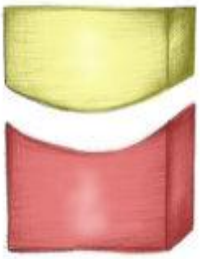
synovial fluid and reinforcing ligaments to hold the bones together. Synovial joints are found in between the bones of the limbs, and are freely movable.

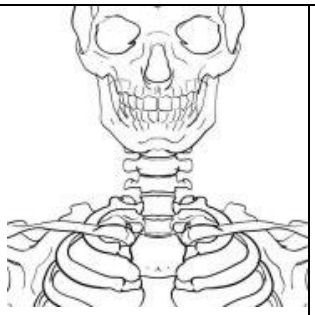
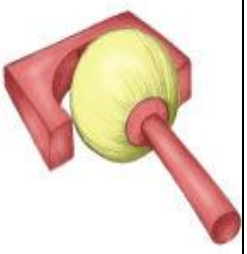
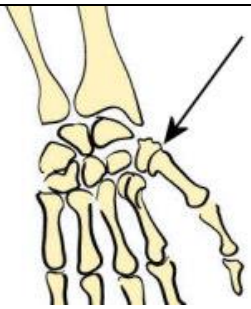
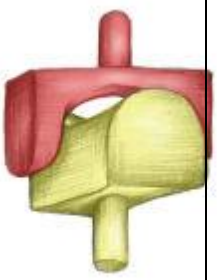


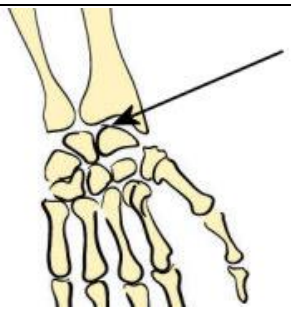
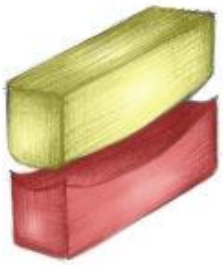
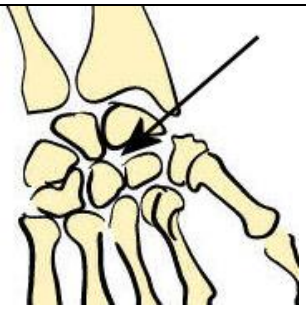
Classes of joints based on the material present in them.

There are 6 types of synovial joints which are classified by the shape of the joint and the movement available.

TYPES OF SYNOVIAL JOINTS

Joint Type	Movement of Joint	Examples	Structure
Hinge	Hinge joints connect a cylindrical bone end to a concave (indented) portion of another bone. Rotation can occur in only one plane (or axis), much like a door hinge.	 Elbow/Knee Hinge joints, such as in the fingers, knees, elbows, and toes, allow only bending and straightening movements.	 Hinge joint

Pivot	Pivot joints connect the rounded end of one bone to a ring or sheath formed by another bone. Rotation of one bone around another	 Top of the neck Such as the neck joints, allow limited rotating movements. The joint between the radius and ulna at the elbow is a pivot joint.	 Pivot Joint
Ball and Socket	Ball-and-socket joints join the spherical end of one bone to the concave, rounded socket of another bone. These joints allow movement in all axes and rotation. They are the most movable of all synovial joints	 Shoulder/Hip Shoulder and hip joints, allow backward, sideways, and rotating movements.	 Ball and socket joint
Saddle	Saddle joints are characterized by concave and convex surfaces on both articular surfaces. Saddle joints allow side to side and forwards-backwards movements, but no rotation, similarly to condyloid joints. Movement occurs in two planes.	 Joint of the thumb The joint between the carpal and metacarpal of the thumb is a saddle joint.	 Saddle joint

Condyloid	Condyloid joints fit the rounded convex articular surface of one bone into the rounded concave surface of another bone. Because both bone ends are rounded and fit closely together, condyloid joints allow side to side and forwards-backwards movements, but no rotation, similarly to saddle joints. Movement occurs in two planes.	 Wrist joints The joints of the knuckles are condyloid joints.	 Condyloid joint
Gliding	Gliding joints are found where bones meet as flat surfaces and allow for the bones to glide past one another in any direction. Gliding movements	 Intercarpal joints Gliding joints, such as the ones between the carpals of the wrist.	 Gliding joint

Types of Joints Found in the Human Body

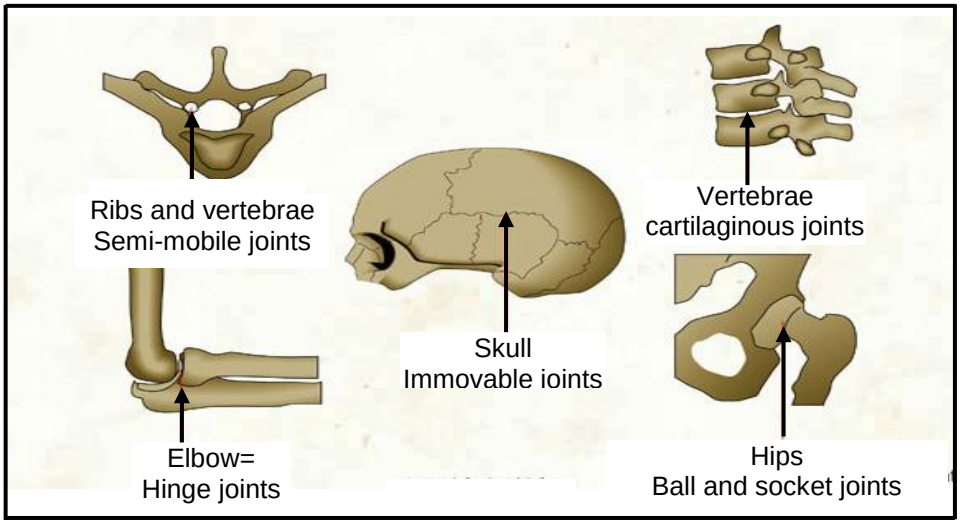
Ribs and vertebrae have semi-mobile joints. It has a very restricted flexibility. Examples: Ribs bones (thoracic cage), Vertebra (each of the bones of the spinal column).

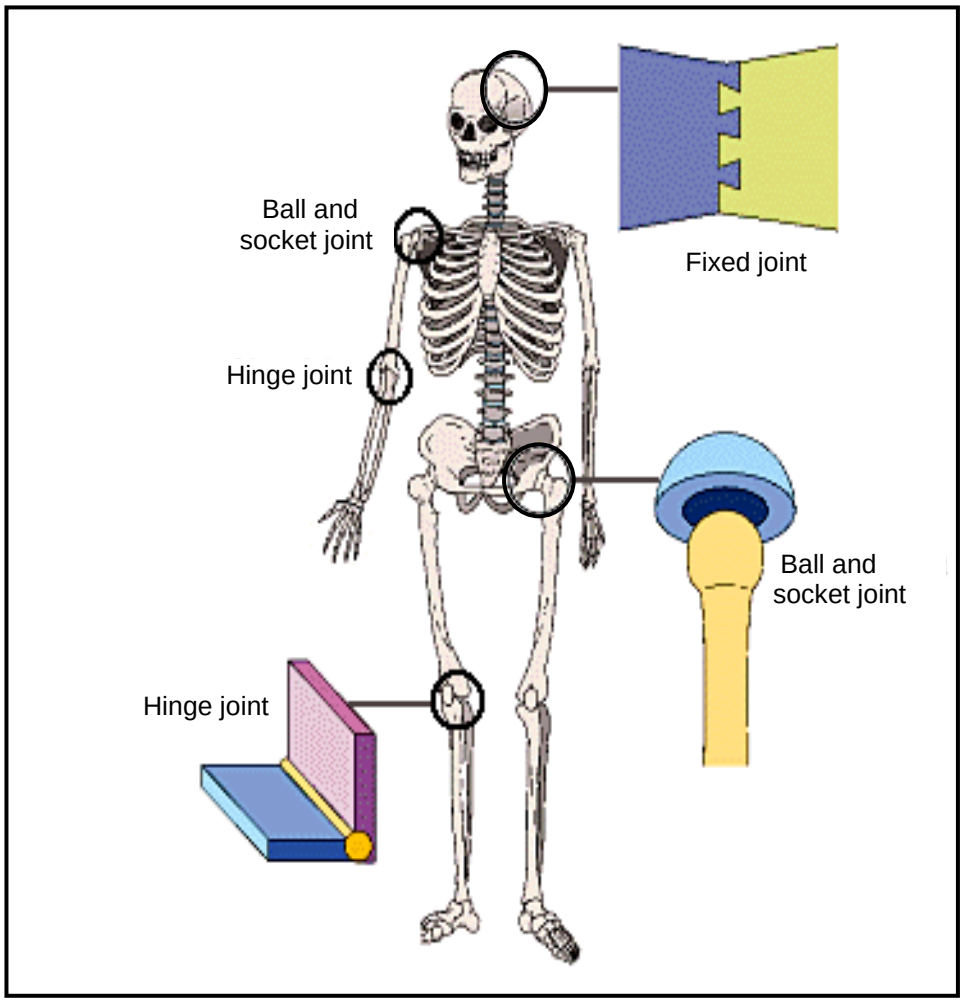
Vertebrae have cartilaginous joints. Its flexibility is due to cartilage, an elastic tissue. Examples: Each of the bones of the spinal column.

Skulls have immovable joints. It has fixed joints, meaning it does not allow flexibility. Example: Bony case of the brain.

Elbows have hinged joint. It connects the forearm to the upper arm. It is flexible in only one direction.

Hips have ball and socket joint. Hip is part on the side of the body, between the waist and the top of the thigh. Its flexibility is due to a domed bone that turns in a cavity of the same shape.

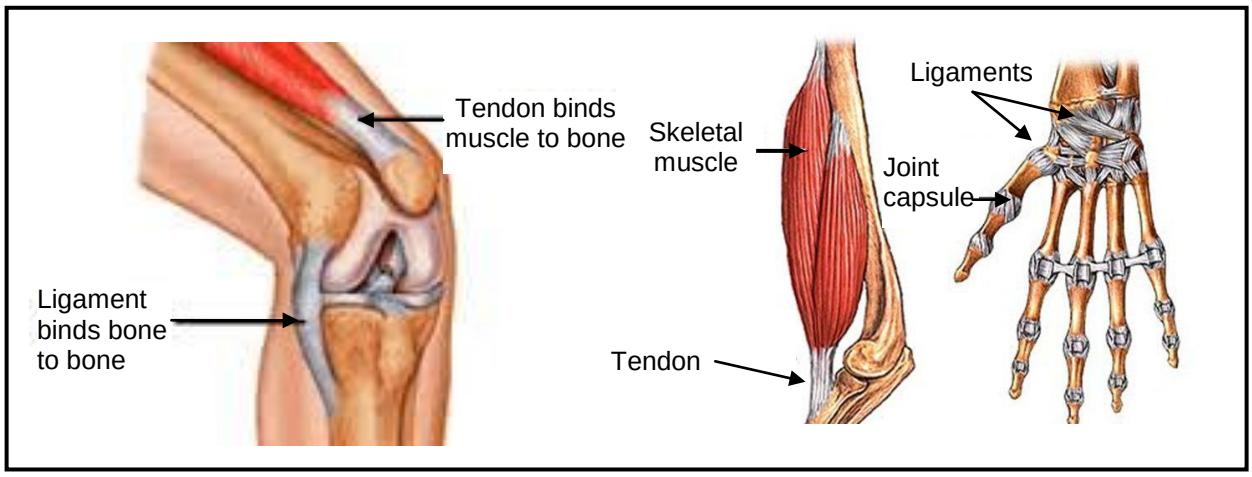




Joints found in the human body

What is Ligament?

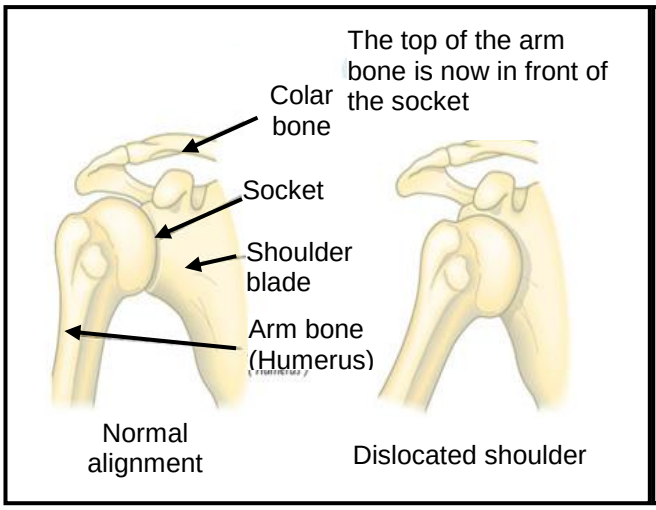
A ligament is a tough band of white, fibrous, connective tissue. This is an essential part of the skeletal joints; binding the bone ends together to prevent dislocation and excessive movement that might cause breakage. Ligaments also support many internal organs; including the **uterus***, the bladder, the liver, and the diaphragm and helps in shaping and supporting the breasts. Ligaments, especially those in the ankle joint and knee, are sometimes damaged by injury.



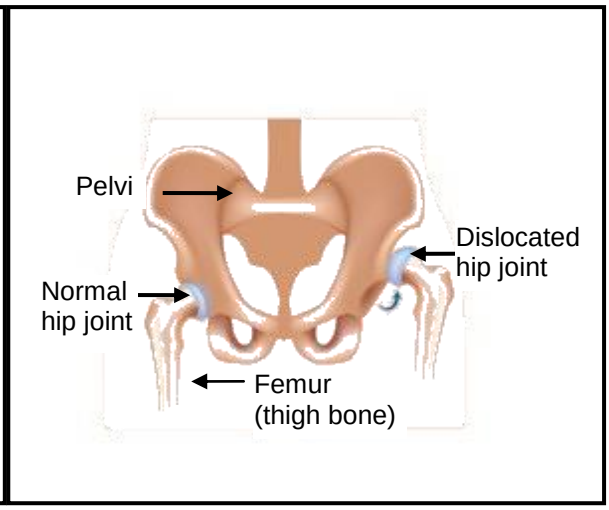
Difference between ligament and tendon

Common Joint Injuries

Dislocation of joint is the most common injury of joint. Dislocation denotes that ends of bones, which are connected with the cartilage at joint, have lost their original position. Falls is often main cause behind dislocation of joint. Usually, dislocations are serious in nature and need immediate medical treatment. Hips, Fingers, wrist, ankle and shoulder joints are the common sites where dislocation can take place.



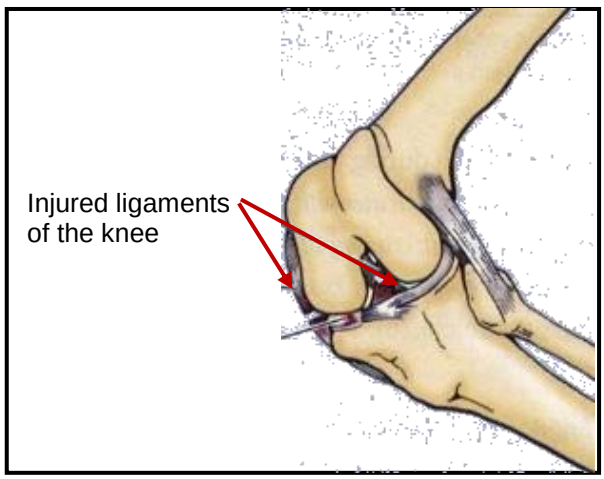
Dislocation of shoulder joint



Hip dislocation

Knee injuries

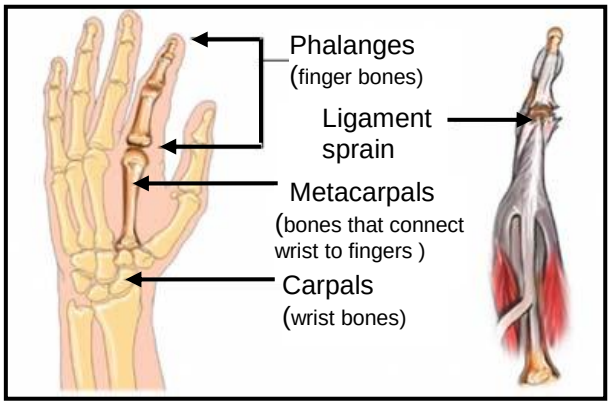
Because of its complex structure and weight-bearing capacity, the knee is the most commonly injured joint. Each year, more than 5.5 million people visit doctors for knee problems. Knee injuries can result from a blow to or twist of the knee; from improper landing after a jump; or from running too hard, too much, or without proper warm-ups.



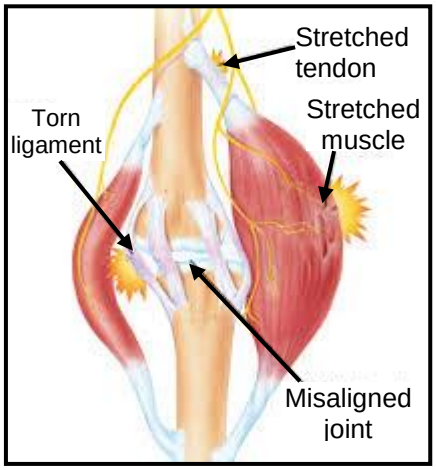
Common injury when the knee is twisted

Sprains and strains

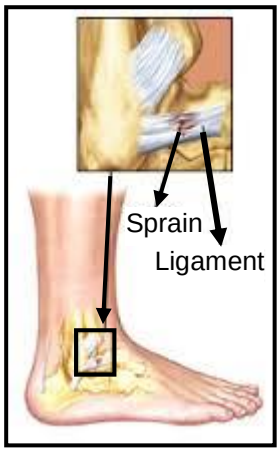
A **sprain** is a stretch or tear of a ligament, the band of connective tissues that joins the end of one bone with another. Sprains are caused by trauma such as a fall or blow to the body that knocks a joint out of position and, in the worst case, ruptures the supporting ligaments. Areas of the body most vulnerable to sprains are ankles, knees, and wrists.



Finger sprain

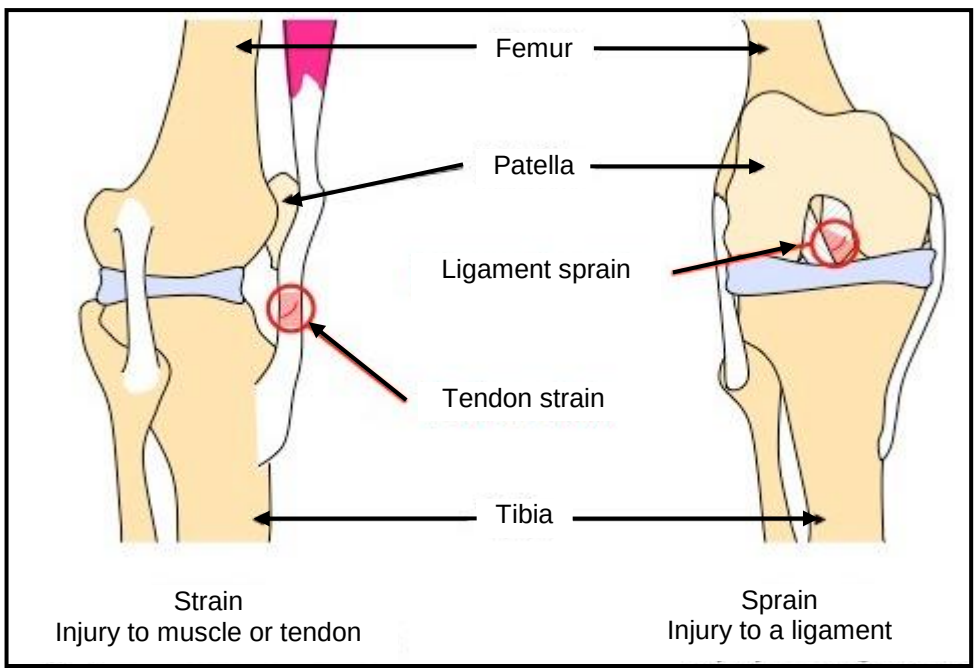


Leg strain



Ankle sprain

A **strain** is a twist, pull, or tear of a muscle or tendon, a cord of tissue connecting muscle to bone. It is an acute, no contact injury that results from overstretching or over contraction.



Strain versus sprain

Activity: **Now test yourself by doing this activity.**

Circle the letter of the correct answer.

1. Two bones are held together in a joint by _____.

   A. tendons B. muscles

   C. cartilage D. ligaments

2. Which of the following is the name for freely moving joints?

   A. Fibrous B. Osseous

   C. Synovial D. Cartilaginous

3. An example of a fibrous joint is the

   A. jaw joint. B. skull sutures.

   C. symphysis. D. shoulder joint.

4. Synovial joints are endowed by an elastic

   A. cartilage. B. ligament.

   C. joint capsule. D. synovial membrane.

5. Braces or splints used to prevent or correct deformities are called

   A. orthotics B. paediatrics

   C. orthopaedics D. prosthetics

6. What is a joint?

   A. A hinge
   B. A ball and socket
   C. The place where two bones are joined
   D. The place where tendons are fastened together

7. Which of the following are the functions of synovial fluid?

   A. Lubrication of the joint forces
   B. Absorption of shock within the joint
   C. Prevention of infection within the joint
   D. Nutrition of the cartilage within the joint

8. Which of the following are characteristics of fibrous joints?

   A. This type of joint is found in the skull.

   B. The structure of these joints is fixed early in life.

   C. The bones of the joint have a space between them.

   D. The bones of the joint are held firmly together by fibrous connective tissue.

9. The type of joint that permits the widest range of motion is called_____.

   A. pivot B. hinge

   C. gliding D. ball-and-socket

10. Which joint is naturally loose and flexible and most likely to become dislocated?

    A. Hip joint B. Knee joint

    C. Elbow joint D. Shoulder joint

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 4.

Summary

You have come to the end of lesson 4. In this lesson you have learnt that:

- a joint is the location where two or more bones meet.
- joints are constructed to allow movement and provide support, and are classified structurally and functionally.
- ligaments are tough band of white, fibrous and slightly elastic tissue that attach from bone to bone. They provide for the stability of a joint and hold the adjacent bones in the proper alignment.
- fibrous (immoveable) joint is held together by only a ligament.
- cartilaginous (partially moveable) joints occur where the connection between the articulating bones is made up of cartilage.
- synovial (freely moveable) joints are the most common classification of joint within the human body. They are highly moveable and all have a synovial capsule surrounding the entire joint, a synovial membrane which secretes synovial fluid (a lubricating liquid) and cartilage.
- dislocation of joint is the most common injury of joint. Dislocation denotes that ends of bones, which are connected with the cartilage at joint, have lost their original position.
- the knee is the most commonly injured joint.
- a sprain is a stretch or tear of a ligament, the band of connective tissues that joins the end of one bone with another.
- a strain is a twist, pull, or tear of a muscle or tendon, a cord of tissue connecting muscle to bone.

NOW DO PRACTICE EXERCISE 4 ON THE NEXT PAGE.

Practice Exercise 4

Answer the following questions:

1. Define the following.

   a. Joints

   _____

   b. Ligaments

   _____

2. Name and describe the three classifications of joints.

   _____
   _____

   _____
   _____

   _____
   _____
   _____

3. Identify and describe the common joint injuries.

   _____
   _____
   _____

   _____
   _____
   _____

   _____
   _____
   _____

   _____
   _____
   _____

4. Match the joint in the first column with the type of joint it represents.

	Column A
	Shoulder
	Elbow
	Ankle
	Thumb

	Column B
A	Saddle
B	Gliding
C	Ball-and-socket
D	Pivot
E	Hinge

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity

1.	D	4.	D	7.	A	10.	B
2.	D	5.	C	8.	A		
3.	A	6.	C	9.	D		

Lesson 5: Muscles

From the previous lesson you have studied about human joints. You have described joints and ligaments and its different classifications. You also studied and described the types of joints and the common joint injuries. For this lesson you will study the human muscles.

Your Aims:

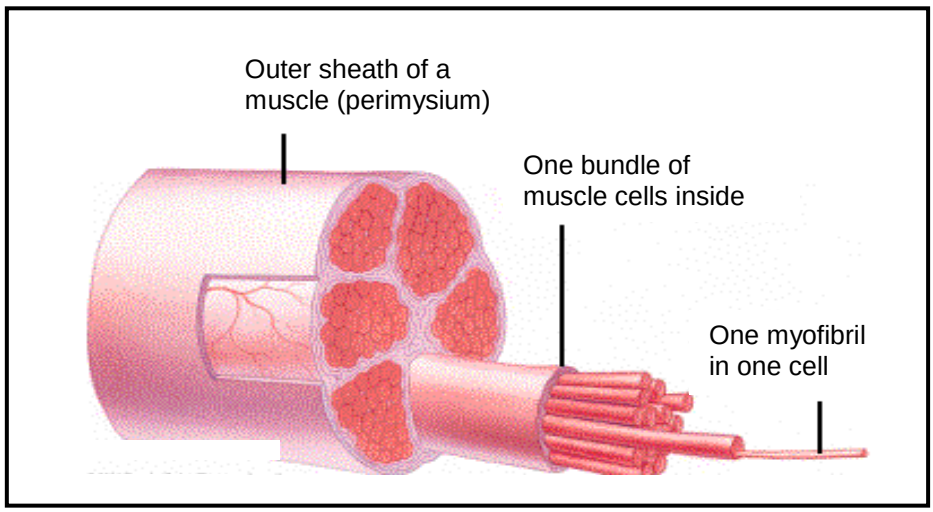
- define muscles and tendons
- identify types of muscles in the body

What are Muscles?

Muscles are the fleshy bits that move the different parts of your body, inside and outside. Muscles are made of fibres. Groups of muscle fibers are bundled together and encapsulated in connective tissue to form an entire muscle. Each bundle is wrapped in a thin skin called **perimysium** (say perry-miss-ee-um).

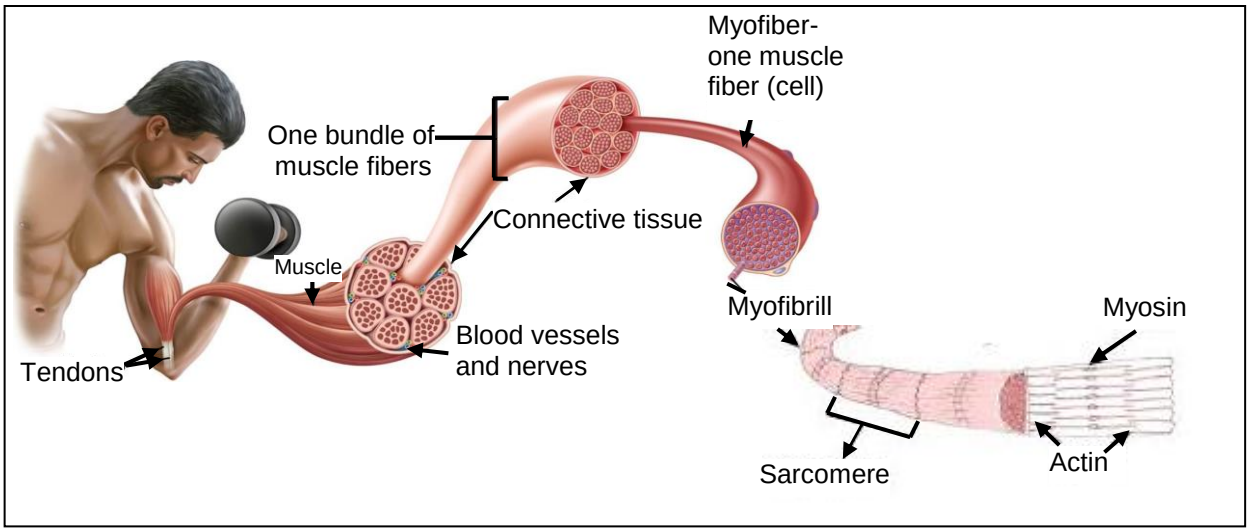
Each muscle has lots of these bundles, the bigger the muscle the more bundles of fibres it has. Inside the muscles there are nerves which carry messages to and from the brain. There are also blood vessels, which carry the energy that your muscles need and also carry away waste that your muscles have finished with. If you eat meat you will know what a muscle looks like, because red meat is muscles of the animal.

An individual muscle fiber may also be called a **myofiber** or a muscle cell. Each muscle fiber is a single, narrow cell that spans the entire length of a muscle. Each myofiber is surrounded by a membrane called a **sarcolemma**. Myofibers are composed mostly of cylindrical bundles of proteins called **myofibrils.**



A muscle is made up of **muscle cells**. A muscle fiber or **myofiber** is a single muscle cell. Each fiber contains **myofibrils.**

There are two different types of protein filaments found in each myofibril, **actin** and **myosin**. When these filaments slide past one another, the muscle contracts.



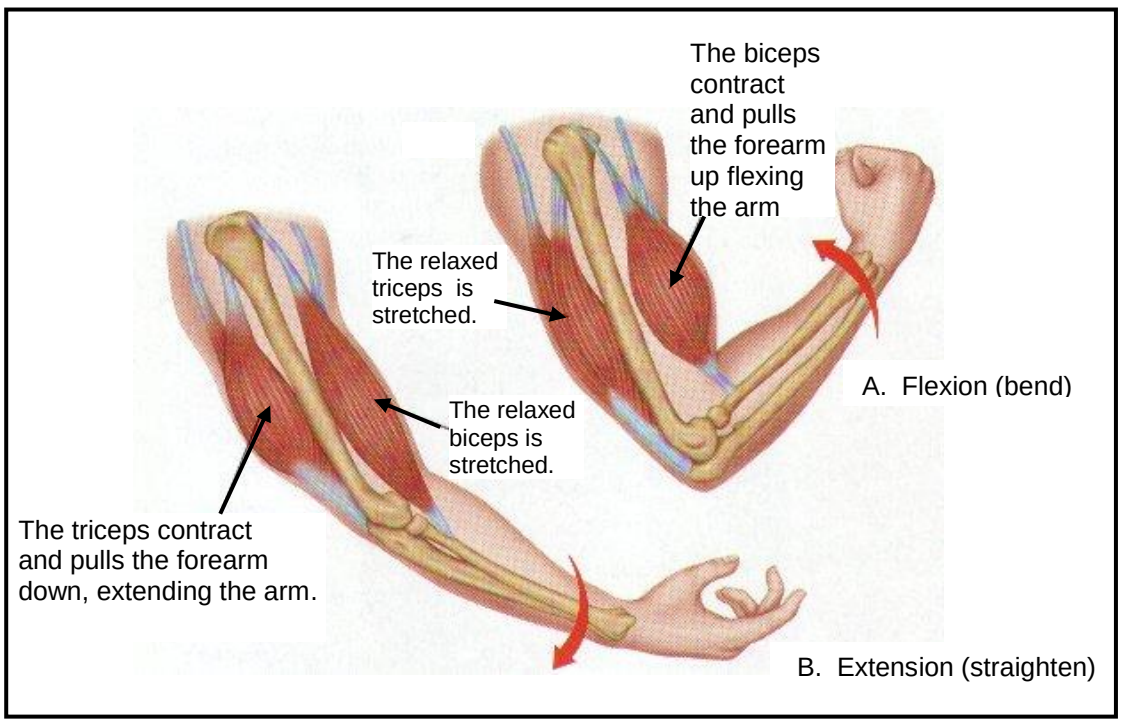
Structure of Muscle

How do muscles move?

Muscles move the body by contracting and relaxing.

- **Contracting** means becoming shorter. The muscle fibres slide together and stack up to make a fatter shape, a bit like when you shuffle a pack of cards together.
- **Relaxing** means the fibres slide apart and the muscle gets longer and thinner.

Muscles act together in pairs. This means that as one muscle contracts, its partner relaxes. Then as the partner muscle contracts the first muscle relaxes again. The messages sent by the brain are contract or relax. The brain sends the messages to one muscle partner and to other at the same time. For example is your arm movement. By contracting and relaxing the, triceps and biceps muscles in the upper arm enable you to bend or straighten your elbow as shown below.



Action of the triceps and biceps muscles during flexion and extension

Voluntary and Involuntary Muscles

Voluntary muscles

A voluntary muscle is when you consciously choose to move a muscle, for example. like pointing a finger or holding a glass. It is your voluntary muscles which move your arms, legs and body around. But they cannot do that unless your brain sends the right muscles the messages to 'contract' or 'relax'.

Pointing a finger Holding a glass

Skeletal muscles are voluntary. Its activity can be consciously controlled by our bodies because those are the bones that allow us to move our muscles and bones when we want for example, when we want to walk, jump run and swim.

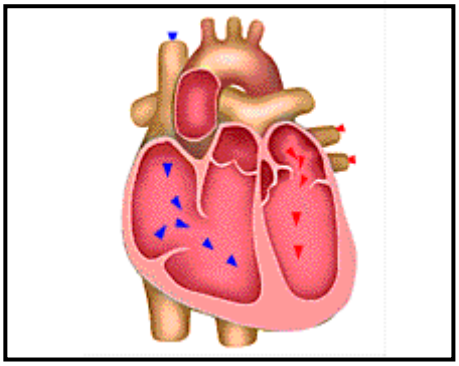
Walking Jumping Running Swimming

Involuntary muscles

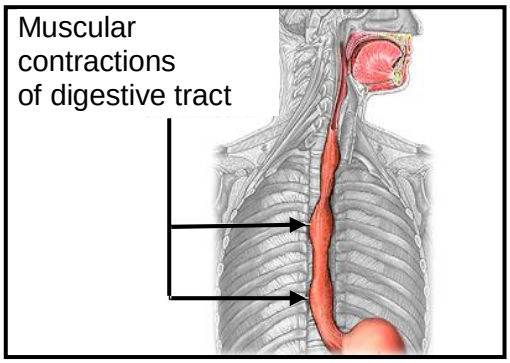
An involuntary muscle is when it moves without you choosing to, such as heart muscles or reflex muscles like blinking an eye. They are named as such because a person cannot physically will them to move. We do not have conscious control over them. Involuntary muscles do not need the brain to send them messages. They know their job and they keep right on doing it.

Some examples are:

- The muscles in your heart, which keep blood pumping, round your body.
- The muscles in your digestive system which move food down to your stomach and keep moving it along until all the goodness that the body needs is taken out. Then they work to push the waste that is left over out of your body.

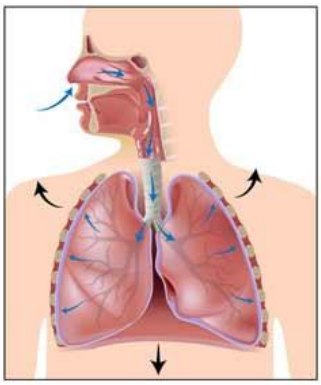


Heart muscles pump blood round your body

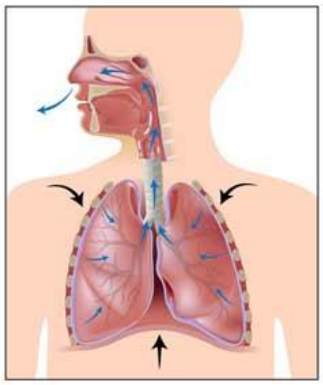


Movement of food down to your stomach

- The lungs have no skeletal muscles of their own. The **diaphragm** is the major muscle responsible for breathing. It is a thin, dome-shaped muscle that separates the abdominal cavity from the thoracic cavity. When you breathe in, or inhale, your diaphragm contracts (tightens) and moves downward. This increases the space in your chest cavity, into which your lungs expand air is sucked in through your nose or mouth and travels down into your lungs. When the diaphragm relaxes and moves back up, the elasticity of the lungs and chest wall pushes air out of the lungs.



Breathe in – diaphragm moves down



Breathe out – diaphragm rises up

There are three different kinds of myofibers found in the body: cardiac, skeletal and smooth.

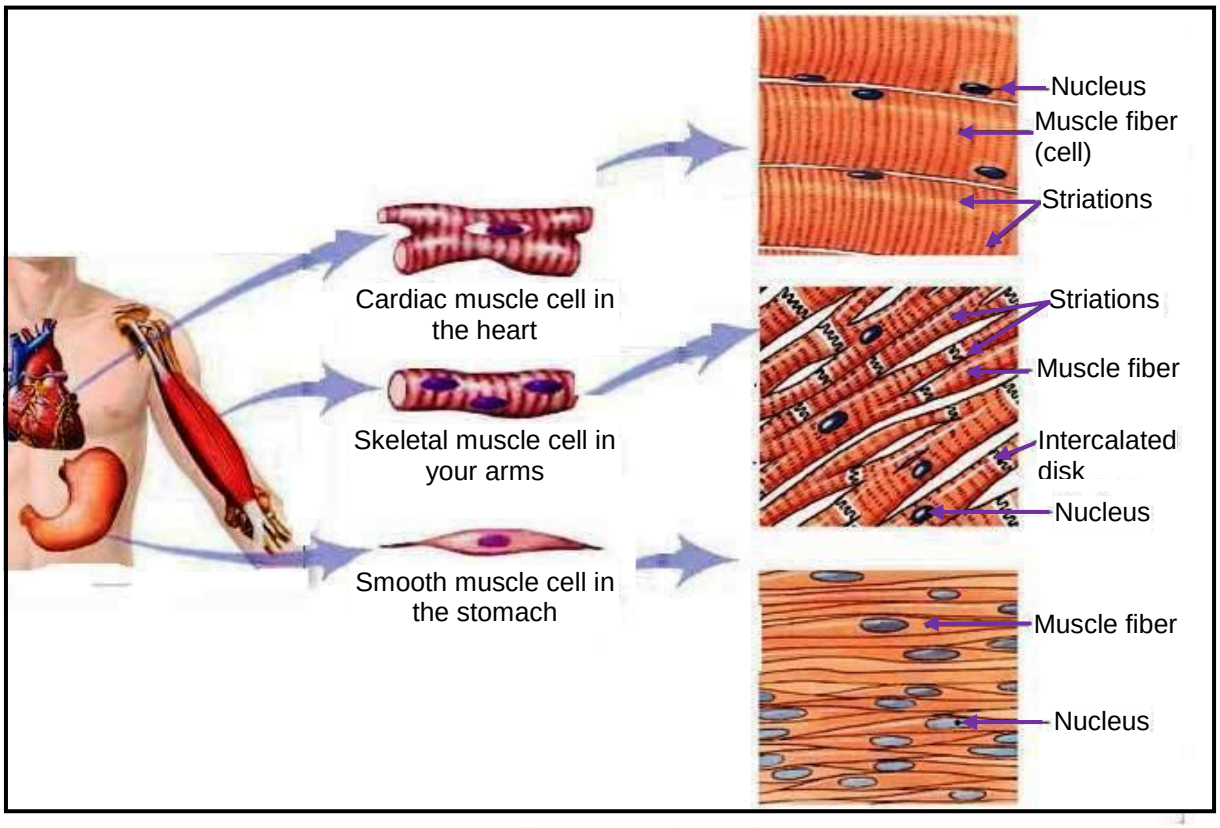
Types of muscles
Although you have more than 600 muscles in your body, there are only three types of muscle: smooth, cardiac and skeletal.

1. **Smooth Muscles**

Smooth muscles are also called **involuntary** muscles. You cannot control this type of muscle. Instead, smooth muscles are controlled by involuntary responses in the brain and body. Your brain and body tell these muscles what to do without you even thinking about it. You cannot use your smooth muscles to make a muscle in your arm or jump into the air.

In terms of appearance, smooth muscles are long, thin-shaped cells attached to bones in the body. Each muscle fiber consists of a single cell with one centrally located nucleus.

Smooth muscles are at work all over your body. One example of smooth muscle is the digestive system, where muscles in the esophagus contract to move food down to the stomach and tighten when you have an illness that causes you to vomit. The muscles push the food back out of the stomach so it comes up through the esophagus and out of the mouth. Other examples of smooth muscle include the uterus, the bladder and the muscle behind the eyes that keeps your eyes focused. They are also found in the walls of the arteries and veins, helping blood to move around the body.



Types of muscle cells

2. **Cardiac Muscle**

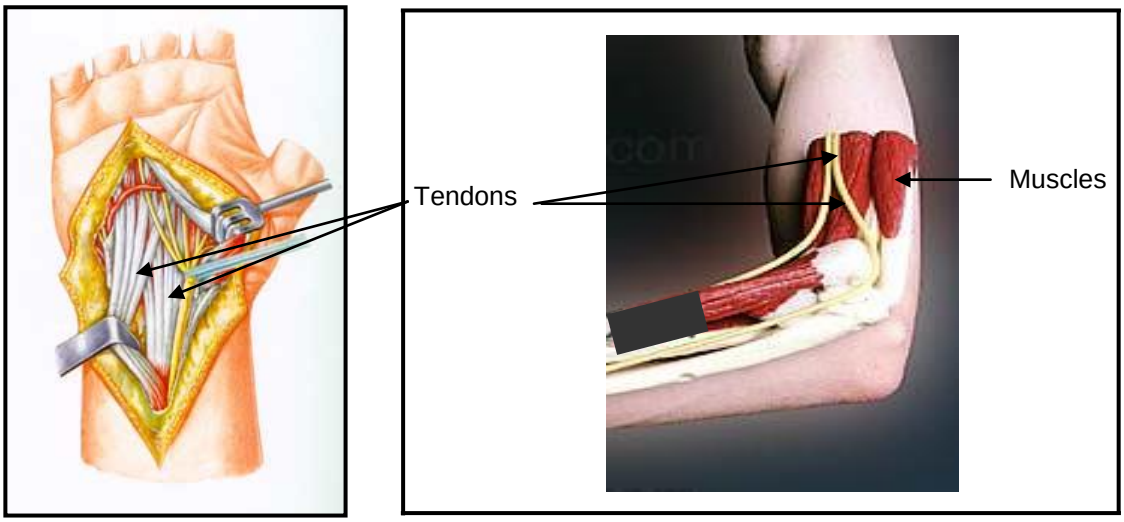
The muscle that makes up the heart is called cardiac muscle. It has characteristics of both skeletal and smooth muscle. This means it is both striated and has one nucleus. Just like smooth muscle, cardiac muscle works all by itself with no help from you. Cardiac muscle is an **involuntary muscle**. A special group of cells within the heart are known as the pacemaker of the heart because it controls the heartbeat.

3. **Skeletal Muscles**

Now, let us talk about the kind of muscle you think of when we say "muscle" — the ones that show how strong you are and let you boot a soccer ball into the goal. These are your skeletal muscles. Skeletal muscles are **voluntary muscles**, which mean you can control what they do. Your leg will not bend to kick the soccer ball unless you want it to.

Each fiber it has more than one nucleus in each cell and is crossed by alternating light and dark bands called **striations**. The striations are caused by overlapping strands of the contractile proteins actin and myosin. Skeletal muscles also have sarcomeres, or contractile units.

Skeletal muscles are held to the bones with the help of tendons. **Tendons** are cords made of tough tissue, and they work as special connector pieces between bone and muscle.



Skeletal muscle tissue attaches to bones for voluntary movements

Major Skeletal Muscles

Skeletal muscles come in many different sizes and shapes to allow them to do many types of jobs. Some of your biggest and most powerful muscles are in your back, near your spine. These muscles help keep you upright and standing tall.

They also give your body the power it needs to lift and push things. Muscles in your neck and the top part of your back are not as large, but they are capable of some pretty amazing things. Try rotating your head around, back and forth, and up and down to feel the power of the muscles in your neck. These muscles also hold your head high.

Here are a few of the major skeletal muscles in your body.
In each of your shoulders is a deltoid muscle. Your **deltoid muscles** help you move your shoulders every which way; from swinging a softball bat to shrugging your shoulders.

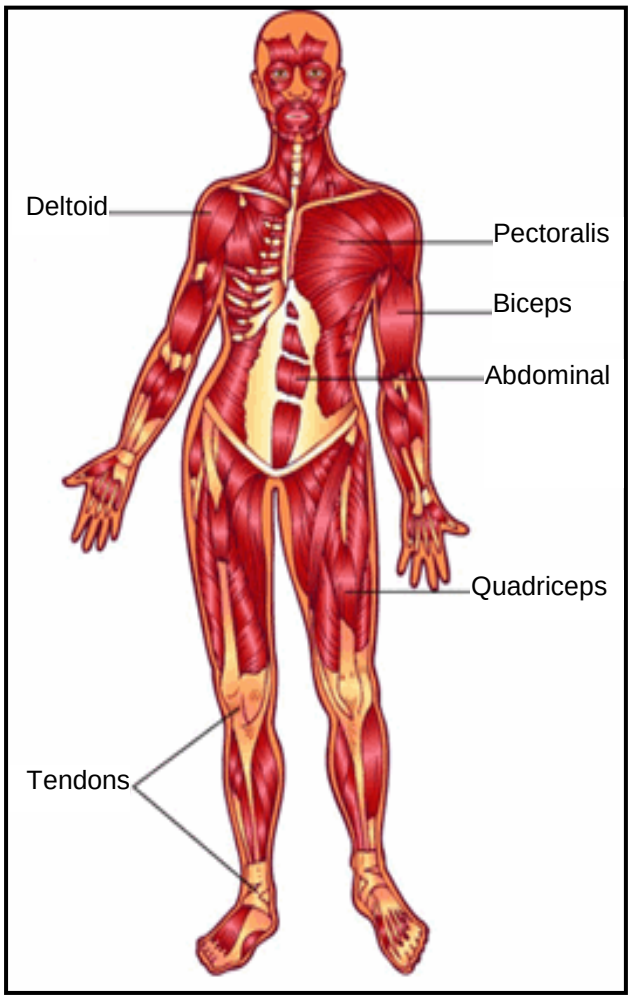
The **pectoralis muscles** are found on each side of your upper chest. These are usually called pectorals or pecs for short. When many boys reach puberty, their pectoral muscles become larger. Many athletes and bodybuilders have large pecs, too.

Below these pectorals, down under your ribcage, are your **abdominal muscles.** They're often called **abs** for short.

When you move your arm, you tense your **biceps muscle**. When you contract your biceps muscle, you can actually see it push up under your skin.

Your quadriceps or quads are the muscles on the front of your thighs. Many people who run, bike, or play sports develop large, strong quads.

And when it is time for you to take a seat? You will be sitting on your gluteus maximus), the muscle that is under the skin and fat in your behind.



Major muscles in the body

Face muscles

You may not think of it as a muscular body part, but your face has plenty of muscles. You can check them out next time you look in the mirror. Facial muscles does not all attach directly to bone like they do in the rest of the body. Instead, many of them attach under the skin. This allows you to contract your facial muscles just a tiny bit and make dozens of different kinds of faces.

Smallest movement can turn a smile into a frown

Even the smallest movement can turn a smile into a frown. You can raise your eyebrow to look surprised or wiggle your nose. And while you are looking at your face, do not pass over your tongue; a muscle that is attached only at one end.

Your tongue is actually made of a group of muscles that work together to allow you to talk and help you chew food. Stick out your tongue and wiggle it around to see those muscles at work.

Tongue wiggle

What can cause muscles to hurt?

- If you exercise too long, you can get a build-up of chemicals like lactic acid in your muscles, and this causes it to tighten up.
- Sweating and not drinking enough on a hot day can mean that you are more likely to get a muscle spasm.
- Try drinking water, and stretching and massaging the muscle that hurts and it will get better.

Common Muscle Disorders

1. **Rotator Cuff Tear**
   The shoulder muscles help in rotating the shoulder as well as move the hand in front and back. The structural strength for this joint is due to the tendons of these muscles. Rigorous, fast or hard movements, like that in baseball and tennis, can cause a tear in the tendon which causes pain and reduced mobility. Torn tendon can be repaired by surgery.

2. **Muscle Cramps**
   Have you ever had cramp? This is when your muscles seem to lock up, and you have a pain in your foot or your leg, or a 'stitch' in your side? This happens when one or more of your muscles contracts and will not relax again (called a spasm).

   Cramps in muscles can occur suddenly and involuntarily, in one or more muscles. It can happen late night or after exercising and can be caused due to a variety of reasons, lasting for seconds to minutes. Overusing a muscle or pinching nerve can cause a cramp. Gentle massage helps temporarily. To reduce spasms and cramps, steroids or medicines can be prescribed.

3. **Sprains and Strains**
   Twist or pull in the muscles or tendons which can either be sudden or over a period of time may cause sprains and strains. Strains can happen when muscles are stretched too far. Some of the muscle fibres can be torn and there can be bruising inside the muscle. It can take several days for the fibres to heal and the bruising to go away.

   Back and hamstring muscles are commonly affected. This is one of the muscular system diseases that cause pain, swelling and difficulty in movement. Rest and ice compress are advised. It’s important to keep the area immobile and take medicine for the pain.

4. **Tendonitis**
   When a tendon gets inflamed or irritated, it results in tendonitis and the inflammation can occur in any tendon of the body. However, it is seen more commonly in wrists, elbows, shoulders and heels. It causes pain, mild swelling, tenderness and can be treated with pain relievers, rest and ice compress.

Activity: Now test yourself by doing this activity.

Circle the letter of the correct answer.

1. Muscles are made of

   A. silica
   B. polyester threads
   C. calcium and phosphorous
   D. groups of cells called fibres

2. What is the function of a tendon?

   A. To link bones to bones
   B. To link muscles to bones
   C. To link muscles to ligaments
   D. To bind the cells in compact bone closer together

3. Ligaments and tendons are formed of

   A. cartilage
   B. epithelial tissue
   C. muscular tissue
   D. connective tissue

4. Smooth muscles occur in

   A. vein
   B. artery
   C. uterus
   D. all the above

5. How do muscles attached to the bones move the body?

   A. Automatically
   B. Pull movement only
   C. Push movement only
   D. Push and pull movement

6. Which of the following is **not** performed by muscles?

   A. Motion
   B. Excretion
   C. Heat production
   D. Maintenance of posture

7. The type of muscle that makes up the walls of blood vessels is

   A. cardiac muscle
   B. skeletal muscle
   C. cardiac and smooth
   D. cardiac and skeletal muscle

8. The earliest type of muscle to evolve was _____ muscle.

A. cardiac B. smooth

C. skeletal D. stratified

9. Approximately how many skeletal muscles are there in the human body?

A. 60 B. 100

C. 600 D. 1, 000

10. Muscle tissue refers to all contractile tissue. To what does the term muscular system most often refer?

A. Skeletal muscle system
B. Cardiac muscle system
C. Visceral muscle system
D. Computerised muscle tissue

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 5.

Summary

You have come to the end of lesson 5. In this lesson you have learnt that:

- muscles are made of fibres that move the different parts of your body, inside and outside.
- contracting means becoming shorter. The muscle fibres slide together and stack up to make a fatter shape, a bit like when you shuffle a pack of cards together.
- relaxing means the fibres slide apart and the muscle gets longer and thinner.
- A voluntary muscle is when you consciously choose to move a muscle, your brain sends the right muscles the messages to 'contract' or 'relax'.
- involuntary muscles do not need the brain to send them messages. They know their job and they keep right on doing it.
- spindle-shaped muscles are like biceps and triceps in your upper arms.
- smooth muscles are usually in sheets, or layers, with one layer of muscle behind the other. In your stomach and digestive system, they contract (tighten up) and relax to allow food to make its journey through the body.
- the muscle that makes up the heart is called cardiac muscle. The thick muscles of the heart contract to pump blood out and then relax to let blood back in after it has circulated through the body.
- skeletal muscles are voluntary muscles, which mean you can control what they do.
- tendons are cords made of tough tissue, and they work as special connector pieces between bone and muscle.

NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE.

Practice Exercise 5

Answer the following questions:

1. Define the following.

   a. Muscles

   _____
   _____
   _____

   b. Tendons

   _____
   _____
   _____

2. Describe the following types of muscles in the body.

   a. Smooth muscle

   _____
   _____
   _____
   _____

   b. Cardiac muscle

   _____
   _____
   _____

   c. Skeletal muscles

   _____
   _____
   _____
   _____

3. Differentiate deltoid from pectoralis.

   a. Deltoid muscles

   _____
   _____
   _____
   _____

b. The pectoralis muscles

_____
_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity

1.	D	6.	B
2.	B	7.	C
3.	D	8.	C
4.	D	9.	C
5.	A	10.	A

Answers to Practice Exercises 1- 5

Practice Exercise 1

1. Label the parts of the diagram.

A.	Shoulder	F.	Chest
B.	Arm	G.	Hand
C.	Foot	H.	Leg
D.	Head	I.	Toes
E.	Neck		

2. Head, trunk and limbs

3. The trunk includes the chest (in front), the back, the shoulders and the abdomen. The internal organs which we cannot see are the heart, the lungs, the stomach, the liver with the gall-bladder, the pancreas, the spleen, the kidneys and the small and large intestines (bowels).

   The upper extremity (arm) consists of the upper arm, the elbow, the forearm, the wrist and the hand with four fingers and one thumb. The inner side of the hand is called the palm. The finger nails protect the finger tips. The lower extremity (leg) is attached to the pelvic girdle. It is composed of the thigh, the knee with patella, the shin, the calf, the ankle and the foot. Each foot has a heel, a sole and five toes

4. Head is composed of the cranium and facial parts. It contains the brain which controls the whole body. The cranium is partly covered with hair. The parts of the face are the forehead, the temples, the ears, the eyes with eyebrows, the cheeks, the nose, the jaw, the mouth and the chin.

Practice Exercise 2

A. A skeleton is the flexible inner framework of our body made of bone and cartilage.

B.

1.	H	6.	E
2.	G	7.	B
3.	J	8.	C
4.	I	9.	F
5.	A	10.	D

C. Animals with backbones are called vertebrates. Some vertebrates are mammals, birds, reptiles, amphibians and fish. Animals without backbones are called invertebrates. Some invertebrates are molluscs, worms, arthropods, echinoderms and coelenterates.

Practice Exercise 3

1. a. Cartilage is a type of connective tissue which is tough, semi-transparent, elastic and flexible with no nerves or blood vessels.
   b. Bones is a specialised form of dense connective tissue and main component of the skeleton in the adult human. It gives the skeleton the necessary rigidity to function as attachment and lever for muscles and supports the body against gravity.
   c. Fracture is a break in the bone. A break can be complete or incomplete.

2. Baby's bones are made entirely of a special material called cartilage. This cartilage is soft and flexible. During childhood, as the baby is growing, the cartilage grows and is slowly replaced by bone, with the help from calcium. By the time the baby are about 25, this process will be complete. After this happens there can be no more growth; the bones are as big as they will ever be. All of these bones make up a skeleton that is both very strong and very light.

3. a. A simple fracture is a complete fracture where the bone is broken into two fragments and do not pierce the skin. This break can be transverse (which means straight across the bone), oblique (which means at an angle) and spiral (which means an angle that is twisted).Simple fractures are usually treated with immobilization with a cast or sometimes with pins, screws and plates.

   b. When bone breaks and penetrates through the skin it is known as a compound fracture. Compound fractures are usually caused due to high impact injuries like sports injuries, heavy falls, and car crashes, and so on. This is generally considered to be a more serious form of fracture, since it requires immediate treatment. Usually, an operation is required to quickly cleanse the area and realign the bone. In addition, because of the higher chances of infection, a compound fracture is more difficult to heal.

   c. A greenstick fracture is an incomplete fracture wherein the bone cracks but doesn't break all the way through, only one side of the bone breaks causing the bone to bend. A greenstick fracture can be difficult to diagnose, because it may not cause all the classic signs and symptoms of a broken bone. Greenstick fractures are usually treated by immobilization with a cast to allow it to mend so that the bone will grow back properly.

4. Bones can mend themselves when they break because they contain living cells that can grow, repair and replace themselves, and produce new bones. So, when a bone breaks, all that is needed is to hold the broken parts together. This is usually done with a plaster cast. The bone will begin to mend all by itself while in the cast.

Practice Exercise 4

1. a. Joints — A joint is the location where two or more bones meet.

   b. Ligaments — Ligaments are tough band of white, fibrous and slightly elastic tissue that attach from bone to bone.

2. Fibrous — This type of joint is held together by only a ligament.

   Cartilaginous — These joints occur where the connection between the articulating bones is made up of cartilage.

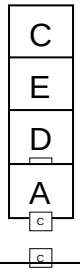
   Synovial — These joints are by far the most common classification of joint within the human body. They are the most complex of the joint types and are highly moveable.

3. Dislocation of joint is the common injury of joint. Dislocation means that the ends of bones which are connected with the cartilage at joint have lost their original position.

   Knee injury the knee is the most commonly injured joint. Knee injuries can result from a blow to or twist of the knee; from improper landing after a jump; or from running too hard, too much, or without proper warm-ups.

   A sprain is a stretch or tear of a ligament, the band of connective tissues that joins the end of one bone with another.

   A strain is a twist, pull, or tear of a muscle or tendon, a cord of tissue connecting muscle to bone. It is an acute, no contact injury that results from overstretching or over contraction.

4. 

Practice Exercise 5

1. a. Muscles are made of fibres that move the different parts of your body, inside and outside.
   b. Tendons are cords made of tough tissue, and they work as special connector pieces between bone and muscle.

2. a. Smooth muscles are also called involuntary muscles. You cannot control this type of muscle. Instead, smooth muscles are controlled by involuntary responses in the brain and body. In terms of appearance, smooth muscles are long, thin-shaped cells attached to bones in the body. Each muscle fiber consists of a single cell with one centrally located nucleus.

b. The muscle that makes up the heart is called cardiac muscle. It has characteristics of both skeletal and smooth muscle. This means it is both striated and has one nucleus. Just like smooth muscle, cardiac muscle works all by itself with no help from you. Cardiac muscle is an involuntary muscle.

c. Skeletal muscles are voluntary muscles, which mean you can control what they do. Each fiber it has more than one nucleus in each cell and is crossed by alternating light and dark bands called striations. The striations are caused by overlapping strands of the contractile proteins actin and myosin. Skeletal muscles also have sarcomeres, or contractile units.

3. a. Deltoid muscles are located in your shoulders. These muscles help you move your shoulders every which way; from swinging a softball bat to shrugging your shoulders when you are not sure of an answer.

b. The pectoralis muscles are found on each side of your upper chest. These are usually called pectorals or pecs for short. When many boys hit puberty, their pectoral muscles become larger. Many athletes and bodybuilders have large pecs, too.

REVISE TOPIC 1 USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 1: Skeletal and Muscular System

Revise all the Lessons in this Topic and then do **ASSIGNMENT 3.**
Here are the main points to help you revise.

Lesson 1: Human Body

- Humans belong to a group of animals called mammals.
- The human body is a single structure but it is made up of billions of smaller structures of four major types, cells, tissues, organs and organ systems.
- Cells are the smallest and simplest unit of living matter that can maintain life and reproduce themselves.
- Large number of similar cells with the same physical characteristics grouped together to perform same functions are called tissues.
- An organ is a collection of several different kinds of tissues so arranged that they can perform a special function.
- A group of organs that work together is called an organ system.
- The human body refers to the entire structure of a human being and comprises the three main parts which are the head, trunk (which includes the thorax and abdomen) and the limbs (extremities, which include arms and hands, legs and feet).

Lesson 2: The Skeleton

- A skeleton is the flexible inner framework of our body made of bone and cartilage.
- The main job of the skeleton is to provide support for our body.
- The human skeleton is divided into two distinct parts; axial and appendicular.
- Cranium is the box that encloses and protects the brain from damage and the other organs of sight, hearing and balance.
- Collar bone supports the upper arm and scapula.
- Scapula is the movable bone to which most of the shoulder muscles are attached.
- Breast bone protects the vital organs of the body, such as the heart, the lungs, and the air passages.
- The humerus bone serves as a connection between the scapula and the elbow, where it links to the two lower arm bones.
- The ribs play a role in protecting the internal organs particularly the heart and lungs.
- The vertebral column support for the body's frame, keeping it standing upright. It connects the head to the rest of the body.
- The pelvis is a muscle, bone, and connective tissue structure that provides a foundation for the legs and also supports a portion of the abdominal and pelvic regions.
- The radius is the shorter of the two long bones of the lower arm that extends from the elbow to the wrist, and is the bone on the thumb side of the arm. It has a pivot joint at both ends and rotates over the ulna and enables the hand to rotate and be flexible.
- The ulna is also located in the lower arm. The functions of the ulna include supporting movement of the hands and arms, creating insertion points for muscles, producing blood cells in bone marrow, and storing some minerals, such as calcium and phosphorus.

- Femur is the thigh bone and it is the longest, heaviest, and strongest bone in the entire human body. All of the body's weight is supported by the femurs during many activities, such as running, jumping, walking, and standing
- The patella is the thick circular-triangular bone that forms the kneecap.
- The fibula is an attachment point for muscles, located to the side of the tibia and between the patella and ankle.
- Tibia is a bone in the lower leg that connects to the fibula and provides movement of the legs.
- Animals with backbones are called vertebrates. Some vertebrates are mammals, birds, reptiles, amphibians and fish.
- Animals without backbones are called invertebrates. Some invertebrates are molluscs, worms, arthropods, echinoderms and coelenterates.

Lesson 3: Bones and Cartilage

- Cartilage is a type of connective tissue which is tough, semi-transparent, elastic and flexible.
- Bone is a specialised form of dense connective tissue and main component of the skeleton in the adult human. It gives the skeleton the necessary rigidity to function as attachment and lever for muscles and supports the body against gravity.
- Spongy bone consists of delicate bars and sheets of bone which branch and intersects to form a sponge like network. It is lighter and less dense than compact bone.
- Compact bone has a hard outer layer and does not have any spaces or hollows in the bone that is visible to the eye. Compact bone forms the thick-walled tube of the shaft of long bones, which surrounds the marrow cavity.
- Bone sheath is the outer surface of the bone. It is a thin, dense membrane that contains nerves and blood vessels that nourish the bone. It makes new cells when bone breaks.
- Bone marrow is sort of like a thick jelly that fills the inside hollow of the large bone. Its main function is to make red blood cells. Blood vessels pick up these newly made red cells and carry them throughout the body.
- A break in a bone is called a fracture. A break can be complete or incomplete.
- Fractures are commonly caused by a fall from a height or strike from an object or repetitive forces on the bone because of physical activities like running or weightlifting.
- A simple fracture is a complete fracture where the bone is broken into two fragments and the broken bones do not pierce the skin.
- When bone breaks and penetrates through the skin it is known as a compound fracture. Usually, an operation is required to quickly cleanse the area and realign the bone. In addition, because of the higher chances of infection, a compound fracture is more difficult to heal.
- A greenstick fracture is an incomplete fracture wherein the bone cracks but does not break all the way through, only one side of the bone breaks causing the bone to bend.
- Bones can mend themselves when they break. Bones can do this because they contain living cells that can grow, repair and replace themselves, and produce new bones.

Lesson 4: The Joints

- A joint is the location where two or more bones meet.
- Joints are constructed to allow movement and provide support, and are classified structurally and functionally.
- Ligaments are tough band of white, fibrous and slightly elastic tissue that attach from bone to bone. They provide for the stability of a joint and hold the adjacent bones in the proper alignment.
- Fibrous (immoveable) joint is held together by only a ligament.
- Cartilaginous (partially moveable) joints occur where the connection between the articulating bones is made up of cartilage.
- Synovial (freely moveable) joints are the most common classification of joint within the human body. They are highly moveable and all have a synovial capsule surrounding the entire joint, a synovial membrane which secretes synovial fluid (a lubricating liquid) and cartilage.
- Dislocation of joint is the most common injury of joint. Dislocation denotes that ends of bones, which are connected with the cartilage at joint, have lost their original position.
- The knee is the most commonly injured joint.
- A sprain is a stretch or tear of a ligament, the band of connective tissues that joins the end of one bone with another.
- A strain is a twist, pull, or tear of a muscle or tendon, a cord of tissue connecting muscle to bone.

Lesson 5: The Muscles

- Muscles are made of fibres that move the different parts of your body, inside and outside.
- Contracting means becoming shorter. The muscle fibres slide together and stack up to make a fatter shape, a bit like when you shuffle a pack of cards together.
- Relaxing means the fibres slide apart and the muscle gets longer and thinner.
- A voluntary muscle is when you consciously choose to move a muscle, your brain sends the right muscles the messages to 'contract' or 'relax'.
- Involuntary muscles do not need the brain to send them messages. They know their job and they keep right on doing it.
- Spindle-shaped muscles are like biceps and triceps in your upper arms.
- Smooth muscles are usually in sheets, or layers, with one layer of muscle behind the other. In your stomach and digestive system, they contract (tighten up) and relax to allow food to make its journey through the body.
- The muscle that makes up the heart is called cardiac muscle. The thick muscles of the heart contract to pump blood out and then relax to let blood back in after it has circulated through the body.
- Skeletal muscles are voluntary muscles, which mean you can control what they do.
- Tendons are cords made of tough tissue, and they work as special connector pieces between bone and muscle.

REVISE WELL AND THEN DO TOPIC TEST 1 IN YOUR ASSIGNMENT 3.

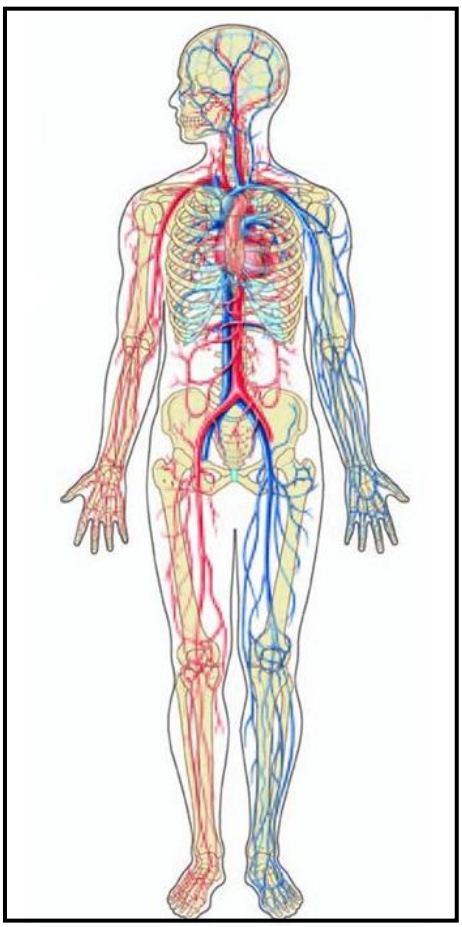
TOPIC 2

CIRCULATORY SYSTEM

In this topic you will learn about:

- **the blood**
- **the blood vessels**
- **the heart and circulation**

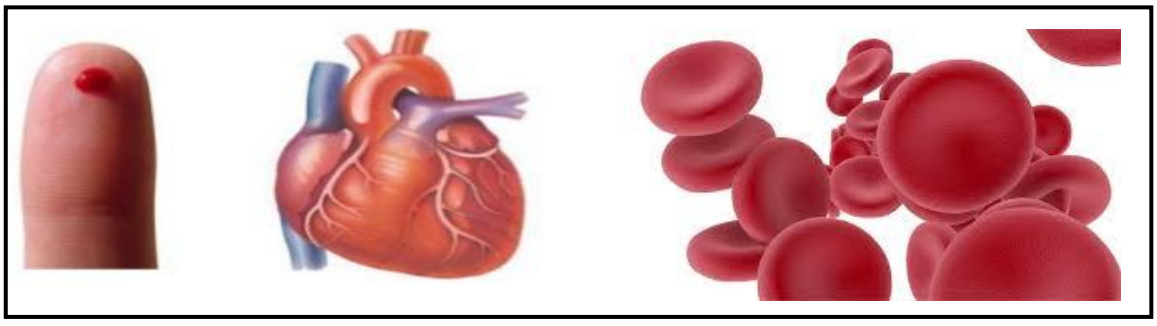
INTRODUCTION TO TOPIC 2: CIRCULATORY SYSTEM



Circulatory system, group of organs that transport blood and the substances it carries to and from all parts of the body. The circulatory system can be considered as composed of two parts: the systemic circulation, which serves the body as a whole except for the lungs, and the pulmonary circulation, which carries the blood to and from the lungs. The organs of circulatory system consist of vessels that carry the blood and a muscular pump, the **heart,** that drives the blood.

Of the vessels, the **arteries** carry blood away from the heart; the main arterial vessel, the **aorta,** branches into smaller arteries, which in turn branch repeatedly into still smaller vessels and reach all parts of the body. Within the body tissues, the vessels are microscopic **capillaries** through which gas and nutrient exchange occurs. Blood leaving the tissue capillaries enters converging vessels, the **veins,** to return to the heart and lungs.

The human heart is a four-chambered organ with a dividing wall, or septum that separates it into a right heart for pumping blood from the returning veins into the lungs and a left heart for pumping blood from the lungs to the body via the aorta.



Components of the Circulatory System

Questions will arise such as

- What are the different types of blood?
- How are blood vessels important to our body?
- What are the parts and functions of the heart?

In this Topic, you will find the answers to these questions and other questions relating to the circulatory system.

Lesson 6: The Blood

Welcome to Lesson 1. This lesson will discuss about the human blood its components and its functions to the body.

Your Aims:

- define blood
- identify and describe the types of blood cells
- enumerate the different functions of blood in the body

What is Blood?

The red liquid that circulates in the arteries and veins of humans and other vertebrate animals, carrying oxygen to and carbon dioxide from the tissues of the body.

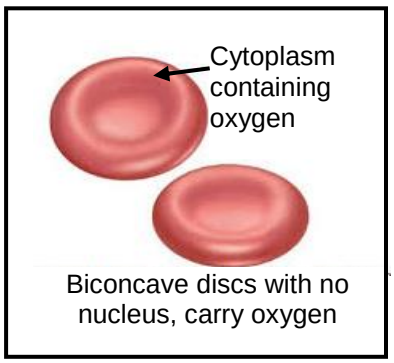
The blood

The average human adult has more than 5 litres (6 quarts) of blood in his or her body. Blood carries oxygen and nutrients to living cells and takes away their waste products. It also delivers immune cells to fight infections and contains platelets that can form a plug in a damaged blood vessel to prevent blood loss.

Through the circulatory system, blood adapts to the body's needs. When you are exercising, your heart pumps harder and faster to provide more blood and hence oxygen to your muscles. During an infection, the blood delivers more immune cells to the site of infection, where they accumulate to ward off harmful invaders. It contains **blood cells**, **platelets** and **plasma**.

What are red blood cells (RBC)?

Red blood cells are round with a flattish, indented centre, like doughnuts without a hole. They play an important role in our health by carrying fresh oxygen throughout the body.



Red blood cells

Red blood cells at work

Hemoglobin is the protein inside red blood cells that carries oxygen. Red blood cells also remove carbon dioxide from the body, transporting it to the lungs for us to exhale. Red blood cells are made inside the bones, in the bone marrow. They typically live for about 120 days, and then they die.

Nutrition and red blood cells

Foods rich in iron help you maintain healthy red blood cells. Vitamins are also necessary to build healthy red blood cells. These include vitamin E, found in foods such as dark green vegetables, nuts and seeds, mango, and avocados; vitamins B2, B12, and B3, found in foods such as eggs, whole grains, and bananas; and folate, available in fortified cereals, dried beans and lentils, orange juice, and green leafy vegetables.

Illnesses of the red blood cells

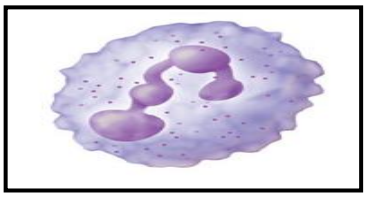
Most people do not think about their red blood cells unless they have a disease that affects these cells. Problems with red blood cells can be caused by illnesses or a lack of iron or vitamins in your diet. Some diseases of the red blood cells are inherited.

Diseases of the red blood cells include many types of anemia, a condition in which there are too few red blood cells to carry sufficient oxygen throughout the body. People with anemia may have red blood cells that have an unusual shape or that look normal, larger than normal, or smaller than normal.

Symptoms of anemia include tiredness, irregular heartbeats, pale skin, feeling cold, and, in severe cases, heart failure. Children who do not have enough healthy red blood cells grow and develop more slowly than other children. These symptoms demonstrate how important red blood cells are to your daily life.

What are white blood cells (WBC)?

White blood cells are an important component of the blood system. Although, white blood cells account for only about 1% of the blood, their impact is significant. White blood cells, also called **leukocytes**, are essential for good health and protection against illness and disease.



White blood cell (WBC)

Think of white blood cells as immunity cells. In a sense, they are continually at war. They flow through bloodstream to battle viruses, bacteria, and other foreign invaders that threaten health. When the body is in distress and a particular area is under attack, white blood cells rush in to help destroy the harmful substance and prevent illness.

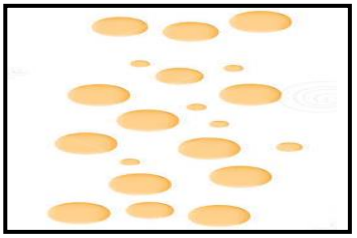
White blood cells are made inside the bone marrow and stored in the blood and lymphatic tissues. Because some white blood cells have a short lifespan of one to three days, your bone marrow is constantly making them.

What are Platelets?

Remember the last time you cut yourself? You can recall the sharp stab of pain, and the sight of blood slowly oozing out of the wound. As you reach for a bandage, you are probably hoping to minimize the mess of blood.

But is your mind racing, trying to figure out how and when you will stop bleeding? Probably not, because you know that your body will take care of that for you. The reason we do not bleed to death every time we are cut is due largely to particles in our blood called platelets.

Platelets are tiny cell fragments that are found within our blood. They originate in the bone marrow as pinched-off pieces of larger cells. Platelets are neither smooth nor round, but are shaped more like paper that has been ripped into tiny bits. They spend much of their time cruising through the bloodstream alongside their red and white blood cell counterparts.

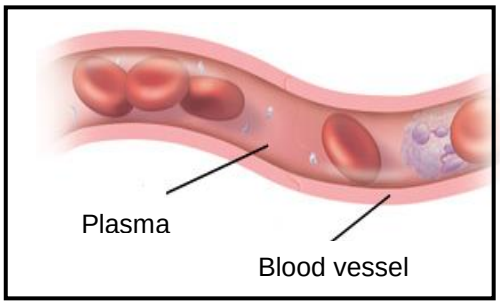


Platelets

The primary responsibility of the platelets is to stop the bleeding when there is an injury to the body. A barrier called a blood clot must be formed to seal the wound. Just like a leaking pipe must be plugged, a damaged blood vessel must be blocked so that there is not excessive blood loss. But how do the platelets accomplish this task?

What is Plasma?

Plasma is the often forgotten component of blood. White blood cells, red blood cells, and platelets are essential to body function, but plasma also plays a crucial, and mostly unrecognized, job. It carries these blood components throughout the body as the fluid in which they travel.

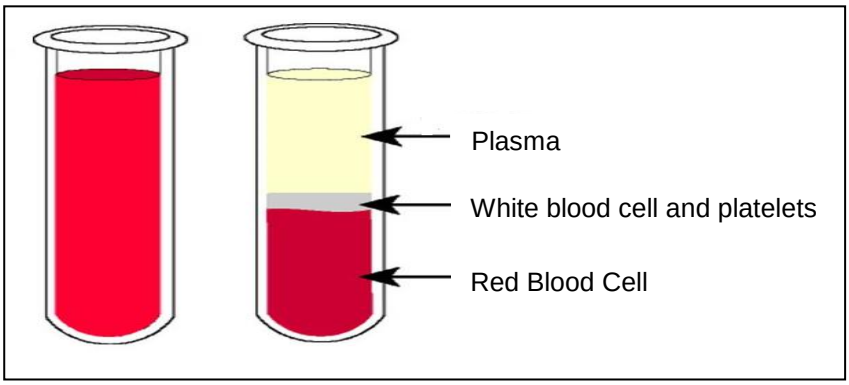


Plasma and blood vessel

Facts about plasma

Plasma is the largest component of your blood, making up about 55% of its overall content. When isolated on its own, blood plasma is a light yellow liquid, similar to the color of straw. Along with water, plasma carries salts and enzymes.

The primary purpose of plasma is to transport nutrients, hormones, and proteins to the parts of the body that need it. Cells also deposit their waste products into the plasma. The plasma, in turn, helps remove this waste from the body. Blood plasma also ushers the movement of all the elements of blood through the circulatory system.



Composition of blood

When exercising, blood does the following things:

- **Transports** nutrients and waste
- Delivers **oxygen** to the working muscles
- Removes heat (**temperature regulation**)
- Dilutes/carries away lactic acid (**acidic balance**)

Functions of Blood

1. **Transports the following:**
   - dissolved gases (example oxygen, carbon dioxide)
   - waste products of **metabolism*** (example water, urea)
   - hormones
   - enzymes
   - nutrients (example glucose, amino acids, vitamins and minerals, fatty acids)
   - plasma proteins (associated with defence such as blood clotting anti-bodies) and
   - blood cells (white blood cells and red blood cells)
2. **Maintains body temperature.**
3. **Controls pH.**
   The pH of blood must remain in the range 6.8 to 7.4; otherwise it begins to damage cells.
4. **Removes toxins from the body.**
   The kidneys filter all of the blood in the body (approx. 8 pints), 36 times every 24 hours. Toxins removed from the blood by the kidneys leave the body in the urine. Toxins also leave the body in the form of sweat.
5. **Regulation of body fluid electrolytes**
   Excess salt is removed from the body in urine, which may contain around 10g salt per day.

What Are the Symptoms of Blood Cell Disorders?

Symptoms will vary depending on the type of blood cell disorder. Common symptoms of red blood cell disorders are:

- fatigue
- shortness of breath
- trouble concentrating from lack of oxygenated blood in the brain
- muscle weakness
- a fast heartbeat

Common symptoms of pediatric white blood cell disorders are:

- chronic infections
- fatigue
- unexplained weight loss
- malaise, or a general feeling of being unwell

Common symptoms of platelet disorders are:

- cuts or sores that do not heal or are slow to heal
- blood that does not clot after an injury or cut
- skin that bruises easily
- unexplained nosebleeds or bleeding from the gums

Activity: **Now test yourself by doing this activity.**

Fill in the blank. Circle the letter of the correct answer.

1. The red liquid that circulates in the arteries and veins of humans and other vertebrate animals is called _____.

   A. blood B. plasma

   C. platelet D. hemoglobin

2. _____ is the protein inside red blood cells that carries oxygen.

   A. Plasma B. Blood

   C. Platelet D. Hemoglobin

3. _____ are tiny cell fragments that are found within our blood.

   A. Plasma B. Blood

   C. Platelets D. Hemoglobin

4. Red blood cells are made inside the bones, in the _____ marrow.

   A. bone B. blood

   C. muscle E. platelets

5. _____ blood cells are round with a flattish, indented centre, like doughnuts without a hole.

   A. Red B. White

   C. Yellow D. Orange

6. _____ is not a symptom of leukemia.

   A. Tiredness B. Pale skin

   D. Heart failure D. Gum bleeding

7. White blood cells, also called _____ are essential for good health and protection against illness and disease.

   A. phagocytes B. leukocytes

   C. thymocytes D. adipocytes

8. _____ is the largest component of your blood, making up about 55% of its overall content.

A. Plasma B. Platelet

C. Red Blood Cell D. White Blood Cell

9. The average human adult has more than _____ litres of blood in his or her body.

A. 3 B. 4

C. 5 D. 6

10. Blood carries _____ and nutrients to living cells and takes away their waste products.

A. oxygen B. hydrogen

C. nitrogen D. aluminium

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 6.

Summary

You have come to the end of lesson 6. In this lesson you have learnt that:

- blood is the red liquid that circulates in the arteries and veins of humans and other vertebrate animals, carrying oxygen to and carbon dioxide from the tissues of the body.
- red blood cells are round with a flattish, indented centre, like doughnuts without a hole.
- white blood cells are an important component of the blood system.
- platelets are tiny cell fragments that are found within our blood.
- plasma is the often forgotten component of blood.
- white blood cells, red blood cells, and platelets are essential to body function, but plasma also plays a crucial, and mostly unrecognized, job.
- common symptoms of red blood cell disorders are:
  - fatigue
  - shortness of breath
  - trouble concentrating from lack of oxygenated blood in the brain
  - muscle weakness
  - a fast heartbeat

NOW DO PRACTICE EXERCISE 6 ON THE NEXT PAGE.

Practice Exercise 6

Answer the following questions:

1. Define blood.

_____
_____

2. Identify and describe the types of blood cells.

_____
_____
_____

_____
_____
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_____
_____
_____

3. What is plasma?

_____
_____

4. Enumerate the different functions of blood in the body.

_____
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CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity

1. A
2. D
3. C
4. A
5. A
6. D
7. B
8. A
9. C
10. A

Lesson 7: Blood Vessels

From the previous lesson you have studied about human blood. You have identified and described the types of blood cells in our body. You also studied and enumerated the different functions of blood in the body. For this lesson you will study the human blood vessels.

Your Aims:

- define blood vessels
- identify and describe the types of blood vessels

What are Blood Vessels?

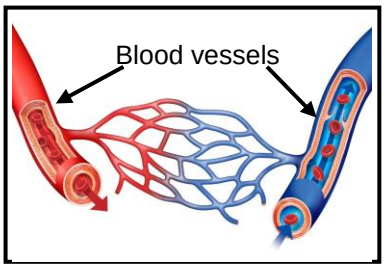
The blood vessels are the part of the circulatory system that transports blood throughout the body. Besides circulating blood, the blood vessels provide two important means of measuring vital health statistics: pulse and blood pressure. We measure heart rate, or pulse, by touching an artery. The rhythmic contraction of the artery keeps pace with the beat of the heart. Since an artery is near the surface of the skin, while the heart is deeply protected, we can easily touch the artery and get an accurate measure of the heart's pulse.

There are three major types of blood vessels: the arteries, which carry the blood away from the heart; the capillaries, which enable the actual exchange of water and chemicals between the blood and the tissues; and the veins, which carry blood from the capillaries back toward the heart. The arteries and veins have the same structure with three layers, from inside to outside.

What do blood vessels look like?

Blood vessels are long thin tubes that run all through the body. Some are larger than others. Most are very small. Some are so small that you cannot even see them without a microscope. If you look at your wrist or leg, you can see blue lines just below the skin.

These are your blood vessels. They look blue because of the way light goes through your skin and lights up the carbon dioxide rich cells in the blood stream, but the blood plasma remains red. There are a huge number of blood vessels in your body. If they were all stretched out, there would be over 60,000 miles of blood vessels.

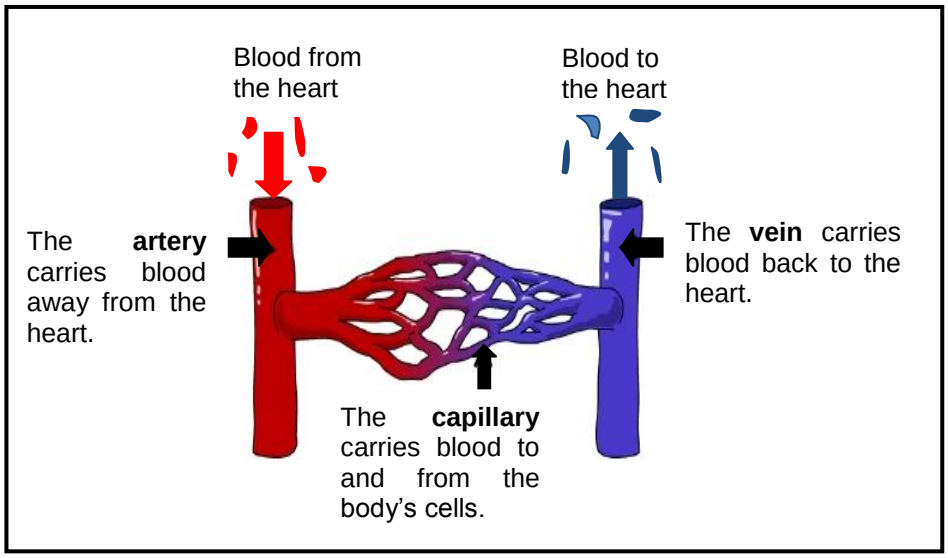


What are the parts of the blood vessels?

Blood vessels are hollow tubes that blood flows through. They have walls made of muscle. The hollow place inside of the blood vessel is called the lumen. Veins have small flaps of tissue called valves. These keep the blood flowing to the right direction.

Types of Blood Vessel

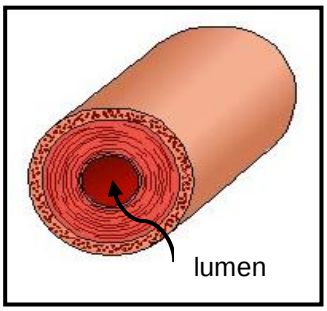
The different blood vessels have different jobs to do in carrying blood around the body.



Types of Blood Vessel

Arteries

Arteries carry blood away from the heart at high pressure in thick walled lumen. **Lumen** ("an opening") is the inside space of a tubular structure, such as an **artery** or intestine. The heart pumps blood out through one main artery called the dorsal aorta.



Artery

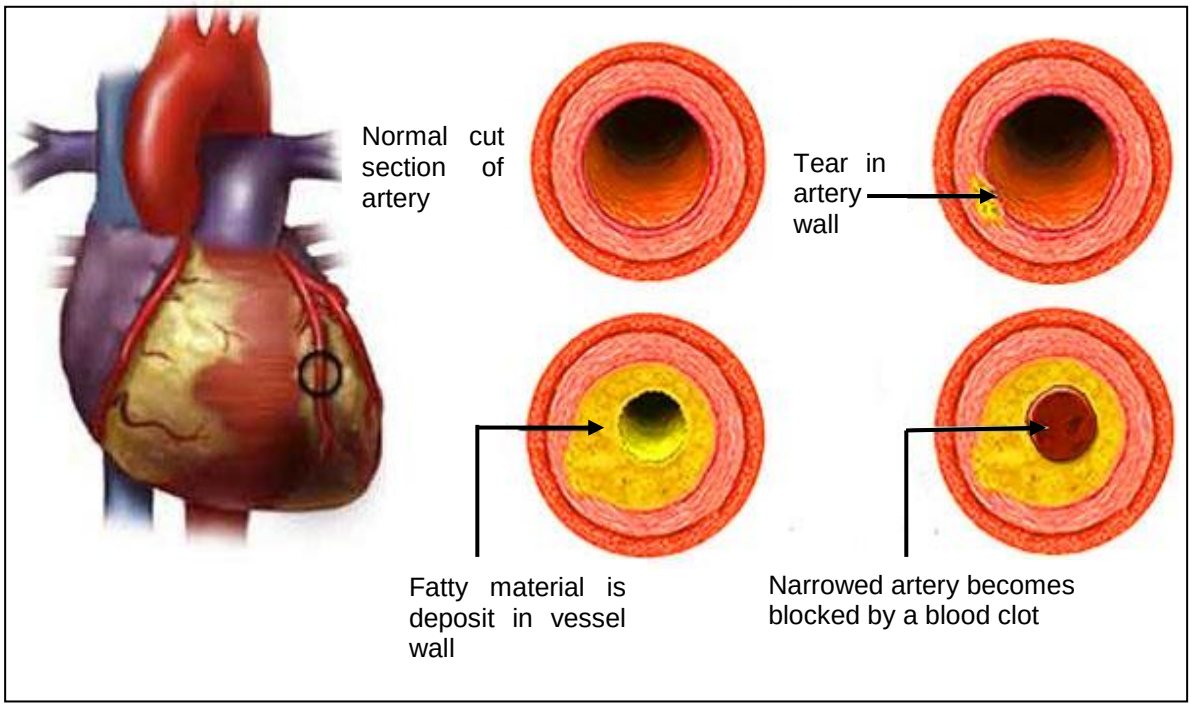
The main artery then divides and branches out into many smaller arteries so that each region of your body has its own system of arteries supplying it with fresh, oxygen-rich blood. Arteries are tough on the outside and smooth on the inside.

An artery actually has three layers: an outer layer of tissue, a muscular middle, and an inner layer of epithelial cells. The muscle in the middle is elastic and very strong. The inner layer is very smooth so that the blood can flow easily with no obstacles in its path.

The muscular wall of the artery helps the heart pump the blood. When the heart beats, the artery expands as it fills with blood. When the heart relaxes, the artery contracts, exerting force that is strong enough to push the blood along. This rhythm between the heart and the artery results in an efficient circulation system.

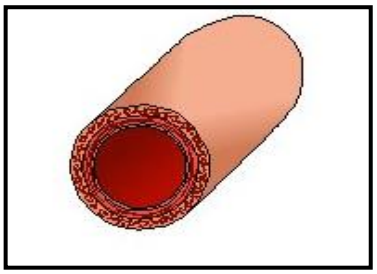
You can actually feel your artery expand and contract. Since the artery keeps pace with the heart, we can measure heart rate by counting the contractions of the artery. That is how we take our pulse.

The arteries deliver the oxygen-rich blood to the capillaries where the actual exchange of oxygen and carbon dioxide occurs. The capillaries then deliver the waste-rich blood to the veins for transport back to the lungs and heart.



Veins

Veins are similar to arteries but, because they transport blood at a lower pressure, they are not as strong as arteries. Like arteries, veins have three layers: an outer layer of tissue, muscle in the middle, and a smooth inner layer of epithelial cells.



Vein

However, the layers are thinner, containing less tissue. Veins receive blood from the capillaries after the exchange of oxygen and carbon dioxide has taken place.

Therefore, the veins transport waste-rich blood back to the lungs and heart. It is important that the waste-rich blood keeps moving in the proper direction and not be allowed to flow backward. This is accomplished by valves that are located inside the veins. The valves are like gates that only allow traffic to move in one direction.

The vein valves are necessary to keep blood flowing toward the heart, but they are also necessary to allow blood to flow against the force of gravity. For example, blood that is returning to the heart from the foot has to be able to flow up the leg.

Generally, the force of gravity would discourage that from happening. The vein valves, however, provide footholds for the blood as it climbs its way up.

Blood that flows up to the brain faces the same problem. If the blood is having a hard time climbing up, you will feel light-headed and possibly even faint. Fainting is your brain's natural request for more oxygen-rich blood. When you faint, your head comes down to the same level as your heart, making it easy for the blood to quickly reach the brain.

Because it lacks oxygen, the waste-rich blood that flows through the veins has a deep red colour, almost like maroon. Because the walls of the veins are rather thin,

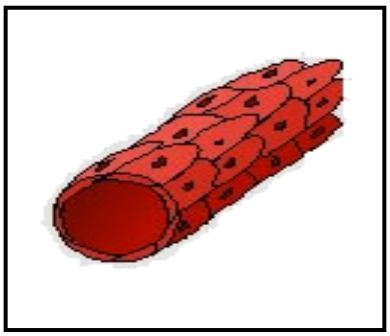
the waste-rich blood is visible through the skin on some parts of the body. Look at your wrist, or hands, or ankles. You can probably see your veins carrying your blood back to your heart. Your skin refracts light, though, so that deep red colour actually appears a little blue from outside the skin.

Here are some of the key **differences** between the two main types of blood vessels.

Arteries	Veins
Take blood away from the heart	Take blood to the heart
Walls are thick and elastic	Walls are thin
Transports oxygenated blood	Transports deoxygenated blood
Has small lumen	Has large lumen
Has a pulse and blood travels in spurts	Has no pulse and blood travels smoothly
Has no valves	Has valves

Capillaries: Connecting Arteries and Veins

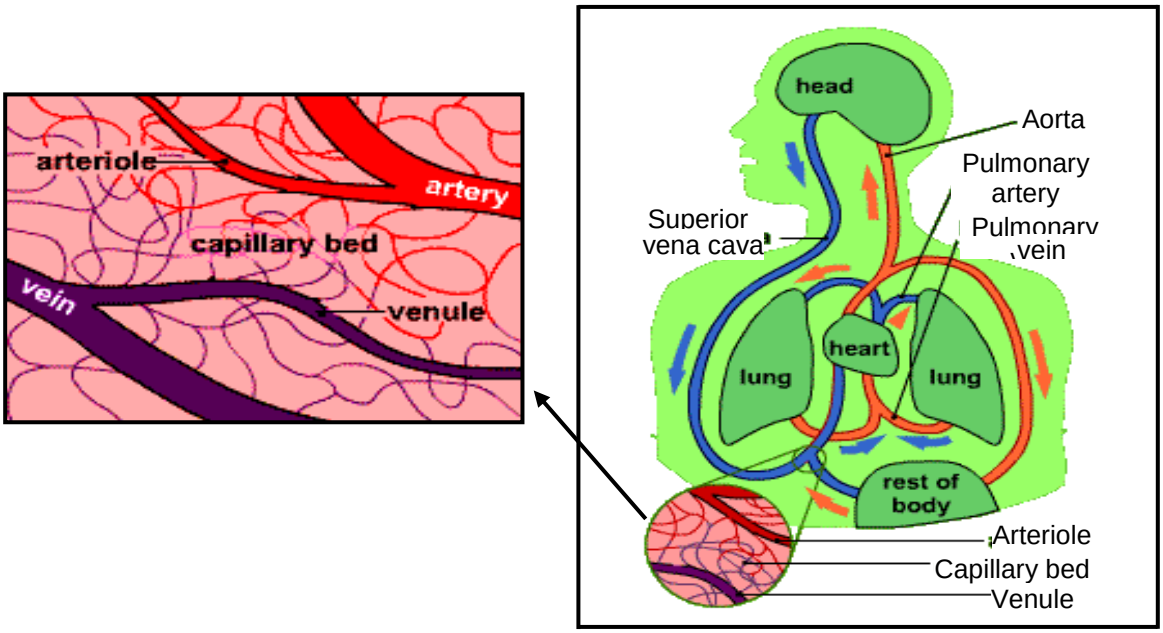
Unlike the arteries and veins, capillaries are very thin and fragile. The capillaries are actually only one epithelial cell thick. They are so thin that blood cells can only pass through them in single file. The exchange of oxygen and carbon dioxide takes place through the thin capillary wall. The red blood cells inside the capillary release their oxygen which passes through the wall and into the surrounding tissue. The tissue releases its waste products, like carbon dioxide, which passes through the wall and into the red blood cells.



Capillary

Arteries and veins run parallel throughout the body with a web-like network of capillaries, embedded in tissue, connecting them. The arteries pass their oxygen-rich blood to the capillaries which allow the exchange of gases within the tissue. The capillaries then pass their waste-rich blood to the veins for transport back to the heart.

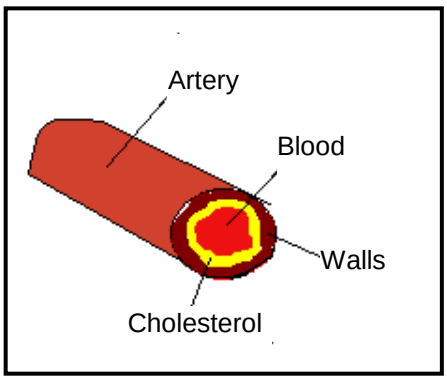
Capillaries are also involved in the body's release of excess heat. During exercise, for example, your body and blood temperature rises. To help release this excess heat, the blood delivers the heat to the capillaries which then rapidly release it to the tissue. The result is that your skin takes on a flushed, red appearance. If you hold your hand, for example, under hot water, your hand will quickly turn red for the same reason. Your arm, however, is not likely to change colour because it is not actually feeling an increase in temperature.



Capillaries: connecting arteries and viens

How can you keep your blood vessels healthy?

An important part of keeping your blood vessels healthy is eating right. If you eat too much fatty food, like butter, cheese, chips, or crisps, some of this fat naturally builds up around the arteries and veins. This is known as **cholesterol***. If there is too much cholesterol, it can build up and eventually starts to clog or block your arteries. Here are two pictures showing this:



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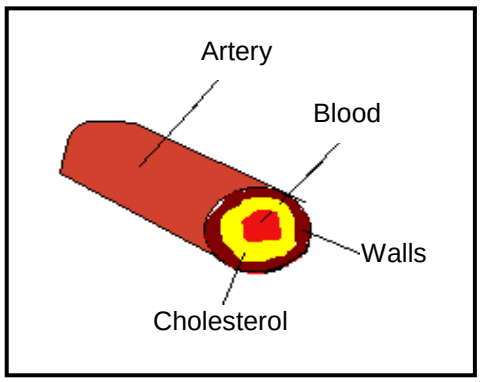


2

In the first picture, there is more blood and also less cholesterol. In the second picture, there is less blood in the arteries and more cholesterol. This is because the cholesterol clogs the arteries and reduces the amount of blood which flows in them. Because the arteries carry blood from the heart all over the body, this reduces the amount of blood supplied to your body cells.

This can have dangerous and life-threatening effects. Eventually, it may even cause a heart attack. Reducing the amount of fatty food you eat can reduce cholesterol. Eating fruits and vegetables can also help reduce cholesterol. It is also helpful to get exercise. Playing outside, riding a bicycle, or playing your favourite sport are all good activities.

Activity: **Now test yourself by doing this activity.**

Circle the letter of the correct answer.

1. Thick muscular walls are present in _____.

   A. veins B. arteries

   C. venules D. arterioles

2. The smallest blood vessel in the body is a _____.

   A. veins B. venule

   C. capillary D. vena cava

3. Valves are present in _____.

   A. veins B. arteries

   C. capillaries D. arterioles

4. Which blood vessel carries blood from the heart to all parts of the body?

   A. Aorta B. Vena cava

   C. Cardiac vein D. Coronary artery

5. Which blood vessel carries blood from the lungs to the heart?

   A. Hepatic vein B. hepatic artery

   C. pulmonary vein D. pulmonary artery

6. Which blood vessel carries blood from all parts of the body to the heart?

   A. Aorta B. Vena cava

   C. Cardiac vein D. Coronary vein

7. The blood vessel carrying blood from the heart to the lungs is

   A. carotid artery B. carotid vein

   C. pulmonary vein D. pulmonary artery

8. When compared to arteries, veins generally

   A. are more elastic. C. have thicker endothelium.

   B. have thinner walled. D. carry faster moving blood.

9. Which statement is true of arteries?

A. All arteries lack valves.

B. All arteries carry oxygenated blood away from the heart.

C. All arteries carry blood low in carbon dioxide away from the heart.

D. Some elastic arteries release significant amounts of renin-inhibiting factor.

10. In humans, gas exchange and gas transport occur as a result of the functioning of a system of

A. tubes

B. blood vessels

C. lungs and tubes

D. lungs and blood vessels

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 7.

Summary

You have come to the end of lesson 7. In this lesson you have learnt that:

- the blood vessels are the part of the circulatory system that transports blood throughout the body.
- there are three major types of blood vessels: the arteries, which carry the blood away from the heart; the capillaries, which enable the actual exchange of water and chemicals between the blood and the tissues; and the veins, which carry blood from the capillaries back toward the heart.
- arteries carry blood away from the heart at high pressure in thick walled lumen.
- **lumen** ("an opening") is the inside space of a tubular structure, such as an **artery** or intestine.
- the capillaries are actually only one epithelial cell thick.
- arteries and veins run parallel throughout the body with a web-like network of capillaries, embedded in tissue, connecting them.
- veins are similar to arteries but, because they transport blood at a lower pressure, they are not as strong as arteries.
- blood that flows up to the brain faces the same problem. If the blood is having a hard time climbing up, you will feel light-headed and possibly even faint.
- fainting is your brain's natural request for more oxygen-rich blood.

NOW DO PRACTICE EXERCISE 7 ON THE NEXT PAGE.

Practice Exercise 7

Answer the following questions:

1. Define blood vessels.

_____
_____
_____

2. Identify and describe the types of blood vessels.

_____
_____
_____
_____

_____
_____
_____
_____

_____
_____
_____
_____

3. Write the types of blood vessels associated in the following.

	The most muscular blood vessels
	These blood vessels carry blood from the heart
	These vessels return blood to the heart
	Exchange of materials occurs from these vessels
	Vessels in which the pulse is felt
	Contain valves to prevent the backflow of blood
	Very thin and fragile that blood cells can only pass through them in single file

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity

1. B
2. C
3. A
4. A
5. C
6. B
7. D
8. B
9. A
10. D

Lesson 8: Heart and Circulation

From the previous lesson you have studied about human blood vessels. You have identified and described the types of blood vessels in our body. You also studied the different functions of blood vessels in the body. For this lesson you will study the human heart and circulation.

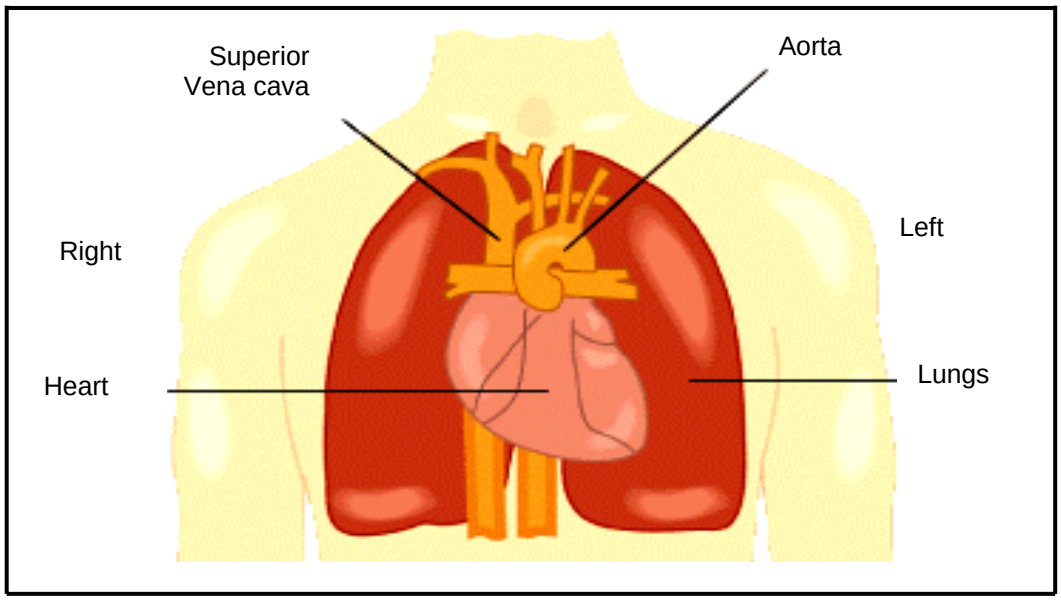
Your Aims:

- describe the human heart and its position
- identify the heart and blood related problems

The Human Heart

Everyone knows that the heart is a vital organ. We cannot live without our heart. However, when you get right down to it, the heart is just a pump. It is a complex and important one, yes, but still just a pump. As with all other pumps it can become clogged, break down and need repair. This is why it is critical that we know how the heart works. With a little knowledge about your heart and what is good or bad for it, you can significantly reduce your risk for heart disease.

The **heart** is a muscular organ about the size of a fist, located just behind and slightly left of the breastbone. It pumps blood through the network of arteries and veins called the cardiovascular system. It is a hollow, cone-shaped muscle located between the lungs and behind the sternum (breastbone). Two-thirds of the heart is located to the left of the midline of the body and 1/3 is to the right.



Heart position

Heart is located in the middle of your chest slightly to the left.

Chambers and valves of the heart

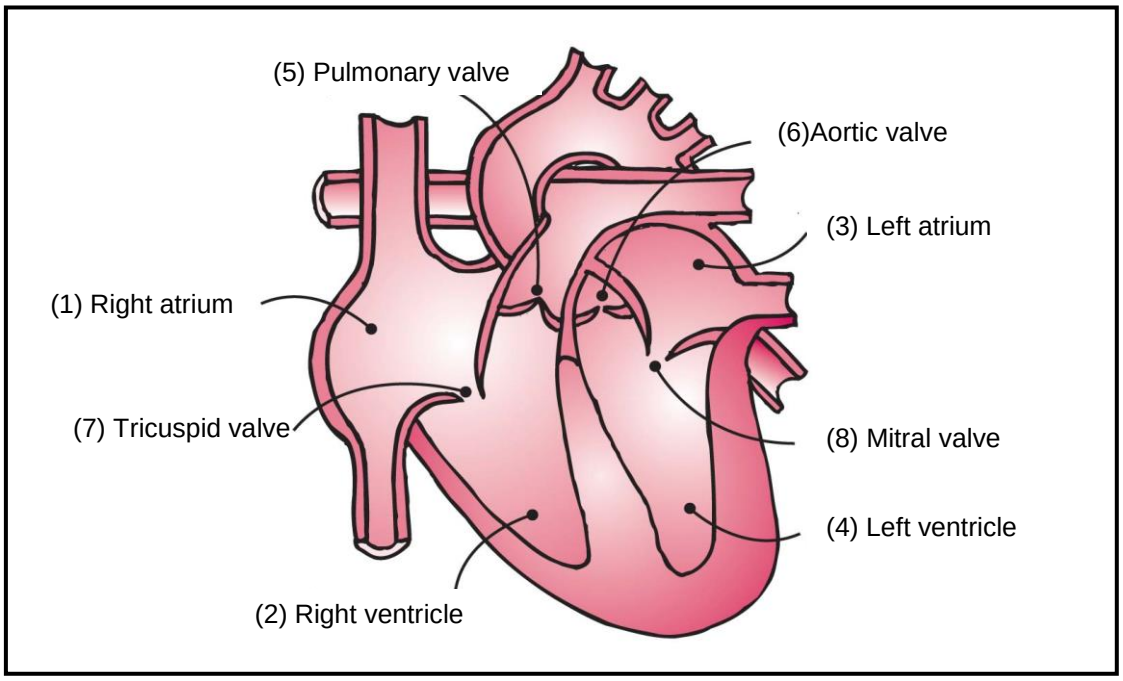
Looking inside the heart there are four chambers.
(1) Right atrium (RA),
(2) Right ventricle (RV),
(3) Left atrium (LA) and
(4) Left ventricle (LV).

At the top, the **right atrium** receives blood coming from the body and the **left atrium** collects blood coming from the lungs. The **ventricles** are underneath the atria (plural for atrium) and are the chambers that pump blood out of the heart. The **right ventricle** has a thin wall because it only needs to pump the blood around the lungs at low pressure. The **left ventricle** however has a much thicker wall because it generates the high pressure needed to push blood to the head and body.

The blood flow in and out of the ventricles is controlled by four valves. These ensure that blood always comes in from the atria and flows out through an artery.

(5) Pulmonary valve
(6) Aortic valve
(7) Tricuspid valve
(8) Mitral valve

One-way valves between the chambers stops blood from flowing in the wrong direction when the heart contracts. Sometimes they become damaged and cause the blood to flow irregularly. This can cause heart failure so valves can be replaced with artificial ones.



Chambers and valves of the heart

Blood Flow

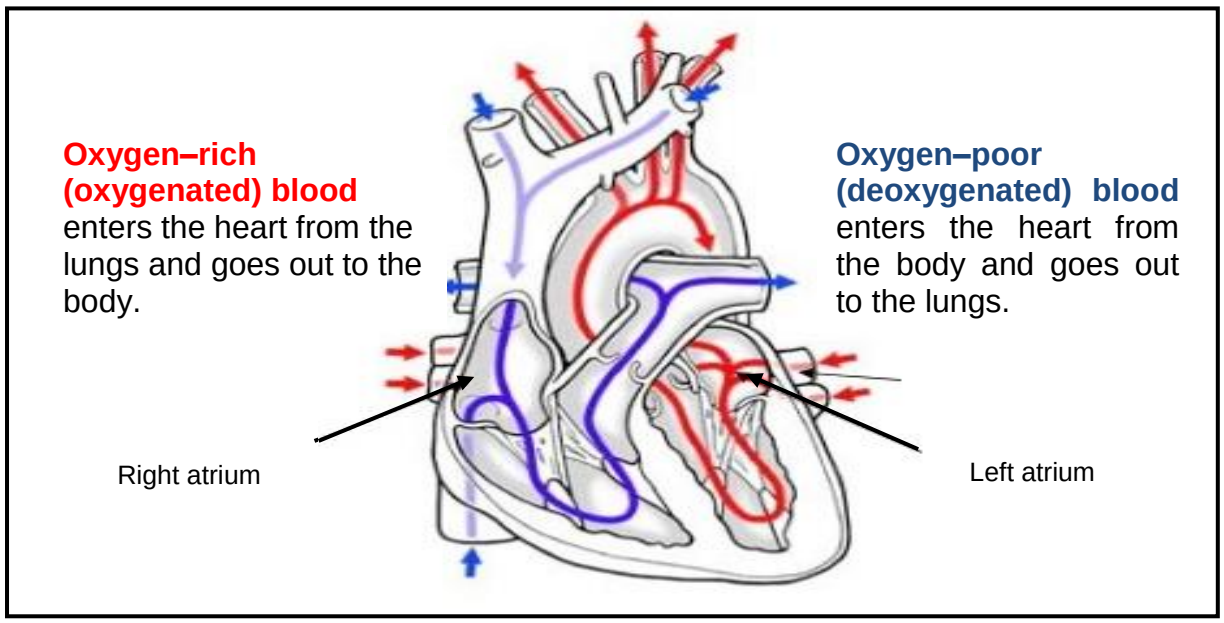
The large blood vessels carry blood to and from the heart's pumps. The **aorta** is the main artery from the heart.

When the heart muscle contracts or beats (called **systole**), it pumps blood out of the heart. The heart contracts in two stages.

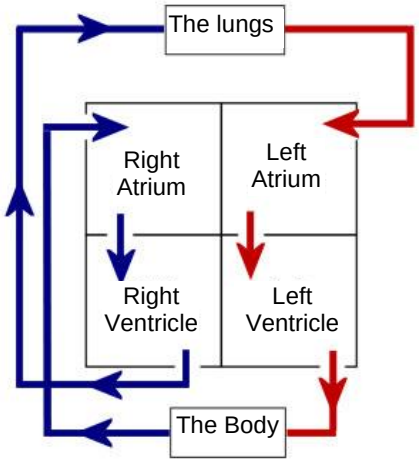
- In the first stage, the right and left atria contract at the same time, pumping blood to the right and left ventricles.
- Then the ventricles contract together to propel blood out of the heart.

Then the heart muscle relaxes (called **diastole**) before the next heartbeat. This allows blood to fill up the heart again.

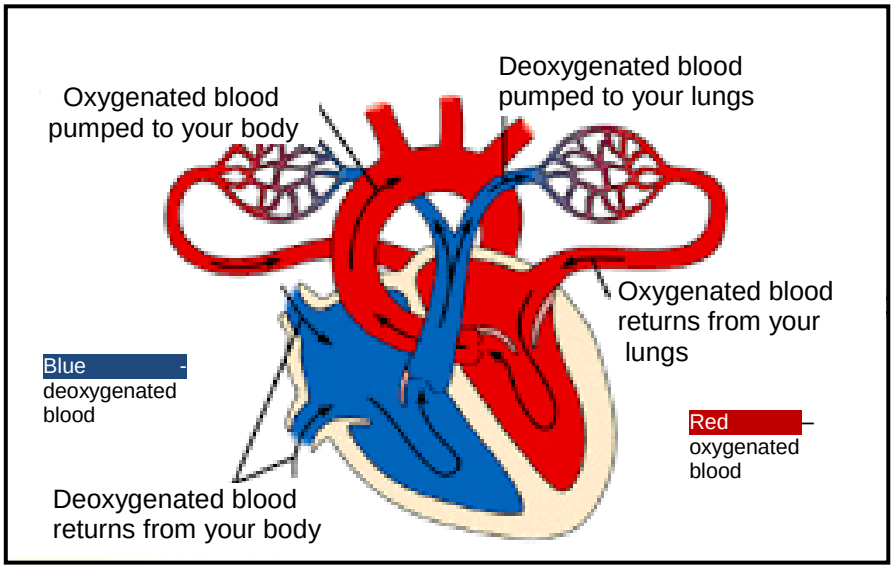
The right and left sides of the heart have separate functions. The right side of the heart collects oxygen-poor blood from the body and pumps it to the lungs where it picks up oxygen and releases carbon dioxide. The left side of the heart then collects oxygen-rich blood from the lungs and pumps it to the body so that the cells throughout your body have the oxygen they need to function properly.



How blood flows through the heart?
Blood from the body travels into the **right atrium**, moves into the **right ventricle**, and is finally pushed into **lungs** in the **pulmonary arteries**. The blood then picks up oxygen and travels back to the heart into the **left atrium** through the **pulmonary veins.** Then travels through to the **left ventricle** and exits to the **body** through the **aorta.**



Simple illustrations of the path of the blood flow through the heart are shown on the right and on the next page.

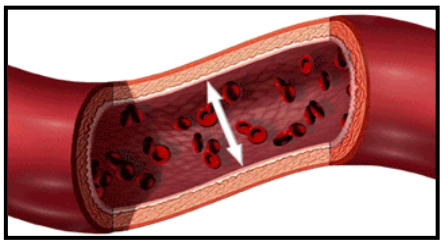


Path of blood through the heart

What is blood pressure (BP)?

The heart is a muscular pump which generates the blood pressure needed to keep the blood flowing.

Blood pressure is the pressure exerted by the circulating blood on the walls of the blood vessels (artery walls).



Blood pressure is the measurement of force applied to artery walls.

How is BP measured?

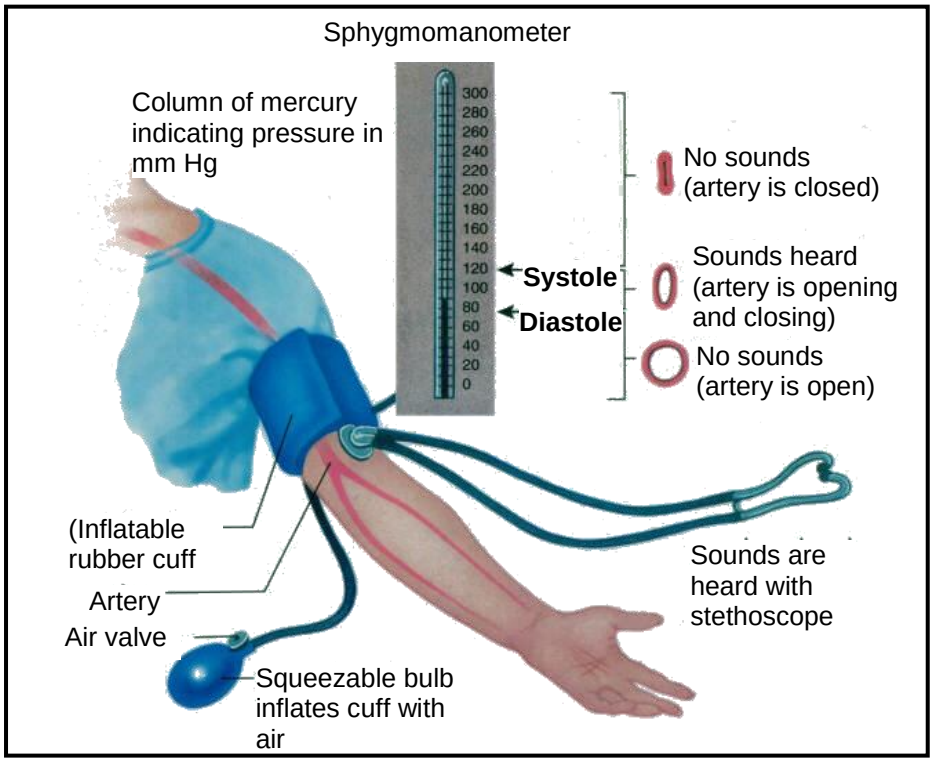
This can be measured using a piece of equipment called a **sphygmomanometer,** *(pronounced as sfig'-mo-ma-nom-eter).*

There are also modern digital blood pressure meters which take the readings automatically.

Types of sphygmomanometer

Measuring blood pressure

To measure blood pressure, place the blood pressure cuff, sphygmomanometer and stethoscope as shown in the on the next page. The blood pressure cuff is inflated until no blood flows through the artery Doctors always give blood pressure as two readings. The first reading is recorded when sounds are produced as the pressure in the cuff is released and blood begins to hit the arterial walls. The second reading is recorded when sounds end. A healthy person's normal pressure might be "120 over 80 mm of mercury (mmHg)".



Measuring blood pressure

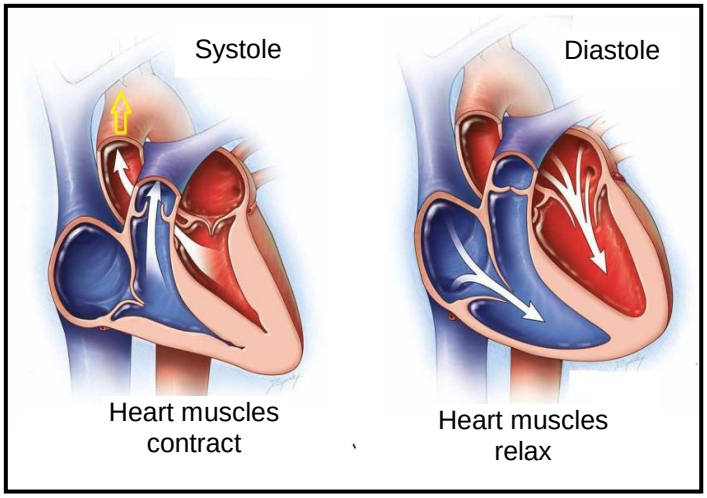
Blood pressure numbers- what does it indicate?

The first /top number- systolic pressure

The first number, which is also the higher of the two numbers, is the measure of the pressure in the arteries when the heart beats or left ventricle contracts to pump the oxygenated blood out of the heart. This is known as the systole of the heart as shown in the diagram on the right. Doctors call this the **systolic pressure.**

The second/bottom number- diastolic pressure

The second number is also the lower of the two numbers. It indicates the pressure in the arteries when the heart muscles are relaxing between two heart beats and refilling with blood. This is the **diastolic pressure.**



(The standard unit of pressure is the Pascal (Pa) and blood pressure can be measured in kilopascals (kPa). A pressure reading of 120 over 80 mmHg is equivalent to 16 over 10 kPa.).

Systolic: It measures the peak pressure on your arteries when the heart is pumping blood out to the body.

Diastolic: It measures the pressure between heart pumps when the blood is circulating throughout the body (resting).

If you notice that either your systolic blood pressure or your diastolic blood pressure are consistently over the normal levels after two or three visits, please see your primary physician.

High Blood Pressure (Hypertension)
During activity the blood pressure rises to supply blood faster to the hard-working muscles. This is caused by the body producing adrenaline, the so-called “fear, flight or fright” hormone. When relaxed, the pressure drops as the body's demands are normally much lower.

A person has high blood pressure if their resting blood pressure is higher than about 140/90mmHg. Hypertension is a problem because it puts great strain on the heart and can also cause tiny blood vessels to break. If this happens in the brain it leads to a stroke.

A **blood clot*** forms and deprives a part of the brain of blood. This damages nerve cells and can lead to paralysis or even death. People with hypertension should alter their lifestyle to take more exercise and eat a balanced diet with a high fruit and vegetable intake; low levels of saturated fat and salt and limited amounts of alcohol.

Low Blood Pressure (Hypotension)
Low blood pressure can be a sign of heart failure and may be due to a dramatic loss of blood due to severe bleeding after something like a road accident. If it is not treated quickly, oxygen is not delivered to the brain and this is fatal.

At the scene of a car accident, fluids may be put in to the blood stream, using an intravenous drip, to help maintain the blood pressure. Adrenaline can be given to stimulate the heart and during a heart attack a defibrillator gives an electric shock to "jump start" the heart to get it beating properly again.

Activity: **Now test yourself by doing this activity.**

A. Fill in the missing words.

The paragraphs below describe the flow of blood through the heart.

Deoxygenated blood enters the _____ through the vena cava. The atrium contracts and pushes this blood into the _____. The tricuspid valve makes sure that the blood flows the correct way.

When the _____ contracts, it forces blood through the semi lunar valve and along the pulmonary arteries to the _____.

In the lungs the blood becomes oxygenated. It returns to the heart in the _____. These enter the _____. When this contracts it pushes blood into the _____. This has a thick wall because when it contracts it generates high pressure to force the blood through the _____ to the head and body.

B. **A number of different factors can cause hypertension or hypotension. Look at each of the factors below. Decide whether they will cause hypertension or hypotension and give comments.**

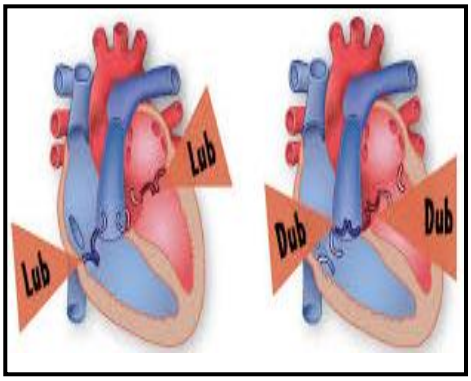
	Hypertension/ Hypotension	Comments
Excess fat in diet		
Over production of anti-diuretic hormone		
Bleeding (haemorrhage)		
Stress		
Heart attack		
Skin burns		

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 8.

Heart sounds

When someone listens to your heart with a stethoscope the sound is often described as lub-dub lub-dub. The first heart sound (lub) is caused by the acceleration and deceleration of blood and a vibration of the heart at the time of the closure of the tricuspid and mitral valves.

The second heart sound (dub) is caused by the same acceleration and deceleration of blood and vibrations at the time of closure of the pulmonic and aortic valves.



Heart sounds

Pulse rates

Your heart beats without fail all day every day. A healthy person's heart runs at about 72 beats per minute when they are resting. That is over 100 thousand beats in a day and over 2 billion in a lifetime.

The heart muscle is extremely efficient and it can be regulated to meet the demands of the body. Your heart rate goes up during activity to supply more blood to hard-working muscles. You can check your pulse in many places. The easiest is on your wrist and your neck.

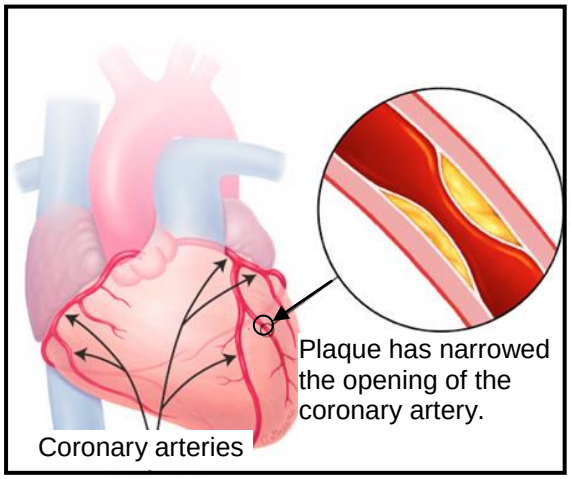
Pulse rates

To check your **pulse** at your wrist, place two fingers between the bone and the tendon over your radial artery — which is located on the thumb side of your wrist. When you feel your **pulse**, count the number of beats in 15 seconds. Multiply this number by 4 to calculate your beats a minute.

Common Heart Conditions

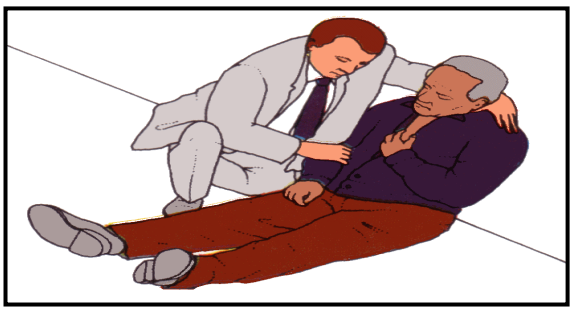
1. **Coronary artery disease**
   This happens when the arteries that supply blood to heart muscle become hardened and narrowed due to buildup of cholesterol and other material called plaque on the inner walls.

   As a result, the flow of oxygen-rich blood to your heart muscle is reduced or blocked, heart attack can occur. A heart attack occurs when heart muscle tissue dies.



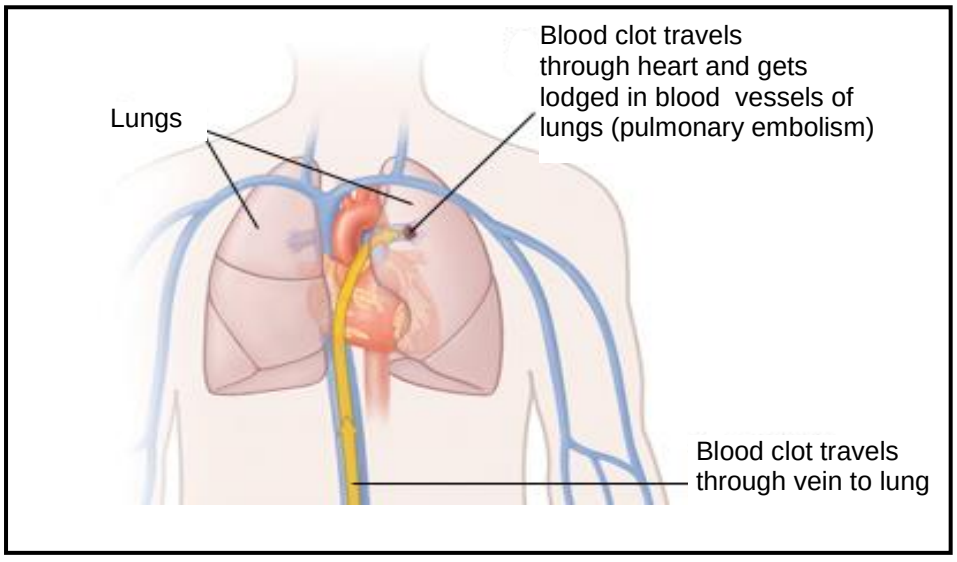
Coronary artery disease

2. **Cardiac arrest**
   This happens when your heart stops beating and pumping blood around your body. Someone who is having a cardiac arrest will suddenly lose consciousness and will stop breathing or stop breathing normally.



Cardiac arrest

3. **Pulmonary embolism**
   Typically a blood clot travels through the heart to the lungs.



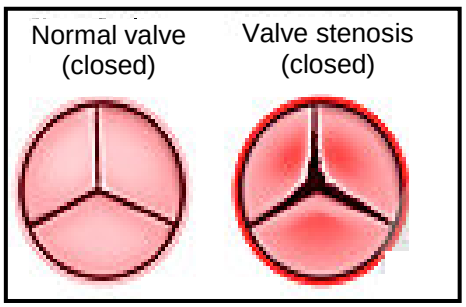
Pulmonary embolism

4. **Stable angina pectoris**
Narrowed coronary arteries cause predictable chest pain or discomfort with exertion. The blockages prevent the heart from receiving the extra oxygen needed for strenuous activity. Symptoms typically get better with rest.

Narrowed coronary artery

Person suffering of chest pain

5. **Heart valve disease**
There are four heart valves, and each can develop problems. If severe, valve disease can cause congestive heart failure.



Heart valve disease

Summary

You have come to the end of lesson 8. In this lesson you have learnt that:

- the heart is a muscular pump which generates the blood pressure needed to keep the blood flowing. This can be measured using a piece of equipment called a sphygmomanometer.
- it is a hollow, cone-shaped muscle located between the lungs and behind the breastbone. Two-thirds of the heart is located to the left of the midline of the body and 1/3 is to the right.
- the heart has three layers. The smooth, inside lining of the heart is called the endocardium. The middle layer of heart muscle is called the myocardium. It is surrounded by a fluid filled sac call the pericardium.
- a healthy person's heart runs at about 72 beats per minute when they are resting. That is over 100 thousand beats in a day and over 2 billion in a lifetime.
- the first sound of your heart is caused by the acceleration and deceleration of blood and a vibration of the heart at the time of the closure of the tricuspid and mitral valves.
- the second heart sound is caused by the same acceleration and deceleration of blood and vibrations at the time of closure of the pulmonic and aortic valves.

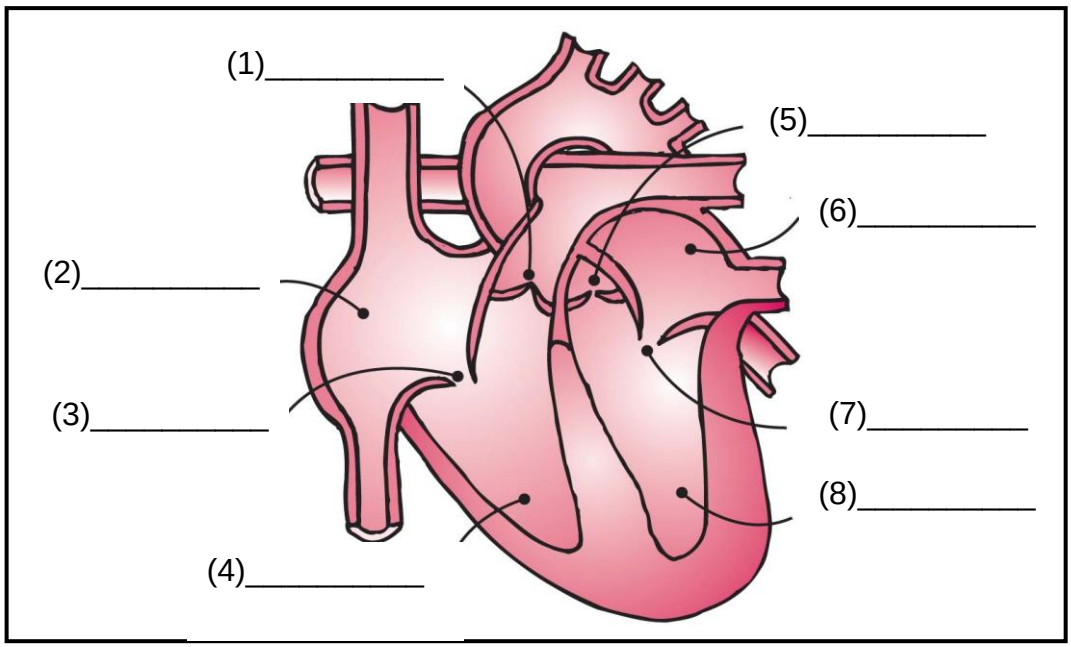
- the heart is divided into four chambers; (1) Right atrium, (2) Right ventricle, (3) Left atrium and (4) Left ventricle.
- the aorta is the main artery from the heart. It carries oxygenated blood to the body and head.
- the ventricles are underneath the atria and are the chambers that pump blood out of the heart.
- the right ventricle has a thin wall because it only needs to pump the blood around the lungs at low pressure.
- the left ventricle has a much thicker wall because it generates the high pressure needed to push blood to the head and body.
- hypertension and hypotension are problems of the blood.
- heart conditions include coronary artery disease, cardiac arrest, pulmonary embolism, stable angina pectoris and heart valve disease.

NOW DO PRACTICE EXERCISE 8 ON THE NEXT PAGE.

Practice Exercise 8

Answer the following questions:

1. Label the diagram below.



2. Identify and describe the different heart problems.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity

Part A.

Deoxygenated blood enters the **right atrium** through the vena cava. The atrium contracts and pushes this blood into the **right ventricle**. The tricuspid valve makes sure that the blood flows the correct way.

When the **right ventricle** contracts, it forces blood through the semi lunar valve and along the pulmonary arteries to the **lungs**.

In the lungs the blood becomes oxygenated. It returns to the heart in the **pulmonary veins**. These enter the **left atrium**. When this contracts it pushes blood into the **left ventricle**. This has a thick wall because when it contracts it generates high pressure to force the blood through the **aorta** to the head and body.

Part B.

	Hypertension/ Hypotension	Comments
Excess fat in diet	Hypertension	Excess fat can build up and cause partial blockages of arteries. They lose their flexibility and this leads to an increase in blood pressure.
Over production of anti-diuretic hormone	Hypertension	Over secretion of anti-diuretic hormone (ADH) can happen in cancer of the hypothalamus. The kidneys retain excess amounts of water which increases the blood volume and pressure.
Bleeding (haemorrhage)	Hypotension	Severe bleeding causes a loss of blood which results in a fall in pressure because there is simply less in the system.
Stress	Hypertension	Stress causes the release of the hormone adrenalin. This raises the blood pressure.
Heart attack	Hypotension	During a **heart attack***, the heart fails to pump the blood efficiently. Without the heart forcing blood around the body, the blood pressure rapidly falls.
Skin burns	Hypotension	An extensive burn causes a loss of fluid from the affected tissues. In turn, this reduces the blood volume and pressure. Following burns, dehydration can be a severe problem.

Answers to Practice Exercises 6 - 8

Practice Exercise 6

1. It is the red liquid that circulates in the arteries and veins of humans and other vertebrate animals, carrying oxygen to and carbon dioxide from the tissues of the body.

2. (i) Red blood cells are round with a flattish, indented centre, like doughnuts without a hole. They play an important role in our health by carrying fresh oxygen throughout the body.
   (ii) White blood cells are an important component of the blood system. White blood cells, also called leukocytes, are essential for good health and protection against illness and disease.
   (iii) Platelets are tiny cell fragments that are found within our blood. They originate in the bone marrow as pinched-off pieces of larger cells

3. Plasma is the often forgotten component of blood. White blood cells, red blood cells, and platelets are essential to body function, but plasma also plays a crucial, and mostly unrecognized, job. It carries these blood components throughout the body as the fluid in which they travel.

4. (i) Transports dissolved gases
   (ii) Maintains body temperature
   (iii) Controls pH
   (iv) Removes toxins from the body.
   (v) Regulation of body fluid electrolytes

Practice Exercise 7

1. Blood vessels are the part of the circulatory system that transports blood throughout the body.

2. The arteries carry the blood away from the heart.

   The veins, which carry blood from the capillaries back toward the heart. The arteries and veins have the same structure with three layers, from inside to outside.

   The capillaries enable the actual exchange of water and chemicals between the blood and the tissues.

3.

Arteries
Arteries
Veins
Capillaries
Arteries
Veins
Capillaries

Practice Exercise 8

1. (1) Pulmonary valve
   (2) Right Atrium
   (3) Tricuspid valve
   (4) Right ventricle
   (5) Aortic valve
   (6) Left atrium
   (7) Mitral valve
   (8) Left ventricle

2. Heart attack or Coronary thrombosis - causes severe pain in the chest, stomach, neck or shoulders. During an attack, the heart rate becomes rapid and the person may become light headed, sweat, get short of breath and feel sick.

   A therosclerosis is where arteries are partly blocked by fatty deposits that build up and harden on their inside wall. If this happens in a coronary artery it can cause angina or even a heart attack.

   Angina - there are chest pains which may spread to the shoulders and both arms. Attacks are often triggered by activity and stop within minutes of the person resting. In severe cases, even everyday activities like climbing the stairs can start an attack.

   Heart failure - the heart cannot pump effectively and this causes a build-up of blood pressure in the lungs. The heart weakens gradually over a period of years. A person suffering from long term heart failure will generally be tired, breathless and find any form of physical activity a problem.

   Heart bypass or Coronary artery bypass - patients suffering from a narrowing of a coronary artery may need to have an operation to divert blood around this blockage.

REVISE TOPIC 2 USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 2: Circulatory System

Revise all the Lessons in this Topic and then do **ASSIGNMENT 3.**
Here are the main points to help you revise.

Lesson 6: The blood

- Blood is the red liquid that circulates in the arteries and veins of humans and other vertebrate animals, carrying oxygen to and carbon dioxide from the tissues of the body.
- Red blood cells are round with a flattish, indented centre, like doughnuts without a hole.
- White blood cells are an important component of the blood system.
- Platelets are tiny cell fragments that are found within our blood.
- Plasma is the often forgotten component of blood.
- White blood cells, red blood cells, and platelets are essential to body function, but plasma also plays a crucial, and mostly unrecognized, job.
- Common symptoms of red blood cell disorders are:
  - fatigue
  - shortness of breath
  - trouble concentrating from lack of oxygenated blood in the brain
  - muscle weakness
  - a fast heartbeat

Lesson 7: The Blood Vessels

- The blood vessels are the part of the circulatory system that transports blood throughout the body.
- There are three major types of blood vessels: the arteries, which carry the blood away from the heart; the capillaries, which enable the actual exchange of water and chemicals between the blood and the tissues; and the veins, which carry blood from the capillaries back toward the heart.
- Arteries carry blood away from the heart at high pressure in thick walled lumen.
- Lumen ("an opening") is the inside space of a tubular structure, such as an artery or intestine.
- The capillaries are actually only one epithelial cell thick.
- Arteries and veins run parallel throughout the body with a web-like network of capillaries, embedded in tissue, connecting them.
- Veins are similar to arteries but, because they transport blood at a lower pressure, they are not as strong as arteries.
- Blood that flows up to the brain faces the same problem. If the blood is having a hard time climbing up, you will feel light-headed and possibly even faint.
- Fainting is your brain's natural request for more oxygen-rich blood.

Lesson 8: Heart and Circulation

- The heart is a muscular pump which generates the blood pressure needed to keep the blood flowing. This can be measured using a piece of equipment called a sphygmomanometer.
- It is a hollow, cone-shaped muscle located between the lungs and behind the breastbone. Two-thirds of the heart is located to the left of the midline of the body and 1/3 is to the right.

- The heart has three layers. The smooth, inside lining of the heart is called the endocardium. The middle layer of heart muscle is called the myocardium. It is surrounded by a fluid filled sac call the pericardium.
- A healthy person's heart runs at about 72 beats per minute when they are resting. That is over 100 thousand beats in a day and over 2 billion in a lifetime.
- The first sound of your heart is caused by the acceleration and deceleration of blood and a vibration of the heart at the time of the closure of the tricuspid and mitral valves.
- The second heart sound is caused by the same acceleration and deceleration of blood and vibrations at the time of closure of the pulmonic and aortic valves.
- The heart is divided into four chambers; (1) Right atrium, (2) Right ventricle, (3) Left atrium and (4) Left ventricle.
- The aorta is the main artery from the heart. It carries oxygenated blood to the body and head.
- The ventricles are underneath the atria and are the chambers that pump blood out of the heart.
- The right ventricle has a thin wall because it only needs to pump the blood around the lungs at low pressure.
- The left ventricle has a much thicker wall because it generates the high pressure needed to push blood to the head and body.
- Hypertension and hypotension are problems of the blood.
- Heart conditions include coronary artery disease, cardiac arrest, pulmonary embolism, stable angina pectoris and heart valve disease

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REVISE WELL AND THEN DO TOPIC TEST 2 IN YOUR ASSIGNMENT 3.

TOPIC 3

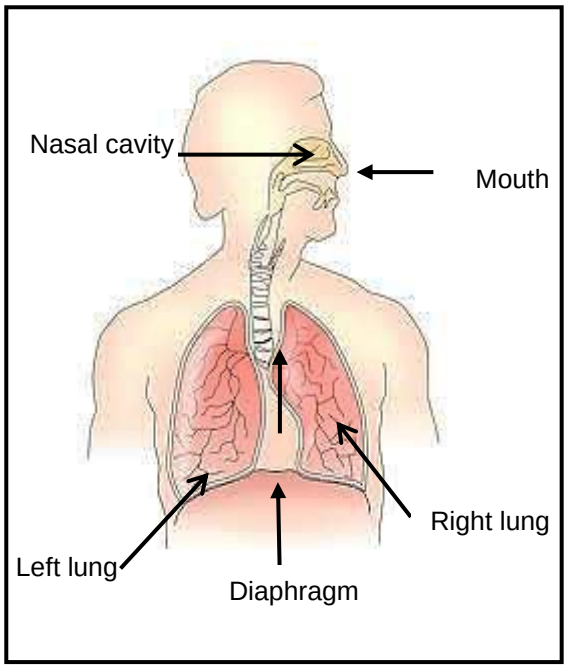
RESPIRATORY SYSTEM

In this topic you will learn about:

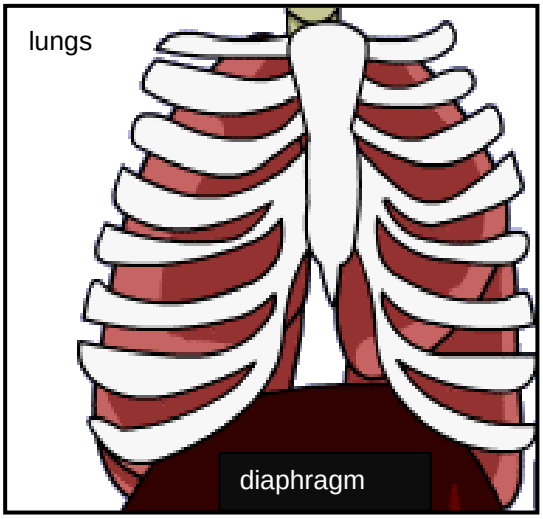
- **respiratory system**
- **breathing**
- **digestive system**

INTRODUCTION TO TOPIC 3: RESPIRATORY SYSTEM

Your respiratory system is made up of various organs that allow you to take in oxygen and expel carbon dioxide



The lungs are the main organs of the respiratory system. In the lungs oxygen is taken into the body and carbon dioxide is breathed out. The red blood cells are responsible for picking up the oxygen in the lungs and carrying the oxygen to all the body cells that need it. The red blood cells drop off the oxygen to the body cells, then pick up the carbon dioxide which is a waste gas product produced by our cells. The red blood cells transport the carbon dioxide back to the lungs and we breathe it out when we exhale.



The trachea is sometimes called the windpipe. The trachea filters the air we breathe and branches into the bronchi.

The bronchi are two air tubes that branch off of the trachea and carry air directly into the lungs.

Breathing starts with a dome-shaped muscle at the bottom of the lungs called the diaphragm. When you breathe in, the diaphragm contracts. When it contracts, it flattens out and pulls downward. This movement enlarges the space that the lungs are in. This larger space pulls air into the lungs. When you breathe out, the diaphragm expands reducing the amount of space for the lungs and forcing air out. The diaphragm is the main muscle used in breathing.

Some of the questions that you may be asking yourself now are:

- Why is the breathing process important?
- What are the proper ways to keep the body healthy?
- What are the effects of smoking in the respiratory systems?
- How are digestion and enzymes important in the digestive system?

In this Topic, you will find the answers to these questions and other questions relating to the respiratory system.

Lesson 9: Respiratory System

Welcome to Lesson 9. When you breathe in and out, your respiratory system is working. The respiratory system is made up of various organs that allow you to take in oxygen and expel carbon dioxide. If you do not have oxygen, you cannot get rid of carbon dioxide and your body cannot live for longer than a few minutes. In this lesson you will learn more about the human respiratory system.

Your Aims:

- define diffusion and respiration
- describe structure of respiratory system
- identify the diseases associated with respiratory system

What is Diffusion?

If you have ever had a cup of tea, you will have probably watched the tea spread out as it hits the hot water. The tea starts in the tea bag, which is filled with tea leaves. Slowly, the tea seeps out into the water. As time passes, the once clear water becomes the same brown colour with the tea. Once the tea cools, you are then free to enjoy it. This process you see every time with your tea is called diffusion. **Diffusion** is the process of something moving from high concentration to low concentration, and it happens in your body all the time. Diffusion does not need energy to get started.

Diffusion continues until it reaches **equilibrium**, or the point where everything is in balance, is reached. Think of your tea. It eventually becomes all the same colour, dark brown, and stays that way. The tea has reached equilibrium at that point. Now that we are clear on diffusion, let us take a look at the respiratory system and how diffusion works there. Let us first of all look at what respiration is.

What is Respiration?

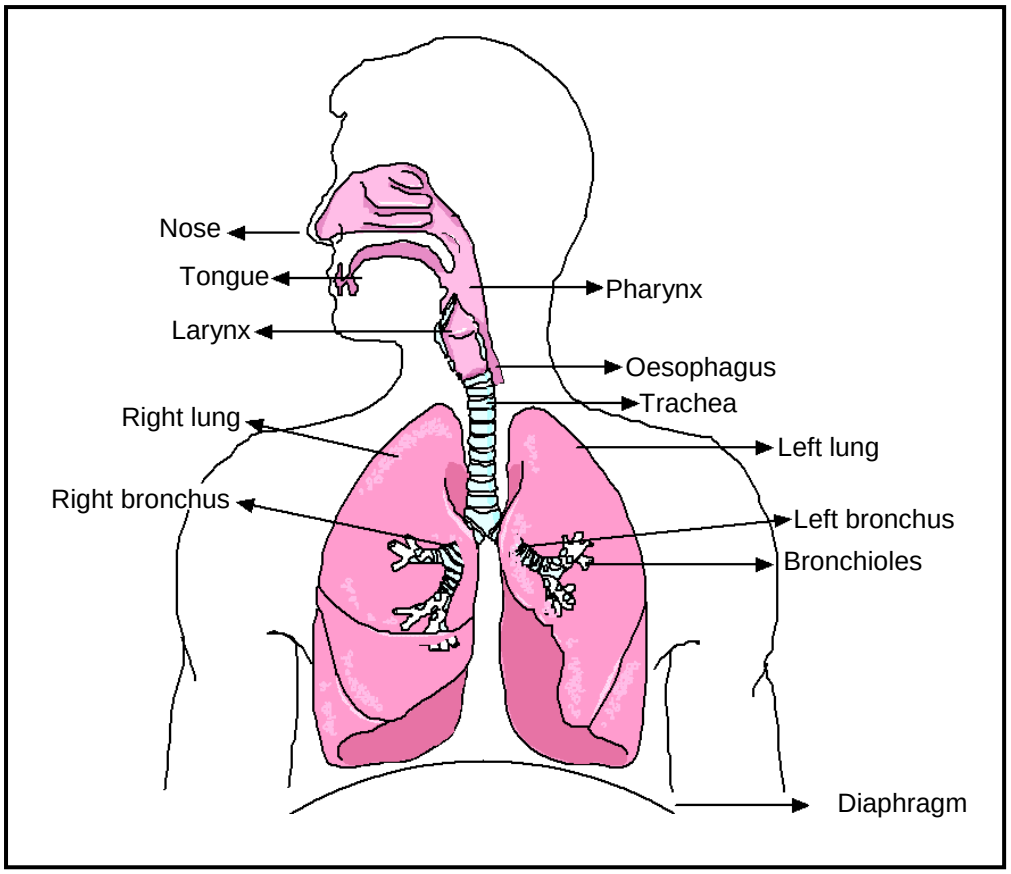
The air that we breathe is made up of several gases. Oxygen is the most important for keeping us alive because our body cells need it for energy and growth. Without oxygen, the body's cells would die.

Carbon dioxide is the waste gas that is produced when carbon is combined with oxygen as part of the body's energy making processes. The carbon dioxide that is produced is a result of chemical reactions within the cells. The exchange of oxygen and carbon dioxide occurs by way of diffusion across cell membranes.

What is the respiratory system?

The human respiratory system is a series of organs that are responsible for controlling the exchange of gases in the body. It is how we take in oxygen and expel carbon dioxide.

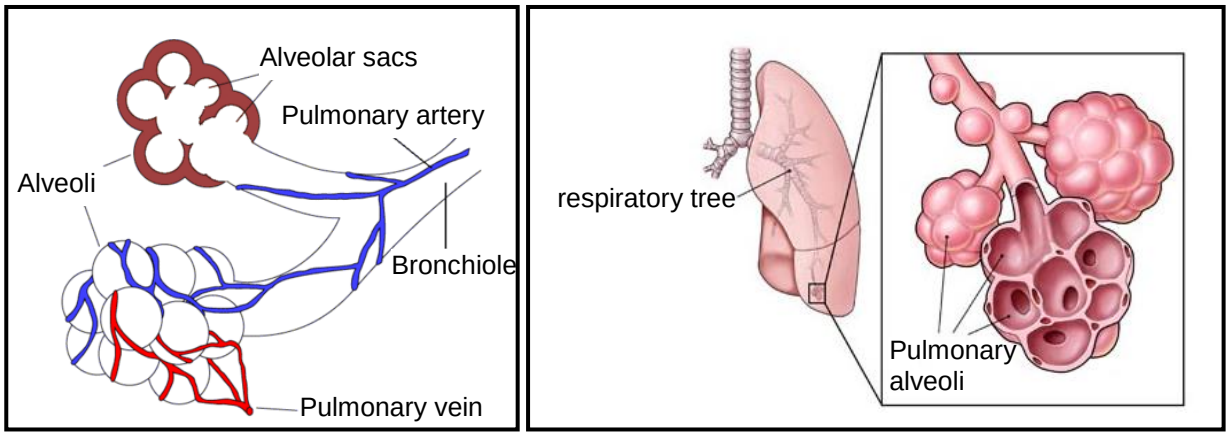
The human respiratory system is composed of the nasal passage, the pharynx, larynx, the trachea, bronchi and lungs. It is responsible for the process of respiration that is vital to the survival of living beings



The respiratory system

In our bodies, the respiratory system starts with the mouth and nose, where air enters the body. Next the air travels through the trachea, or windpipe in the throat. After that, the trachea splits into tubes called right and left bronchi. These tubes continue to get smaller and smaller like branches on a tree.

At the smallest branches of the bronchi, called bronchioles, there are little sacs known as alveoli, which are surrounded by tiny blood vessels called capillaries. Think of the alveoli like the leaves on the end of tree branches.



Alveoli

The exchange of gases is the respiratory system's means of getting oxygen to the blood. The lungs carry out the process of gas exchange. In order for the blood to deliver oxygen, the respiratory system does this through breathing. When we breathe, we inhale oxygen and exhale carbon dioxide.

Red blood cells collect the oxygen from the lungs and carry it to the parts of the body where it is needed. During the process, the red blood cells collect the carbon dioxide and transport it back to the lungs, where it leaves the body when we exhale.

The purpose of the respiratory system is to perform gas exchange. The lungs carry out the process of gas exchange.

The Process of Gas Exchange

We now know that our bodies need oxygen to survive, but in the process of using oxygen, we also produce carbon dioxide which is poisonous. The body needs a way to get oxygen in and carbon dioxide out, which is through diffusion. When blood returns to your lungs from the body, it has a lot of carbon dioxide and no oxygen. The carbon dioxide concentration is much greater in your blood than the alveoli. So, by the rule of diffusion, the carbon dioxide moves from the blood to the alveoli, where it can be exhaled through the lungs.

The same thing happens with oxygen. Since blood returning to the lungs has lots of carbon dioxide and very little oxygen, there is more oxygen in the alveoli compared to the blood. Oxygen diffuses into the blood from the alveoli through the capillaries.

Functions of Respiratory System

You may use the table below to study the functions of the different organs that make up the respiratory system.

Parts	Functions
Nasal Passages	The nasal cavity is responsible for conditioning the air that is received by the nose. The process of conditioning involves warming or cooling the air received by the nose, removing dust (the tiny hairs called cilia filters out dust) particles from it and also moistening it, before it enters the pharynx.
Pharynx	It is located behind the nasal cavity and above the larynx. It is also a part of the digestive system of the human body. Food as well as air passes through the pharynx.
Larynx	It is associated with the production of sound. It consists of two pairs of membranes. Air causes the vocal cords to vibrate, thus producing sound. The larynx is situated in the neck of mammals and plays a vital role in the protection of the trachea.
Trachea	The term refers to the airway through which respiratory air travels. The rings of cartilage within its walls keep the trachea open.
Bronchi	The trachea divided into two main bronchi. The bronchi extend into the lungs spreading in a tree-like manner as bronchial tubes. The bronchial tubes subdivide and with each subdivision, their walls get thinner. This dividing of the bronchi into thin-walled tubes results in

	the formation of bronchioles. The bronchioles terminate in small air chambers, each of which contains cavities known as alveoli. Alveoli have thin walls, which form the respiratory surface. The exchange of gases between the blood and the air takes place through these walls.
Lungs	Lungs form the most vital component of the human respiratory system. They are located on the two sides of the heart. They are responsible for transporting oxygen from the atmosphere into blood and releasing carbon dioxide from blood to the atmosphere.
Diaphragm	Breathing begins with a dome-shaped muscle located at the bottom of the lungs which is known as diaphragm. When we breathe in the diaphragm contracts and flatten out and pull downward. Due to this movement the space in the lungs increases and pulls air into the lungs. When we breathe out, the diaphragm expands and reduces the amount of space for the lungs and forces air out.

Diseases Associated with Respiratory System

Pollutants and infectious diseases can affect your lungs and respiratory system and cause respiratory problems. Some of the problems of the respiratory system that can affect people include:

Asthma
Asthma is a long-term, inflammatory lung disease that causes airways to tighten and narrow when a person with the condition comes into contact with irritants such as cigarette smoke, dust or scales shed from feathers, hair or skin of various animals.

Bronchitis
Bronchitis affects those who smoke. In bronchitis, the thin layers of tissues (membranes) lining the larger bronchial tubes become inflamed and an excessive amount of mucus is produced. The person with bronchitis develops a bad cough to get rid of the mucus.

Common cold
Colds are caused by over two hundred viruses that cause inflammation in the respiratory tract. The common cold is the most common respiratory infection. Symptoms may include a mild fever, cough, headache, runny nose, sneezing, and sore throat.

Emphysema
Emphysema is a disease where the alveoli are enlarged and damaged resulting in breathing difficulty, which is made worse by infections.

Pneumonia
Pneumonia is an inflammation of the lungs, which usually occurs because of infection with a bacteria or virus. Pneumonia causes fever, inflammation of lung tissue, and makes breathing difficult because the lungs have to work harder to transfer oxygen into the blood stream and remove carbon dioxide from the blood.

Activity: Now test yourself by doing this activity.

Choose the letter of the correct answer.

1. Exchange of air occurs in _____ which are also known as 'air sacs'.

   A. Alveoli B. Bronchi

   C. Bronchioles D. Alveolar ducts

---

2. Write the correct sequence of the pathway through which air travels after entering the body.

   A. Larynx, pharynx, trachea, bronchioles
   B. Pharynx, larynx, trachea, bronchioles
   C. Pharynx, larynx, bronchioles, trachea
   D. Pharynx, trachea, larynx, bronchioles

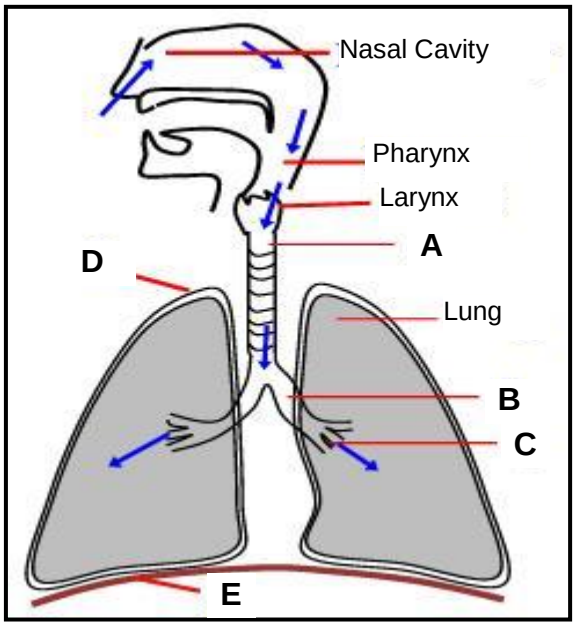
---

3. Which process does **not** occur in the nasal cavity?

   A. Exchange of gases
   B. Warming of inhaled air
   C. Humidification of inhaled air
   D. Trapping of large foreign bodies

4. Given this diagram, identify

   i. diaphragm _____
   ii. bronchus _____



5. Which part of the respiratory tract is also known as the voice box?

A. Larynx B. Pharynx

C. Trachea D. Epiglottis

---

6. What is the purpose of the little hairs inside the nose?

A. To fight disease

B. They serve no purpose

C. To keep dust out of the lungs

D. To tickle the nose and cause sneezes

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 9.

Summary

You have come to the end of Lesson 9. In this lesson you have learnt that:

- respiration is the process of obtaining and using oxygen, while eliminating carbon dioxide.
- diffusion is the process of something moving from high concentration to low concentration.
- the human respiratory system is composed of the nasal passage, the pharynx, larynx, the trachea, bronchi and lungs.
- the primary function of the respiratory system is to supply the blood with oxygen to all parts of the body.
- the respiratory system is made of body parts that are in charge of your breathing. It includes your nose and nasal cavity.
- the nasal cavity is responsible for conditioning the air that is received by the nose.
- the windpipe (trachea) joins the upper respiratory tract to the lungs.
- trachea refers to the airway through which respiratory air travels. The rings of cartilage within its walls keep the trachea open.
- the alveoli give our lungs a huge surface for absorbing oxygen from the air.
- the lungs carry out the process of gas exchange.
- pollutants and infectious diseases can affect the lungs and respiratory system and cause respiratory problems.

NOW DO PRACTICE EXERCISE 9 ON THE NEXT PAGE.

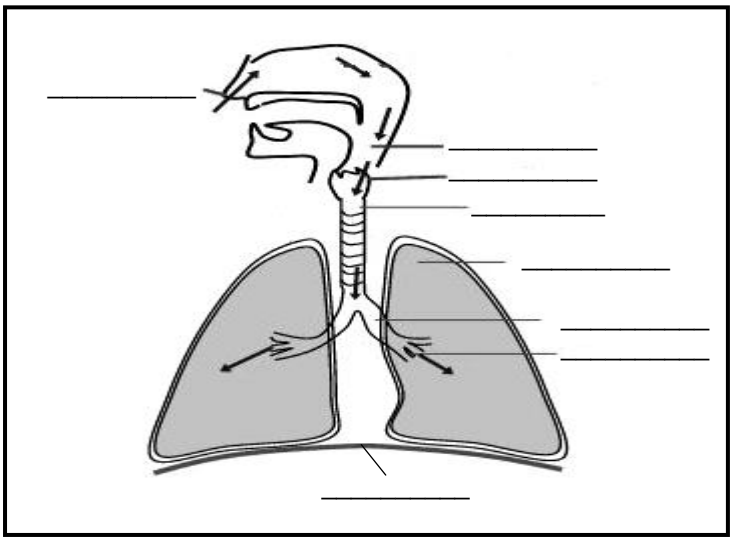
Practice Exercise 9

Answer the following questions;

1. Define respiration.

_____
_____

2. Label the following.



3. Give the functions of the following.

Pharynx	
Nasal Passages	
Lungs	
Diaphragm	

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.

Answers to activity

1. A
2. B
3. A
4. i. E
   ii. B
5. A
6. C

Lesson 10: Breathing

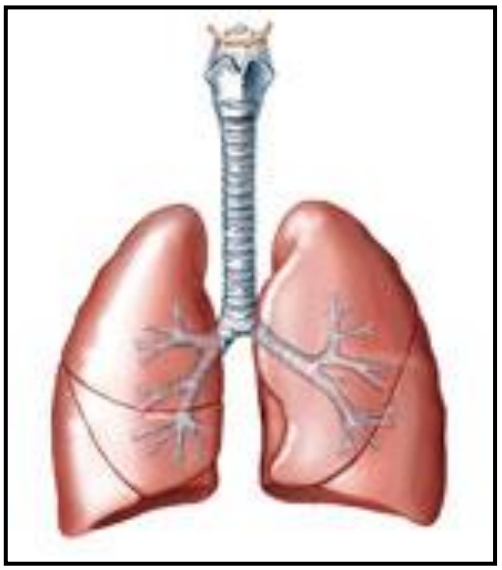
Welcome to Lesson 10. In the previous lesson you learnt about the respiratory system. In this lesson, you will learn about breathing. Do you know that each day we breathe about twenty thousand times? Breathing is so important to life that it happens automatically. All of us cannot live without breathing. All of this breathing could not happen without help from the respiratory system.

Your Aims:

- define breathing
- describe the breathing rate
- describe the artificial respiration
- describe the organs involved in breathing

What Is Breathing?

Breathing is the only process that delivers oxygen to where it is needed in the body and removes carbon dioxide. All animals need oxygen to live. Land animals get oxygen from the air. Without the oxygen in the air we cannot survive more than a few minutes. Breathing happens automatically, we do not have to even think about it.



Lungs

We breathe in air in order to take in oxygen into our bloodstream and get rid of carbon dioxide. The oxygen is carried in the blood to all the body's cells. The air we breathe out has 100 times more carbon dioxide than the air we breathe in.

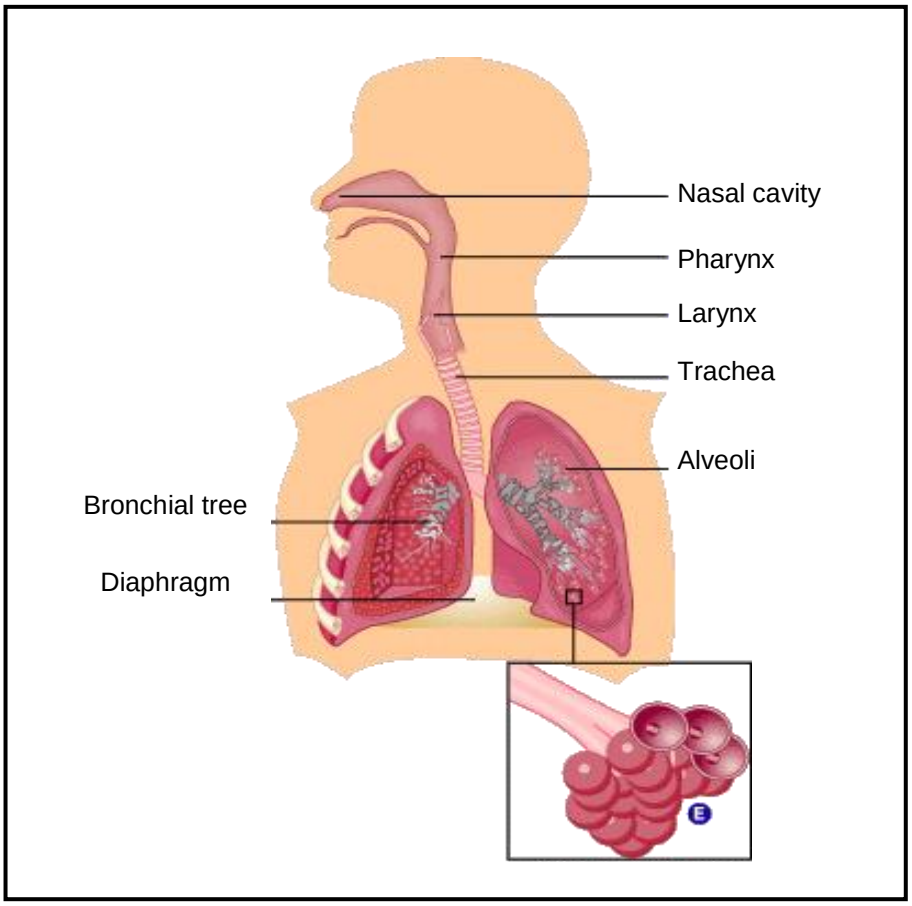
And what are the two parts that are large and in charge when it comes to breathing?

If you guessed your lungs, you are right. Your lungs make up one of the largest organs in your body, and they work with your respiratory system to allow you to breathe. The process of taking air into the lungs is called **inhalation or inspiration** and the process of breathing it out is called **exhalation or expiration**.

Air comes into your body through the nose or mouth, and enters the airways. **Airways** are the tubes that carry air into our lungs. As they branch out, they become smaller and smaller, and eventually connect to small air sacs where fresh oxygen from the air is exchanged for carbon dioxide in the blood. This oxygen is then taken through the blood to the rest of your body, where it is used to produce energy.

Organs used in Breathing

The respiratory system is composed of the nose and mouth, pharynx and larynx, trachea and bronchi, as well as the lungs and thorax.



Nose and Mouth

The nose is what we normally use to inhale and exhale. It has two holes called nostrils through which air passes. The skin lining both nostrils is embedded with tiny hairs called cilia, which act like a filter to catch dust and other small particles in the air we breathe. The mouth is what we use to breathe when we need more air than what can be taken in through the nostrils, as when we pant or puff when we are exhausted.

Pharynx and Larynx

The pharynx is the opening just behind the nose and mouth and is part of both the respiratory and digestive systems. Since both food and air pass through the pharynx, it is lined with tissues called tonsils which can partially obstruct the passage of either of the two. Like when swallowing, respiration is interrupted. The pharynx ends in the oesophagus and the larynx, which is also known as the "voice box" because it houses the vocal chords and the different muscles used in producing sounds. The epiglottis, a cartilage found at the top of the larynx, aids in closing it tightly to prevent the passage of food or liquids.

Trachea and Bronchi

The trachea, also referred to as the windpipe, is a tube through which respiratory gas transport takes place. It is lined with ciliated cells to push particles out, and cartilage rings to guard it against pressure when breathing. The end of the trachea is split into two tubes called the bronchi, which also have several thin-walled

branches called bronchioles. These bronchioles lead to air sacs called alveoli, where most of the gas exchange happens.

Lungs and Thorax

The lungs are the most essential organ for respiration. They consist of a cluster of bronchioles and alveoli, blood vessels and capillaries, and elastic tissue. Their main function is to transfer oxygen into the bloodstream, and to excrete carbon dioxide into the air.

The thorax is the region of the body that extends from the neck to the back. The thoracic cavity is the area that contains the heart and the lungs, and is protected by the rib cage and the sternum.

The Act of Breathing

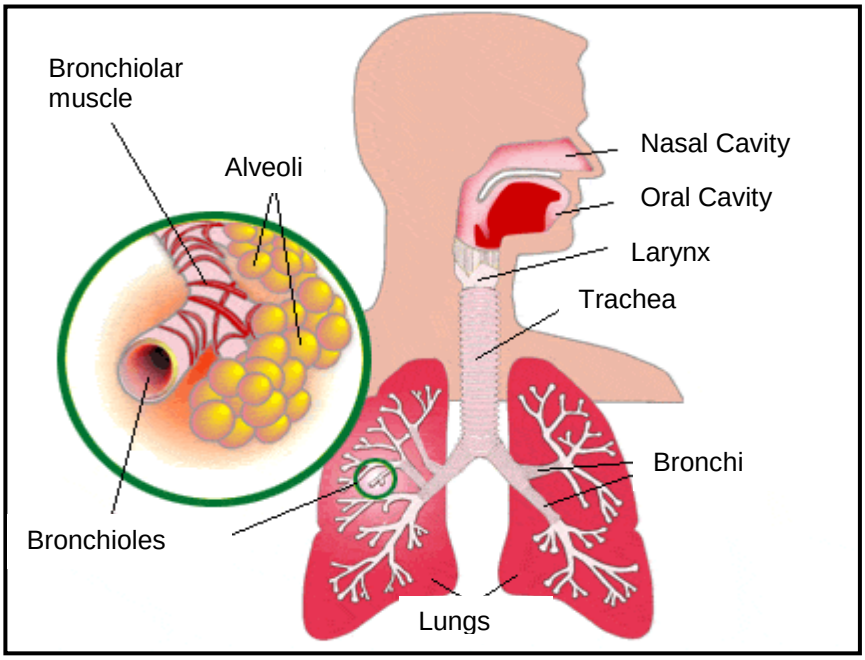
Breathing starts at the nose and mouth. You inhale air into your nose or mouth and it travels down the back of your throat and into your windpipe or trachea. Your trachea then divides into air passages called bronchiole tubes.

As the bronchiole tubes pass through the lungs, they divide into smaller air passages called bronchioles. The bronchioles end in tiny balloon-like air sacs called alveoli. Your body has over 300 million alveoli.

The alveoli are surrounded by a mesh of tiny blood vessels called capillaries. This is where gas exchange takes place. Here, oxygen from the inhaled air passes through the alveoli walls into the blood.

After absorbing oxygen, the blood leaves the lungs and is carried to your heart. Your heart then pumps it through your body to provide oxygen to the cells of your tissues and organs.

As the cells use oxygen, carbon dioxide is produced and absorbed into the blood. Your blood then carries the carbon dioxide back to your lungs, where it is removed from the body when you exhale.

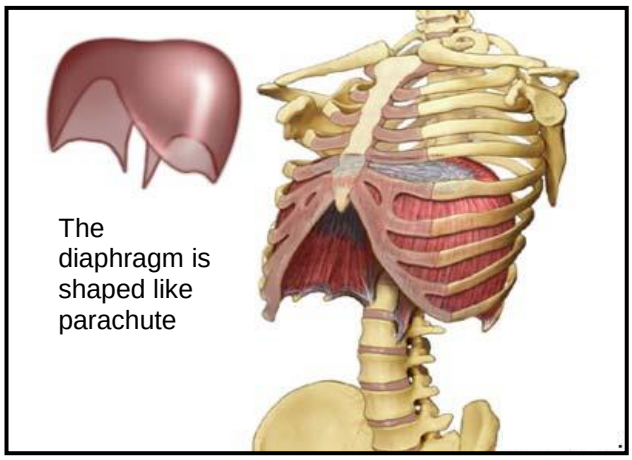


Muscles Used for Breathing

Muscles near the lungs help expand and contract (tighten) the lungs to allow breathing. These muscles include the:

- Diaphragm (Di-ah-fram)
- Intercostal muscles
- Abdominal muscles
- Muscles in the neck and collarbone area

The diaphragm is shaped like a parachute and located below your lungs. It separates the chest cavity from the abdominal cavity. The diaphragm is the main muscle used for breathing.



The intercostal muscles are located between your ribs. They also play a major role in helping you breathe.

Beneath your diaphragm are abdominal muscles. They help you breathe out when you are breathing fast, for example, during physical activity.

Muscles in your neck and collarbone area help you breathe in when other muscles involved in breathing do not work well, or when lung disease weakens your breathing.

What Happens When You Breathe?

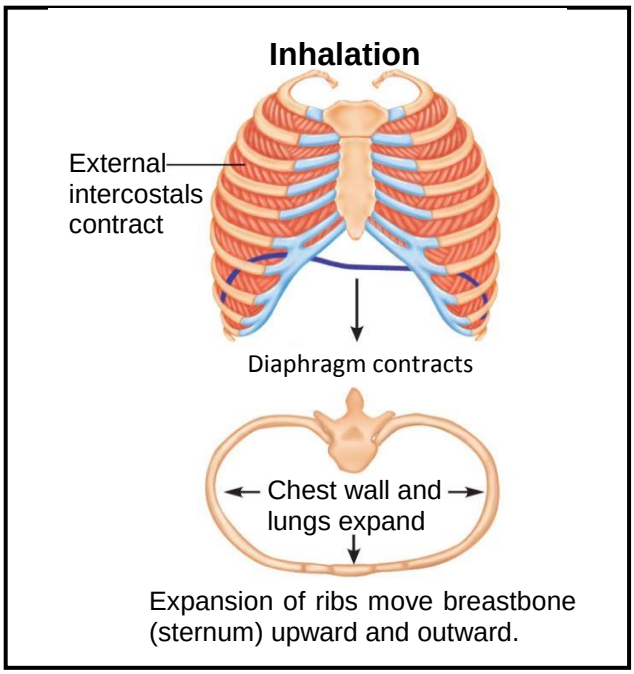
You now know that inhalation and exhalation are the processes by which the body brings in oxygen and expels carbon dioxide.

You breathe with the help of the diaphragm and the intercostal muscles between your ribs.

Breathing in (Inhalation)

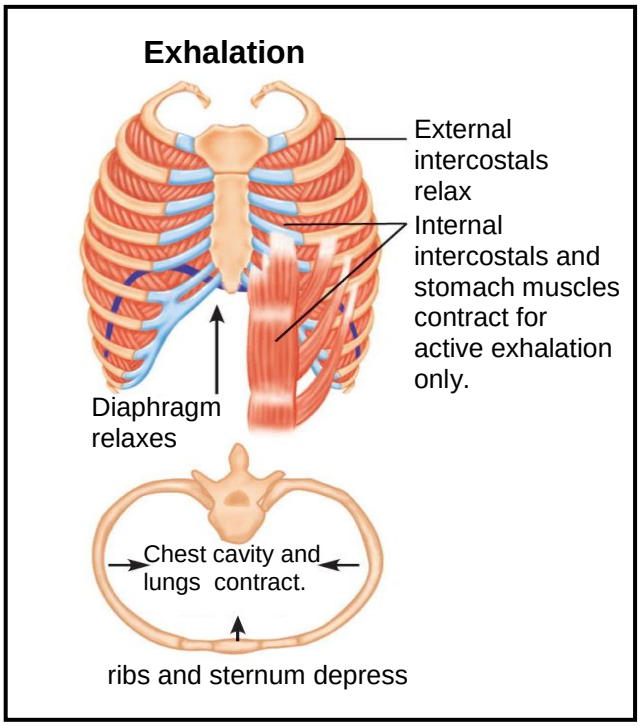
When you breathe in (inhale), your diaphragm contracts (tightens) and moves downward. This increases the space in your chest cavity, into which your lungs expand. The intercostal muscles between your ribs also help enlarge the chest cavity. They contract to pull your ribs cage both upward and outward when you breathe.

As your lungs expand, air is sucked through your nose and mouth. The air travels down your windpipe and into your lungs.



Breathing out (Exhalation)
When you breathe out (exhale), your diaphragm relaxes and moves upward into the chest cavity. The intercostal muscles between the ribs also relax to reduce the space in the chest cavity.

As the space in the chest cavity gets smaller, air rich in carbon dioxide is forced out of your lungs and windpipe, and then out of your nose or mouth.



What Is A Breathing Rate?

A breathing rate is the number of breaths a person takes in 1 minute while at rest. It can be measured by counting the number of times a person's chest rises and falls within a minute.

How to check someone's breathing rate
The rate at which we breathe is one of our vital signs. When we breathe in we obtain oxygen and when we breathe out we expel carbon dioxide. Checking the breathing rate is an important way to make sure someone's respiratory tract is healthy and functioning.

Breathing is measured in breaths per minute or bpm. To get an accurate measurement, the person must be at rest. This means the person is not breathing faster than usual due to exercising.

Now with a friend, do the activity below on counting breaths.

You need a stop watch to do this activity. Your friend should be still for at least 10 minutes before you count her breaths.

Activity: Counting Breaths

Follow the steps given below to complete this activity.

1. Have your partner sit up straight. If you are measuring an infant, lay the baby flat on her back on a firm surface.
2. Use a stop watch to time one minute. Count the number of times the person's chest rises and falls during that minute.
3. Record your results in breaths per minute.

If you tell people that you are going to measure their breathing, they are likely to change their breathing rate without realising it. Tell them to breathe normally. To improve the accuracy of your result, you can take the measurement three times and average the answers.

If you are pressed for time, count the breaths in fifteen seconds, and then multiply the number of breaths by four. This gives a close approximation of breaths per minute and is useful in emergency situations.

Children breathe faster than adults. An individual's normal breathing rate will change based on his or her age, and an abnormally high or low breathing rate may indicate certain medical conditions.

When counting breathes like you did in your activity, you can determine whether the breathing rate is within the normal range by using the rates below.

- 30 to 60 bpm for an infant who is 0 – 6 months old
- 24 to 30 bpm for an infant who is 6 to 12 months old
- 20 to 30 bpm for a child who is 1 to 5 years old
- 12 to 20 for a child who is 6 to 11 years old
- 12 to 18 for someone who is 12 or older

If someone’s breathing rate is higher or lower than the expected range, and she has not been exercising, this could be an indication that something is wrong.

What is artificial respiration?
Artificial respiration means applying some method to supply a person with air, or essentially breathing for them. There are natural methods for doing this, such as blowing air into a person’s mouth when performing cardiopulmonary resuscitation (CPR) and there are also hand operated or mechanical ways to provide these needed breaths if a person is not breathing on his own or is not breathing adequately.

When the body does not get enough oxygen because of lack of breathing or insufficient breathing, brain cells begin to deteriorate rapidly. They rely on a constant supply of oxygen in order to stay alive. This is why artificial respiration is so vital under many circumstances. In order to hopefully preserve brain cells and prevent tissue death, a continued supply of oxygen is required.

Difference between Respiration and Breathing

Breathing and respiration are often considered the same, but they are different functions of the respiratory system. Breathing is a voluntary physical process that takes place between the body and the outside environment. Respiration on the other hand is the involuntary function that happens inside the body. It is the process of producing energy and expelling carbon dioxide from the cells in the body

Activity: Now test yourself by doing this activity.

Circle the letter of the correct answer.

1. Emily coughed at the dinner table, claiming that her food "went down the wrong tube." What is the correct "tube" for food to go down?

   A. Trachea B. Larynx

   C. Epiglottis D. Oesophagus

---

2. What is known as the voice box?

   A. Trachea B. Larynx

   C. Pharynx D. Epiglottis

---

3. Which structure separates thorax from abdomen?

   A. Lungs B. Heart

   C. Rib cage D. Diaphragm

---

4. What happens to the diaphragm when you breathe in air? It _____.

   A. relaxes B. shrinks

   C. enlarges D. contracts

---

5. What is the purpose of the little hairs inside the nose?

   A. To fight disease

   B. They serve no purpose

   C. To keep dust out of the lungs

   D. To tickle the nose and cause sneezes

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 10.

Summary

You have come to the end of Lesson 10. In this lesson you have learnt that:

- breathing is the only process that delivers oxygen to where it is needed in the body and removes carbon dioxide.
- breathing involves inhaling and exhaling.
- the nose is what we normally use to inhale and exhale.
- the pharynx is the opening just behind the nose and mouth and is part of both the respiratory and digestive systems.
- the trachea, also referred to as the windpipe, is a tube through which respiratory gas transport takes place.
- the lungs are the most essential organ that allows you to breathe.
- the thorax is the region of the body that extends from the neck to the back. The thoracic cavity is the area that contains the heart and the lungs, and is protected by the rib cage and the sternum.
- you breathe with the help of your diaphragm and other muscles in your chest and abdomen.
- a breathing rate is the number of breaths a person takes in 1 minute and is measured in breathes per minute (bpm).

NOW DO PRACTICE EXERCISE 10 ON THE NEXT PAGE.

Practice Exercise 10

Answer the following:

1. Define the following.

   a. Breathing

   _____
   _____
   _____

   b. Breathing rate

   _____
   _____
   _____

2. Describe the following organs of breathing.

   a. Pharynx

   _____
   _____
   _____
   _____

   b. Trachea

   _____
   _____
   _____
   _____

   c. Thorax

   _____
   _____
   _____
   _____

3. Describe breathing rate.

   _____
   _____
   _____
   _____
   _____

4. What is artificial respiration?

_____
_____
_____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.

Answers to activity

1. D
2. B
3. D
4. D
5. C

Lesson 11: Digestive System

Welcome to Lesson 11. In the previous lesson you learnt about breathing. You have discussed breathing and breathing rate. You also described the different organs involved in the breathing process and the artificial respiration. In this lesson you will learn about the human digestive system.

Your Aims:

- define digestion and enzymes
- identify digestive organs and their functions
- describe how digestion works
- discuss ways of keeping the body healthy

.

What is Digestion?

Digestion refers to the breakdown of food into smaller components that can be absorbed into the blood stream. It allows your body to get the nutrients and energy it needs from the food you eat.

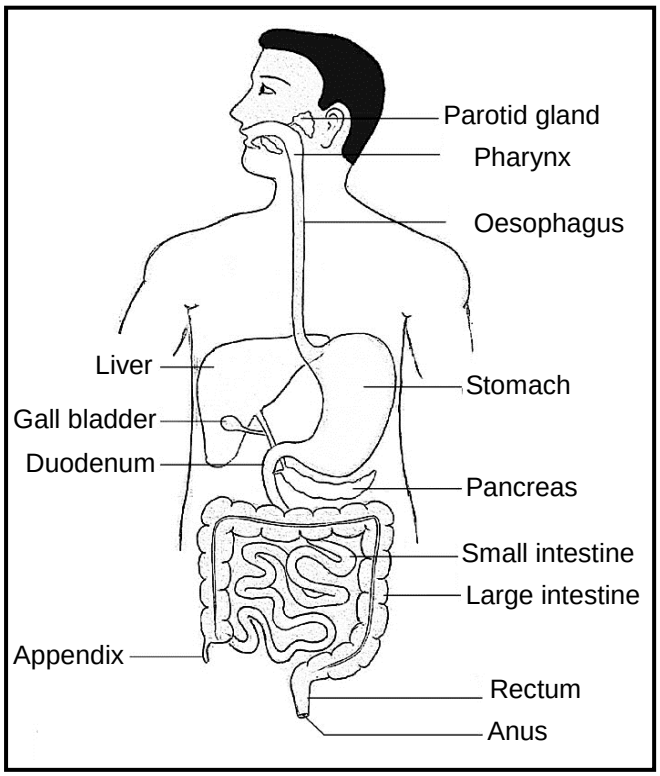
There are two kinds of digestion which are mechanical and chemical. Mechanical digestion occurs in the mouth when food is chewed and broken into smaller pieces. Chemical digestion involves breaking down the food into simpler nutrients that can be used by the cells. Chemical digestion begins in the mouth when food mixes with saliva.

What Is The Digestive System?

The digestive system is made up of the digestive tract (also called the alimentary canal) and the liver, pancreas and gall bladder.

The digestive tract is a series of hollow organs joined in a long, twisting tube from the mouth to the anus. The hollow organs that make up the digestive tract are the mouth, oesophagus (also spelt esophagus), stomach, small intestine and large intestine which include the rectum and anus. Food enters the mouth and passes to the anus through the hollow organs of the digestive tract.

The liver, pancreas and gall bladder are the solid organs of the digestive system. The digestive system helps the body digest food.



Human digestive system

Bacteria in the digestive tract help with digestion. Parts of the nervous and circulatory systems also play roles in the digestive process. Together, a combination of nerves, hormones, bacteria, blood, and the organs of the digestive system completes the complex task of digesting foods and liquids a person consumes each day.

Why is digestion important?
Digestion is important for breaking down food into nutrients which the body uses for energy, growth and cell repair. Food and drink must be changed into simpler forms of nutrients before the blood absorbs them and carries them to cells throughout the body. The body breaks down nutrients from food and drink into carbohydrates, protein, fats and vitamins.

Every piece of food we eat has to be broken down into nutrients that can be absorbed by the body, which is why it takes hours to fully digest food. In humans, protein must be broken down into amino acids, starches into simple sugars, and fats into fatty acids and glycerol. The water in our food and drink is also absorbed into the bloodstream to provide the body with the fluid it needs.

How does digestion work?
Digestion works by moving food through the alimentary canal. It begins in the mouth with chewing and ends in the small intestine.

The mouth is the beginning of the alimentary canal. Digestion starts in the mouth as soon as you take the first bite of a meal. Chewing breaks the food into pieces that are more easily digested, while saliva mixes with food to begin the process of breaking it down into a form your body can use.

As food passes through the alimentary canal, it mixes with digestive juices, causing large particles of food to break down into smaller and simpler forms of nutrients.. The body then absorbs these simpler nutrients through the walls of the small intestine into the bloodstream, which delivers them to the rest of the body. Waste products of digestion pass through the large intestine and out of the body as a solid matter called stool.

The table below shows the parts of the digestive process performed by each digestive organ, including movement of food, type of digestive juice used, and food particles broken down by that organ.

Organ	**Movement**	**Digestive Juices Used**	**Food Particles Broken Down**
Mouth	Chewing	Saliva	Starches
Esophagus	Swallowing	None	None
Stomach	Upper muscles in stomach relaxes to let food enter and lower muscle mixes food with digestive juice.	Stomach acid	Protein
Small intestine	Peristalsis	Small intestine digestive juice	Starches, protein and carbohydrates
Pancreas	None	Pancreatic juice	Starches, fats and protein
Liver	None	Bile acids	Fats

How does food move through the alimentary canal?
The large, hollow organs of the alimentary canal contain a layer of muscle that enables their walls to move. The movement of organ walls is called **peristalsis** and it forces food and liquid through the alimentary canal and mixes the contents within each organ. Peristalsis looks like an ocean wave travelling through the muscle as it contracts and relaxes.

Throat
The throat is also called the pharynx and is the next destination for food you have eaten. From here, food travels to the esophagus or swallowing tube.

Esophagus
When you swallow, food pushes into the esophagus. The esophagus is a muscular tube that extends from the pharynx to the stomach. By peristalsis, the esophagus delivers food to the stomach. Just before the connection to the stomach, there is a ring like muscle at the junction of the esophagus and stomach called the lower esophageal sphincter. As food approaches the closed sphincter, the muscles relaxes and lets food pass through to the stomach. The sphincter also acts like a valve that keeps food from passing back into the esophagus.

Stomach
The stomach is a sac-like organ with strong muscular walls. It stores swallowed food and liquid, mixes the food and liquid with digestive juices it produces until the food turns into a thick liquid paste called **chyme**. From the stomach, the food moves to the small intestine.

The muscle of the upper part of the stomach relaxes to accept large volumes of swallowed material from the esophagus. The muscle of the lower part of the stomach mixes the food and liquid with digestive juice.

Small intestine
The muscles of the small intestine mix food with digestive juices from the pancreas, liver and intestine. Peristalsis is also at work in this organ, moving food through and mixing it up with digestive juices. The walls of the small intestine absorb the digested nutrients into the bloodstream. The blood delivers the nutrients to the rest of the body.

Large intestine
The waste products of the digestive process include undigested parts of food and older cells from the alimentary canal lining. Muscles push these waste products into the large intestine. The large intestine absorbs water and any remaining nutrients and changes the waste from liquid to stool. The large intestine empties the stool into the rectum. The rectum stores stool until it pushes it out of the body.

How do digestive juices in each organ of the alimentary canal break down food?
Digestive juices contain enzymes that break food into different nutrients. **Enzymes** are substances that speed up chemical reactions in the body.

Salivary glands
Saliva produced by salivary glands in the mouth moistens food so it moves more easily through the esophagus into the stomach. Saliva also contains an enzyme that begins to break down the starches from food.

Glands in the stomach lining
The glands in the stomach lining produce stomach acid and an enzyme that digests protein.

Pancreas
The pancreas produces a juice containing several enzymes that break down carbohydrates, fats and proteins in the food we eat. The pancreas delivers digestive juice to the small intestine through small tubes called **ducts**.

Liver
The liver produces a digestive juice called **bile**. The bile is stored in the gall bladder until needed. The gall bladder stores bile between meals. When a person eats, the gall bladder squeezes bile through the bile ducts, which connect the gall bladder and liver to the small intestine. The bile mixes with the fat in food. The bile acids dissolve fat into the watery contents of the intestine, much like how detergents dissolve grease from a frying pan, so the intestinal and pancreatic enzymes can digest the fats. The liver also cleanses and purifies blood coming from the small intestine containing the nutrients just absorbed.

Small intestine
Digestive juice produced by the small intestine combines with pancreatic juice and bile to complete digestion. The body completes the breakdown of proteins, and the final breakdown of starches produces glucose molecules that absorb into the blood. Bacteria in the small intestine produce some of the enzymes needed to digest carbohydrates.

What happens to the digested food molecules?
The small intestine absorbs most digested food molecules, as well as water and minerals, and passes them on to other parts of the body for storage or further chemical change. Specialized cells help absorbed materials cross the intestinal lining into the bloodstream. The blood stream carries simple sugars, amino acids, glycerol and some vitamins and salts to the liver.

Proper Ways to Keep the Body Healthy

You can live longer when you have a healthy body. When your body is healthy, you are less likely to develop all kinds of diseases. By following a few guidelines, you can develop habits that contribute to the ongoing health of your body.

Eat healthy foods
When you eat right, you feel better and have more energy. You also provide your body with vital nutrients like protein, carbohydrates, fat, vitamins, minerals and fibre that maintains your body’s health. A diet that is rich in nutrients includes whole grains, fish, nuts, eggs, poultry and lean meats, fat-free or low-fat dairy foods such as yogurt and fortified milk, and unsaturated fats like olive oil and avocados. Processed and refined foods are most often loaded with fats and sugars and have little nutritional value.

Regular exercise
Just like eating healthy foods, taking part in regular exercise is important in keeping your body healthy. Exercising regularly helps control your weight, strengthens your bones and muscles, improves how you feel and your overall mental health and may help you live longer. An exercise such as brisk walking is good and safe for most people. If you are experiencing health issues, always check with a doctor or nurse before beginning any exercise program.

Get enough sleep
Getting enough, quality sleep plays a very important role in your daily performance and in keeping your body healthy throughout your life. Sleep is necessary for the healing and repair of your heart and blood vessels. It aids in the balance of your body's hormones and supports your body's growth and development. Your immune system, which defends your body against infections and other harmful substances, relies on adequate sleep to remain strong and function properly. Noticing when your body needs sleep and honoring that need is important to maintaining good health. Aim for seven to eight hours of sleep a day.

Reduce stress
Stress is a feeling that we have when we are under pressure and is sometimes unhealthy. Managing stress in your busy, active life plays an important role in keeping your body healthy. Although stress cannot be avoided, it can be controlled. When stress is repeated, excessive and left untreated, your body can develop physical health problems, such as high blood pressure, weakened immune system, and mental issues like depression and lack of concentration. Effective methods like exercise, yoga, meditation and participating in stress-reduction programs have been developed to manage stress and help keep a healthy body.

Drink water
Water is essential to your body's health and its survival. It is an essential nutrient that makes up between 60 and 70 percent of your body. Every cell in your body needs water to function properly. Water maintains body temperature, moves nutrients and waste materials through your body, helps normalize blood pressure and lubricates and cushions body joints and organs. You must replace the water lost through body functions like sweating and breathing every day to avoid **dehydration**. Dehydration is the lack of water in the body when you are not taking in enough water or when you are losing too much through sweating, vomiting or diarrhoea. Keep a bottle of water handy during the day to drink from. It is healthy to drink at least eight glasses of water in a day.

Activity: **Now test yourself by doing this activity.**

Circle the letter of the correct answer.

1. The solid organs of the digestive system are

   A. colon, caecum and rectum.
   B. pharynx, liver and stomach.
   C. duodenum, pancreas and ileum.
   D. liver, pancreas and gall bladder.

2. Large intestine in man mainly carries out _____.

   A. absorption B. assimilation
   C. digestion of fats D. digestion of carbohydrates

3. The part of the digestive system where digestion begins is _____.

   A. ileum B. mouth
   C. stomach D. oesophagus

4. What is removed from the undigested food when it is in the Large Intestine?

   A. Water B. Energy
   C. Sugar D. Nutrients

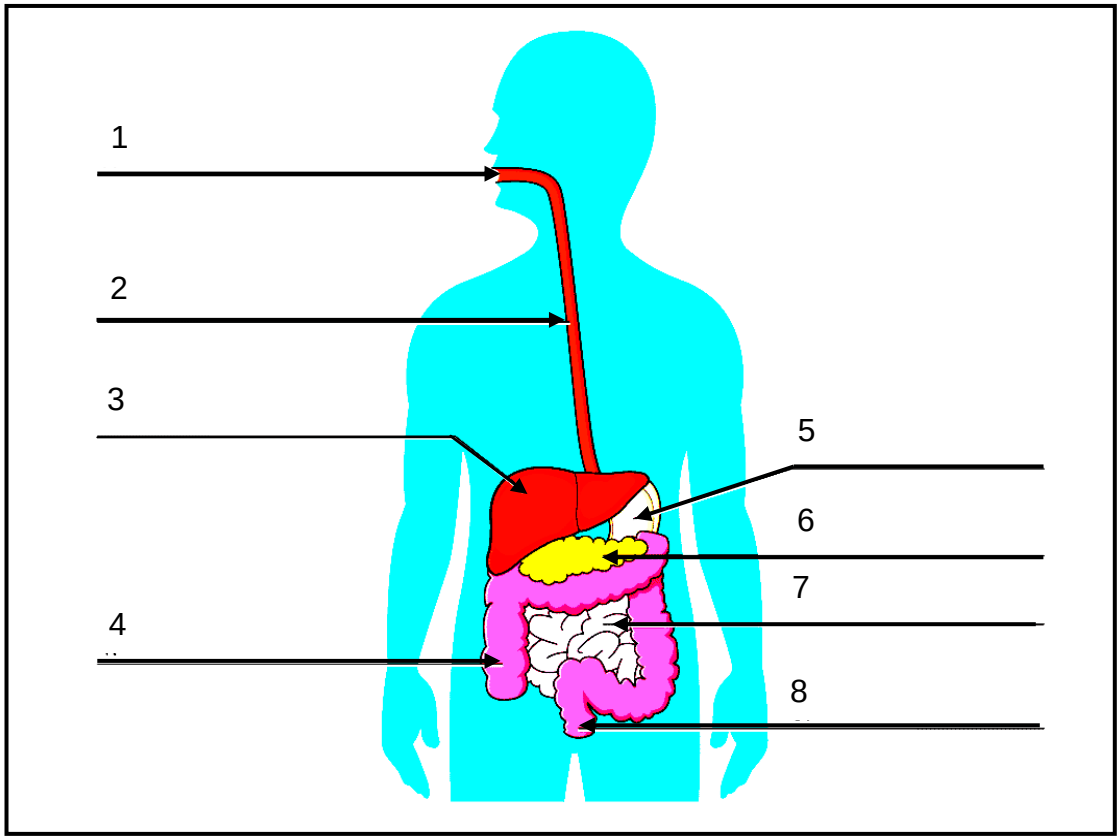
5. After the food leaves our stomach it heads into which part of the digestive system?

   A. Oesophagus B. Pancreas
   C. Small intestine D. Large intestine

6. What is inside your stomach that helps break down food into a thick liquid paste?

   A. Water and acids
   B. Acids and enzymes
   C. Villi and water
   D. Enzymes and villi

Part B. Label the diagram below.



CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 11.

Summary

You have come to the end of Lesson 11. In this lesson you have learnt that:

- digestion refers to the breakdown of food into smaller components that can be absorbed into the blood stream.
- there are two types of digestion, and they are mechanical and chemical.
- the digestive system is made up of the alimentary canal (also called the digestive tract) and the liver, pancreas and gall bladder.
- the alimentary canal is the long tube of organs that runs from the mouth to the anus.
- enzymes are substances that speed up chemical reactions in the body.
- after food is being chewed and swallowed, it enters the oesophagus. The oesophagus is a long tube that runs from the mouth to the stomach.
- the stomach is a large, sac-like organ that stores food and mixes it digestive juices.
- the liver produces a digestive juice called bile.
- the large intestine absorbs water and any remaining nutrients and changes the waste from liquid to stool.
- the rectum stores solid waste until it pushes it out of the body through the anus.
- you can live longer when you have a healthy body.

NOW DO PRACTICE EXERCISE 11 ON THE NEXT PAGE.

Practice Exercise 11

Answer the following questions:

1. Enumerate the process of digestion.

   a. _____
   _____
   _____
   _____

   b. _____
   _____
   _____

   c. _____
   _____
   _____

   d. _____
   _____
   _____
   _____

   e. _____
   _____
   _____

   f. _____
   _____
   _____
   _____

2. Identify the functions of the following.

   a. Large intestine
   _____
   _____

   b. Digestive enzymes
   _____
   _____

   c. Oesophagus
   _____
   _____

   d. Stomach
   _____
   _____

e. Liver

_____
_____

3. How do you maintain good health?

_____
_____
_____
_____

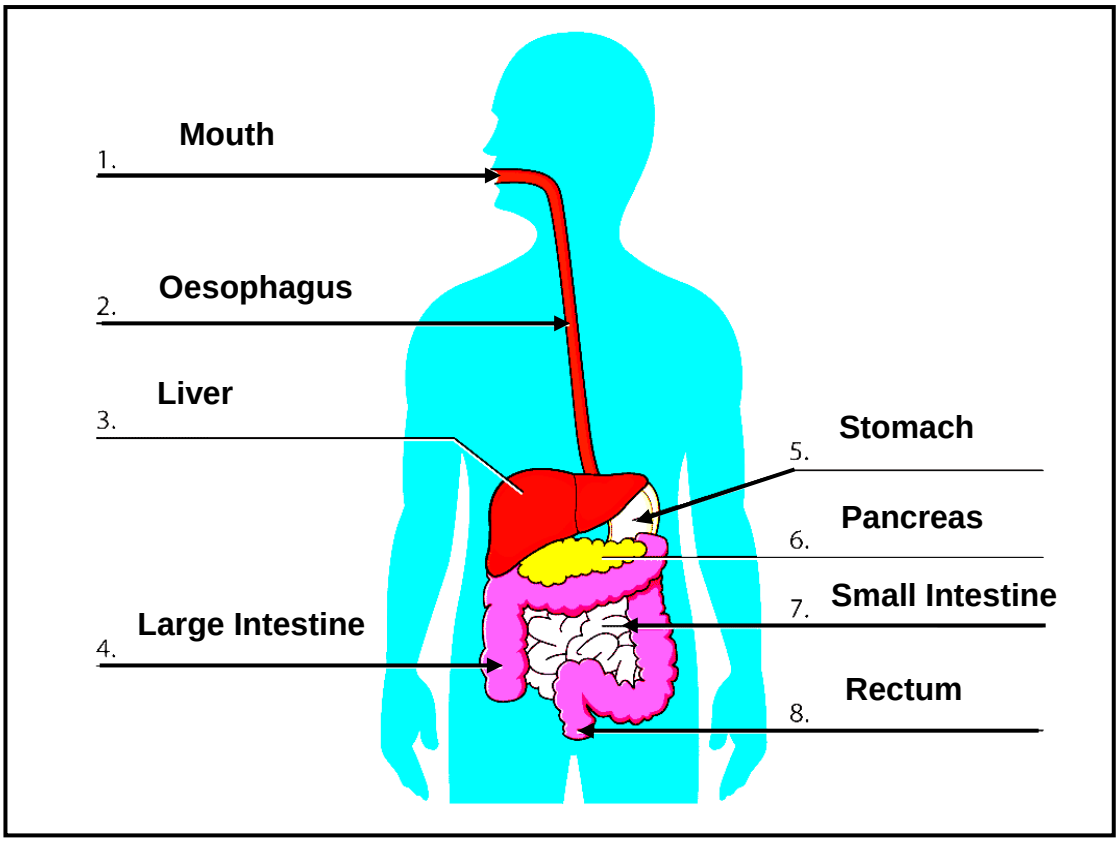
CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.

Answers to activity

Part A

1. D
2. A
3. B
4. A
5. C
6. B

Part B. Label the diagram below.

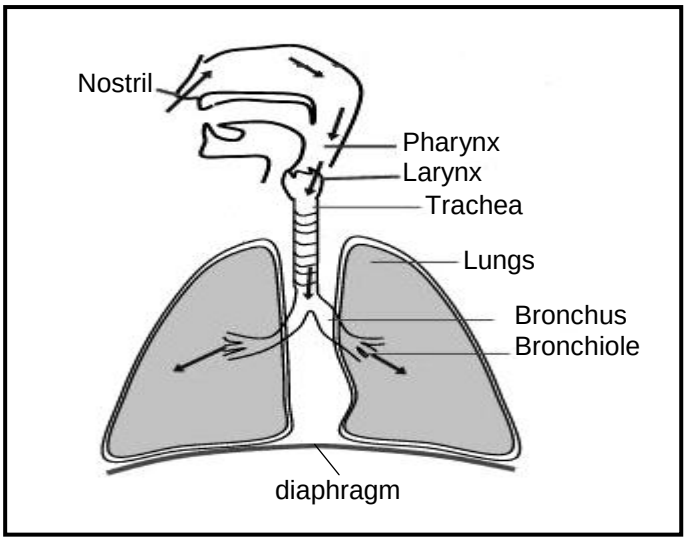


Answer to Practice Exercises

Practice Exercise 9

1. Respiration is the process of obtaining and using oxygen, while eliminating carbon dioxide.

2.



3.

Pharynx	It is located behind the nasal cavity and above the larynx. It is also a part of the digestive system of the human body. Food as well as air passes through the pharynx.
Nasal Passages	The nasal cavity is responsible for conditioning the air that is received by the nose. The process of conditioning involves warming or cooling the air received by the nose, removing dust (the tiny hairs called cilia filters out dust) particles from it and also moistening it, before it enters the pharynx.
Lungs	Lungs form the most vital component of the human respiratory system. They are located on the two sides of the heart. They are responsible for transporting oxygen from the atmosphere into blood and releasing carbon dioxide from blood to the atmosphere.
Diaphragm	Breathing begins with a dome-shaped muscle located at the bottom of the lungs which is known as diaphragm. When we breathe in the diaphragm contracts and flatten out and pull downward. Due to this movement the space in the lungs increases and pulls air into the lungs. When we breathe out, the diaphragm expands and reduces the amount of space for the lungs and forces air out.

Practice Exercise 10

1. a. Breathing is the only process that delivers oxygen to where it is needed in the body and removes carbon dioxide.

   b. Breathing rate is the number of breaths a person takes in 1 minute while at rest.

2. a. The pharynx is the opening just behind the nose and mouth and is part of both the respiratory and digestive systems.

   b. The trachea is also referred to as the windpipe, is a tube through which respiratory gas transport takes place.

   c. The thorax is the region of the body that extends from the neck to the back. The thoracic cavity is the area that contains the heart and the lungs, and is protected by the rib cage and the sternum.

3. A breathing rate is the number of breaths a person takes in 1 minute while at rest. It can be measured by counting the number of times a person's chest rises and falls within a minute. An individual's normal respiratory rate will change based on his or her age, and an abnormally high or low breathing rate may indicate certain medical conditions.

4. Artificial respiration means applying some method to supply a person with air, or essentially breathing for them. There are natural methods for doing this, such as blowing air into a person’s mouth when performing cardiopulmonary resuscitation (CPR) and there are also hand operated or mechanical ways to provide these needed breaths if a person is not breathing on his own or is not breathing adequately.
   When the body does not get enough oxygen because of lack of breathing or insufficient breathing, brain cells begin to deteriorate rapidly. They rely on a constant supply of oxygen in order to stay alive. This is why artificial respiration is so vital under many circumstances. In order to hopefully preserve brain cells and prevent tissue death, a continued supply of oxygen is required

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Practice Exercise 11

1. a. In the mouth food is partly broken mechanical and chemical digestion.

   b. After being chewed and swallowed, the food enters the oesophagus.

   c. By peristalsis, the oesophagus delivers food to the stomach where it is partly digested and mixed with digestive juices until it turns into a sticky paste called chyme.

   d. In the small intestine, food is mixed with digestive juices from the from the pancreas, liver and intestine. The walls of the small intestine absorb the digested nutrients into the blood stream. The blood delivers the nutrients to the rest of the body.

e. The waste products from the digestive process are pushed into the large intestine. The large intestine absorbs water and any remaining nutrients and changes the waste from liquid to stool. The large intestine empties the stool into the rectum.

f. The end of the process - Solid waste is then stored in the rectum until it is pushed out of the body through the anus.

2. a. Large intestine - its main function is to remove water from the undigested matter and form solid waste that can be excreted.

b. Digestive enzymes - produced by the inner wall of the small intestine help in the breakdown of food.

c. Oesophagus is a long muscular tube that runs from the mouth to the stomach. Food travels down in this organ.

d. Stomach – this is where food is partly digested and mixed with stomach acids called chyme.

e. Liver - The liver also plays a major role in the handling and processing of nutrients, which are carried to the liver in the blood from the small intestine.

3. Eating a healthy diet, plenty of exercise, drink a lot of water, avoid smoking and excessive intake of alcohol is the best way to maintain good health. The kinds and amounts of food a person eats and how the digestive system processes that food play key roles in maintaining good health and preventing common digestive problems.

REVISE TOPIC 3 USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 3: RESPIRATORY SYSTEM

Revise all the Lessons in this Topic and then do **ASSIGNMENT 3.**
Here are the main points to help you revise.

Lesson 9: Respiratory System

- Respiration is the process of obtaining and using oxygen, while eliminating carbon dioxide.
- Diffusion is the process of something moving from high concentration to low concentration.
- The human respiratory system is composed of the nasal passage, the pharynx, larynx, the trachea, bronchi and lungs.
- The primary function of the respiratory system is to supply the blood with oxygen to all parts of the body.
- The respiratory system is made of body parts that are in charge of your breathing. It includes your nose and nasal cavity.
- The nasal cavity is responsible for conditioning the air that is received by the nose.
- The windpipe (trachea) joins the upper respiratory tract to the lungs.
- Trachea refers to the airway through which respiratory air travels. The rings of cartilage within its walls keep the trachea open.
- The alveoli give our lungs a huge surface for absorbing oxygen from the air.
- The lungs carry out the process of gas exchange.
- Pollutants and infectious diseases can affect the lungs and respiratory system and cause respiratory problems.

Lesson 10: Breathing

- Breathing is the only process that delivers oxygen to where it is needed in the body and removes carbon dioxide.
- Breathing involves inhaling and exhaling.
- The nose is what we normally use to inhale and exhale.
- The pharynx is the opening just behind the nose and mouth and is part of both the respiratory and digestive systems.
- The trachea, also referred to as the windpipe, is a tube through which respiratory gas transport takes place.
- The lungs are the most essential organ that allows you to breathe.
- The thorax is the region of the body that extends from the neck to the back. The thoracic cavity is the area that contains the heart and the lungs, and is protected by the rib cage and the sternum.
- You breathe with the help of your diaphragm and other muscles in your chest and abdomen.
- A breathing rate is the number of breaths a person takes in 1 minute and is measured in breathes per minute (bpm).

Lesson 11: Digestive System

- Digestion refers to the breakdown of food into smaller components that can be absorbed into the blood stream.
- There are two types of digestion, and they are mechanical and chemical.
- The digestive system is made up of the alimentary canal (also called the digestive tract) and the liver, pancreas and gall bladder.

- The alimentary canal is the long tube of organs that runs from the mouth to the anus.
- Enzymes are substances that speed up chemical reactions in the body.
- After food is being chewed and swallowed, it enters the oesophagus. The oesophagus is a long tube that runs from the mouth to the stomach.
- The stomach is a large, sac-like organ that stores food and mixes it digestive juices.
- The liver produces a digestive juice called bile.
- The large intestine absorbs water and any remaining nutrients and changes the waste from liquid to stool.
- The rectum stores solid waste until it pushes it out of the body through the anus.
- You can live longer when you have a healthy body.

REVISE WELL AND THEN DO TOPIC TEST 3 IN YOUR ASSIGNMENT 3.

TOPIC 4

EXCRETORY SYSTEM

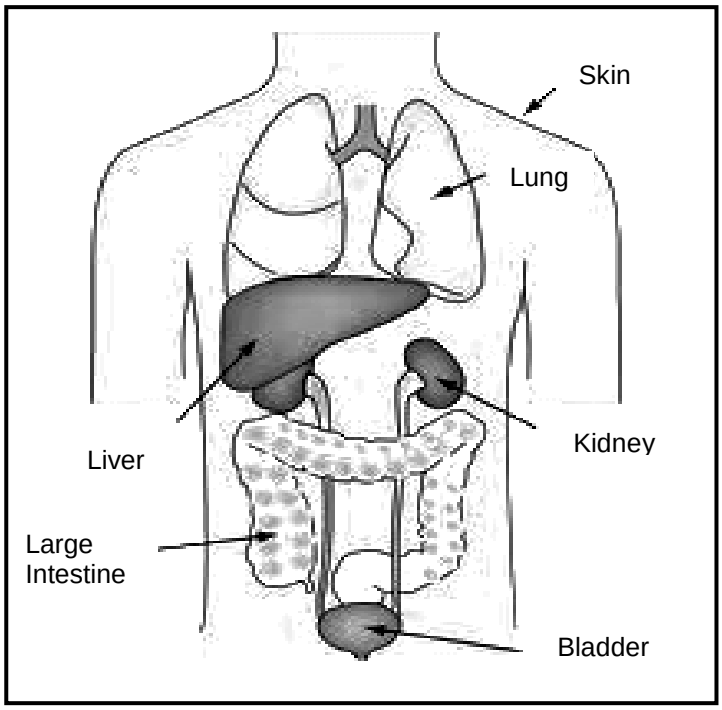
In this topic you will learn about:

- **the skin**
- **the kidneys**

INTRODUCTION TO TOPIC 4: EXCRETORY SYSTEM

Introduction

The Excretory System is the system in the body that excretes waste and the most important factors about the excretory system are the organs involved, the main functions of the system with other systems, and the problems if some organs are lost. This system is often mistaken to only correspond when people go and use the bathroom; however, the Excretory System actually consists of the **lungs, skin, kidneys, urinary bladder, ureter, urethra** and the **liver.**



Excretory organs

The **lungs** take in oxygen and they exchange that for the waste product- carbon dioxide.

The **skin** sweat to take out the dirt, bacteria, and the dead skin cells out of the pores to cleanse themselves. So the excretory system does do a lot with other parts of the body. However the other parts of the excretory system are their own. The **kidneys** of the body are connected to the liver and digestive system to take surplus amount of water and waste to be taken out of the system. Also the **ureter** and the **urethra** take the waste from the kidneys to the **urinary bladder** to be taken out of the body.

So the main function of the excretory system is to take waste out of the body. If one organ is lost or does not function correctly, machines can help or you can just die- so take care of yourself. If you are losing an organ from the Excretory System you got a huge problem. This system's purpose is to take used waste out of the body. For example, if you lost the bladder, you would either need a bag to hold your urine or a machine to act like a bladder to take out the urine/used fluid out of the body. Therefore, without the excretory system, we would literally be full of waste and most likely die of early age without the most disgusting system in the body- the excretory system.

But some questions will arise such as

- Why is the skin important?
- What are the layers and functions of the skin?
- What are the kidneys related problems and preventions?
- How are kidney and water balance important in the excretory system?

In this Topic, you will find the answers to these questions and other questions relating to the excretory system.

Lesson 12: The Skin

From the previous lesson you have studied about the digestive system. You have discussed how digestion worked. You also described the different organs involved in digestion and its problems. For this lesson you will study the human skin.

Your Aims:

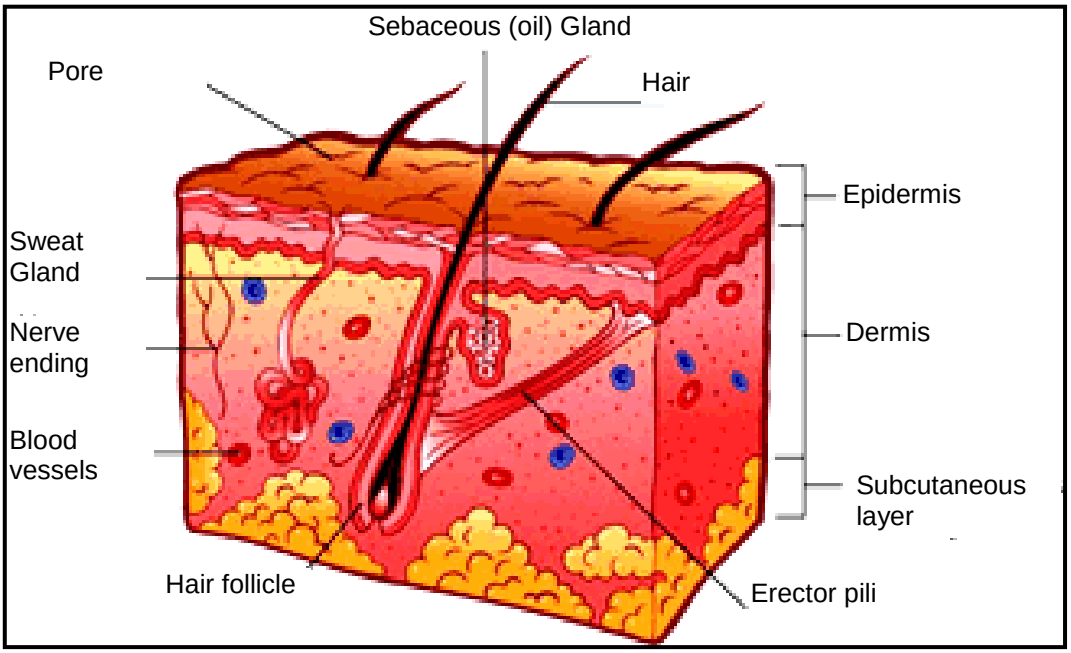
- draw and label the structures of the skin
- explain the functions of the layers of the skin

What is the Body's Biggest Organ?

You might be surprised to find out it is the skin, which you might not think of as an organ. No matter how you think of it, your skin is very important. It covers and protects everything inside your body. The skin is the largest organ of the body, with a total area of about 20 square feet. The skin protects us from microbes and the elements, helps regulate body temperature, and permits the sensations of touch, heat, and cold.
Skin has three layers:

- The epidermis, the outermost layer of skin, provides a waterproof barrier and creates our skin tone.
- The dermis, beneath the epidermis, contains tough connective tissue, hair follicles, and sweat glands.
- The deeper subcutaneous tissue (hypodermis) is made of fat and connective tissue.

The skin's color is created by special cells called **melanocytes**, which produce the pigment melanin. Melanocytes are located in the epidermis.



Layers of the skin

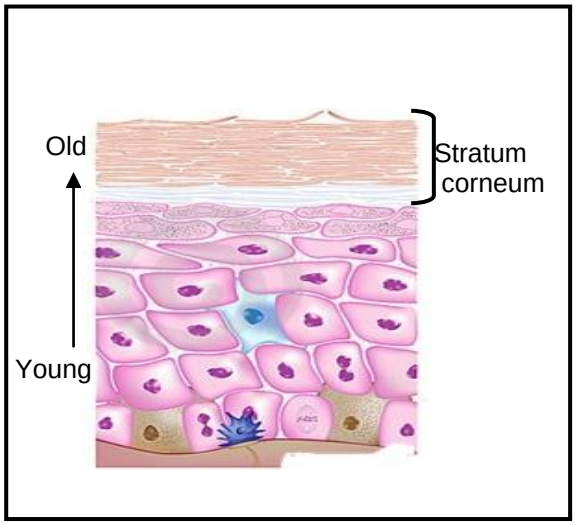
- **Epidermis**

The epidermis is the part of your skin you can see. The epidermis is the relatively thin, tough, outer layer of the skin. Most of the cells in the epidermis are **keratinocytes**. They originate from cells in the deepest layer of the epidermis called the basal layer. New keratinocytes slowly migrate up toward the surface of the epidermis. Once the keratinocytes reach the skin surface, they are gradually shed and are replaced by newer cells pushed up from below.

The outermost portion of the epidermis, known as the stratum corneum, is relatively waterproof and, when undamaged, prevents most bacteria, viruses, and other foreign substances from entering the body.

The epidermis (along with other layers of the skin) also protects the internal organs, muscles, nerves, and blood vessels against trauma.

In certain areas of the body that require greater protection (such as the palms of the hands and the soles of the feet), the outer keratin layer of the epidermis (stratum corneum) is much thicker.

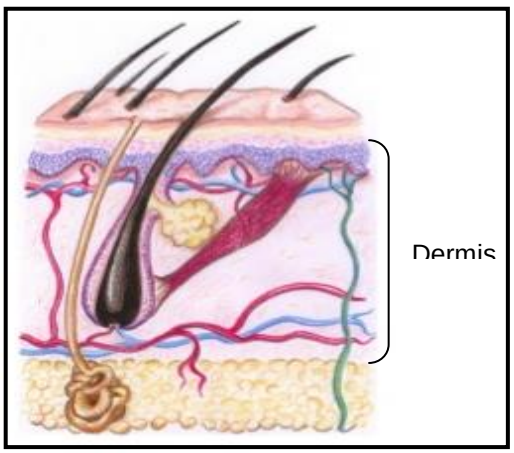


Structure of Epidermis

Scattered throughout the basal layer of the epidermis are cells called melanocytes, which produce the pigment **melanin**, one of the main contributors to skin color. Melanin's primary function, however, is to filter out ultraviolet radiation from sunlight, which damages DNA, resulting in numerous harmful effects, including skin cancer.
The epidermis also contains **Langerhans cells**, which are part of the skin's immune system. Although these cells help detect foreign substances and defend the body against infection, they also play a role in the development of skin allergies.

- **Dermis**

The dermis, the skin's next layer, is a thick layer of fibrous and elastic tissue (made mostly of collagen, elastin, and fibrillin) that gives the skin its flexibility and strength. The dermis contains nerve endings, sweat glands and oil (sebaceous) glands, hair follicles, and blood vessels.



The **nerve endings** sense pain, touch, pressure, and temperature. Some areas of the skin contain more nerve endings than others.

For example, the fingertips and toes contain many nerves and are extremely sensitive to touch.

The **sweat glands** produce sweat in response to heat and stress. Sweat is composed of water, salt, and other chemicals. As sweat evaporates off the skin, it helps cool the body. Specialized sweat glands in the armpits and the genital region (apocrine sweat glands) secrete a thick, oily sweat that produces a characteristic body odor when the sweat is digested by the skin bacteria in those areas.

The **sebaceous glands** secrete sebum into hair follicles. Sebum is an oil, that keeps the skin moist and soft and acts as a barrier against foreign substances.

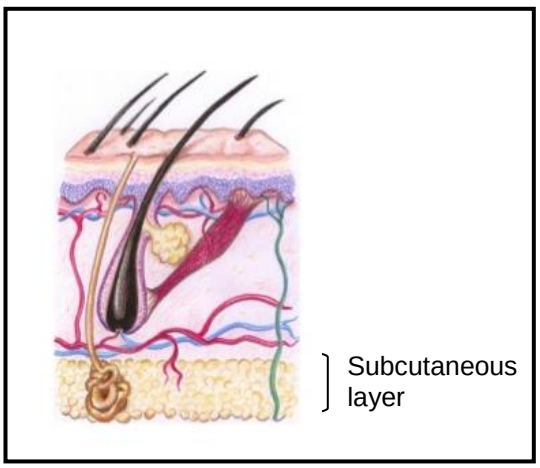
The **hair follicles** produce the various types of hair found throughout the body. Hair not only contributes to a person's appearance but has a number of important physical roles, including regulating body temperature, providing protection from injury, and enhancing sensation. A portion of the follicle also contains stem cells capable of re-growing damaged epidermis.

The **blood vessels of the dermis** provide nutrients to the skin and help regulate body temperature. Heat makes the blood vessels enlarge (dilate), allowing large amounts of blood to circulate near the skin surface, where the heat can be released.

Cold makes the blood vessels narrow (constrict), retaining the body's heat. Over different parts of the body, the number of nerve endings, sweat glands and sebaceous glands, hair follicles, and blood vessels varies. The top of the head, for example, has many hair follicles, whereas the soles of the feet have none.

- **Subcutaneous layer (fat)**

The bottom layer of the skin is called the **subcutaneous layer**. It is made mostly of fat and helps your body stay warm and absorb shocks, like if you bang into something or fall down. The subcutaneous layer also helps hold your skin to all the tissues underneath it.



This layer is where you will find the start of hair, too. Each hair on your body grows out of a tiny tube in the skin called a **follicle**. Every follicle has its roots way down in the subcutaneous layer and continues up through the dermis.

You have hair follicles all over your body, except on your lips, the palms of your hands, and the soles of your feet. And you have more hair follicles in some places than in others; there are more than 100,000 follicles on your head alone. Your hair follicles rely on your sebaceous glands to bring on the shine. Connected to each follicle in the dermis layer is a tiny sebaceous gland that releases sebum onto the hair. This lightly coats the hair with oil, giving it some shine and a little waterproofing.

Skin can warm and cool you

Your skin can help if you are feeling too hot or too cold. Your blood vessels, hair, and sweat glands cooperate to keep your body at just the right temperature. If you were to run around in the heat, you could get overheated. If you play outside when it is cold, your inner temperature could drop. Either way, your skin can help.

To cool you down, sweat glands also swing into action by making lots of sweat to release body heat into the air. The hotter you are, the more sweat your glands make! Once the sweat hits the air, it evaporates (this means that it changes from a liquid to a vapour) off your skin, and you cool down.

Keep It Clean

Unlike other organs (like your lungs, heart, and brain), your skin likes a good washing. When you wash your skin, use water and a mild soap and do not forget to cover scrapes and cuts with gauze or a bandage. This keeps the dirt out and helps prevent infections. It's just one way to be kind to the skin you are in.

What are the Main Functions of the Skin?

With a total surface of about 1.8 m^2 and a total weight of about 11kg, our skin is the largest human organ. The skin not just only gives us our appearance and shape, it also serves other important functions.

The skin is one of the largest organs in the body in surface area and weight. The skin consists of two layers: the epidermis and the dermis. Beneath the dermis lies the hypodermis or subcutaneous fatty tissue. The skin has three main functions: protection, regulation and sensation. Wounding affects all the functions of the skin.

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

The skin is an organ of regulation. The skin regulates several aspects of physiology, including: body temperature via sweat and hair, and changes in peripheral circulation and fluid balance via sweat. It also acts as a reservoir for the synthesis of Vitamin D.

The skin is an organ of sensation. The skin contains an extensive network of nerve cells that detect and relay changes in the environment. There are separate receptors for heat, cold, touch, and pain. Damage to these nerve cells is known as neuropathy, which results in a loss of sensation in the affected areas. Patients with neuropathy may not feel pain when they suffer injury, increasing the risk of severe wounding or the worsening of an existing wound.

Regulation
The skin regulates our body temperature. The production of sweat, which evaporates on the skin’s surface will cool us down.

The 5th Sense
Besides the senses of smell, taste, sight and hearing the sense of touch is one of our body's most important senses. Without it, we would not be able to feel the gentle touch of a dear person, the warmth of a hot cup of tea, or the wind blowing in our face. This sense is made possible by various cells and nerve endings in the skin, which send impulses to our central nervous system.

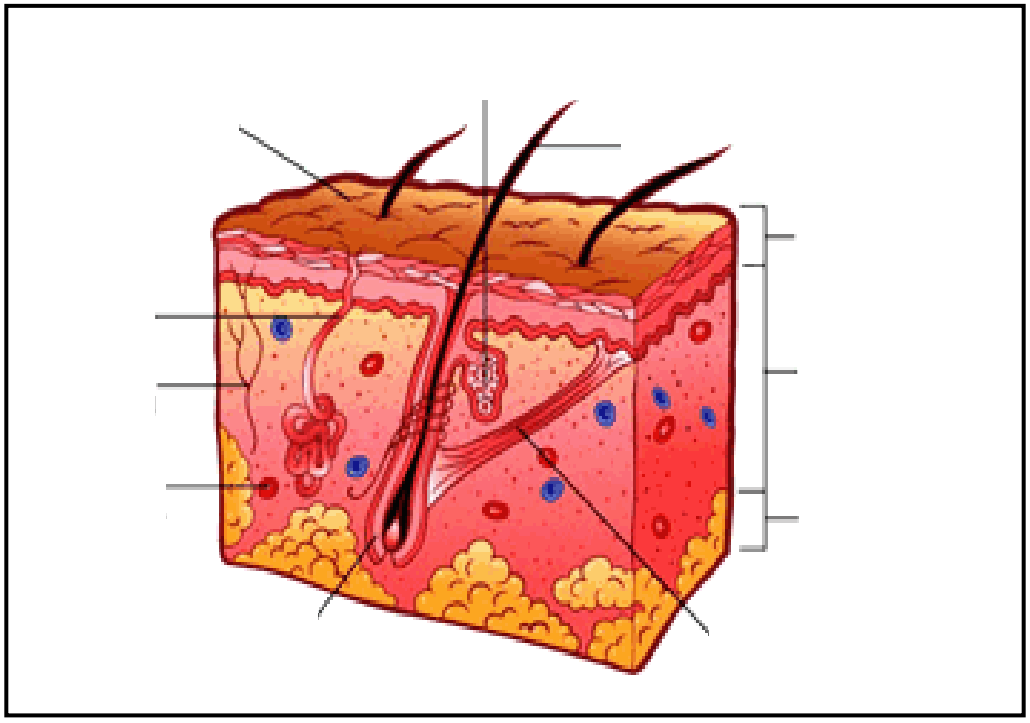
Activity: **Now test yourself by doing this activity.**

A. Choose from the words below to fill in the following sentences.

capillaries	melanin	hair
dermis	temperature	mends
sebaceous	water	protects
epidermis	micro organisms	

The skin has two main layers. The outer, waterproof, layer is the _____ with the _____ underneath. This lower layer contains _____ follicles, _____ glands, tiny blood vessels called _____ and a pigment called _____ which protects us from ultra violet rays.
The skin has many useful functions. It helps to control body _____, it keeps out _____, it _____ the delicate tissues underneath, it _____ itself when damaged and it is _____ proof.

B. Label the given diagram



CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 12.

Summary

You have come to the end of Lesson 12. In this lesson you have learnt that:

- skin is the largest human organ. It covers and protects everything inside your body. It also protects our bodies, helps keep our bodies at just the right temperature and allows us to have the sense of touch.
- the skin is made up of three layers, each with its own important parts. The layer on the outside is called the epidermis. The epidermis is the part of your skin you can see.
- the next layer down is the dermis. You cannot see your dermis because it is hidden under your epidermis. The dermis contains nerve endings, blood vessels, oil glands, and sweat glands. It also contains collagen and elastin, which are tough and stretchy.
- the nerve endings in your dermis tell you how things feel when you touch them.
- your dermis is also full of tiny blood vessels. These keep your skin cells healthy by bringing them the oxygen and nutrients they need and by taking away waste.
- the dermis is home to the oil glands, too. These are also called sebaceous glands, and they are always producing sebum. Sebum is your skin's own natural oil. It rises to the surface of your epidermis to keep your skin lubricated and protected. It also makes your skin waterproof.
- the third and bottom layer of the skin is called the subcutaneous layer. It is made mostly of fat and helps your body stay warm and absorb shocks, like if you bang into something or fall down.
- water, salts, and some urea diffuse from the blood into the sweat glands and are subsequently excreted as perspiration.
- melanin is a pigment which protects us from ultra violet rays.
- Unlike other organs (like your lungs, heart, and brain), your skin likes a good washing. When you wash your skin, use water and a mild soap. And do not forget to cover scrapes and cuts with gauze or a bandage. This keeps the dirt out and helps prevent infections.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE.

Practice Exercise 12

A. Multiple Choice Questions Circle the letter of the correct answer.

1. The main aim of secretion of sweat from the body is

   A. cleaning of body. B. to keep skin moist.

   C. control of temperature. D. all of the above.

2. Against which anti bodies protect the body?

   A. Infection B. Incident

   C. Conditions of environment D. Shortage of nutritive substance

3. Sometimes body shows chill in winters because

   A. the amount of blood increases in skin.
   B. the distribution of body heat is stopped.
   C. more heat production due to sliding of muscles.
   D. more heat is produced due to contraction of muscles.

B. Explain briefly the functions of the following.

1. Epidermis

   _____

   _____

2. Dermis

   _____

   _____

3. Subcutaneous layer

   _____

   _____

4. Blood vessels

   _____

   _____

5. Nerve endings

_____

_____

6. Melanin

_____

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.

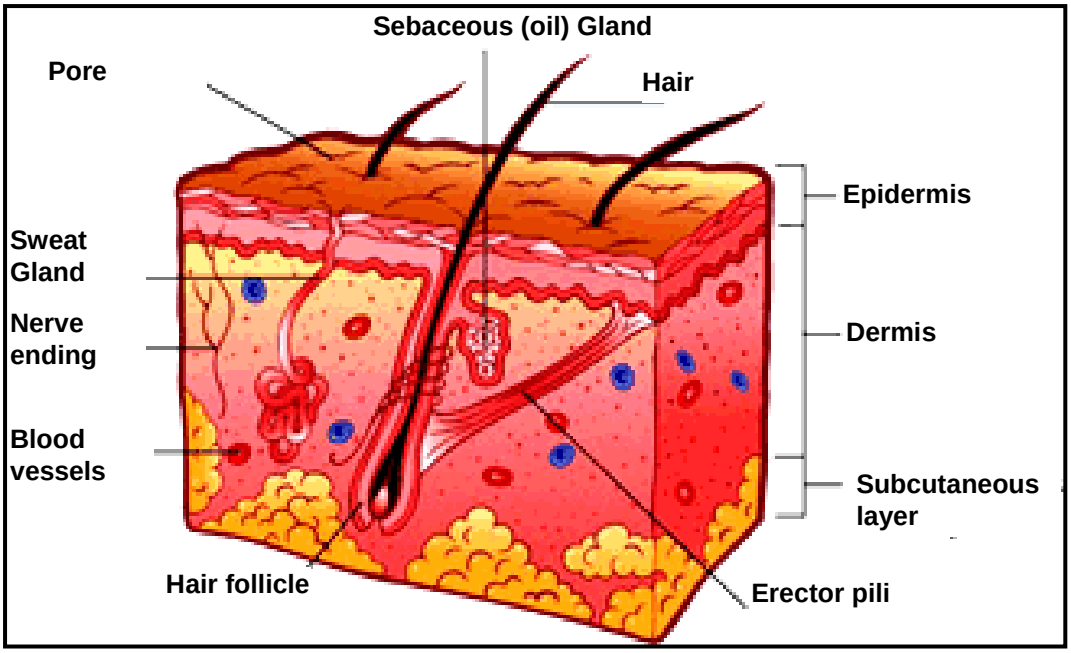
Answers to activity

Part A

The skin has two main layers. The outer, waterproof, layer is the **epidermis** with the **dermis** underneath. This lower layer contains **hair** follicles, **sebaceous** glands, tiny blood vessels called **capillaries** and a pigment called **melanin** which protects us from ultra violet rays.

The skin has many useful functions. It helps to control body **temperature**, it keeps out **micro-organisms**, it **protects** the delicate tissues underneath, it **mends** itself when damaged and it is **water** proof.

Part B Label the diagram given.



Layers of the skin

Lesson 13: The Kidneys

From the previous lesson you have studied about the human skin. You have described the structures of layers and functions of the skin. You also label its different parts. For this lesson you will study the human kidneys.

Your Aims:

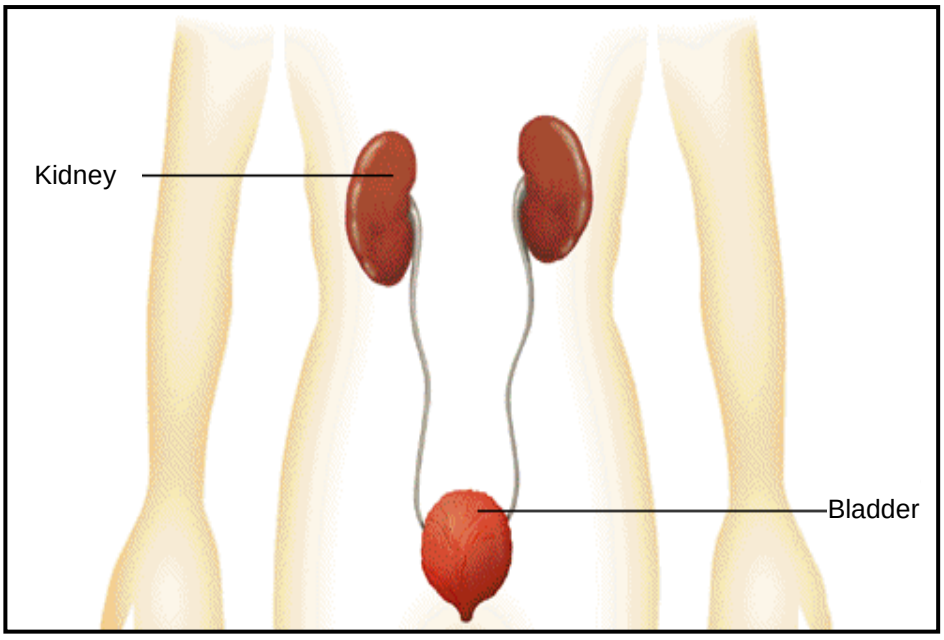
- label the structures of kidneys
- describe the parts and functions of kidneys
- enumerate some kidney related problems and its preventions

What Are Kidneys?

You have heard the word 'kidney' before, and you probably already know the shape of one. You know those big red beans often found in chili? Well, those are called kidney beans because their shape is almost the same as an actual kidney.

Real **kidneys** are organs, not beans, and they are extremely important in maintaining a healthy body. You have two kidneys, one located on each side of your spine, right below your lowest rib. The kidneys face one another and look kind of like a pair of parentheses. When you are an adult, each kidney is about 3 inches wide and 5 inches long. That is roughly the size of a smartphone.

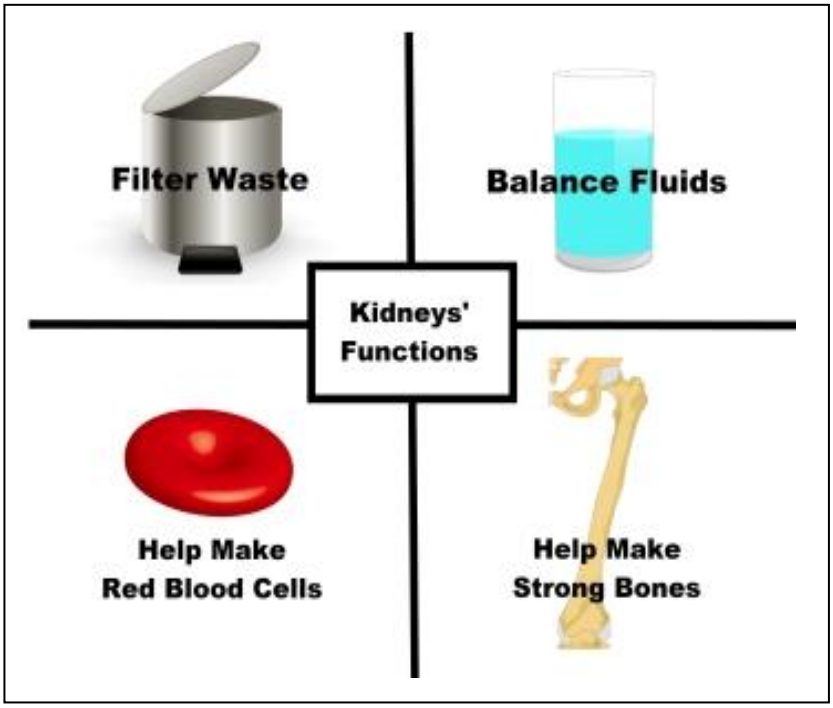
Everybody knows that some organs in the human body are necessary for survival; you need your brain, your heart, your lungs and your kidneys.



What Do Kidneys Do?

Kidneys have many functions, but there are four that are the most important. For one, your kidneys help to make new red blood cells--these organs release a hormone that helps your body create red blood cells, which are essential for delivering oxygen to other organs. Second, the kidneys help make your bones stronger by working to maintain healthy levels of calcium and phosphorus (both of which make for strong bones).

In addition to these functions, perhaps the most important jobs of the kidneys are filtering harmful products from your blood and balancing your body's fluids.



Filtering waste products

The kidneys filter waste products out of your blood. After all, the blood carries all sorts of things to be used by your body: hormones, electrolytes, oxygen, and more. When your body uses these materials, it produces waste products that your body can no longer use. It is the kidneys' job to get rid of these wastes.

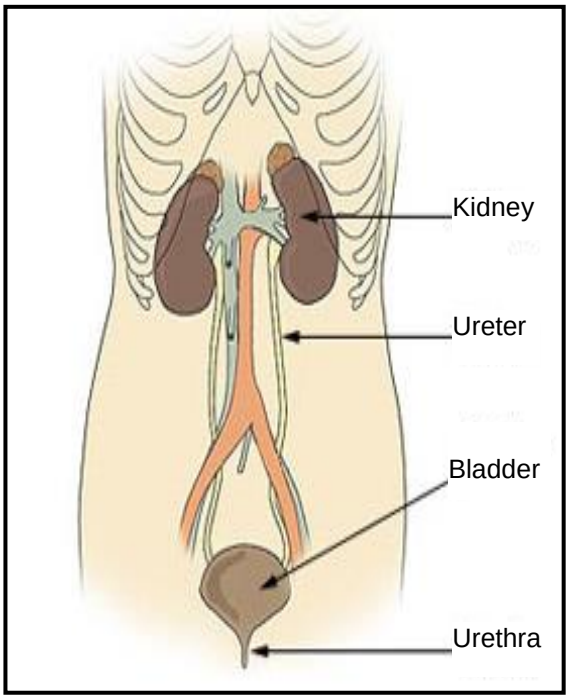
So how exactly do the kidneys get rid of the waste? Each kidney is made up of hundreds of tiny filters called **nephrons**. These tiny filters work fast because your body has a lot blood. Your nephrons filter approximately 50 gallons of blood every day. How much is a gallon? Look at the milk jug on your kitchen table in the morning—that is one gallon. Now multiply that by 50. There would be no room for your cereal bowl.

Parts of the Urinary Tract

The kidneys, the bladder, and their tubes are called the urinary tract. Here is a list of all of the parts of the urinary tract:

- the kidneys: filters that take the waste out of the blood and make urine
- the ureters: tubes that carry the urine to the bladder
- the bladder: a bag that collects the urine
- the urethra: a tube that carries the urine out of the body

The kidneys are key players in the urinary tract. They do two important jobs — filter waste from the blood and produce urine to get rid of it. If they did not do this, toxins (bad stuff) would quickly build up in your body and make you sick. That is why you hear about people getting kidney transplants sometimes. You need at least one working kidney to be healthy.



Parts of the urinary tract

The waste that is collected combines with water (which is also filtered out of the kidneys) to make urine (pee). As each kidney makes urine, the urine slides down a long tube called the ureter and collects in the bladder, a storage sac that holds the urine.

When the bladder is about halfway full, your body tells you to go to the bathroom. When you pee, the urine goes from the bladder down another tube called the **urethra*** and out of your body.

Keeping a balance

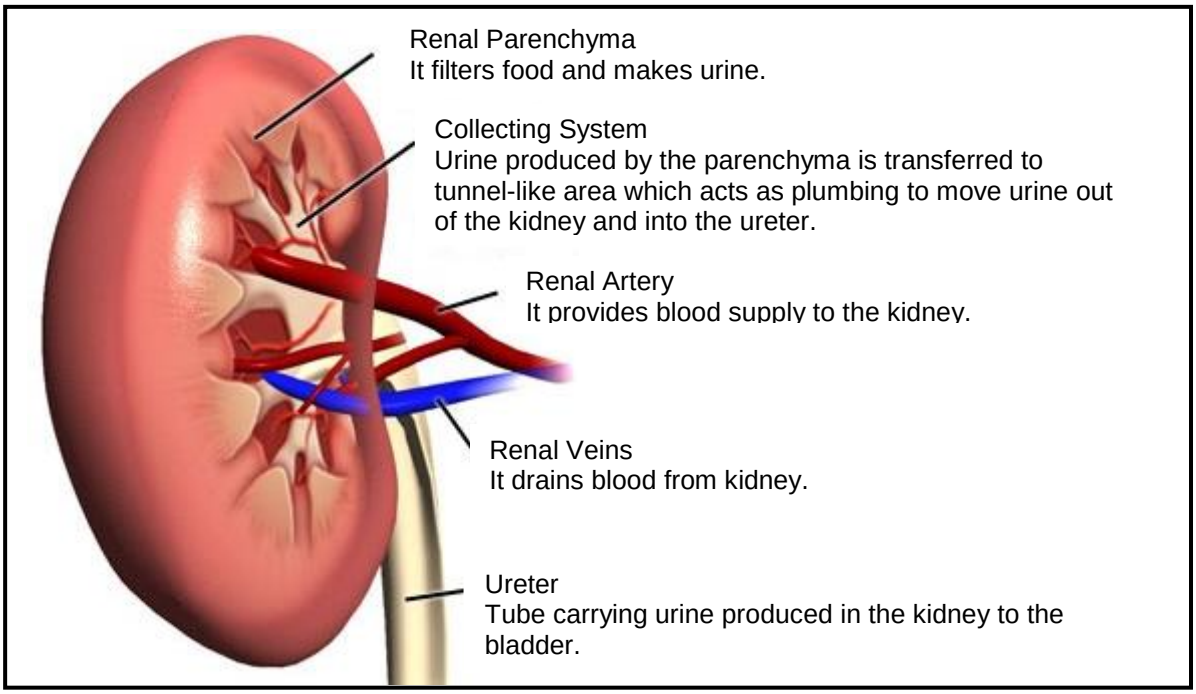
The kidneys also balance the volume of fluids and minerals in the body. This balance in the body is called **homeostasis***. If you put all of the water that you take in on one side of a scale and all of the water your body gets rid of on the other side of a scale, the sides of the scale would balance. Your body gets water when you drink it or other liquids. You also get water from some foods, like fruits and vegetables.

Water leaves your body in several ways. It comes out of your skin when you sweat, out of your mouth when you breathe, and out of your urethra in urine when you go to the bathroom. There is also water in your bowel movements.

When you feel thirsty, your brain is telling you to get more fluids to keep your body as balanced as possible. If you do not have enough fluids in your body, the brain communicates with the kidneys by sending out a hormone that tells the kidneys to hold on to some fluids. When you drink more, this hormone level goes down, and the kidneys will let go of more fluids.

You might notice that sometimes your urine is darker in colour than other times. Remember, urine is made up of water plus the waste that is filtered out of the blood. If you do not take in a lot of fluids or if you are exercising and sweating a lot, your urine has less water in it and it appears darker. If you are drinking lots of fluids, the extra fluid comes out in your urine, and it will be lighter.

What Are The Parts Of The Human Kidney?



Kidney Related Problems and Preventions

1**. High Blood Pressure (Hypertension)**

Hypertension is commonly referred to as high blood pressure. It is "**silent killer"** because many people have no symptoms to let them know that something is wrong. Some people do experience headaches or light headedness which they mistake for other causes. Many people have high blood pressure and do not know it. High blood pressure can strike anyone at any time. That is why it is so important to regularly check your blood pressure.

Blood pressure is a very important measurement of the flow of blood throughout your body. Our hearts must pump oxygen-rich blood all the way down to our fingers and toes. Blood pressure measures the force of the blood against the artery walls. If the pressure is too high (hypertension), it weakens the blood vessels and strains the heart because it must work extra hard to get the oxygenated blood to the rest of the body. Make a habit of taking the time to check your blood pressure wherever the self-service machines are available.

Causes - In 90% of people with hypertension, the cause of high blood pressure is not known and is referred to as primary or essential hypertension. While the specific cause is unknown, there are risk factors that can contribute to developing high blood pressure.

Factors that can be changed

- Obesity - As body weight increases, the blood pressure rises. Being overweight increases the risk of high blood pressure. Health care practitioners recommend that all obese people with high blood pressure lose weight until they are within 15% of their healthy body weight.
- Sodium (salt) sensitivity - Some people have high sensitivity to sodium (salt), and their blood pressure increases if they use salt. Reducing sodium intake tends to lower their blood pressure. Fast foods and processed foods contain particularly high amounts of sodium. Many over-the-counter medicines also contain large amounts of sodium. Read food labels and learn about salt content in foods and other products as a healthy first step to reducing salt intake.
- Alcohol use - Drinking more than one to two drinks of alcohol per day tends to raise blood pressure in those who are sensitive to alcohol.
- Birth control pills (oral contraceptive use) - Some women who take birth control pills develop high blood pressure.
- Lack of exercise (physical inactivity) - A sedentary lifestyle contributes to the development of obesity and high blood pressure.
- Medications - Certain drugs, such as amphetamines (stimulants), diet pills, and some medications used for cold and allergy symptoms tend to raise blood pressure.

Factors that cannot be changed

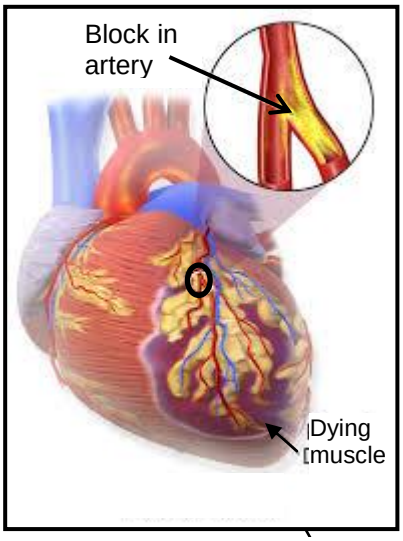
- Age - The older a person is, the greater the likelihood that he or she will develop high blood pressure especially elevated systolic readings. This is largely due to hardening of the arteries.
- Race - African Americans develop high blood pressure more often than Caucasians. They develop high blood pressure at a younger age and develop more severe complications sooner in life.
- Socioeconomic status - High blood pressure is found more commonly among the less educated and lower socioeconomic groups.
- Family history (heredity) - The tendency to have high blood pressure appears to run in families.
- Gender - Generally men have a greater likelihood of developing high blood pressure than women. This likelihood varies according to age and among various ethnic groups.

Prevention - High blood pressure may be prevented by living a healthy lifestyle, including some of the following eating a nutritious, low-fat diet, exercising regularly, decreasing salt (sodium) intake, maintain a healthy weight and if you are overweight or obese, try to lose weight, drink alcohol in moderation, stop smoking, get routine health assessments and blood pressure screening, reduce stress and practice relaxation techniques.

2. Heart Attack

The heart is a muscle like any other in the body. It needs blood flow to supply oxygen to allow it to do work. When there is not enough oxygen, the muscle starts to suffer, and when there is no oxygen, the muscle starts to die.

Heart muscle gets its blood supply from arteries that start in the aorta and run on the surface of the heart, known as the **coronary arteries.**



Heart attack

Causes

Over time, **cholesterol** build-up can occur in the blood vessels in the form of plaque. This narrows the artery and can restrict the amount of blood that can flow through it. If the artery becomes too narrow, it cannot supply enough blood to the heart muscle when it becomes stressed.

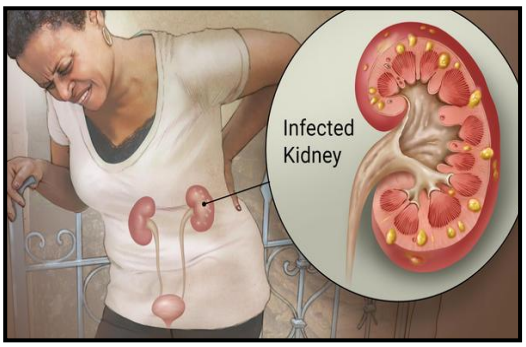
Just like arm muscles that begin to hurt if you lift too much, or legs that ache when you run too fast; the heart muscle will ache if it does not get adequate blood supply. This ache is called **angina.**

If the plaque ruptures, a small blood clot can form within the blood vessel and acutely block the blood flow. When that part of the heart loses its blood supply completely, the muscle dies. This is called a **heart attack**.

Prevention - While people cannot control their family history and genetics, they can minimize risk factors for heart disease such as quit smoking, manage high blood pressure, manage cholesterol, manage diabetes, exercise regularly and take a baby aspirin a day. These are all lifelong challenges to prevent heart disease, stroke, and peripheral vascular disease.

3. Kidney infection

Kidney infection belongs to the family of infections of the urinary system called **urinary tract infections** (UTIs).



In general, the infection of the urethra, bladder, and **prostate*** are known as lower urinary tract infection. When the infection ascends up to involve the kidneys, then it is called upper urinary tract infection.

Urinary tract infections are very common and may affect 40% of women and 10% of men in their lifetime. It is also common in children, and it may be difficult to diagnose as the symptoms are not easily recognizable.

Causes

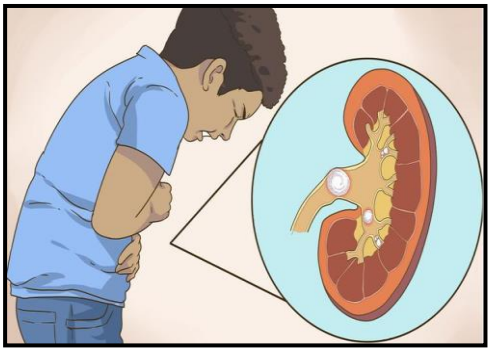
- May be caused by bacteria invading the urine, which is normally a sterile body fluid. Bacteria most commonly gain access to the urine through the urethra, which can be exposed to bacteria from outside of the body.
- Pregnant women may also be at higher risk for developing urinary tract infections. This may be caused by slower transit of urine from the ureters into the bladder because of increased pressure on the ureters from the enlarged uterus.

- **Kidney stones*** are another factor that may increase the likelihood of urinary tract infection. Stones can cause partial or complete obstruction to the flow of urine from the kidneys and ureters. This obstruction may act as a focus of infection in the urinary system, leading to urinary tract infections.

Prevention - Prevention of urinary tract and kidney infection primarily focuses on reducing the associated risk factors. As mentioned earlier, the majority of urinary tract infections are caused by the bacteria gaining entry into the urinary system through the urethra. Therefore, personal hygiene plays an important role in preventing kidney infection.

4. Kidney Stones

The kidney acts as a filter for blood, removing waste products from the body and making urine. It also helps regulate electrolyte levels that are important for body function.



Urine drains from the kidney through a narrow tube called the ureter into the bladder. When the bladder fills and there is an urge to urinate, the bladder empties to the outside through the urethra, a much wider tube than the ureter.

In some people, chemicals crystallize in the urine and form the beginning of a kidney stone. These stones are very tiny when they form, smaller than a grain of sand, but gradually can grow over time to 1/10 of an inch or larger. The size of the stone does not matter as much as where it is located and whether it obstructs or prevents urine from draining.

When the stone sits in the kidney, it rarely causes problems, but when it falls into the ureter, it acts like a dam. As the kidney continues to function and make urine, pressure builds up behind the stone and causes the kidney to swell. This pressure is what causes the pain of a kidney stone, but it also helps push the stone along the course of the ureter. When the stone enters the bladder, the obstruction in the ureter is relieved and the symptoms of a kidney stone are resolved.

Causes

- Some people are more susceptible to forming kidney stones, and heredity may play a role. Examples include people with problems metabolizing a variety of chemicals including cystine (an amino acid), oxalate, (a type of salt), and uric acid (as in gout).
- The poor fluid intake may cause people to be relatively **dehydrated***, with their urine becoming more concentrated and allowing chemicals to come in closer contact to form the nidus, or beginning, of a stone.
- People taking diuretics (or "water pills") and those who consume excess calcium-containing antacids can increase the amount of calcium in their urine and potentially increase their risk of forming stones.
- Underlying illnesses such as cystic fibrosis, renal tubular acidosis, and inflammatory bowel disease.

Prevention - While kidney stones probably cannot be prevented, the risk of forming a stone can be minimized by avoiding dehydration. Keeping the urine dilute will not allow the chemical crystals to come out of solution and form the beginning nidus of a stone. Making certain that the urine remains clear and not concentrated (dark yellow) will help minimize stone formation. Medication may be prescribed for certain types of stones, and compliance with taking the medication is a must to reduce the risk of future episodes.

Activity: **Now test yourself by doing this activity.**

A. Answer the following.

1. What are the jobs done by the kidneys?

_____
_____
_____
_____
_____

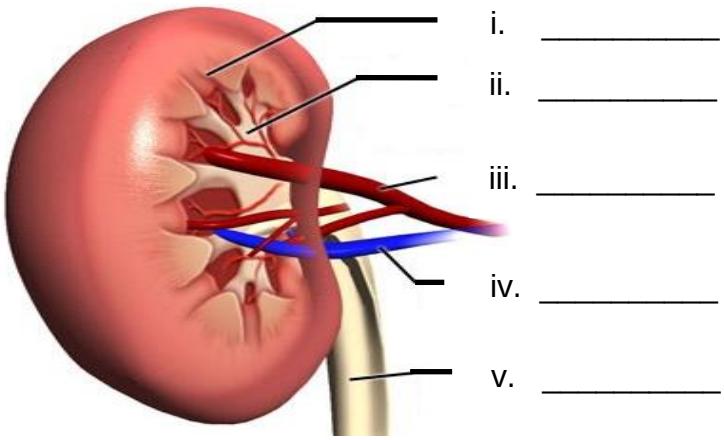
2. What happens to waste substances removed by the kidneys?

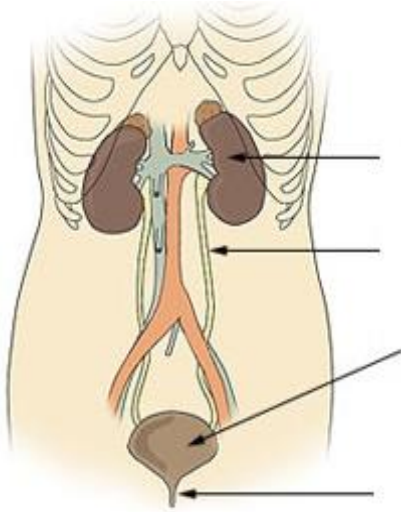
_____
_____
_____
_____

3. Why are the kidneys called organs of excretion?

_____
_____
_____

B. Label the following parts.





vi. _____

vii. _____

viii. _____

ix. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 13.

Summary

You have come to the end of Lesson 13. In this lesson you have learnt that:

- kidneys are organs of excretion: they remove unwanted substances from your body.
- one of the main jobs of the kidneys is to filter the waste out of the blood. Some of the waste is the result of the chemical reactions which occur in the cells of your body.
- the kidneys also balance the volume of fluids and minerals in the body. This balance in the body is called homeostasis.
- the renal capsule is the membranous covering of the kidney.
- the cortex of the kidney is the outer section which covers the internal medulla. It is composed of blood vessels and urine tubes and is supported by a fibrous matrix.
- the renal columns are lines of the kidney matrix which support the cortex of the kidney. They are composed of lines of blood vessels and urinary tubes and a fibrous, cortical material.
- the renal pyramids are conical segments within the internal medulla of the kidney.
- the hilus is the slit-like opening in the middle of the concave medial border of the kidney.
- hypertension is the medical term for high blood pressure. It is known as the "silent killer" since it has no initial symptoms but can lead to long-term disease and complications.
- kidney infection belongs to the family of infections of the urinary system called urinary tract infections (UTIs).
- chemicals crystallize in the urine and form the beginning of a kidney stone. These stones are very tiny when they form, smaller than a grain of sand, but gradually can grow overtime.

NOW DO PRACTICE EXERCISE 13 ON THE NEXT PAGE.

Practice Exercise 13

Answer the following questions.

1. What are the parts of the human kidney and its functions?

(i) _____
_____
_____

(ii) _____
_____
_____

(iii) _____
_____
_____

(iv) _____
_____
_____

(v) _____
_____
_____

2. Enumerate some kidney related problems and its prevention.

(i) _____
_____
_____

(ii) _____
_____
_____

(iii) _____
_____
_____

(iv) _____
_____
_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.

Answers to activity

A 1.

- One of the main jobs of the kidneys is to filter the waste out of the blood. Some of the waste is the result of the chemical reactions which occur in the cells of your body. The waste has to go somewhere; this is where the kidneys come in.
- The kidneys also balance the volume of fluids and minerals in the body. This balance in the body is called homeostasis. Your body gets water when you drink it or other liquids. You also get water from some foods, like fruits and vegetables.

2. Waste substances removed by the kidneys will go the bladder.

3. Kidneys are called organs of excretion because they remove unwanted substances from the body.

B.
i. Renal Parenchyma
ii. Collecting System
iii. Renal Artery
iv. Renal Veins
v. Ureter
vi. Kidney
vii. Ureter
viii. Bladder
ix. Urethra

Answers to Practice Exercises 12-13

Practice Exercises 12

A.

1. **C**
2. A
3. **D**

B.

1. Epidermis
   The layer on the outside of your skin is called the epidermis. The epidermis is waterproof and the part of your skin you can see.

2. Dermis
   The next layer down is the dermis. You cannot see your dermis because it is hidden under your epidermis. The dermis contains nerve endings, blood vessels, oil glands, and sweat glands. It also contains collagen and elastin, which are tough and stretchy.

3. Subcutaneous layer
   The third and bottom layer of the skin is called the subcutaneous layer. It is made mostly of fat and helps your body stay warm and absorb shocks, like if you bang into something or fall down.

4. Blood vessels
   Blood vessels keep your skin cells healthy by bringing them the oxygen and nutrients they need and by taking away waste.

5. Nerve endings
   The nerve endings in your dermis tell you how things feel when you touch them.

6. Melanin
   Melanin is a pigment which protects us from ultra violet rays.

Practice Exercise 13

1. (i) Renal Parenchyma
It filters and blood and makes urine.

(ii) Collecting System
Urine produced by the parenchyma is transferred to tunnel-like area which acts as plumbing to move urine out of the kidney and into the ureter.

(iii) Renal Artery
It provides blood supply to the kidney.

(iv) Renal Veins
It drains blood from kidney.

(v) Ureter
Tube carrying urine produced in the kidney to the bladder

2. (i) High Blood Pressure
It may be prevented by living a healthy lifestyle, including some of the following eating a nutritious, low-fat diet, exercising regularly, decreasing salt (sodium) intake, maintain a healthy weight and if you are overweight or obese, try to lose weight, drink alcohol on moderation, stop smoking, get routine health assessments and blood pressure screening, reduce stress and practice relaxation techniques.

(ii) Heart attack
While people cannot control their family history and genetics, they can minimize risk factors for heart disease such as quit smoking, manage high blood pressure, manage cholesterol, manage diabetes, exercise regularly and take a baby aspirin a day. These are all lifelong challenges to prevent heart disease, stroke, and peripheral vascular disease.

(iii) Kidney infection
The majority of urinary tract infections are caused by the bacteria gaining entry into the urinary system through the urethra. Personal hygiene plays an important role in preventing kidney infection.

(iv) Kidney Stones
While kidney stones probably cannot be prevented the risk of forming a stone can be minimized by avoiding dehydration. Keeping the urine dilute will not allow the chemical crystals to come out of solution and form the beginning nidus of a stone. Making certain that the urine remains clear and not concentrated (dark yellow) will help minimize stone formation. Medication may be prescribed for certain types of stones, and compliance with taking the medication is a must to reduce the risk of future episodes.

REVISE TOPIC 4 USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 4: EXCRETORY SYSTEM

Revise all the Lessons in this Topic and then do **ASSIGNMENT 3.** Here are the main points to help you revise.

Lesson 12: The Skin

- Skin is the largest human organ. It covers and protects everything inside your body. It also protects our bodies, helps keep our bodies at just the right temperature and allows us to have the sense of touch.
- The skin is made up of three layers, each with its own important parts. The layer on the outside is called the epidermis. The epidermis is the part of your skin you can see.
- The next layer down is the dermis. You cannot see your dermis because it is hidden under your epidermis. The dermis contains nerve endings, blood vessels, oil glands, and sweat glands. It also contains collagen and elastin, which are tough and stretchy.
- The nerve endings in your dermis tell you how things feel when you touch them.
- Your dermis is also full of tiny blood vessels. These keep your skin cells healthy by bringing them the oxygen and nutrients they need and by taking away waste.
- The dermis is home to the oil glands, too. These are also called sebaceous glands, and they are always producing sebum. Sebum is your skin's own natural oil. It rises to the surface of your epidermis to keep your skin lubricated and protected. It also makes your skin waterproof.
- The third and bottom layer of the skin is called the subcutaneous layer. It is made mostly of fat and helps your body stay warm and absorb shocks, like if you bang into something or fall down.
- Water, salts, and some urea diffuse from the blood into the sweat glands and are subsequently excreted as perspiration.
- Melanin is a pigment which protects us from ultra violet rays.
- Unlike other organs (like your lungs, heart, and brain), your skin likes a good washing. When you wash your skin, use water and a mild soap. And do not forget to cover scrapes and cuts with gauze or a bandage. This keeps the dirt out and helps prevent infections.

Lesson 13: The Kidneys

- Kidneys are organs of excretion: they remove unwanted substances from your body.
- Kidneys are organs of excretion: they remove unwanted substances from your body.
- The kidneys also balance the volume of fluids and minerals in the body. This balance in the body is called homeostasis.
- The renal capsule is the membranous covering of the kidney.
- The cortex of the kidney is the outer section which covers the internal medulla. It is composed of blood vessels and urine tubes and is supported by a fibrous matrix.
- The renal columns are lines of the kidney matrix which support the cortex of the kidney. They are composed of lines of blood vessels and urinary tubes and a fibrous, cortical material.

- The renal pyramids are conical segments within the internal medulla of the kidney.
- The hilus is the slit-like opening in the middle of the concave medial border of the kidney.
- Hypertension is the medical term for high blood pressure. It is known as the "silent killer" since it has no initial symptoms but can lead to long-term disease and complications.
- The heart is a muscle like any other in the body. It needs blood flow to supply oxygen to allow it to do work. When there is not enough oxygen, the muscle starts to suffer, and when there is no oxygen, the muscle starts to die. This is what you call heart attack.
- Kidney infection belongs to the family of infections of the urinary system called urinary tract infections (UTIs).
- Chemicals crystallize in the urine and form the beginning of a kidney stone. These stones are very tiny when they form, smaller than a grain of sand, but gradually can grow over time.

GLOSSARY

Angina	Chest discomfort, pain, tightness or pressure. May also have associated pain in neck, jaw, back or arm. May include profuse sweating, nausea, or shortness of breath.
Aorta	The large trunk artery that carries blood from the left ventricle of the heart to branch arteries.
Artery	A blood vessel that carries blood from the heart to the body.
Bladder	In anatomy, the urinary bladder is the organ that collects urine excreted by the kidneys prior to disposal by urination.
Blood vessels	The blood vessels are the part of the circulatory system that transport blood throughout the body.
Blood clot	A clump or thickened mass of blood in an artery that may partially or completely block the flow of blood.
Capillaries	Any of the small blood vessels that connect arteries to veins. Their walls are composed of a single layer of cells which allows molecules such as oxygen, water and lipids to pass through them by diffusion.
Cholesterol	A type of fat that is manufactured in the liver or intestines, but is also found in some of the foods we eat. (Only animal foods, such as eggs, milk, cheese, liver, meat and poultry contain cholesterol).
Dehydrated	Suffering from excessive loss of water from the body.
Dermis	The tissue of the skin underlying the epidermis.
Diabetes	Is a condition in which a person has a high blood sugar (glucose) level as a result of the body either not producing enough insulin, or because body cells do not properly respond to the insulin that is produced.
Digestion	The organic process by which food is converted into substances that can be absorbed into the body.
Epidermis	The outer, protective, nonvascular layer of the skin of vertebrates, covering the dermis.
Follicle	A follicle is a small spherical or vase-like group of cells containing a cavity in which some other structure grows. Follicles are best known as the sockets from which hairs grow in humans and other mammals.

Gender	Sex: the properties that distinguish organisms on the basis of their reproductive roles.
Goose bumps	Raised skin, usually on the neck or arms caused by cold, excitement, or fear.
Heart Attack	A sudden severe instance of abnormal heart functions.
Heredity	The biological process whereby genetic factors are transmitted from one generation to the next.
Homeostasis	The ability of a system or living organism to adjust its internal environment to maintain a stable equilibrium; such as the ability of warm-blooded animals to maintain a constant temperature.
Hormone(s)	A hormone is a chemical released by a cell in one part of the body that sends out messages that affect cells in other parts of the organism.
Hypertension	High blood pressure: a common disorder in which blood pressure remains abnormally high (a reading of 140/90 mm Hg or greater).
Inflammatory Bowel Disease	A condition in which the large or small intestine becomes irritated and/or infected.
Kidney	Either of two bean-shaped excretory organs that filter wastes (especially urea) from the blood and excrete them and water in urine; "urine passes out of the kidney through ureters to the bladder".
Kidney Stones	A hard, rock-like mass made of minerals in the kidney. Kidney stones are also known as "renal calculi."
Melanin	Any of a group of naturally occurring dark pigments, especially the pigment found in skin, hair, fur, and feathers.
Metabolism	Metabolism is the set of chemical reactions that happen in living organisms to maintain life. These processes allow organisms to grow and reproduce, maintain their structures, and respond to their environments.
Nephrons	Parts of the kidney that removes waste products from the blood, recover some substances to be used again by the body, and eliminate what is left as urine.

Nerve Endings	A nerve is an enclosed, cable-like bundle of peripheral axons (the long, slender projections of neurons). A nerve provides a common pathway for the electrochemical nerve impulses that are transmitted along each of the axons.
Obesity	Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems.
Prostate	Prostate gland: a firm partly muscular chestnut sized gland in males at the neck of the urethra; produces a viscid secretion that is the fluid part of semen.
Subcutaneous Fat	The fat found just under the skin that gives it a plump, padded look.
Skin	A natural protective body covering and site of the sense of touch; "your skin is the largest organ of your body".
Sweat Glands	Sweat glands also referred to as sudoriferous glands are exocrine glands, found under the skin of all mammal species that are used for body temperature regulation. In humans a system of apocrine - and merocrine sweat glands is the main method of cooling.
Ureter	Either of a pair of thick-walled tubes that carry urine from the kidney to the urinary bladder.
Urethra	A small, tubular structure that enables urine to pass from the bladder out of the body. The female urethra is relatively short in length compared to the male urethra.
Uterus	A hollow muscular organ in the pelvic cavity of females; contains the developing foetus.

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FODE SUBJECTS AND COURSE PROGRAMMES

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language& Literature
	2. Mathematics – General/Advance
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) subjects.
- For Grades 9 and 10, you must complete five (5) subjects and one (1) optional to be certified. Business Studies and Design & Technology – Computing are optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) subjects to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject and course.

Notes: You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

GRADES 11 & 12 COURSE PROGRAMMES			
No	**Science**	**Humanities**	**Business**
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics -General/Advance	Mathematics -General/Advance	Mathematics –General/Advance
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

CERTIFICATE IN MATRICULATION STUDIES		
No	**Compulsory Courses**	**Optional Courses**
1	English 1	**Science Stream:** Biology, Chemistry, Physics
2	English 2	**Social Science Stream:** Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.