NSANGI SECONDARY SCHOOL

S.3 BIOLOGY NOTES

- ***Read and write these notes please***

(S.3 continuation of transport of materials in animals)

The Lymphatic system

The capillaries are not the only route by which the tissue fluid returns to the circulation. Some of it returns via the lymphatic system.

The lymphatic system is made up of tiny very thin-walled vessels called **lymphatics**.

Lymphatics penetrate between the cells of tissues like capillaries do. Neighbouring lymphatics join to form lymphatic vessels which make the lymphatic system.

The lymphatic system closely resembles the blood circulatory system. It consists of lymph, lymph vessels through which lymph travels, and lymphoid organs and tissues such as **thymus**, **adenoids**, **tonsils**, **lymph nodes** and **spleen**.

Lymphatic system connects with the blood circulatory system at the **superior vena cava** after cells get their requirements from tissue fluid, not all the fluid flows back into the capillaries, Part of it flows into **lymph vessels**. Once in these vessels, the fluid is called **lymph**. Lymph is a pale yellow fluid. It has the same components as tissue fluid, but more fatty substances and less proteins. The lymph also contains a certain type of white cell **lymphocyte** which is made in the lymph nodes. Lymph nodes are at various points along the lymph vessels. In these nodes **antibodies** and **new white cells** are produced.

The lymph flow takes place in only one direction from the tissues to the heart.

Lymphatic vessels have valves like those in veins and many pass through muscles.

Muscle contraction, force lymph along the vessels in one direction.

Lymph vessels unite to form larger vessels called **lymph ducts**. There are two main lymphatic ducts; **the right lymphatic duct** empties into the right **subclavian vein** while **the left lymphatic duct** drains into the left **subclavian vein.** The two veins join to form the superior vena cava. In this way, the contents of lymph enter the blood circulation system.

Diagram of human lymphatic system

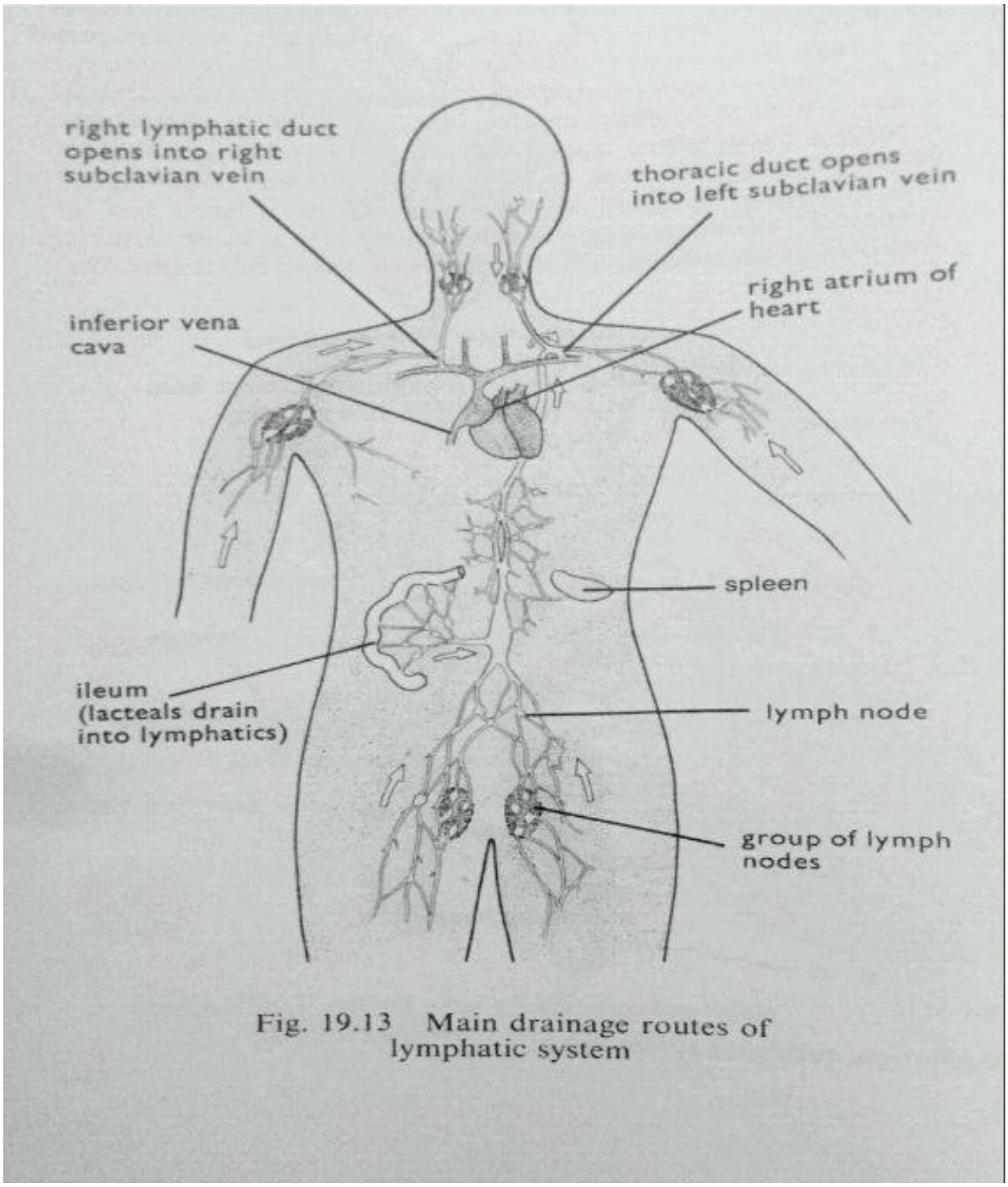

Fig. 19.13 Main drainage routes of lymphatic system

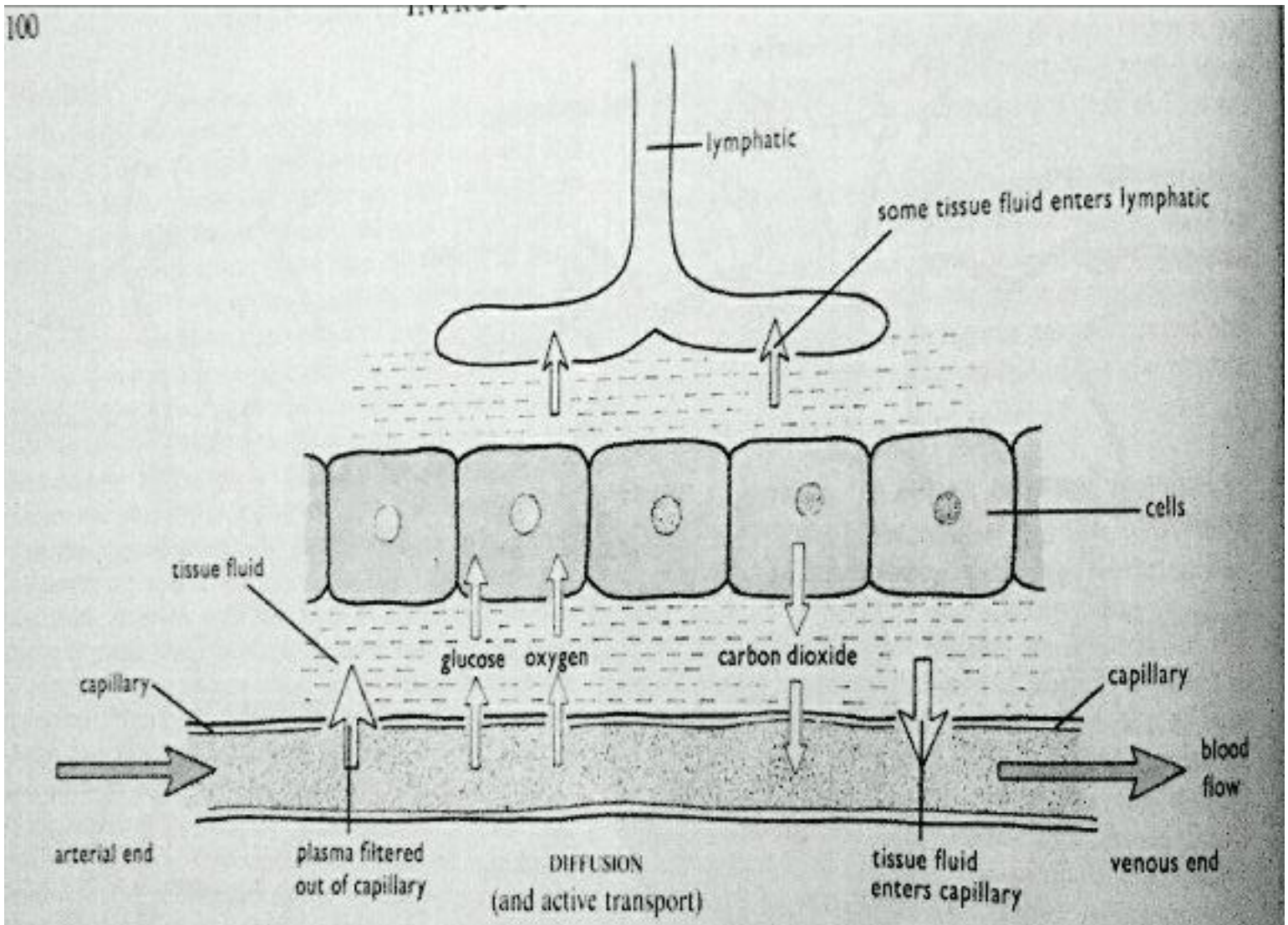

Fig. 19.12 Blood, tissue fluid and lymph

Formation of lymph

Lymphatic ducts form nodule-like structures called **lymph nodes**. These nodes are found in the abdomen, groin, armpits and neck. Lymph nodes are important sites for the production of white blood cells. They also filter out foreign materials such as bacteria and dead tissue before they enter the bloodstream.

The flow of lymph depends greatly on the squeezing of lymph vessels by breathing movements, intestinal movements and muscular movements. The lymph vessels have valves to prevent back flow of lymph.

Importance of the lymphatic system

1. Lymph nodes produce lymphocytes (white blood cells) which help to defend the body to fight diseases and pass them into the blood stream.
2. Lacteals enable absorption of fatty acids after digestion.
3. Returns excretory materials including carbon dioxide from the tissues to the blood stream for excretion.
4. The spleen destroys worn out red blood cells.
5. The spleen, the adenoids and the tonsils produce antibodies which help in fighting disease-causing microorganisms.

Differences between the blood vascular system and the lymphatic system

Blood vascular system	Lymphatic system
Has three types of blood vessels i.e veins, arteries and capillaries.	Has one type of lymph vessels i.e the lymphatics.
Have valves only in veins and at the base of large arteries.	Have valves throughout.
Does not have nodes at all.	Has lymph nodes.
Blood flows faster.	Lymph flows relatively slowly.
Transporting fluid is blood plasma.	Transporting fluid is lymph.

Disorders and diseases of the lymphatic system

There are many diseases and disorders that affect the lymphatic system. Some of these diseases and disorders are explained below.

Elephantiasis

This is a disease that is caused by worms (filarial) that block the lymph vessels and prevent the flow of lymph. The affected part affected part becomes swollen like the feet of an elephant hence the disease elephantiasis.

Filarial worms are transmitted by culex mosquito. Elephantiasis is treated by destroying the parasites. One way of preventing it is by eliminating breeding areas of mosquitoes, for instance bushes and stagnant water. **Oedema**

This is the swelling of body tissues due to excessive lymph. It is caused by increased blood pressure in the capillaries, causing the production of large amounts of lymph that the lymphatic system cannot transport efficiently, pregnancy, obesity and protein deficiency.

Oedema can be controlled by taking measures to reduce blood pressure, pregnant women keeping the feet slightly raised when sitting or lying down eating a wellbalanced diet and taking measures to reduce body weight, for example by exercising and avoiding eating excessive amounts of food.

Lymphoma

Lymphoma is the term used to refer to cancers that affect the lymphatic system. These cancers cause abnormal growth or functioning of the components of the lymphatic system. The result is weakened immune response in the body.

Symptoms of lymphoma include swollen and painful lymph nodes, fatigue, weight loss, night sweats and itching.

Lymphomas are treated using chemotherapy and radiation therapy. Severe cases may call for bone marrow transplants

Tonsillitis

This is an infection and swelling of the tonsils. It is caused by bacteria or viruses that enter the body through the mouth or sinuses.

Symptoms include red and swollen tonsils, sore throat, fever or chills, muscle ache and tiredness.

Mild cases of tonsillitis are treated by having adequate rest and taking plenty of fluids. More severe cases may require medical treatment; frequent tonsillitis is sometimes solved by tonsillectomy (surgical removal of the tonsils).

THE CLOTTING OF BLOOD

when one cuts himself/herself provided the cut is not too big, bleeding soon stops because the blood hardens at the surface of the cut. This is called **clotting**.

Importances of blood clotting

It stops too much blood from being lost cuts and wounds.

The clot seals up the cut or wound and prevents germs from entering the body.

The clot is the first step towards healing.

For blood to clot, the following are required:

(i) Blood platelets (cell fragments)
(ii) Fibrinogen (plasma protein)
(iii) Vitamin K
(iv) Calcium ions
(v) A protein prothrombin.

The process of blood clotting

When tissues are damaged or cut and exposed, Platelets release an enzyme **thrombokinase** (**thromboplastin)** which in the presence of calcium ions converts a blood protein **prothrombin** produced from **vitamin K** to the **thrombin. Thrombin** then converts the soluble blood protein **fibrinogen** to insoluble threads

called **fibrin.** Fibrin then forms a network of fibres that traps debris and blood cells. The result is a clot at the site of the wound preventing further loss of blood.

Some liquid called serum oozes out of the clot which eventually dries out to form a scub.

(leave a space of about 5 lines for a summary of blood clotting)

BLOOD GROUPS AND BLOOD TRANSFUSION

Blood Groups

Grouping of human blood is done using the ABO system and the Rhesus factor.

There are four major blood groups A, B, AB, and O. A human being can inherit one of the blood groups from the parents.

The presence of antigens is the basis of these blood groups. Antigens are molecules that form part of the surface coating of red blood cells. Antigens stimulate the body to produces antibodies such antibodies combine with red blood cell antigens (cell factors) to cause agglutination or clumping thus blocking the small blood vessels.

There are only two such antigens when considering blood groups. These antigens are either A or B. If you have blood group A, then the surface of your red blood cells has antigen A. if you have blood group B, then you have antigen B on your red blood cells. If you have blood group AB,, then you have both antigens A and B.

However, if you have blood group O, you have neither A or B antigens on your red blood cells.

Furthermore, the blood serum of each contains antibodies against which every antigen is not present on its blood cells. Therefore, type A blood has antibodies against type B red blood cells. Type B blood has antibodies against type A

antigens. Type AB has neither antibodies but type O has both antibodies against type A and type B.

Table giving a summary of the antigens and antibodies in the various blood groups.

Blood group	**Antigen present**	**Antibody in the serum of the same individual**
A	antigen A	antibody a
B	antigen B	antibody b
AB	antigen A and B	no antibodies
O	no antigen	antibody a and b

Blood transfusion

Blood transfusion is the transfer of blood from one person (the donor) to another (the recipient).

During blood transfusion therefore, a person whose blood is group A can only receive group A or O blood, group B person can receive only B or O blood, group AB person however, can receive A, B, AB or even O blood since he/she has no antibody a or antibody b. Group AB is called a **universal recipient** because can receive all other groups.

A blood group O person can only receive blood from another blood group O person, but blood group O can be given to all other groups making blood group O persons, **universal donors**.

Table showing safe transfusion

Recipient's (patient's) blood group	Safe r dono
A	A and O
B	B and O
AB	A, B, AB and O
O	O

Rhesus factor

This factor is named after the Rhesus monkey in which it was first observed. When the rhesus factor is present on the red blood cell membrane, a person is said to be rhesus positive. This is abbreviated as Rh+. If it is absent, the person is rhesus negative this is abbreviated as Rh-. Thus, a person's blood is said to be A+ if it is blood group A and has the Rhesus factor or A- if it is blood group A but lacks the Rhesus factor. There is also B+ or B-, O+ or 0- and AB+ or AB- blood groups.

If a rhesus negative woman marries a rhesus positive man, their children are highly likely to be rhesus positive. During the last months of pregnancy, the rhesus antigen from the foetus passes into the mother's blood. This causes the mother's body to produce antibodies which destroy some of the foetus's red blood cells. This destruction is minimal in the first child but in the children that follow, a lot of destruction could take place, killing the foetus. This is called haemolytic disease of the newborn or erythroblastosis foetalis. To prevent this, the mother is treated

with anti-rhesus globulin. This prevents her body from forming antibodies against the rhesus antigen. Most people are rhesus positive(Rh+).

The following is a compatibility table for the different blood groups.

Compatibility of blood groups Donor's blood group and Recipient's blood group

Donor / Recipient	A	B	AB	O
A	√	×	√	×
B	×	√	√	×
AB	×	×	√	×
O	√	√	√	√

Key:

v – Means compatible

X – Means incompatible.

If blood from a rhesus positive person is transfused to a rhesus negative person, the recipient produces rhesus antibodies. If such a transfusion is done a second time, massive agglutination can occur. This can lead to loss of life.

Precautions taken during transfusion

- Blood from the donor must be checked for compatibility with blood from the recipient in terms of both ABO blood group and Rhesus factor in order to avoid agglutination.
- The donor's blood must be screened to ensure that it does not have pathogens that can cause diseases such as HIV and AIDS, syphilis and hepatitis B.
- Donated blood is stored in special bags and an anticoagulant is added to prevent it from coagulating.
- Donated blood is kept in a refrigerator for a maximum of 21 days. After that it expires and should not be used.
- Transfusion should be done only when extremely necessary.

Advantages of blood transfusion

- It ensures rapid replacement of blood lost from the body, for example during surgery or due to an accident.
- Blood transfusion is used to treat diseases such as sickle-cell anaemia

Disadvantages of blood transfusion

- There are no exact blood matches. Blood is a complex tissue that contains many different. One person's blood cannot be exactly the same as another's. Hence, there are chances of developing a reaction to transfused blood.
- Transfused blood may not always be 100% free of infections.

DISEASE AND IMMUNITY

Many diseases are caused by the presence of viruses or bacteria in the body and symptoms may be one or more of the following:

(i) The poisonous chemicals usually called toxins which are produced by the bacteria.

(ii) The broken down products of the infected tissue (iii) Foreign proteins of the bacteria themselves.

Recovery from the disease and subsequent immunity depends mostly on the production of antibodies in the blood. Antibodies are chemicals made in the body by special white cells.

These antibodies which are releases into the plasma may affect bacteria or their products in a number of ways;

(a) **Opsonins**

These antibodies adhere or stick to the outer surface of the bacteria and so make it easier for the phagocytic white cells to ingest them. (b)**Agglutinins**

These antibodies cause bacteria to stick together in clumps in this case, the bacteria cannot invade the tissues.

(c) **Lysins**

They destroy bacteria by dissolving their outer coats and anti-toxins, combine with them and so neutralize the poisonous toxins produced by the bacteria.

The substances which stimulate the production of antibodies are called antigens.

When someone recovers from the disease, the antibodies remain for a short time in the circulatory system, but the ability to produce them is greatly increased so that a further invasion by the bacteria or viruses is likely to be stopped at once so that the person is said to be **immune** to the disease.

IMMUNIZATION

This is the process by which the ability of the body to resist a disease is increased by giving vaccines.

In other words, immunization is the introduction of dead or weakened germs into the body so that it produces substances called **antibodies** which remain in the blood stream to fight against disease.

When immunizing, vaccines are introduced into the body. A **vaccine** is a drug(medicine) given to a person inorder to increase his/her immunity against diseases or it is a preparation of killed-disease bacteria or viruses or forms of these, treated in such a way as to prevent their reproduction.

Vaccines are divided into two:

(a) Live vaccines
(b)Dead vaccines

LIVE VACCINE

This is a vaccine or drug which contains weakened bacteria i.e the bacterium is in a slightly non-dangerous form.

DEAD VACCINE

This is the introduction of dead bacteria.

A person who is immune to the disease is that person who is protected against that disease by means of antibodies circulating in his/her blood.

TYPES OF IMMUNITY

1 Artificial immunity

2.Natural immunity

ARTIFICIAL IMMUNITY

This is divided into two:

(i) Passive
(ii) Active

PASSIVE IMMUNITY

Antibodies may be given to the child ready made outside the patient's body. Serum, is given to patients or injected into the blood stream. This type of immunity is quick in action but lasts for a short time. This immunity, is given when a person is already suffering from a disease or has come into contact with someone suffering from the disease.

Some people react badly to this immunity e.g tetanus.

ACTIVE IMMUNITY

Killed or weakened bacteria are introduced to the blood stream so that the body cells are stimulated to produce antibodies.

This kind of immunity is introduced by the vaccine injected or given orally. This type of immunity lasts for a long time. Diseases immunized against take long to get someone.

NATURAL IMMUNITY

It is divided into two:

1. Innate
2. Acquired

INNATE IMMUNITY

This kind of immunity is passed from generation to generation, so a child inherits it at birth.

People who live in an area where a particular disease is prevalent, tend to survive through the course of the disease.

ACQUIRED IMMUNITY

When a person recovers from an attack of a disease against which he/she has prior precaution, it shows that he/she has built up enough antibodies not to be affected by that disease. This is nature's own way of giving protection.

Vaccines given during immunization

(i) **At birth:**

The baby is given the BCG vaccine (*Bacillus Calmelle Guenis*). This is a vaccine against *tuberculosis.*

(ii) **At 3 months**

The baby is given DPT, commonly known as triple. D-diptheria, Ppertusis(whopping cough),T-tetanus.

(iii) **Polio vaccine**

This is a vaccine given orally. It is a vaccine against polio myelitis and is given together with DPT.

(iv) **Measles vaccine**

This one is given at the 9^{th} month. It is against measles.

(v) **Tetanus toxoid(TT)** this is a vaccine against tetanus given to women between 15 and 45 years.

Important points to note on immunization

- ✓ Immunization is one of the major ways by which diseases are prevented.
- ✓ Be aware of the immunization schedule i.e type of vaccine e.g BCG, TT, measles.
- ✓ Dosage ✓ Number of doses given ✓ Minimum interval between doses ✓ Site of administration of vaccine

Summary:

1. The mammalian heart is responsible for pumping blood to all parts of the body. It has four chambers: two auricles (or atria) and two ventricles.
2. Valves in the heart and veins prevent the back flow of blood.
3. The flow of blood in the heart is as follows:

(a) Deoxygenated blood from the body enters the right auricle through the vena cava

(b) The right auricle pumps blood to the right ventricle.

(c) The right ventricle pumps blood to the lungs through the pulmonary artery.

(d) Oxygenated blood from the lungs enters the left auricle through the pulmonary vein.

(e) The left auricle pumps blood to the left ventricle.

(f) The left ventricle pumps blood to all parts of the body through the aorta.

4.The main blood vessels are arteries, veins and capillaries.

5. Arteries are muscular vessels that transport blood away from the heart. Arteries contract and relax, creating a pulse.

6. Veins are less muscular than arteries. They transport blood towards the heart.

7. Capillaries are very small vessels whose walls are one cell thick. They are in direct contact with the body tissues.
8. Blood is a fluid tissue consisting of plasma, red blood cells, white blood cells and platelets
9. Plasma is the fluid part of blood. It transports dissolved substances, helps to regulate body temperature and pH and acts as a site for the exchange of nutrients and waste products.

10. Red blood cells are biconcave in shape, lack a nucleus and contain haemoglobin. Their function is to transport oxygen and carbon dioxide.

11. White blood cells are irregularly shaped. They are important for immunity.

12. Platelets are fragments of cells. They help in blood clotting.

13. Grouping of human blood is done according to the ABO system and the Rhesus factor.

14. Blood transfusion is the transfer of blood from a donor to a recipient.

15. Agglutination occurs if transfused blood is incompatible with the recipient's blood.

16. Blood circulation is the movement of blood from the heart to all parts of the body. Blood circulation in humans involves a double circulation system where there are two cycles:

    - Pulmonary cycle (from the heart to the lungs and back).
    - Systemic cycle (from the heart to all parts of the body and back)

17. Diseases and disorders of the human circulatory system include high blood pressure, arteriosclerosis, sickle-cell anaemia and leukemia.

18. Blood pressure is measured by considering the pressure when the ventricles contract (systole) and the pressure when the auricles contract (diastole).

19. Lymph is formed from tissue fluid that does not flow back into the capillaries.

20. Disorders of the lymphatic system include oedema lymphoma, tonsillitis and elephantiasis.