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National Correspondence College
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G.C.E. ’O’ LEVEL LESSON 11
EpMAN BIOLOGY
The Circulatory sttem Part III
This is the last of three lessons on the circulatory system. This lesson is about
The Functions of the Blood
A. The blood as the transport system of the body.
B. The blood as the body’s main defence system.
In part A of this lesson we shall study the ways in which blood transports various substances around the body. In part B of the lesson we shall study the ways in which the blood fights bacteria which enter the body.
You should go back to lesson 10 and revise the circulation of blood in the body again before you start to study this lesson.
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HB
11

PART A

THE BLOOD AS THE TRANSPORT SYSTEM OF THE BODY

a) Blood transgorts oxygen around the body

The human body is quite large and is composed of countless numbers of cells. Most cells in the body are not near the surrounding air and they cannot obtain their own supplies of oxygen. The lungs. therefore, have the job of obtaining Oxygen for all other parts of the body. Once the oxygen has been removed from the air by the lungs it has to be carried to all parts of.the body. It is the blood which picks up oxygen from the lungs and carries it to every cell in every part of the body.

As you learnt in lesson 9, the blood contains vast numbers of red blood cells. It is the job of these red blood cells to carry oxygen and they can do this because they all contain a red-coloured chemical called haemoglobin. (Haemoglobin is a special kind of protein with iron in its molecule.)

Haemqglobin has one remarkable property. When it is in an area of high oxygen concentration (much oxygen present) it picks up oxygen and becomes a substance called oxyhaemoglobin.

HAEMOGLOBIN e OXYGEN--9OXYHAEMOGLOBIN

When oxyhaemoglobin is in an area of low oxygen concentration (little Oxygen present) it releases its oxygen and becomes haemoglobin once more.

OXYHAEMOGIDBIN-__9HAEMOGLOBIN e OXYGEN

This ability of haemoglobin to pick up oxygen enables it to carry Oxygen around the body.

The lungs are an area of high oxygen concentration. When blood flows through the lungs in the pulmonary circulation the haemoglobin in the blood picks up oxygen and becomes oxyhaemoglobin. This Oxyahaemo-globin in the blood returns to the heart and is then pumped out along the body circulation which carries blood to all the tissues of the body.

The tissues of the body always have a low oxygen concentration because they are constantly using up oxygen during respiration. As the blood flows

through the capillary networks in these tissues the oxyhaemoglobin releases its oxygen and becomes haemoglobin once more. The released oxygen passes out of the capillaries to the cells, which require it to oxidise sugar during respiration. The haemoglobin is returned to the heart and pumped out along the pulmonary circulation to the lungs where it can pick up another supply of oxygen. This process repeats itself continuously throughout one's life.

The transport of oxygen in the body is summarised in the following diagram.

HAEMOGLOBIN IS RETURNED IN THE BLOOD TO THE LUNGS

UCH OX YGEN L l TTLE OXYGEN

BODY TISSUES

This is carried.

in Ha bbod.

b) Blood distributes-heat around the body

The liver is the largest and most active organ in the human body. The chemical processes taking place in this organ produce much heat. As blood flows through the liver it becomes warmer as it picks up heat. This warmer blood will eventually become cooler as it passes through cooler parts of the body.

When muscles are doing work, (i.e. when the body is being moved), they produce a lot of heat. Some of this heat is carried to cooler parts ofexhe body (less active parts of the body).

You can see that the blood helps to distribute heat evenly throughout the body and prevents the build-up of too much heat in any one area.
The temperature of the normal human body is approximately 370C. You will see in a later lesson how the blood carries unwanted heat to the surface layers of the skin where it can be lost by radiation.

c) Blood transports food materials

The digestive system prepares food for use in the body by digesting the complicated food substances. The simple substances, which are the products of digestion, are assimilated through the wall of the small intestine. It is the job of the blood to distribute these simple food substances to the parts of the body where they are required. (You should check in lesson 8 about the assimilation and use of food in the body.)

d) Blood transgorts waste Eroducts.

Hundreds of chemical reactions are constantly taking place inside each cell in the body. Many of these chemical reactions produce waste products which would, if they were allowed to accumulate, be poisonous to the cells. These waste products normally pass out of the cells into the lymph and are carried away before they can build up to a dangerous level. The lymph eventually drains into the blood which then carries the waste products to the excretory organs of the body.
The excretory organs of the body are the lungs, kidneys, sweat glands and liver. Their jOb is to remove harmful waste products from the body and pass them to the outside. The process of removing waste products from within the body is called excretion; you will learn more about this process and about the excretory organs in a later lesson.
You have now learnt about four ways in which the blood transports substances around the body. Other substances, which will not be mentioned here, are also carried around the body by the blood but the four topics in the first Section of this lesson are the most important.

EXERCISE 1

(1) The red chemical in red blood cells is called
This chemical contains the mineral
(2) A high concentration of oxygen is found in the .
(3) is the process of removing waste products from the body.
(4) The four excretory organs of the body are the ,
and
(5) Waste products pass out of the cells into the
(6) The most active organ in the body is the

PART B

THE BLOOD AS THE BODY'S MAIN DEFENCE AGAINST DISEASE

In this part of the lesson we are going to study the different ways in which the blood defends the body against bacteria and other foreign substances which invade the bddy.

1. White blood cells destroy bacteria

White blood cells are the body's defence against invaders. They have the following three characteristics,which give them the ability to carry out this function.

(a) White blood cells, mainly granulocytes, can form "false feet" and move through the body to the site of invasion by bacteria. These"false feet" are called Eseudopodia (singular - pseudopodium). A pseudopodium is formed by the cell wall bulging outwards and cytoplasm flowing into it. As the cytoplasm flows into the pseudopodium the whole cells moves forward.

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pseudopodium
This method of movement is often called "amoeboid movement" and white cells move in this way to the site of invasion by bacteria.
(b) White blood cells, mainly granulocytes, can ingest bacteria. (To ingest means to take into the cell). This is done by the white blood cell pushing out pseudopodia and surrounding the bacteria. The bacteria are then drawn into the body of the white blood cell and destroyed. This process is called Ehagocxtosis. (A Ehagocxte is any white blood cell which can ingest bacteria)
pseudopodua .
Bacteria pseudopodaa Surround the, hoorerno bocreric Ingesred
Any one white blood cell can ingest as many as 10-20 bacteria and destroy them.
(c) White blood cells, mainly lymphocytes3 produce anti-toxins and antibodies Wthh inactivate or destroy bacteria.
_ 6 -

Some bacteria produce chemical substances called toxins which can harm the body's tissues. White blood cells can make anti-toxins which are chemical substances which make toxins harmless.
White blood cells also produce antibodies. These are special kinds of chemical substances which inactivate or destroy bacteria. More will be said about antibodies in a later part of this lesson when we discuss immunity.
An examgle of what may haREen when the bodx is invaded.
Let us consider a very simple case of the body being invaded. Suppose a dirty splinter of wood breaks through the skin. A dirty splinter will have bacteria on it.
1. White blood cells move in large numbers to the site of the invasion.
2. The white blood cells form a wall around the splinter to prevent the spreading of toxins and bacteria.
3. The white blood cells attack and remove the bacteria by phagocytosis.
4. The white blood cells also break down and remove damaged skin cells by phagocytosis. They will also try and break down the splinter itself.
5. Some white cells may be killed by the toxins which have been produced by the bacteria. Dead white blood cells, damaged tissue cells and bacteria collect in the invaded area and form PUS.
6. If the splinter of wood is removed, the pus is discharged from the body.
7. If the splinter is broken or anything happens to close in the pus an abcess may be formed under the skin. The abcess will get larger and eventually it will burst. When the abcess bursts the pus and the splinter will be discharged from the body.

As you have seen from the previous example the white blood cells recognise substances which are foreign to the body. The white blood cells attempt to destroy any foreign substance which enters the bodv. Particular attention has to be paid to this fact when transfusions of blood from one person to another are given. In a later section of this lesson you will learn about blood transfusions and blood groups.

2. Blood clotting

You will have seen your own blood clotting. If you out yourself you bleed. At first the blood flows freely. Then it slows down and sets into a jelly. After a time it shrinks and becomes harder. The clot seals the cut in the skin and stops the bleeding.

Blood clotting is useful to the body in two ways:

a) It seals ofi the cut ends of small blood vessels and prevents the body from losing too much blood.

b) It quickly seals off a cut in the skin to prevent large numbers of bacteria from entering the body. (Bacteria cannot pass through healthy undamaged skin)

If you look at a blood clot under a microscope you see a mass of fine thread-like fibres. Trapped in the fibres are white blood cells, red blood cells and broken platelets.

The threads in the clot are made from a protein called FIBRIN. A lot of the fibrin threads seem to come from the broken platelets.

Blood clotting does not normally take place unless the blood is exposed to the air. It is dangerous if blood clots are formed inside the blood vessels because these clots may block-off the blood vessels and cause serious damage to the body.

Fibrin cannot normally be present in the blood because it would harden and form clots. There is a soluble protein in the blood called FIBRINOGEN which can be changed into fibrin by an enzyme called THROMBIN. Thrombin also is not normally present in the blood because an enzyme anti-thrombin causes its destruction. The thrombin is carried in the blood in an inactive form called PROTHROMBIN. So the chemicals prothrombin and firbinogen alongwith anti-thrombin are always found in the blood.

When the skin is cut blood leaks out of the cut blood vessels and is exposed to the air. This causes damaged blood platelets, blood vessels and tissue to release a substance called THROMBOKINASE into the blood. This thrombokinase plus the mineral calcium, which is always present in blood, cause prothrombin to change into thrombin. The thrombin then changes fibrinogen into fibrin. The fibrin hardens to form the fibres which trap blood cells and form a clot.

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.3!) H46!) PLATTLE".
7HK0H8/N w P144719
THROMB/N 4’ F/BR INOGENgF/BRIN

3. Blood transfusions
Blood transfusions must be given when more than 40% of the blood in the body has been lost. They may also be needed to provide haemoglobin for infants suffering from severe malnutrition. When it is mainly a question of restoring the volume of blood in the body, as in the case of burns, then plasma or serum transfusion may be given. Plasma is blood which has had the cells removed. Serum is plasma which has had the fibrinogen removed.

.a) Transfusions of whole blood.
These must be given when both fluid and red blood cells are needed.

(1) Whole blood will clot so an ANTI-COAGULANT must be added. This is a substance which prevents the clotting process from taking place.

(2) Whole blood must be stored at low temperatures but does not keep wellfor a long time.

(3) Whole blood from one donor (the giver) cannot be given to just any other person. It can only be given to a recigient (receiver) with exactl matchin blood. There are different groups (types; of blood. Mixing of certain groups can cause death.

b) Transfusions of Elasma or serum
These can be used whenever red blood cells are not urgently needed.

(1) Plasma or serum do not have to be matched. Plasma from any donor can be given to any recipient. Plasma can be given to people with any type of blood.

(2) Plasma will clot and can only be stored with anti-coagulatnt added. Serum will not clot.

(3) Plasma and serum can be dried and stored for a very long time. When needed the powder is just mixed with the correct quantity of completely pure and sterile water.

Earlier in this section you learnt that blood can be divided into different groups and that whole blood must be exactly matched with the recipients blood before a transfusion can take place. You are now going to learn about blood groups.

4. Blood GrouEs

A donor’s blood must be exactly matched to that of the recipient. What happens if it is not?

If the donor’s blood is of the erng group the red blood cells of the donoxls blood will AGGLUTI_ NATE (ie. stick together in clumps) when it mixes with the recipient’s blood.

COMPATIBLE, NO CLUMPS INCOMPATIBLE, CLUMPS

Groups of blood which, when mixed. result in agglutination are called INCOMPATIBLE.

Agglutination is caused by the coming together of two factors.

(1) A factor in the donor’s red blood cells. This is called an agglutinogen, (also known as antigen).

(2) A factor in the recipient’s plasma. This is called an agglutinin, (also known as antibody).

All peoples’ blood can be divided into 4 groups according to what happens when they are mixed. The groups are called A. B. 0 and AB.

The agglutinogens and agglutjnins found in the different blood groups are as follows.

GROUP A Agglutinogen A Agglutinin b

GROUP B Agglutinogen B Agglutinin a

GROUP AB Agglutinogen A No Agglutini n Agglutjnogen B

GROUP 0 No Agglutinogen Agglutinjn a & b

Agglutination takes place when agglutinogens and agglutinins of the same type are brought together. (e.g. Agglutinogen A mixed with agglutinin a causes agglutination.)

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/ COMPATIBLE (No mumps)

X INCOMPATIBLE (cwmps)

If you look at the chart above you will see that the following transfusions are pcssible without the blood agglutinating.

GROUP A may receive blood from Groups A and O
GROUP B " " " " " B and 0
GROUP AB " " " " " A.B AB and O
GROUP 0 n H H u u 0
People with group AB blood can receive blood of all four types. They are called universal reciEients 0r universal acceptors.
People with Group 0 blood can give blood to all four groups. They are called universal donors.

5 IMMUNITY

It is of two types i.e. Natural and Artificial.

Natural Immunitx

Immunity to a disease can be produced by having the disease and recovering. This is called the natural immunity.
When bacteria enter the body they may cause a disease. The white blood cells in the body react towards the invading bacteria as described on pages 7 and 8 of this lesson. If the white blood cells are succeSSful in their fight against the bacteria the body recovers from the disease.
One of the methods used by white blood cells to fight invading bacteria is to produce antibodies. These are chemicals which inactivate or destroy bacteria. When the body recovers from a disease the antibodies, which were produced to fight the bacteria causing the disease remain in the blood. These antibodies will be present in the blood to destroy bacteria of the same txge, should they try to enter the body again, before these bacteria can multiply sufficiently to cause disease.

When antibodies for a particular disease are present in the blood, the body is said to be IMMUNE to that particular disease.

Immunity to diseases lasts from a few days to life depending on the particular disease. The antibodies produced to fight the common cold virus remain active in the blood for between 5 and 10 days. After this time we can catch another cold. The antibodies produced to fight the measles virus remain active in the blood for the rest of our life. Once having had measles a person cannot be infected with the disease again.

ARTIFICIAL IMMUNITY

Doctors, over the last 200 years, have discovered that it is possible to make a person immune to certain diseases without he or she having to suffer the disease. This type of immunity is often called the artificial immunitx.

Artificial immunity can be produced in three separate ways. These three ways all depend upon stimulating the white blood cells and are described below.

1) Dead bacteria are injected into the body. The white blood cells produce antibodies against these bacteria just as if they were living. Sometimes, as in immunisation against polio-myelitis, the dead bacteria are eaten on a lump of sugar.

2) Living, but weakened, bacteria are injected into the body. These weakened (alternuated) bacteria are not p0werful enough to cause a disease. The white blood cells still produce antibodies to fight these bacteria.

3) The third method can only be used against smallpox. There is a disease called 00w pox which is caused by viruses very similar to the viruses that cause smallpox. Cow pox is not a very serious disease and the body quickly recovers from it. When we are vaccinated against smallpox the doctor introduces a liquid containing cow pox Viruses into our bodies through a cut in the Skin (usually on the arm). A blister soon develops and we suffer for a few days from cow pox. After suffering from cow pox we cannot catch smallpox. This is because the antibodies produced to fight cow pox viruses will also kill smallpox viruses.

IMPORTANT FACTS ABOUT IMMUNITY

1) Antibodies are chemicals produced by white cells to destroy or inactivate bacteria.

2) The antibodies produced to fight one type of disease will usually not act against other types of disease.

3) Antibodies, once produced may remain in the blood for many years. This makes the body immune to the disease which the antibodies were produced to fight.

EXERCISE II

1. White cells produce "false feet" called

2. They move in a Special way. This moment is called .

3. The poisons produced by bacteria are called

4. are chemicals produced by white blood cells to destroy bacteria.

5. A blood clot consists of a network of fibres made from a substance called

6. A person receiving a blood transfusion is called a .

_____-_-_

7. A person giving blood for a transfusion is called a .

The four human blood groups are

8.

and

ANSWERS TO EXERCISE I
Haemoglobin
Iron
Lungs
Excretion
Lungs, Kidneys, skin and liver
Plasma
Liver
ANSWERS TO EXERCISE II
Pseudopodia
Amoeboid movement
Toxins
Antibodies
Fibrin
Recipient
Donor
A. B, AB and O

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HUMAN BIO LOGY
REVISION OF LESSONS 1 - 11
LESSON 12

This lesson is a test which gives you some guidance and practice in answering the types of questions set in the London University Examinations.

Before you start doing the test please pay special attention to the following points:-

1. Revise all the lessons 1-11 very carefully and thoroughly with special attention to the diagrams. Sometimes you can get more marks for an illustration than for the rest of the answer. It is, therefore, essential that you draw and llbel all the diagrams neatly and properly. (Read pages 6 and 7 of Lesson 1).
2. Read through the whole question paper quickly without concentrating on any particular question. This gives you an idea of what sort of questions there are at a first glance.
3. Select the easier questions to do first instead of lingering on difficult ones which you can tackle later:
4. Spread your time wisely over all the questions you wish to do rather than wasting too much time on one question only.
5. Answer all the questions by yourself. Do not refer to or copy from your lessons.

Noter- Write the answers to Human Biology 1 using the spaces provided, and the answers to Human Biology 2 on separate sheets.

Send in your answered Human Biology 1 together with your answers to Human Biology 2 for marking

Human Biology 2
One hour
Answer TWO questions; ONE from Section A and ONE from Section B.

Section A

Answer ONE question from this Section.

1. Prepare a list to show your diet yesterday. Explain how you think this was related to your body needs. (25)

2. Give an account of the evidence supporting the theory of evolution. Illustrate your answer wherever possible by reference to man. (25)

3. Explain how the flow of blood through the heart is maintained in a constant direction.
What is the pulse?
Why does a doctor feel a patient's pulse? (25)

Section B

Answer ONE question from this Section.

4. Summarize the methods of prevention of diseases spread by
(a) food,
(b) water. (25)

5. Give an account of three different organisms, other than bacteria or viruses, which are parasites of man.
(25)

6. State five major deficiencies common in poor housing and describe their probable effects on the health of the residents. (25)

Total Marks : 50
100
Total marks for Paper 1 & 2

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HUMAN BIOLOGY LESSON 13
This lesson is about
A. The Living Nature of Bone.
B. Factors controlling its Healthy Development.
C. General Structure and Functions of the Skeleton.
D. Main Parts of the Skeleton.

A. The Living Nature of Done.
A bone is a connective tissue which is also called a skeletal tissue. The skeletal tissun is of two types:
(i) Cartilage. Hyaline cartilage tissue contains cartilage cells which are separated 1y large amounts of non lixing material called matrix. Hyaline cartilaqv tissue is found near the edges of a bone and also provides a smooth surface for joints to articulate. In the case of an infant, it forms the major part of a hon:
(ii) Bone Tissue. It is a stronger and more specialised skeletal tissue. The bone tissue is a Cylindrical tissue having living bone cells, capillaries, lymph vessels and a nerve fibre as well as nun" living deposits of calcium salts. So thw bone tiSSue on the whole is as much ajixr as any other tissue.
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Ossification or bone formation begins before birth.
Bone is produced by bone producing cells called OSTEOBLASTS.
Bone formation takes place mainly in two places:
1) around the outside of the bone, ize in an area called the periosteum.
ii) at each epiphysis near each end of the bone.
The epiphySis is the extreme swollen end of the bone and is separated from the shaft by a cartilaginous plate called the epiphyseal plate. Bone grows in length by new bone which is laid down at the epiphyseal plate.
The cartilaginous bone becomes impregnated with calcium salts (mainly calcium phogphate) and is gradually replaced by bone.
Growth in thickness of diameter is caused by the activity of the periosteum and growth in length is caused by the activity of the epiphyseal plate.
OSSIFICATION OF A LONG BONE.
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mint ’

The bone formed by the petriosteum is solid and comEact. The shaft of the bone becomes hollow and spongy. The bone tissue is replaced by bone marrow. The bone formed within the cartilage is spongy and is called the cancellous bone. Both forms, compact and cancellous, are live and active tissues in which there is a constant changing of materials. The bone has the ability of repairing itself in case of a fracture or any other injury.

The Structure 0? (1 Bone. (Fomup)

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one

Murrow

Endosteuw

Pemiosteum

Bone Marrow. It is a soft tissue found in the spaces of all cancellous bones and in the hollow shafts of long bones.

It is of two kinds:_

Yellow Marrow. It is made of fatty tissue and soft, connective tissue.

Red Marrow. It contains a lot of blood. It is very important as it produces red blood cells.

In adults, red marrow, is found in the skull, backbone and in a few other bones, but in children it is present in most of the bones.

B. Factors Controlling the Healthy DeveloEment of Bones.

The three main things essential for the healthy development of bones are

1. proper food,
2. correct posture and
3. proper exercise.

1. ProBer Food

Childhood is the most important stage in the development of the skeleton. 50, special care must be taken about the diet of the child. Minerals calcium and phosphorus form a large part of the bone. Vitamin D is also very important in the growth of the bones.

Bones store calcium deposits, so that they can be used in case of emergencies such as in pregnancies. A pregnant woman’s calcium intake is three times that of an ordinary person’s. But this is a temporary requirement to meet the needs of the foetus inside the body. An adult needs calcium to repair the worn out bone cells. But a child needs large supplies of calcium so that his bone can grow healthy and strong.

The rich sources of calcium are

a) milk
b) cheese
c) fish
d) eggs
e) cabbage and some other vegetables.

The mineral calcium itself cannot be absorbed in the body unless phosphorus and vitamin D are present. We always get enough phosphorus from our ordinary diet but Vitamin D is obtained from

a) cheese
b) butter
c) egg yolk
d) cod-liver oil.

Ultra-violet light present in the sunlight enables the body to produce its own supply of Vitamin D. But undue exposure to sunlight in hot tropical countries can lead to a heat stroke. So great care should be taken in obtaining Vitamin D in this way.

2. Correct Posture

The way we sit and stand is called our posture. A child must be taught to sit, stand and walk properly so that his bones take the correct shape While still in an early stage of develOpment. Once the bones have developed and hardened in a wrong posture, it is very difficult to bring them in the correct position.

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3. ProEer Exercise Taking proper exercise regularly is very important for the healthy growth of bones. Playing games involving walking and running, swimming and dancing are all good exercises for this purpose.

C. General Structure of the Skeleton
A complete diagram of the skeleton, with the proper scientific names of its parts, is given below. There is no need to learn to draw it. But learn the names of its parts and how they are joined together.
THE HUMAN SKELETON
ShuH
lower jaw
clavicle.
sternum
humerus
spine
(ygrl’ebral comma)
carpal;
__ meJ’a’
_- xecarpab
G phalanges
femur
patella
Ea sols
’hf hum
meka- h -. hbula
faraols
Phal nge’s _____
In the front of the body, the collar bone (claricle) joins the breast bone (sternum). Each arm is joined onto the outer edge of the shoulder blade (scapula).

The hip bone (pelvis) is made up of 3 bones joined together. The pelvis is joined to the bottom of the back bone (spine). Each leg or thigh bone (femur) is joined to the bottom outside edge of the pelvis.
The rib cage is joined to the vertebral column (spine/backbone) at the back, and the sternum at the front. The ribs curve round to give shape to the chest, and to protect the heart and lungs.

Functions of the Skeleton

The skeleton is a framework which
(i) suEEorts the body,
(ii) gives it a sha e,
(iii) protects the internal organs,
(iv) has muscles attached to it with the help of tough tendons,
(v) allows movement of the body at its joints,
(vi) produces red blood cells in its red bone marrow and
(vii) acts as a store house for minerals the body may need.

About two-thirds of the weight of a bone is formed from the mineral salts which are mainly calcium and phosphorus.
These salts are constantly dissolving and passing into the blood stream while new supplies from food and other tissues take their place. If the diet lacks these minerals or the body needs them in excess (e.g. when a woman is pregnant), the mineral salts in the bones are readily available for use. But if they are not replaced by eating food rich in them, bones can become soft and deformed.

Now do the following Exercise and check your answers on page 16.

EXERCISE 1

1. Describe 2 kinds of bony tissue.
(a)
(b)

2. (a) Where would you find the bone marrow?
(b) Why is the red marrow so important?
3. (a) Do all bones have a hollow centre?
(b) What is the periosteum for?
(c) Why are the ends of some bones covered with cartilage?
4. Write any 4 functions of the Skeleton.
(i)
(ii)
_____-___.o--___-__
(iii)
_____-___-_
(iv)
D. MAIN PARTS OF THE SKELETON
a. The Skull. It has 2 main parts. One part, the lower jaw called the mandiglf , is movable. The other part called the cranium contains the brain. The skull curves downwards to form the upper jaw which is the upper part of the mouth cavity. The lower jaw is separate from the rest of the skull but articulates (forms a joint) with it.
b. The SEine. It is also called the backbone or the vertebral column. It consists of 33 small bones called vertebrae with pads or discs of cartilage in between them. These discs allow the vertebrae to twist and slide over each other a little.
The spine and skull form the axial skeleton to which 2 girdles are fixed. The upper, shoulder (pecotral) girdle is fixed by means of the ribs. The lower, hip (pelvic) girdle articulates with it near the bottom of the spine.
Both the shoulder and the hip girdles are called the appendicular skeleton.
The vertebrae are divided into the following groupso

No. of Movable or
vertebrae fused
lllliillllllIliiiiiiiilll
5 Movable Allow movement
of trunk.
Fused Support pelvic
girdle.
_-_
YICAL V TEB A
Naurul Spine
FUNCTION
Allow movement
of head.
Neck (CERVICAL)
Supports ribs
and pectoral
girdle.
Chest(THORACIC
Loin (LUMBAR)
annsvu’so
Process
Transverse
Process
Tn qnsvuvsc
Process
cunt:
Bod incl copd (155% Ne, I
j thro ugh hfm) 5Fm2a
FRONT WEN EOE WEW
Look at the diagram of the backbone. It has been
divided into the 5 regions.
The top most vertebra is called the atlas
vertebra which carries and articulates with the
skull. The lower vertebrae are larger and

stronger than the cervical ones. Every vertebra, except those of the tail, has a hole through it called the Neural Canal. It becomes a long canal or passage when the vertebrae are placed on each other. The Spinal cord of nervous tissue passes through it. Nerves leaving and joining the spinal cord pass through spaces between the sides of the vertebrae. The neural canal is towards the back of each vertebra. The main part of a vertebra is a bony mass called the Centrum or the body. Vertebrae above and below articulate with it. The neural spine is a long bony part at the back of each vertebra. Some muscles of the back are attached to these neural spines which protect the spinal cord. These neural spines can be seen projecting beneath the skin.

On either side of each vertebra, there is a process (projection) called the transverse process. The ribs articulate with the transverse processes (projections) of the thoracic vertebrae. Other processes have muscles attached to them.

The vertebral column

(a) protects the spinal cord,
(b) supports the head and neck,
(0) allows movement of the body,
(d) supports the shoulder and hip girdles,
(e) has muscles attached to it.

c. The Thorax. It contains the lungs, heart and some large blood vessels. The body cage of the ribs protects them.

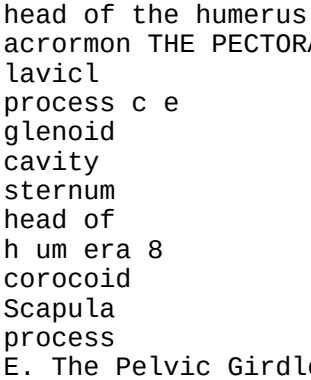
There are 12 pairs of ribs, the last 2 of which are not attached to the sternum. These 2 ribs are called the "floating ribs". The other 10 ribs articulate with the thoraciLvertebrae and curve round the sides of the chest forming rings or hoops. They are joined.to the sternum in front by the sternal cartilage.

d. The Pectoral Girdle

Each pectoral (shoulder) girdle consists of a clavicle (collar bone), a scapula, and some muscles and ligaments. The clavicle is a flattened bone which articulates with the sternum at one end and with the acromion process of the scapula at the other. The scapula is a flat triangular bone which is also called the shoulder blade. It is joined to the spine, chest and to the humerus by muscles.

Apart from the acromion process, the scapula has another projection, like a small knob, called the coracoid process to which some muscles are attached.

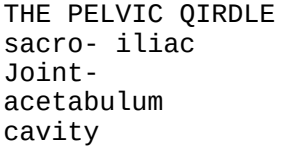
At the point where the clavicle, coracoid and scapula meet, there is a shallow round cavity (socket) called the glenoid cavity. The round head of the humerus fits into this cavity.



THE PECTORAL GIRDLE

E. The Pelvic Girdle

It is also called the hip girdle. It is made up of two hip bones, the sacrum and some muscles. Each hip bone consists of 3 bones called ilium, ischium, and the Rubis, all fused together. The hip bone is joined to 5 fused sacral vertebrae (sacrum) by the sacro-iliac joint. On each side of the pelvic girdle is the acetabulum cavity into which the rounded head of the femur fits.



THE PELVIC QIRDLE

The pelvic girdle forms a basin which supports and protects organs such as the lower part of the intestines, the bladder and some of the reproductive organs.
The pelvic girdle of a woman is wider and shallower than that of a man in order to help her in child-bearing and child birth.
F. The bones of Limbs
The two arms and the two legs are called the limbs of the body.
The leg bones are longer and stronger than those of the arm. There is a knee cap (patella) at the knee but no such bone exists on the elbow. But this one bone shortage in the upper limb (arm) is made up for by an extra bone in the wrist. There are 8 wrist bones compared to 7 ankle bones so that the total number of bones in each limb remains the same - 30.
The upper bone is a single long and strong bone called the humerus in the case of the arm and the the femur in the case of the leg. The lower part of each is supported by two bones. The humerus is supported by the radius and ulna at the elbow, and the femur by tibia and fibula at the knee-
The arm and leg.
humans Fe Mur.
patella
11an (Mt _
311de
CurfaJs
Metamrwds ___Ig%% Tarsds
inhahnys ’ 33.1 tums

The tibia is called the shin bone. It articulates with the fermur but in the case of the arm, both the radius and ulna articulate with the humerus. The radius and ulna can twist over each other so that the palm can face upwards or downwards. But this is not possible with the bones of the leg. The wrist consists of 8 small bones called CarBals while the ankle contains 7 bones called tarsals. The biggest tarsal is the heel bone.

The palm of the hand contains 5 rod-shaped bones called metacargals, and the sole of the foot has 5 metatarsals. Both the finger and toe bones are called Bhalanges.Thereare 14 in each hand or foot. Each finger and toe have 3 phalanges but the thumb and the big toe have only 2 each.

Now do this exercise. CHECK YOUR ANSWERS on page 16.

EXERCISE 2

1. (a) How many vertebrae are there in the vertebral column?

(b) How many of the vertebrae are fused together?

(c) What are the fused vertebrae called?

(i) (ii) i

(d) Which part of the vertebral column does the pelvis articulate with?

(e) What is the atlas vertebra?

(f) Which part of a vertebra does the spinal cord pass through?

(3) Which part of a thoracicvertebra articulates with the ribs?

2. Name the parts of the pectoral girdle. (Use scientific names.)

_____,___

_____,_____

3. Name the bones of the arm from shoulder to fingers

Upper arm; Hand;

Fore-arm; Fingers;

. _____1_____

Wrist;

ANSWERS TO THE EXERCISES

EXERCISE 1.

1. (a) Compact bone is very hard, dense and compact.
(b) Cancellous bone is soft and spongy.
2. (a) Bone marrow is found in the spaces of cancellous bone and in the hollow shafts of long bones.
(b) Because red blood cells are formed in it
3. (a) No.
(b) To protect the bone and to supply it with bone cells.
(c) To protect bones where they meet.
4. Any 4 of the following:-
(1) Supports the body.
(ii) Gives shape to the body.
(iii) Protects the internal organs.
(iv) Muscles are attached to it.
(v) Allows movement of the body.
(vi) Produces red blood cells.
(vii) Acts as a store house for minerals.

EXERCISE 2

1. (a) 33.
(b) 9.
(c) (i) Sacrum (ii) Coccyx.
(d) Sacrum.
(e) The top cervical vertebra; the head balances on it.
(f) Neural Canal.
(5) Transverse process.
2. Clavicle, Scapula and Sternum.
3. Upper arm; humerus.
Fore arm; radius, ulna. Hand; metacarpals
Wrist; carpals. Fingers; phalanges

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G.C.E. ’O’ LEVEL
HUMAN BIOLOGY LESSON 14
This lesson is about
A. Joints
B. The Living Nature of Muscles, and Factors controlling their healthy Development
C. Muscle Groups and Movement

A.
A
mus
and
to make the desired movements. The bones at the joints have to be protected against damage caused by
The following are the three main types of joints:
1.
JOINTS
Sutures
joint is where two or more bones meet. A joint
t be strong enough to withstand sudden movements
shocks and yet supple enough to enable a person
rubbing against each other.
sutures (fixed joints)
cartilaginous joints (slightly moveable)
synovial joints (freely moveable)
The best example of such joints is a man’s skull. The edges of skull bones are jagged like the edges of a saw. They fit into each other to form a tight smooth joint. In babies, there are spaces between the skull bones to allow room for growth. These spaces become narrower and narrower as the baby grows until they form the tight joints called Sutures.
An Intervertebral Cartilaginous Joint
As is clear from its name above, this is a joint between two vertebrae of the spine. In other words, the spinal column consists of vertebrae joined together by the cartilaginous joints. The name of the joint is derived from the fact that each bone is covered by a layer of CARTILAGh which is a connective tissue. Also there is a round pad or DISC of CARTILAGE between each pair of bones (vertebrae).
Ill", a
,1
INTERVERTEBRAL
CARTILAGINOUS JOINTS -_
V/IllI/I/IIIIIII
M
Cami .
dug?
Vo-idmu
f7

The cartilage discs help to prevent any damage to the spine by acting as cushions or shock absorbers between the bones if the spine is jarred by any sudden shock or movement.
As with all the other bones, the spinal vertebare are held together by straps of fibrous connective tissue called LIGAMENTS.
The smooth slippery surfaces of cartilage allow the vertebrae to slide over each other slightly and twist a little. This results in the whole spine bending and twisting. A slight movement at each joint results in quite a large general movement of the spine as a whole.
slightly moveable vertebrae .
because of the cartilaginous jclnts
3. A anovial Joint
The joint is enclosed in a bag of connective tissue, called the JOINT CAPSULE, the outside of which is covered with thick, tough ligaments. The capsule and ligaments hold the joint together and protect it. The INSIDE of the capsule is lined with a smooth SYNOVIAL MEMBRANE. It produces a thick SYNOVIAL fluid, also known as the ’joint fluid’. This fluid oils or lubricates the joint which makes movement easier and protects the bone surfaces.

$5novml MQMbrtm
Joint fluid .
Layers of smooth slippery cartilage between the bone surfacesalso protect them from damage by rubbing against each other.
Here are some examples of synovial joints.
(a) Ball and Socket Joint. In such a joint one bone has a rounded end like a ball which fits into a rounded cavity called a socket in the other bone. The shoulder and hip joints are examples. Such joints allow movements in many directions.
qu
Q SOCK’T.
fem" forks Me. BALL, ound. :
F(Nur

b) Hinge Joint. The elbow and knee joints are hinge joints. Bones in a hinge joint can move in one direction only. They can open until they form a straight line. Further movement is not possible because of the shape of the bones.
A hinge joint.
HuMQrus.
mmm.
We shall now discuss one example each of Ball and Socket Joints and Hinge joints.
The H12 Joint (Ball and Socket)
The head of the femur, the shape of a ball, fits into the socket in the pelvis. It is a very strong joint and supports the weight of the body. It is very stable and so, difficult to dislocate (move out of position). Its strength and stability are due to
(i) a deep socket in the pelvis
(ii) a tight capsule around it
(iii) extra ligaments. A small ligament inside the joint joins the head of the femur to the inside of the socket. A big strong Y shaped ligament outside the joint at the front joins the femur to the ilium of the pelvis. (See diagram on the next page).

CAPSULE
PART or RING
OF CARTM$9E
WHICH MAKES
JOCKET.DE:PER
SMALL L/cAME/vr
INSIDE JOINT
6YNOV/AL FLUID
Swvo V/AL
MimeanE
?ELvns
Movements of the Hi2 Joing
1. The leg can move sideways.
2. It can rotate.
3. It can move upwards until it reaches the abdomen.
4. It can move backwards but the Y-shaped ligament at the front will only stretch a little and prevents further backward movement.
(7
UPwARcs
MOVEMENT
x RD
3/05WAYS ISACKWANTE
moVEME/VT K MOVEME
R0 TA RY
A MOVEMENT g

The Elbow Joint (Hinge Joint)
The convex surface at the end of the humerus fits into the concave surface of ulna.
HUMERUS
CanEx SURFACE
//// (WITH CART/LAqE)
UL NA
CONCAYE SURFA cE
(WITH CART! LAq E.)
Both these surfaces are covered with pads of cartilage. The joint is enclosed in a joint capsule as is the case with all the synovial joints. The joint cavity is filled with the synovial fluid produced by the synovial membrane.
Movements. The elbow joint movements are very limited. The arm at this joint can move in one direction and back only as shown in the following diagrams:_
MOVEMENT
BENo/Ng OF 7745 ARM

Now do the following exercise. EXERCISE I
A freely moveable joint is called a
An intervertebral joint is called
Fixed joints are called
There is a of
each pair of vertebrae.
The hip joint is a
An elbow joint is a
Underline the joint which is the most
difficult to dislocate.
Shoulder joint, Hip joint, Elbow joint.
Which of the following joints has more
restricted movement than the others?
Hip joint
Elbow joint ANS.
Check your answers with those given on page 16.
B. The Living Nature of Muscles
I would like you to read pages 16-18 of lesson 1
again. Muscle tissue is made up of bundles of
muscle cells. These cells are like fibres which
can contract (shorten) and relax. There are three
different types of muscles in the body:
1. striated muscle
2. smooth muscle
3. cardiac muscle

1. Striated Muscle
Striated means striped, and the stripes are clearly seen running across cells when they are seen through a microscope. Striated muscles are attached to the skeleton and hence are also called the ’skeletal muscles’. These are the muscles which contract and cause our bodies to move. They form the red flesh of the body. Striated muscles are also called the VOLUNTARY muscles as you can contract them when you want to and produce voluntary movements such as those of legs, arms and of other parts of the body.
luau m
NucuEus
THICK 5mm:
THIN STRIPE
CYTOPLASM
SARCOLEMMA
A SlNgLE MUSCLE FIBRE
Each fibre is covered by a delicate skin called a SARCOLEMMA. The nuclei do not lie in the centre of the cells but along the sides, just under the sarcolemma. Each fibre is made of smaller fibres called MYOFIBRILS with alternating dark and light sections which produce the striped appearance of the muscle. Muscle fibres form small bundles, and these small bundles are then bound up in larger bundles which form the actual muscles with a tough outer covering of connective tissue.
2. Smooth or Visceral Muscle
Smooth muscle is found in the walls of the arteries, the intestines, the stomach, the bladder and the uterus. This is also called visceral muscle. Smooth muscle cells are wider in the middle than they are at the ends. The nucleus is large, oval and lies in the middle of each cell. The cells form flat bundles or layers of muscle tissue. The flat bundles are bound together into larger layers which form the visceral walls.

snoorn MUSCLE CeLL SARCOLEMMA
N
CYTOPLASM NUCLEUS
Another name for smooth muscle is INVOLUNTARY muscle as it is not under the control of our will; we cannot stop the muscle contracting when we wish to do so. As these muscles have no stripes, so they are sometimes called unstriped muscles also. Smooth muscle is slow to contract, in comparison with striped muscle, and is much less subject to fatigue (tiredness).

3. Cardiac Muscle

Cardiac means ’of the heart’. This is a special type of muscle which is only found in the heart. Cardiac muscle cells have no sarcolemma and only faint stripes. They are not properly divided into separate units; they branch and join up with their neighbours so that a kind of network is formed.

CARDIAC MUSCLE

Like smooth muscle, the cardiac muscle is not under the control of the will. It contracts and relaxes regularly and never gets tired, unlike voluntary muscle which soon becomes fatigued.

Factors Controlling the Healthx DeveloEment of muscles

There are three main factors for the healthy development of muscles, namely

1. proper food
2. proper exercise
3. good posture

1. ProBer Food. Muscles are the flesh of our body so the type of food which contains amino acids is the best for their development. Protein foods, especially the animal protein foods are essential. Food stuffs containing vegetable proteins are beans, peas, nuts and lentils. The above food stuffs do not contain all the amino acids needed by our body. But the following food stuffs give us animal proteins which contain all the necessary amino acids:- meat (beef, chicken and pork), fish cheese, eggs and milk.

We also need energy giving foods carboydrates and fats for the proper functioning of muscles. Muscular activity uses a lot of energy which must be replenished by eating carbohydrates and fats. (Read pages 19, 20 and 21 of Lesson 8 about A.T.P.)

2. Prerr Exercise. Muscles become slack and flabby through inactivity. If not exercised regularly they lose their tension (muscle tone) resulting in slackness. With exercise they become firm and strong.

Athletic events and sports activities are good exercises for muscles. But it must be remembered that proper rest is as important as exercise. During activity, chemical reactions take place resulting in muscle tiredness called fatigue. If no rest is given then the muscles become fatigued and lose efficiency. Fast and vigorous exercises tire the muscles much quicker than slow and mild ones.

Exercise is essential for those who do jobs involving little activity such as office workers, teachers, students etc.

3. Good Posture. Please see page 6 of lesson 13 for the correct posture essential for the healthy development of the skeleton. The same correct postures of standing and sitting are important for the healthy development of muscles also.
In order to maintain stability of posture, muscles and bones should be positioned properly. In a good standing posture, the muscles concerned possess a tone that causes the least fatigue. But in a "round shoulders" posture the back is rounded backwards, and the muscles of neck, shoulders and chest are affected. The chest becomes cramped and proper breathing is not possible. In the case of a "hollow back" the abdomen is pushed forwards resulting in the slackening of the muscles in the wall of the abdomen. Permanently slack abdominal muscles can cause breathing disturbances and disorders of the digestive system.
Before we conclude the topic on the nature of muscles, please remember the following points.
Muscle Tone. This is, the slight tension which exists in a muscle. It is caused by the contraction of a few muscle fibres at a time in relays or turns. Exercise and good posture are essential for good muscle tone.

Muscle Fatigue. This is the tiring of the muscles due to the accumulation of lactic acid in them. The lactic acid is produced by the muscular activity, and is removed during the period of rest. Rest is essential for fatigued muscles.

Now do the following exercise.

EXERCISE II

1. Striated muscles are also called muscles as you can contract them when you want to.

Smooth muscles are not under the control of our will, so they are called muscles.

Name the type of muscle which is

(1) most subject to fatigue

(ii) least subject to fatigue

What are the three factors which control the healthy development of muscles?

(1) (ii)

(iii)

What is the slight tension which exists in a muscle called? .

What is the tiring of the muscles called 7

What chemical accumulates in the muscle cell to cause the above condition? .

How can we overcome the above condition?

Check your answers with those given on page 16.

C. Muscle GrouEs and Movement

Both bones and muscles are responsible for any movement of the body at the joints. Muscles always work in opposing groups or pairs. Before we study the actual movement of a joint, we must know the arrangement of the bones and muscles in that

joint. A good example is the arrangement of bones and muscles of the elbow (a hinge joint). The pair of muscles involved are the biceEs muscle and the tricegs muscle. They always oppose the movement of each other i.e. when the biceps contracts, the triceps relaxes and straightens.

Muscles must be attached to each part of a joint. For each joint;one part can be regarded as immobile and the other as mobile. The attachment of the muse to the immobile bone is called the ORIGIN of the muscle and that on the moveable bone is known as the INSERTION.

The origin covers a comparatively large surface of bone. The muscles become thinner, fibrous and very tough towards the insertion until at the insertion its end is cord-like and tough, and is called a TENDON. The insertion tendon covers a very small area of bone. This tough material (the tendon) can withstand very great strains.

L
OUTER END OF
SCAPULA
TENDONS OF
BICEPS MuscL TENDONS 0F
(omqm) Tmceps MUSCLE
(aRanN)
BICEPS , TRICEPS
MUSCLE . MUSCLE
_ Humanus
TENDOH
/ TEN ooN
(INSLRTION)

In a muscle like the biceps contraction takes place near its origin, and the pull is transmit-ted by means of tendon to a point on the radius. So, the joint acts like a lever.

Both biceps and triceps are called opposing muscles as they have opposite movements i.e. when the biceps contracts, the triceps expands or relaxes and vice versa. 50 any movement, once made, can be reversed by the action of the opposing FLEXION, and the reverse (straightening) is called the EXTENSION. The following diagrams illustrate these movements:-

_ 1h _ I

Q90")! Bundle
Conrrocred
Biceps muscle
Humerus
Expanded
Humerus e 1," biceps
1; wmsde
t Expanded
N%Ceps Contracted
muscle friceps
vnusde
Ulna Fore arm
Io wered
Flexion. The forearm is raised by the contraction of the biceps and the accompanying relaxing 0f the triceps.
Extension. The reverse action to flexion takes place when the forearm is straightened i.e. relaxation of the biceps and contraction of the triceps.
Now do the following exercise.
EXERCISE Ill
1. A movement at a joint is produced by and .
2. Muscles always work in 3
3. The end of the muscle attached to the immobile bone is called the and the other attachment on the moveable bone is called the .
4. The muscle end,a c0rd-11ke fibre on the moveable bone, is called a .
5. The bending of a hinge joint is called which takes place by the of the biceps and relaxing of the triceps.
6. The reverse action to the above is called which takes place by relaxation of the biceps and of the triceps.
_____l

ANSWERS TO EXERCISES
EXERCISE I
1. synovial joint cartilaginous joint
3. sutures
5. ball; socket
disc; cartilage
hinge joint
mmt-PN
a
Elbow joint.
EXEECISE II
1. voluntary
2. involuntary
3. (i) striated or voluntary muscle
(ii) cardiac muscle
4. (i) proper food
(ii) proper exercise
(iii) good posture
5. Muscle tone
6. muscle fatigue
7. Lactic acid
8. By taking rest.
EXERCISE III
1. bones; muscles
. pairs or groups
orlgln; insertion
tendon
flexibn; contraction
mmrwm
0
extension; contraction.

REPUILK: OF IAMIIA MINISTRY OF EMATW
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HUMAN BIOLOGY LESSON 1E
This lesson is about the Respiratory System.
A. THE RESPIRATORY ORGANS
B. MECHANISM OF BREATHING
C. PERSONAL VITAL CAPACITY AND VARIATIONS IN RATE AND DEPTH OF BREATHING WITH EXERCISE
D. GAS TRANSPORT IN BLOOD AND BODY FLUIDS, AND ACROSS CELLULAR MEMBRANE
E. THE EFFECTS OF TOBACCO SMOKE ON THE RESPIRATORY MUCOUS MEMBRANE

A. THE RESPIRATORY ORGANS

The function of the respiratory system is to make possible a gaseous exchange so that oxygen can be taken into the blood and carbon dioxide and water vapour can be removed from it.
The nostrils are the external openings of the nasal passages or cavities. These cavities are separated from each other by a seEtum which is usually placed a little to one side of the centre line. The cavities are separated from the mouth by the alate. The nasal passages open into the pharynx (throat) on the other end. There are specially shaped bones in the cavities which increase the surface area over which the air has to to pass on its way to the lungs. The cavities passages are lined with mucus secreting cells and with cilliated cells. The lining is rich in blood capillaries. This lining is called the nasal mucosa.
Air that enters the nostrils is filtered by the hairs at the openings. It becomes warm by passing over the specially shaped bones having blood capillaries. At the same time it is moistened by the secretion of the mucous membrane. During a cold, the mucous membrane becomes inflamed and produces extra mucus. The mucus traps harmful bacteria and dust particles.
quqacf
Eusrochian fube
uvuw
pharynx (fhroaf)
epiglorris

As you can see, the air breathed-in through the nose is filetered, warmed and moistened. It is therefore very important for us to breathe-in through the nose.

At the back of the palate is a flap called the uvula or the soft palate. If you open your mouth you can see it at the other end with the help of a mirror. The nasal passage can be closed by it.

At the bottom of the pharyx are two tubes, the wind-pipe (trachea) and the foodepipe (oesophagus or gullet). In order to understand how the air goes down the trachea when you breathe in, and how the food goes down the oesophagus when you swallow, please look at the following diagrams carefully.

Before swallowing swallowing

Fonsue poiare palate

During normal breathing the positions of uvula and the epilottis are as shown in diagram (a) above. But when we swallow, the tongue moves back and the uvula lifts up and closes the nasal cavity. At the same time the toungue pushes down the epiglottis to form a lid over the trachea as shown in diagram (b). The voice box (larynx) moves up under the epiglottis. These actions stop the food going into the trachea instead of entering the oesophagus.

But when we are talking or laughing,
is raised to let the air enter the trachea. This is
why it is dangerous to laugh and talk while there
is some food in the mouth because some food
particles might find their way into the wind pipe
through the open epiglottis. This can cause choking
which makes you cough violently in order to push
the food back into the throat. In serious conditions
choking may cause the death of the person.
The trachea is about 13cm long. Its top part is
called the larynx or the voice box. The ogening
of the larynx into the pharynx (throat) is called
the glottis and is protected by the epiglottis.
The larynx is much broader than the rest of the
trachea and is protected by a number of plates of
cartilage. Between these plates are a number of
tightly stretched ligaments called the vocal cords.
It is the vibration of these vocal cords which
produces sound when air is breathed out over them.
The quality of the sound depends on the tension
of the cords and the size of the glottis. The
tension is varied by the vocal muscles. For high
pitched notes, the tension is high and the glottis
is narrow. But when the cords are slack and the
glottis wide, the sound is low pitched. The pharynx,
mouth, and the nasal cavities act as resonating
cavities like the sound box of a guitar.
the epiglottis
At its lower end, the tree
and left bronchi (singular,
into the lungs themselves.
by incomplete hoops of cart
open passage whatever
and neck.
hea forks into right
’bronchus’) which pass
The trachea is protected
ilage which ensure an
position is taken by the head
The bronchi branch into many small tubes known
as bronchioles which go on branching further until
they are only one cell thick tubes like capillaries.
Each tube ends in tiny air sacs called alveolar
sacs. Each sac consists of many lobes called alveoli
(singular, ’alveolus’). Many tiny blood capillaries,
also one cell thick, form a network over each
alveolus. It is here that the gaseous exchange takes
place. The gass has to diffuse through only two
cells thick membranes, one of the capillary and
the other of the alveolus. Millions of alveoli
form the respiratory surface

rah?
bronchus rrachea
bronch iol e
t alvequs
blood
l capillaries
(c)
There are two lungs which are sgongx elastic organs. They surround the heart and almost fill the chest cavity. Their lower surfaces rest on the diaphragm. The right lung has three lobes, and the left has two.
Nghtlung
t - x I r
- /Y YX/xt/h/ . CF lung
t I
x/VV

A double layer of membrane called the PLEURA covers each lung. It is like a sealed plastic bag. The pleural cavity (the space between two pleurae) is filled with a fluid which acts as a lubricant. It allows the inner and the outer layers to slide over one another very smoothly.

Now do the following exercise and check your answers on page 18.

EXERCISE 1

1. The nasal cavities are separated from each other by a , and they are separated from the mouth by the
2. The other name for the throat is the
3. The air passing through the nasal cavities is (i) , (ii) and (iii) .
4. The opening of the larynx into the pharynx is called the which is protected by a lid called the
5. The voice is produced by the vibrating of in the larynx.
6. Name two factors which control the quality of the sound.

(1)

M

B. MECHANISM OF BREATHING

Breathing can be divided into two parts.

1. Inspiration, Inhaling or Breathing in.
2. Expiration, Exhaling or Breathing out.

1. InsEiratjon

Breathing in takes place when the chest cavity is made larger by (a) the ribs moving upwards and outwards and (b) the diaphragm stretching downwards.

(a) The intercostal muscles between the ribs contract moving the ribs upwards and outwards. Their movement is like that of the handle of a bucket as shown in the diagram below.

Your ribs move
breast bone upwards
and outwards
er this bucket handle

(b) The diaphragm contracts and moves downwards. As the walls (ribs) and floor (diaphragm) of the chest move outwardS, the lungs are pulled with them as they are elastic in natureo So they expand to fill the enlarged chest cavity.

The air inside the lungs is now at a lower pressure than the air outside in the atmosphere. The air always rushes from the higher pressure area to the one at the lower pressure. So, the air from outside rushes into the lungs to equalise the pressures inside and outside the lungs.

2. Eggiration: It is the opposite of inspiration. It is the result of the chest cavity becoming smaller and squeezing the air out of the lungs. It takes place by

(a) the intercostal muscles relaxing making the ribs move downwards and inwards.

(b) the diaphragm relaxes making the abdominal muscles and organs push it up to its original position.

As the ribs and diaphragm move inwards, the lungs are Squeezed. This helps to push the air out as the air pressure now is greater inside the lungs than that outside.

The movement of the diaphragm and that of the lungs can be shown by the following diagram. The balloons represent the lungs, the rubber sheet the diaphragm and the glass tubes the trachea and the bronchi.

0- b.
glass tube re resean
hmheoP 3
glass tube
re cnh’
ngihuJS
balloon
rqwunang
lung
rubber shearing
Mpmsenrms
diaphragm
ardfhepumn
BREATH Ncaour WHO" Shwmsgdmn
8 BKEATH/NC-v/N

(C) EbRSONAL VITAL CAPACITY AND VARIATIONS IN RATE AND DEPTH OF BREATHING WITH EXERCISE

1. Personal Vital Cagacitx

The lungs are never completely empty. In fact, it is impossible, even with the greatest effort, to remove all the air Srom them. During normal breathing about 500 cm (0.0.) of fresh air is breathed in, and after about two seconds, the same volume of used air is breathed out. This air which flows into and out of lungs without any effort is known as the TIDAL AIR. With maximum effort, we can breath-in about another 1500 cm3 of air which is called the COMPLEMENTAL AIR. With an extra effort we can breathe-out an extra 1500 cm of air called the SUPPLEMENTAL AIR.

The total volume of the air that can be exchanged i.e. the total of the tidal air, complemental air and the supplemental air is called the VITAL CAPACITY. As the total volume differs from person to person, it is also called the PERSONAL VITAL CAPACITY,

Tidal air 500 cm3
Complemental air 1 500 cm3
Supplemental air 1 500 cm3
PERSONAL VITAL CAPACITY : 3 500 cm3

As mentioned before, however hard we may try, we can never empty our lungs completely. Some air is always left in the lungs. This air which can never be expelled from the lungs is called the RESIDUAL AIR which means the remaining air. It is about 1 000 cm . If we add this volume to the vital capacity, we get the total capacity of the LUNGS. Study the following table very carefully:-

Tidal Air ------- 500 cm3
Complemental Air ------- 1 500 cm3
Supplemental Air ------- 1 500 cm3
Residual Air ------- l 000 cm3
Total capacity of the 4 500 Cm3
Lungs

2. Variations in Rate and DeEth of Breathing with Exercise

The rate and depth of breathing vary according to the needs of the body. During sleep our energy needs are minimum and the breathing is very slow and shallow. The tidal air is even less than 500 cm3. But during vigorous exercise, for instance during a kilometre race, the deEth of breathing increases. The rate of breathing also increases tremendously. So, the total volume of air flowing into and out of the lungs in the same time increases many folds. During vigorous exercise, the body’s demand for energy increases tremendously, so the demand for oxygen to liberate energy in the body cells increases proportionately. Let us take examples of the volume of air breathed in while at rest and the volume of air after a vigorous exercise.

At Rest

Shallow breathing _ Tidal air : 500 cm3

. Slow breathing rate : 15 times per minute.

. .Total volume of the exchan%ed air per minute : 15 x 500 cm : 7.5 litres (1 litre : 1 000 cm3)

After 1 Kilometre race

._____

Deep breathing _ Tidal air : 1 500 cm3

. Fast breathing Rate : 25 times per minute.

. .Total volume of the exchanged ?ir per minute : 25 x 1 500 cm : 27.5 litres

If you compare the two volumes of air, 7.5 litres at rest and 37.5 litres after the vigorous exercise, you would notice that the volume of air exchanged had increased 5 times in the latter case.

Now do the following exercise and check your answers on page 18.

EXERCISE 2

1. The process of breathing in or inhaling is called , while that of exhaling is called .
2. In breathing in the chest cavity is made larger by the diaphragm stretching and the ribs moving and .
3. The movements of ribs are caused by the muscles.
4. The air which flows into and out of the lung without any effort is called air, and the air we :an inhale with the maximum effort is called air.
5. The capacity of the lungs is the total volume of the air, air, and the air.

D. GAS TRANSPORT IN BLOOD AND BODY FLUIDS, AND ACROSS CELLULAR MEMBRANES

1. Gaseous Exchange in the Lungs.

External ResEiration

Oxygen in the fresh breathed in air in the lungs enters the blood and carbon dioxide leaves it by DIFFUSION. In diffusion, the molecules of a substance which may be a gas or a liquid flow from an area of higher concentration to one of lower concentration. This flow continues until there is an equilibrium, that is, the concentrations in both the areas become the same.

When blood reaches an alveolar sack through the capillaries, there is a low concentration of oxygen in the plasma. 0n the other side of the alveolar membrane there is a film of moisture full of oxygen. So, the oxygen molecules diffuse into the plasma. The passage of oxygen into the plasma upsets the equilibrium (balance) between the dissolved oxygen in the plasma and in the red cells. Therefore the oxygen molecules diffuse into the red cells where they combine with the haemoglobin to form a compound called oxyhaemoglobin. Oxyhaemoglobin gives blood its bright red colour.

In the meantime, oxygen in the lung spaces diffuses to take the place of the gas which escaped from the moisture on the alveolar membrane. Similarly, oxygen in the tidal air diffuses into the lung spaces to keep the balance.

There is a similar diffusion gradient in the opposite direction, in which carbon dioxide from the plasma travels into the lungs to be excreted. This chain of diffusion is called the DIFFUSION GRADIENT and can be summed up for oxygen as shown on the next page.

!
Oxggen -_) 0X39en _-)Oxggen _-) -)Ox39en -)
’m ridal air in residual air in moiarure In plGSma
(lung spaces) on wall
diffusion
membrane
-)HAEMOQLOBIN 4- OxygenHOXYl-OAEMOQLOBIN-
in red cell
The exchange of gases in the alveolar sacs
of lungs is shown by the following diagram:
capillary leading ro
pulmonary vein
and carrying
oxygenated blood
capillary brin Mg
deoxygenafed load
from the hearf via
’ 4/ the pulmonarg
arrerg
bronchial:
alveolar soc
ilm Of
m0l51’ure
network of C02.
COPIHOHCS
coveri
aIveoh’
oiveoh’
C02 : carbon dioxide
02 : oxygen

2. Internal or Cellular ResRiratign

The blood rich in oxygen has 95% of oxygen in oxyhaemoglobin in red blood cells and only about 5% dissolved in the plasma. When the blood reaches tissues, it loses oxygen, again by a diffusion gradient as shown below.

OXYHAEMOGLOBIN -% HAEMOGLOBIN ’f OXYGEN -)
in red cell in plasma
-)OXYC,EN -90XYGEN
in Igmph in tissue ceJl

There is a supply of glucose circulating in the blood, study Lesson 8 again . Oxygen in the tissue cells oxidises this glucose to liberate energy. Carbon dioxide and water vapour are also produced as waste products which are carried to the lungs through a diffusion gradient, and excreted in the expired air.

SUGAR tr OXYGEN _)ENERGY 4- CARBON DIOXIDE’O-WATER
((xLUcOSE)

Energy is life. It is used for warmth, for muscular activity, for chemical changes and for growth.

Most of the carbon dioxide travels in the form of bicarbonates. First, the gas is dissolved in the the plasma and forms carbonic acid there. This acid reacts with the sodium present in the plasma proteins to form sodium bicarbonate. The red cells contain

proteins which have Potassium in them. Carbonic acid diffuses into the red corpuscles to form potassium bicarbonate which diffuses back into the plasma. When these bicarbonates reach the lungs they break down. The metals, sodium and potassium, recombine with their respective proteins.

Carbon dioxide diffuses from the blood into the lungs and thence to the air along a diffusion gradient similar to the one for oxygen which has already been discussed before.

The quantity of carbon dioxide dissolved in the blood plays an important role in the control of breathing. When its level rises in the blood due to some vigorous activity, the respiratory nerve centres in the brain are stimulated, and the rate of breathing guickens. But when there is a fall in the level of carbon dioxide in blood, the rate is slowed down. In this way the rate of breathing is being adjusted continuously to body requirements.

Now do the following exercise and check your answers on page 18.

EXERCISE 3

The passing of molecules of a substance from a higher concentration to a lower one is called .

The above process stops when an is reached, that is the concentrations becomes of the same strength in both the areas.

Write an equation to show the passage of oxygen from the air we breathe in to the red blood cells.

Write an equation for the liberation of energy in our tissue cells.

5. Name the acid produced by the dissolving of carbon dioxide in plasma.

_____

6. Name two metals with which the above acid forms bicarbonates. and

E. The effects of Tobacco Smoke on the

_____

Respirator! Mucous Membrane

It has now been proved statistically that smoking is hazardous and injurious to health. In fact, in cetain countries, it is obligatory for cigarettee manufacturing firms to print on cigarette packets that smoking may be hazardous to health. The followers of the Sikh religion, which originated in Punjab, North India, are prohibited from smoking tobacco. The prophet of this sect brought in this prohibition more than 200 years ago. Any foreign body which enters the respiratory system causes irritation in the system. If it is a food particle or some liquid, we cough violently to get rid of it before it chokes us to death. Coughing is nature’s method of getting rid of any foreign body which irritates the mucous membranes, of our respiratory system. The following are the bad effects of smoking.

(1) Effect on Bronchi

In the case of heavy smokers, the respiratory system cannot get rid of the smoke deposit on the mucous membrane as fast as the smoke particles collect there. As a result the smoker develops a persistent type of cough called the ’smoker’s cough’. In addition to that smoking may complicate and slow down the recovery of a patient suffering from the various respiratory diseases such as bronchitis, influenza and cold etc.

(ii) Effect on the Lungs
It has been proved statistically that more smokers die of lung cancer than do non-smokers. Tobacco smoking damages the mucous membrane of the lungs and certainly aggravates pulmonary diseases.
(iii) Effect on the Heart
Smoking may be instrumental in bringing about Coronory Heart Disease to a person. It damages the mucous membrane of the cardiac muscle and blocks the coronary artery which brings blood to the heart muscle.
(iv) Effect on a Eregnant Woman
Tobacco smoking in the case of a pregnant woman can damage the child in the womb. There is a possibility of the brain cells of the foetus being damaged by the mother’s heavy smoking.
Now do the following exercise and check your answers on page 19.
EXERCISE 4
1. How is an irritant expelled from the trachea?
What parts of our body have their mucous membranes damaged by heavy smoking?
(1) (ii) and (iii)
What part of the foetus may be affected by the heavy smoking habit of a pregnant woman?
Write any 3 things for which the body uses energy. (i)
(ii)
(iii)

ANSWERS TO EXER
EXERCISE 1
Septum:
2. pharynx.
3. (i) filtered (ii) warmed (iii) moistened.
. glottis: epiglottis.
. vocal cords.
; (i) Iension of the vocal cords.
(11) Size of the glottis.
palate
BFBCLEA
1. inspiration: expiration.
2. dowhwards: upwards and outwards.
3. intercostal.
Q; tidhl: complemental.
54 tidal: complemental: supplemental: residual.
EXERCISE 3
1. diffusion 2. equilibrium.
2. equilibrium
3.
$
OXYGEN __, oxvctN _) OXYGEN --) _, oxYaEN-r
in Hdol in residual in moisture % in plasma
oh oh on we" 5
Diffusion
membrane
#HAEMOGLOEIN .r OXYGEN _; OXYHAEMOGLOBIN
ln red ceH kn red ceH

GLUCOSE - OXYGEN _, ENERGY 4’ WATER 4- CARBON
mome
5. carbonic acid.
6. Sodium; potassium.
EXERCISE 4
1. By coughing violently.
2. (i) Bronchi
(ii) Lungs
(iii) Heart
3. Brain
4. Any three from the following four:-
Warmth,
Growth,
muscular activity,
Chemical changes.

The tar and discharge that collects in the Inn
of an average smoker.
SEE FACE IQ.
_LJ()-

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