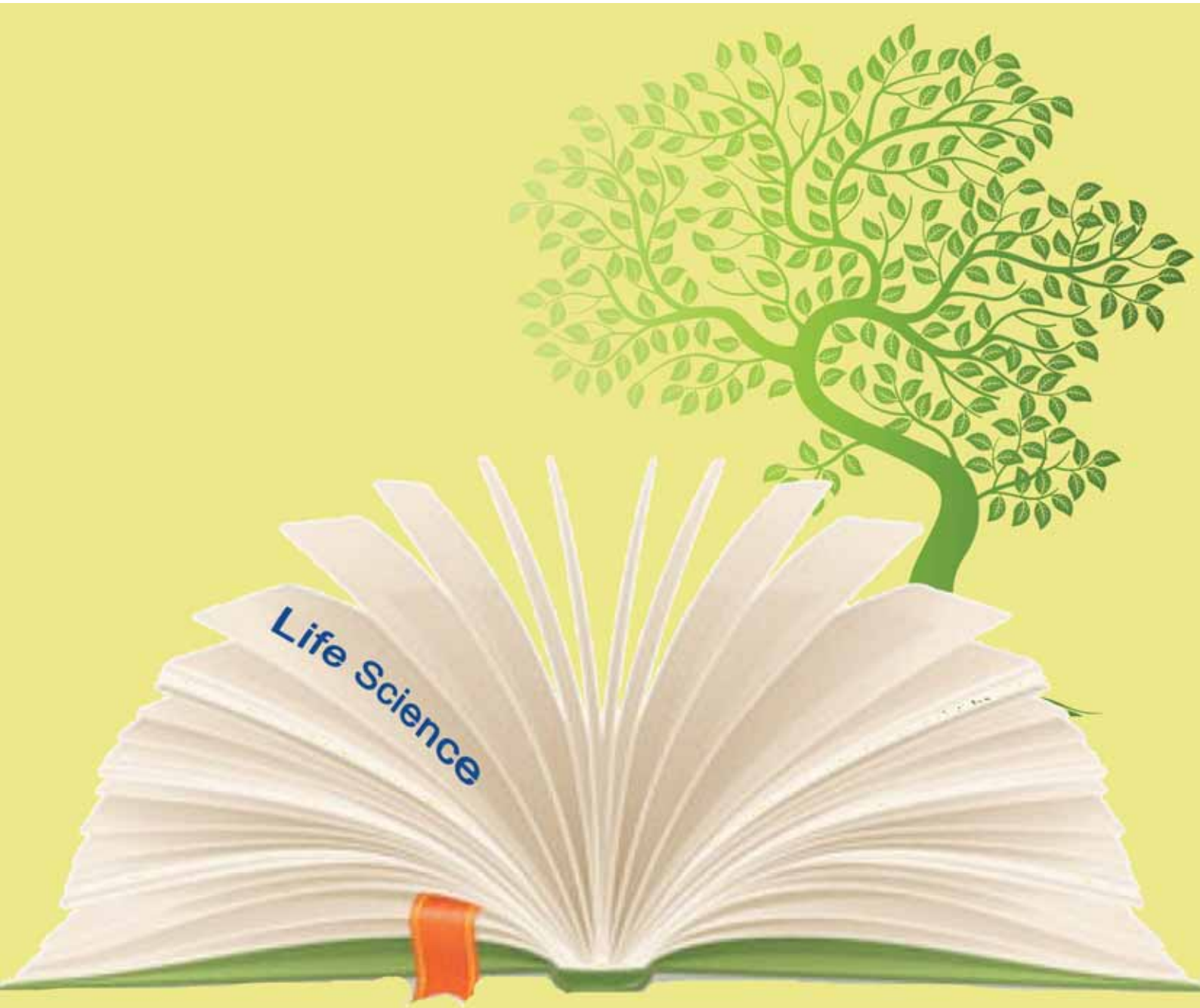

OPEN EDUCATIONAL RESOURCES

4

OPEN SCHOOLS

Taking Education to the People

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Open Educational Resources (OER) for Open Schooling

The Commonwealth of Learning (COL) Open Schools Initiative launched an Open Educational Resources (OER) Project to provide materials under the Creative Commons license agreement to support independent study in 17 specially selected secondary school subjects. Funded by the William and Flora Hewlett Foundation its aim is to broaden access to secondary education through the development of high quality Open Distance Learning (ODL) or self-study materials.

These specially selected OER subjects include:

1. Commerce 11
2. Coordinated Science 10 (Biology, Chemistry and Physics)
3. English 12
4. English Second Language 10
5. Entrepreneurship 10
6. Food & Nutrition
7. Geography 10
8. Geography 12
9. Human Social Biology 12
10. Life Science 10
11. Life Skills
12. Mathematics 11
13. Mathematics 12
14. Physical Science 10
15. Physical Science 12
16. Principles of Business
17. Spanish

Open Educational Resources are free to use and increase accessibility to education. These materials are accessible for use in six countries: Botswana, India, Lesotho, Namibia, Seychelles and Trinidad & Tobago. Other interested parties are invited to use the materials, but some contextual adaptation might be needed to maximise their benefits in different countries.

The *OER for Open Schooling Teachers' Guide* has been developed to guide teachers/instructors on how to use the Open Educational Resources (OER) in five of these courses.

1. English
2. Entrepreneurship
3. Geography
4. Life Science
5. Physical Science

The aim of this teachers' guide is to help all teachers/instructors make best use of the OER materials. This guide is generic, but focuses on Namibian examples.

Print-based versions are available on CD-ROM and can be downloaded from www.col.org/CourseMaterials. The CD-ROM contains the module and folders with additional resources, multimedia resources and/or teacher resources. Note that not all subjects have multimedia resources.

Acknowledgements:

The William and Flora Hewlett Foundation
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Ministry of Education, Seychelles: www.education.gov.sc
Ministry of Education and Training, Lesotho: www.gov.ls/education
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The Commonwealth of Learning (COL) is an intergovernmental organisation created by Commonwealth Heads of Government to encourage the development and sharing of open learning and distance education knowledge, resources and technologies.

COURSE MATERIAL

Life Science

Grade 10

COL Open Schools Initiative
Namibia

Copyright

Effort has been made to contact the following copyright owners for the information included in this material.

1. New Namibian Syllabus Biology Module 1, 2007 edition ,by Kadhila N., Chalmers L., Stout w., Webb S.
    - Figure: showing a horse front leg, a human arm and a bat's wing
    - Figure: showing The 'Fluid Mosaic' model of the structure of the cell surface membrane.
    - Figure: showing an apparatus to demonstrate osmosis.
    - Figure: showing an animal cell in pure water.
    - Figure: showing an animal cell in concentrated solution.
    - Figure: showing a plant cell in a concentrated solution.
2. Department of National Examination and assessment (DNEA)
    - Life Science Question papers: 2003, 2004, 2005 and 2006.

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Ben Areseb	**Editor/Developer**
Eslon Kaangundue	**Developer**
Alexia Nakaziko	**Developer**
Marianne Kloppers	**Developer**

Contents

About this Course Material

Life Science has been produced by COL Open Schools Initiative. All Course Materials produced by COL Open Schools Initiative are structured in the same way and have a generic structure, as outlined below.

How this Course Material is structured

The course overview

The course overview gives you a general introduction to the course. Information contained in the course overview will help you determine:

- If the course is suitable for you.
- What you will already need to know.
- What you can expect from the course.
- How much time you will need to invest to complete the course.

The overview also provides guidance on:

- Study skills.
- Where to get help.
- Course assignments and assessments.
- Activity icons.
- Units.

We strongly recommend that you read the overview *carefully* before start studying your content.

The course content

The course is broken down into units. Each unit comprises:

- An introduction.
- Unit outcomes.
- New terminology.
- Core content of the unit with a variety of learning activities.
- A unit summary.
- Assignments and/or assessments as applicable.

Your comments

After completing Life Science course we would appreciate it if you would take a few moments to give us your feedback by completing the following form:

Course feedback form

Your constructive feedback will help us to improve and enhance this course.

Course overview

Welcome to Life Science Grade 10

Life Science as an applied science encourages curiosity and the development of skills in problem solving through investigation. This course is part of a series of teaching and learning materials in the Natural Sciences learning area. The course comprises of 8 learning areas referred to as “units”. Each unit covers a specific area of learning divided by sub-topics. You will have to do a “quick check” and a “check your progress” activities to gauge your understanding of the concepts.

Life Science —is this course for you?

The Namibian society needs to be scientifically literate if it is to cope with challenges of appropriate global technology and other requirements. The curriculum guide for this Life Science course in the Natural Science area promotes the following aims:

Knowledge with Understanding
Values and Attitude
Democratic Principles
Scientific Skills

Course outcomes

 Outcomes	• demonstrate knowledge and an understanding of ethical issues, • use process skills to investigate phenomena related to natural sciences, • demonstrate an understanding of concepts and principles, • understand the interaction between human beings and the environment, • sustain the natural resources, • demonstrate knowledge and understanding of health related issues and • understand issues of living a healthy lifestyle.

Timeframe

How long?

This course is expected to be completed over 23 weeks or 61 hours, which allows approximately 8 hours per unit including the activities and assessments. However, the number of hours per unit is flexible so you may spend less time on shorter units and more time on longer units. Distance education learners have to be flexible to complete the units to their satisfaction as we all have different styles of learning.

Study skills

As an adult learner, your approach to learning will be different from that of your school days. You will choose what you want to study because you have professional and/or personal motivation for doing so. You will most likely be fitting your study activities around other professional or domestic responsibilities.

Essentially you will be taking control of your learning environment. As a consequence, you will need to consider performance issues related to time management, goal setting, stress management, etc. Perhaps you will also need to reacquaint yourself in areas such as essay planning, coping with exams and using the web as a learning resource.

Your most significant considerations will be *time* and *space*, such as the time you dedicate to your learning and the environment in which you engage in that learning. We recommend that you take time now — before starting your self-study — to consider these issues. There are a number of excellent resources on the web. To get you started, we suggest the following links:

- http://www.how-to-study.com/

  The "How to study" web site is dedicated to study skills resources. You will find links to study preparation (a list of nine essentials for a good study place) and taking notes, as well as strategies for reading textbooks, using reference sources, and coping with test anxiety.

- http://www.ucc.vt.edu/stdysk/stdyhlp.html

  This is the web site of the Virginia Tech, Division of Student Affairs. You will find information about time management (including a "where does time go?" link), basic concentration techniques, control of the study environment, note taking, how to read essays for analysis, memory skills ("remembering"), and a study skill checklist.

- http://www.howtostudy.org/resources.php

  Another "How to study" web site with useful links to time management, efficient reading, questioning/listening/observing skills, getting the most out of doing ("hands-on" learning), memory building, tips for staying motivated, and developing a learning plan.

At the time this course was written these web links were active, but they may have expired. If you want to look for more, go to www.google.com and type "self-study basics", "self-study tips", "self-study skills" or something similar.

Need help?

Help

1. The course web address is: www.namcol.edu.na
2. You can contact the course instructor, Ms. U Kazombiaze at Yetu Yama Centre

   Telephone: 061 320 5243

   Fax: 088620106 or 061 216 987

   Email: Kazombiaze@namcol.com.na
3. Learners can access the Yetu Yama Resource Centre any time on Mondays to Fridays between 8 and 17H00.

   The manager is Mr. J. Kavetuna

   Telephone: 061 320 5271

   Email: Kavetuna@namcol.com.na
4. For technical assistance, contact Mr. D. Tsauseb at 061 230 5222

   Email: tsauseb@namcol.com.na

Assignments

Assignments

The Life Science course consists of 24 pieces of formative assignments. There is at least one assignment at the end of each sub-topic within a unit. Learners should compare their answers with those given in the feedback section provided at the end of each unit.

Assessments

Assessments

There are 8 assessments in the course, one after every unit. Each assessment is worth a total of 50 marks. These are tutor-marked assessments that contribute to the continuous assessment marks. Feedback and answer keys for these assessments are included in the tutor's folder.

No summative assessment (examination) is given as part of the course. Namibian learners will write National Examination administered by the Directorate of National Examination and Assessment (DNEA).

Feedback

Feedback

Feedback for all assignments and activities is given at the end of each unit. Feedback for tutor-based assessment is provided and included in the tutor's folder.

Resources

Resources

Links to internet resources are given at the end of each unit. A list of multimedia resources is provided at the end of each unit and are provided to learners on the CD-ROM.

Getting around the Course Material

Margin icons

While working through the course material you will notice the frequent use of margin icons. These icons serve to "signpost" a particular piece of text, a new task or change in activity; they have been included to help you to find your way around the course material.

A complete icon set is shown below. We suggest that you familiarize yourself with the icons and their meaning before starting your study.

 Activity	 Assessment	 Assignment	 Case study
 Discussion	 Group activity	 Help	 Note it!
 Outcomes	 Reading/ Resources	 Reflection	 Study skills
 Summary	 Terminology	 Time	 Tip

Unit 6

Health Education

Introduction

Do you know that approximately 40.3 million people are living with HIV worldwide? This necessitates the teaching and learning of health and HIV issues in our schools. This Health Education unit includes information about health issues, the affect that living conditions have on health outcomes and to motivate people to act on whatever interests they have in improving their living conditions so as to prevent illness. This unit will primarily focus on components of the immune system, basic functions of the immune system, how HIV destroys the immune system of the body, various tests to reveal the presence of HIV in blood samples, types of Antiretroviral Drugs (ARV) available in Namibia, the importance of ARV treatment and its side effects, infectious diseases, prevention and cure of diseases and sexually transmitted infections.

What is in this unit?

This unit consists of 4 topics:

Topic 1: HIV and AIDS and the Immune system

Topic 2: Infectious Diseases

Topic 3: Prevention and Cure of Diseases

Topic 4: Sexually Transmitted Infections (STIs)

It is important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: ▪ list the components of the immune system and outline the basic functions of each component. ▪ recognise phagocytes and lymphocytes under a light microscope. ▪ describe the origin, maturation and mode of actions of phagocytes. ▪ distinguish between B- and T-lymphocytes in their mode of action in fighting infection and describe their origin and functions. ▪ explain the meaning of the term "immune response." ▪ describe how HIV destroys the immune system of the body and outline how HIV is diagnosed. ▪ list the types of ARVs common to Namibia, the importance of ARV treatment in prolonging life, and the side effects of ARV treatment. ▪ list infectious diseases commonly occurring in Namibia, the social implications, and list different ways of transmission. ▪ describe the life cycle of the malaria parasite and symptoms of malaria. ▪ describe ways of preventing and curing infectious diseases, including examples commonly employed in Namibia. ▪ discuss the importance and role of traditional medicine. ▪ identify Sexual Transmitted Infections (STIs) common to Namibia. ▪ understand transmission, symptoms, effects, treatment and prevention of common STIs
 **Study Time**	You need to spend about 6 hours on this unit. Don't worry if it takes you longer because we all learn at a different pace. The important thing is to achieve the set objectives.

Terminology	**antigens**	cells that have the ability to divide and are present in pathogens
	antibodies	gamma globulin proteins that are found in blood or other bodily fluids and are used by the immune system to identify and neutralize foreign objects, such as bacteria and viruses
	immunisation	the artificial induction of immunity to diseases
	immunity	ability of the body to protect itself against foreign substances and cells, including disease-causing agents
	pathogen	a specific causative agent (bacteria or virus) of disease
	pathogenretrovirus	a specific causative agent (bacteria or virus) of diseasea RNA –containing virus that converts its RNA to DNA using the enzyme reverse transcriptase
	retrovirusimmunisation	an RNA-containing virus that converts its RNA to DNA using the enzyme reverse transcriptase the artificial induction of immunity to diseases
	STI	Sexual Transmitted Infection
	vaccination	an injection of antigens against which the recipient's body makes its own antibodies
	vector	injections or tablets which are used for immunizationa carrier of a pathogen from one host to another
	vaccines	injections or tablets which are used for immunization

Human immunodeficiency virus(HIV) and the Immune system

The Immune system

The immune system is the complex group of organs and cells that defend the body against infection or disease.

The immune system protects your body against infection. Its main component is white blood cells. These cells hunt and destroy invading germs, including bacteria and viruses, preventing the development of serious diseases and damage to the body.

The immune system protects the body against infection in three ways.

- It forms a barrier that prevents bacteria and viruses (pathogens) from entering your body.
- When pathogens invade your body, the immune system detects and tries to eliminate them before they can reproduce.
- If a pathogen reproduces, your immune system works to detect and eliminate it in early stages.

Organs of the immune system

The organs of the immune system are called lymphoid organs. They produce specialized cells responsible to maintain the first line of defence by eliminating invading pathogens. The immune system consists of primary and secondary lymphoid organs.

Listen to the audio by double clicking on the icon.

Audio- Components of Immune system.mp

Double click to hear audio.

Primary lymphoid organs

Primary lymphoid organs include:

- **Bone marrow**: produces new blood cells, both red and white. All blood cells are produced from stem cells. Stem cells are cells that branch off and differentiate into a variety of cell types with specialized functions; they have the ability to divide for an indefinite period. *B-lymphocytes* and *T-lymphocytes* are different white blood cells produced from stem cells in the bone marrow and are discussed further below. B-lymphocytes mature in the bone marrow. T-lymphocytes migrate to the thymus and mature there.
- **Thymus:** incubates T-lymphocytes until they are mature and releases them into the bloodstream to respond to antigens encountered in the body.

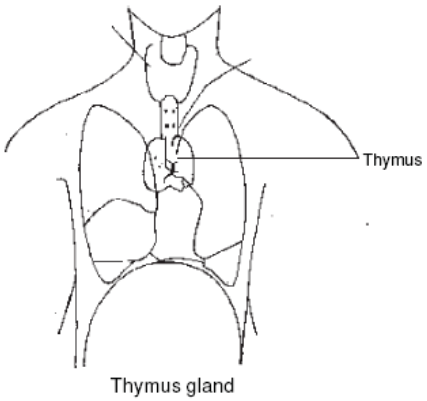


Diagram: Thymus and Thymus Gland

Secondary lymphoid organs

The secondary lymphoid organs include highly organized organs such as lymph nodes and the spleen as well as less organized organs scattered throughout the body such as skin. (See diagram: Organs of the Immune System.)

- The **spleen** is an organ that creates lymphocytes and phagocytes for the destruction and recycling of old red blood cells and also serves as a blood reservoir. It supplies the body with blood in emergencies such as bad cuts. The spleen is also the location where white blood cells trap pathogens. The B-cells are activated in the spleen therefore the spleen is important in fighting infections that have invaded the blood and acts as a filter.
- The **skin** is the first line of immune defence that secretes oil with bacteria-killing properties.
- **Lymph nodes** are found throughout the body (concentrated where limbs/bones are attached to the body) and are major centres for the immune function. The lymph nodes contain large numbers of B- and T-lymphocytes. The major function of the lymph nodes is to filter antigens from the lymph. **Lymph** is the fluid that circulates throughout the lymphatic system.

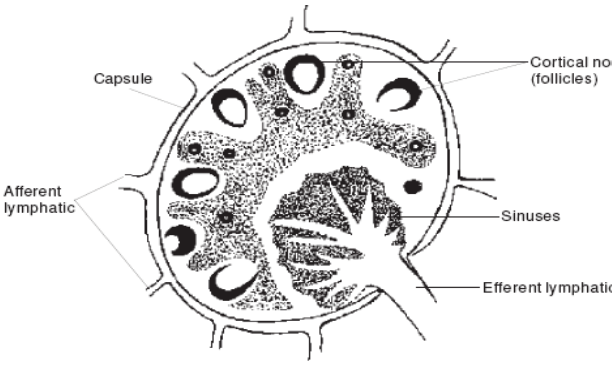


Diagram: Lymph Node

Now you can identify the organs of the immune system on the diagram below.

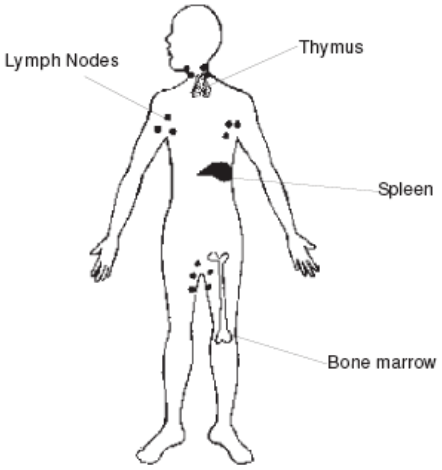
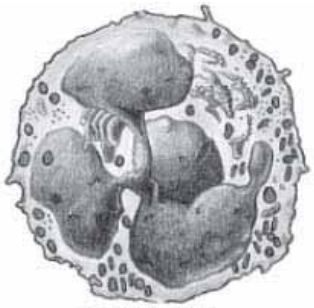


Diagram: Organs of the Immune System

The cells of the immune system:

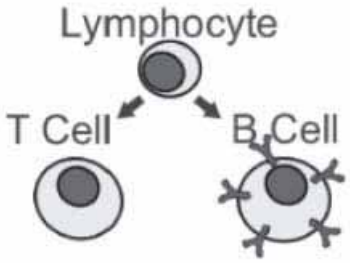
White blood cells form the most important part of our immune system. These cells are a whole collection of different cells that work together to destroy invading pathogens. The lymphocytes and phagocytes are types of white blood cells protecting you from viral infection, fighting bacterial and fungal infections and coordinating the activities of other cells in the immune system. Look at the diagrams of a typical lymphocyte and phagocytes and then we will discuss them in detail.



Lymphocyte

Phagocyte

The diagram below shows how a lymphocyte divides into a B-cell and T- cell



We will now discuss in detail, the two lymphocytes (B-cells, T-cells) and macrophages. We briefly discussed them at the beginning of this section, and will now provide specific information regarding the types of cells.

T-cells get their name from the role that the thymus gland plays in their production. Pre-T lymphocytes and phagocytes arise from stem cells in the bone marrow and migrate through the thymus in order to develop into mature functional T- cells.

Helper T-cell: The helper T-cell is normally the main cell which carries the CD4 surface protein. CD4 cells are a type of T-cell This means that it is the main type of cell targeted by **Human immunodeficiency virus** HIV. HIV can destroy the majority of CD4+ cells in the human immune system.

B-cells: These cells circulate in the blood and lymph. The major function of B-lymphocytes is producing antibodies in response to foreign proteins of bacteria and viruses. **Antibodies** are specialized proteins that specifically recognise and bind to a particular foreign protein, called an **antigen**. Antibody production and binding to a foreign substance or antigen is often critical to stimulating other cells to engulf, kill or remove that substance from the body.

You are now aware of the importance of the organs of the immune system. Can you recall some examples of the cells of the immune system? How do these cells defend the body against pathogens? Let's see.

Do the following activity in your notebook. Compare your answers with mine given at the end of the unit.

Activity 1

1. Match the words in column A with the descriptions in column B (*interactive).*

A	B
1. HIV 2. Immune system 3. Skin 4. Lymphoid 5. Bone marrow 6. Thymus 7. Stem cell 8. Spleen 9. Lymph node 10. Spleen, lymph node and skin	a. filter antigen from lymph b. produces B- and T-lymphocytes c. cell with the ability to divide for an indefinite period d. human immunodeficiency virus e. group of organs and cells that defend the body f. a barrier that prevents pathogens from entering g. signs and symptoms of AIDS h. secondary lymphoid organs i. T-lymphocytes mature in this organ j. organs of an immune system k. organ that filters blood

To get feedback, click on the icon. 

The immune response

Your body is under constant attack from disease-causing micro-organisms such as harmful bacteria and viruses. If your skin is cut and damage, these pathogens can get into your tissues. The white blood cells recognise the pathogens as foreign invaders and attack them.

The body production of disease-fighting cells and antibodies is called an **immune response**. **Phagocytosis** is a general immune response to any invading pathogen while antibody production is a specific immune response to a specific pathogen.

Remember that antibodies are specific to antigens. A macrophage is an antibody important in the regulation of immune responses.

Macrophages

Macrophages specialize in the removal of bacteria and pathogens (antigens). They pick up and ingest these antigens and present them to other cells of the immune system such as T- cells and B- cells. This is one of the important first steps in the initiation of an immune response.

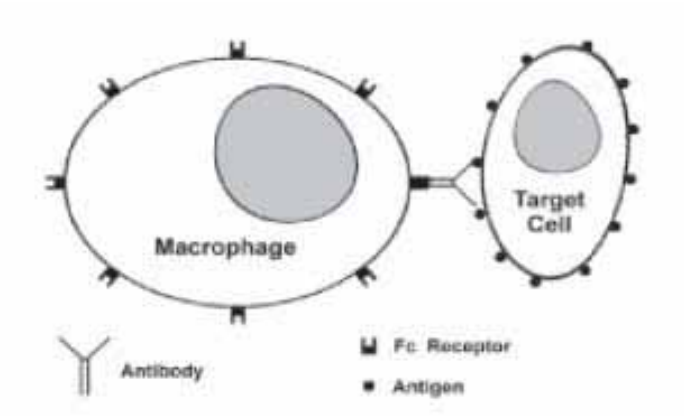


Diagram: Macrophage using receptors to target antibodies

In the diagram above, a macrophage with receptors on its surface is able to recognize a target cell coated with antibodies. The macrophage is able to destroy the target cell by using its receptors.

Viruses:

A virus is a very small organism and can only be seen with an electron microscope. Viruses, including HIV, cannot survive on their own and they need a host cell to survive. HIV invades a host cell and replicates itself.

An infectious viral particle is called a virion. Virions are made of either a DNA (deoxyribonucleic acid) or RNA (ribonucleic acid) core that contains genetic material necessary for replication of a virus. They also have a protein coat, the capsid, which covers the DNA or RNA core and some virus also possess an outer protein membrane called an envelope.

A virus is not a cell though there are similarities such as a membrane, the fact that they made of the same sort of molecules (lipids) and also have protein sticking through their membranes. The viral core is where a virus keeps its genetic makeup, which in this sense it is a bit like a cell's nucleus except that the viral core is not surrounded by a cell membrane. The viral core is simply two strands of RNA wrapped in proteins bundled into a conical shape.

Surface proteins of both capsid and envelope serve to protect genetic material, regulate the attachment of a virus to receptors on a host cell's surface and act as antigens stimulating specific antibody production in a host.

Viruses enter a host cell to replicate in several ways, including:

1. adsorption – a virus attaches itself to a specific receptor on a host cell membrane;
2. penetration – a virus passes into host cell(intracellular;
3. uncoating – a virus sheds its capsid coating freeing up its genetic material (DNA or RNA);
4. viral replication – viral constituents, DNA or RNA, coat proteins and enzymes are synthesised within a host cell by making use of the host cell's metabolic and synthesis processes and

5. assembly and release – viral constituents are assembled and the newly formed virus is released from a host cell either by lysis (rupturing of the cell membrane) or by budding.

Human Immunodeficiency Virus (HIV) is the name given to a closely-related family of retroviruses that cause profound immune dysfunction overtime. How then does HIV affect the immune system? Let us look at this now.

HIV avoids being destroyed by the immune system by repeatedly changing its outer coat. It replicates within a special type of white blood cell called CD4 cells (Helper T-cells). These cells are normally involved in helping other types of immune cells to attack and destroy disease-causing micro-organisms (pathogens). The human immunodeficiency virus binds to CD4 receptors on the surface of the CD4+ cells (Helper T-cells) and is able to fuse with the cell membranes to invade and infect CD4+ T-cells. Look at the diagram.

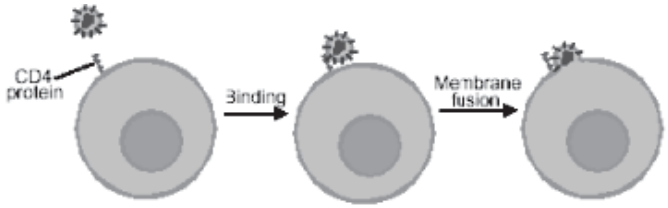


Diagram: T-cell binding with HIV

HIV uses the enzyme "reverse transcriptase" to change so it can gain entry into the nucleus of a cell and takes control of the CD4 cell. The viral RNA is converted by reverse transcriptase into viral DNA and is released as new copies of the virus ready to leave the cell to invade more CD4 cells (Helper T-cells). The body is then infected with the HIV virus. The immune system loses the ability to defend the body against disease-causing micro-organisms and the body becomes vulnerable and becomes infected with opportunistic diseases.

Good progress so far, but now let us summarise how HIV destroys the immune system of the body.

HIV attaches itself to a CD4+ cell, fuses with the membrane of the cell and injects its generic material into the cell. It then makes new viral proteins and multiplies to invade more CD4+ cells. Other cells of the body are unable to fight invading pathogens as they do not receive a signal to produce antibodies. CD4+ cells decline in numbers and the body becomes prone to infection, which leads to Acquired Immune Deficiency Syndrome (AIDS).

You may want to ask how HIV is diagnosed.

Blood tests are the most common way to diagnose HIV. There are different types of tests that can be used to monitor the presence of HIV in the blood.

Elisa Test - Is performed on the blood drawn from a vein and is the standard screening test used to detect the presence of antibodies to HIV.

Rapid Test - Is a screening that produces very quick results, in approximately 15-20 minutes. Rapid tests use blood or oral fluid to look for the presence of antibodies to HIV**.** All New Start HIV Testing Centres in Namibia use a Rapid Test method for HIV testing according to the Minitry's of Health and Social Services

guidelines. As is true for all screening tests, a reactive rapid HIV test result must be confirmed with a follow up confirmatory test before a final diagnosis of infection can be made. This test has a similar accuracy rates as the traditional Elisa screening test. **Click here to view the video.**

Complete Blood Count (CBC) - Is a test of all the components that make up the blood. It measures the number of white blood cells, haemoglobin and platelets in your blood. A high number of white blood cells suggest that the body is fighting an infection which may be undetectable with a low red blood cell count. This test does not show direct progression related to HIV, but helps to determine the overall health of the body.

Viral Load - Is used to measure the number of HIV in the blood. The result of this test tell you whether your viral load is low, medium or high.

T4-Cell Count - This test detect the number of CD4 or T4-cells in the blood, reflecting the health of your immune system. T4-cells are a type of T-cell. The T4 count indicates how much damage HIV has done to the immune system

Now it is time for an activity. Do it in your notebook. Compare your answers with mine given at the end of the unit.

 Activity 2	***1. Choose the correct words from the list to complete the following statements.*** **LIST: Elisa test; viral load; antibodies; rapid test** 1.1. The HIV test looks for the presence of HIV …….. in the blood. 1.2 The ……. HIV test takes about 15-20 minutes to give results. 1.3. The amount of HIV in the blood is called …….. . 1.4 The ……. HIV test is performed on blood drawn from the vein. **2.State whether the following statements are true or false (***interactive)* 2.1. A virus is a living cell 2.2. HIV is AIDS. 2.3. HIV is a virus. **To get feedback, click on the icon.** 

 Note it!	*There are different types of Antiretroviral drugs (ARVs) that can be used to prolong life even if you are infected with HIV. Most people lose hope when they find out that they are HIV positive.*

Why is it important to know your HIV status?

The best way to prevent the spread of HIV is to get tested and know your status. An HIV test looks for the presence of HIV antibodies in a person's blood. Knowing how many T4 cells you have (which is determined by blood tests ordered by your doctor) tells you how healthy your immune system is and how well it is holding up in the fight against HIV. Your T4 cell count will also be helpful in figuring out when to start anti-HIV therapy and whether or not you should start taking medication to prevent AIDS-related infections.

Importance of treatment

The drugs given to HIV+ people reduce the level of HIV in the blood and delay the development of AIDS. It prolongs the lives of people infected with the virus.

Let us now look at the different types of antiretroviral drugs (ARVs) available in Namibia. A dramatic reduction in viral load is achieved by combining three drugs. This is called "Highly Active Antiretroviral Therapy" (HAART). The immune system regains its function to fight pathogens that may enter the body. (It boosts the immune system.)

How does HAART work?

Each class of anti-HIV drugs attacks the virus at a different stage of replication. This inhibits the virus from replicating and reduces the viral load in the blood (of an infected person) significantly.

Types of ARVs

The common class of ARVs prescribed for Namibia is large and therefore we will only refer to the most common ones:

- nucleoside reverse transcriptase – inhibits transcription of the virus;
- nevirapine – slows viral infection from mother to child; and
- indinavir – protease inhibitor.

Side effects of ARVs

Side effects are unintended actions or adverse drug reactions. Different ARVs can cause a number of side effects. Listed below are examples of side effects:

- nausea and vomiting;
- diarrhea; and
- tiredness.

These side effects may appear soon after a person starts taking ARVs, but they do not last long.

Other side effects

- Skin rash
- Insomnia

The above- listed side effects are common to Namibia. There are numerous other side effects. **Click here to view the video.**

Now, do Activity 3 that follows in your notebook. Do not forget to compare your answers with mine given at the end of the unit.

Activity 3	1. **Write a short paragraph of not more than 50 words on how you can encourage your friend or family member to take ARVs.** 2. **List common side effects of ARVs that are common to Namibia.** 3. **Explain the function of ARVs.** To check feedback, click on the icon.

The assignment that follows is in the form of a survey. Find time and carry it out to familiarise yourself with the facts about the HIV and AIDs pandemic in Namibia. There will not be any feedback given for this assignment.

Assignment

 **Assignment 1**	1. Carry-out a survey on different ways of HIV transmission by visiting your nearest health centre. Your survey questions can include the followings: Which method of transmission is the most common and the least common? Present your information in a form of a table. What recommendations can be given to help prevent further transmission of HIV in Namibia? 2. Find out about how the AIDS pandemic is being dealt with in Namibia. For instance, make an appointment with a nurse from your local clinic to find out what programmes are available for HIV-positive people in your community. Speak to a person from an organisation that is involved with HIV and AIDS such as the AIDS Care Trust of Namibia. 3. In Namibia 82% of people dying of tuberculosis (TB) are also infected with HIV. In South Africa these figures are even higher and stand at 88%. Suggest the relationship between the death-rate of TB and the infection of HIV.

Now we will look at other infectious diseases common in Namibia.

Infectious Diseases

In this section we will look at common infectious diseases in Namibia such as malaria, tuberculosis and dysentery. We will talk about different ways to transmit infectious diseases. In addition, we will discuss the life cycle of the malaria parasite and the prevention of malaria.

What are infectious diseases?

Infectious diseases are diseases that are passed from one person to another through air, water or physical contact. These diseases are caused by **microorganisms** (microbes) called **pathogens**. In everyday life pathogens are referred to as germs. Not all micro-organisms are pathogens. Some microorganisms are beneficial to humans, such as the bacterium that converts milk into sour milk and the "*Penicillium"* fungus that produces the antibiotic *Penicillin*.

Now that we have learned the meaning of the word pathogens, let us look at different examples of pathogens and the diseases caused by them in the table below. Pathogens can be viruses, bacteria, fungi or **protoctists**.

The table below shows pathogens and their effects on the human body.

Pathogen	Description	How the pathogen affects our bodies	Infectious diseases caused
Virus	Viruses can only reproduce in a living host cell	Once the virus is established in the body it will be dispersed in the blood, invade new cells and destroy body cells.	• AIDS • Common cold • Influenza (flu) • Poliomyelitis(polio) • Rubella (German measles) • Chicken Pox • Measles
Bacterium	Single cell organism without nuclei. Bacteria can reproduce by dividing into two.	Harmful bacteria cause disease either by destroying our body cells or by producing poisons called "toxins." The toxins make a person ill.	• Tuberculosis • Cholera • Typhoid fever • Whooping cough • Pneumonia • Gonorrhea • Syphilis
Fungus	They have thread-like structures called hyphae. They do not make their own food. They obtain food under favorable conditions in the environment in which they live.	Fungi produce threads called hyphea which absorb food on moist skin and damage it. Some fungi feed on skin	• Ringworm • Athletes foot • Thrush

		diseases.	
Protoctist	Single-cell organisms, including protazoa, found in different parts of our body such as the blood, intestines and nervous system.	The harmful protozoa that can live in the human body are known as parasites and can cause serious diseases.	• Malaria • Amoebic infections • Dysentery • Bilharzia

Complete the activity below to check your progress. Compare your answers with mine given at the end of the unit.

Activity 4

The table below pairs an infectious disease with its causative organism. For example, Ringworm is caused by a Fungus. Complete the table below by filling in the missing infectious diseases or causative organism for the spaces marked A, B, C, etc.

Infectious disease	**Causative organism**
1. Ringworm	*Fungus*
2. Polio	a.
3. Dysentery	b.
4. c.	Bacteria
5. Gonnorhea	d.
6. Bilharzia	e.
7. f.	Bacteria
8. g.	Virus
9. h	Fungus
10. Malaria	i

To check feedback, click on the icon. 

Let us move on to how we are infected with diseases.

How are infectious diseases transmitted?

Pathogens are everywhere. We swallow them, breathe them in etc. Infectious diseases are transmitted in different ways. Let us discuss some of these.

1. Direct contact

Sometimes skin-to-skin contact is enough to transmit diseases, but often diseases are transmitted through sex or other direct contact with bodily fluids. Some fungal diseases – ringworm for example – and sexually-transmitted diseases like syphilis, gonorrhea and AIDS all spread through direct physical contact between people.

2. Air-by-droplet infection
Some diseases caused by organisms are transmitted from person to person through tiny droplets of moisture. Coughing, sneezing, talking and breathing leave moisture particles in the air. People breathe in these fine droplets and as a result "catch" a disease. Droplets in the air spread diseases like the common cold, flu, measles and tuberculosis.

3. Ingestion of water or food
Drinking water is a source of many diseases that affect the digestive tract such as dysentery and cholera. Spores and active organisms are released with faeces and can spread into water supplies due to unsanitary conditions. Many organisms transmitted by water may also be carried by some foods. Unwashed hands, exposed septic sores and flies also spread germs to food during preparation.

Hint: *Boil drinking water to kill diseases in water, even if you live in urban areas.*

4. Bacteria and viruses entering the body through the skin
Some diseases enter the body through cuts or insect bites.
a) The *Staphylococcus* bacterium lives on surfaces and enters the body through cuts. Some viruses can cause warts, even on undamaged skin.
b) *Vectors*
Some parasites enter the skin through insect bites. Malaria is a disease caused by a single cell organism (a protozoan) through a female Anopheles mosquito (the vector.) These insects feed on human blood.

Now that we have looked at ways infectious diseases can be transmitted. Let's now discuss some examples of common infectious diseases in Namibia mentioned in the introduction.

Malaria

Malaria is a very serious disease that causes death for millions of people all over the world. In Africa alone, malaria kills over one million people each year. Many people in Namibia are treated for malaria and many die due to malaria each year. However, there are ways to prevent malarial infections and death. In Namibia, malaria deaths have dropped by 90% between 2001 and 2008. The number of malaria cases treated in hospitals has also fallen by 77%, from 41,100 to 5,200, during the same period. Malaria occurs all over Namibia but it is more common in the northern regions of the country.

What causes malaria? To answer this question we need to look at the life cycle of the malarial parasite.

The life cycle of the malarial parasite

Malaria is caused by a parasite (a protoctist) called *plasmodium* that lives in and feeds on red blood cells. The human body is the **host** for plasmodium. The malarial parasite has to go through two phases to complete its life cycle. Phase one is the *asexual* phase, which occurs in the host. The second phase is the *sexual* phase, where the plasmodium reproduces using mosquitoes. Mosquitoes are called **vectors** because they spread the malaria parasite from one person to another.

The development of malaria

There are different species of mosquitoes. The females of the anopheles species are the only mosquitoes that spread malaria. The female anopheles mosquito feeds on human blood.

Let us look at the figure below, which shows the life cycle of the malarial parasite. You must constantly refer to this diagram when you read the content below.

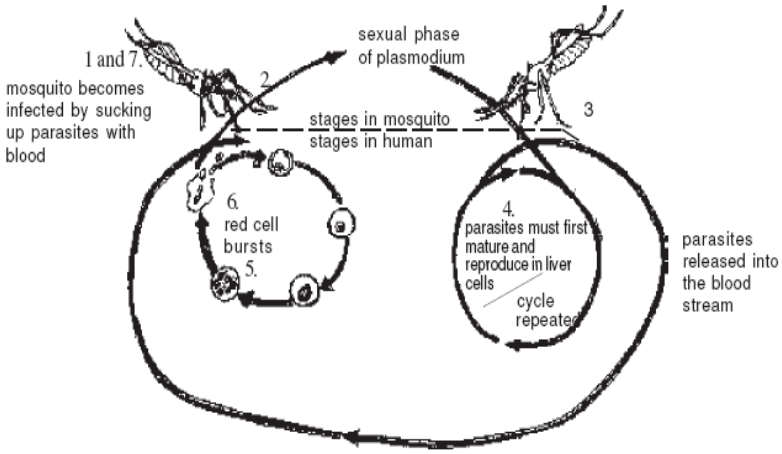


Diagram: Malaria Parasite

1. A female anopheles mosquito bites an infected person; the malarial parasite plasmodium enters the saliva of the mosquito.
2. The plasmodium moves to the stomach of the mosquito and breeds. The process lasts for about three weeks. The plasmodium moves to the salivary gland of the mosquito.
3. When the mosquito bites uninfected persons, the mosquito injects saliva into their blood. The plasmodium moves with the saliva into the blood stream.
4. The parasite is carried through the human body in the blood stream and into the liver. The parasite can only develop further in the cells of the liver. This reproduction is completed in about *48 hours*.
5. After about two weeks, the parasites move back into the blood stream. Inside the red blood cells the parasites feed, grow and multiply again.
6. As a result, the red blood cells burst and release huge numbers of parasites and their waste products into the blood stream. This is accompanied by the symptoms of fever, headache, chills, enlargement

of the liver and spleen, lack of oxygen carried by red blood cells to body cells (anaemia) and shivering. The symptoms last about three days.

7. If another mosquito bites the infected person, the parasites enter into the mosquito where they mate and multiply. When the mosquito bites another person, the disease will be passed to that person. In this way the vector (mosquito) spreads malaria.

How can we prevent malaria?

Although malaria is a common disease we can prevent it by controlling or avoiding mosquitoes. Mosquitoes breed in long grass and near stagnant water. Females lay eggs on the surface of water. Water is found in pools or containers near homes. Litter such as tins, bottles and plastic containers also collect water during rainy seasons. To prevent malarial infection, we should:

1. Avoid stagnant water:

By removing litter and stagnant water around homes, we can reduce the breeding sites of mosquitoes. In this way, we can reduce the number of mosquitoes in our environment.

2. Kill mosquito larvae:

- Since mosquitoes breed in water and lay their eggs in lakes, ponds and swamps, we can destroy the larvae by spraying oil or petrol on the surface of the water.
- We can also kill mosquitoes by spraying insecticides such as DDT. Insecticides should be sprayed on the outer walls of buildings, under roofs and inside huts and rooms. Insecticides remain effective for weeks and even months, killing any insects that land on the sprayed surfaces.

3. To control mosquito reproduction biologically, without chemicals, we could Biologial controls such as:

- Fish in stagnant water eat mosquitoes.
- Bacteria can be added to water to kill larvae by infecting them.

4. Prevent mosquito bites in the following ways:

- Sleeping under mosquito nets at night. Mosquitoes cannot enter through the nets.
- We should also have wire net screen on doors and windows.
- Mosquitoes are most active in the evenings. People should wear long-sleeved dresses or shirts to protect themselves against mosquito bites.
- Apply insect repellent to parts of the body that are not covered by clothes.

5. Take preventative medication (drugs)- if a person is bitten by malaria mosquitoes he/she won't get infected.

Curing malaria

Vaccines (drugs) are available for the treatment of malaria. If patients show symptoms of fever, shivering and chills, headaches, pains and vomiting they should be tested for malarial parasites. If a test is positive the patient should be given medication. There are many drugs available such as chloroquine and mapacrine that kill malaria parasites in the liver and blood cells. After the patient has completed the course of these drugs the malarial parasite dies and the patient is free from malaria. However, in some cases the malarial parasite may become resistant to some chemicals in medicines and the patient may be in

danger. This brings us to the end of our discussion on malaria. We will now move on and look at other common infectious diseases in Namibia.

Common Infectious Diseases in Namibia:

What other common infectious diseases do we have in Namibia?

Besides malaria, there are other infectious diseases in Namibia. We will concentrate on dysentery and tuberculosis as they are most common.

1. Dysentery
Dysentery is a common disease in communities where sanitary conditions are very poor. When drinking water is contaminated with sewage (that is feces, urine and other waste) and people use this water for drinking, they can contract dysentery. The disease affects all people who use the contaminated water. Severe diarrhea and vomiting are the symptoms of this disease. If not treated, the disease may even cause death. The microorganisms (protozoan) from sewage enter the liver. It can cause an epidemic and spread very quickly. The disease can be prevented by boiling drinking-water.

2. Tuberculosis (TB)
Tuberculosis is caused by a very small bacterium known as *mycobacterium*. The disease is spread by droplet infection as well as through milk from infected cows. The bacteria enter through the nose or mouth and infects the lungs. The disease is common in poor communities where people live in over-crowded places. Usually such people do not eat healthy food. Many people in Africa, especially women, die as a result of this disease. This may be due to unhealthy living conditions or inadequate medical treatment. Symptoms include a severe cough, pain in the chest, high temperature and weight loss. The disease can be cured by taking antibiotics, along with a balanced diet and getting enough fresh air and rest.

Social implications of infectious diseases:

• Many children become orphans when adults die of these diseases. This results in less parental care and some surviving family members are forced to take on extra responsibilities.
• If too many children die of these diseases, the population of future leaders will be low.
• Proper sanitation for people becomes important to prevent dysentry.
• TB patients require special units at hospitals.

To check your progress, do the following assignment in your notebook. Compare your answer with the feedback at the end of the unit.

Assignment

Assignment 2

1. What is a pathogen?
2. Name four types of pathogens.
3. Name four ways in which infectious diseases are spread.
4. Why is malaria considered to be a serious disease?
5. List the symptoms of malaria.
6. Explain why only the female anopheles mosquito causes malaria.
7. Discuss the economic impact of malaria.
8. Name the protozoan that causes malaria.
9. Suggest three ways in which villagers could reduce the occurrence of malaria carrying mosquito in their immediate area.

To check feedback, click on the icon 

How will you protect yourself against pathogens? The next topic will answer this question.

Prevention and Cure of Diseases

The best protection against disease is good health. Normally, a person who is well fed, clean and not overtired will resist infection better than one who is not. Hygiene is one way of maintaining good health. In this section, we will look at vaccination as an immunization process against diseases. We will also briefly discuss the role of traditional medicine.

Preventative measures for diseases

Your body is surrounded by microorganisms. Many pathogenic microorganisms live on the surface of the skin, in the mouth and in the digestive tract (alimentary canal). How can you prevent pathogenic microbes from invading your organs?

Prevention

Prevention is better than cure. The following ways can be used to help prevent diseases:

- **abstinence**: not having sex at all
- **be faithful**:when you do have sex, stick to one partner
- **condomise**: use a condom during sexual intercourse. It stops the bacterium passing from one person to another.

We can identify preventative measures as follows:
1. Personal hygiene;
2. Hygiene in living areas;
3. Community hygiene;
4. Balanced diet; and
5. Exercise.

Let us now look at some of these measures in detail.

1. Personal hygiene
Personal hygiene is of utmost importance in keeping microbes and insect parasites such as flies and lice under control. Wash your body with soap and water in order to remove sweat, body oils, dead body cells and dirt. Through washing, you control the breeding of bacteria. Washing your hair prevents microbes from breeding in your hair. Wash your hands before preparing and eating food and after you have been to the toilet. Regularly clean your teeth to remove bits of food left between them. This prevents dental decay.

2. Hygiene in living areas
A house and its surroundings can contribute to the spread of diseases when attention is not given to its cleanliness. Food preparation areas must be kept clean and free from stale pieces of food. Household waste must be cleared away and not thrown on the ground around the house. Flies breed in organic waste and carry bacteria to food. House flies can spread intestinal diseases such as cholera, typhoid and dysentery. If possible, waste food and other matter should be placed in a bin with a tight-fitting lid and disposed of properly. Human feaces and urine also transmit disease-spreading organisms. Thus, human waste should not be deposited in exposed places. Flush toilets should be installed so that excretory matter is removed to sewage works where it can be treated.

3. Community hygiene
A clean water supply is very important for any community. The contamination of drinking water is one of the most frequent causes of diseases. Running water from a piped supply is good and convenient for consumption. Normally a piped water supply from a reservoir passes through filter beds of gravel and sand to remove harmful organisms. After the filtering process, the water is chlorinated to kill any remaining bacteria. If water is drawn from a well, the well should be kept covered. City councils are responsible for disposal of sewage in large towns as well as disposal of rubbish.

4. Balanced Diet
By eating right we can stay healthy. Different foods contain certain essential nutrients. For example, Oranges contain Vitamin C. A lack of vitamin C can lead to a disease called **Scurvy.** Scurvy can be prevented by having a good diet that includes a sufficient intake of vitamin C.

5. Exercise
Exercise is another way to remain healthy. By exercising on a regular basis we can maintain a regular healthy body.

Now that you understand how diseases can be prevented, let us continue with immunization.

Immunization

An attack of a disease such as *poliomyelitis* or *small pox* can cause death or permanent damage to the body. By improving our immune system we can fight most diseases. This is done by introducing antigens through injections, drops or tablets called **vaccines** to improve the production of antibodies in your body. This process of introducing antigens to boost the ability of your body to produce more antibodies is called **immunization**. A person who has been immunized will not fall ill if attacked by the same disease causing microbes that would make an unimmunized person sick.

A vaccine consists of the antigens of the microbes that cause a disease. Vaccines stimulate the body to produce antibodies that fight certain diseases. To prepare a vaccine, the pathogenic microbes are killed but the antigens in the microbes are not destroyed. The process of giving a vaccine, usually by injection, is called vaccination. The first vaccination was performed more than 200 years ago by a doctor named Edward Jenner.

To test your knowledge of immunization, carry out the practical investigation that follows.

Practical Investigation

Title: Investigating transmission of diseases

You have probably had a cold or flu and know what it is like to sniff and sneeze. However, sneezing is not only uncomfortable for you, but can also spread the viruses and bacteria that have infected you. Airborne pathogens carried within the aerosol droplets you release by sneezing to the respiratory system of others. The rapid spread of disease, known as an epidemic, is of great concern to public health officials.

What do you need?

Small numbered bottles of neutral or dilute base solutions
Dropper
Small test tube
Small test-tube holder
Phenolphthalein

What to do:

- You need to get two numbered bottles with solution A neutral solutions simulate healthy people in the model and the diluted base solutions simulates an infected person.
- Use the dropper and transfer two droppers full of your solutions into the test tube.
- When everybody is ready, choose a person at random and transfers a dropper full of your test tube solutions to your classmates' test tube.
- At the same time he/she will give you a dropper full of his/her test tube.
- Record the name of the people you have interacted with.
- Repeat this for a total of three times.
- Now place two drops of phenolphthalein indicator solution into your test tube.
- Neutral solution = colourless; basic solution will turn pink.
- In your notebook, list the names of all the people who are 'infected' (pink solution).
- Obtain from the infected people the names of all their contacts, by round, and record their names.

Your bottle number:_____

Contact	Round 1	ound 2	Round3

Phenolphthalein colour:_____

To find the identity of the first infected person, cross off the names of the uninfected person from the contact list. That will narrow down the infected people from the first round to two people.

The two people should now test their samples with phenolphthalein.

Name of infected person	Contacts of each infected person		

1. Make a chart with people names and arrows to show the transmission route from one round to the next.

2. How many people where infected?

_____

To check feedback, click on the icon ☺

Types of Immunity:

The body is capable of being immune to some diseases. Let us look at the chart that follows to better understand the types of immunities.

Different types of immunity

The chart below shows different types of immunity.

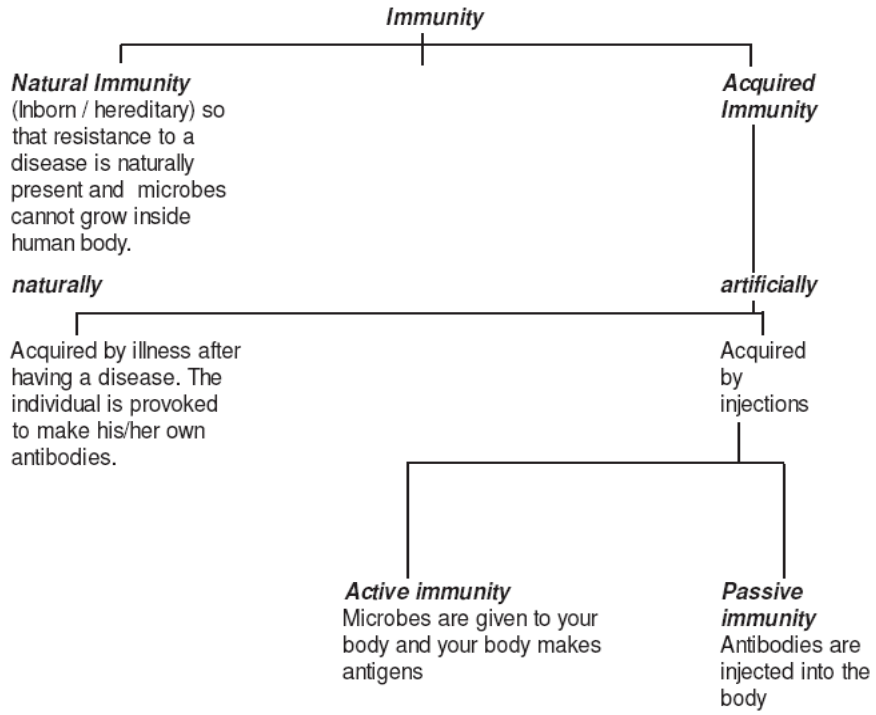


Diagram: Chart of Types of Immunities

Acquired passive immunity

If there is an outbreak of a dangerous disease in a city then people need to be protected quickly. This can be done by injecting people with ready-made vaccine of antibodies or antitoxins. The chemicals needed for such injections are obtained from another person or an animal.

Acquired active immunity

Acquired active immunity is achieved by injecting small amounts of antigens into your body over a period of time. This makes your body produce its own antibodies that fight infections.

Comparison between active and passive immunity:

Active Immunity	Passive Immunity
Lymphocytes stimulated to make antibodies by a natural infection or vaccine	Lymphocytes not stimulated to make antibodies
Antibodies not acquired	Antibodies acquired through placenta,

	breast milk and anti-serum injection
Antibody level takes long to be high	Antibody level become high immediately
Takes long to provide immunity	Provides immediate immunity
Long-lasting	Short-lived

Namibia provides vaccines to children for some diseases. Below is the vaccine schedule for Namibia.

Namibia's National Immunization Schedule:

Age of child	**Vaccine**
Newborn	polio, tuberculosis
6 weeks	polio, diphtheria, whooping cough, tetanus
10 weeks	polio, diphtheria, whooping cough, tetanus
14 weeks	polio, diphtheria, whooping cough, tetanus
9 months	Measles
5 years 10 years	diphtheria, tetanus, polio diphtheria, tetanus, polio

How does medicine cure disease?

Sometimes your immune system cannot destroy the pathogenic microbes which make you ill. Then it is necessary to use drugs to cure an illness. Many diseases can be cured by taking medicines. However, there are some diseases which cannot be cured by medicine, for example, the common cold and flu are caused by a virus that cannot easily be cured with medicines.

Antibiotics are drugs that cure diseases. Chemicals in antibiotics kill pathogenic microbes without damage to patients. When a person falls ill, either a doctor or a nurse examines the person and diagnoses the disease. Then the doctor or nurse prescribes medicine and tells the patient how to use the medicine. Medicines are taken in different ways. Some medicines are taken in liquid form, others in tablet form. In some cases medicine is injected into the body of a patient. There are also creams or lotions that are applied to the skin. The effect medicine has depends on how much is taken. It is important to follow the instructions and to complete a course of medicine.

Medicines are often made of plants. In some communities the knowledge of preparing traditional medicine is passed on from one generation to another. Traditional healers play a very important role in some communities. Unfortunately, in some communities this knowledge has been lost.

We all are aware that our forefathers played an important role before the introduction of new chemically tested medicine and professionals doctors. Let us now look at how traditional medicines were used to treat and cure people in the past and today.

Traditional medicines

In most countries in the world, plants have been traditionally used as medicines. In Namibia there are many indigenous plants with leaves, bark and roots that are used as medicines. Some examples include:

- the leaves of the bitter bush are used to cure constipation.
- mopane leaves are used to stop vomiting.
- dried devil's claw root from the desert regions of Namibia is used as tea or in tablets by people who suffer from **arthritis**, which is a disease that affects the joints in the body.
- aloe is used to heal wounds.

All the above traditional medicines are now recognized in other parts of the world and Namibia exports them to Europe.

Now, do the self-mark assignment that follows to check your progress. Do not forget to compare your answers with mine given at the end of the unit.

Assignment

Assignment 3

1. List four ways of personal hygiene to protect yourself against the entry of pathogenic microbes into your body.
2. Describe two ways in which active immunity differs from passive immunity
3. Explain why a person who has been bitten by a snake is sometimes given an injection of antibodies.
4. Vaccination is a defense mechanism against infectious diseases. How can a vaccine protect you against a disease?
5. State any three ways by which people can reduce the spread of infectious disease.
6. Visit your local community and carry out an investigation on what types of traditional medicines are used. You should include the following information in your investigation. At least you should find out the following information about three different plants:
    - Local or scientific name of the plant
    - Area where it is commonly found
    - How it is being prepared
    - Diseases it is used to treat

To check feedback, click on the icon 

Sexually Transmitted Infections (STI)

What are sexually transmitted infections?

Sexually transmitted infections (STIs, formerly referred to as sexually transmitted diseases or STDs), are spread primarily through person-to-person sexual contact. The causative organisms are bacteria, viruses and parasites. HIV and syphilis can also be transmitted from mother to child during pregnancy, childbirth, through blood products and tissue transfer. Although Namibia's population is less than 2 million, the number of people infected with STIs is very high for such a small population. In this section of the course, we will study gonorrhoea and syphilis in more detail.

The section will explore the following key characteristics of selected STIs:

- transmission
- symptoms
- effects
- treatment
- prevention

Gonorrhoea

What is gonorrhoea?

Gonorrhoea is an infection caused by bacteria known as *Neisseria gonorrhoeae* or gonococcus. This type of bacterium grows and multiplies easily in the warm, moist areas of the reproductive tract. The reproductive organs that can support bacteria growth include the cervix (opening to the womb), uterus (womb), fallopian tubes (egg canals) in women and in the urethra (urine canal) in women and men. The bacterium can also grow in the mouth, throat, eyes and anus.

Transmission

Gonorrhoea is transmitted through sexual contact with an infected person. Gonorrhoea can also be spread from mother to baby during delivery. People who have had gonorrhoea and received treatment may get infected again when they have sexual contact with a person infected with gonorrhoea.

Symptoms

Sometimes symptoms of gonorrhoea are not clearly visible, and one can be infected with gonorrhoea without showing symptoms. The symptoms are different and varied in both men and woman. Following is a description of symptoms in males and females.

Males

As stated above some men with gonorrhoea may have no symptoms and in some cases symptoms may appear two to five days after infection. Symptoms may include:

- a yellow (white or green) discharge from the penis;
- pain/burning sensation when passing urine; and
- painful or swollen testicles.

Females

Symptoms are often mild in women and can at times be mistaken as vaginal or bladder infection. Common infections may include:

- vaginal discharge;
- burning when passing urine;
- irregular vaginal bleeding; and
- lower abdominal pain or pain during sex.

In **both sexes, g**onorrhoea can occur in the rectum (anus) and also the throat, but is not very common. Symptoms of rectal infection may include discharge, anal itching, soreness, bleeding, or painful bowel movements. Gonorrhoea infections in the throat may cause a sore throat.

Effects

Left untreated, gonorrhoea can have long-term negative affects on men and women. These long-term consequences are explained below.

Males

Untreated infections in men cause **epididymitis**, a painful condition of the ducts attached to the testicles that may lead to infertility.

Females

Untreated infections of gonorrhoea may affect the reproductive organs by causing *pelvic inflammatory disease* (PID), which damages the fallopian tubes and results in infertility. This condition may also increase the risk of ectopic pregnancy, which is a condition where a fertilized egg grows in a fallopian tube instead of the uterus. It may also result in spontaneous abortions and premature deliveries or prenatal deaths. It is estimated, worldwide, that between 1,000 and 4,000 newborn babies become blind every year because of PID.

Treatment

Several antibiotics like penicillin can successfully cure gonorrhoea in infected individuals. It is important to take all of the medication prescribed to cure gonorrhoea. A follow-up is needed 10 days after treatment to check that the gonorrhoea has been cured. Both partners must be treated for the STI. It is

advisable to abstain from sex during treatment and until you know the result of the follow-up test.

Three months after you have been treated for gonorrhoea, it is very important to have a blood test to detect blood-borne infections that you might have been exposed to at the time you had gonorrhoea.

Prevention

The spread of gonorrhoea can be prevented in the following ways:

- practice safe sex by using a condom every time;
- abstain from sex;
- avoid having sex with an infected person;
- limit the number of sexual partners;
- visit a clinic or doctor if you suspect an infection;
- confirm the sexual history of your partner and
- have regular STI check-ups.

For more information on symptoms, causes and treatment of gonorrhoea

click here.

Now that we have discussed gonorrhoea in detail, let us now continue to look into the second most common STI that affects people in Namibia: syphilis.

Syphilis

What is Syphilis?

Syphilis is a complex STI caused by the bacterium. *Treponema Pallidum.* Syphilis causes sores mainly on the external genitals, vagina, anus, or in the rectum.

Transmission

Like gonorrhoea, syphilis is also caused by a bacterium. Syphilis is passed on from one person to another during sexual intercourse. A pregnant woman may pass the bacteria to her unborn baby. It may pass through the placenta into the baby's blood stream. As a result, the baby may be born dead (still birth). When the baby is born with the disease, it may suffer from lung disease or other infectious diseases that may cause death.

Symptoms

The signs and symptoms occur in three stages:

First stage (Primary Stage)

Painless **sores** appear around the sexual organs two or four weeks after infection. Sores appear on the penis in the male and in the vagina or on the cervix in a female, and sometimes around the mouth or anus of an infected person.

The sores are not painful and last for a week or two. In some cases, the sores may disappear even without any treatment but the bacteria will still remain in a person's body.

Second stage (Secondary Stage)

If syphilis is not treated after a few months, it enters into its second stage. The diagram below shows the second stage of syphilis. Skin rash appears all over the body and the lymph glands becomes swollen. If the infection is **not** treated, the bacteria remain inactive in the body until the third stage of the disease.

Diagram: Skin rash during second stage of syphilis

Third stage (Late and Latent Stages)

The disease may take ten years or more to reach to its final stage. The infected person may suffer from heart failure, paralysis, or blindness and may die eventually.

Syphilis is a very serious disease and medical help is of utmost importance! When one of the symptoms is experienced (described above) do not hesitate to visit your nearest clinic or consult a doctor. The good news is – syphilis can be **cured.**

Treatment

Syphilis can be treated by taking a course of antibiotics like penicillin.

Prevention

Prevention is better than cure. The following ways can be used to prevent syphilis:

- **abstinence**: not having sex at all
- **be faithful**:when you do have sex, stick to one partner
- **condomise**: use a condom during sexual intercourse. It stops the bacterium passing from one person to another.

Now is the time to check your progress. Do the following assignment in your notebook. No feedback is given for this assignment.

Assignment

 **Assignment 4**	1. Carry out a project on different common STIs in your local community and prepare a presentation for the school-going children to help prevent the further spread of STIs among the youth. The following can be included in your presentation. a) causes of STIs b) preventative measures c) what the community can do to assist the youth Note that you can visit the local health centres and traditional leaders for more information.

Unit summary

 Summary	In this unit you learned that: • the immune system is made up of groups of cells and organs that act together to defend the body against invaders that may cause disease; • the immune system consists of immune cells called lymphocytes and antibodies; • white blood cells are the main defenders of the body; • some lymphocytes mature in the bone marrow and are called B-lymphocytes. Other lymphocytes called T–lymphocytes or T-cells mature in the thymus. • the HIV infects CD4+ cells which can cause a complete lack of immune functions which make the body susceptible to opportunistic infections; • various tests are used to detect the presence of the virus in the blood, e.g. Elisa, Blood count, rapid test and viral load; • sexually transmitted infections (STIs) are passed on during sexual contact with an infected person; • abstinence from sex and the use of latex condoms are the best ways of limiting infections; • man infected with gonorrhoea find it hard to urinate and a yellowish/green discharge can be seen on the tip of the penis; • gonorrhoea can be treated with a course of antibiotics; • syphilis can be prevented either by not having sex or by using a condom during sexual intercourse. • syphilis can be cured by treating an infected person with antibiotics.

We have come to the end of the unit. You are expected to do the assessment below. Submit this assignment to your tutor and regard it highly important as it will contribute to your continuous assessment marks.

Assessment

Assessment

Section A – Multiple choice questions

Choose the correct answer from the options given.

1. What will any HIV test reveal?
   A. antibodies in the blood
   B. CD4 counts in the blood
   C. HIV status in the blood
   D. viral load in the blood
2. Which test measures the amount of all components in the blood?
   A. complete blood count
   B. Elisa test
   C. Rapid test
   D. Viral load
3. Against which of the following is vaccination a defence mechanism?
   A. gonorrhoea
   B. bacterial diseases
   C. infectious diseases
   D. STIs
4. To which family of viruses does HIV belong?
   A. Arenavirus
   B. Arterivirus
   C. Reoviridae
   D. Retrovirus
5. Which one of the following diseases can never be passed on to another person?
   A. AIDS.
   B. chicken pox
   C. measles
   D. scurvy
6. If a pregnant woman is infected with which of the following STIs, the baby might be born blind.

A. gonorrhoea

B. herpes

C. AIDS

D. syphilis

7. In Namibia newborn babies are vaccinated against two diseases. The two diseases are:

A. diphtheria and tetanus

B. polio and whooping cough

C. smallpox and measles

D. TB and polio

8. Which of the following is a symptom of gonorrhoea to women?

A. blindness

B. stillbirth

C. sterility

D. painful penis

9. What type of pathogen causes gonorrhoea?

A. bacteria

B. fungi

C. viruses

D. protozoans

10. Which of the following prevents STIs?

A. antibiotics

B. condoms

C. injections

D. loops

Total [10]

Section B – Structured Questions

1. Case 1 – Veruka

Veruka was excited to go away to university. At university he began to visit a local bar during weekends. One night, Veruka went home with someone he had just met at the bar and they had intercourse. A few weeks later, Veruka experienced pain with urination and a discharge from his penis.

a) Suggest what Veruka should do?

.....

.....

.....

.....

.....(1)

b) What STI might Veruka have?

.....

.....

.....(1)

c) How can this STI be treated?

.....

.....

.....

.....(1)

2. Describe how HIV destroys the immune system.

.....

.....

.....

.....

.....(3)

3. To which family of viruses does HIV belong?

.....

.....(1)

4. Name three types of blood cells that mediate an immune response to an infectious agent.

.....

.....

.....

.....

	……(3) 5. List three diagnostic tests for HIV infection. …… …… …… …… …… ……(3) 6. Describe different HIV tests. …… …… …… …… …… …… …… …… …… ……(5) 7. State the importance of ARVs treatment. …… …… …… …… ……(1) 8. List the type of ARVs common to Namibia. …… ……

.....
.....
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.....
.....
.....
.....(3)

9. Discuss the side effects of ARV treatment.

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.....
.....
.....
.....
.....
.....(3)

10. How can a vaccine protect you against a disease?

.....
.....
.....
.....
.....(2)

11. Name two examples of traditional medicines and give their uses.

.....
.....
.....
.....(2)

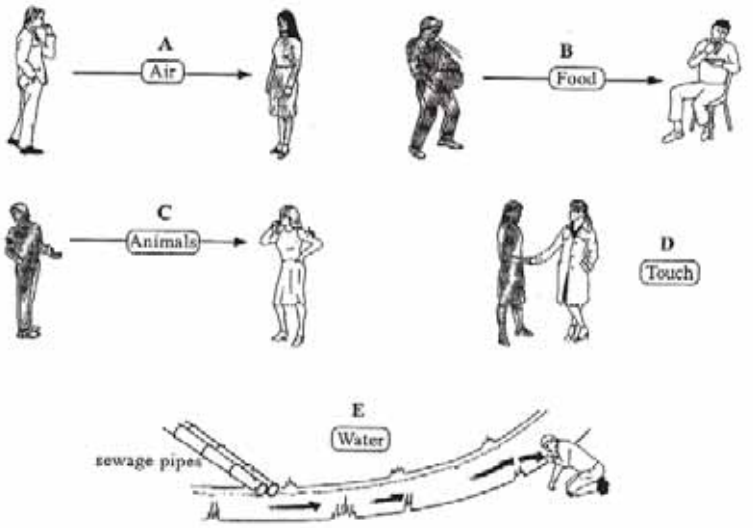
12. The table shows four common infectious diseases in Namibia. Complete the table by writing the letters A, B and C in your answer book and next to it the organisms that cause the disease.

Infectious Disease	Causative Organism

Dysentery	A	
Malaria	B	
Tuberculosis	C	
Chicken-pox	Virus	

(3)

13. To answer the questions below, use Diagrams A to E, which show five different ways infectious diseases are passed from person to person.



(a) Identify from the diagrams the most likely method of transmission of

(i) Dysentery

.....

.....

.....(1)

(ii) Tuberculosis

.....

.....

.....(1)

(b) (i) Identify from the diagrams the method of transmission of malaria.

.....

.....

.....

.....

.....(1)

(ii) State two symptoms of malaria.

.....

.....

.....

.....

.....

...(2)

(iii) Describe two ways in which malaria can be prevented.

.....

.....

.....

.....

.....

.....

.....

.....(2)

(c) State one way in which sewage contaminated water can be purified.

.....

.....

.....

.....(1)

Total [50]

Feedback

 **Feedback** **Activity 1**	1. d 2. e 3. f 4. j 5. b 6. i 7. c 8. k 9. a 10. h To go back, click here.

 **Feedback** **Activity 2**	1.1.antibodies 1.2.rapid test 1.3.viral load 1.4.elisa test 2.1.true 2.2.false 2.3.true To go back, click here.

 **Feedback** **Activity 3**	1. Positive statement Reference to drugs that are available Reference to health care Reference to counselling support services Motivating in such a way that the friend get hope to live longer. 2. Skin rashes Insomnia 3. Prolonging life by reducing the multiplication of the virus in our body. To go back, click here

 **Feedback** **Activity 4**	2. Virus 3. Protozoa 4. TB/Cholera or any other 5. Bacteria 6. Protozoa 7. TB/Cholera or any other 8. Polio/AIDS or any other 9. Ringworm/ Thrush or any other 10. Protozoa To go back, click here

Feedback

Assignment 2

1. Pathogens are microorganisms that cause diseases.

2. Bacteria, virus, fungi, protozoa

3. Direct contact
   Air-by-droplet infection
   Ingestion of water or food
   Bacteria and viruses entering the body through the skin

4. Malaria spread very fast and it can cause death

5. Fever, shivering and chills, headaches, pains and vomiting

6. The female anopheles mosquito feeds on human blood.

7. Mosquito nets, malaria treatment, preventative sprays

8. Plasmodium

9. Ways to prevent malaria infection:
   - Sleeping under mosquito nets at night.
   - We should have wire net screen on doors and windows.
   - Mosquitoes cannot enter through the nets.
   - Mosquitoes are most active in the evenings. People should wear long-sleeved dresses or shirts to protect themselves against mosquito bites.
   - Apply insect repellent to parts of the body that are not covered by clothes.

To go back, click here

Feedback

Assignment 3

1. Wash your body with soap and water in order to remove sweat, body oils, dead body cells and dirt.
Washing your hair prevents microbes from breeding in your hair.
Wash your hands before preparing and eating food and after you have been to the toilet.
Regularly clean your teeth to remove bits of food left between them.

2.

Active Immunity	**Passive Immunity**
Lymphocytes stimulated to make antibodies by a natural infection or vaccine	Lymphocytes not stimulated to make antibodies
Antibodies not acquired	Antibodies acquired through placenta, breast milk and anti-serum injection
Antibody level takes long to be high	Antibody level become high immediately
Takes long to provide immunity	Provides immediate immunity
Long lasting	Short-lived

3. Snakes bites are poisonous and the white blood cells will take to long to prepare antibodies against the antigen.

4. A vaccine contains microbes that cause the disease, which helps stimulate the body to produce antibodies.

5. Personal hygiene

Hygiene in living area

Community hygiene

Balanced diet

Exercise

6. At least two types of traditional medicine should be discussed in the survey.

To go back, click here

 **Feedback** **Practical Activity**	**Points to consider:** • Use the dropper correctly • Write down the contact name • Follow instructions correctly 1. Marks allocated for: • arrows into right direction • all names written down 2. Number infected should be the same as number of pink solutions. To go back, click here

Optional Multimedia Resources

Internet resources:

To view immune systems.

http://images.google.com.na/images?hl=en&q=immune+system&btnG=Search+Images&gbv=2

To view images of people suffering from gonorrhea

people suffering from gonorrhea - Google Image Search

To view images of syphilis symptoms.

syphillis - Google Image Search

To get more information about syphilis.

STD Facts - Syphilis

CD –ROM Resources

1. **Audio clip – components of the immune system**
2. **Video clip – Rapid test**
3. **Video clip – Types of ARVs**

Now that we have learned that the immune system of our body needs to be strong and healthy in order to protect us against pathogens, lets learn more about the food we need to eat to assist our immune system. The next unit is called Nutrition.

Unit 7

Nutrition

Introduction

Have you ever wondered why we eat food? Do you just take it for granted that we eat food because we become hungry? Well, we eat food because there are "things" in food which perform different functions in our bodies. We refer to these things as nutrients.

Nutrition involves eating the right kind of food to keep you healthy, give you energy and keep your cells growing. It also involves eating the right *amount* of food. In this unit, we will talk about nutrients, their functions and their sources. We will discuss the following nutrients: carbohydrates, proteins, fats, vitamins, minerals and water.

What is in this unit?

This unit explains the importance of nutrition and health.

Topic 1: Nutrition and health

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: ▪ list the main characteristics and categories of nutrients. ▪ distinguish between macro- and micro-nutrients. ▪ describe the role of carbohydrates, fats, proteins, minerals and vitamins. ▪ describe the role of water and fibre in the human diet. ▪ classify food types according to their main nutrients. ▪ define and discuss a 'balanced diet' and the causes of malnutrition. ▪ identify problems related to not eating the right kind of food. ▪ explain why people of different ages and genders have different energy requirements. ▪ design a balanced diet for people of different ages and gender who perform the same or different activities.
 **Study Time**	You need to spend about 6 hours on this unit. Don't worry if it takes you longer. We all learn at a different pace. The important thing is to achieve the set objectives.

 **Terminology**	**anorexia**	a disease caused by eating too little food, although food is available
	autotrophic nutrition	is the feeding of plants that take in simple inorganic nutrients like minerals, water and carbon dioxide and use them to make complex organic nutrients such as carbohydrates, proteins, vitamins and oil
	balanced diet	a diet that contains all the food nutrients needed by the body in correct and adequate proportions
	cellulose	a group of carbohydrate mainly made of cell wall
	cholesterol	fatty substance mostly found in animal fat which may cause blockage of arteries
	deficiency disease	a disease caused by a lack of a particular nutrient in a diet

	heterotrophic nutrition	is the feeding of organisms whereby complex organic food nutrients are taken in from either plants or from animals
	macro-nutrient	nutrients needed in large or significant quantities by the body
	metabolism	is a chemical processes occurring in living organisms which are necessary for maintaining of life
	micro-nutrient	nutrients needed in small amounts by the body
	nutrients	substance found in food which are vital to our body and perform different functions in the body
	obesity	is an increased body weight caused by excessive accumulation of fat

Nutrition and health

Introduction?

Characteristics, categories and types of nutrients

A nutrient is any element or compound necessary for or contributing to an organism's **metabolism**, growth or other functions. **There are six nutrient groups, namely** proteins, fats, carbohydrates, vitamins, minerals and water. Nutrients can be classified as those that provide energy and those that support metabolic processes in the body.

What makes these nutrients so vital?
We will look at the categories and characteristics of each nutrient.

First, let us look at macronutrients.

Macronutrients: The source of all calories

All macronutrients contain **calories** (the unit in which energy is measured), thereby supplying us with energy. Macronutrients include carbohydrates, proteins and fats, which comprise the greatest portion of the human diet and are required in large amounts. Water and certain minerals e.g., calcium, sodium and chlorine are also macronutrients.

1. Carbohydrates (Click here to view video)

Carbohydrates are organic compounds that contain:

- carbon, hydrogen and oxygen;
- energy - containing molecules and
- basic building blocks that form a monosaccharide.

There are three **categories** of carbohydrates: simple, complex and dietary fibre.

Simple carbohydrates are sugars and fall into two categories:

1. **Monosaccharides**
   Monosaccharides (saccharide is sugar) are simple sugars. The three major monosaccharides are **glucose**, **fructose** and **galactose**. These are found in table sugar, honey and natural fruit sugars. Two mono-saccharides form a disaccharide.

2. **Disaccharides**
   The disaccharide category is a combination of two monosaccharides, i.e. glucose+ galactose = lactose which is milk sugar.

Complex carbohydrates
These carbohydrates are called **polysaccharide*s*** and are referred to as starches. They are chains of glucose stuck together. Complex carbohydrates are present in food such as bread, cereals, rice and pasta.

Dietary Fibre

Diagram: Photos of cereal and bread

Fibre includes cellulose and pectin as found in whole grains, legumes, fruit and vegetables. When we eat vegetables or fruit and other fresh plant material we take in large amounts of fibre. The fibre component of carbohydrates helps to regulate bowel function. The cellulose in cereals or plants is not digested and passes unchanged through the gut. Its function in our diet is to prevent constipation and to help food move smoothly through the digestive system.

People who do not eat enough vegetables or fruit may not get enough fibre in their bodies and become constipated. When you are constipated, you have hard stools that cannot be passed easily. It is sometimes painful.

When you eat too many carbohydrates, your body can store the excess energy as fat and you become fat or overweight. We refer to being dangerously overweight as *obesity*, which has negative health consequences like heart disease. When you eat too few carbohydrates you may suffer from a disease called *marasmus* or starvation, which is characterized by weak bones and thinness.

Diagram: A child suffering from marasmus

Before we continue, check your progress by answering the following questions in self-mark Activity 1. Compare your answers with mine at the end of the unit.

Activity 1	1. Which three elements are contained in all carbohydrates? 2. List three categories of carbohydrates. 3. Explain the function of fibre. 4. Name the deficiency disease that you can get from eating too few carbohydrates. For feedback, click on the icon ☹

2. Proteins **(Click here to view the video)**

The term protein is derived from the Greek word **protas** meaning "of primary importance".

A protein is a complex organic compound that consists of **amino acids** joined by **peptide** bonds. Proteins contain the elements carbon, hydrogen, oxygen and nitrogen and sometimes sulphur. Proteins are made up of small units called amino acids. Proteins are used for bodybuilding – that is, making new body tissues and repairing those that are damaged or worn out. Growing children and pregnant women need a lot of protein-rich food to enable their bodies to build cells. Other categories of proteins are enzymes, hormones and antibodies. These are important in the overall maintenance and functioning of the body. When there is a deficiency of protein in a person's diet, the disease kwashiorkor can develop. Some of the characteristics of this disease are swollen stomach, slow growth, and thin upper limbs.

The most common food sources of protein are meat, fish, poultry, seafood, eggs, dairy products, whole grain and legumes (beans, peas).

Some examples of food rich in proteins

Diagram: Fish, Steak, Eggs, Chicken.

If you eat too little protein , you may suffer from a disease called *kwashiorkor,* characterised by thin upper limbs, swollen tummy, slow growth, wrinkled skin and sometimes brain development may be negatively affected .

A child suffering from kwashiorkor

Diagram: Example of Kwasiorkor

3. Fats (also called 'lipids')

The term lipid is derived from the Greek word ***LIPOS*** which means fat. The two forms of lipids that are most commonly known are **oils** and **fats**. They are different because oil becomes liquid at room temperature, while fats remain solid at room temperature.

Organic compounds that classify as lipids include:

- carbon, hydrogen and oxygen compounds with a hydrogen to oxygen ratio of more than 2:1. For example a hydrogen to oxygen ratio of (18:1);
- saturated fats (animal fat) and unsaturated fats (of plant origin);
- basic building blocks that are 3 fatty acids and 1 glycerol molecule; and
- building blocks called fatty acids.

There are two general categories of fats based on their chemical structure i.e. **saturated** and **unsaturated** fats. Saturated fats are mostly found in animal sources. They include butter, cream, beef fat, chicken skin, full cream milk, cheese and ice-cream. These tend to be solid at room temperature. Unsaturated fats tend to be liquid at room temperature and are mostly found in plant sources. They include vegetable oils, olives, avocados, nuts and peanut butter.

Fat is an important food because it provides double the amount of energy as the same quantity of carbohydrates or proteins. Small amounts of fat are needed in our body. Our bodies store fat in various parts of the body including the skin. A

layer of fat is deposited in many organs in our bodies to protect them. However, when we eat more fat than our bodies require and store too much excess fat, we can become overweight or obese. Obesity is a serious problem that causes heart and circulatory problems. A diet high in saturated fats and **cholesterol** may cause heart diseases.

Now that we discussed macro-nutrients, let's look at micro-nutrients and their role for the body.

Micro-nutrients

Micro-nutrients do not contain calories and are required in small amounts in the body and they protect the body against diseases. **Vitamins and minerals are micro-nutrients.** They support good health e.g., zinc enables the body to use vitamin A to promote good vision.

Vitamins and trace minerals are labeled micronutrients because the body only requires them in very small amounts, whereas macronutrients are nutrients needed by the body in relatively large amounts. Vitamins are organic substances that we ingest with our food and that act as catalysts (substances that help to trigger other reactions in the body). Trace minerals are inorganic substances that, once ingested, play a role in a variety of metabolic processes.

Let us look at examples of minerals and vitamins.

1. Vitamins (Click here to view the video)

Vitamins are organic compounds essential to the body and are needed in small amounts. Vitamins play a vital role in the metabolic processes that convert carbohydrates, proteins and fat to energy. They activate enzymes which are proteins and act as catalysts to speed up biological reactions that take place in the body.

Vitamin A (retinol) is needed for normal growth, good eyesight and healthy skin. A lack of vitamin A causes **night blindness**, very dry skin and mucous membrane damage. Examples of food rich in Vitamin A are spinach, carrots and all yellow vegetables, eggs, milk, margarine, butter, animal liver and fish-liver oil.

Vitamin B

This group has different essential vitamins like vitamin B1, B12, etc. They play a part in the process by which our cells get energy needed for normal growth. A lack of vitamin B1 (thiamine) causes digestion problems called **beri-beri,** which is characterized by stunted growth and paralysis of the limbs. A lack of vitamin B2 (riboflavin) causes sores, skin problems such as **dermatitis** and **weak muscles.** A lack of niacin (also in the B-vitamin group) causes a deficiency disease called **pellagra**, which is characterized by skin infections, abdominal pains and marks around the neck.

Examples of food rich in Vitamin B are milk, cheese, eggs, whole meal bread, liver, kidney, yeast extract, peanuts, pork, nuts, brown rice, green leafy vegetables, fish and meat.

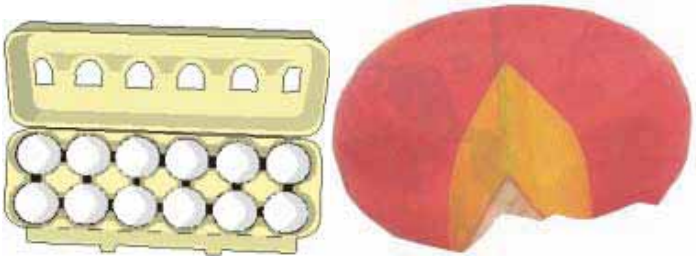


Diagram: Eggs and cheese

Vitamin C

Generally vitamin C is needed to help heal wounds, keep healthy gums and teeth and for collagen formation. A lack of vitamin C causes **anaemia** and **scurvy**. Scurvy causes weakness, bleeding gums, loose teeth, joint pains and slow healing of wounds. Vitamin C is found in many fresh fruits and vegetables, especially citrus fruits like oranges and lemons. Some other examples of food rich in Vitamin C are tomatoes, potatoes, strawberries, cauliflower, spinach and green leafy vegetables.

Some examples of food rich in vitamin C.

Diagram: Foods rich in vitamin C

Vitamin D ("sunshine vitamin")

Vitamin D helps to build strong, healthy bones and teeth because Vitamin D is required for calcium and phosphorus absorption. A lack of this vitamin in children causes **rickets**. This is a disease that causes growing bones to become soft and deformed. A lack of Vitamin D in adults causes *osteoporosis.* Examples of food rich in Vitamin D are eggs, fish-liver oil, white fish, butter, milk and cheese. The skin also makes its own vitamin D when it gets enough sunshine. In Namibia, we

do not have to suffer from a lack of vitamin D since we get it freely from the sun. However, too much exposure to sunlight is not good and may cause skin cancer.

Diagram: A child suffering from Rickets, demonstrating bowed legs.

2. Minerals (Click here to view the video)

Minerals are inorganic substances required in relatively small amounts to help our bodies work the best they can. Minerals can also be classified into two categories i.e, **major minerals** (including calcium, phosphorus, magnesium, sodium and potassium) and **trace minerals, which** include iron, zinc and iodine to mention just the important ones required by our bodies. We get minerals either by eating plants grown in mineral-rich soil or by eating animals that have fed on these plants.

Calcium and phosphorus

Calcium and phosphorus together with Vitamin D are needed for strong bones and teeth. They are also necessary for normal clotting of blood and working of the muscles. A lack of these minerals will cause weak and soft bones in growing children (rickets). Examples of food rich in calcium and phosphorus are fish, breast milk, eggs, cheese, butter and green vegetables.

Iron

Iron is needed to make a protein called haemoglobin in the red blood cells. Haemoglobin is the red pigment in the blood (the pigment that gives blood its red colour). It carries oxygen around the body. A lack of iron in food causes anaemia, which is a lack of red blood cells in the body. An anemic patient looks pale. Examples of food rich in iron are egg yolk, spinach, liver, kidney and red meat.

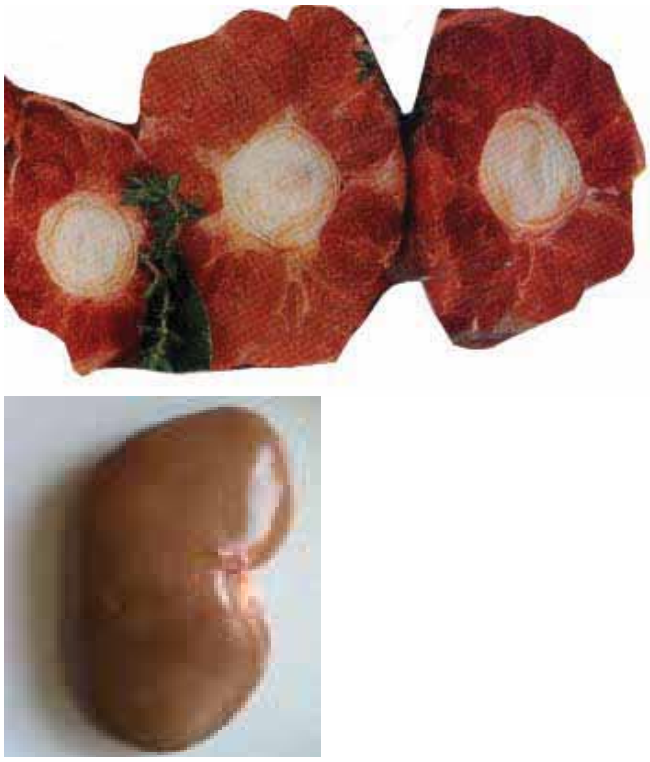


Diagram: Examples of red meats

Iodine

Bodies need iodine in very small amounts for the composition of the hormone thyroxin. A lack of iodine results in **goiter,** which is a swollen or enlarged thyroid gland as well as reduced growth. Iodine is needed in very small amounts and can be found in sea food and iodized salt. **N**ote that not all salt is a source of iodine, just iodized salt. When you buy groceries, buy iodized salt to protect against goitre.

Diagram: A goiter patient

The table below shows different nutrients, rich sources and their deficiency disorder

Nutrient	Rich source	Deficiency disorder
Iron	Liver/ spinach	Anaemia
Iodine	Table salt/ Sea Food	Goitre
Calcium	Milk/Green vegetables	Rickets
Vitamin A	Carrots/Pumpkin	Night blindness
Vitamin B	Whole grain/ cereals/Beans	Beri-beri/ Pellagra
Vitamin C	Oranges/Green vegetables	Scurvy
Vitamin D	Fish liver oil/Sunlight energy	Rickets
Protein	Fish/Beans	Kwashiorkor
Carbohydrates	Potatoes/Rice	Marasmus

Organic and Inorganic Nutrients

Inorganic nutrients are of mineral origin whereas organic nutrients are usually of animal or plant origin. Let us look at how we distinguish between organic and inorganic substances to get a better understanding.

Organic and inorganic substances

Inorganic substances are substances, which do not contain carbon whereas organic compounds refer to substances derived from living organisms and thus contain carbon in their structure. Materials such as sand, salt, iron, calcium salts and other mineral materials are inorganic. An inorganic compound is a chemical compound that is not an organic compound. Inorganic compounds come principally from mineral sources of non-biological origin. The modern definition of inorganic compounds often includes all metal-containing compounds, even those found in living systems. Although most carbon compounds are classed as organic, cyanide salts, carbon oxides and carbonates are usually considered to be inorganic.

Water

Drinking enough water is another very important part of nutrition. Water is an inorganic substance essential for all living organisms. We can live for days without food, but not without water. This is because:

- Our body cells contain water and it is the medium in which most substances are dissolved.
- Water is needed in the body as a transport medium for digested food, salts and vitamins in the blood.
- Water acts as a solvent to remove excess salts and *urea* from the body in solutions by the kidneys.

We take in water by drinking water, tea or any other liquid and eating food rich in water. If you do not drink enough water, your body will *dehydrate*. In tropical

climates, at least 3-4 liters of water are needed per day to make up for the water lost through urine and perspiration.

It is again time for checking your progress. Do the following activity in your notebook. Do not forget that feedback is provided at the end of the unit.

Activity 2

1. The table below provides information about some nutrients found in four different food types.

Food type per 100g portion	Protein (g)	Fibre (g)	Vitamin C (mg)	Calcium (mg)
Wholegrain maize	9,3	11,0	3,0	12,0
Milk	3,8	0,0	1,0	143,0
Potatoes	1,7	3,7	21.0	13,0
Liver	20,0	0,0	30,0	10,0

a. Give two types of food from the table that contain no fibre.

b. State the main function calcium in the body.

c. State the name of the nutritional disease that is caused by the lack of:

i) Protein: _____

ii) Vitamin C: _____

iii) Calcium: _____

d. Identify any macronutrient from the table.

2. Outline the role of iron in the body.

3. Name two elements found in proteins that are not found in carbohydrates.

For feedback, click on the icon. 

A balanced diet

Not only people who want to lose weight are on a diet. All people are on a diet, because we eat every day. **Diet** means the food we eat each day. Not all people eat the same food because people have different preferences. Cultures and traditions also influence our eating habits. When you look at the region where you come from, the food you eat is different from the food people eat in other regions. What people eat depends on the income of a family and availability of food in that specific region. Another factor is that we like to eat certain food and others we do not like.

Food that is a good source of one nutrient may completely lack another nutrient. Therefore, we have to eat a variety of foods in order to get all the essential substances or nutrients. When the food we eat provides our bodies with the proteins, carbohydrates, fats, vitamins, roughage, minerals and water that we need in the right quantities, then we have a **balanced diet**.

All these nutrients must be included in our diet in order to have a balanced diet. Now you know what nutrients are, where to find them and how to prepare a balanced diet. Another question that we have to answer is, "How much should we eat?"

Different energy requirements
The amount of food you need depends on the energy you use in a day. This depends on your age, the type of work you do and your gender.

Age
Think about this: between yourself and your younger brother or sister (a baby or a teenager), who will need more food? Can you think of a reason for this? Yes, teenagers need more energy than babies because they are more active than babies (and adults). Growing children need more proteins than adults.

Growing children need more protein than adults

Boys need more carbohydrates than girls and babies because they use more energy.

Diagram: Photos of children

Work
The type of work you do also matters. A person working on a farm uses more energy than a person working in an office. Why? An athlete uses more energy than a bank manager. Why?

It is because the person working in an office sits most of the time but an athlete and a person working on a farm are active most of the time. The more active you are the more energy you use and the more energy giving food you need to replace the used energy.

People who work in offices use less energy than people who work on land/ farms and therefore need fewer carbohydrates.

Diagram: Office worker

Gender

Research has shown that males use more energy than females of the same age even when they do the same job or perform the same activity because males have more muscles than females. More muscle uses more energy so males need more energy to use their muscles compared to females of the same age doing the same job.

Males use more energy than females of the same age.

Diagram: Picture of boy and girl

Problems related to not eating the right amount of food

Our bodies need the right mix of nutrients to work their best, so when a person does not have a balanced diet they may experience health problems such as malnutrition or over-nutrition.

Malnutrition means that certain nutrients are either lacking or are in excess in a diet. Malnutrition causes many illnesses among infants, young children, pregnant women and breast-feeding women. We can talk of under-nutrition and over-nutrition. ***Over-nutrition*** *(when nutrients are in excess in our diet)* causes problems like obesity that may lead to heart disorders and bulimia. Bulimia occurs when a person eats a large amount of food, but in private he or she deliberately vomits it out. This causes him or her to have a loss of appetite.

There are many great sources that provide health information related to nutrition. Here is one example:

http://www.livestrong.com/importance-of-eating-healthy/

Under-nutrition (when some nutrients lack in our diet) causes deficiency diseases like kwashiorkor, anaemia, anorexia nervosa etc. Anorexia occurs when a person starves herself or himself.

Food composition and food labels

We need to lead healthy lifestyles. You now know what types of food to eat in order to have a balanced diet. When we plan our meals, we should consider the table below and choose the right food for every meal in order to prepare a balanced meal. Finally, we will look at how to read food tables and food labels. Say for instance, you bought a tin of fish. You can read from the label on the tin the ingredients used as well as nutrients contained by these ingredients.

When you buy canned food or any other processed food, it is necessary to read on the labels what the food is made from. Labels tell us about the composition of the food including the nutrients present in the specific food as well as the recommended daily requirements (RDR), and whether the food contains additives like colourings and flavourings.

The following table shows the nutritional value for a variety of foods that are available in Namibia.

Food: Units of 100 g (edible portions)	Water Ml	Energy kJ	Protein G	Fat G	Carbo-hydrates	Ca Mg	Iron mg	A mg	B mg	C mg
Stable foods										
Maize	11	1 508	9,3	4,4	73,7	12,0	3,8	41,0	2,24	3
Millet	12	1 432	10,4	4,0	71,6	22,0	20,7	-	2,20	3
Rice	12	1 529	7,0	0,6	79,8	6,0	2,4	-	5,60	-
Sweet potato	69	508	1,6	0,2	28,5	33,0	2,0	75,0	0,83	37
Potato	78	344	1,7	0,1	18,9	13,0	1,1	25,0	1,40	21
Wheat flour	12	1 474	10,5	2,0	74,7	36,0	3,6	-	3,25	-
Vegetables										
Groundnut	45	1 394	15,0	25,0	12,0	30,0	1,5	-	10,60	10
Carrot	89	168	0,9	0,1	9,6	35,0	0,7	5 480,0	0,68	8
Tomato	94	88	1,0	0,2	4,8	10,0	0,6	450,0	0,70	26
Green bean	70	437	7,0	-	19,0	40,0	2,0	90,0	1,95	25
Green pepper	86	202	2,0	0,8	10,0	29,0	2,6	180,0	2,47	140
Beetroot	87	189	1,8	0,1	10,0	24,0	0,8	-	0,35	3
Fruit										
Apple	34	244	0,2	0,4	15,1	3,0	0,2	80,0	0,26	1
Banana	77	370	1,5	0,1	20,6	9,0	1,4	120,0	6,06	9
Orange	86	206	0,8	0,3	12,3	38,0	1,1	230,0	0,33	46
Guava	82	269	1,1	0,4	15,7	24,0	1,3	290,0	1,40	326
Watermelon	94	97	0,4	-	5,0	5,0	0,3	18,0	0,24	5
Papaya	91	134	0,4	0,1	8,3	21,0	0,6	950,0	0,46	52
Animal products										
Fish	75	500	21,6	3,0	-	32,0	1,7	-	2,93	-
Beef	63	995	18,2	17,7	-	11,0	3,6	-	4,72	-
Goat	73	609	16,0	9,0	-	11,0	2,5	-	5,55	-
Pork	46	1 756	12,4	40,5	-	11,0	1,8	-	3,65	-
Poultry	73	584	19,0	7,0	-	15,0	1,5	-	9,25	-
Liver	70	571	20,0	4,0	5,0	10,0	10,0	6 600,0	15,80	30
Egg	77	588	11,8	9,6	0,6	45,0	2,6	650,0	0,77	-
Butter	15	3713	0,5	83,0	0,6	15,0	-	695,0	0,42	-
Cow milk	85	332	3,8	4,8	5,4	143,0	0,2	175,0	0,44	1
Human milk	87	281	1,1	3,1	9,1	30,0	0,2	61,0	0,26	4
Goat milk	84	357	3,4	4,9	7,0	130,0	0,1	77,0	0,45	1

Diagram: Table of nutritional value of foods common to Nimibia

Rusk is common in Namibia, but is not included in the table. Nutrition information for rusk is below.

Rusk *(Nutritional information per 100 g)*
Energy - 1690 kJ
Protein - 8, 4 g
Carbohydrates - 64, 5 g

Fat - 14, 0 g
Sodium - 598, 0 mg
The measurement is given per 100 g only. The rusk consists only of these nutrients and does not provide a balanced diet alone. If you decide to eat it for supper, you have to include a fruit/vegetable to provide you with minerals and vitamins.

Check your progress by doing the following activities in your notebook.

Activity 3

Title: Investigation and analysis of personal diet

Procedure

1. With your family, list the types of food each member has been eating for the past 5 days.

2. Estimate the nutritional composition and value of each food.

3. Tabulate your results as illustrated below.

Food type	Main nutrient present	Importance to the body

4. Identify nutrients missing in the diets of each member that would make the person's diet more balanced.

5. State any improvements each member can make to his/her diet in order to achieve a balanced diet.

 Practical Activity	**Title: Testing for starch in a food sample (Iodine test)** a. Take two test tubes labels them A and B respectively. b. In test tube A, add starch suspension up to three-quarter full. c. In test tube B, add starch suspension up to three-quarter full. d. Using a dropper, add three drops of iodine solution to each of the test tubes A and B. Observe colour changes and answer the questions below. e. Try tests 2 and 3 using Mahangu meal. **Questions** a) State the original colour of iodine solution. b) State the colour change of iodine solution when added to test tube A and to test tube B. c) Using results from tests indicated in step 5 (above), state the type of nutrient found in Mahangu meal. d) Make a conclusion from your observations.

Now, do the unit assignment. Remember, the feedback is provided at the end of the unit.

Assignment 1

1 .Name the vitamin and a mineral which help harden bones and teeth.

2. One hundred grams of boiled potato will provide 340kJ but 100 grams of potato chips provide 900kJ. Why do you think there is such a big difference?

3. Why should a high fibre diet help prevent you from putting on weight?

4. The table shows recommended amounts of four nutrients for seven different people. You can see that these vary with age and sex.

Person	Protein G	Vitamin mg	Iron mg	Calcium Mg
1 year old	30	20	7	600
6 year old	43	20	10	600
14 year old boy	66	25	12	700
14 year old girl	53	25	13	700
30 year old man	70	30	10	500
30 year old woman	55	30	12	500
pregnant woman	60	60	14	1200

4. Answer the following questions using the information in the table.

a. Why would a 14 year old boy need more protein in his diet than a 30 year old woman?

b. Why would a pregnant woman need more calcium in her diet than a woman who is not pregnant?

c. Why would a 30 year old woman needs more iron in her diet than a 30 year old man?

Complete the following multiple choice question

5. Which of the following correctly list the types of nutrients required by the body?

a. meat, fish, milk, cooking oil, bread

b. proteins, fats, carbohydrates, minerals, vitamins

c. proteins, fats, carbohydrates, water, fibres

d. maize meal, beef, eggs, oranges, beetroot

	To check feedback, click on the icon 

Before we conclude this unit, let's summarize what we have learned.

Unit summary

 Summary	In this unit you learned that: • nutrition means eating the right food to keep us healthy and to keep our cells growing. • we need food for growth, repair and energy and to stay healthy. • the energy value of food is measured in calories or kilojoules (kJ). • the seven nutrients are carbohydrates, proteins, fats and oils, minerals, vitamins, roughage and water. • carbohydrates provide energy and contain the elements carbon, hydrogen and oxygen. • the different types of carbohydrates are sugar, starch and cellulose. • proteins are responsible for growth and repair of damaged tissues and contain the elements carbon, hydrogen, oxygen and nitrogen. • proteins are made up of long chains of simpler units called amino acids. • fats and oils provide the largest amount of energy. • fats contain the elements carbon, hydrogen and oxygen. • vitamins and minerals help us to keep our bodies healthy. • a balanced diet is a diet that contains food made up by the six essential nutrients covered.

The tutor-based assessment will follow.

Assessment

Assessment

Answer all the questions in the spaces provided.

Multiple choice questions

1. The best reason for including protein foods in a diet is that they

A. are the best source of energy.
B. contain amino acids for cell growth.
C. contain important vitamins.
D. prevent constipation and colon cancer.

Answer……..

2. Which person requires the most energy daily?

A. a female, 35 years of age, working as a nurse.
B. a female, 50 years of age, working as a bank clerk.
C. a male, 35 years of age, working as a miner.
D. a male, 50 years of age, working as a bank clerk.

Answer……

3. Which of the following should be given to a child who suffers from scurvy?

A. antibiotics
B. iron tonic
C. orange juice
D. raw carrots

Answer……

4. The most proteins are found in

A. butter
B. maize
C. peanuts
D. spinach

Answer……

5. Which vitamin is a child suffering from rickets lacking in her diet?

A. vitamin A
B. vitamin B
C. vitamin C
D. vitamin D

Total [5]

Structured questions

1. List the main categories of nutrients.

……
……
……
……
……
……(5)

2. Differentiate between macro- and micronutrients and give examples of each nutrient.

.....

.....

..... (2)

3. State the difference between an organic and an inorganic nutrient.

.....

.....

.....

.....

.....(2)

4. List three major monosaccharides

.....

.....

.....

.....

.....

.....(3)

5. Describe the role of water for maintaining good health.

.....

.....

.....

.....

.....(3)

6. List functions of protein.

.....

.....

.....

.....

.....
.....(3)

7. Briefly explain the role of fibre in your diet.

.....
.....
.....
.....
.....
.....(2)

8. Name two general categories of fats based on their chemical structure.

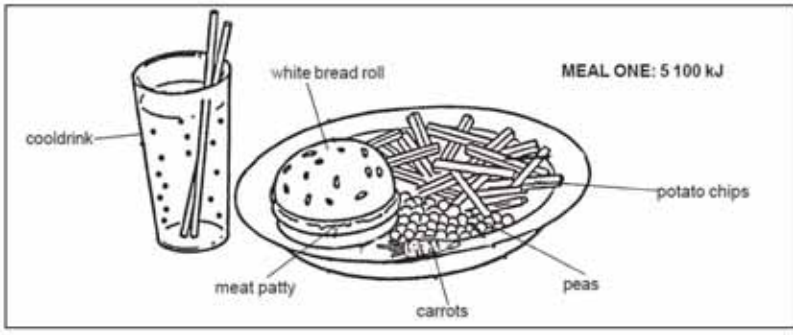
.....
.....(2)

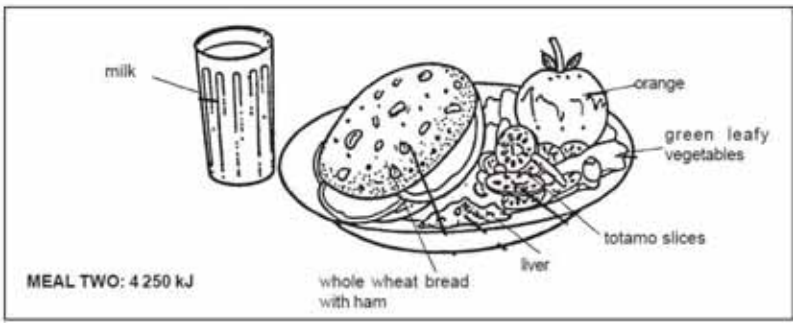
9. Complete the table below about the functions, sources and deficiency diseases of nutrients.

Food substances and nutrients	**Food source**	**Function(s)**	**Deficiency may cause**
1.....	fish-liver oil	2.....	rickets
Vitamin B	3.....	responsible for healthy skin and eyes	beri-beri, digestive problems

(3)

10. The diagram shows two meals that contain various food substances. Answer the following questions.





(a) Calculate the total energy content of the two meals.

.....(2)

(b) A person working in a mine needs approximately 17 000 kJ a day. How much energy will this person still need after eating both meals? (Show your calculation).

.....

.....(2)

(c) Name one source of calcium from meal two.

.....(1)

(d) List two sources of carbohydrates from meal one that could supply more energy.

.....

.....(2)

(e) List one food type from meal one that supplies Vitamin A.

.....(1)

(f) Which of the meals will be better in preventing scurvy? Justify your answer.

.....

.....(2)

(g) What is the difference between anorexia and obesity?

.....

.....

.....

.....(2)

(h) Define the term malnutrition.

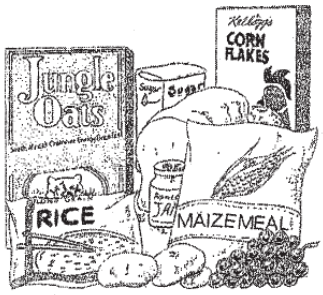
.....

.....

.....(2)

11. Study the examples of different food types

A



B

(a) Identify the nutrients present in each group of food types A and B.

A.....

B.....(2)

(b) (i) Give one function of nutrient A.

.....(1)

(ii) Name the disease caused by a lack of nutrient A in your diet.

	.....(1) (iii) Explain why a fourteen-year-old boy needs more energy than an old man ....(2) **Total (50)**

Feedback

Feedback **Activity 1**	1. carbon, hydrogen and oxygen 2. simple, complex and dietary fibre 3. regulate bowel movement 4. marasmus To go back, click here.

 **Feedback** **Activity 2**	1. a). Milk, liver b). For strong bones and teeth, clotting of blood c). i) kwashiorkor ii) scurvy iii) rickets d) protein, fibre 2. to make the red pigment (haemoglobin) that carry oxygen around the body 3. nitrogen, sulphur To go back, click here.

 **Feedback** **Assignment 1**	1. Vitamin- vitamin D Mineral- calcium 2. Chips contain fats and fats have twice the amount of energy as carbohydrates 3. Mostly fibre contains cellulose and human beings are unable to digest cellulose. Therefore, fibre will not have any energy value. 4. (a) A 15 year old boy needs to grow more than the woman (b) A pregnant woman needs calcium for her unborn baby (c) A woman needs more iron because women lose blood during their monthly periods. 5. (b) To go back, click here.

Optional Multimedia resources

CD – ROM Resources

1. Video clip – types of carbohydrates

2. Video clip – proteins and fats

3. Video clip – vitamins

4. Video clip - minerals

The next unit will explore the classification of living organisms.

Unit 4

Classification of Living Organisms

Introduction

Welcome to Classification of Living Organisms. Think for a bit about the following question: When you organise your room, kitchen or house, do you put your clothes, stationery and shoes in one drawer?

To understand and organize living organisms, scientists use biological classification to group them according to how closely-related people believe the organisms to be. This is called **phylogenetic classification**. Carl Linnaeus, a Swedish naturalist, was the first to try this kind of scientific classification in 1735. Let us find out how scientists go about classifying organisms into particular species. Can you list all the living organisms in your environment and put them in groups

What is in this unit?

This unit consists of two topics:

Topic 1: Taxonomy and major levels of classification

Topic 2: Types of cells

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: ▪ define taxonomy and list the major levels of classification. ▪ discuss the importance of classifying organisms. ▪ outline and identify the principles used to classify organisms. ▪ define the binomial system as a system using a two word Latin name (genus and species) to identify a specific type of organism (notice that the genus name is capitalised and the species name is never capitalised). ▪ relate a **cladogram** to a branching diagram showing relationships among **taxa**. ▪ state the three domains of a cladogram. ▪ outline the process of evolution and discuss the relationship between classification and evolution. ▪ suggest how to use a **dichotomous key.** ▪ describe cell theory. ▪ list various structures of a eukaryotic cell (cell membrane, mitochondria, nucleus, vacuoles, cell wall and chloroplast) and describe their functions, ▪ compare eukaryotic and prokaryotic cells (plants, animals and bacteria). ▪ differentiate between unicellular and multicellular organisms. ▪ describe the structure of a plasma membrane and relate the structure to its various functions (no reference to fluid mosaic model). ▪ discuss the significance of cell processes for an organism (include osmosis, diffusion).
 **Study Time**	You need to spend about 12 hours on this unit. Don't worry if it takes you longer. We all learn at a different pace. The important thing is to achieve the set objectives.

 **Terminology**	**branch**	defines the relationship between the taxa in terms of decent
	branch length	represents the number of changes that have occurred in a branch
	clade	an organisational term used in cladistics to describe a

		group of related organisms being compared
	cladistics	a branch of biology that determines the evolutionary relationships between organisms based on their evolutionary history
	root	the common ancestor of all taxa
	systematics	the study of the diversity of life and the relationships between organisms
	taxa	groups or representatives of related organisms that are being compare; they can vary on hierarchical level (such as genus, family, order and so on)
	taxonomy	the science of classifying organisms (describing, naming and categorising organisms)

Taxonomy and major levels of classification

There are millions of organisms on earth, and there would be a mess if they were left unidentified and unorganized. To organize organisms so they are easier to study and understand, there is a branch of biology that deals with the identification of organisms known as **taxonomy**. **Taxonomy** is the science of naming and classifying living organisms.

Scientist Carl Linnaeus was the first to classify organisms based on their natural relationships, observable features or similarities. Scientists look at external features and put organisms with similar features in groups. To classify organisms, scientists begin with general features and determine a major level of classification, then look more closely at specific features that distinguish between organisms. Classification done from the highest level to the smallest level creates a kind of multi-level grouping that is called **a hierarchy** or **hierarchal system of classification.**

Why is it important to classify organisms?

- To keep track of all organisms.
- To recognise new organisms upon discovery.
- You are able to identify organisms and see into which group it fits.
- You can communicate about organisms, since it is either new or known
- To sort organisms into order
- To get information about organisms 'evolutionary relationships.
- An organism has the same scientific name which can be used everywhere in the world.

Now, look at the hierarchical system of classification or what is referred to as the major level of classification:

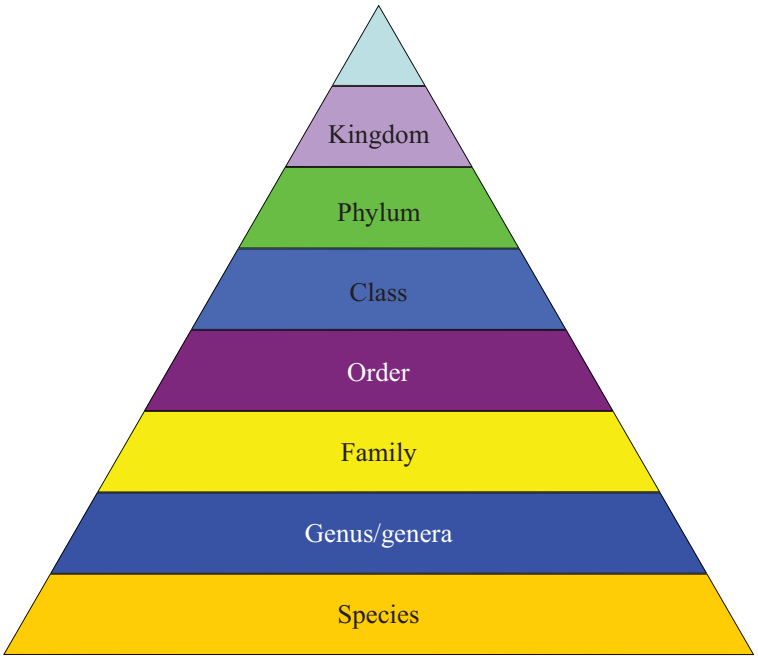


Diagram: Major levels of classification

The major levels of classification follows a sequence, starting with the largest group which is **kingdom** to the smallest which is **species** or smallest to the largest group. The acronym in the table below will help you to remember the levels. In 4 minutes you know it all; you can even recite it as a poem. Click here to view slides about levels of classification.

Study skills	Kingdom = King (the most) Phylum = Philip Class = Came Order = Over Family = For Genus = Ginger Species = Snacks (one)

Well, let us proceed to the next diagram that shows us how organisms have been sorted into some order and identified according to their similar structures.

Let us look at how living organisms are classified.

There are two types of classification

Classification can be based on two different principles, namely, **natural** and **artificial**. Let us look at natural classification first:

1. Natural classification

The diagram on how organisms are classified you saw above is based on a natural classification system that use common features shared by organisms. Natural classification is based on two ideas:

- Evolutionary relationships
- Homologous structures

Evolutionary relationships

If you look at your own family or neighbouring family who share common ancestors such as parents, grandparents or great grandparents, you often see startling similarities in appearance. They are obviously related to each other and have inherited some features from their ancestors.

In a natural classification, biologists group together organisms that are structurally similar and share common ancestors. Natural classification produces a branching set of relationship as shown in Fig 2. Look at the plant kingdom for example; all plants are divided into five phyla (ferns, mosses, bryophytes, algae and flowering plants). Flowering plants can be divided into two classes' i.e., monocotyledonous and dicotyledonous. All plants show common ancestors.

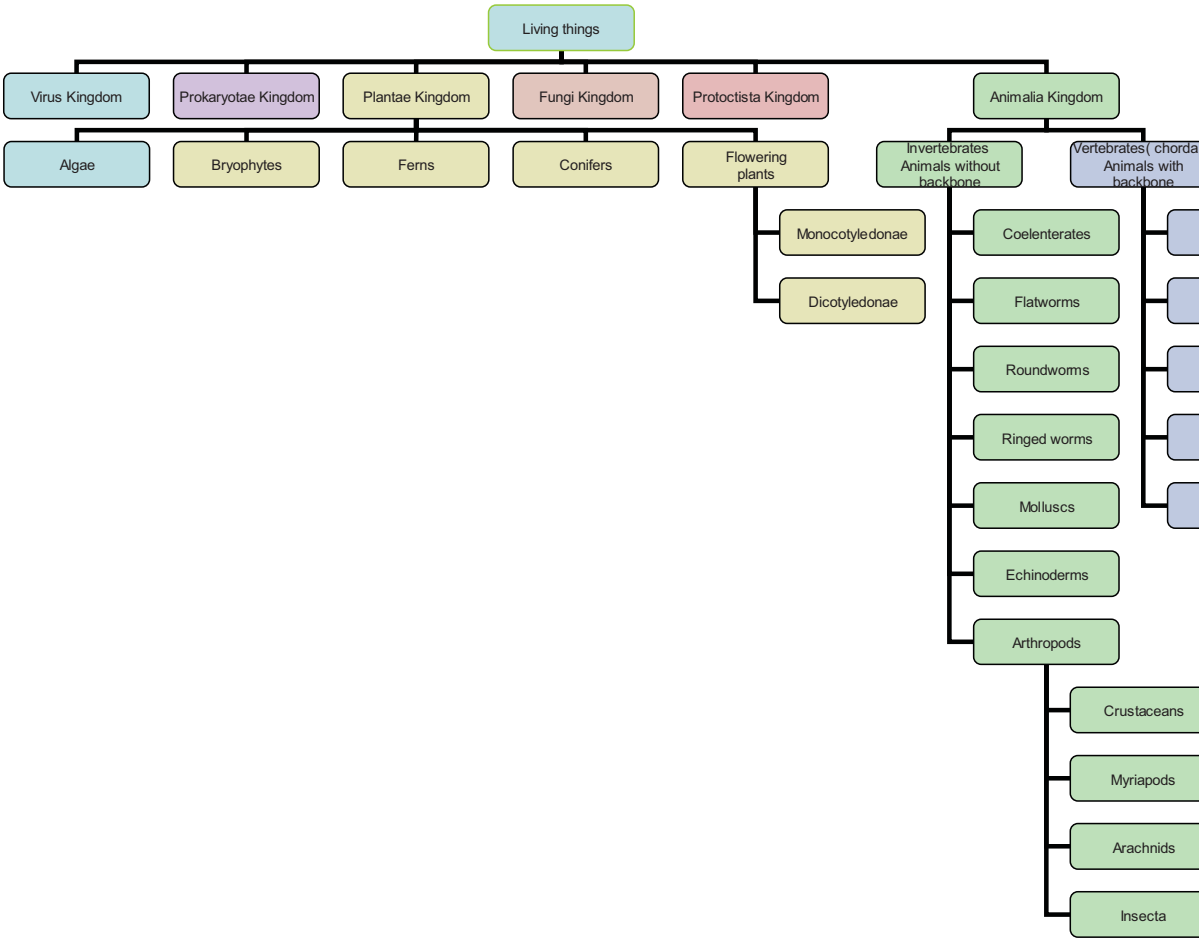


Fig 2: Natural Classification

Homologous structures

Homologous structures are physical characteristics of organisms that are similar although they may look different from each other and may be used for different purposes. Homologous structures develop differently to suit a specific purpose for an organism, but they come from similar origins.

For examples, look at the diagrams below of a horse's front leg, a human arm and a bat's wing. Notice that they have similar components and structure even though they look very different and are used for different purposes. A horse's front leg is used for walking, a human arm for grasping/holding/carrying things and a bat's wing for flying.

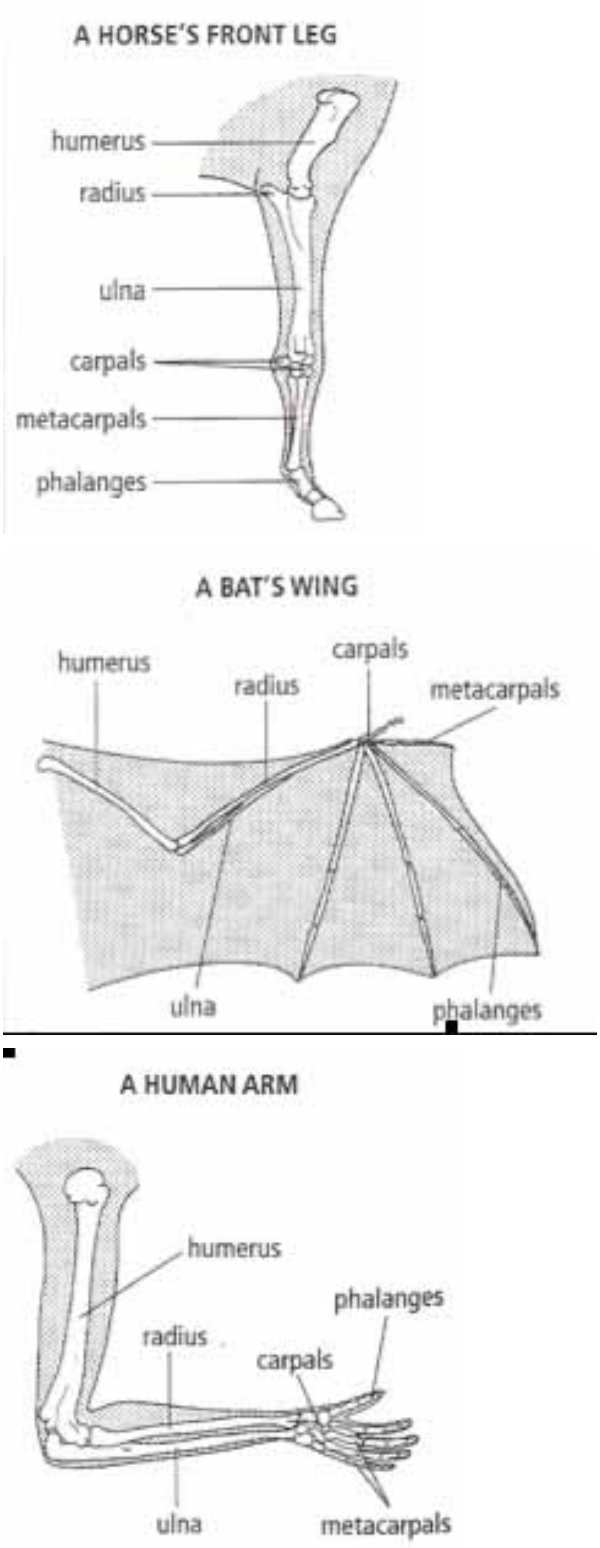


Diagram: Variety of animal limbs

In another instance, you may find organisms that have different components and structures but use them for the same function. For example, a wing of an insect – such as a wasp, house fly, grasshopper or mosquito – are made of different parts than a bats wing but all wings help these creatures fly. These are called **analogous structures**. They have different structures but use them for the same purpose: flying. A grasshopper's wing is not homologous with a bat's wing because they develop from a completely different origin.

Let us move on to the second type of classification: artificial classification.

2. Artificial Classification

With this type of classification, scientists classify organisms on the basis of similarity of appearance, instead of common ancestry. For example, they put all organisms that can swim in one group and organisms that lay eggs in another group. Try to come up with your own grouping. Which organisms can you put in one group according to artificial classification?

Artificial classification is also used as a basis for **dichotomous keys** that biologists use to identify organisms.

Dichotomous keys

A dichotomous key is one of the strategies artificial classification biologists use to identify organisms. It is a key a series of yes-or-no questions with two pairs of description about features you can see and you have to choose the one that applies. The key will tell you which descriptions to go to next. This process repeats itself until you eventually arrive at the identity of unknown organisms. Below is an example of a dichotomous key.

Look at Figure 3 and follow the instructions on how to use dichotomous keys.

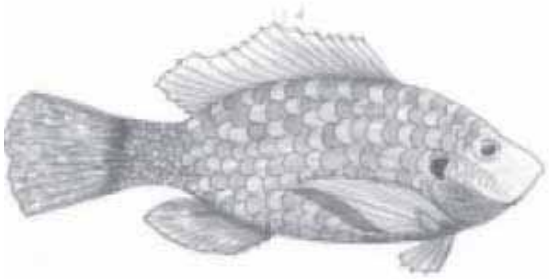


Figure 3:

Use the simple key below to identify if the organism is:

A. mammal **B.** bird **C.** reptile

D. fish **E.** amphibian

First, ask yourself question 1a.

1 a	is the body covered with feathers?	If yes, go to 2
b	is the body covered with scales?	If yes, go to 3

If the answer to 1a is No go to 1b.

If the answer to 1b is Yes go to 3.

In this case, the answer to 1a is No but to 1b is Yes – **so go to question 3.**

2 a	has a beak?	Animal **B**
b	has smooth skin?	Animal **E**

Ask yourself question 3a. If the answer is Yes the animal is animal D. If the answer is No read question 3b.

3 a	it has fins?	Animal **D**
b	fins absent	Animal **C**

In this case, the answer to question 3a is Yes; therefore the organism in Figure 3 is animal **D. This is the correct answer.**

As you can see, using the dichotomous key is quite easy. The keys scientists use to identify species have much more detail but they are used in the same way. In an assessment, you may be presented with a detailed key to work through. Do not be put off because the 'key' looks difficult. Any unfamiliar words will be explained and if you work your way through the key, you will be surprised how straight-forward it is.

A possible task in an assessment is to be given diagrams of several organisms or with pairs of descriptions to identify. Try to identify the next animal in Activity 1 below. Do not forget to compare your answers with mine at the end of the unit.

Activity 1

Animal Identification:

Use the simple key below to identify if the animal is:

A. mammal **B.** bird **C.** reptile
D. fish **E.** amphibian

1 a is the body covered with feathers? If yes, go to 2
b is the body covered with scales? If yes, go to 3

2 a has a beak therefore it is: Animal **B**
b has smooth skin, therefore it is: Animal **E**

3 a it has fins, therefore it is: Animal **D**
b fins absent, therefore it is: Animal **C**

What animal did you identify?

_____

Click on the icon for feedback.

If you found this activity difficult, re-read the description of a dichotomous key and practice the activity until you understand.

Now we are moving on to discuss the scientific names of organisms. You may remember from when we discuss the major levels of classification that the last two groups mentioned are **genus** and **species**. Every organism has been given a

scientific name that comprises of the genus and species. This system is called the binomial system. Let's learn more about it.

The binomial system of nomenclature

The binomial system is a system whereby each species has a two-part Latin name to identify it, which is referred to as the organism's scientific name. For example, the scientific name of the African elephant is *Loxodonta africana.* The first part of the binomial name in this case is (*Loxodonta*). This is the genus name and the first letter is capitalised. The second part of the binomial is the species name in this case *africana* and is written with a lower case letter. Scientific names are always in Latin and written in italics when typed or it is underlined when handwritten. This scientific name is recognized internationally by scientists and can be used all over the world in all countries and all languages.

Now do activity 2 to see how you are progressing.

Compare your answers with mine at the end of the unit.

 **Activity 2**	1. Explain what is meant by the term 'binomial' using *Culex pipiens* as an example. 2. Complete the following sentences: a) The…….name is written first and must always be written with a …….. letter. b) The …….. name is written second and should be written with a …… letter. Click on the icon for feedback.

Next we will look at the Cladistics.

A cladogram and domains

We will still be doing taxonomic study in this section and specifically focusing on a modern Systematics called 'Cladistics.' Systematics is the study of the diversity of organism characteristics. **Cladistics** is used to determine the evolutionary relationship between organisms based on their evolutionary history. It is a study of how organisms have evolved over a period of time and what features they share, and sometimes uses the protein sequence on the DNA of organisms to

determine their relatedness. **This section is comprehensive and you need to spend some time to get a proper understanding of a cladogram.**

A **cladogram** is a diagram of how organisms are related to each other (like a **genealogy).** Instead of showing the relationships between individuals, like a family tree, a cladogram shows how species or more inclusive groups of organisms are related to each other.

Cladistics is based on three principles:

- Groups of organisms are descended from a common ancestor.
- At each node there are two branching lines of descendants
- Evolution results in modifications of characteristics over time.

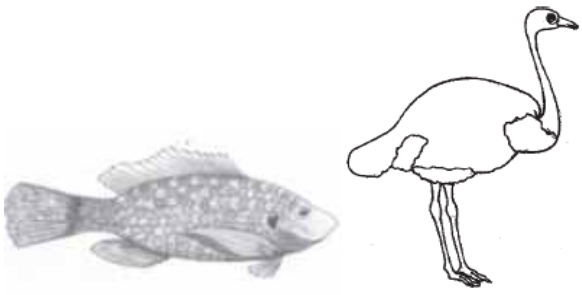
Organisms are placed in groups by common ancestry, based on the branching of the evolutionary family tree. Organisms that share common ancestors and therefore have similar features are grouped into taxonomic groups called clades. Animals are grouped together on a cladogram based on the presence of shared unique features. A unique feature is a characteristic of an animal that was not present in the animal's immediate ancestor.

First, let us look at how biologists do it:

Biologists developed a tree-like diagram to show the evolutionary relationship of organisms by following the steps below:

- They select a taxonomic group to be analysed, for example, a group of vertebrates or invertebrates.
- Next, they construct a table/Venn diagram of characters of the taxa being compared or used.
- Then, for each of the members of the group, they determine some observable traits (characters), and note their 'states' (a character state is one of two or more possible forms of that character).

Let us be practical and determine how related the following organisms are, keeping in mind the steps above. Could these animals be related to one another?



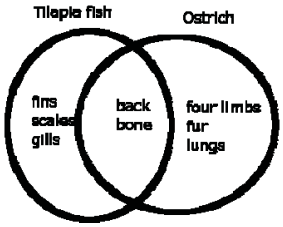
Tilapia fish

Ostrich

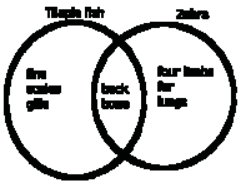
Zebra

Picture: Fish, Ostrich, Zebra

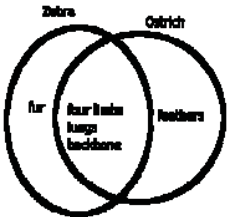
Now, Let us determine the features that are similar and different in the zebra, tilapia fish and ostrich. Look at the Venn diagrams.



Venn Diagram 1:



Venn Diagram 2:



Venn Diagram 3:

The first diagram compares the tilapia fish and the zebra, looking at features shared and features unique to a specific organism. The second diagram

compares the tilapia fish and ostrich. The only feature shared in the two diagrams is the backbone. It means fewer features are shared and these organisms are less related.

The third diagram compares the zebra and the ostrich. It is obvious from the Venn diagram that these animals share more special features and are more closely related.

With this background information we can now construct a cladogram to show that these animals share a common ancestor with a backbone and are thus related to one another. See diagram.

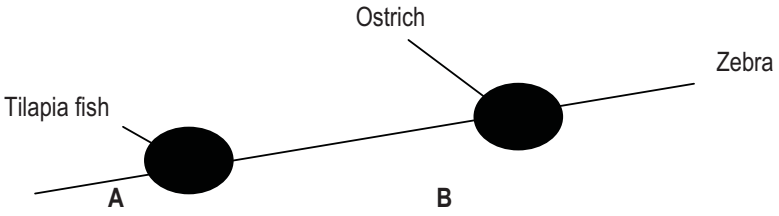


Diagram: Cladogram

This ancestor with a backbone is represented by the letter A (node) on the diagram. The zebra and ostrich are even more closely related because they also share an ancestor who had four limbs and lungs. This ancestor is represented by the letter B on the diagram. We can present the information on a different phylogenetic tree or cladogram. Let us look at the diagram of a cladogram below:

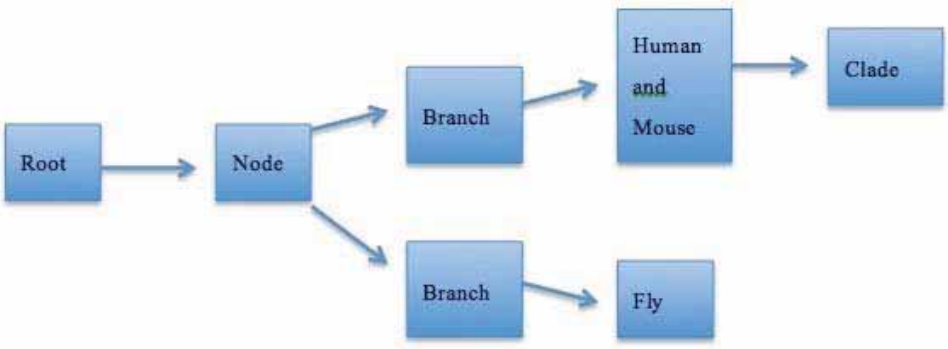


Diagram: Cladogram

In the cladogram, **nodes** are the places where branches are attached to each other and represent ancestors. This can either be an existing species or an ancestor. The **root** represents the common ancestor of all taxa and the **branch** defines the relationship between the taxa in terms of descent. The farther up the diagram the animals share an ancestor, the more closely they are related.

For example, two animals that share many unique characteristics, like a human and a mouse are more closely related than two animals that share fewer unique characteristics like a fly and a human or a mouse. The two taxa on either side of a split are called sister taxa or sister groups. Organisms in a clade display a series of characteristics that share a common ancestor, one which they do not share with any other organism on the diagram. See the example below:

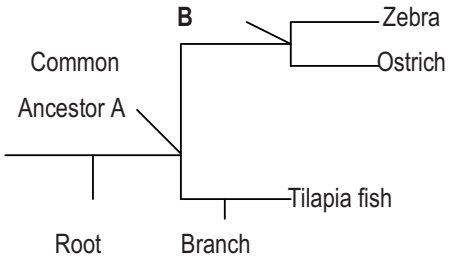


Diagram: Clade and sister clade

The zebra and the ostrich form a **clade** and the tilapia fish is the sister clade as they share a common ancestor with a backbone.

Let us further explore a cladogram.

Modern taxonomy has embarked on a system of comparing evolutionary relationships among different organisms based on evolution and molecular genetics to determine common ancestry. Organisms are divided into three domains in a cladogram: *Archae*, *Bacteria* and *Eukarya*.

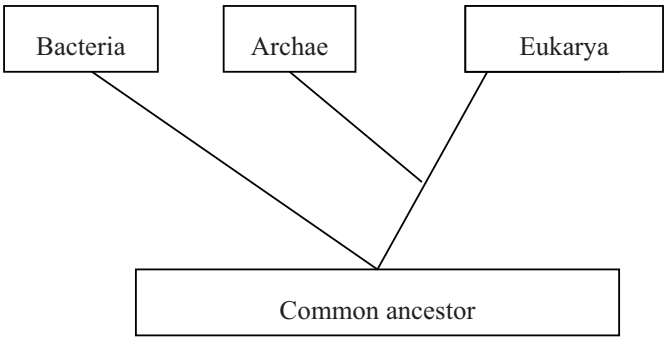


Diagram: Organism Domain Cladogram

Let us look at each domain:

The first domain is Archae - this includes the kingdom Archaebacteria and is composed of prokaryotes that lack muramic acid in their cell walls and live in harsh conditions like very salty lakes, intestines of mammals and hot, sulphur springs. Archaebacteria may be autotrophic or heterotrophic and are referred to as Ancient bacteria.

The second domain is Bacteria - this includes eubacteria, which are prokaryotes with muramic acid in their cell walls. Sometimes these are called the true bacteria and some of them cause diseases.

The third domain is Eukarya - this includes all eukaryotes, which are organisms composed of cells that have a nucleus and membrane-bound organelles. These include organisms from the other Kingdoms (Protista, Fungi, Plantae and Animalia).

Altogether, organisms are classified into 6 Kingdoms, which include Archaebacteria, Eubacteria, Protista, Plantae, Fungi and Animalia. These will be discussed the next section, Types of Cells.

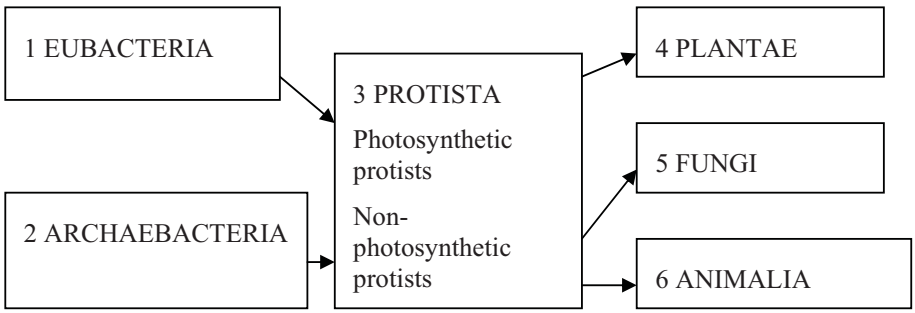


Diagram: Organisms of the 6 Kingdoms

Now that you have a clear understanding of the three domains, let us look at the process of evolution.

Evolution

Evolution is the gradual change of a species over a very long period of time. It is the process through which organisms descend from common ancestors. All organisms arise from existing organisms. Because of how genes have developed, new species have evolved over time. Although some orgranisms are only distantly related, most organisms are related by common descent. Charles Darwin first published this theory of evolution in 1859. At that time, scientists knew nothing about genes. Now, scientists have conducted much more research about the science of genes.

In taxonomy, classification and scientific names can be based on common evolutionary decent. When organisms are classified, the evolutionary histories of organisms are taken into account. Look at natural classification you have studied earlier to see the relationship between classification and evolution. Before you proceed to the next,section, go back and review the types of classification.

Now do the following assignment in your notebook. Remember that the feedback is provided at the end of the unit.

Assignment 1

1. Which scientific name of the mosquito is written correctly using the binomial system?

A. Culex Pipiens

B. Culex pipiens

C. Culex PIPIENS

D. Culex pipiens

2. A biologist discovered a new living cell with a strand of DNA but without a nucleus.

The cell is likely to be called…..

A. eukaryotic

B. prokaryotic

C. circular

D. linear

3. This type of classification is also used as a basis for dichotomous keys.

A. natural

B. artificial

C. evolution

D. identification

4. Natural classification is based on one of the following ideas.

A. analogous

B. monologous

C. homologous

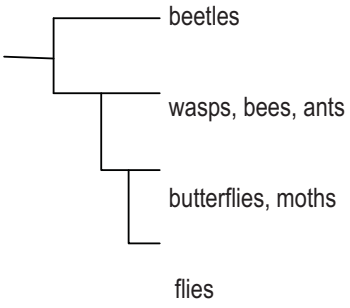
D. hetelogous

5. Define taxonomy.

6. Why are common names not good to use when classifying organisms/

7. What is Linnaeus' naming system called? What does it imply?

8. Look at the cladogram below that shows the relationship among various insects .Describe the relatedness of the organisms to one another as presented on the cladogram



9. Define the following terms

a) Cladistics

b) Taxa

c) Cladogram

d) systematics

For feedback, click on the icon.

The next topic will deal with types of cells.

Types of cells

Welcome to our sub-topic of cell theory and types of cells. Have you ever wondered where living things come from? All living organisms are made up of one or more cells which are the smallest parts of an organism that carry out all the characteristics of life. To create life, cells reproduce. Think of a human for example a sperm cell fusing with an egg cell or a plant, a male nucleus in a pollen grain fusing with an egg cell in the ovule. These are cells that grow and become specialized for different functions.

Inside some cells are structures called organelles that help the cell to carry out its functions. In some cells, organelles float in cytoplasm, which is a solution of proteins and other substances in water, but other cells do not contain membrane bound organelles.

What is a cell?

A cell is a basic unit from which living organisms are made. Some organisms, such as bacteria and many protocists, are made from just a single cell. These are known as **unicellular** organisms. Other organisms are made from many cells and these are called **multi-cellular** organisms – these include all plants and animals.

Most cells are very small and must be looked at through a microscope. However, some are big enough to be seen with the naked eye. Bacteria usually have particularly small cells, often around 0.5 µm across, so that you can only see them with a good light microscope. Human cells range between about 10 µm and 30 µm in diameter, while those of plants tend to be a little larger, with diameters from 10 µm and up. Some unusual cells can be enormous. For example, the yolk of a hen's egg is a single cell.

There are two basic types of cells. We will learn about them in a moment, but first let us look at the cell theory.

What is the cell theory?

Think for a moment how can you tell whether something is living or non-living? All living organisms must have 7 characteristics to qualify them as living things. They are as follows:

- Respiration
- Movement
- Reproduction
- Excretion
- Growth
- Nutrition
- Sensitivity

Clearly a car is not a living thing because it is not made up of cells and it does not reproduce. On the other hand a cat is a living thing because it has all characteristics of living things. A cell is the smallest structural unit of living matter capable of functioning independently and has all the characteristics of a living thing.

The cell theory is one of the unifying concepts in biology and life science and states that:

- All living organisms are made of cells. The cell is the basic unit of structure and function of living organisms. The cell is the building block of living organisms and all living organisms consists of cells and cell products.
- All chemical reactions of life (metabolism) take place within cells.
- The cell contains chromosomes that are used as instructions for growth, reproduction and functioning.
- Cells are formed from other cells by cell division (mitosis and meiosis).

Living organisms are made up of one or more cells and there are two types of cells, **the prokaryotes** and **eukaryotes.** Let's look at their structures as well as their functions.

Both prokaryotic and plant eukaryotic cells have a cell wall and a cell membrane. Each type of cell consists of structures that carry out important functions for the survival of an organism. These structures are called **organelles.** Organelles are small structures within the cells that perform specific functions. There are different types of organelles commonly found in eukaryotic cells.

Prokaryotic cells e.g. bacteria

Prokaryotic cells are surrounded by a cell wall containing peptidoglycans and other polysaccharides. This give them support and protection by stopping them from bursting and from being invaded by viruses. Prokaryotic cells are usually smaller, typically with volumes about 1000 or 10000 times less than eukaryotic cells. All bacteria, are single-celled (unicellular) organisms and are prokaryotic cells. They have no true nucleus. Figure 1 shows the structure of the bacteria.

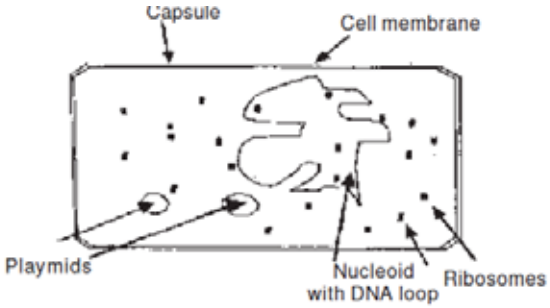


Diagram: Figure 1. Structure of Bacteria

Many bacteria are surrounded by a capsule made of polysaccharide, which absorbs water to form a slimy material and also protects the bacteria from attack by viruses and antibodies. They have a cell membrane made up of phospholipids bilayer in which protein molecules float. This membrane serves to keep the contents of the cell separate from its surroundings, but still allows substances to enter and leave in a controlled manner.

Cytoplasm of prokaryotics contains large numbers of ribosome, which are made of ribosomal RNA and protein and are the sites of protein synthesis.

The DNA of bacteria is a single, large, circular molecule. Prokaryotic DNA does not form chromosomes and there is no nuclear envelope in a prokaryotic cell. Therefore, the DNA lies freely in the cytoplasm. Prokaryotic cells do not have a cytoskeleton, which means they do not have microtubules or intermediate filaments supporting the structure of the cell. Some prokaryotic cells have a flagellum, which are little hair-like structures used for movement.

Eukaryotic cells

Plant, animal and fungal cells that do have a nucleus are eukaryotic cells. Eukaryotic cells are usually larger and more complex than prokaryotic cells.

The DNA of eukaryotic cells is linear and is usually made up of several molecules that form a chromosome. Chromosomes are complex structures involving proteins called histones as well as DNA. Eukaryotic cells contain membrane bound organelles such as mitochondria, rough and smooth endoplasmic reticulum (ER), etc. They have a plasma membrane, cytoplasm and cytoskeleton composed of microfilaments and microtubules that suspend organelles.

Of course, you find differences within eukaryotic cells structures as well as in their functions. Let's look types of eukaryotic cells and their characteristics in the table below:

Plant cells	**Animal cells**	**Fungal cell**
Cell walls made of cellulose	No cell walls	Cell walls made of chitin
Have chloroplasts	No chloroplasts	No chloroplasts
Nucleus not usually central	Central nucleus in cytoplasm	linear DNA
Thin lining of cytoplasm	Most of the cell is cytoplasm	The cytoplasm central
Vacuole filled with cell sap	No vacuole	vacuole

Well, you may want to ask how to distinguish between eukaryotes and prokaryotes. Look at the following table below.

Eukaryotes	Prokaryotes
True nucleus	Lack true nucleus
Membrane bound organelles present	No membrane bound organelles
Linear DNA	Circular DNA
Large numbers of ribosome	Small numbers of ribosome
Nucleus surrounded by nuclear envelope	No nuclear envelope, no nucleus

You can look at the diagrams below and see how a prokaryote cell differs from a eukaryote cell.

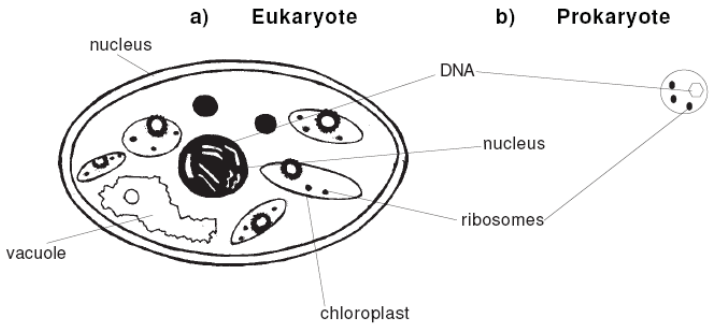


Diagram: Figure 4: Prokaryote and Eukayote Cell

By the end of this sub-topic, you should be able to label the structures of eukaryotic cells and give their functions. The diagram of a typical plant cell is shown below:

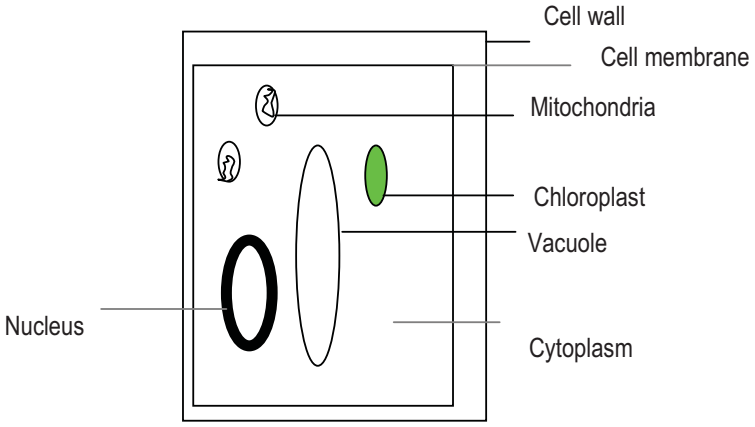


Diagram: Figure 5: Typical Plant Cell

The functions of cell organelles/structures of eukaryotic cells

- **Cell membrane** is made of phospholipids and protein. It is a thin membrane that surrounds the cell and controls movement in and out of cells, which means it is partially /selective permeable (e.g. parenchyma). It is present in all cells.
- **Cytoplasm** is a jelly-like liquid (colloidal solution) of mainly proteins in water and other substances inside the cell in which metabolic reactions take place. It is present in all cells. Every cell contains various organelles within its cytoplasm, but the types and numbers of these organelles differ from cell to cell.
- **Mitochondria** are very variable in size and shape with large ones up to 10 µm in length and several micrometers in diameter. Mitochondria can move around, divide, fuse and change shape. A mitochondrion has two membranes separated by an inter-membrane space. The outer is relatively smooth, but the inner membrane is folded to form projections called cristae. Between the cristae is a matrix that fills the rest of the space inside the mitochondria. The matrix also contains ribosomes and DNA that are used to make some of the mitochondria's proteins. The mitochondrion is a site of respiration - energy is released here. There are more mitochondria in animal cells than in plant cells, but they are present in all cells.
- **Vacuoles** are membrane-bound organelles that usually contain liquid. A vacuole stores sucrose and proteins, pigments and enzymes in plants and also provides support for plant cells. All cells have vacuoles, but plant cells have larger vacuoles that are permanent and usually occupy a position fairly nearer the centre than animal cells. The plant vacuole is surrounded by a membrane known as a **tonoplast**.
- **Cell wall** is situated outside the cell membrane in plant cells, but animal cells do not have cell walls. Plants cells are found in anything considered a plant (onions, tomatoes, etc.) The cell wall is made up of glycoprotein, several different polysaccharides and most importantly a material known as cellulose. The cell wall provides support, strength and shape to plant cells and prevents them from bursting. It is **fully permeable**, meaning all molecules can pass through. All plant cells are surrounded by a cell wall.
- **Nucleus** is a section of a cell that contains genetic materials (chromosomes) and DNA, which carry instructions for the cell.
- **Chloroplasts** are large organelles, often 10 µm in length, only present in plant cells. Inside chloroplasts are many tiny flattened sacs called thylakoids. A thylakoid membrane contains chlorophyll molecules that give the whole chloroplast and a leaf its green colour. Chloroplasts are the site of photosynthesis. They contain the chlorophyll that traps light energy for photosynthesis and converts light energy into chemical energy. The process of photosynthesis involves the plant cells taking carbon dioxide and solar energy and converting it into glucose and oxygen.

For an example of what a question about organelles may look like on the assessment, look at the diagram below.

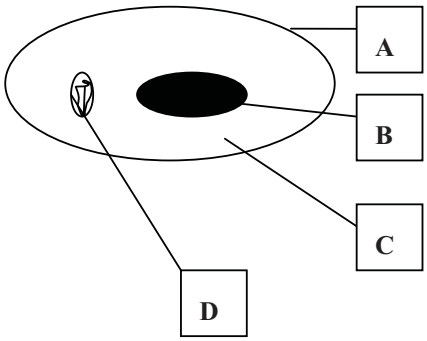


Figure 6: is a diagram of a typical animal cell with its organelles labelled.

A – Cell membrane

B – Nucleus

C – Cytoplasm

D – Mitochondria

Use figures 5 and 6 of a plant and animal cell to answer the following questions in Activity 3. Compare your answers with mine at the end of the unit.

Activity 3

1. Place a tick (√) in the appropriate box to indicate the presence of each organelle in the cell and a cross (x) to indicate the absence of that organelle.

	Plan cell	Animal c ll
Chloroplast		
Cell membrane		
Mito hondria		
Cytoplasm		

C ll wall		
Cytoplas		

For feedback click on the icon 

From Cells to Organisms

Now that you know what a cell is and what it is made from, let us look at how cells lead to the formation of an entire organism. This section covers the relationship between cells, tissues, organs, organ systems and organisms. Remember that all living organisms are made up of one or more cells and the **cell** is a structural and functional unit of all living organisms.

A group of similar cells working together to perform a particular function is called **tissue**. They include muscle tissue, epidermal tissue, nerve tissue etc.

Groups of tissues working together to perform a specific function are called **organs**. They include a heart, kidney, an eye of an animal, a leaf of a tree etc.

Groups of organs working together to perform a specific function are called **organ systems**. They include the digestive system, the skeletal system, etc.

A group of organ systems working together to perform a particular function is called an **organism**. A dog, human, dove, squirrel, and fig tree are all different types of organisms that serve different functions with their lives. Some organisms can be very small and consist of one cell only (such as bacteria) and others consist only of tissues (such as a jelly fish).

Let us continue to discuss the cell and the significance of cell processes.

Staying alive is not as easy as we might think. It is difficult to figure out what makes life possible in an organism. Some organisms are very small and made of one cell, but others are larger and more complex. Unicellular organisms are organisms that consist of one cell only, for example, bacteria and many protocists. These are the simplest forms of life. Multi-cellular organisms are organisms that consist of many cells. All plants and animals are multi-cellular.

Remember, all living things have to fulfil 7 functions in order to remain alive. These include exchanging gases (usually carbon dioxide and oxygen), taking in water, minerals and food and getting rid of wastes. These functions ultimately occur at the cellular level and cells must constantly carry out a variety of activities to sustain life. What makes it possible? Let us start by looking at the requirements to remain alive and transport through membranes.

In order to understand the importance of cell processes for all living organisms (uni-cellular or multi-cellular), we will have to revisit the cell membrane. This membrane is a complex structure that is responsible for separating the contents of the cell from its surroundings, for controlling the movement of materials into and out of the cell and for interacting with the environment surrounding the cell.

Completing functions that sustain life requires that molecules move through the membrane that surrounds the cell.

Let us look closely at the cell membrane as one of the organelles in a cell and study it in more details.

The structure and functions of the cell membrane

The cell surface membrane covers a cell, separating it from its surroundings while controlling the movement of substances in and out of the cell. The cell membrane is made up of two components: **Phospholipids** and **proteins.**

The cell membrane is mostly made of a double layer (bilayer) of phospholipids molecules and some protein molecules. How are these components arranged in the cell membrane? Let us look at the diagram below.

The structure of the cell surface (plasma) membrane

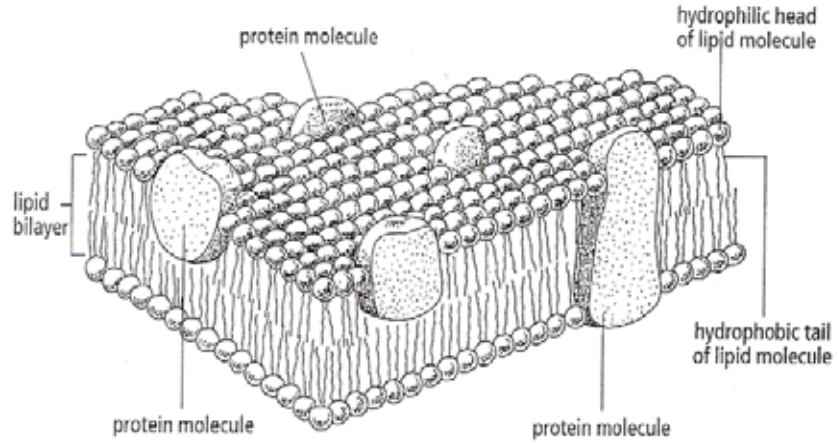


Diagram: Cell Surface Membrane

The phospholipids give the membrane fluidity and are responsible for permeability. Substances like water, oxygen, carbon dioxide, fatty acids and glycerol move through the phospholipids. The bilayer consists of a polar hydrophobic tail (which likes water or dissolves in water) and a non – polar hydrophilic head (which does not like water).

In general, non-polar molecules do not interact with polar molecules. For example, oil is non-polar. It does not like to interact with water and instead of dissolving, clumps together into pockets on top of the water. Polar molecules like oil typically interact only with other polar molecules and ions. However, table salt (ionic) is polar because it dissolves in water.

Because of this quality, we can say that this cell membrane is **selectively/partially/differential permeable** because it allows only certain materials to cross it. Larger molecules and ions like glucose and Sodium(Na^+)

move through the channel/carrier proteins of the membrane and enter a cell. Proteins also help cells to identify other cells.

A membrane that allows all materials to cross it, like a cell wall, is called **fully permeable**.

How are you doing so far? Do Activity 4 to test your progress.

Do not forget, feedback is given at the end of the unit.

Activity 4	1. State whether the following are permeable or selectively permeable. a) epidermis b) onion leaf scale c) tomato d) parenchyma cells e) cell walls For feedback, click on the icon.

How molecules move through the membrane

As we have learnt, molecules can pass through certain membranes. This allows, for example, plants to receive certain molecules so that the plant can continue to grow. Molecules can travel through cell membranes a number of ways including diffusion and osmosis.

Let us start with diffusion. **Diffusion** is the movement of molecules, ions, or particles from an area of high concentration to one of low concentration down what is called a **concentration gradient**. A concentration gradient is a gradual change in the concentration of solutes in a solution between two regions.

As an example, consider taking a beaker of distilled water and adding a few grains of potassium permanganates or one drop of ink that sink to the bottom of the beaker. Because the beaker has a relatively high concentration of potassium permanganate at the bottom and a low concentration on top, we can say there is a concentration gradient for potassium permanganate. Indeed, potassium permanganate on both sides is moving around randomly down its concentration gradient to fill areas with lower concentration. These molecules will travel through the water until it becomes purple completely, at which point the molecules are equally distributed and the water has reached a state called **dynamic equilibrium**. Another common test to determine the pH balance (acidic or basic) of a solution also demonstrates diffusion. Ammonia causes wet red litmus paper(a pH test strip) to turn blue, through diffusion because ammonia is a basic solution.

Diffusion is a passive process meaning that it does not require energy. Instead, it depends on the motion of the molecules and continues until the arrangement of the molecules reaches a state of equilibrium, which means that the molecules are evenly distributed throughout the system. Substances like oxygen, carbon dioxide, fatty acids, urea and glycerol move through the phospholipids of the cell surface membrane in and out of cells by diffusion. Glucose and Na^+ move by diffusion through the channel proteins of the cell surface membrane.

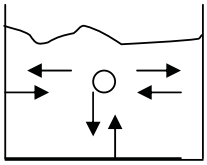


Diagram: Movement of molecules in diffusion.

Several factors affect the rate of diffusion:

1. Temperature - when the temperature is high, the molecules have more energy and move faster.
2. Concentration gradient - the steeper the concentration gradient the faster molecules will move.
3. The size of particles - when particles are small the molecules will move faster because than the larger ones.

Example of diffusion in living things

1. Gaseous exchanges in the alveoli and blood capillaries; also between the blood capillaries and tissues.
2. Carbon dioxide entering a leaf through its stomata
3. Diffusion of digested food in the small intestine (ileum).

Another process is osmosis

Osmosis is a special type of diffusion that takes place through a membrane using water. Osmosis is the movement of water from an area of high water potential to an area of low water potential through a selectively permeable membrane. Guided by the information in the structure of the cell membrane, water moves through the phospholipids of the cell membrane..

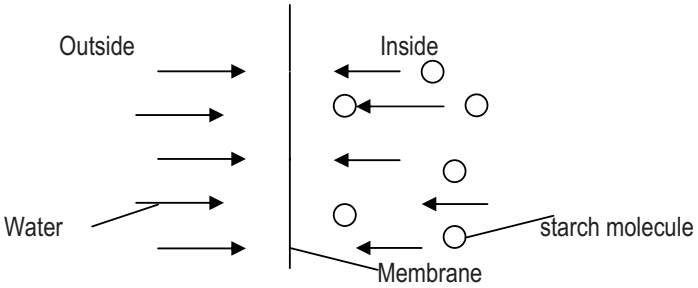


Diagram: Example of osmosis

In the diagram above, there is a high concentration of water on the outside of the cell membrane and a low water concentration on the inside. Therefore, the water moves from the outside to the inside by osmosis. There is also a starch solution inside the cell that reduces the water's potential to move.

The next diagram further explains the movement of water between the two concentrations. You may try it at home by using a drinking straw, clear drinking glass and plastic instead of a visking tube and the two concentrations.

An osmometer and a theoretical explanation of osmosis.

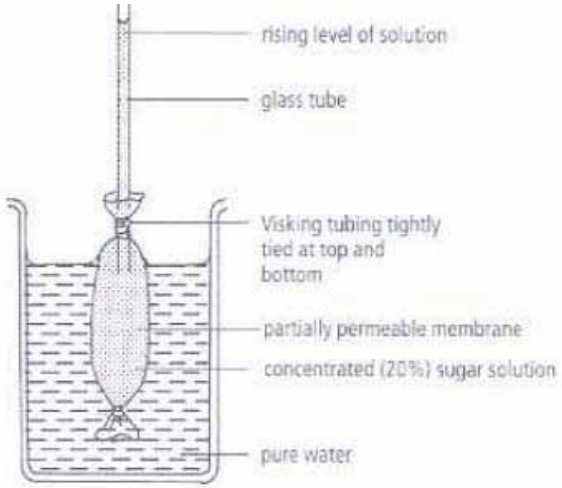


Diagram: Osmometer

Selective permeability of the visking tube allows only water to pass through from the region of high water concentration (pure water) to the region of low water concentration (concentrated sugar solution). The volume of the visking tube increases and pressure causes a rise in the solution level.

Do the following practical activity below to get a clear understanding on osmosis.

Practical activity

Effect of osmosis on potato chips/plant cells

Materials:

2 beakers

A potato tuber

Sodium chloride (table salt)

Distilled water/tap water

Ruler

Stirrer/glass rod/table spoon

Instructions:

Take two beakers/cups of the same volume.

Label one beaker 'distilled water' and the another 'salt solution.'

Put distilled water in the beaker labelled distilled water and salt solution in the beaker labelled salt solution.

Peel the potato tuber and cut 5 chips of equal length and width.

Put two chips in the distilled water and the other two chips in the salt solution.

Expose the remaining chip to air.

Leave your experiment for 2 hours then observe and record your findings in the table below.

Chips	Initial length	Final length	Change in length	Mean in length
1 in distilled water				
2 in distilled water				
3 in salt solution				
4 in salt solution				

1. Which potato chip decreased in length? Explain what caused the change?
2. Which potato chip increased in length? Explain what caused the change?
3. What happened to the potato chip which was exposed to air and what could be done to avoid the change?

The findings from the practical activity you have just finished is further explained below where we continue to discuss the effects of osmosis on plant cells.

A plant cell in distilled water will take in water by osmosis through a partially permeable membrane of the cell. As the water enters, the vacuole swells and pushes the cytoplasm and the cell membrane up against the cell wall, but the strong cell wall prevents the cell from bursting.

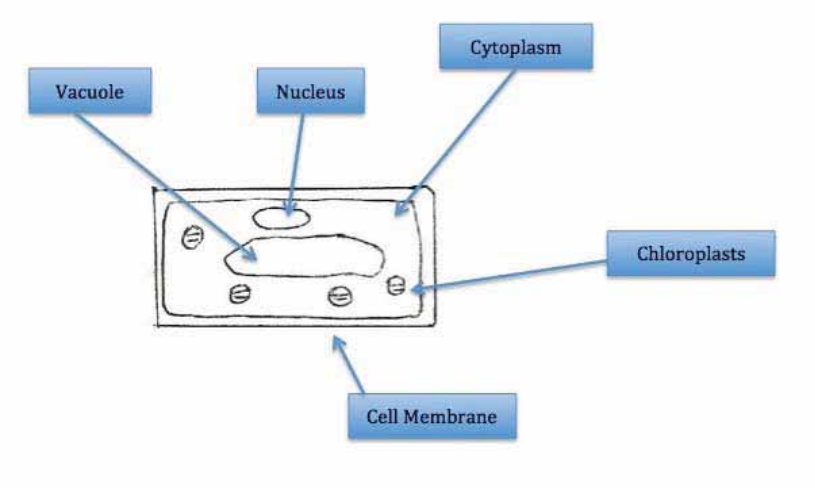


Diagram: Plant cell

The plant cell that is full of water is said to be **turgid** and turgid cells helps to support soft parts of a plant such as the stem, leaves and flowers and keep them firm. This is why plants often wilt when they do not have enough water. Turgid cells are important in plants that are not supported by something else.

However, when a plant cell is placed in a concentrated solution, for example a salt solution or concentrated sugar solution, the water potential within the plant cell is greater than the outside (hypertonic) solution. The water will move out from the cell through osmosis and the cytoplasm and vacuole will shrink away from the cell wall. In the diagram below, look at the dented cell wall, detached cytoplasm and a small vacuole.

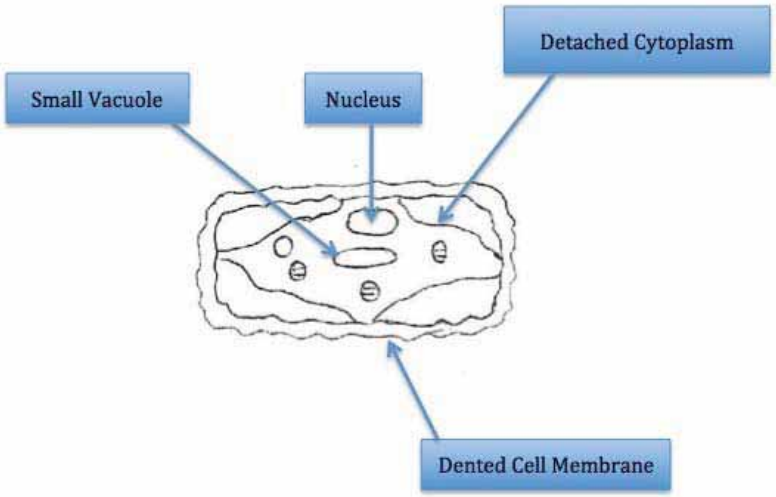


Diagram: Plant cell in concentrated solution

Cells that have lost water are said to be **plasmolysed**. A cell in this state is said to be **flaccid**. If the plant cells do not regain water, the whole plant will shrink and eventually die.

Effects of osmosis on animal cells

Unlike plant cells, animal cells do not have a rigid cell wall and may burst when placed in pure water. The cytoplasm inside an animal cell is a fairly concentrated solution. Proteins and many other substances dissolved in it are too large to get through the cell membrane, but water molecules can get through. Water molecules will diffuse through the cell membrane from the pure water into the cell. As more and more water enters, the cell swells and stretches the cell membrane. Eventually, the pressure may become too much and the cell bursts. Look at this diagram of a normal cell.

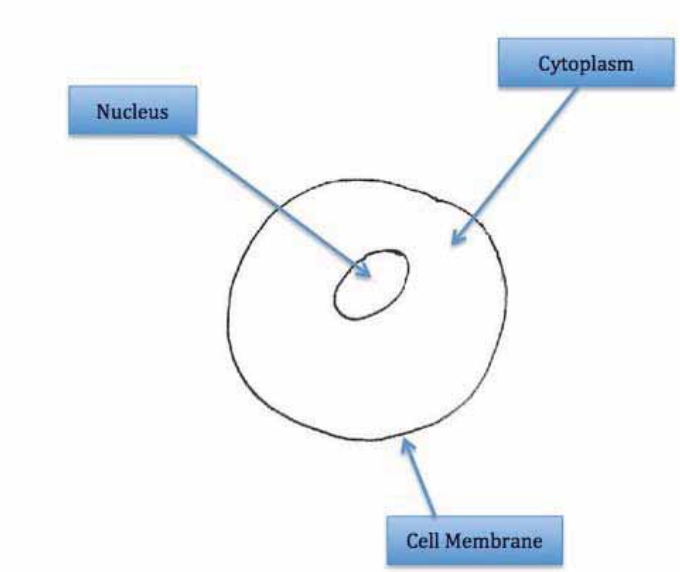


Diagram: Normal Cell

When placed in solutions more concentrated than the cytoplasm such as a salt solution, the water will diffuse out of a cell and animal cells shrink. As water molecules move through the cell membrane, the cytoplasm shrinks and the cell shrivels up as in the diagram below.

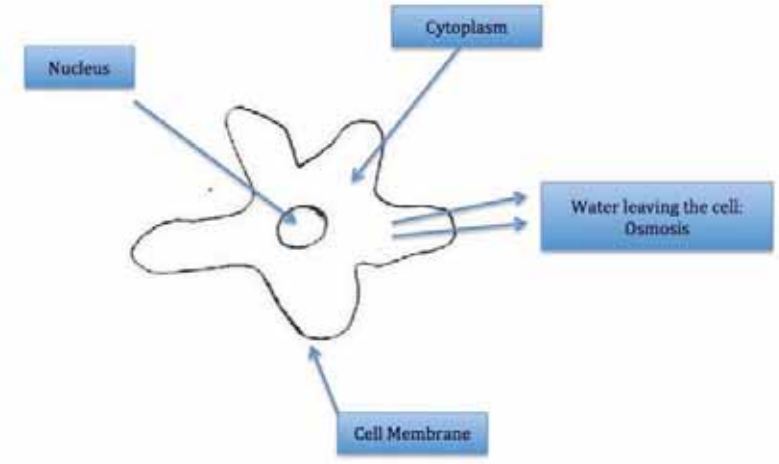


Diagram: Effects of osmosis

For more information on the effects of osmosis on plant and animal cells, click on the link to view the slides. Effect of osmosis on plant and animal cells

Do the following assignment in your notebook. Compare your answers with mine at the end of the unit.

Assignment 2

1. Through which process does ammonia cause wet red litmus paper to turn blue.

   A. osmosis

   B. respiration

   C. diffusion

   D. transpiration

2. Which structure of the cell controls cell's activities?

   A. vacuole

   B. nucleus

   C. cytoplasm

   D. chloroplast

3. In which structure is glucose made?

   A. mitochondria

   B. nucleus

   C. chloroplast

   D. vacuole

4. At which level of organization is a leaf of a plant

   A. a cell

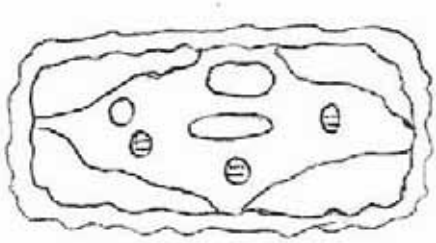
   B. an orga

   C. an organ system

   D. a tissue

5. The diagram shows a cell after it was placed in a concentrated salt solution

Why did the cell change shape?



A. salt solution entered the cell

B. the cell wall burst

C. water moved out by osmosis

D. water entered the cell by osmosis

6. Which set of characteristics is common to both a liver and an onion cell?

A. cell wall; cytoplasm; chloroplasts

B. nucleus, cell wall, chloroplasts

C. cell wall, nucleus, cell membrane

D. nucleus, cell membrane, cytoplasm

7. A cell membrane is

A. fully permeable

B. partially permeable

C. completely permeable

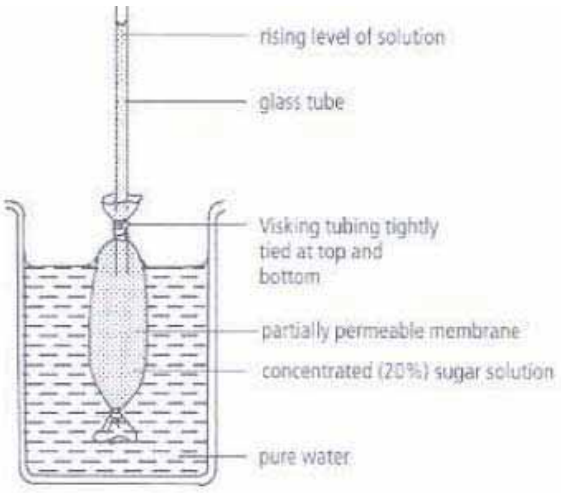
D. absolutely permeable

8. How does osmosis differ from diffusion?

9. What is the role of a cell wall in plants?

10. Name two components of the cell membrane

11. The diagram shows the apparatus which was used to measure osmosis. Visking tubing is permeable to water but not to sugar. The beaker contains pure water and the tubing contains 20% sugar solution. The level in the glass tube shows that the volume of the sugar solution is increasing.



What do you think would happen to the level of liquid in the glass tube if the pure water in the beaker was replaced by:

a) a 25% sugar solution?
The level in the glass tube would rise/ drop / stay the same.
Explain your answer.

b) a 50% sugar solution?
The level in the glass tube would rise / drop /stay the same.
Explain your answer.

For feedback, click on the icon.

Now let's summarise what we have learned so far.

Unit summary

 **Summary**	In this unit you learned that: • taxonomy is the science of naming and classifying living organisms. • the binomial system of naming organisms is based on a name in two parts, one part for the genus name and one part for the species name. • an organism is grouped in a hierarchical system into kingdom, phylum, order, family, genus and species. • natural classification is hierarchical and is based on homologous features and evolutionary relationships. • artificial classification is based on any descriptive features. • cladogram shows how organisms are related. • evolution is the gradual change of a species over a very long period of time • dichotomous keys are based on pairs of descriptions and used to identify organisms. • all living things are made of cells, the structural units of organism that function as self-sufficient units. • prokaryotic cells are simple cells with no nucleus. • eukaryotic cells have nuclei and membrane bound organelles. They are large and more complex (multi-cellular). • the structure of a plasma membrane is made up of two components phospholipids bilayer and proteins molecules. • there are processes through which molecules move in and out the cell membranes: diffusion, osmosis.

We have come to the end of the unit. You are expected to do the assessment below and submit it to your tutor. Regard it highly important because it will contribute to your continuous assessment.

Assessment

Assessment

Multiple choice questions

1. Bacteria belong to the prokaryotic group because

A. it has a vacuole

B. it has cell wall

C. it has nucleus

D. it is without a true nucleus

…….. (1)

2. Which one of the following factor does not affect diffusion?

A. wind

B. temperature

C. size of particle

D. energy input from the cell

…….. (1)

3. Which of the following is a scientific name?

A. equus zebra

B. *Equus zebra*

C. equus Zebra

D. Equus Zebra

…….. (1)

4. A cell membrane is

A. dully permeable

B. partially permeable

C. completely permeable

D. absolutely permeable

..... (1)

5. The diagram below shows a vertebrate.

Using the key, what is the identity of the vertebrate?

1. body with fur .....go to 2
   body with scales.....go to 3
2. external ear flap.....vertebrate A
   internal ear flap.....vertebrate B
3. lay leathery eggs.....vertebrate C
   lay hard shelled eggs.....vertebrate D

..... (1)

6. Complete the following statements by using the words listed below.

Water, high, partial, permeable, low concentration, gradient

For an animal cell to swell and burst it means that it was surrounded with .....

Concentration of ..... than inside the cell contents where the concentration was .....

Therefore water moves through a ..... membrane down a .....,..... (5)

7. Humans are scientifically named *Homo sapiens.*

With reference to a human, explain the binomial system.....

	…… …… …. …… …. …… (3) 8. Give reasons why it is important to classify organisms? (2) …… …… …… …… 9. Distinguish between prokaryotic and eukaryotic cells. (2) …… …… …… 10. Define the following terms (a) Taxa…… …… ……(1) (b)Taxonomy…… …… ……(1) (c) Cladogram…… …… ……(1)

	(d) Cladistics…… …… ……(1) 11. Design an investigation to demonstrate diffusion by using either ammonia solution or perfume. …… …… ……(5) 12. List two ways in which substances pass through a cell membrane. (2) 13. Define an organelle and list one example. …… …… …… …… (2) 14. State the functions of the following organelles. • Nucleus…… …… ……(1) • Chloroplast…… …… ……(1) • Vacuole……

	…….. ……. …..(1) 15. What is the role of a cell wall in plants? ……. ……..(2) 16. Name two components of the cell membrane. ……. ……..(2) 17. Mention the changes that would take place if a potato chip is immersed in a concentrated salt solution; you may accompany your answers with a diagram. ……. ……. ……. ……..(3) 18. List the major level of classification from the lowest to the highest. ……. ……. ……. ……..(3) 19. Distinguish between natural and artificial classification.

	…… …… …… …… ……(1) 20.Identify the following organelles: (a)a storage depot in a cell……(1) (b) Contain DNA in a cell…… (1) (c) surrounds the vacuole in plant cell……(1) 21. Six kingdoms have been divided into three domains in a cladogram, what are they? Give one example of each domain. …… …… …… ……(3) Total (50)

Feedback

Feedback **Activity 1**	**Answer:** The animal identified is a bird. The reasons are, its body is covered in feathers, and the animal has a beak. To go back, click here.

 **Feedback** **Activity 2**	1. genus, species 2. a) capital b) lower case To go back, click here.

 **Feedback** **Assignment 1**	1. A 2. B 3. C 4. A 5. Taxonomy is the branch of biology that deals with the identification and naming of organisms. 6. An organism may have more than one common name and a common name may be used by more than one organism. 7. Binomial system, consists of a genus name and the species name, the genus name is written with a capital letter and the species name is written with a lower case letter. When the scientific name is typed, it is italicized and, when handwritten, it is underlined. 8. The ancestors of the beetles, wasps and butterflies are different but the butterflies and flies have a common ancestor and are closely-related as they share more features. The cladogram further shows that ancestors of wasps, butterflies, flies and beetles descend from a common ancestor, however, they share fewer features and are closely related. The beetles are the sister group of wasps and butterflies and wasps are the sister group of butterflies and flies. 9. a) Cladistics is a branch of biology that determines the evolutionary relationships between organisms based on their evolutionary history.

	b) Taxa are a groups or representatives of related organisms that are compared; they can vary on the hierarchy. c) A cladogram is a branching diagram showing relationships among taxa. d) Systematics is the study of the diversity of life and the relationships between organisms. **To go back,** click here.

Feedback

Activity 3

	Animal cell	Plant cell
chloroplast	√	x
Cell membrane	√	√
mitoc ondria	√	√
cytoplasm	√	√
Cell wall	√	x
cytop s	√	√

To go back, click here.

 **Feedback** **Activity 4**	1. a) permeable b) permeable c) selectively permeable d) permeable e) permeable To go back, click here.

Feedback **Assignment 2**	1. C 2. B 3. C 4. B 5. C 6. D 7. B 8. Osmosis involves water molecules and pass through a cell membrane. 9. Cell wall is made up of cellulose and it protects the plant cell against mechanical injury (bursting). 10. Cell membrane consist of protein molecules and phospholipids' bilayer 11. a) drop: high concentration inside, low concentration outside, water moved out of the visking tube. b) drop more: high concentration inside, low concentration outside, water moved out of the visking tube. To go back, click here.

Optional Multimedia Resources

CD – ROM Resources

1. **Power point – levels of classification**
2. **Power point – effects of osmosis on cells**

We have learned that organisms are classified based on their features. Unit 4 will cover the specific features of different groups of organisms.

Unit 5 - Diversity of Organisms

Introduction

In Unit 4, we learned about levels of classifying organisms. In this unit, we will look at features of different kingdoms into which organisms can be classified. Millions of different organisms are on earth and many are still being discovered. There is a very great diversity of living organisms on earth. Organisms look different from each other and have different features that have led to their identification. These features are called diagnostic features. Scientists use these features to classify organisms into different groups

What is in this unit?

This unit is made up of one topic:

Topic 1: Six kingdoms

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: ▪ describe the six kingdoms classification (Eubacteria, Archaebacteria, Prostita, Fungi, Plantae and Animalia) to illustrate the diversity of organisms. ▪ outline the differences among the major phyla in each kingdom (Monera, Prostita, Fungi and plants). ▪ describe the diagnostic features of a monocotyledon and a dicotyledon as found in their local environment. ▪ identify five major classes of vertebrates. ▪ describe the external diagnostic features of fish (tilapia or trout). ▪ investigate the adaptation of tilapia/trout to the Namibian environment. ▪ suggest the importance of fish to enhance healthy living.
 **Study time**	You need to spend about 6 hours on this unit. Don't worry if it takes you longer because we all learn at a different pace. The important thing is to achieve the set objectives.

Terminology		
	autotrophs	organisms that can produce their own food
	diversity	variety/refers to differences
	eukaryotes	organisms with a nucleus and membrane bound organelles
	heterotrophs	organisms which do not produce their own food rely on plants or other organisms for food
	multi-cellular	organisms that consist of many cells
	prokaryotes	organisms without a nucleus and no membrane bound organelles
	unicellular	single celled-organisms

Six Kingdoms

All living organisms can be classified into six kingdoms. Each of the kingdoms is classified according to fundamental similarities, methods of obtaining nutrients and metabolism. In unit 3, levels of classification was covered. The six kingdoms covered in this unit is another type of classification system. Now we will discuss the main features of each kindom.

Kingdom Archaebacteria

- They are unicellular organisms.
- Some are autotrophs or heterotrophs.
- They are prokaryotes.
- They have a cell walls without muramic acid.
- Sometimes they are called ancient bacteria.
- They can live in harsh conditions like very salty lakes, intestines of mammals and hot sulfur springs

Kingdom Eubacteria

- They are prokaryotes.
- They are unicellular.
- Thay have muramic acid in their cell walls.
- Sometimes they are called the true bacteria and many bacteria belong to this kingdom.

- Some of these bacteria cause diseases.

Kingdom Protista (e.g., algae and protozoan)

- They are eukaryotes.
- Some are autotrophs and some are heterotrophs.
- Most of them are unicellular, though few are also multi-cellular.
- The proctoctists include single-celled organisms like the protozoa and also plant-like organisms such as algae. Many live in water, either sea or fresh water, where they feed on smaller protoctists and bacteria. Some protoctists are parasites, such as the malarial parasite *called plasmodiu.* Others are mutualistic, such as flagellated protozoa that live in the digestive system of termites and help the termites to digest the wood which they eat. Some have tiny shells, such as amoeba. Some have a well developed cytoskeleton, such as the ciliate *Paramecium*.

Kingdom Fungi (e.g. ,moulds, mushrooms and toadstools)

- Fungi are eukaryotes.
- They are multi-cellular organisms (except yeast, which consists of a single cell and does not have hyphae). The main body of fungi is made up of **hyphae** which are long thin threads. The hyphae are a tubes with many nuclei in it. A mass of hyphae is called **mycelium**.
- All are heterotrophs and never contain chloroplasts. Because they do not have chloroplasts or chlorophyll, they do not photosynthesise.
- Fungi feed saprotrophically by absorbing soluble organic substances as well as inorganic from their surroundings. Many fungi feed on dead plants, animals, animal faeces and bread.
- Fungi reproduce by means of spores,sometimes asexual and sometimes sexual.
- Fungal cells always have cell walls which are made up of chitin.

Kingdom Monera (e.g. bacteria)

- They are unicellular.
- Their cell walls are made up of maramic acidity.
- They do not have true nuclei.

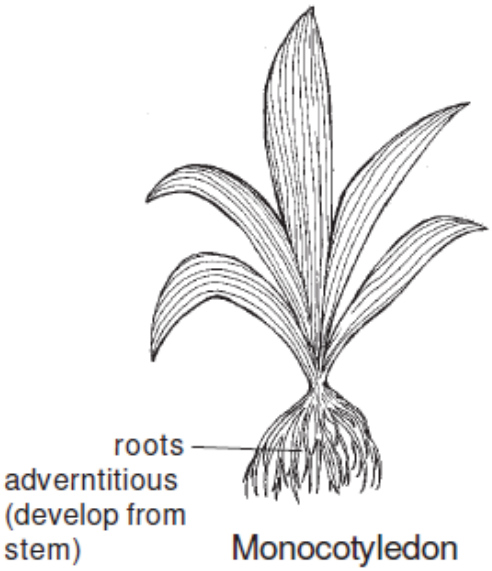
Kingdom Plantae (e.g., ferns, liverworts, mosses, flowering plants and horsetails)

- They are eukaryotes.
- All are multi-cellular.
- All are heterotrophs.

- Their cell walls are made up of cellulose.
- Almost all plants photosynthesise.
- Their cells contain chloroplasts.

Flowering Plants

Flowering plants or angiosperms are the most successful plants. These plants bear flowers and produce seeds. There are two main groups of flowering plants: **monocotyledonae** and **dicotyledonae.** The diagrams below show examples of a monocotyledon and a dicotyledon.



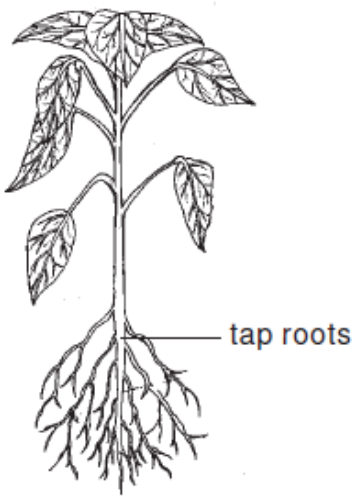


Diagram: Monocotyledon and Dicotyledon Plants

Diagnostic features of Dicotyledonae (e.g. Commiphora)

- Their seeds contain two seed lobes/cotyledons.
- They have broad leaves.
- Their leaves have branching patterns of veins.
- They have tap root systems.
- Their flowers are grouped in fours or fives.

Diagnostic features of monocotyledonae (e.g. ,maize and grasses)

- They have long strapped leaves.
- They have parallel veins running along the length.
- They have one seed lobe/cotyledon.
- They have adventitious (abnormal) fibrous root systems.
- Their flower parts are always grouped in threes.

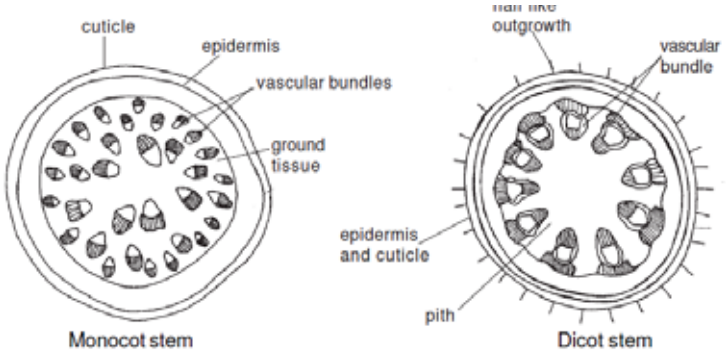


Diagram: The transverse section of a monocot stem (corn) and of a dicot stem (Sunflower**).**

Kingdom Animalia

- They are eukaryotes and their cells do not have cell walls.
- They are multi-cellular.
- They are heterotrophs and do not have chloroplasts.
- Most animals are **sessile**, that is they spend most of their lives in one place.
- Animals are **motile**, meaning that they can move their whole body from place to place, unlike plants. Most animals use muscle cells to move and they all have nerve cells to assist coordinate the contraction of muscle cells.

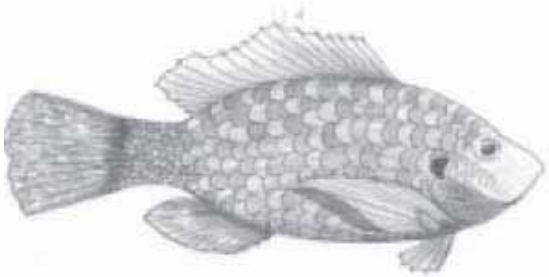
The kingdom Animalia is divided into phyla. One of the phyla we will be looking at is vertebrates/chordates, which are animals with backbones. All chordates have a notochord(backbone), pharyngeal slits(filter feeding organs) and post-anal tail (tail).

The phylum vertebrate is further divided into five classes, which are: fish/pisces, amphibians, reptilians, birds/aves and mammalian.

Click here to view the slides.

Let us look at their diagnostic features.

Fish/Pisces (e.g. tilapia, trout, carp and galjoen)



- They have gills for gaseous exchange.
- They have fins for swimming and balance.
- They have a lateral line along its length to detect vibrations in water.
- Their body is streamlined with wet scales.

Tilapia

Tilapia is a kind of tropical fish that have been raised in dams and ponds in Africa and are now in Namibia. This type of fish has been established along rivers such as the Okavango, Kunene, Chobe, Orange and Zambezi as well as in lakes and at dams. The Ministry of Fisheries and Marine Resources have developed six community-based farms in the Caprivi and Okavango regions. There are two species of tilapia. They are the mossambica and T. Melanopleura. The common names for Tilapia are bream, Wonder fish and Nile perch. People are interested in tilapia farming because tilapia are adaptable to the Namibian environment.

Reasons for the great interest in tilapia fish and tilapia farming:

- They are resistant to most fish diseases.
- They grow and reach maturity quickly.
- They reproduce easily.
- They can tolerate variations in water temperature.
- They eat a wide variety of foods.
- They have streamlined bodies that cut water for movement.
- Their scales overlap and face backwards to reduce friction
- Fins for maintaining balance and steering in water.
- They are weightless in water because of swimming bladder filled with air.
- They have flexible backbones to manoeuvre from side to side to move forward in water.

- They have gills for obtaining oxygen and for gaseous exchange under water.
- They can grow and reproduce in captivity.
- They adapt to a wide range of environmental conditions.

Characteristics of tilapia

- Very deep and laterally-compressed body
- Scales are large and cycloid (have overlapping layers)
- They have a double-lateral line system.
- They taste excellent; their firm white meat that is low in fat and low in calories.
- They do not have an oily, fishy taste that some people object to in many types of seafood.
- They have tiny combs in their gills that enable them to constantly filter and remove micro-algae from their water environment.
- They have a strong digestive tract and immune system.
- They have a long dorsal fin.
- A black patch, 'tilapia spot' at the base of posterior section.
- They are all principally herbivores.

Economic importance of Tilapia Farming for Namibia

- It contributes to the development of the fish industry.
- It creates employment.
- Some fish are exported as food and bring in foreign currency to our country.
- Tourists come to our country to fish and money is brought into the country.
- Fishermen sell fish and earn an income

The importance of eating fish to enhance healthy living

Fish are rich in the proteins needed for growth and to repair damaged tissues. Proteins also help to make enzymes, keratin, collagen, hormones, antibodies and haemoglobin. A lack of protein in a diet cause wasting of muscles and a pot-belly and a deficiency/nutritional disease called kwashiorkor.

Birds/Aves (e.g., ostriches, chikens, eagles, flamingos and eagles)

Diagram: Ostrich

- They have beaks
- They have feathers and the front pair of limbs is modified to form wings.
- They are endothermic.
- They have dry scales on their legs and their bodies are covered with feathers.
- They lay eggs with hard, calcium shells.

Mammalia (e.g., zebras, cats, cows, elephants and whales)

Diagram: Zebra

- Mammals are warm blooded or endothermic, meaning that they must generate heat in order to maintain body temperature. Their bodies are covered with fur or hair.

- For most mammals, the young develop completely inside the mother's body. The uterus obtains nutrients and oxygen that are passed to the unborn via the placenta. However, some mammals reproduce differently. Kangaroos, for example, have a different type of placenta and their young are born at an early stage of development then complete their development inside a pouch. The platypus and the spiny anteater are mammals, but they lay eggs.
- They have mammary glands to feed their young with milk.
- They have external earflaps called pinnae.

Amphibians (e.g., frogs, toads and salamanders)

Diagram: Frog

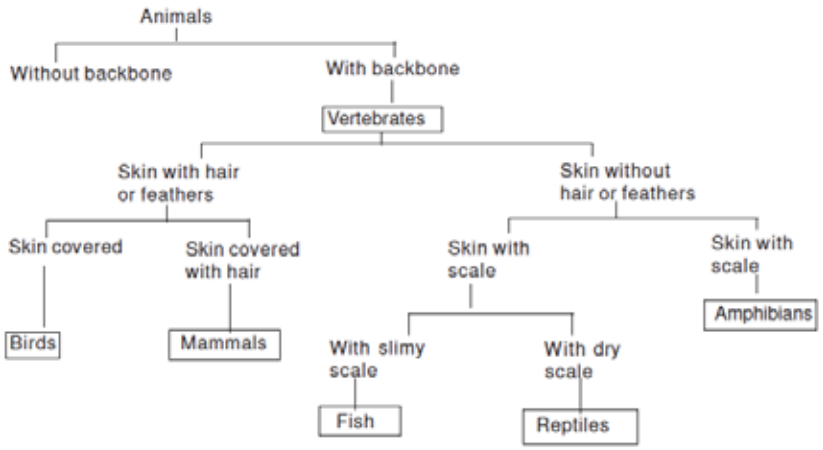
- They have soft, moist skins with no scales called naked skin. They have limbs that they can use for swimming or for moving on land.
- They live on land and in water. This is why they are called Amphibians, which means double life
- They lay their soft eggs in water.
- Adults breathe with lungs but their eggs hatch into tadpoles that breathe with gills. The tadpoles change into adults through a process called metamorphosis.

Reptilia (e.g., crocodiles, snakes, turtles, geckos and lizards)

Diagram: Lizard

- Their skin is covered with tough, dry horny scales and it is waterproof.
- They lay eggs with leathery shells on land, although some live in water.
- Reptiles use their lungs for breathing.

The diagram below summarises the relationship among vertebrates in the Animalia Kingdom.



Now do the following activity in your notebook to check your progress so far.

Activity 1

1. Complete the table below. If a feature is present, place a tick (√) in the appropriate box and if a feature is absent, place a cross(x) in the appropriate box.

feature	fish	birds	mammal	amphibi n
pinnae				
air/fur				
w t scales				
na ed skin				
Warm-blooded				

2. The diagram below shows the structure of a vertebrate. It has a notochord, which is a characteristic of all vertebrate.

(a) State two other features that are characteristic of vertebrates.

(b) State the class of vertebrate to which the vertebrate shown belongs.

(c) State the name of two organs, visible in the diagram, which are used for sensing external stimuli. **For example:** The zebra uses its nose for smelling.

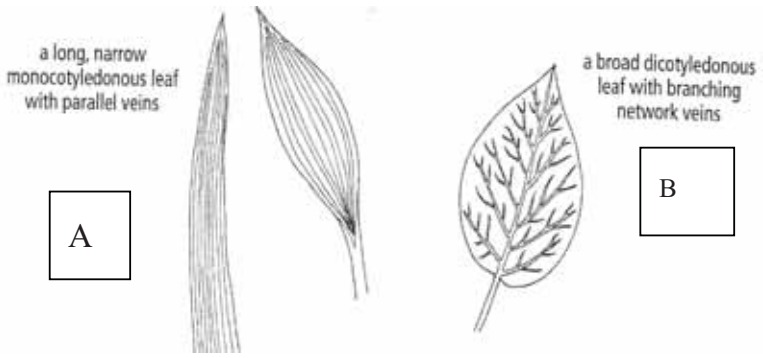
To check feedback, click on the icon 

Before you can conclude, do the self-mark assignment in your notebook. Do not forget to compare your answers with mine at the end of the unit.

Assignment

Assignment 1

1. List three external diagnostic features of mammals that distinguish them from all other vertebrates.
2. Explain how plants are different from fungi.
3. Tilapias are native to Africa and the Nile Basin in Lower Egypt. What distinguishes this type of fish from other fish?
4. Why is it important to eat fish as part of your diet?
5. Describe the adaptation of tilapia to the Namibian environment.
6. Discuss the economic importance of tilapia to Namibia.
7. Look at the following diagram and answer the following question:



Apart from the features shown on the diagram, list other diagnostic features of a monocotyledonae plant.

8. Look for an organism that is a vertebrate in your environment and briefly describe how it is adapted to its environment.

To check feedback, click on the icon

Unit summary

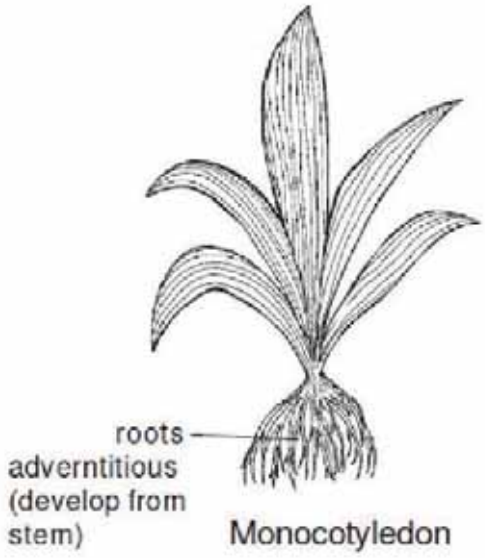
 **Summary**	In this unit you learned that: • all living organisms are classified into six kingdoms. They are: Plantae, Animalia, Fungi, Protista, Eubacteria and Archaebacteria). • Plantae are multi-cellular. Their cells have cell walls made of cellulose. They have chloroplasts with chlorophyll. They photosynthesise. • Animalia are also multi-cellular, though their cells contain nuclei. They do not have cell walls or chlorophyll. • Fungi are also multi-cellular. They do not photosynthesise but feed on dead matter (saprophytic nutrition). This means they do not have chloroplasts with chlorophyll. Their cell walls are made up of chitin. • Monera are bacteria. They are unicellular. Their cell walls are made up of maramic acidity. They do not have true nuclei. • Vertebrates are divided into five classes: fish, birds, reptiles, mammals and amphibians.

We have come to the end of the unit. You are expected to do the assessment below and submit it to your tutor. Regard it highly important because it will contribute to your continuous assessment.

 **Assessment**	1. List five classes of vertebrates and one example of an organism that belongs to each class. (5) 2. List three external diagnostic features of mammals that distinguish them from all other vertebrates. …… ……

	…… …… (3) 3. Explain how plants are different from fungi. …… …… …… …… ……(4) 4. Tilapias are native to Africa and the Nile Basin in Lower Egypt, what distinguish this type of fish from other fish. …… …… …… …… …… …… (3) 5. Why is it important to eat fish as part of your diet? …… …… ……

	…… …… (5) 6. Describe the adaptation of tilapia to the Namibian environment. …… …… …… …… …… ……(5) 7. Discuss the economic importance of tilapia to the Namibian environment. …… …… …… …… …… ……(5) 8. Look at the following diagram and answer the following questions



(a) Give the name of a class to which this plant belongs.

.....(2)

(b) Apart from the features shown on the diagram, list other features which **are not visible** on the diagram above

.....

.....

.....

.....(3)

9. Look for an organism that is a vertebrate **in your environment** and briefly describe how it is adapted to its environment.

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.....(8)

10. By means of a table give the differences and similarities of birds and fish. (7)

Differences

Birds	*Fish*

Similarities

Total (50)

Feedback

Activity 1

1.

feature	fish	birds	mammal	amphibian
pinnae	x	x	√	X
Hair/ ur	X	x	√	x
Wet scales	√	x		
Naked skin	√	√	√	√
Warm-blooded	x	√	√	x

2. (a) pharyngeal slits and post-anal tail

(b) Mammalia

(c) eye and ear

To go back, click here.

Feedback

Assignment 1

1.

- external earflap/pinnae
- body covered with hair or fur
- mammary gland

2.

- plants are photosynthetic, fungi are not
- their cell walls are made up of cellulose

3.

- They have a strong digestive tract and immune system.
- They can thrive in fresh, brackish or salt water.
- They do not have an oily, fishy taste that some people object to in many types of seafood.
- They are hardy fish that like warm water.

4.

- Fish are rich in proteins
- Proteins are needed for growth and repairing damaged tissues
- Proteins also help to make enzymes, keratin, collagen, hormones, haemoglobin and antibodies.

5.

- Scales overlap and face backwards to reduce friction
- Fins for maintaining balance and steering in water
- They are weightless in water because of swimming bladder filled with air.
- They have flexible backbones to manoeuvre from side to side to move forward in water.
- They have gills for obtaining oxygen and for gaseous exchange under water.
- They are resistant to most fish diseases
- They grow quickly.
- They reproduce easily.
- They can tolerate variations in water temperature.

	• They eat a wide variety of foods. • Streamlined bodies that cut water for movement. 6. • It contributes to the development of industry. • It creates employment. • Some fish are exported as food and bring in foreign currency to our country. • Tourists come to our country to fish and money is brought into the country. • Fishermen sell fish and earn an income. 7. a) They have adventitious fibrous root systems Their flower parts are always grouped in threes 8. An vertebrate organism must belong to one of the following classes: fish, amphibians, reptilian, mammals and birds. **Fish** are adapted to an aquatic environment in that they have streamlined bodies that cut the water easily for free movement. Their scales overlap and face backwards to reduce friction in water, they have fins that help with steering and balance. **Birds** have wings which enable them to fly, they have streamlined bodies to minimise air resistance, their bodies is covered with feathers that trap air and act as an insulator,they have light hollow bones that make them lighter to fly in the air. **Mammals** are covered with hair or fur which traps air and serves as an insulator,they have sweat glands that produce sweat to regulate temperature. They have mammary glands to feed their young. To go back, click here.

Optional Multimedia Resource

Power point – classes of vertebrates

The features we possess make us to belong in the class called mammalian and to the species called humans. Humans differ from other organisms due to the physiology of their bodies. Let us study Unit 5 to learn how the human body functions.

Unit 1 - The Human Body-Part 1

Introduction

In this unit we look at how the human body works. The study of processes that take place in the human body is called **physiology**. The study of internal structures of human systems is called **anatomy**. In this unit, we explore physiology and anatomy and will look at several systems that make the body function.

What is in this unit?

This unit is made up of four topics:

Topic 1: Breathing (Respiratory) System

Topic 2: Blood Circulation

Topic 3: Excretion and Water Balance

Topic 4: Nervous System and Hormonal Control

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: • list the features of the gaseous exchange surfaces in animals. • describe the structure of the human gas exchange system. • discuss the significance of gaseous exchange surfaces for maintaining life. • describe the process of gas exchange between air in the alveoli and the blood. • list the effects of air pollution and smoking on the respiratory system. • discuss how air pollution and smoking impair the function of the respiratory system. • identify and name the structures of the circulatory system. • outline the functions of the heart, arteries, veins, capillaries and components of blood. • suggest how the build up of cholesterol in the circulatory system can lead to functional disorders. • suggest how a healthy lifestyle and living conditions contribute to maintaining an effective circulatory system. • define excretion as the process of removing the waste products of cellular respiration from the body. • identify the structures of the excretory system. • discuss the functions of the lungs, skin and renal system in excretion. • identify the waste products expelled from the organs involved in excretion. • identify the components of the nervous system and outline their function. • discuss functions of the central nervous system. • describe effects of alcohol and drug abuse on the nervous system. • identify the location of major glands in the body and describe their functions. • explain effects of growth hormones on the body. • explain how sense organs respond to stimuli.
 **Study Time**	You need to spend about 12 hours on this unit. Don't worry if it takes you longer because we all learn at a different pace. The important thing is to achieve the set objectives.

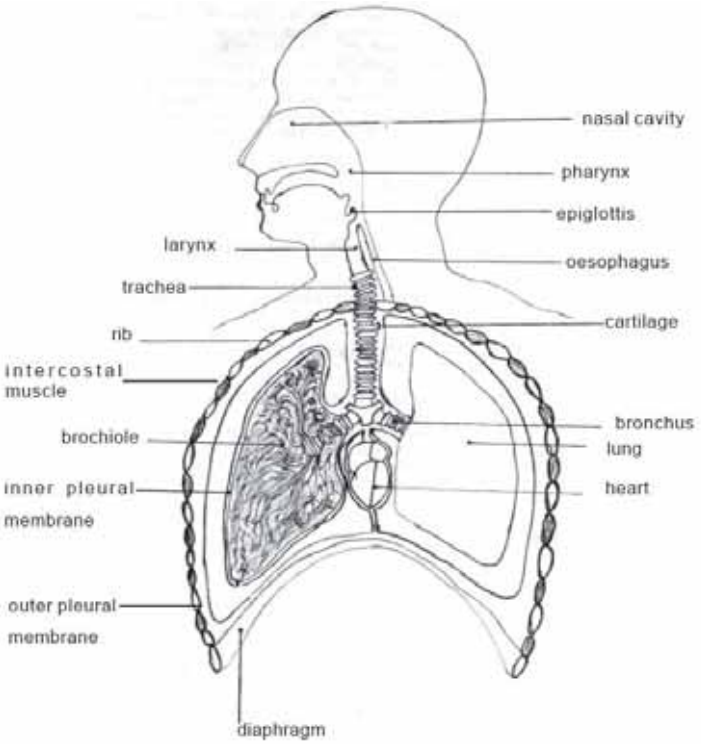
Terminology	**arteries**	thick-walled elastic blood vessels which carry blood from the heart to the body
	blood vessel	a tube through which blood passes/flows
	bronchitis	an inflammation of the bronchial tubes
	capillaries	very small blood vessels that have very thin walls
	double circulation	a type of blood circulation system in which the blood flows through the heart twice. In this type of circulation, the pulmonary circulation is separate from the systemic circulation.
	drug	a substance taken out of habit or pleasure or excitement. e.g. alcohol, tobacco, etc.
	excretion	the removal of chemical waste products produced during metabolic reactions from the body
	fibrinogen	a soluble protein present in blood plasma
	homeostasis	the process of keeping the internal environment (body fluid) constant
	receptors	cells or organs such as eyes or ears that have adapted to respond to stimuli
	reflex actions	rapid, involuntary response to a stimulus
	stimulus	a change in the surroundings of an organism or part of it producing a reaction
	synapse	the junction between two neurons
	tumour	a mass of diseased cells in the body which have divided and increased too quickly causing swelling
	veins	thin-walled blood vessels that carry blood from the body to the heart

Breathing system

Introduction

The human breathing or respiratory system consists of muscles and structures that allow us to breath oxygen that feeds our cells. The parts of the respiratory system are shown in the diagram below. You will need to know the structure and functions of the various parts of the respiratory system. Make sure that you know the exact location and function of each part.

Figure Title.



The Structure of the Respiratory System

Let us now look at each **part** and **function** in particular:

Part	Function
nasal cavity	warms, moistens and cleans the air we breathe in
pharynx	the point where the breathing and the alimentary pathways cross
glottis	a small hole through which air enters larynx
epiglottis	a flap that covers the glottis during swallowing to prevent food or liquids from entering the larynx
larynx	contains vocal cords which vibrate to makes sounds
trachea	a tube through which air passes to and from the lungs
bronchi	tubes into which the trachea divides to carry air to and from left and right lungs
bronchioles	narrow tubes into which the bronchi divide after entering the lungs and through which gases diffuse to and from the alveoli
alveoli	tiny air sacs, across whose thin, moist walls gaseous exchange takes place
lungs	thin-walled elastic sacs containing the gaseous exchange surfaces

Muscles of the breathing system

These include: the diaphragm, intercostal muscles and the abdominal muscles. Let's start with how the diaphragm works.

The **diaphragm** is a sheet of muscular tissue that separates the **thorax** from the abdomen. The thorax is the part of the human body enclosed by the ribs. The diaphragm contracts, enlarging the chest allowing air to be sucked into the lungs. When the diaphragm relaxes, air is exhaled by elastic recoil of the lungs. The tissues lining the **thoracic cavity,** which is the cavity in the vertebrate body enclosed by the ribs between the diaphragm and the neck and containing the lungs and heart, act together with the abdominal muscles as an antagonist to the diaphragm's contraction.

Now that we know the parts and muscles of the breathing system, let us look at the structures through which air reached the lungs.

The air passage

When we breathe in air, it has a route that it follows. This route is called an air passage. We will now discuss the parts that form the air passage.

The nose and the mouth

Air passes through the nose or mouth into your breathing system. Mucus covers the lining of the nose and moistens the air we inhale. When you have influenza (flu) your nose becomes blocked and it is difficult to breathe through it. You then have to breathe through your mouth. The lining of the nose also has ciliated hairs that clean the air that we inhale.

The nasal cavities

The nasal cavities connect the nose with the air passage that leads to the lungs. Cells lining this passage secrete sticky mucus to moisten dry air and trap germs and dust present in the air, preventing them from entering the lungs. Blood vessels in this passage also warm cold air.

The trachea, bronchi and bronchiole

The air from the mouth and the nose passes through the **trachea** into the lungs. The trachea is also called the windpipe and is located in the neck. The trachea is made from incomplete rings of cartilage. Cartilage is a flexible connective tissue that is found between joints and bones. The cartilage keeps the trachea permanently open.

The trachea wall is also lined with a mucous membrane. The mucous membrane traps dust particles and bacteria in the air so that we can inhale clean air. The inner surface of the trachea also has **cilia** that move all the time. The cilia drive the mucus and trapped dust particles upwards away from the lungs so it can be swallowed or coughed out.

The trachea divides into two **bronchi**. One bronchus goes to the left lung and the other to the right lung. Within the lungs each bronchus branches into smaller tubes called **bronchioles.** The bronchiole tubes can increase or decrease in size, allowing more or less air to pass through.

The lungs

The lungs are situated in the **thoracic cavity** where they are protected by the ribs and the chest bone. The lungs have a spongy texture. They are elastic and can expand. The surface of the lungs is covered by the **pleural membrane.** The pleural membrane protects the lungs by reducing friction and protection against shock.

The size of the lungs depends on age, body size and gender. The lungs contain **alveoli**, which are tiny sacs that fill with air when we breath. Alveoli are well

supplied with a network of tiny blood capillaries, and this is where oxygen from the air enters the blood stream through gaseous exchange.

Together, these organs form the air passage. Let us see how gases are exchanged during breathing.

How do we breathe?

Have you ever thought about breathing and how it happens? Now that you are aware of your breathing and know the body parts that make it happen, try to notice how your chest cavity moves when you breathe in and out. Look at the two diagrams A and B shown below and relate them to your own breathing.

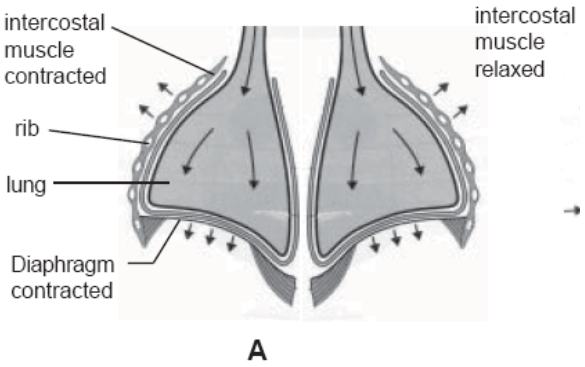


Diagram A: Breathing in(inspiration)

When we *breathe in*, such as in Diagram A, air moves in from high to low air pressure through the windpipe to fill up extra space due to an active process called **inspiration**. The intercostals muscles contract during inspiration. This pulls the rib cage up and outwards so that the chest cavity can increase in volume. The diaphragm muscles contract and the diaphragm flattens allowing the chest to get even larger.

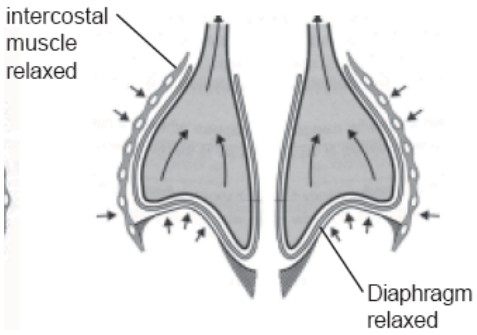


Diagram B: Breathing out (Exhalation)

When we breathe out, such as in Diagram B, the intercostal and diaphragm muscles relax, lowering the ribs. This decreases the size of the chest cavity and pushes air out from the lungs. When air is forced out of the lungs it is called **expiration**. When we breathe in and out, the chest changes in shape. This happens because the ribs and diaphragm move. Expiration is usually a passive process, but becomes active during coughing etc.

Can you see the difference between Diagrams A and B? Write your answers in your notebook. Did you notice that, in Diagram A, the size of the lungs is larger than in Diagram B?

Are you coping with this new information? Click on **breath** and compare the animations with Diagram A and B. Now, click on **passage of air** select *animation* on the web page. Select *narrated* part and *play.* Watch the full animation.

Features of gaseous exchange surfaces

Gas exchange takes place at a **respiratory surface**, which is a boundary between the external environment and the interior of the body. These surfaces as found in various organisms must allow efficient exchange of gases in order to maintain life. For unicellular organisms the respiratory surface is simply the cell membrane, but large animals have developed respiratory surfaces and systems that increase the surface area for gaseous exchange, making respiration possible for their larger bodies. This surface is found in different places for different organisms. Respiratory surfaces include the **lungs** in animals such as mammals, **gills** in fish and the **skin** of earthworms. Why do you think a large organism/animal like an elephant has a different respiratory system than a small organism like a bacteria?

All gaseous exchange surfaces must have the following features:

- large, increase surface area,
- moisture,
- contact with many blood capillaries; and

- extremely thin walls (a single layer of cells) or walls made up of single epithelial cells.

Listen to the audio by double- clicking on the icon.

1. Audio clip - Features of gaseous

Let us examine how significant these features are to ensure efficient exchange of gases.

Large surface area

To start with, organisms like an elephant are multi-cellular, meaning they consist of many cells. Millions of alveoli increase the surface area and thus maximize efficiency for gas exchange. It allows more (a lot of) gas to diffuse across it at the same time.

Moisture

Before diffusion will occur, molecules must dissolve in moisture to prevents cells from drying out and dying.

Transport network

The surface area must be in contact with the blood capillaries that take the gases to and from the cells. The transport network provides a rich blood supply that maintains a steep diffusion gradient and favours the rapid diffusion of gases.

Extremely thin and permeable walls

Gases diffuse quickly across the thin cell membrane because there is a short diffusion distance between the two cell layers. See the diagram below for an example of the role that thin cell walls plays for gaseous exchange.

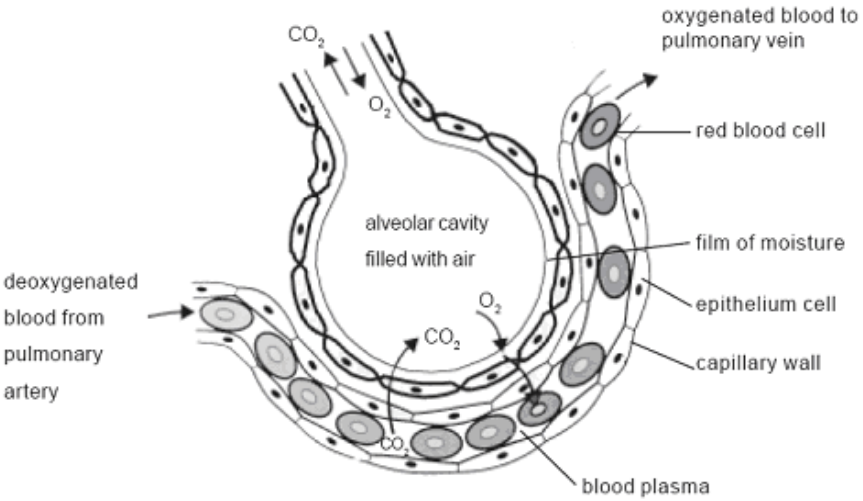


Diagram: Oxygen and carbon dioxide moving through thin, permeable walls

The maintenance of the life of an organism depends on how effective gas exchange takes place at the gas exchange surface. This will partly depend on the existing gradient difference across the cell membrane. Click on the link and view the tutorial on **gas exchange**.

The amount of air that we breathe in differs from the air that we breathe out because the respiratory system transfers important gases from the air that we need to survive, such as oxygen. The table below shows the difference between the amounts of certain gases found air you breathe in and compares them to the air you breathe out.

Gas	Air breathed in	Air breathed out
oxygen	21%	17%
carbon dioxide	0.04%	4%
argon and other inert gases	1%	1%
nitrogen	78%	78%
water vapour-a little	(varies)	A lot (saturated)
temperature	very variable	around 30 - 35^{0}C (always high)

Complete the practical activity that follows to test your knowledge about the respiratory system.

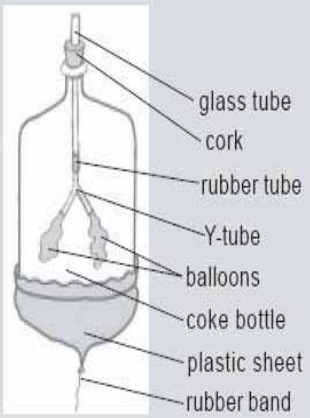
Practical Activity

Practical Activity 1

To show the role played by the diaphragm during breathing

What you need

- 1 two litre cooldrink bottle
- 1 plastic sheet
- 1 rubber band
- 1 glass tube
- 1 y- tube
- 1 cork
- 2 balloons



What to do

1. Cut out the bottom of the cool drink bottle.
2. Cover the bottom of the bottle with a plastic sheet and tie the middle with a rubber band.
3. Make a small hole in the cork and fit the cork in the coke bottle.
4. Insert a glass tube into the hole and glue the y-tube to the bottom of the glass tube.
5. Tie a balloon at each end of the y-tube.
6. Now pull the plastic sheet downwards. What do you see?
7. Push the plastic sheet inwards. What do you see?

Click here to see the observation and conclusion of the experiment.

You have learned the importance of our lungs, and why we should take good care of them. In the next section, we will look at what happens when we do not take care of our lungs.

Lung disorders

As you may recall, gaseous exchange takes place in the alveoli in the lungs. The alveoli are very delicate, sensitive and easily damaged, which is why the respiratory system has developed mucus membranes to protect them. Your breathing system is designed to protect your lungs from harmful substances in the air that you may breathe in. The epithelial ciliated cells lining the trachea are covered by mucous excreted by special cells called **goblet** cells. Dust and bacteria get trapped in the mucus. The other cells have **cilia** that move back and forth and push the mucus up and out of the lungs.

When this does not happen, or when the air we inhale is too dirty for the lungs to capture and expel contaminants, normal functioning of the lungs will be disturbed and lung disorders may occur. Dust, dirt, bacteria, viruses and polluted gases may enter your alveoli during gaseous exchange. Since our lungs are warm and moist they are an ideal breeding place for all organisms that can cause disease.

Audio clip - Effect of smoking on lungs.mp3

Double click to hear audio.

How does smoking affect the respiratory system?

Listen to the audio by clicking on the icon.

Have you noticed the warnings on cigarette packets and in cigarette advertisements? Here is one such statement: *"Smoking causes lung cancer, heart diseases, emphysema and may complicate pregnancy."*

Some of the most common lung disorders affecting Namibians are due to smoking tobacco. Tobacco smoke contains many chemicals that are harmful to the body. Some of the chemicals in tobacco are *irritants* that damage the lungs and are commonly referred to as carcinogens. The following are examples of these substances.

Carcinogens

Carcinogens are a class of substances that are directly responsible for damaging DNA, which promotes or aids cancer. Tobacco, asbestos, arsenic, radiation such as gamma and x-rays, the sun and compounds in car exhaust fumes are all examples of carcinogens. When our bodies are exposed to carcinogens, free radicals are formed and they try to steal electrons from other molecules in the body. These free radicals damage cells and affect their ability to function and divide normally.

Examples of chemicals found in cigarettes:

- **Nicotine** – this is a stimulant in tobacco. It is a chemical that is absorbed in the blood system and carried throughout the body. Nicotine makes a smoker's blood vessels smaller in diameter for a while and causes the heart to work harder. This could damage the heart, blood vessels and nerves. Nicotine is an addictive substance and is why smokers find it hard to give up smoking.
- **Tar** – this is the collective term for all the various particles suspended in tobacco smoke. The particles contain chemicals including several cancer-causing substances. Tar is sticky and brown and stains teeth, fingernails and lung tissue. Tar contains the carcinogen benzo(a)pyrene that is known to trigger tumour development (cancer).
- **Carbon monoxide** – this odourless gas is fatal in large doses because it takes the place of oxygen in the blood. Each red blood cell contains a protein called haemoglobin that transports oxygen molecules around the body. However, carbon monoxide binds to haemoglobin better than oxygen. This means that less oxygen reaches the brain, heart, muscles and other organs. You will learn more about these terms later in the unit.
- **Hydrogen cyanide** – the lungs contain tiny hairs (cilia) that help to clean the lungs by moving foreign substances out. Hydrogen cyanide stops this lung clearance system from working properly, which means the poisonous chemicals in tobacco smoke can build up inside the lungs. Other chemicals in smoke that damage the lungs include hydrocarbons, nitrous oxides, organic acids, phenols and oxidising agents.
- **Free radicals** – these highly reactive chemicals can damage the heart muscles and blood vessels. They react with cholesterol, leading to the

build-up of fatty material on artery walls. Their actions lead to heart disease, strokes and blood vessel disease.

- **Metals** – tobacco smoke contains dangerous metals including arsenic, cadmium and lead. Several of these metals are carcinogenic.
- **Radioactive compounds** – tobacco smoke contains radioactive compounds, which are known to be carcinogenic

It is important to realise that all these substances from cigarette smoke increase the tendency for blood to clot and, as a result, block the coronary arteries.

Remember, smoking does not only cause lung disorders, but many other disorders like heart diseases, emphysema, cancer and bronchitis to mention but a few. Each of these disorders will be discussed in the next session. Below is an example of a lab experiment to demonstrate the initial effects of smoking cigarettes:

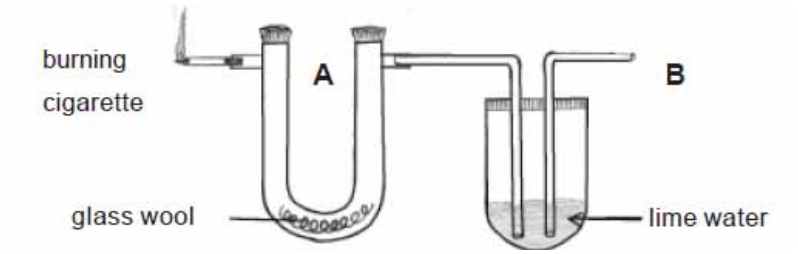


Diagram: Cigarette smoking lab

This experiment demonstrates the effect of the cigarette smoke on the glass wool and the lime water. As the smoke from the burning cigarette moves through the testing devices, there are changes to both substances in the system.

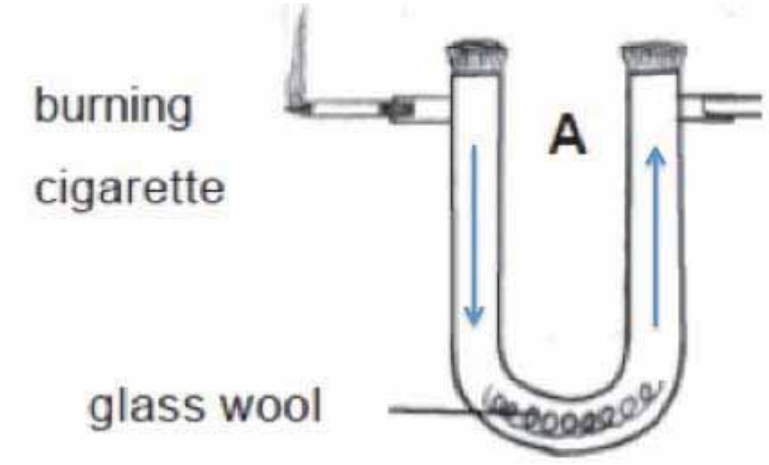


Diagram: Part A of smoking apparatus

As the burning cigarette produces smoke, it is passed through the glass wool. The glass wool starts to become stained yellowy-brown because of the various chemicals carried in the smoke. This is similar to what happens when a person smokes. The smoke is carried into the lungs and some of the chemicals get

caught in our respiratory system and can remain there for a long time, which is quite dangerous to our health.

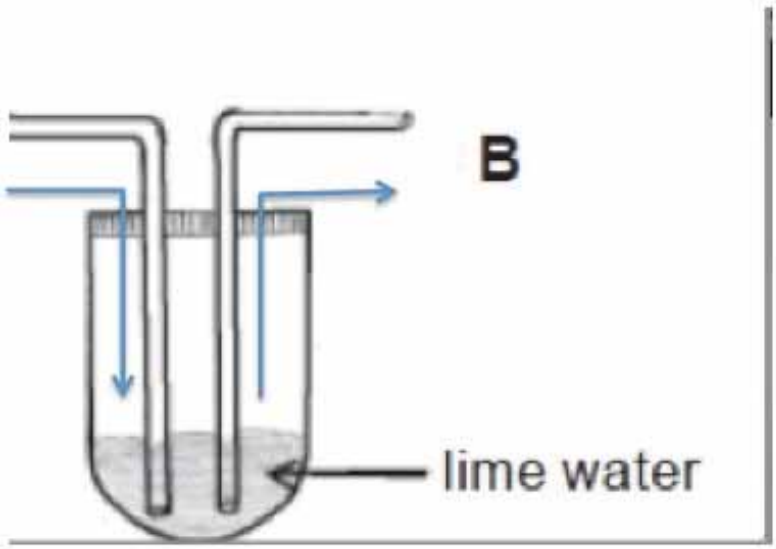


Diagram: Part B of smoking apparatus

In part B of the experiment, the lime water is collecting the carbon dioxide (CO2) that is created by the cigarette smoke. The lime water will turn a milky colour because of the C02. CO2, is another dangerous chemical to be taking into our lungs. We typically breathe in oxygen (O2) and breath out CO2. By smoking, C02 is taken into our lungs.

Diseases caused by smoking:

Cancer

What causes cancer?

Cancer is ultimately the result of cells that uncontrollably grow and do not die. Normal cells in the body follow an orderly path of growth, division and death. Programmed cell death is called apoptosis and when this process breaks down, cancer begins to form. Unlike regular cells, cancer cells do not experience programmatic death and instead continue to grow and divide, creating a mass of abnormal cells that grow out of control.

Lung cancer

Lung cancer occurs when a lung cell's gene mutation makes the cell unable to correct DNA damage and finish its normal life cycle. Mutations can occur for a variety of reasons. Most lung cancers are the result of inhaling carcinogenic substances.

Lung cancer may develop as the lungs produce new tissue to defend themselves against the constant irritation of nicotine and tar. Carcinogenic substances like tar in tobacco cause lung cancer and form a **tumour**. The tumour spreads through the lungs and destroys the normal lung tissue.

There is scientific evidence that smoking cigarettes can increase the likelihood of lung cancer. Lung cancer is one of the major killer diseases in the world. If you are not a smoker at present, please do not try it. If you are a smoker, how about giving it up? To give up smoking is difficult, but it is worth trying.

Heart diseases

It is also evident that heart diseases are more common among smokers than among non-smokers.

Emphysema

When exposed to cigarette smoke, the air sacs of the lungs produce defensive cells, called macrophages, that "eat" the inhaled particles. However, macrophages release materials that can destroy the proteins called elastin and collagen, which let the lungs expand and contract. When the tiny airways in the lungs called bronchioles are damaged, delicate walls of the alveoli become torn and broken. As a result, the lungs:

- lose elasticity they become less able to contract.
- alveoli cannot deflate completely, and the person has difficulty exhaling.
- the trapped "old" air takes up space, so the alveoli are unable to fill with enough fresh air to supply the body with needed oxygen.

Click on Emphysema to view an illustration.

Bronchitis

Bronchitis is a disease where bronchial tubes are congested. Bronchitis can be caused by:

- Viruses
- Bacteria
- Smoking
- Breathing in certain kinds of irritating chemicals

Smoking irritates the air passage to the lungs and carbon monoxide and nicotine paralyse the **cilia**. This stops the cilia in the air passage from moving, leading to inflammation of the bronchial tubes and causing them to become swollen and clogged with mucus. A person needs to cough to push the mucous upwards out of the lungs.

Bronchitis also affects the formation of material associated with irritation (inflammation); it increases, causing the passages to become clogged.

Effects of smoking on the circulatory system are as follows:

- Raised blood pressure and heart rate
- Constriction (tightening) of blood vessels in the skin, resulting in a drop in skin temperature
- Less oxygen carried by the blood
- Stickier blood, which is more prone to clotting and the increased risk of strokes and heart attacks due to blockages of the blood supply
- Damage to the lining of the arteries, which is thought to be a contributing factor to atherosclerosis (the build-up of fatty deposits on the artery walls)
- Reduced blood flow to extremities like fingers and toes

Try the self-mark activity in this section to see how well you understand the topic.

Activity 1	Design a poster on the harmful effects of smoking

Other respiratory disorders and their causes

Air pollution also contributes to some diseases. Air is polluted with smoke, dust and harmful gases. Most of these substances that pollute the air come from power stations, factories and vehicles. Click Air pollution to review the possible causes of air pollution.

Some of the pollutants affect the air passage in the respiratory system. Sulphur dioxide is one of the harmful gases produced when fossil fuels burn. Sulphur dioxide enters the air passage and makes the bronchiole contract. This makes it difficult for air to pass into the lungs.

The polluted gas in air also causes **asthma**. Athsma is a lung condition where the muscles in the walls of the bronchioles contract. When the bronchiole tubes get narrower, it is much more difficult for a person to breathe and a person wheezes.

During rainy seasons or when flowers bloom, pollen is carried into the air and causes **hay fever**, which is a type of allergy. The lining of the nasal cavity becomes sensitive and inflamed and produces a large amount of mucus. The nose runs and a person sneezes a lot.

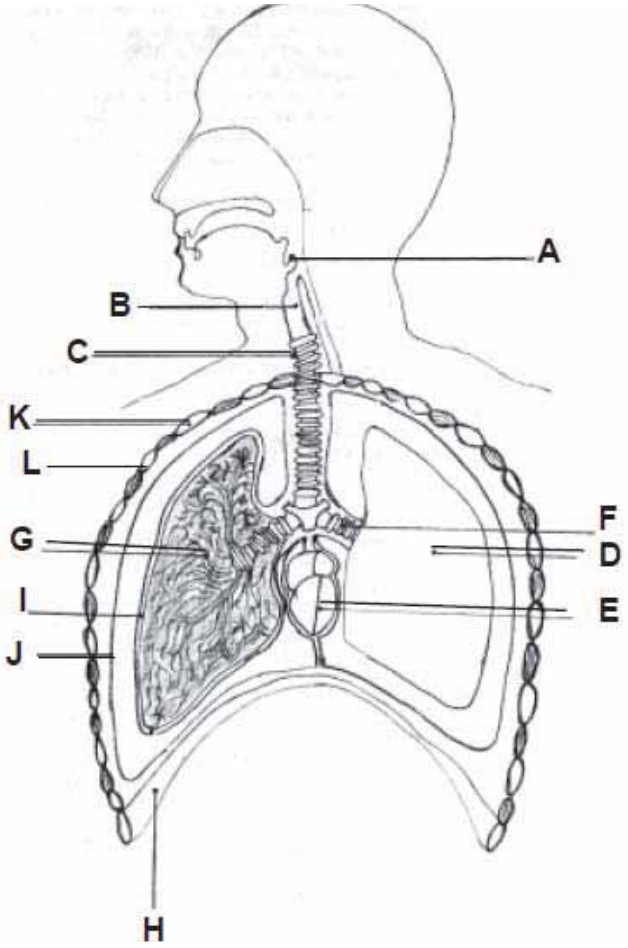
Now, complete the assignment for this section. It should not take you more than 1 hour. Remember feedback is given at the end of the unit.

Assignment 1

1. List the features of gaseous exchange surfaces.

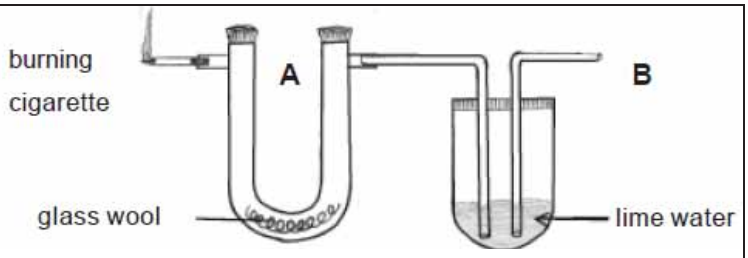
2. Describe the significance of these features for maintaining life.

3. The diagram below represents the human respiratory system. Label the parts A to L on the diagram.



4. Respiration is usually accompanied by gaseous exchange:
   a) What is gaseous exchange?
   b) Where precisely are the sites of gaseous exchange in humans?

5. The diagram below shows an apparatus set up to collect tar in cigarette smoke.



a) What is the purpose of the part of the apparatus labeled B?
b) What would you see on the glass wool after the cigarette has burned?
c) What is the function of cilia in the air passage of a healthy person?
d) When the cilia are damaged, what will happen to the mucus in the air passage?
e) How does carbon monoxide increase the risk of heart disease?

To check feedback, click on the icon

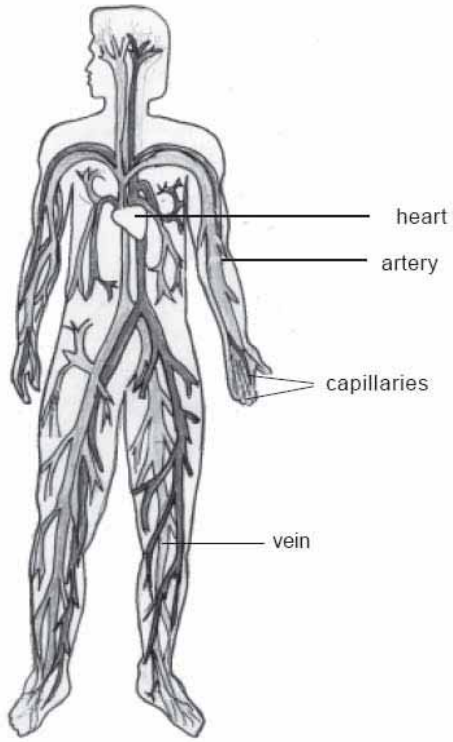
Next we will learn about blood circulation.

Blood circulation

In Section 1, we looked at how the breathing system works. In this section we will look at the heart and blood vessels, as well as the role of the circulatory system and how it works. We are going to look at the components of the circulatory system and the function of each component.

The circulatory system

The circulatory system is made up of the heart, blood vessels and blood. A blood vessel is a tube through which blood flows. Study this diagram and make sure you know all the indicated parts.



What is blood?

An adult person has approximately 5 litres of blood in his or her body. Blood consists of components suspended in a fluid called plasma. These components comprise of red blood cells (Erythrocytes), white blood cells (Leukocytes) and platelets. Blood appears red because it contains more red blood cells than white blood cells and because red blood cells contain the pigment hemoglobin.

Let us look at each of these components in turn. The functions of the components of blood are often confused therefore re-read this section if necessary.

Components of blood

Red blood cells (RBC)

The primary function of red blood cells is to transport oxygen from the lungs to the cells of the body. RBCs contain a protein called haemoglobin that actually carries the oxygen. Haemoglobin combines loosely with oxygen in the lungs where the oxygen level is high and then easily releases it in the capillaries where the oxygen level is low. Oxy-haemoglobin is haemoglobin containing oxygen and is carried to the cells of the body. Each molecule of haemoglobin contains four **iron** atoms. Each iron atom can bind with one molecule of oxygen (which contains two oxygen atoms, called O_2) for a total of four oxygen molecules or eight atoms of oxygen for each molecule of haemoglobin. The iron in haemoglobin gives blood its red colour.

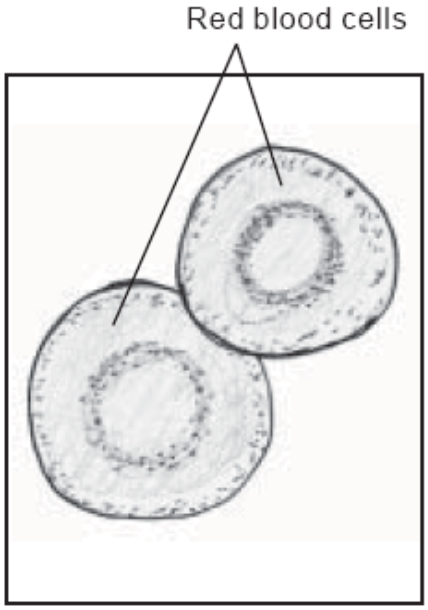


Diagram: Red blood cells (RBC's)

There are several things about RBCs that make them distinctive.

- A RBC has a special **shape** -- small biconcave disc that is round and flat, sort of like a shallow bowl.
- A RBC has **no nucleus**. The nucleus is extruded from the cell as it matures.
- A RBC can **change shape** to an amazing extent as it squeezes single file through the tiny capillaries without breaking.
- A RBC contains **hemoglobin**, a molecule specially designed to hold oxygen and carry it to cells that need it.

White blood cells

Our blood also contains white blood cells. White blood cells are larger than red blood cells and have nuclei. White blood cells are located in the lymph nodes and the spleen. Their main function is to produce antibodies that destroy foreign chemicals and pathogenic microorganisms in the blood. They are the "soldiers" of the body that protect it against disease(s). There are several types of white blood cells with different shapes and sizes. The figure below shows a standard white blood cell, and a Lymphocyte. A lymphocyte is a type of white blood cell.

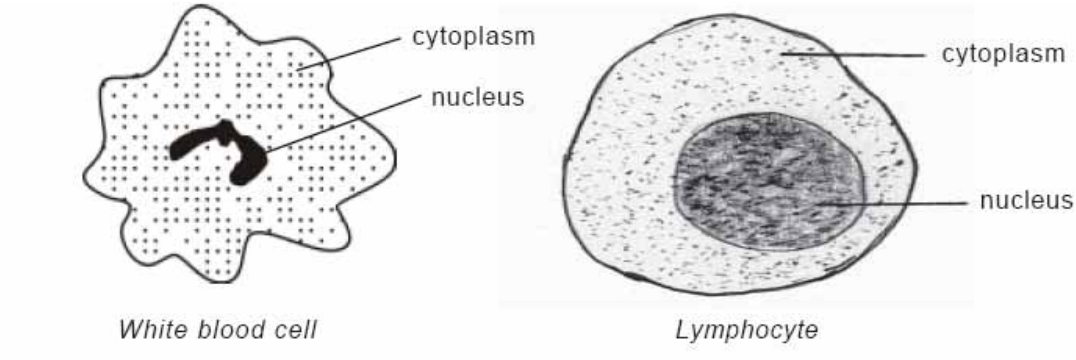


Diagram: White blood cell and lymphocyte

Platelets

Platelets are small fragments of cells formed in the bone marrow. Their function is to stop the bleeding when, for example, you cut your finger accidentally with a knife and blood flows from the cut. The platelets trap red blood cells and create a thick substance called a blood clot. This stops the bleeding. The clot hardens to form a scab.

Platelets

Plasma

Plasma is the liquid component of blood. It is a pale yellow fluid that is composed mainly of water and salt. Plasma transports hormones and waste products such as carbon dioxide. It also dissolves substances such as amino acids, glucose, vitamins, and minerals.

Plasma contains blood protein. Such protein is called **fibrinogen**. This protein helps with the clotting of blood.

Exchange of substances between blood and tissues

Between our cells there are narrow spaces filled with a watery fluid called tissue fluid. Tissue fluid is formed at the arterial end of the capillaries where high blood pressure forces fluid out through the thin walls of the capillaries into spaces

between the cells. The tissue fluid contains oxygen, glucose and amino acids. It does not contain protein molecules, because they are too large to pass through the capillary walls. Substances moving between blood and cells must pass through tissue fluid. It can only enter and leave the circulatory system through capillaries.

Cells absorb oxygen, glucose and amino acids by diffusion and active transport from the tissue fluid. Carbon dioxide and nitrogenous waste diffuse from cells into the tissue fluid at the venous end of the capillaries. Not all fluid that leaves the capillaries is returned to the bloodstream. Some filters into small lymph capillaries and become lymph. Lymph fluid forms a link between blood and cells.

Let us continue with the lymphatic system and its functions.

Lymphatic system

Lymph means clear water and it is basically the fluid and protein that have been squeezed out of the blood (i.e. blood plasma). The lymph vessels form a network throughout the body. Unlike the blood, the lymph system is a one-way street draining lymph from tissue and returning it to the blood. The lymph capillaries are very permeable.

The lymph is drained from the tissue in microscopic blind-ended vessels called lymph capillaries. The lymphatic system is a system of tiny tubes that end in tissues. Because they are not pressurized, the lymph fluid can drain easily from the tissue into the lymph capillaries. .

Click on **Lymphatic** system to view the diagram.

Functions of the lymphatic system

The lymphatic system works in close cooperation with other body systems to perform the following important functions.

- It works with the circulatory system to deliver nutrients, oxygen and hormones to the cells that make up the tissues of the body.
- It removes excess fluid, waste, debris, dead blood cells, pathogens, cancer cells and toxins from these cells and the spaces between them.
- It collects protein molecules created by cells and returns them to the bloodstream because the molecules are too large to pass through the capillaries of the circulatory system.
- It aids the immune system in destroying pathogens and filtering waste so that the lymph can be safely returned to the circulatory system.
- It transfers substances between tissues and blood.
- It returns plasma to the blood.
- It absorbs fat to discharge it to the blood.
- It aids in the destruction of bacteria by phagocytes.
- Antibodies are produced by the lymphocytes.

Now let us look at the functions of blood.

Functions of blood

Blood has some important functions. Let us discuss each in turn.

Transport

Blood transports oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. It transports dissolved food substances (glucose, fats and amino acids) from the small intestine (ileum) to various parts of the body. Blood also carries waste products from the liver to the kidneys and skin. Blood carries hormones from the endocrine glands to the tissues that need them.

Temperature regulation

Blood distributes heat from active organs (liver, muscles) to the rest of the body. The circulatory system varies the amount of blood flowing to the skin, to change the amount of heat lost from the body according to the body temperature and external conditions.

Maintaining a constant internal environment

Blood helps to maintain steady internal conditions, which is called **homeostasis**. Blood temperature, osmotic pressure, acidity and amounts of substances such as sugar, hormones and salts are best kept at constant levels so the body tissue is supplied with a fluid of constant composition. You will learn more about homeostasis in Section 3.

Healing and prevention of infection

By clotting, blood prevents fluid from being lost because of cuts and wounds. Blood prevents infection by healing wounds with clotting and destroying invading pathogenic microbes before they cause infection.

How blood flows in the body

Have you ever noticed bluish “tubes” underneath your skin on your arms? Do you know how these vessels carry blood around the body? These are tubes that carry blood and are called **blood vessels**.

Blood cannot flow through the body by itself. It is pumped through the blood vessels by the heart. Blood leaving the heart travels through blood vessels called **arteries**. Blood returning to the heart goes through blood vessels called **veins.** Very thin blood vessels, called **capillaries,** connect the arteries to the veins. It is the tiny capillaries that supply cells with glucose, amino acids, oxygen and other substances.

The blood flows twice through the heart for every complete circuit of the body. First, blood flows from the heart to the lungs and then back to the heart. This completes one circulation. Then, blood flows from the heart to the rest of the body and back to the heart. This is called **double circulation.**

Blood vessels

Arteries

These are thick-walled structures that carry blood away from the heart. The diagram below shows a cross-section of an artery.

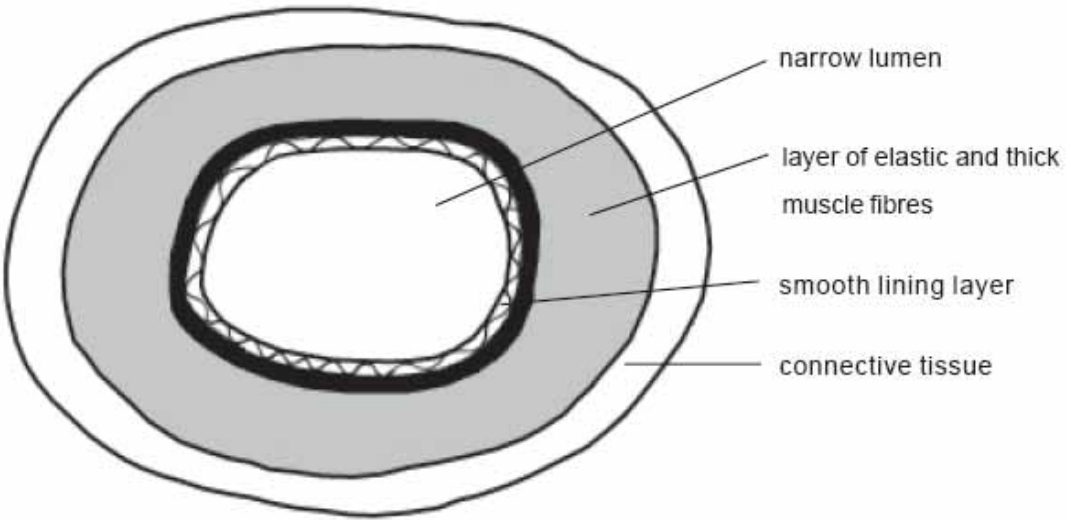


Diagram: Artery

Veins

Blood from capillaries run into **minute venules** (a small vein) and then into the veins. Veins always carry blood back to the heart. The diagram below shows a cross-section of a vein.

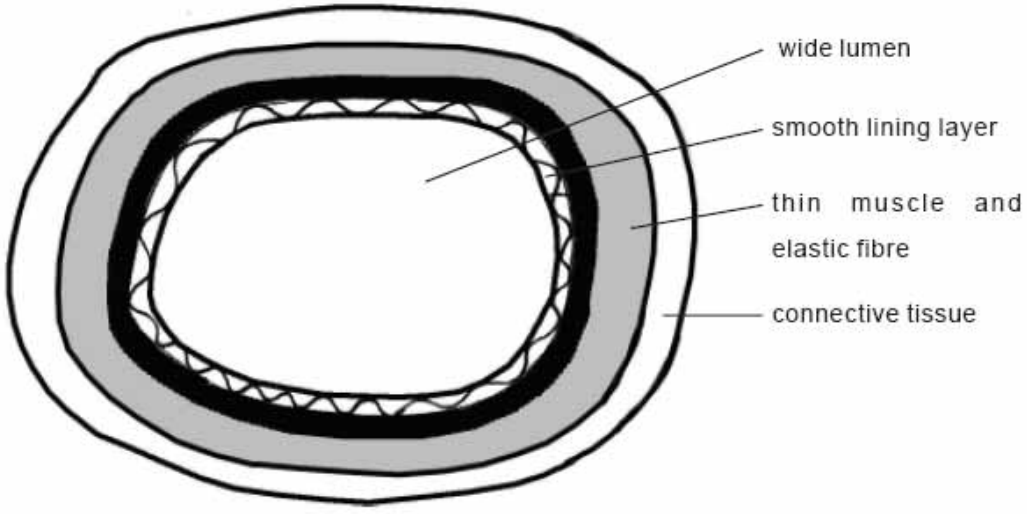


Diagram: Vein

The table below shows the differences between arteries and veins

Arteries	Veins
• blood flows away from the heart	• blood flows towards the heart
• possess thick elastic walls	• possess thin, not very elastic walls
• carry oxygenated blood except pulmonary arteries	• carry deoxygenated blood except pulmonary vein
• do not possess valves except in the aorta	• have valves to prevent back-flow of blood
• arteries are deeper in the flesh than veins	• veins are nearer the surface of the skin than arteries
• pulse is detectable	• pulse is usually not detectable
• have narrow lumen	• have wider lumen

Diagram: The differences between arteries and veins

Capillaries

When an artery enters an organ of the body, it branches into small arteries called **arterioles**, which in turn branch into many **capillaries**. Capillaries are small, thin-walled blood vessels. Blood capillaries connect arteries to veins.

The capillaries join to form **venules**. The thin walls of capillaries are permeable, to allow water and dissolved substances such as oxygen, carbon dioxide (CO_2) and dissolved food to pass in and out. Capillaries feed cells and remove their wastes. The diagram below shows a capillary circulation with an organ.

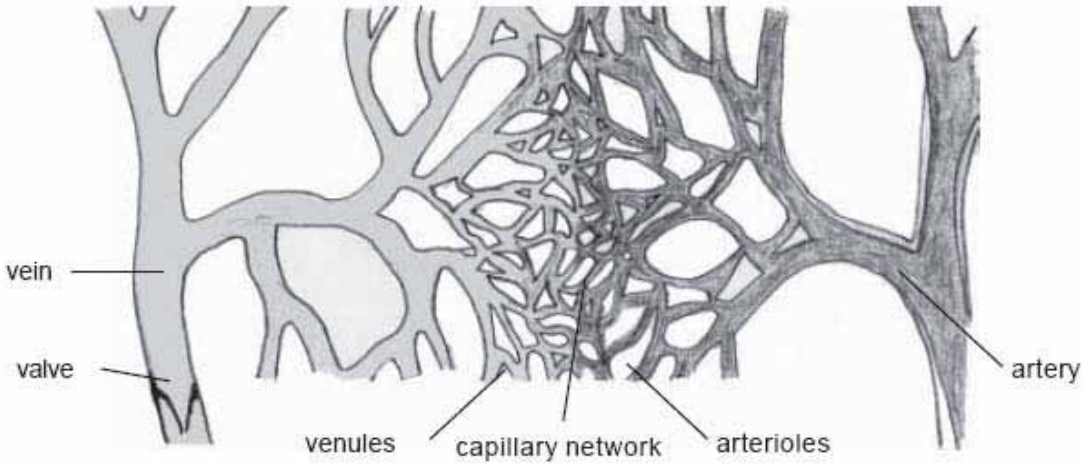


Diagram: Arteries and veins are linked by capillaries.

The heart

The main organ of the circulatory system is the heart. The heart is made up of cardiac muscle. It never stops working. Even when you are at rest or asleep, your heart still beats. The heart of an adult person weighs about 300 g. The heartbeat of a normal person is 70 beats a minute. Your heart is situated in the thoracic cavity.

Have you seen the heart of any animal? If you have not seen one, you can visit an abattoir and ask the staff there to show you the heart of any animal.

Coronary arteries supply glucose and oxygen to the heart muscles, and also take away CO_2 and other waste products.

The diagram below shows the heart of a human as seen from the outside.

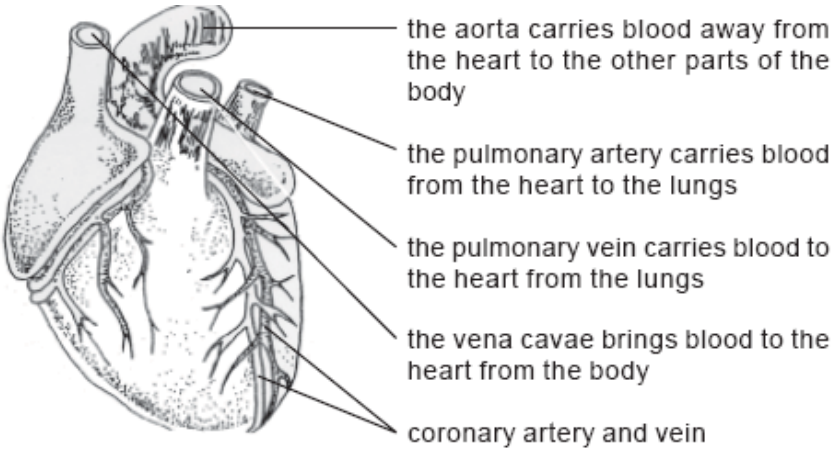


Diagram: Heart

Click here to view the video.

You must constantly refer to this diagram when you read the content that follows. The diagram below shows a longitudinal section of a heart.

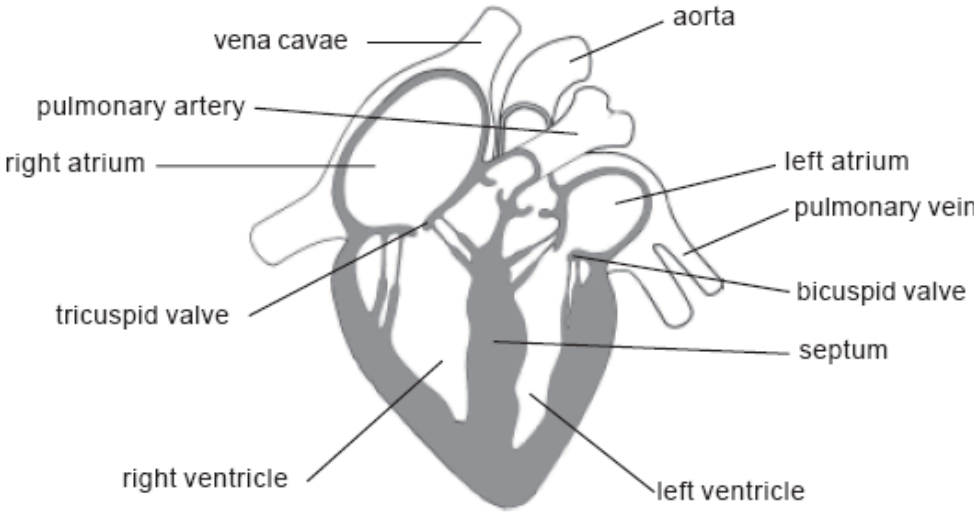


Diagram: Longitudinal section of a heart

The next section contains a number of new terms and a lot of new information. You have to read this section more than once if you find it difficult.

The heart consists of four chambers. The two upper chambers are called the **atriums** and the two lower chambers are called **ventricles**. Both atriums and ventricles have muscular walls that contract and pump blood. The left ventricle is the most muscular because it pumps oxygenated blood all round the body. The right and left sides of the heart are separated by a **septum**. Refer to the diagram and view the structure of the lower chambers.

How the heart pumps blood

The muscle of the atrium and the ventricle is supplied with food and oxygen by **coronary arteries**. The heart pumps blood by contracting. The heart becomes smaller so blood gets squeezed out into the arteries. Then, the heart relaxes again and fills up with blood from the veins.

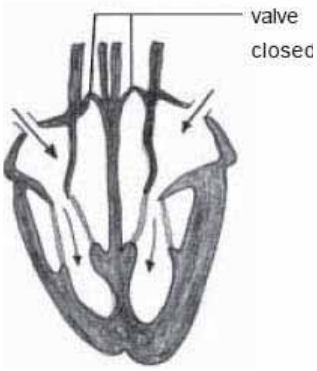
When the heart is relaxed, it is called the **diastole phase**. During this phase the atriums and ventricles relax. Deoxygenated blood from the body enters the right atrium through the **vena cavae**. As a result, the heart fills up with blood.

Deoxygenated blood (blood without oxygen) from the body enters the right atrium of the heart from the vena cavae. Look again at the diagram and make sure you see the vena cavae.

- The left and right atriums are connected with the left and right ventricles through an opening that is controlled by a **valve** which allows blood to flow only from the atrium to the ventricle.

- The valve between the left atrium and left ventricle is the mitral or **bicuspid valve**.
- The valve between the right atrium and right ventricle is the **tricuspid valve**.
- The right ventricle pumps blood to the lungs through the **pulmonary artery**.
- The **pulmonary vein** brings oxygenated blood (blood that contains oxygen) from the lungs into the left atrium.
- Oxygenated blood passes from the left atrium through the bicuspid valve to the left ventricle, which pumps oxygenated blood out into the aorta.
- Oxygenated blood from the lungs enters the left atrium through the pulmonary veins.

Do you see the aorta on the diagram? The aorta carries oxygenated blood to the different parts of the body. **Semilunar** valves are found in the pulmonary artery and aorta. Together with the bi- and tricuspid valves, these prevent the blood from flowing backwards.



When the heart contracts it is called the **systole phase**. During this phase, the atriums contract forcing blood into the ventricles through the bi- and tricuspid valves. In the systole phase, the ventricles contract and pump blood into the arteries.

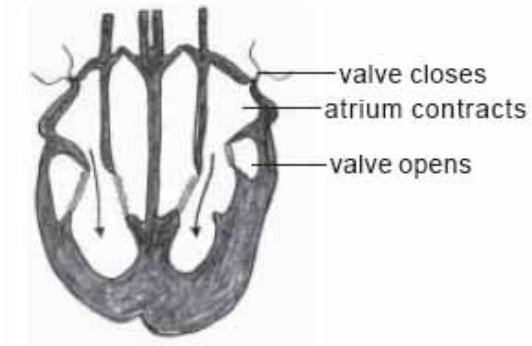


Diagram: Systole phase

Ventricular systole

The ventricles contract and the valves between the atriums and the ventricles close. As a result, the blood from the left ventricle is pumped along the aorta to the organs of the body. Blood from the right ventricle is pumped along the pulmonary artery to the lungs and forced out of the heart. One complete relaxation and contraction is called a **heartbeat.**

The pulse

The heart pumps blood round the body and the sudden expansion of the arteries as blood enters from the heart is transmitted as a pressure wave. This can be felt as a pulse at a pressure point where an artery lies near the skin. The artery can be pressed against a bone to feel the pulse.

Diagram: Photo of pulse reading

Diseases of the circulatory system

The heart needs a good supply of food and oxygen, which it gets through the blood supply carried in through the coronary arteries. If the arteries become blocked, the heart will not get sufficient blood supply. The heart muscle receives less blood and therefore less food and oxygen. It may eventually stop working. This blockage is called a heart attack. When a small part of the coronary arteries gets blocked, the heart attack is mild. When the blockage is large, the heart does not get enough oxygen and the heart attack is severe. In this case, a person may die.

If blockage occurs in an artery that takes blood to the heart muscles, a heart attack known as **thrombosis** can occur. Thrombosis means the thickened walls have reduced the diameter of the artery and it has become blocked by a blood clot.

How do arteries get blocked? A fatty substance called cholesterol can make the arteries stiff and even block them. As a result, blood stops flowing through the arteries into the heart. This is called *artherosclorosis*. Stress and tension of modern life, over-eating and drinking too much alcohol may cause high blood pressure. This puts an extra strain on the heart and may lead to heart failure.

Click here to view the video on the main causes of heart diseases.

Some risk factors include:

- lack of exercise,
- being overweight or obese,
- smoking cigarettes,
- eating too many fatty food stuffs like ice-cream, butter, eggs, fried food, fatty meat, etc,
- stress,
- physical traits like sex, age and heredity; and
- other diseases like diabetes mellitis.

Can you think of other factors that can increase your chances of suffering from heart disorders? Write your answer in your notebook. Can you think of anything we can do to decrease the chances of getting a heart attack?

You know that blood is supplied to all parts of the body through the circulatory system. This blood is pumped from the heart. The heart provides the power to drive the blood through blood vessels. To keep pumping, your heart needs food and oxygen. Your heart gets these substances from the coronary arteries that supply food and oxygen to the heart. It is vital for your health that you keep the circulatory system in good working order. This can be done by leading a healthy lifestyle.

When these arteries become blocked, the heart cannot function properly and this may result in heart diseases.

You can avoid heart diseases by:

• using less fat in your diet,

• eating food which has less cholesterol,

• eating less red meat that contains fat,

• eating fewer dairy products (butter, cream, full cream milk, etc.),

• eating fewer eggs, especially egg yolks,

• eating more fresh fruit and vegetables,

• not smoking,

• exercising regularly; and

• taking time to relax.

Click here to view the video on how to reduce the risk of heart attack.

Do the following assignment in your notebook. You should not spend more than 2 hours on this assignment. Compare your answers with mine given at the end of the unit.

Assignment 2

1. *Name two things that are transported by blood.*
2. *Explain how blood defends the body from illness.*
3. *Choose the correct word from the following list to complete the sentences*

antibodies, bacteria, haemoglobin, oxyhaemoglobin, variable, infection, platelets, white, biconcave, nucleus, red, shape, carbon dioxide, oxygen, clotting, bone marrow, tissues.

a) Blood cells are made in the .....

b) .....blood cells are smaller than ..... blood cells and there are more of them.

c) Red blood cells are ....., or disc-like in shape.

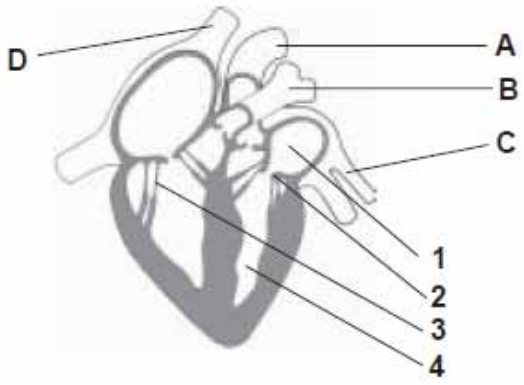
d) Red blood cells have no ..... and are filled with a substance called .....

e) In the lungs ..... diffuses into red blood cells and combines with ..... to form .....

f) In this way oxygen is carried round the body to the .....

g) Red blood cells also carry small amounts of .....

4. The diagram below shows a section through a mammalian heart.



a) i)label the parts 1 to 4

ii) State whether the parts labeled A, B, C and D are arteries or veins and name them.

	A ..... *B .....* *C .....* *D .....* *To check feedback, click on the icon*

Blood carries water and oxygen to the body. Excess water and other waste products need to be removed from the body. The next topic deals with excretion.

Excretion and water balance

Your cells respire and produce waste materials such as carbon dioxide and water. Excess amino acids cannot be stored in the body.

The removal of waste products is important. The process of regulating and maintaining water balance is another function in our body. This is done by an organ system called the **excretory system**. **Excretion** is the removal of chemical waste products produced during metabolic reactions. Egestion is the removal of waste products that were never absorbed and used by the body. You will also learn about the functions of water and the regulation of the water content in the body in this section.

Think carefully and explain how these waste products may be removed from your body. Write your ideas in your notebook.

Examples of how products are removed from the human body:

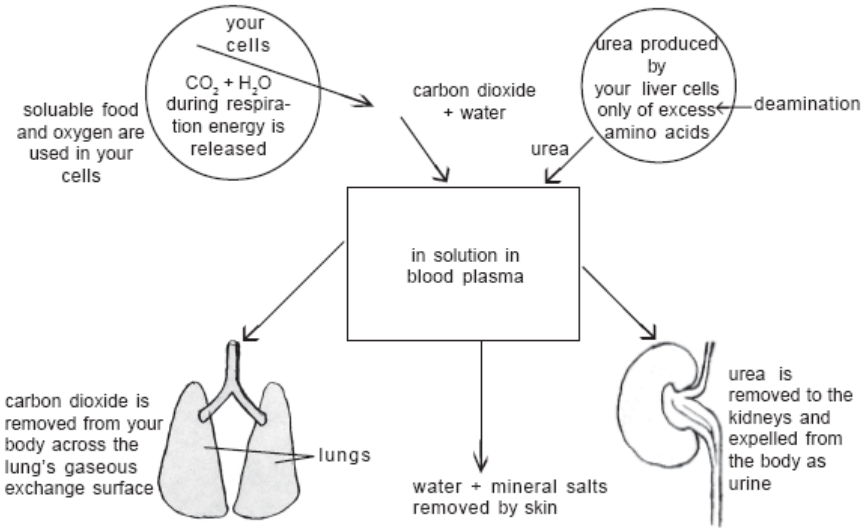


Diagram: Product removal from body

Excretory products in human beings

Carbon dioxide and water are formed as a result of tissue respiration in your body. Your body excretes water, carbon dioxide and nitrogenous compounds.

The word equation is as follows:

glucose + oxygen =? carbon dioxide + water + energy.

Sources of nitrogenous waste

Nitrogenous compounds come from excess or unusable protein in a diet and from the breakdown of damaged and dead cells. The liver breaks down and deaminates this protein into amino acids. Deamination is the process by which amino acids are broken down if there is an excess of protein intake. The amino group is removed from the amino acids and converted into glucose and urea. Most waste products containing nitrogen are toxic (poisonous) and must therefore be removed quickly and efficiently.

The human excretory system

Study the diagram below and make sure you know all labelled parts.

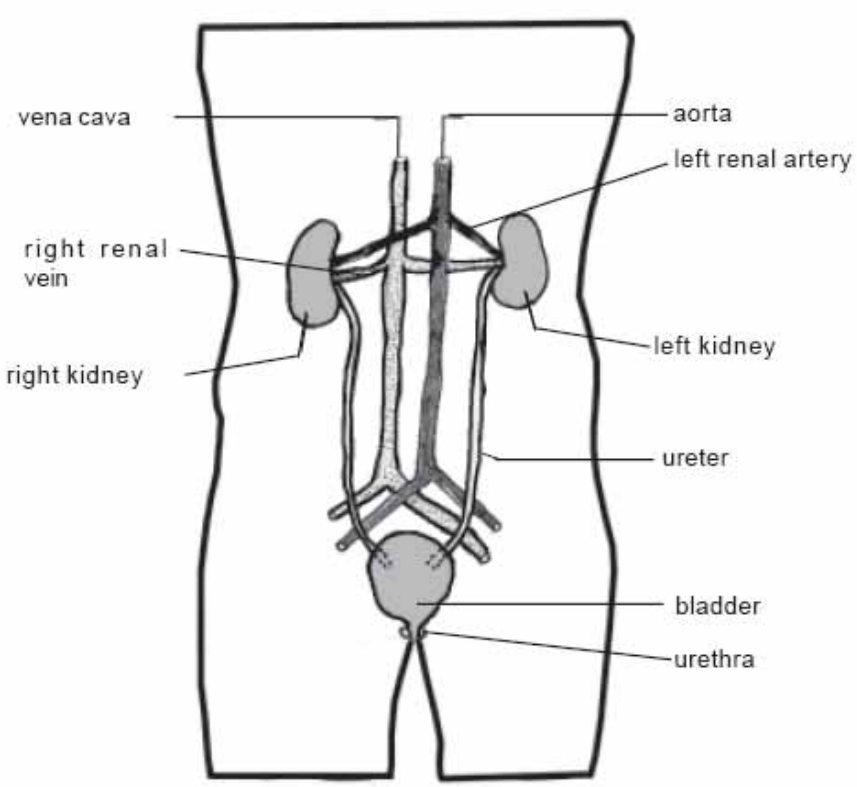


Diagram: Human excretory system

The kidneys

There are two kidneys in your body and they play an important role in the excretory system. Unused proteins are changed into amino acids, which are converted into urea. Urea produced in the liver is carried by the blood to the kidneys. As blood enters the kidneys through the renal artery, it carries urea and oxygenated blood.

The kidneys produce a solution of urea in water called urine. The **renal vein** takes deoxygenated blood away from the kidneys. The **ureter** connects the kidneys are connected to the **bladder**. The bladder is drained of waste by the **urethra**, which opens directly outside in females and through the penis in males.

Composition of urine - *normal person*

- proteins 0%
- urea 2%
- uric acid 0.05%

• ammonia 0.05%

• water 95%

• chloride 0.6%

• other substances 1.8%

Did you know?

- Only a small portion of kidney tissue is used at a given time. As a result, a person can live with just one kidney.
- More than a litre of blood is filtered through each kidney every minute of the day.

Let us look at two other excretory organs.

Excretion by the skin: Excretory substances (e.g. mineral salt) and water leave the body as sweat. When you exercise, you sweat a lot. Sweat contains waste products. Sweat is produced in the sweat glands. A sweat gland is a coiled tube and lies in the dermis but opens on the skin's surface into a sweat pore. The sweat gland is well supplied with blood capillaries and water

Excretion by the lungs: We already talked about the breathing system in Section 1. You may remember that, during expiration, the breathing system removes carbon dioxide and water vapour. The lungs are excretory organs, because they help your body get rid of carbon dioxide. Carbon dioxide and water vapour are waste products of cell respiration. It diffuses out of the blood into the air in the alveoli of the lungs and is breathed out with expired air. Carbon dioxide in the lungs is poisonous and must therefore be removed from the lungs.

Maintaining water balance

You keep many things constant inside your body. Examples are body temperature and the level of glucose in the blood. The process of keeping the internal environment (body fluid) constant is called **homeostasis**. Your body needs a water balance because the amount of water in body fluids must be kept steady. When the amount of water taken in by the body is not sufficient, the body will soon become **dehydrated**. To carry out vital functions, there must be enough water in the body. When the amount of water is too little, dehydration takes place in cells.

Water is constantly lost from and gained by the body. Do you agree?

You take in water by drinking tea, water, coffee, juices, soft drinks and milk. You also take in water by eating watery foodstuffs like fruit and vegetables. Your body also makes a little water as a by-product of tissue respiration. Water is lost from the body through urine, sweat, expired breathed air and faeces.

You feel thirsty when you do hard work or a lot of exercise. Thirst is an indication that your body needs water and that you are **dehydrated**. Your blood becomes too concentrated when you do not drink enough water.

When your body is dehydrated, special cells in your brain detect it and secrete a **water retention hormone**. This hormone passes through the blood stream to the kidneys and alerts them to **reabsorb** more water into the blood stream. More concentrated urine is formed. This is why the volume of urine decreases and it

has a yellowish colour on a hot day or after doing exercise. This is how your body maintains the concentration of blood and water balance.

When you drink water your blood becomes diluted. Some of the water moves through the kidneys to the bladder. Fewer water retention hormones are secreted and diluted urine is formed. Water is removed as urine. Your bladder is full and you feel the need to urinate. In this way your body regulates its water balance.

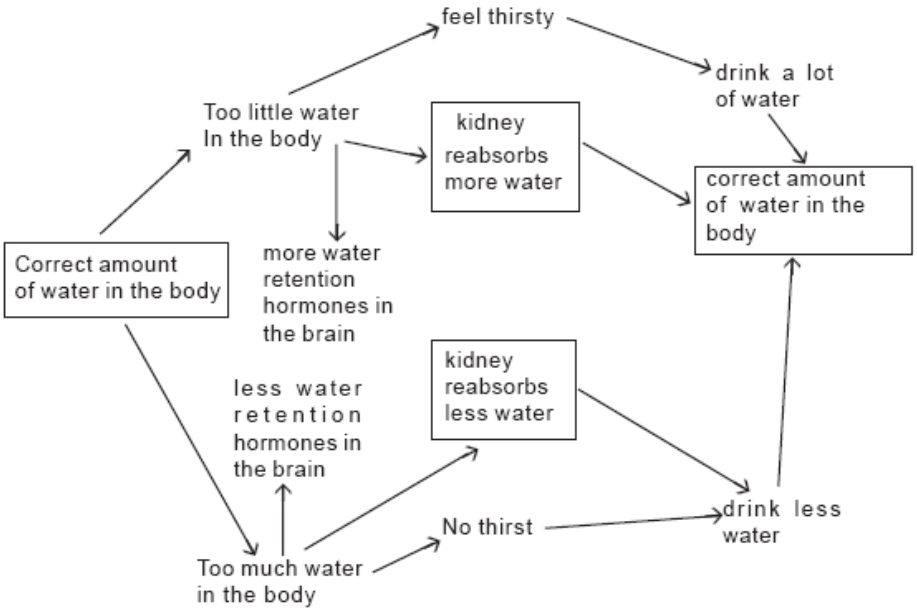


Diagram: Water balance in human system

Feedback control of water retention hormone

The flow diagram above explains how the water retention hormone works.

It is again time for an assignment. Do it in your notebook and compare your answers with mine at the end of the unit.

Assignment

Assignment 3

1. What is urea?
2. Where in the body is urea formed?
3. Name the process by which it is formed in the body
4. Name two organs that are responsible for removing waste substances from the human body.

To check feedback, click on the icon 

How did you find the assignment? If you found it challenging, go through the section once again. The next topic will deal with yet another important system, the nervous system and hormonal control.

Nervous system and hormonal control

When you run a 100-metre race, many things happen in your body. While running, your muscles contract and relax so that the running action is smooth and efficient. During the race you breathe rapidly and your heart beats faster. After the race your heartbeat and breathing rate return to normal. All the activities need to be controlled and co-ordinated. This is done by two systems, the nervous system and the hormone system. In this section we will discuss the nervous system and hormonal control.

The nervous system

In this section, we will look at how the nervous system receives and interprets stimuli and coordinates activities in your body. Your body is able to detect stimuli around it and react to any changes. This ability is called **sensitivity**.

Sensitivity is the job of the nervous system and allows you to get food and avoid danger. The nervous system is composed of two parts, the central nervous system (brain and spinal cord) and the peripheral nervous system in which nerves are connected to receptors (sense cells) and effectors (muscles and glands). The nervous system coordinates between **stimulus** and response.

The parts of the nervous system

The diagram below shows the main parts of the central nervous system.

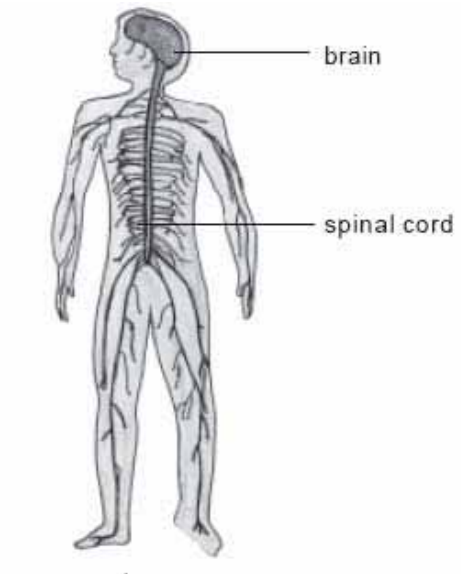


Diagram: Main Parts of the Central Nervous System

A. The central nervous system

The central nervous system is composed of the brain and the spinal cord. The brain is found inside the skull and the spinal cord in the backbone. The brain and the spinal cord need to be protected. The delicate tissues of the brain and spinal cord are enclosed within tough protective membranes. These membranes secrete cerebrospinal fluid, which helps to protect the brain and spinal cord by acting as a shock absorber.

The central nervous system contains grey and white matter. The grey matter contains cell bodies and blood vessels while the white matter consists of nerve fibres.

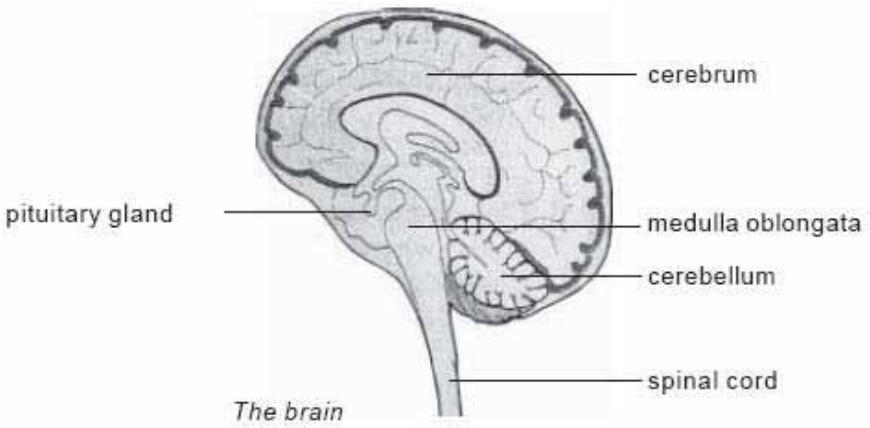


Diagram: The Brain

The brain is a large, delicate organ made up of three parts: the cerebrum (made up of two cerebral hemispheres), the cerebellum and the medulla oblongata.

The functions of the parts of the brain are as follows:

- The cerebrum is the centre of intelligence and consciousness.
- The cerebellum also co-ordinates the working of the muscles for balance, for posture and movement.
- The medulla oblongata controls breathing, heart rate, blood flow and temperature.

The spinal cord is an extension of the brain. It is protected by the vertebral column. It contains spinal nerves that connect all parts of the body.

B. The peripheral nervous system

The peripheral nervous system consists of nerves that connect the central nervous system with all other parts of the body. The nerves are made of thousands of long thin nerve fibres that provide the central nervous system with information about what happens inside and outside the body.

Now, let us study the nerve cells.

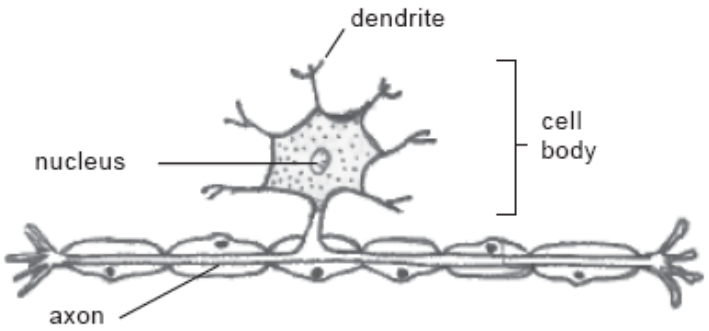
Nerve cells

The nervous system and nerve fibres are made of nerve cells called **neurons**. Each neuron consists of a cell body that allows numerous branching processes. Processes that direct impulses away from the cell body are called *axons*. Processes that send impulses towards the cell body are called *dendrites*.

There are three types of neurons that differ in function and shape; they are described and shown below.

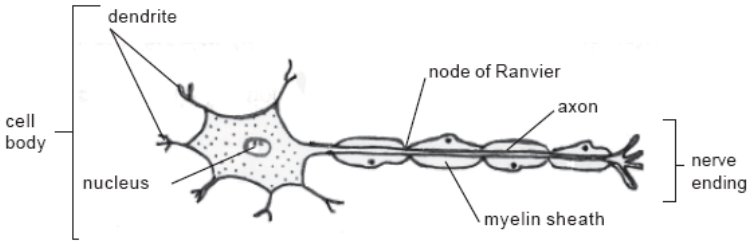
Sensory neurons

Sensory neurons conduct **impulses** from sensory cells (receptors) to the brain or spinal cord. Their dendrites are connected to sensory cells. The cell bodies of the sensory neurons are located in the spine.



Motor neurons

Motor neurons conduct impulses from the brain or spinal cord to the muscles and glands (effectors). The cell body of the motor neuron is either located in the brain or the spinal cord and it has a long axon which carries the impulses to the muscles for example.



Intermediate neurons

The intermediate neurons are found in the brain or spinal cord. Intermediate neurons have many short dendrites that collect messages from other neurons in the brain or spinal cord. Intermediate neurons connect the sensory neurons to the motor neurons.

The junction between two neurones is called a **synapse**. There are millions of these synapses in the nervous system. They act like miniature switching stations, where the arrival of one impulse causes the start of another impulse in the next neurone. The synapses form the basis of the mechanisms of the nervous system.

This is a lot of new information. If you did not find it easy to understand, please read the information again.

Functions of the peripheral nervous system

Here is a list of the functions of the peripheral nervous system:

- It conducts impulses rapidly from sensory cells to the brain or spinal cord and from there to the organs that respond.
- It controls or directs the activities of different parts of the body.
- It coordinates the activities of various parts of the body into a common action e.g., playing a guitar or sewing a dress.

Functions of spinal cord (reflex arc and reflex action)

The simplest form of reaction in the nervous system is **reflex action**. A reflex is a response that we cannot control and is called an **involuntary action**. A reflex action is a rapid involuntary response to a stimulus and is not under conscious control of the brain. The basic path of a reflex arc is shown below in the order in which the action is produced.

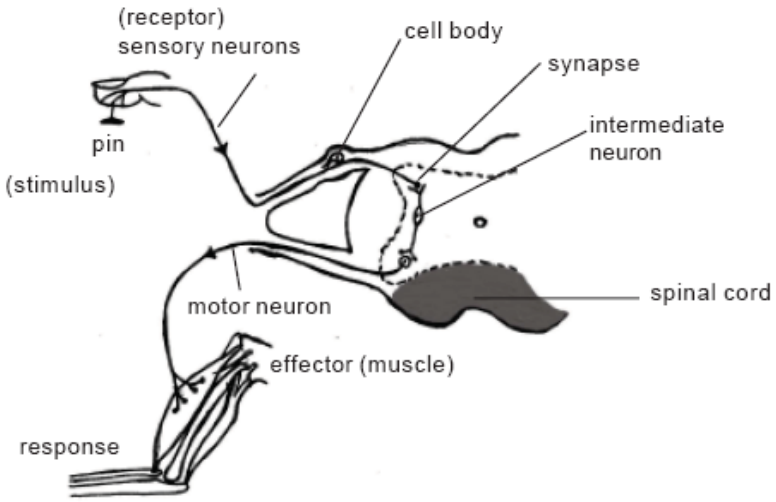


Diagram: Reflex Action of Pin Prick: The pin prick is a stimulus, creating an involuntary response, which is the action of the muscle pulling away from the pin.

As shown in the diagram, the first neuron to fire because of the pin prick is the **sensory neuron**. The signal is picked up by the **intermediate neuron**. This causes the **motor neuron** to fire, which in turn creates the involuntary response: the person pulls their hand away from the pin.

Some other examples of involuntary responses are:

- when a hungry person smells food, the salivary glands secrete saliva;
- the heart beating; as well as
- breathing and blinking.

Voluntary action

Voluntary actions involve conscious thought. Voluntary actions are controlled by the cerebral cortex in the brain and not by the spinal cord. *Can you think* of *and write down some examples of voluntary and involuntary responses in your notebook*.

Some examples of voluntary responses are:

• smiling and waving your hand when seeing your friend;

• jumping over a thorny bush;

• running away from a charging bull;

• holding a falling toddler and

• catching a book falling from a bookshelf.

Try to think of other examples of voluntary responses.

Negative influences on nervous system functions

Many things influence the normal functioning of the nervous system negatively. Two examples are alcohol and drugs.

The word **drug** is used to describe any chemical substance that changes the way the body works. Medicines are useful drugs that improve the health of people or that help fight diseases. Medical drugs kill microbes. Drugs are sometimes not used correctly or are used for other purposes and may be harmful. We say that drugs are abused. Many drugs are illegal, because of their risk to our health. These include hard drugs like cocaine and heroin and soft drugs like cannabis and ecstasy.

When a person takes a drug regularly, he or she becomes dependent on it. Then, he or she becomes addicted. Hard drugs such as heroin and cocaine are particularly **addictive**. Once the body has become used to it, trying to go without it causes painful withdrawal symptoms. Addiction may alter a person's lifestyle and relationships with others. Continued abuse of drugs can irreversibly damage the body.

Let us study the influences of alcohol and drugs on the nervous system.

Alcohol and drug abuse

A great variety of people drink alcohol. The way we use alcohol affects our lives. In most Namibian communities, a variety of alcoholic drinks are available in shebeens and bottle stores. The type of alcohol contained in many drinks is **ethanol**. It is a drug that is absorbed through the stomach.

Alcohol can affect the nervous system if it is misused. Drinking large quantities of alcohol is **sedative**.

Excessive consumption of alcohol has many long-term and short-term effects, including the following:

- slowed reflexes may lead to dangerous driving and sometimes death,
- inhibition of nerve conduction,
- depression in the visual centre of the brain leads to poor coordination and as a result accidents may happen,
- depression in the breathing centre of the brain may cause death,
- lack of appetite may cause malnutrition,
- irritation of the lining of the stomach causes vomiting; and
- conversion products to the liver causes hardening of the lining of the liver passages and destruction of sperm leads to infertility.

Listen to the audio by clicking on the icon.

Audio clip - Effects of alcohol.mp3

Double click to hear audio.

The diagrams below show examples of people who abuse alcohol.

Audio clip - Drug addict.mp3

Double click to hear audio.

The effects of drugs on the body

Some people in Namibia use drugs like **dagga** and **mandrax**. Dagga affects the nervous system in many different ways, for example by slowing down motor-control. Mandrax is a sleeping pill that has a calming effect. When mandrax is taken for a long time, the nervous system may be damaged. It can even cause death.

Drugs cause many social problems. People who use drugs regularly may experience behavioural problems. They may become anti-social, irresponsible and use abusive language, which are behaviours that society may not accept. They sometimes cannot cope with their work or education.

When a person takes drugs regularly, he/she may also end up taking an overdose of the drug. This can frequently lead to death. Mixing alcohol and other

drugs is very dangerous. The combined effect damages the heart and a person may even die.

Audio clip - Hormonal control.mp3

Hormonal control

Listen to the audio by clicking on the icon.

Imagine that you have hit the jackpot and won 1 million Namibia dollars. You will definitely be excited and very happy. Perhaps your heart rate will increase while you are excited. Do you know what makes you so excited?

This is due to hormonal activities in your body. In this section we will look at what hormones are and what they do in our bodies. Hormones are chemicals produced in glands that control the activities of the body.

You know how the nervous system works. The hormone system and the nervous system coordinate and help different parts of the body to work together. Hormones are produced in glands and released into the bloodstream. The blood carries the hormones through the body to specific cells or organs. Hormones take longer to move through the body than an impulse from the nervous system.

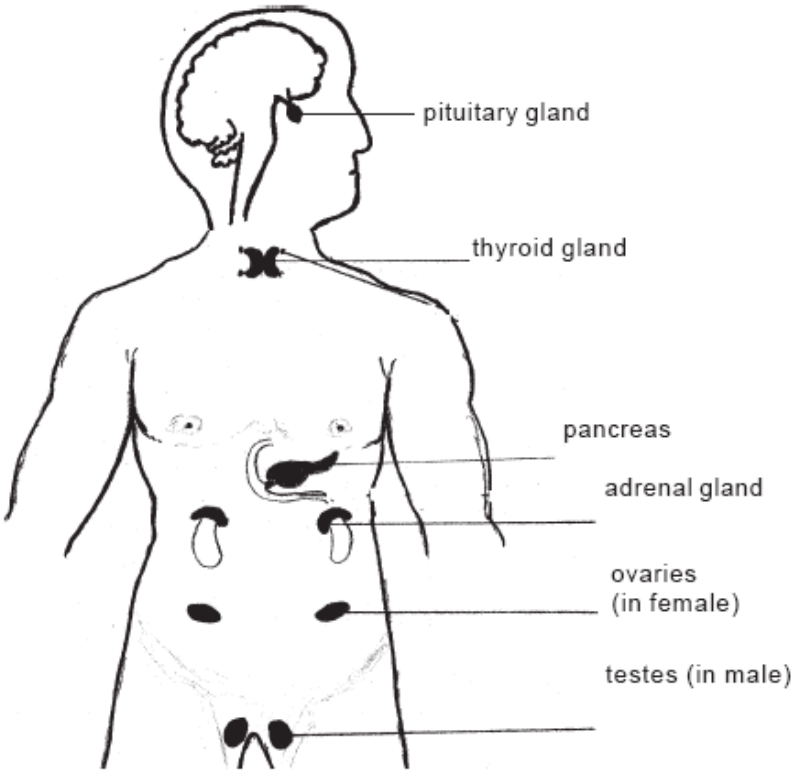


Diagram: Showing the location of glands that produce hormones.

Some Important Applications of Hormones.

Let us study the hormones secreted by the different glands in the body.

The growth hormone

The growth hormone is secreted by the pituitary gland during childhood. If the pituitary gland does not work normally, growth is affected. A person with too few growth hormones becomes a **dwarf**. A person with too much of the hormone may suffer from **gigantism**.

Photo of a dwarf

Thyroxine

The **thyroxine hormone** is secreted by the thyroid glands. Thyroxine stimulates the metabolic rate. In children it is essential for growth. A common cause of thyroxine deficiency is lack of iodine in the diet, because iodine is an important constituent of thyroxine. Remember that, when the body lacks iodine, the person may also suffer from goitre.

Insulin

The pancreas produces a hormone called **insulin**. Insulin promotes the absorption of glucose from the blood by the cells of the body. Insulin reduces the level of glucose in the blood. Diabetes mellitus is an illness caused by insufficient insulin produced in the pancreas that causes high blood glucose. Diabetes is treated by giving patients daily insulin injections. In some cases, a special diet or tablets can be control diabetes.

Adrenaline

The adrenal gland produces **adrenaline**. This hormone is called the "fight or flight hormone" because it prepares the body for action. It speeds up heartbeat and breathing and raises blood pressure. It also allows more glucose to be absorbed into the blood to give you energy.

Testosterone

The hormone Testosterone is primarily produced by the testes in males, and by the ovaries in females. One attribute of testosterone is it helps with creating muscle mass.

Finally, we will look at the table below, which summarizes the differences between nerve and hormonal control.

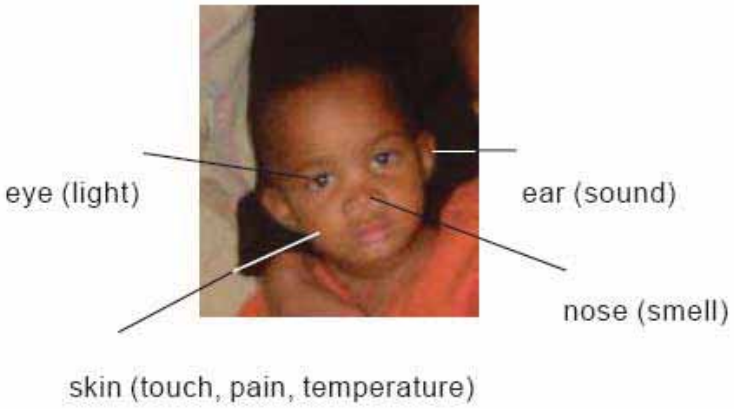
	Nervous control	Hormonal control
Stimulus	Through receptors, eyes, nose or external receptors like light, sound, temperature	through external or internal receptors blood and circulatory system
linking mechanism	central nervous system and nerves	blood and circulatory system
effectors	muscles and glands	whole body, organs or organ systems
speed	rapid reaction, reflex arc or voluntary nerve paths	slow for some such as growth; rapid for others such as fight or flight hormone; adrenalin.

Table: The differences between nerve and hormonal control

Sense organs

Why do you quickly pull your hand away when you accidentally touch a hot plate? It is because your sense organs tell you to do so. You receive information about changes as **stimuli** around you through your sense organs. Can you think of some sense organs?

Eyes, ears, tongue, skin and the nose are all sense organs and you use these organs to detect stimuli from the environment. The picture below shows some of the sense organs.



Examples of Sense Organs

The sense organs have nerve cells called **receptors**, which are able to detect stimuli. The stimuli are changed into nerve impulses. When a sense organ detects a stimulus such as sound or light, it sends messages along nerve cells to the brain. A nerve is a special cell and the brain is an organ.

The skin is the largest sense organ and responds to a range of stimuli such as touch, pressure, heat, pain or cold. The eye is a sense organ that responds to the stimulus of light. The ear responds to sound, the nose to smell and the tongue to the stimulus of taste.

Let us look at the importance of the sense organs.

The eye

Close your eyes for a few minutes and think of problems faced by those who are blind. You will realise how important your eyes are. They are located in sockets in the skull. The skull helps to protect them from damage. You will learn more about the skull in the next section. The eyes are held in place by muscles. These let you move your eyes from side-to-side, up and down and also to rotate the eye.

The diagram below shows a cross-section of an eye.

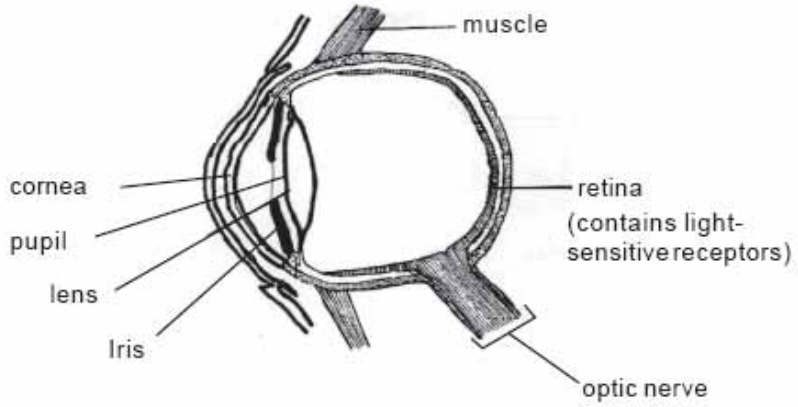


Diagram: Cross Section of an Eye

How you see things

When you look at something (an object like a person, a pencil, etc.), light goes from the object to your eye like this:

object → cornea → pupil → lens → retina.

An upside-down picture of the object is formed on a layer called the **retina** at the back of your eye.

Look at the diagram of the eye again and try to locate the retina to help you understand the process better. The retina contains light-sensitive nerve cells. It sends nerve impulses (messages) along the optic nerve to your brain. The brain interprets the message as vision and you see the object the right way up.

The ear

The ear is a sense organ that responds to sound waves, and to the orientation and movement of the head. The ears give you a sense of hearing and balance.

The sense of hearing is important to humans and all living organisms because it warns us against danger and helps us to communicate. You have one ear on each side of the head. This helps you tell where sound comes from. Ears change vibrations in the air into nerve impulses, which travel to the brain where they are interpreted as sound.

Are you enjoying studying this part? Please do the following self-mark assignment to check your progress so far. Remember to compare your answers with mine given at the end of the unit.

Assignment

Assignment 4

1. What is the central nervous system?
2. Why is it important for the body to be coordinated?
3. What is the difference between a nerve and a neuron?
4. Column A contains the structures of the brain and Column B contains the functions of the brain. Match the structures in Column A with the functions in Column B.

Column A	Column B
a) cerebellum	i) memory and reasoning
b) medulla	ii) balance and muscular coordination
c) cerebral hemisphere	iii) control of heartbeat and breathing
d) mid-brain	iv) eye movment

5. Some drugs and alcohol are addictive. What does this mean?
6. List the changes that take place in the body of a heavy drinker.
7. Complete the following table.

Sense organ	Stimuli
Ear	
eye	
nose	
tongue	
skin	

To check feedback, click on the icon 

We have come to the end of this unit. Go through the summary that follows to emphasise the important concepts.

Unit summary

 Summary	In this unit you have learned that : • the respiratory system consists of the nose, larynx, tracheas and lungs. • gaseous exchange takes place in the alveolus. • the alveolus is a single cell wall with a moist surface and blood capillaries. • during inspiration the intercostal muscles contract and the ribs move upwards while the diaphragm muscle contracts and flattens' • during expiration the intercostals muscle relaxes and the ribs are lowered while the diaphragm muscle relaxes and moves upwards. • breathed-in air contains more oxygen and less carbon dioxide; whereas breathed-out air contains more carbon dioxide and less oxygen. • breathing rate increases during exercise. • diseases caused by smoking are heart diseases, emphysema, cancer and bronchitis. • the circulatory system is composed of the heart, blood and blood vessels. • red blood cells carry oxygen to all parts of the body. • arteries carry blood away from the heart. • veins carry blood to the heart. • capillaries connect the arteries and veins. • blood is pumped through the body by the heart. • the heart consists of four chambers, including the left and right atriums and the left and right ventricles. • excretion is the removal of metabolic waste products from the body. • the three types of excretory products are water, carbon dioxide and nitrogenous compound. • the nitrogenous waste is obtained from protein by the process of deamination. • the kidneys get rid of excess waste chemicals such as urea, salt, toxins and water but reabsorb useful substances such as glucose, mineral salts and some water. • waste products are excreted through the pores in the skin as sweat. • the lungs also expel waste products (carbon dioxide and water). • the body regulates the amount of water lost and gained by maintaining its water balance. • the water retention hormone controls the maintenance of water balance. • the nervous system controls all the activities in the body. • the nervous system is composed of the central and peripheral nervous system. • the basic unit of the nervous system is the neuron (nerve cell). • the three types of neurons are sensory, motor and intermediate. • impulses from the body to the brain or from the brain to the body pass through the spinal cord. • the central nervous system consists of the brain and the spinal cord. • the peripheral nervous system is composed of nerves connected to receptors and effectors.

	• conscious actions are controlled by the brain. • reflex actions and reflex arcs are involuntary responses to a stimulus and the nerve path is taken from receptor to effector in a specific reflex action. • alcohol can be harmful if it is taken in large quantities over a long period of time. • it affects the nervous system and the liver. • drugs are chemicals that affect the nervous system. Drugs used as medicine heal the body but can be dangerous if abused. • hormones are chemicals produced by body glands that control some activities in the body. • hormones are released in the blood, which carries the hormones to different parts of the body. • growth hormones (thyroxine) are produced in the pituitary gland and stimulate growth. • thyroxine hormones stimulate the metabolic rate. • insulin is a hormone that controls blood sugar levels. • diabetes mellitus is an illness resulting from too little insulin being produced. • adrenalin is produced in adrenaline glands and prepares the body for action (flight or fight).

You tutor-based Assessment will follow.

Assessment

Assessment

Unit 5 - Assignment

Answer all questions on the space provided.

Multiple choice questions

1. Which structure in the human body is adapted for gaseous exchange?

A. alveolus

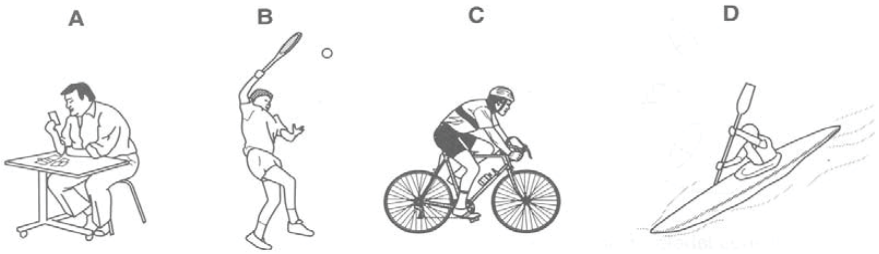
B. bronchus

C. villus

D. trachea

Answer……

2. The diagrams below show how four people often spend their leisure time.



Which person A, B, C or D is most at risk from heart disease?

Answer……

3. A kidney can remove certain substances from the blood. Which one of the following combinations is correct for the substances water and urea?

	Water	Urea
A	All	Some
B	none	some
C	some	all
D	some	none

Answer……..

4. Which part of the central nervous system is directly associated with the learning process?

A. cerebellum

B. cerebrum

C. medulla

D. spinal cord

Answer……..

5. As you grow, the cells in your body divide and become more. How does your body control this process?

A. with nerves impulses

B. with hormones produced in the stomach

C. with hormones produced in the pituitary gland

D. with nerve impulses from the muscles

Answer……..

6. Which organ is both an excretory and sensory organ?

A. kidney

B. liver

C. lung

D. skin

Answer……..

7. Which statement describes the process of excretion in humans?

A. The release of digestive enzymes from the pancreas.

B. The release of insulin from the pancreas.

C. The removal of carbon dioxide through the lungs.

D. The removal of undigested food through the anus.

Answer……..

8. The hormone produced by the testes is:

A. adrenalin

B. insulin

C. testosterone

D. thyroxine

Answer……..

9. Which blood vessel takes deoxygenated blood to the heart?

A. aorta

B. coronary artery

C. pulmonary vein

D. vena cava

Answer……..

10. Which of the following is an involuntary response?

A. catching the ball

B. chasing a fly away

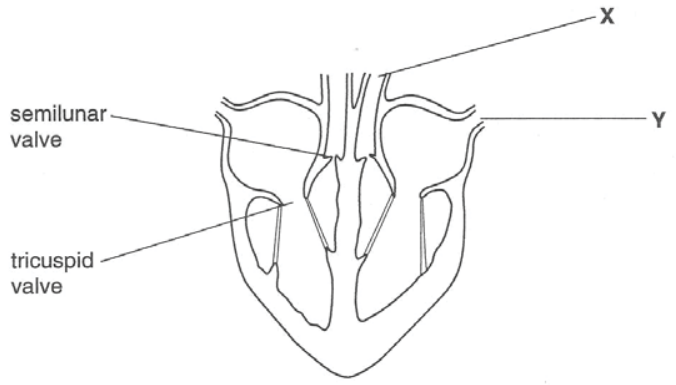
C. beating of the heart

D. nodding one's head

Answer……..

Structural questions

11. a) The diagram below shows a section through the heart.



(b) Identify the blood vessels X and Y.

X……

Y…….. (2)

(c) State the functions of the valves within the heart.

……

……

……(2)

(d) Explain why the wall of the left ventricle is thicker than the wall of the right ventricle.

……

……

……(2)

(e) Suggest two activities of humans that might cause a clot in a coronary artery.

……

……

……(2)

(f) Explain what might be the result of such a blockage.

.....

.....

.....(2)

12.(i) Name two types of stimuli detected by the skin.

1. .....

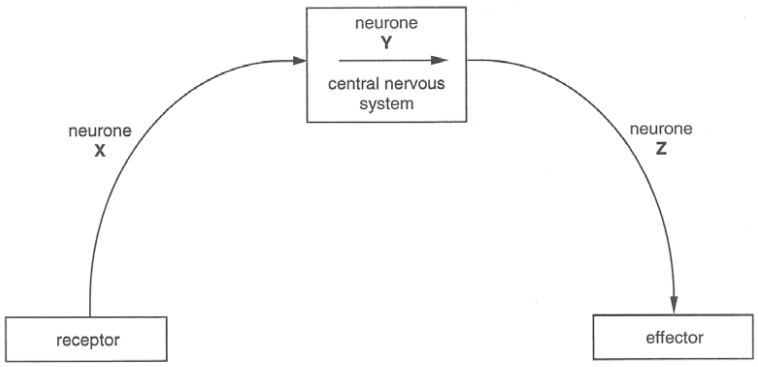
2. .....(2)

(ii) State the function of a sense organ.

.....

.....(1)

13. The diagram below shows a generalized reflex arc.



(i) Identify the three neurons labelled X, Y and Z.

X.....

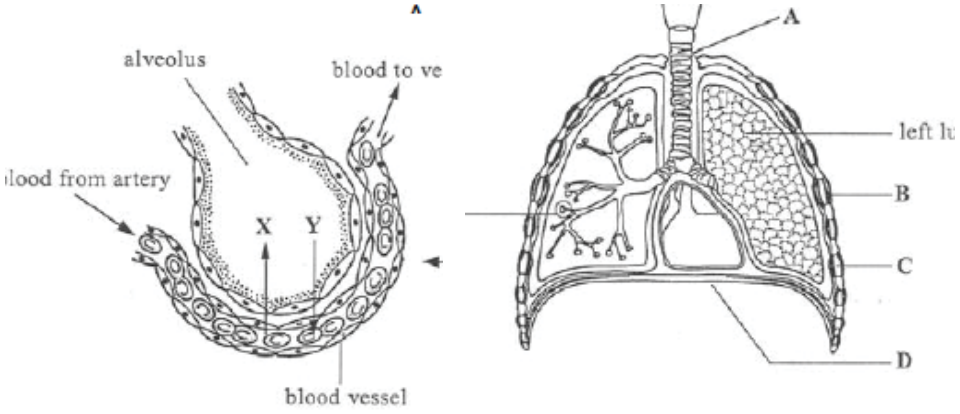
Y.....

Z.....(3)

(ii) Give an example of an effector.

.....(1)

14. The diagrams below shows the blood supply of an alveolus and the human respiratory system.



(i) Identify the respiratory gases labelled X and Y.

X .....

Y.....(2)

(ii) Name the structures labelled A to C

A.....

B.....

C.....(3)

(iii) Discuss the importance of two of the features of the alveoli for an organism's. survival.

.....

.....

.....

.....

.....(4)

15. Smoking cigarettes affects the breathing system. Discuss how excessive smoking may cause Emphysema and Bronchitis.

Emphysema.....

.....

.....

Bronchitis.....

.....

.....(4)

16. What is meant by drug-dependence?

.....

.....

.....(2)

17. The kidney is an excretory organ that produces urine that contains urea.

(i) State where in the body urea is formed.

.....(1)

(ii) State from what urea is formed.

.....(1)

(iii) Describe the functions of the kidney

.....

..... (2)

18. The table shows the amount of urine produced by an adult person.

	Volume of urine produced (cm^3)
A day in December	1 400
A day in June	2 800

a) Give two reasons why less urine is produced in summer than in winter. (2)

.....

.....

b) Explain why it is important to drink more fluids in very hot climates. (2)

.....

.....

	Total [50

Feedback

Assignment 1

1.

Large surface area

Moist

In contact with blood capillaries

Extremely thin

2.

Large surface area: millions of alveoli allows more gas to diffuse across at the same time

Moist: moisture prevents the cells from drying out

Transport network: Provides a rich blood supply which maintains a steep diffusion gradient and favours the rapid diffusion of the gases.

Extremely thin: Gases diffuse quickly across the membrane

3.

A – epiglottis

B – larynx

C – trachea

D – lung

E – heart

F – bronchus

G – bronchiole

H – diaphragm

I – pleural membrane

J – pleural fluid

K – rib

L – intercostals muscle

4.

a) The process whereby oxygen diffuses from alveolar air into the blood and carbon dioxide diffuses out of the blood into the alveolar.

b) In the alveoli

5.

a) To show that carbon dioxide is produced by burning a cigarette. Carbon dioxide turns lime water milky.

b) A glass wool would be stained a yellow-brown colour

c) The cilia move particles of dust and mucous upwards to the larynx and these are expelled by coughing.

	d) Mucous will accumulate in the air passage e) Carbon monoxide competes with oxygen so red blood cells cannot receive adequate oxygen. To go back, click here.

 **Feedback** **Assignment 2**	1. oxygen, glucose, amino acids, carbon dioxide, urea and hormones 2. The white blood cells engulf and digest pathogenic microorganisms. 3. a) bone marrow b) red, white c) bicon cave d) nucleus, haemoglobin e) oxygen, haemoglobin, oxyhaemoglobin f) tissues g) carbon dioxide 4. a) i) 1 – left atrium 2 – biscupid valve 3 – tendon 4 – left ventricle ii) A – aorta B – pulmonary artery C – pulmonary vein D – vena cava vein To go back, click here.

Feedback **Assignment 3**	1) urea is a nitrogenous waste product contained in urine 2) it is formed by the liver 3) deamination 4) skin and lungs To go back, click here.

Feedback **Assignment 4**	1. The central nervous system is made up of the brain and spinal cord 2. The body parts must work together, therefore coordination is necessary 3. A nerve is a collection of neurons. 4. a) – (ii) b) – (iii) c) – (i) d) – (iv) 5. When a person takes alcohol and drugs regularly, the person becomes dependent on it. 6. causes the brain to shrink, dizziness, unnecessary mistakes 7. • Sound waves • Light • Chemicals (Smell/odour) • Chemicals (taste) • Temperature, pain, touch To go back, click here.

Optional Multimedia Resources:

Internet Resources

Diagram of the respiratory system:
http://www.umm.edu/respiratory/images/respiratory_anatomy.jpg

Animation of breathing:
http://www.biotopics.co.uk/humans/inhexh.html
http://www.smm.org/heart/lungs/breathing.htm

Read more about the importance of breathing:
http://www.drstandley.com/bodysystems_respiratory.shtml
http://serendip.brynmawr.edu/sci_edu/waldron/pdf/BreathingLabProtocol.doc

Click the following links to do an enrichment activity on breathing:
http://www.lessonplanspage.com/SciencePELungs-TheBreathingMachine25.htm

http://www.galaxy.net/%7Ek12/body/lungs.shtml

Additional information on the effect of pollution on breathing:
http://www.ehow.com/how-does_4564272_smoking-affect-lungs.html

Different illustrations of the circulatory system:
https://eapbiofield.wikispaces.com/file/view/circulatory_system.jpg
http://www.mikalac.com/tech/sci/pho/circulatorysystem.gif

View the types of white blood cells:
http://www.unomaha.edu/hpa/blood.html

Learn more about the plasma:
http://www.purchon.com/biology/plasma.htm

Learn more about the exchange of substances between blood and tissue:
http://www.msss.sd8.bc.ca/HOMEWORK/Knapik/capillary%20tissue%20exchange.doc

View images of the lymph system:
https://eapbiofield.wikispaces.com/file/view/lymphatic-system-benefits-from-rebounding.gif
http://www.acm.uiuc.edu/sigbio/project/updated-lymphatic/lymph3.html

View the animation of a heartbeat:
http://www.ahealthyme.com/Imagebank/heart.swf

For more information on how to take your pulse:
http://www.cchs.net/health/health-info/docs/0900/0984.asp?index=5508

CD-ROM Resources

1. *Audio clip – features of gaseous exchange*
2. *Word document – observation*
3. *Audio clip – effect of smoking on lungs*
4. *Video clip – heart structure*
5. *Video clip – causes of heart diseases*
6. *Video clip – how to reduce the risk of heart attack*

Unit 6 is a continuation of unit 5 in which more organ systems will be discussed.

Unit 2 -The Human Body – Part 2

Introduction

Why do you have a straight or upright posture? It is because your body consists of **bones** and **muscles** that keep it straight. These bones create the **skeleton**. The skeleton and the muscles give your body support so that you are able to have an upright posture. In this section we will talk about the skeleton and how it protects the organs.

Once we understand the skeleton and the muscles of the body, we will then look at the process of reproduction in people and all the important aspects in the maintenance of human life.

What is in this unit?

This unit consists of 4 topics:

Topic 1: Skeleton and muscles
Topic 2: Reproduction
Topic 3: Conception, pregnancy and birth
Topic 4: Caring for the new born baby

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: • list and describe different types of muscles and determine where each is found in the body. • discuss how the skeleton and muscles are organized to support, protect and move the body. • describe the structures of female and male reproductive systems. • outline the functions of each system (male and female). • discuss the effects of testosterone, oestrogen and progesterone in developing sexual characteristics and puberty. • describe the menstrual cycle and the role of oestrogen and progesterone in the menstrual cycle. • describe conception and the development of a fetus throughout pregnancy. • discuss the function of the placenta, amniotic fluid and the uterus in the development of a fetus. • suggest how the development and health of a fetus are affected by the lifestyle of the expectant mother. • discuss the process of birth. • list and discuss the requirements for the healthy development of a baby. • suggest why a mother should breast-feed her baby.
 **Study time**	You need to spend about 8 hours on this unit. Don't worry if it takes you longer because we all learn at a different pace. The important thing is to achieve the set objectives

 **Terminology**	**adolescence**	the period from puberty to maturity
	colostrum	the first milk produced after birth
	fertilization	the fusion of the egg and the sperm cell to form a zygote
	gestation	the period of time from conception to birth
	heterosexual	sexual relationship with a person of the opposite sex
	homosexual	sexual relationship with a person of the same sex
	joint	a place where two bones meet
	ligament	strong elastic connective tissue holding bones to a joint

	puberty	beginning of sexual maturity
	quintuplets	five babies born to the same mother at the same time
	sexuality	the development of sex organs and sexual characteristics
	weaning	gradually replacing breast milk with solid food

Skeleton and muscles

Your body consists of bones and muscles. The bones are called the skeleton. The skeleton and the muscles give your body support so that you are able to have an upright posture. The skeleton is made up of bones and cartilages.

Muscles

We know that living organisms can move on their own or can perform other types of movement. Muscle tissue has the **ability to relax** and **contract** and so bring about movement and mechanical work in various parts of the body. There are other movements in the body too, which are necessary for the survival of an organism such as the **heartbeat** and the movements of the digestive system, also known as the alimentary canal.

Characteristics of muscles

- muscles respond to stimuli (e.g. nervous impulses);
- able to shorten in length;
- stretch when pulled; and
- tend to return to original shape and length after contraction or extension.

Functions of muscles

Muscles are responsible for:

- motion;
- maintenance of posture;
- heat production; and
- stabilising joints.

Let us look at different types of muscles the body is made of and where they are located.

Muscles can be divided into three main groups according to their structure. The three main groups are:

1. **smooth muscle tissue**
2. **skeletal muscle tissue**
3. **cardiac (heart) muscle tissue**

Let us look at each of these types of muscles

Listen to the audio by clicking on the icon.

Audio clip - Types of muscles.mp3

Double click to hear audio.

Before you proceed, click here to do the Activity 1 based on the audio. Do it in your notebook.

Skeletal muscle / Voluntary muscle

Skeletal muscle is the most abundant tissue in the vertebrate body. These muscles are attached to and bring about the **movement** of various bones of the skeleton, hence the name **skeletal muscles.** Skeletal muscle tissue is also known as voluntary muscle, because this is the muscle over which you have direct control when you want to make a movement. Skeletal muscles function almost continuously to maintain your posture, making one tiny adjustment after another to keep your body upright. These muscles are also found in your face and jaws and are used when you smile or frown and when you talk, eat or drink.

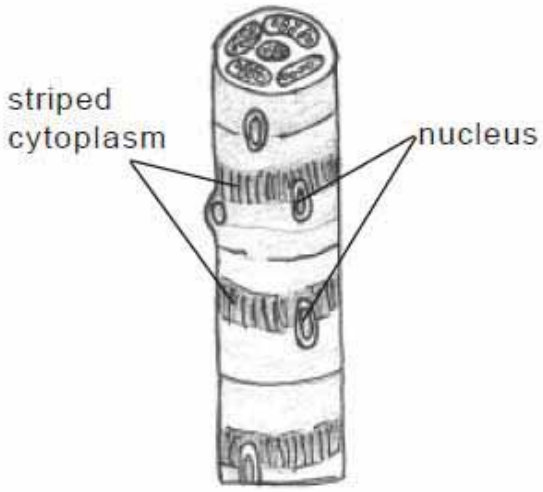


Diagram: Muscle cell

As can be seen from the diagram, the cells of these muscles are long, striated, unbranched(they do not branch out) and multinuclear(have multiple nuclei). The striations are the parallel lines shown in the diagram. Skeletal muscle tissue is

always connected to bones. Skeletal muscles work by pulling or contracting (not pushing) and contractions are controlled by nerve impulses.

Structure of skeletal muscle

- cylindrical (round), striated and multi-nuclear
- bundles of voluntary muscle cells form a skeletal muscle
- muscles contract because of nerve impulses
- voluntary or striped muscle

Functions of the skeletal muscle:

- These muscles work in pairs to bring about coordinated movements of the limbs, trunk, jaws, eyeballs, etc.
- They are also involved in the breathing process (intercostals muscles).

Cardiac muscle

The muscle of your heart is called the cardiac muscle. Cardiac means "of the heart" and is found **only in the walls of the heart**. Cardiac muscle is also striped but it is involuntary. The cardiac muscle contracts and relaxes automatically without you having to think about it. The cardiac muscle contracts to squeeze blood out of your heart and relaxes to fill your heart with blood. Unlike other types of muscle, the cardiac muscle never gets tired.

Structure of cardiac muscle

In terms of its structure, this muscle:

- is shorter than other muscles;
- is striated (see diagram below);
- has cells which contain numerous mitochondria;
- has adjacent cells which join end-to-end at intercalated discs (muscle bridges);
- **sarcolemma membrane** is thinner and not clearly visible and
- has **only one nucleus** in the centre of each cardiac fibre.

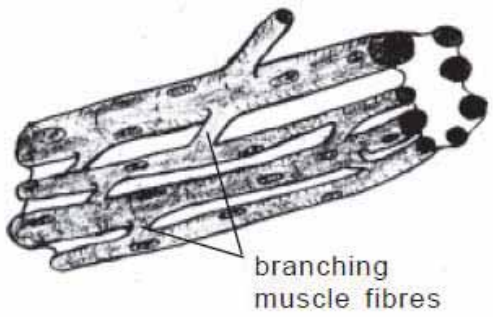


Diagram: Cardiac muscle

As can be seen from the diagram the cells are striated and branched. It is this branching that gives rise to the squeezing effect when the muscle cells contract. The cells connect to one another using junctions called **intercalated** disks and it is these disks that allow electrical impulses to spread quickly through the heart.

When you exercise, your heart beats faster and with a bigger volume. This increase in cardiac output (how fast the blood is pumped around your body) is produced by a hormone called adrenaline. The vagus nerve can make the heart to work slowly. This happens when you are sitting or lying down.

Functions of cardiac muscle tissue

- Cardiac muscle tissue plays the most important role in the contraction of the atria and ventricles of the heart.
- It causes the rhythmical beating of the heart, circulating the blood and its contents throughout the body as a consequence.

Smooth muscle / involuntary muscle

Smooth muscles are composed of elongated, spindle-shaped cells and are commonly responsible for involuntary motions. It is called **smooth muscle** because you cannot see any stripes when you look at it through a microscope. Its other name is **involuntary muscle** because you cannot make it contract and relax through conscious control. Smooth muscle is found in the walls of hollow organs like your intestines and stomach. The muscular walls of your intestines contract to push food through your body. Muscles in your bladder wall contract to expel urine from your body. Smooth muscles in a woman's uterus (or womb) help to push babies out of the body during childbirth. The papillary sphincter muscle in your eye is a smooth muscle that shrinks the size of your pupil.

Structure of smooth muscle

In terms of its structure, this muscle:

- is an involuntary muscle; innervated by the Autonomic Nervous System;
- has spindle-shaped cells typically arranged in sheets and
- has cells which are **not striated** but are made up of thick and thin myofilaments.

Look at the diagram below:

.

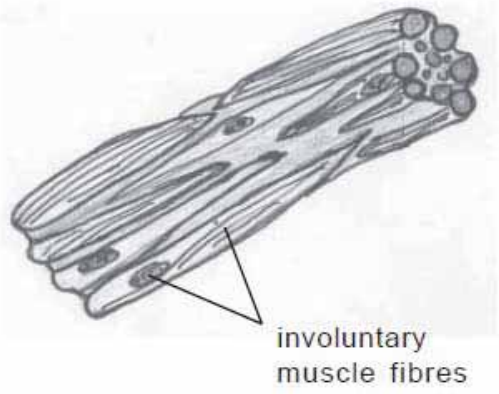


Diagram: Smooth muscle

The muscles in your intestines work in pairs. When the circular muscles contract they make the intestines longer (and thinner) and when the longitudinal muscles contract they make the intestines shorter (and fatter). These muscles move food along the gut (peristalsis) and help to mix food with your digestive juices.

Now that you have learned about different muscles and their importance, let us look at the importance of bones in the body. Different bones are joined together to form a skeleton.

Bone tissue

A group of cells working together are called tissues. If you need to refresh your memory go back to Unit 3 and revisit this.

Bone is a hard material that supports parts of the body and protects some delicate organs. Bone is made up of a tissue that has elastic fibres. If something is elastic (like a rubber band) it returns to its original form after it was stretched. Because of this elastic nature, the bones do not break easily.

A bone consists of bone cells, hard protective material and protein fibres. The mineral calcium phosphate surrounds bone cells and makes the bone hard. Protein fibres give it its slight flexibility.

Cartilage

Take some seconds and touch your nose. How does it feel? Now touch your elbow. What is the difference in hardness between your nose and your elbow? The "bone" in your nose is very soft and the one in your elbow is hard. The soft bone in your nose is called **cartilage**. Cartilage is a tough flexible connective material. You will find cartilage in some parts of your body. Can you think of other parts in your body which are made of cartilage? The pinnae of your ears are made of cartilage.

Joints

Look at your hands and legs. You can bend your fingers, elbows and knees. The place where two bones meet is called a **joint**. In the human skeleton there are a number of bones and they are firmly joined together by fixed joints**.** Some are short, some long and some round but all bones have the same basic structure. Most of the joints in the body are movable, but there are a few joints that cannot move. They are called immovable joints. Ligaments hold joints together.

The diagram below shows the parts of a synovial joint.

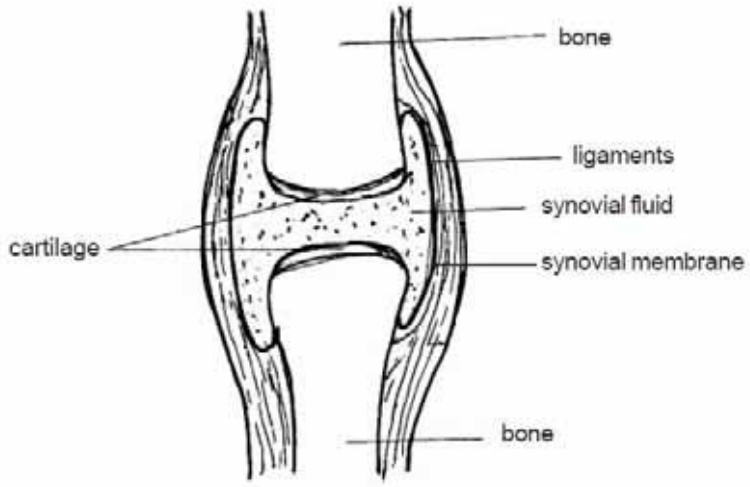


Diagram: Parts of a synovial joint

If bones are so hard, why is there no friction between the joints? It is because there is a liquid called **synovial fluid** that prevents friction. The synovial fluid does not dry out because of the synovial membrane that covers the joints.

The skeleton

Look at the diagram below and see how the bones are housed in the skeleton.

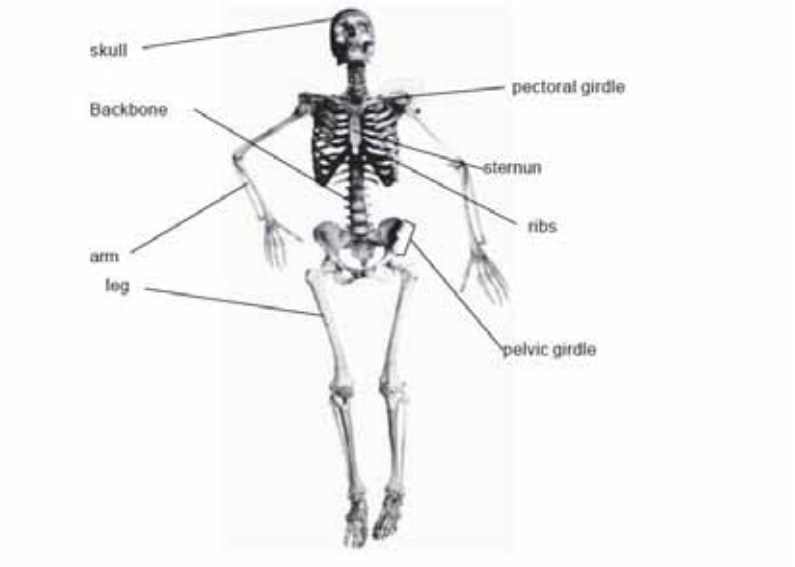


Diagram: Skeleton

Listen to the audio by clicking on the icon.

Audio clip - Functions os the support syster

Double click to hear audio.

Every bone of the skeleton has its own form or shape as you can see in the diagram of the skeleton. The bones of the skull protect the brain. The bones are held together at the joints by strong fibres called **ligaments**. Movements of the body are caused by the muscles. The muscles are connected to the bones by tendons.

Functions of the skeleton

You can see from the diagram of the skeleton that it has a complicated structure. It has this structure, because it has to fulfill the following main functions.

- The skeleton gives shape and support to the body.
- The skeleton gives protection to important and delicate organs of the body, like the brain.
- The skeleton helps the different parts of the body to move, e.g., legs, arms and head.
- New blood cells are produced in some of the bones of the skeleton.

Before you proceed to the next topic, do the assignment that will follow in your notebook. Do not forget to compare your answers with mine given in the feedback at the end of the unit. This assignment should not take you longer than 1hour.

Assignment

 **Assignment 1**	1. In a table format, compare the different types of muscles in terms of their shape, location, presence of striation, and how they function. 2. Listen to audio insert about the support system again then discuss the structure and functions of the support system. To check feedback, click on the icon ☺

The next topic deals with the very important aspect of life, reproduction.

Reproduction

You know that human beings produce babies through a process called **reproduction**. In humans, reproduction is sexual. This means that two sexes, male and female, are involved in the process of reproduction. Both males and females are needed for reproduction. The male and female reproductive systems differ structurally and functionally. In this section we will look at the structures and functions of the male and female reproductive systems. We will also talk about the menstrual cycle.

When you look at a small child at birth, you can tell whether that child is a baby boy or baby girl. Can you think of any difference that would enable you to tell boys and girls apart? A baby boy has a penis and the baby girl has two small folds of skin, called the vulva. Look at the diagrams.

Diagram: Baby Boy and Baby Girl

Before we go into any detail, let us first study the structure of the male and the female reproductive systems.

The male reproductive system

The diagram below shows the male reproductive system.

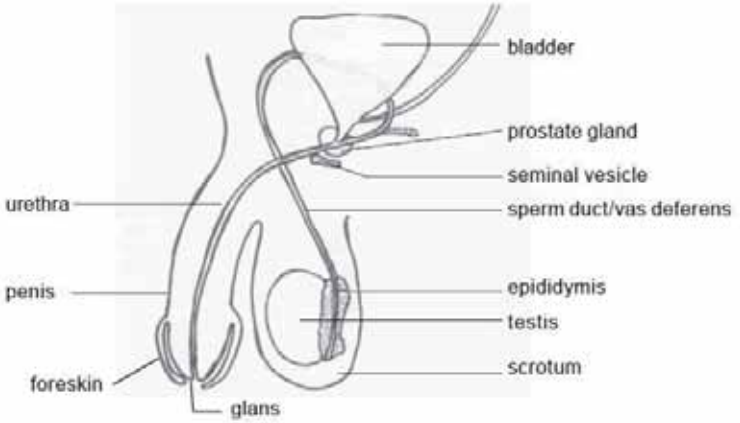


Diagram: Male Reproductive System

The male reproductive system consists of the following parts: scrotum, two testes, epididymis, sperm ducts, urethra, prostate gland, seminal vesicle and penis.

Study the brief descriptions of the male parts and their functions in the table below.

Part	Description	Function
Scrotum	sac containing the testes.	hosts the testes keep testes cooler than the body temperature.
Epidydimus	a long coiled tube on the outside of the testes.	stores sperms.
Sperm duct (also known as vas deferens)	a tube called the sperm duct leads from the epididymis. Sperm ducts from the two testes join with each other just below the bladder.	carries sperms from the testes to the urethra.
Urethra	the two sperm ducts join together and lead into the urethra .	passes semen through penis during ejaculation or urine from the bladder (however, urine and semen can never pass at the same time).
Seminal vesicles and prostate glands	glands found where sperm duct meet the urethra.	secretes fluid which provides energy for the sperm to swim.
Testes	two oval organs situated in scrotum. Each testis consists of a large number of sperm-producing tubules.	produce sperm and the male sex hormone called testosterone.
Penis	is made up of a shaft, glans and a foreskin. The shaft consists of spongy tissue that is richly supplied with blood vessels, which allows for **erections,** where the penis becomes enlarged and firm. The glans is the sensitive part of the penis. Repeated stimulation results in ejaculation and orgasm. The foreskin protects the glans. It can be removed by circumcision in some cultures.	passes sperm from male to female reproductive organ.

The female reproductive system

The diagram below shows the female reproductive system.

Diagram: Female Reproductive System

Study the brief description of the parts and their functions in the table below.

Part	Description	Function
Ovaries	There are two ovaries, one on each side on the dorsal surface of the abdominal cavity.	produce eggs and female hormones.
Oviduct (also called fallopian tubes)	Each oviduct is a narrow muscular tube that leads from the ovary to the uterus. There are two oviducts that have funnel-like openings lying close to the ovaries.	site where fertilization takes place and first stage of zygote development. The zygote is a one-celled organism.
Uterus (also called the womb)	a muscular organ.	is the place where a baby will develop when an egg is fertilized.
Cervix	a ring of muscle that closes the lower end of the uterus.	remains closed during pregnancy to protect the fetus.
Vagina	a muscular tube that connects the uterus to the outside. It opens into a part called the vulva.	semen is deposited here during intercourse. A baby passes along it during birth.
Vulva	outside opening with labia and clitoris. The vulva is enclosed by fleshy lips called labia. A minute organ called the clitoris lies inside the vulva.	leads to the vagina.

Now that you have gone through the difference between the male and the female reproductive systems, we will learn more about the sexual development of human beings.

Puberty

The time when boys and girls become sexually mature is called *puberty*. Puberty starts around the age of 10 and ends around age 16 in girls. In boys, it starts around age 12 and ends around age 18. People vary a great deal and so there is nothing wrong with a girl or a boy who reaches puberty early or late in his/her life.

During puberty, the sexual organs begin to grow and develop. The female reproductive organs, the two **ovaries, begin to** produce sex hormones called *oestrogen* and *progesterone*. The male reproductive organs, the two **testes,** produce a hormone called *testosterone.* The testes and ovaries are stimulated by hormones produced by the pituitary gland. The sex hormones cause the development of secondary sexual characteristics during puberty.

How can you distinguish between a boy at ages 10 and 18 and and a girl at ages 10 and 18 by looking at their physical appearance? Write your answer in your notebook.

Your answer could include any of the following secondary sexual characteristics of girls and boys.

Secondary sexual characteristics in girls include:

- growth of breasts, more rounded figure and large hips as a result of fat deposits under the skin, especially the thighs;
- growth of hair in the armpits and in the pubic region; and
- development of feelings of attraction towards the opposite sex.

Secondary sexual characteristics in boys include:

- growth in the size of muscles and penis;
- voice becomes lower in pitch (voice deepens, not visibly but one can hear this);
- growth of hair in the pubic region, in the armpits and on the face and chest; and
- development of feelings of attraction towards the opposite sex.

Can you remember the time you started puberty? A young person who has reached puberty is called an **adolescent.** What is so exciting about this stage? Read further.

Sexuality

From childhood to **adolescence,** a person goes through different stages of development. During adolescence the body of a child adapts and she/he becomes emotionally mature. Mental and physical development also takes place.

During childhood, children like to play and keep company with the same sex. When they become adolescents, boys and girls show interest in the opposite sex. They want to spend more time together and keep company with the opposite sex. Attraction towards the opposite sex during adolescence is quite normal. Their feelings and moods are difficult to deal with. Does this sound familiar?

By the time a relationship between people becomes very serious, the individuals show affection for each other and may like to have sexual intercourse. **Heterosexual** refers to the sexual relationship between two people of the opposite sex. When people of the same sex get attracted to each other and have sexual activities, we refer to them as ***homosexuals***. Women who are attracted to other women are called **lesbians**. Men who are attracted to other men are called **gays**. **Sexuality** refers to how people experience sexual desire and expresses themselves as sexual beings.

Before you continue, take time to do the following activity in your notebook.

 **Activity 2**	List any other characteristics that you think make boys different from girls.

Another exciting sexual development in females is the menstrual cycle. During puberty, boys start to produce sperms in their testes. Girls start to produce eggs in their ovaries. Girls will notice this, because each month they lose a small amount of blood through the vagina. This is known as **menstruation.**

Let us look at what happens during the menstrual cycle.

The menstrual cycle

Beginning during puberty, a woman's ovary releases one ovum per month into the oviduct. Before the egg is released, the lining of the uterus becomes thick and spongy and suitable to receive a fertilised ovum. An egg lives in the oviducts for a very short time.

Note it	Did you know that women can only become pregnant when the egg is in the oviducts? An egg can only be fertilized while in the oviducts. This happens about 14 days before the next menstruation.

A sexually mature woman produces hundreds of eggs but only a very small number of these eggs will ever be fertilised. If the ovum is not fertilized by sperm from a male, the thickened cells lining the womb gradually disintegrate. Unwanted cells, together with some blood are pushed from the womb through the vagina. This monthly loss of blood is called **menstruation**, and is commonly known as a **period**. The duration of menstruation varies from person-to-person and can last from 3 to 7 days.

Menstruation happens in a cycle. Immediately after a period of menstruation, the pituitary gland attached to the base of the brain produces a hormone that stimulates the ovaries to develop follicles and produce **oestrogen** and **progesterone**. You can see on the diagram below how the oestrogen hormone level increases from about day 5 to day 13. The mature follicle consists of an ovum and a mass of follicle cells. The hormone oestrogen is secreted from the follicle which develops in the ovary.

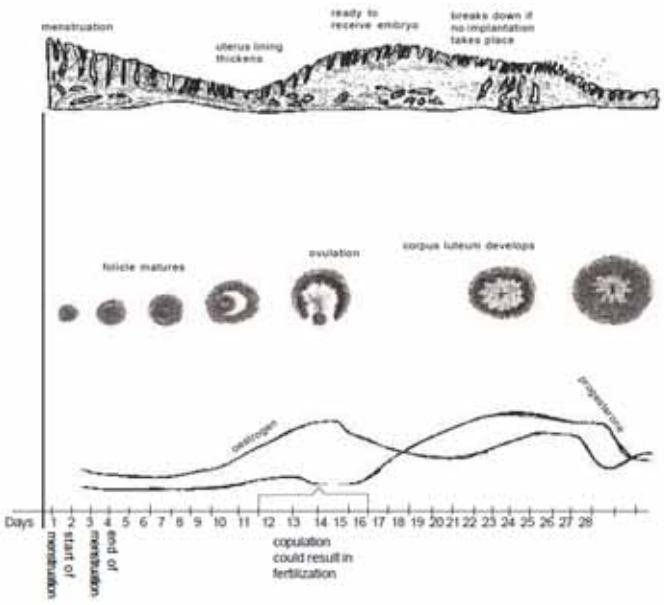


Diagram: Menstruation Cycle

Look at the diagram again. A layer of cells lining the uterus grows rapidly and develops a dense network of blood vessels. This is the effect of oestrogen.

The mature follicle releases an ovum from the ovary into the fallopian tube. This process is known as **ovulation**. At this stage the follicle stops secreting hormones. The remains of the follicle in the ovary forms a structure called the **corpus luteum**. The corpus luteum produces another hormone called progesterone. Progesterone causes the lining of the uterus to become thicker and full of blood vessels in case the ovum is fertilized. You can see in the diagram again the increase of progesterone from day 14 to day 28 before decreasing to a low level if no fertilisation takes place.

If the ovum is not fertilised, the corpus luteum slowly disappears and the hormones oestrogen and progesterone are no longer produced. This causes the lining of the uterus to break down and menstruation starts again. A new follicle starts to develop and the cycle begins again.

What happens to the menstrual cycle during pregnancy?

A woman stops menstruating until the baby has been born. During pregnancy the hormone progesterone continues to increase in the ovaries. This causes the lining of the uterus to continue thickening. Progesterone prevents menstruation and stops any further eggs being produced by the ovaries.

Let us look at the final stage of sexual development in females.

Menopause

Between the ages of about forty and fifty-five a woman loses her ability to reproduce. Her ovaries then stop producing eggs and menstruation stops. These changes occur, because she stops producing sex hormones in large amounts. This is called **menopause.**

Now, do the self-mark assignment in your notebook to check your understanding of the subject matter. You should not spend more than 45 minutes on this assignment. Compare your answers with mine given at the end of the unit.

Assignment

Assignment 2

1. The names of parts of the human reproductive systems are listed below.
Ovaries, oviducts, womb, testes, sperm ducts, seminal vesicle, testis.

Choose the correct description for each part from the following list. Keep in mind that a part may be used more than once as an answer.

I. There is one on each side of the abdomen in a woman.
II. They connect the ovaries to the womb.
III. The organ in which eggs are produced.
IV. A pear-shaped organ with a muscular wall.
V. The place where fertilisation takes place.
VI. The place where the fetus develops.
VII. They connect the testis to the urethra.
VIII. It produces fluid which helps the sperm to swim vigorously.
IX. The organ in which sperms are made.

3. Draw up a menstrual cycle calendar for a period of two months. Indicate the following:
   - menstruation days
   - ovulation days
   - hormonal changes

To check feedback, click on the icon 

I hope you are ready to continue. The next topic will deal with conception, pregnancy and birth.

Conception, pregnancy and birth

In Section 1, we discussed the parts and functions of male and female reproductive systems in humans. We also looked at, eggs and sex hormones in the testes and ovaries. In the next section, we will look at what happens when eggs and sperms fuse. We will also discuss what happens after fertilisation and how a fetus develops in the uterus.

How do human beings reproduce?

How does a woman become pregnant? Can a woman become pregnant alone? For a woman to become pregnant, sperms must be put into the woman's oviduct. The sperms pass into the woman's body during sexual intercourse.

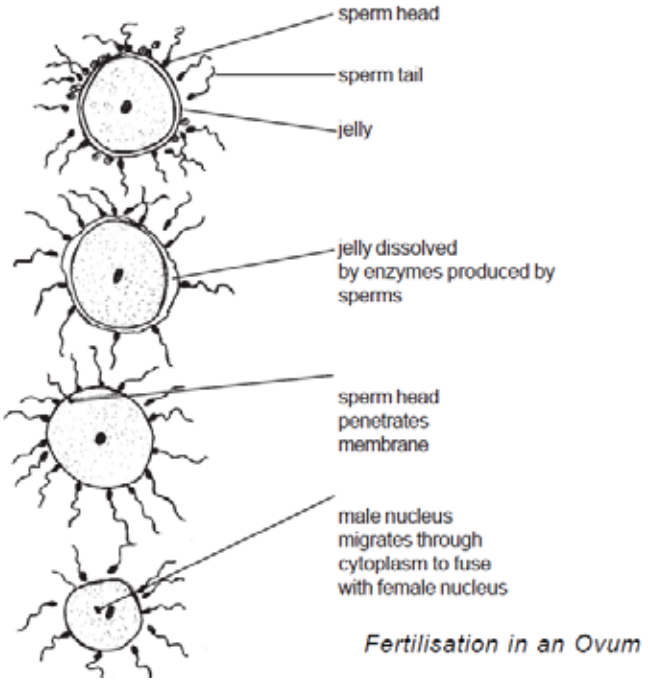
Sexual intercourse

A male and female may decide to have sexual intercourse, either because they want to have a child or they simply love each other and want to share the pleasure of sex.

Conception

Conception, also called **fertilization,** is the fusion of the nucleus of the male gamete with the nucleus of the female gamete to form a **zygote**. Fertilisation occurs inside a woman when a sperm meets an ovum as it passes down the upper part of the oviduct. If an ovum is present in the oviduct, many of the sperms swim towards it. The diagram below shows how it happens.

Figure Title:



Fertilisation in an Ovum

Eventually, the head of one sperm sticks to the ovum. The sperm's head enters the cytoplasm of the ovum and fuses with the female nucleus, sharing genetic

information to create a fetus. A **fertilisation membrane** is produced around the zygote. This membrane prevents any more sperms from entering the egg.

Sterility

Not everyone produces fertile sperms or ova. An infertile person is one who cannot produce children. This condition may have various causes. The possible causes of sterility in males and females include:

- no sperms or too few sperms produced by the testes;
- the penis is unable to get an erection and / or ejaculate;
- sperms die before they reach an egg;
- in females, no eggs are produced by the ovaries; and
- the fallopian tubes may be blocked or an embryo may fail to implant in the uterus.

Twins

You may also wonder why some people give birth to more than one child at a time. Twins occur in about every 90th birth. There are two types of twins, namely, fraternal and identical twins. Let us learn more about these.

Fraternal Twins

Sometimes, instead of one egg being released from the ovaries during ovulation, two or more eggs are released. These may be fertilised by different sperms and will develop in the uterus at the same time. Twins that result from different eggs are called **fraternal** or **non-identical twins**. Seventy per cent of twins born are non-identical.

Identical twins

Identical twins develop from a single egg after fertilisation. The zygote splits into two and each part then develops into separate individuals. These twins share the same placenta. Only 30 per cent of twins born are identical.

In Namibia, some families have triplets born, but this is less common. In every 800 births there is one triplet. Women who take fertility drugs are more likely to give multiple births than other women. In every 750,000 births there is one quadruplet born. In every 41 million births there is one quintuplet (a quintuplet is five babies born to the same mother at the same time).

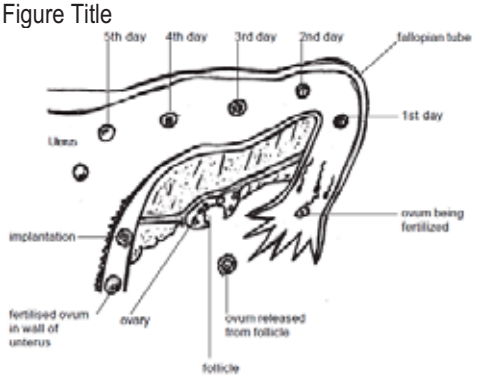
After an egg has been fertilised, pregnancy results. Let us see what happens during this process.

What is pregnancy?

The period during which a woman carries a fetus in her womb is known as **pregnancy**. After fertilisation, the zygote moves down the oviduct. During this time the zygote divides rapidly to form an embryo. The embryo then moves to the uterus. It becomes embedded in the wall of the uterus. This is called **implantation**. A pregnant woman does not menstruate because the ovaries continue to secrete the hormones oestrogen and progesterone. Progesterone maintains the lining of the uterus.

The diagram below shows the stages leading to implantation.

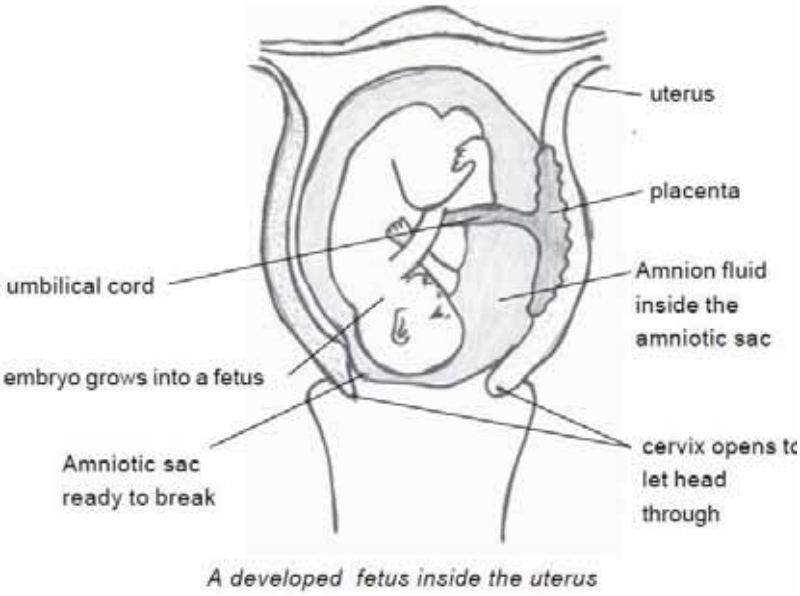
Figure Title



The fetus develops inside the uterus for about 40 weeks (9 months). The interval between conception and birth of a baby is known as pregnancy or **gestation.**

The development of the embryo

The embryo grows inside a bag of liquid called the **amniotic fluid**. This fluid is surrounded by a membrane called the amnion. The amniotic fluid acts as a shock-absorber, protecting the embryo against bumps as the mother moves. During the first two months the embryo grows to a size of about 40 mm. After the first two months, the embryo starts developing organs. When all the organs are formed, the embryo is called a fetus. As the embryo grows, the uterus enlarges greatly so that it can accommodate the fetus. For the birth of the fetus, the wall of the uterus becomes thicker and more muscular. The diagram below shows a developed fetus in a uterus.



A developed fetus inside the uterus

Diagram: Developed Fetus inside Uterus

Audio clip - Functions of the placenta.mp3

Double click to hear audio.

How does the embryo get food?

Listen to the audio by clicking on the icon.

Did you enjoy the audio? Now click here to do Activity 3. Then you can proceed to read more about the functions of the placenta.

At the place where the embryo is implanted in the uterus, the **placenta** is formed. The placenta is a series of fingerlike projections that develops between the fetus and the uterine wall. From the fetal part of the placenta, **villi** protrude into the uterine lining which has thickened and in which capillaries have broken down to form more extensive blood spaces. The membranes separating the fetal capillaries from the maternal blood spaces are very thin so that dissolved substances can pass across in both directions.

In the placenta, oxygen, glucose, amino acids, antibodies and salts in the mother's blood pass from the uterine blood spaces into the capillaries of the fetus. Carbon dioxide and urea from the fetus pass across in the opposite direction, by diffusion through the placenta. In later development, the placenta becomes much more well-defined. It consists partly of the mother's tissue and partly of embryonic tissue and is connected to the body of the embryo by the umbilical cord.

The umbilical cord contains a main vein that carries oxygenated blood and dissolved nutrients, drugs and antibodies to the embryo as well as an artery that takes deoxygenated blood and waste materials to the placenta, back to the mother's body for excretion. The capillaries of mother and fetus are in close contact but there is no direct connection between them. If the capillaries of the mother and of the fetus were connected, the mother's blood pressure would damage the developing circulatory system of the fetus. Study the diagram below, which shows the position of the placenta in the embryo.

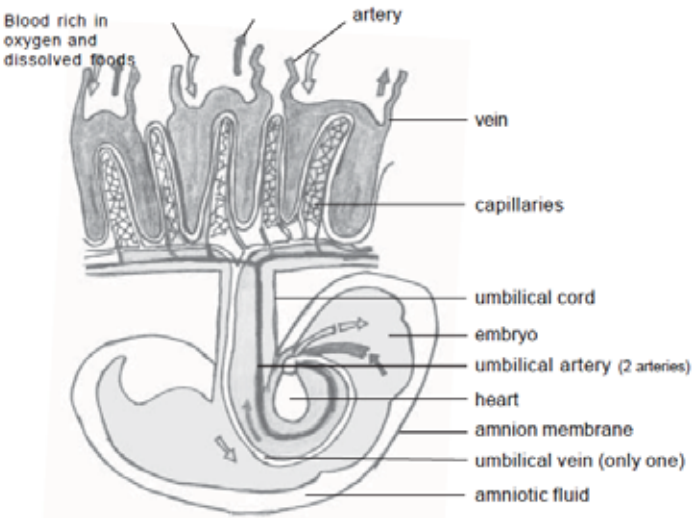


Diagram: Position of placenta in embryo

Recommended lifestyle for a pregnant woman

It is important for a pregnant woman to take care of herself and her unborn baby. She must take care of herself and lead a healthy life.

Diet

A pregnant mother needs a balanced diet. She must take a diet rich in proteins, carbohydrates and minerals. Proteins and minerals are important for the growth and development of a fetus. Carbohydrates provide energy. The diet should include minerals such as calcium and iron. Calcium is needed to build the bones of the fetus. Iron is needed to make haemoglobin in the blood. Vitamins, especially vitamin C, are needed to preserve both fetal and maternal health.

A pregnant woman should also drink plenty of water to stimulate kidney activity. This is important as the kidneys are responsible for the removal of both maternal and fetal waste.

Drugs

Do you still remember the effects of drugs, smoking and alcohol in the human body? If not, go back to unit 5 and read through it once again. Now let us look at the risk of using drugs and alcohol for pregnant mothers.

A pregnant mother should avoid drugs and alcohol. Every drug the mother takes may cross the placenta and enter the fetal blood stream. She should take drugs prescribed by a doctor only. She should avoid drinking alcohol and smoking cigarettes. The substances in cigarettes, especially carbon monoxide and nicotine may cross the placenta. This will result in a smaller and less healthy baby. Alcohol should be taken only in moderation. A high level of alcohol consumption has a damaging effect, since alcohol can easily cross the placenta. Babies with alcohol poisoning are born to mothers who drink heavily.

Diseases

Certain germs may also pass across the placenta and harm the baby. One such germ is the one that causes the disease called German measles or rubella. This is why girls who have not had this disease are always immunized against it. Germs that cause sexually transmitted diseases can also cross the placenta. The HIV is an example.

Exercise

A pregnant woman should go to a doctor or a local clinic for regular checkups during pregnancy. The mother should go to antenatal classes if possible where she will be given exercises to help her strengthen her muscles for birth. If this is not possible, she must get advice from a hospital or a doctor on which exercises to do during pregnancy.

How a baby is born (birth)

Listen to the audio by clicking on the icon.

Audio clip - Process of birth.mp3

Double click to hear audio.

I hope you have mastered the content from the audio. Before you proceed, click here to do the activity 4 based on the audio.

Good. You can now continue to read more about the process of birth.

The time between fertilisation and birth is called the **gestation period**. A few weeks before birth, a fetus turns over in the uterus so that the head points towards the opening of the uterus.

The uterus rhythmically contracts. Before birth, these contractions become more frequent and more regular. This is the onset of **labour**. Intervals between contractions become shorter and the contractions become more forcible. About the same time that contractions and labour begin, the amnion bursts and the amniotic fluid surrounding the fetus flows out through the vagina.

The opening of the cervix gradually dilates far enough to let the fetus's head pass through and the uterus starts to contract powerfully. Finally, the muscular contractions of the uterus and the vagina expel the fetus (head first) through the dilated cervix and vagina. Once out, the sudden change in temperature experienced by the newborn baby stimulates it to take its first breath, usually accompanied by crying.

During delivery a doctor or a midwife ties off the umbilical cord with a thread and cuts it. The umbilical cord is tied off to prevent bleeding and it is cut to separate the baby from the mother. Finally, the placenta and the embryonic membranes are expelled. This is known as the **afterbirth.**

	Did you know that human babies are born after a gestation period of about 9 months?

Normally, a woman delivers the baby in a hospital, but some people prefer to deliver their babies at home. Birth is a natural process and most babies are born without any difficulties. In some women, the gap between the spinal column and the front of the hipbone is too small to permit the passage of the fetus. In this case, after the gestation period, the abdomen and uterus are opened surgically and the baby is removed. This operation is known as a **Caesarian section**.

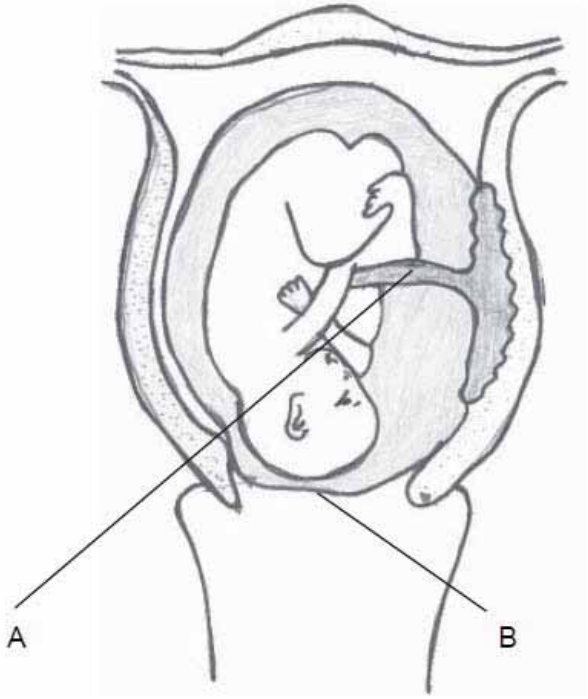
Now, try the self-mark assignment in your notebook to check you progress so far. Do it in your notebook and do not forget to compare your answers with mine at the end of the unit. This assignment should not take you longer than 30 minutes.

Assignment

Assignment 3

1. Discuss the process of fertilization in humans.

2. The diagram below shows a fetus developing in the uterus.



Identify parts labelled A and B and describe their importance to the fetus.

3. Why should a pregnant woman visit an antenatal clinic?

4. Why do you think a pregnant woman needs a balanced diet?

5. Suggest reasons why a pregnant woman should not smoke or take alcohol.

To check feedback, click on the icon

You have learned how a baby grows in the womb and how a baby is born. In the next section, we will look at how the newborn child grows and the important requirements for the growth of a healthy baby.

Caring for a new born baby

When a baby is born, he/she is helpless. The newborn baby needs to be taken care of by the parents. In this section, we will talk about how to care for a newborn child. We will also look at the benefits of breast-feeding.

Where does a fetus get its food from? Write your answer in your note book.

Does your answer include the following? As the fetus grows in the uterus, it is entirely dependent on the mother. The fetus receives food, warmth and protection inside the uterus and develops into a baby. When the baby is born, it is helpless and the baby totally depends on the parents for food, shelter and protection. As the child grows, the period from birth to about two years old is called **infancy**. A child under two years of age is called an **infant**.

Audio clip - Diet of a new born baby.mp3

Double click to hear audio.

Diet in childhood

Listen to the audio by clicking on the icon.

What does a baby eat immediately after birth? From birth up to 6 months, a baby may only take its mother's milk depending on the health status of the mother and the availability of breast milk. The mother's milk provides all the necessary nutrients. You will learn more about breast-feeding later in the section.

After 6 months, a baby needs solid food together with the mother's milk. As the baby grows, the amount of milk should be reduced and more solids should be given. The process of taking the baby off from mother's milk and putting it on solid food is called **weaning**. From age four to six months, the solid food given to the baby must be very soft. The baby cannot chew food before 6 to 7 months, because the chewing muscles and teeth have not yet developed.

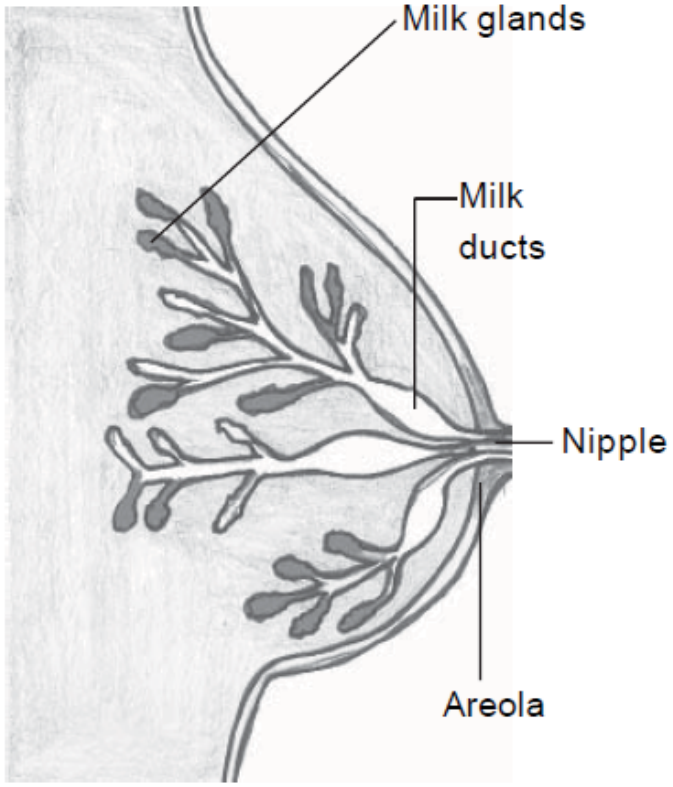
What type of food is suitable at this stage? Write your answer in your notebook.

Compare your answers with mine. The baby can be given any suitable food such as soft porridge, cheese, bananas, etc. These foods are soft and need no chewing. We should not give bones and hard food. We should plan the meal carefully. Lots of small amounts of fruit and vegetables with starch, proteins and fats should be included to give a balanced diet.

Breast-feeding

As the newborn child is helpless, it depends totally on its mother for food. The baby has no teeth and the digestive system cannot digest solid food. The mother's milk is the only food it takes. Milk is produced by a mother's **mammary glands** (breasts). They consist of milk secreting cells for the storage of milk and ducts leading to the nipples. After giving birth, the woman's body produces a milk-

stimulating hormone (**prolactin**) from the pituitary gland causes milk to flow when the baby sucks its mother's nipples.



Cross-section through a breast

Diagram: Cross Section of Breast

Audio clip -
Importance of colostr

Double click to hear audio.

Colostrum

Listen to the audio by clicking on the icon.

During the first three days after birth, a thin lemon-coloured liquid called **colostrum** is produced by the breasts instead of milk. Colostrum is rich in protein, but is not as nourishing as milk. It contains antibodies that protects an infant against infections

Composition of milk

The Ministry of Women Affairs encourages mothers to breast-feed their babies. There are many posters in clinics and hospitals showing the importance of breast-feeding. Government offices and other institutions have special places on their premises for mothers to breast-feed their babies.

Human milk is the best available complete food for growing babies. It contains most types of nutrients needed in a balanced diet at this stage of life. Human milk contains proteins, fats, carbohydrates in the form of lactose (sugar), minerals, vitamins and water in correct proportions. Iron is the only mineral not present in human milk. The newborn child has the mineral iron in his/her tissues and this will last for several months.

The picture below shows a mother breast-feeding her child.

Photo: A Mother Breast-feeding

The table below shows a comparison between breast-feeding and bottle-feeding.

Audio clip - Advantages of breasl

Double click to hear audio.

Listen to the audio by clicking on the icon.

Breast-feeding	Bottle -feeding
ideal for human consumption human proteins are unlikely to cause allergies. easy to digest	not ideal for human consumption milk comes mainly from cows and contains proteins that are foreign to some babies and may cause allergies difficult to digest
human milk contains the correct proportions of nutrients except iron.	mineral content is excessive and may upset the balance of salts in the body. Excessive protein content reduces acidity in stomach, thus increasing risk of gut infections.
kept at a suitable temperature	needs to be kept at a suitable temperature
contains antibodies that give protection against infection during early life.	contains antibodies that provide little protection against infections.
requires no preparation or sterilisation, free from bacteria.	preparation and sterilization may sometimes be inconvenient
breast-feeding helps to develop a close relationship between mother and child	bottle-feeding does not provide such a close relationship.
no costs involved (but the mother must eat a balanced diet)	must be purchased

Listed below, are some of the disadvantages of breast-feeding:

- Fathers cannot assist with feeding. There is also less opportunity to build up a father-child relationship.
- Many women find breast-feeding difficult due to cracks on infected nipples. Some babies seem to prefer to feed from a bottle.
- If a mother is an HIV/AIDS patient, she cannot feed the baby.
- It is not easy to feed in public.
- When a mother works during the day, it is difficult for her to feed the baby.

Now, it is time to check your progress. Assignment 4 is based on the audio clips you have listened to in this section. So, before you attempt it, go back to the audio and listen to them again. Do not forget to compare your answers with mine at the end of the unit. This will take you about 1 hour.

Assignment

Assignment 4

1. Explain how the absence of teeth affects newborn babies.
2. Discuss the effect of hormones on the production of milk.
3. Describe how colostrum milk differs from the normal milk.
4. Discuss the importance of colostrum milk.
5. Explain why the Ministry of Health in Namibia recommends breast milk over bottle milk to babies.

To check feedback, click on the icon. 

We have now come to end of Unit 6, but before we continue to the next unit, let us summarise.

Unit summary

 Summary	In this unit you learned that: • the support and movement system consists of the skeleton and muscles. • the skeleton has four main functions: support, protection, movement and production of new blood cells. • bone is a hard material that supports and protects parts of the body. • cartilage is a tough flexible material. • a joint is where two bones meet. • bones are held together at the joints by ligaments. • muscles are attached to bones by tendons. • there are three kinds of muscles: voluntary, involuntary and cardiac • at birth children are distinguished by their sex organs. • childhood is the period from birth to puberty. • adolescence starts with a period called puberty. • during adolescence persons mature emotionally and sexually. • the sex organs, sexual characteristics, emotional and social aspects change too. • a sexual relationship between two people of the opposite sex is called a heterosexual relationship. • a sexual relationship between two people of the same sex is called a homosexual relationship. • humans produce babies through sexual reproduction. • the male reproductive system consists of the scrotum, testes, epididymis, sperm ducts, urethra, prostate gland and penis. • the testes produce sperm cells and sex hormones. • the sperms are temporarily stored in the epididymis. • the female reproductive system consists of the ovaries, oviducts, uterus, vagina and vulva. • the main functions of the female reproductive system are to produce and release mature eggs and then to protect and feed a developing fetus. • puberty starts between the ages 10 and 18 when boys and girls develop secondary sexual characteristics. • the testes and ovaries produce sex hormones that cause the development of secondary characteristics. • secondary sexual characteristics in girls include enlargement of breasts and hips, and growth of hair in the pubic region. • the secondary sexual characteristics in boys are growth of muscles, growth of hair in armpits, on face and chest. • puberty is the time when reproductive organs start to produce gametes, sperms in males and eggs in females. • the release of eggs from the ovaries is known as ovulation. • the unfertilised egg and the disintegration of the mucous, lining and blood of the uterus with the loss of blood through the vagina is called menstruation. • the hormones oestrogen and progesterone control the menstrual cycle. • if an egg is not fertilised, the hormones oestrogen and progesterone are not produced.

	• when a woman becomes pregnant, the hormone progesterone is produced which maintains the thickening of the uterus lining. • menopause is the period in women during which the menstrual cycle becomes irregular before ceasing totally. • during fertilisation a sperm and an egg meet in the oviduct. • the fertilised egg is called a zygote. • the zygote divides into many cells and forms an embryo. The embryo is embedded in the wall of the uterus, this is called implantation. • during pregnancy progesterone keeps the lining of the uterus in good order. • the placenta supplies the developing embryo with food and oxygen. The umbilical cord connects the placenta and embryo. • the growing embryo is called a fetus. • the embryo is contained in a fluid-filled sac, the amnion. The amniotic fluid protects the embryo from mechanical shock. • a pregnant woman should live a healthy life and eat a balanced diet, so that the embryo develops well. • alcohol, drugs and smoking will slow down the growth and development of the fetus. • exercise helps a pregnant woman with easy childbirth. • the fetus takes about nine months to develop • the most important organs develop during the first two months. • the period between fertilisation and birth is termed pregnancy or gestation. • before birth, the fetus moves so that its head points towards the opening of the uterus. • by a series of powerful contractions, the muscles of the uterine wall force the fetus head first, through the dilated cervix and out of the mother's body via the vagina. • after birth, the uterine muscles contract and force the placenta out. • the period from birth to two years is called infancy. • the time a newborn child starts taking solid food is known as weaning. • the newborn child needs a balanced diet. • parental affection and protection are important at infancy. • breast-feeding is better than bottle feeding. • breast-feeding provides the correct food substances and antibodies.

Now do the end of unit assessment that follows. Remember to submit it to the tutor for marking.

Assessment

Assessment

Multiple choice questions

1. Which one of the following statements describes a ligament?

A. strong fibre that connects bone to bone

B. a non elastic tissue that connects muscle to bone

C. a skeletal bone that produces blood cells

D. the part in the skeleton where two bones meet

Answer:……..

2. Through which tube do sperm pass as it moves from the testes toward the outside of the body?

A. oviducts

B. vas deferens

C. ureter

D. fallopian tube

Answer:…….

3. What helps to move the egg into the oviduct?

A. movement of sperm in the oviduct

B. uterine contractions

C. amoeboid movements of the egg

D. release of estrogen

Answer:…….

4. In which of the following does fertilization occur?

A. uterus

B. vagina

C. ovary

D. oviduct

Answer:……..

5. In a 28-day menstrual cycle, on what day might ovulation occur?

A. Day 2

B. Day 8

C. Day 14

D. Day 28

Answer:……

6. The _____ is where nutrients and wastes are exchanged between the mother's and fetus' blood vessels.

A. placenta

B. umbilical cord

C. amnion

D. cervix

Answer:……

7. As the embryo develops, the placenta supplies it with

A. metabolic wastes

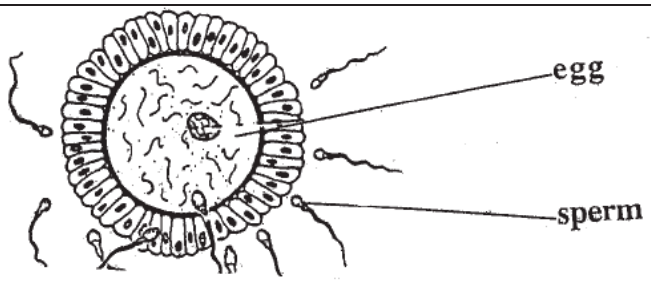
B. blood and oxygen

C. food and blood

D. food and oxygen

Answer:……

The diagram shows an egg cell and some sperm cells. Study it and then answer questions 8 and 9



8. Which process is shown in the diagram?

A. ejaculation

B. fertilisation

C. implantation

D. ovulation

Answer:……

9. How many sperm cells will eventually enter the egg? (1)

A. one

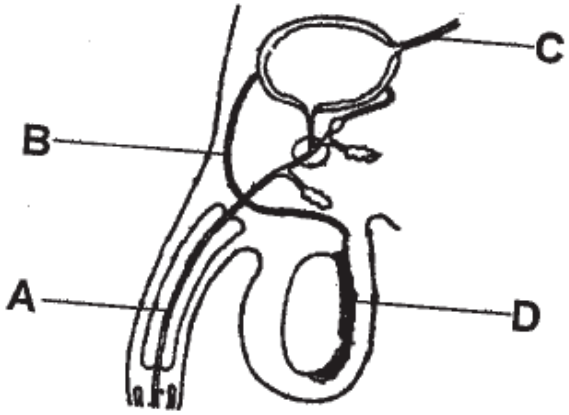
B. two

C. five

D. ten

Answer:……

10. The diagram shows the male reproductive system



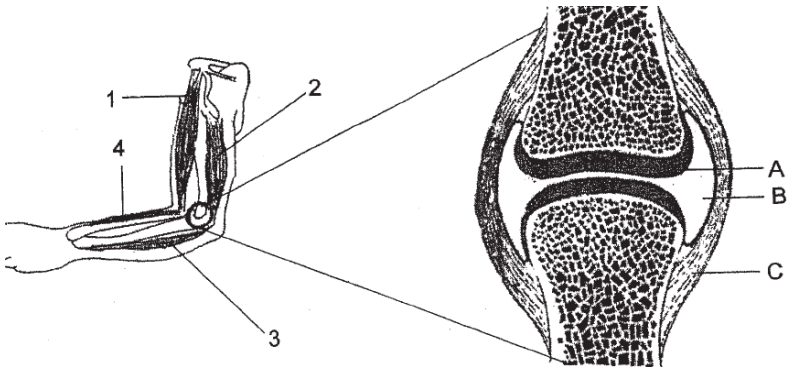
Which tube takes semen from the testes to the urethra?

Answer:……

(Total 10 marks)

Structured questions

1. The figure below shows two bones connected by a synovial joint



a) Identify the parts labeled A – C

A……..

B……

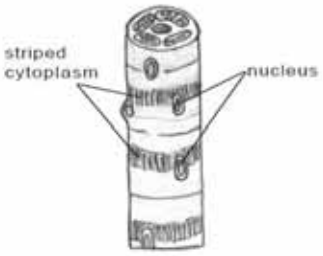
C……..(3)

b) State the functions of the parts labeled B and C.

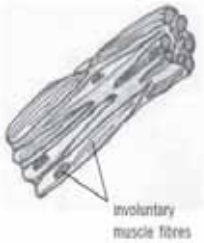
……

……(2)

2. Identify muscles A and B



B

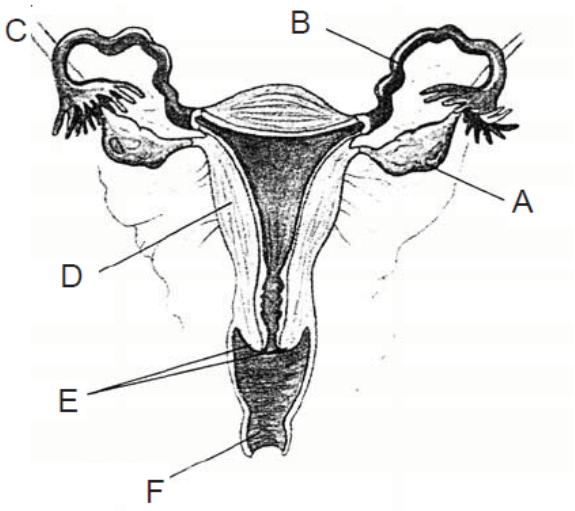


A

A……

B……(2)

3. Study the diagram below of the female reproductive system and answer the questions that follow.



a) Label parts A, B, D and F

A.....

B.....

D.....

F..... (4)

b) State the function of the part labeled E

..... (1)

(c) State the difference in function of the urethra in males and females.

Male.....

.....

Female……

……(3)

d) Name the sex hormone that is responsible for the changes in the body of boys at puberty.

……(1)

e) List the changes that a boy will experience, during puberty, due to this hormone.

……
……
……..(3)

4. Explain the words given below.

a) erection

……

……(1)

b) ejaculation

……

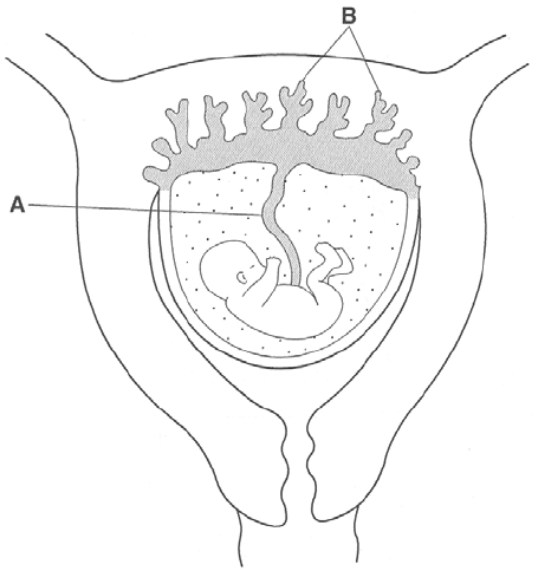
……(2)

(c) fertilization……

……

……(2)

5. The diagram below shows a human fetus inside the uterus



a) Identify the parts labeled A and B.

A……

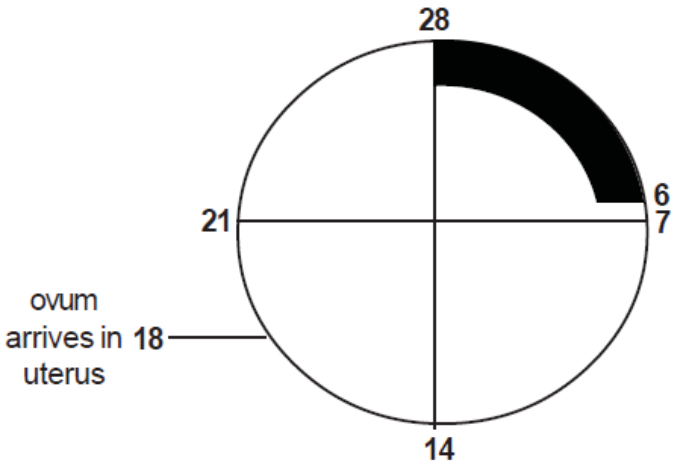
B……(2)

b) Describe the functions of the placenta and amniotic fluid.

Placenta: ……
……
……
……..(4)

Amniotic fluid:
……
……
……..(2)

6. The diagram below shows some of the events taking place in a woman's body during the 28 days of the menstrual cycle. A fertile ovum is released on day 14 of this cycle.



a) In which organ is the ovum produced?

.....(1)

b) What happens in the uterus between days 1 and 6?

.....(1)

c) Which process takes place around day 14 in the diagram?

.....(1)

d) In which structure is the ovum found between days 14 and 18?

.....(1)

e) Around which days is fertilization most likely to occur?

	.....(1) f) Name the two hormones produced by the ovaries and describe their function in the female body. ....(2) Total (40) _ {50}
Feedback **Assignment 1**	1.

	skeletal	smooth	cardiac
shape of cell	cylindrical, striated	elongated, spindle	shorter, striated
presence of striations	striated	not striated	not striated
location in the body	abundant in the vertebrate body	found in the walls of hollow organs	the walls of the hear
voluntary/in voluntary	voluntary	involuntary	involuntary

2.

The human body's support system consists of bones and muscles. These determine the way we look. Some people have short bones, some have very long, or big bones. That is why we all differ in height and in size. The skeleton plays a very important role in the body. Apart from giving the body its shape, the skeleton protects important organs such as the brain, heart and lungs, against injury .

To go back, click here.

Feedback Assignment 2	1. i) ovaries ii) oviducts iii) ovaries iv) womb v) oviduct vi) uterus vii) sperm duct viii) seminal vesicles ix) testes 2.January-February **1 2 3 4 5 6 7** 8 9 10 11 12 13 **14 15 16** 17 18 1 9 20 21 22 23 24 25 26 27 **28 2 9 30 31** **1 2 3** 4 5 6 7 8 9 **10 11 12** 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 **Notes:** Menstruation starts on 1-7th January Ovulation starts on 14th January Menstruation starts again 28-3rd February Ovulation starts on 10th February. Oestrogen levels increase during ovulation Progesterone levels increases after ovulation To go back, click here.

Feedback Assignment 3	1. Fertlisation is the fusion of nuclei of male and female gametes 2. A – umbilical cord – connect the baby to the placenta B – amniotic sac – contains fluid that protect the baby against injuries. 3. A pregnant women is examined by a doctor to make sure that the fetus and mother are progressing well. 4. A balanced diet provides all the food nutrients in their right amounts as needed for the development of the fetus. 5. Smoking and alcohol can affect the health of the baby. To go back, click here.

Feedback Assignment 4	1. The baby is unable to eat solid food. The only food the baby can eat is milk. 2. The Pituitary gland secrete a hormone that stimulate the flow of milk when the baby is sucking. 3. Colostrum milk is a thin-lemon coloured milk produced in the first 4 days after birth. 4. Colostrum is rich in proteins and milk fat. The most important aspect about colostrum, is that it contains antibodies derived from the mother, which give the baby protection against infections, because the baby does not yet have any resistance against diseases or infection. Colostrum also has a laxative effect, it prevents constipation in babies 5. • Breast – fed babies run fewer risks of infection. • Breast milk contains antibodies which protect a baby against infections. • Breast milk has the right temperature. • Breast milk is cheaper than bottle milk . • Breast feeding strengthens the bond between mother and baby. To go back, click here.

Optional Multimedia Resources:

1. **Audio clip – types of muscles**
2. **Audio clip – functions of the support system**
3. **Audio clip – functions of the placenta**
4. **Audio clip – process of birth**
5. **Audio clip – diet of a new born baby**
6. **Audio clip – importance of colostrums milk**
7. **Audio clip – advantages of breast milk**

Let us continue with the human body in unit 7.

Unit 3 - Human body part 3

Introduction

In the previous unit, we looked at how to care for a newborn child. In this section we will talk about the use of contraceptives as methods of birth control. as well as inheritance of genetic characteristics.

What is in this unit?

This unit consists of 4 topics:

Topic 1: Family planning and contraceptive

Topic 2: Inheritance

Topic 3: Variation

Topic 4: Evolution

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: • discuss the advantages of family planning. • identify and describe the advantages and disadvantages of different methods of contraception. • discuss and evaluate biological, social and ethical implications for the use of contraceptive pills. • discuss positive and negative implications of abortion. • define a karyotype as an organised profile of a person's chromosomes. • state the significance of a karyotype. • describe a chromosome as a structure carrying hereditary information (in plants and animals). • describe how sex chromosomes are passed to offspring. • explain how a combination of sex chromosomes determine the sex of a person. • define genetic variation as differences in inherited traits that exist among the members of a species (living things). • discuss how the male and female sex cells contribute to genetic variation. • define the terms locus, allele, recessive, dominant and co-dominant, homozygous, heterozygous, phenotype and genotype. • state examples of variations among human beings caused by a recessive, dominant and co-dominant genes. • explain with examples how mutation may affect the phenotype. • explain with examples how the environment may affect the phenotype. • outline the process of evolution. • explain how natural selection may bring about evolution. • explain why variation is important in selection.
 **Study time**	You need to spend about 6 hours on this unit. Don't worry if it takes you longer because we all learn at a different pace. The important thing is to achieve the set objectives.

 **Terminology**	**abortion**	when a pregnant woman expels a fetus before it is ready to be born or when a doctor removes it
	allele	different varieties of a gene, which code for different forms of the same characteristic

	chromosomes	coiled structures that contain DNA which is the genetic material that makes up genes; chromosomes are found in the nucleus of eukaryotic cells
	condom	a contraceptive made of thin rubber which fits over a penis and prevents pregnancy by trapping the sperm cells and preventing them from reaching the egg
	contraception	any method that can be used to prevent pregnancy
	diploid	describes the nucleus of a cell with chromosomes in homologous pairs
	dominant gene	in a pair of genes, the one that is "stronger"
	evolution	the gradual change of a species over a long period of time
	family planning	when people decide on how many children they want, when they want them and then take steps to ensure that unwanted pregnancies do not occur
	genes	small parts of a chromosome that determine the characteristics that will be inherited; genes pass genetic information from one cell to another and so from one generation to another; genes are made of specific sequences of DNA and are found on a chromosome
	genotype	the nature and arrangement of genes in an individual organism
	haploid	describes the nucleus of a cell that has only one set of chromos
	homologous	two chromosomes in a pair are the same in shape and size
	inheritance	the tendency to transmit characteristics of living organisms from parent to offspring
	mutation	a sudden change in a gene or a chromosome
	natural selection	the process by which individual organisms that are best adapted to their environment will survive and have the most offspring
	phenotype	the observable characteristics of an organism
	recessive gene	a gene in a pair of genes that is "weaker"
	trait	a particular characteristic that distinguishes something; it is commonly used in genetics and evolutionary

		science
	variation	when brothers and sisters inherit different characteristics from those of the parents

Family planning and contraceptives

Throughout history people and communities have had to face changes. This happens all over the world, as well as in Namibia. Life in Namibia has changed considerably over the past few years. As traditions and cultures change, people are also changing their attitudes to family and life. Most married people do not want to have babies. Some young married couples decide to have children at a late stage when they have more money or when they are older. Many older couples decide that they have enough children and do not want to have any more.

Good advice and information about family planning and contraception can improve women's health, children's health and the general health of a community.

The health of a woman is affected by:

how many children she has;

how soon the children are born and

how old she is when she has the children.

By planning your family you can avoid unwanted children. Preventing pregnancy through the use of contraceptives is called contraception. You will learn more about contraception in detail at a later stage.

What is family planning?

Family planning entails decisions jointly made by married couples about:

- when to have their children;
- how many children to have;
- how to space the children;
- when to stop having children; and
- which contraception method(s) to use.

In Namibia, the idea of family planning and contraception has not been widely accepted due to social, religious and political reasons.

The Ministry of Health and Social Services places much emphasis on and supports family planning and contraception. As a result, contraceptives are becoming more accepted in Namibian society. It is estimated that in Namibia about a quarter of all women use contraceptives.

Advantages of family planning

As a learner, you are probably already sexually active or thinking of becoming sexually active. Before you become sexually active you must know that you have certain responsibilities. You have a responsibility to yourself, your partner and your family. One of the options is to plan and prevent falling pregnant.

Can you think of some advantages of family planning? Write your answer in your notebook

Does your answer include the following?

- Many unmarried people do not want to have babies.
- Some married couples want to have children later.
- Some young married couples decide to have children when they have more money or when they are older.
- Many older married couples decide that they have enough children and do not want to have any more.
- Becoming pregnant before the age of 18 or after the age of 35 increases health risks to both the mother and her child.
- Having many children increases the health risks of pregnancy and childbirth.
- A longer period of time between pregnancies is safer for the mother and child.
- The risk of death for young children increases by about 50% when the space between births is less than two years.
- It is easier to clothe, feed, educate and care for a smaller number of children in a family.
- It is best for young people to finish their education and gain some experience in a job before having children.
- Schoolgirls and boys are not ready for parenthood. Family members usually have to take the responsibility of caring for the baby when a schoolgirl gets pregnant.

There are many reasons for encouraging Namibians to practise family planning. In rural areas many young children die during infancy due to:

- malnutrition
- diarrhoea
- infectious diseases
- mothers being teenagers, who are not ready for parenthood. teenage mothers may have difficulty bringing up children because they are young and immature. Family members have to take the responsibility for caring for babies when teenage girls get pregnant.
- young couples not socially and psychologically ready to be parents
- they are often single parents
- having many children increases health risks associated with pregnancy and childbirth
- there is not enough money and food to support everyone
- mothers are tired and do not have enough energy to care for each child

- the spacing between pregnancies is healthier for mothers and children. If the space between births is less than two years, there is a health risk for the mother and the child.

It is important that both mother and father are involved in family planning. Several methods of contraception require the cooperation of both the man and the woman to be successful.

The matter should be discussed and they should agree on the number of children they want, as well as when they want them. Unfortunately, in some Namibian communities, men consider caring and raising children to be the sole responsibility of women.

What is contraception?

What do you think the term contraception means?

Contraception includes any method that prevents a baby being conceived. There are different contraceptives for males and females. The effectiveness of a contraceptive depends largely on whether it is used in the right way. Female contraceptives are available at hospitals, clinics and pharmacies. Male contraceptives are available at some local stores or supermarkets. It is important to use a contraceptive that is suitable and to use it in a correct way.

Some contraceptives can also help prevent transmission of sexually transmitted diseases.

Contraception methods

Whether to have a child or not is your responsibility and decision. You can get advice from a nurse or family planning office to choose the right type of contraceptive.

Audio clip - Contraceptives.mp3

Double click to hear audio.

Listen to the discussion of the youth forum by clicking on the audio icon.

Did you enjoy their discussion?

 Note it	The contraceptive you choose to use must protect you from falling pregnant and from HIV/AIDS and other sexually transmitted diseases.

The different methods of contraception can be grouped into natural, chemical, mechanical, surgical and traditional. The table below shows methods of contraception and the advantages and disadvantages of each.

Methods	How is it used	How it works	Advantages	Disadvantages
Condom	a rubber sheath that is placed over the penis before intercourse	keeps sperm out of the vagina after ejaculation	readily available; cheap; very reliable; protects against the transfer of HIV and other viruses and bacteria which cause sexually transmitted diseases	If kept too long in the vagina it may become leaky; cannot be used more than once
oral contraceptive (also known as pills)	tablets that contain the hormones oestrogen and progesterone; a tablet must be taken every day at the same time of the day for three weeks	the tablet prevents an egg being released from the ovary; if there is no egg then there can be no fertilisation	when the tablet is taken regularly it is a very effective method of preventing pregnancy	If the tablet is not taken regularly, there is a chance to fall pregnant. Some women gain weight. Some women may suffer from circulatory diseases such as strokes.
injection	a chemical substance called Depo-provera is injected into the body by a doctor	The injection is given once every three months. The injection prevents an egg being released from the ovary. It will prevent a woman becoming pregnant for three months.	It is a very reliable method.	There is a possibility of some women getting sterile as a result of these injections
the diaphragm (also called the cap)	This is a circular piece of rubber with a spring that fits over a woman's cervix before intercourse	The diaphragm keeps sperms out of the uterus	This method is effective when the diaphragm fits in the vagina correctly.	The diaphragm does not protect women against HIV and other STis.
the intra-uterine device (IUD) (also called the loop)	The loop is made of metal or plastic and is placed in a woman's uterus by a doctor.	The loop prevents the implantation of fertilised eggs.	a reliable method	makes menstruation heavier than usual; occasionally makes it more difficult for a woman to conceive after is has been

				removed.
spermicide	a chemical substance put into the vagina before intercourse	The chemical kills sperms.	reliable only if the cream is applied together with a condom or a diaphragm	The cream does not protect against HIV and other STDs. Some women get a rash or infection in the sex organs.
femidom (female condom)	a rubber sheath which is placed over the vagina before intercourse	keeps sperms out of the vagina after ejaculation	protects against pregnancy; provides a barrier to HIV and other STDs	A femidom can be used only once. When kept too long in the vagina, it may become leaky
withdrawal	withdrawal of the penis just before ejaculation	prevents fertilisation by releasing sperms outside a woman's vagina	does not cost anything	not reliable; some sperms may be deposited into the vagina. It demands a lot of self-control; does not protect against HIV and other STDs
the safe period (rhythmic method)	To have intercourse a week before and after menstruation	prevents fertilisation	does not cost anything	It takes a lot of self-control; does not protect against HIV and other STDs
male sterilisation (vasectomy)	A surgeon cuts or ties the sperm ducts.	stops sperms getting into semen	very reliable method	needs money for the operation; it is not possible to reverse the operation.
female sterilisation (tubal ligation)	A surgeon cuts or ties the oviducts which take the eggs from the ovaries to the uterus	stops sperms reaching the egg	very reliable method	needs money for the operation; it is not always possible to reverse the operation when the fallopian tubes are cut; but it may be reversed if the tubes are tied.
traditional	a tablespoon of ash from certain firewood with bitter tea from leaves of certain herbs	kills sperms	cheap	side effects and after affects not known; not freely available

Click here to view the types of contraceptive methods on the slides show.

If you are not still coping with the subject matter so far, please re-read the section.

Now do the following activity in your notebook. Compare your answers with mine at the end of the unit.

Activity 1

1. Why is family planning a good thing for
   a) married couples?
   b) teenagers?
   c) the world?
2. What does spermicide do to sperm?
3. Which women might find contraceptive pills harmful?
4. What are the advantages and disadvantages of the pill as a method of contraception?

To check feedback, click on the icon 

Next you will learn more about **abortion**.

Abortion

What is abortion? Write your answer in your notebook.

Does your answer include the following?

Audio clip - Effects of abortion.mp3

Double click to hear audio.

Listen to the audio by clicking on the icon.

Abortion is the termination of a pregnancy before a fetus is fully developed for birth. Abortion may be spontaneous or induced deliberately. A spontaneous, unintentional abortion is known as a miscarriage. It happens when the uterus contracts in the early months of pregnancy. A miscarriage takes place when there is some defect in the fetus or the uterus cannot hold the fetus.

Induced abortion is a deliberate action done by artificially inducing the loss of a fetus with the intention of terminating the pregnancy. Induced abortion can be legal or illegal depending on the abortion laws in individual countries. Abortion is illegal in Namibia. It is legal in South Africa.

Legal abortion in Namibia is only allowed when the pregnancy is a result of **rape.** Rape is a violent crime that occurs when a person is forced to have sex against his or her will.

Many people believe that abortion should be made legal in Namibia so that children who are a result of unwanted pregnancies do not place a burden on their families and communities. Others believe that abortion is the same as murder, because the fetus is alive in the uterus and dies when it is removed.

Read the following poem about abortion.

Why, why, why?
I am still a young girl
Full of life
I am still a school girl
Why is my tummy getting bigger?
Because of that one perfect mistake?
Pregnant, oh no!
What now?
The shame …
What will my parents say?
I have a plan!
Sorry baby, but I have to
Get rid of you!
Abortion will save me from this shame

What do you think about that? Listen to the audio about the effects of abortion once again.

Next we will discuss arguments for and against abortion, but before that, do the following activity in your notebook.

Activity 2	Is abortion a good or a bad thing? Do you think the Namibian government legalise it? Please give reasons for your answer.

Arguments for and against abortion.

For abortion	Against abortion
A woman should have the right to decide. It is her body.	An embryo is a separate life and has a right to life.
Rape victims should have the right to terminate pregnancies they did not choose.	An embryo committed no crime.
A fetus with a genetic defect should be aborted to prevent a defective child being born.	Even defective children are loved and can live a happy life.
People will use back-street abortions when they are not allowed legal abortion.	Even legal abortion will leave a woman with feelings of guilt and loss. It is agreed that illegal abortions can cause excessive bleeding, infection, infertility, blood poisoning and death.

Other views:

Arguments for abortion:

- Historically, abortion has been the most common method of birth control.
- Abortion is incorporated into family planning and population programmes in different countries.
- In most countries, couples wish to limit the number of children they have through abortion.
- Some view abortion as a means of preventing an unwanted birth. If not prevented, it could lead to serious personal and family problems.

Arguments against abortion:

- Abortion is considered as a criminal act or murder.
- Various churches generally adopt a strong anti-abortion policy.

Now, try this self-mark assignment to check your progress so far. This assignment should not take you longer than 4 hours. The guidelines will be given at the end of the unit.

Assignment

 Assignment 1	1. Visit a clinic or health centre near you and collect **different examples** of various **contraceptives** you have learned about. Make a poster using these contraceptives. 2. Do a survey in your local area to determine what types of contraceptives are more popular than the others. To check feedback, click on the icon ☺

Genetic Inheritance

Why do children look like their parents? We will attempt to answer this question in this section, which will cover genetic inheritance.

When you look at the members of your family, your father, mother, grandmother, grandfather, uncle or aunt you will notice that you may look like one of them.In living organisms, there is a tendency to transmit characteristics from parents to offspring. The passing on of characteristics from one generation to the next is called **inheritance** (heredity).

The information for your appearance is passed to you in the genetic material in the sperm cell from your father and the ovum from your mother. All human life starts with an egg in the body of a mother where an egg is fertilised by a sperm from a father. This means that all characteristics that we inherit from our mother must be carried in the egg and those that we inherit from our father are carried in the sperm.


Audio clip - Inheritance.mp3

Double click to hear audio.

Listen to the audio by clicking on the icon.

Characteristic features are controlled by units of inheritance called **genes** carried in chromosomes found in the nucleus of a cell. The genes that contro and determine characteristic features are passed down from parents to children through sex cells. Genes are sometimes called factors of inheritance.

Genetics is the study of inheritance concerns the variation between organisms and how genetic inheritance is affected by interaction with the environment**.**

Look at your parents, your sisters and brothers and check for similarities in the following characteristics caused by genetics:

- colour of eyes;
- shape of nose;
- shape of mouth;
- colour of hair;
- hairstyle (straight or wavy);
- shape or ears (lobed or unlobed); and
- skin colour.

The characteristics above may not be among all your family members. Some characteristics may be similar in all of you, but do not look exactly alike.The development of these characteristics is controlled by genes and chromosomes. You inherit some of your characteristics from your parents.

Characteristics that are passed on from parents to their children are called **inherited characteristics**. Hair, eye and skin colour are examples of inherited characteristics. **Acquired characteristics**, on the other hand, are caused by the environment.

The diagram below shows inherited characteristics in a family. The father has blond curly hair, brown eyes, a broad nose and a cleft chin. The mother has straight black hair, blue eyes, a long thin nose and a pointed chin. The children in the family inherited some characteristics from each of their parents.

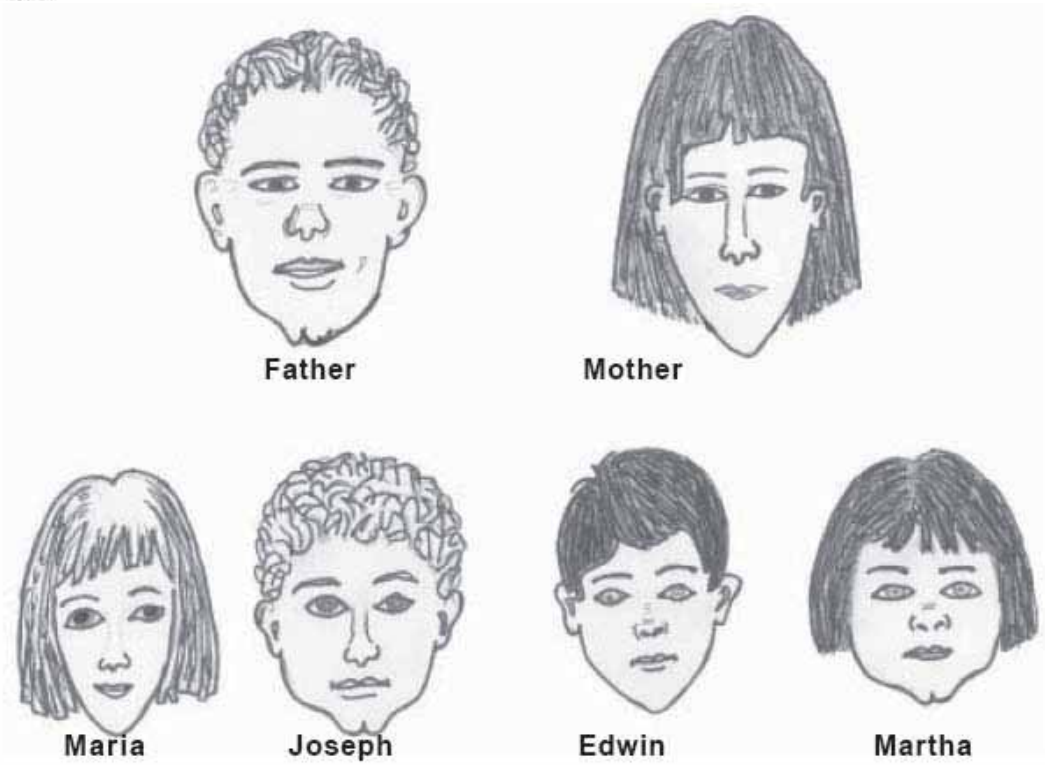


Diagram: Inherited Characteristics in a Family

Spend a few minutes to answer the following question.

Activity 3	Can you tell which characteristics come from which parent? Write your answer in your notebook.

Your answer may include the following: Maria has straight blond hair, brown eyes, a long thin nose and pointed chin. Joseph has blond curly hair, brown eyes, a long thin nose and a cleft chin. Edwin has straight black hair, blue eyes, a broad nose and a pointed chin. Martha has straight black hair, blue eyes, a broad nose and a cleft chin.

Chromosomes

Chromosomes are thread-like protein structures found in the nucleus of a cell. Each ordinary human body cell contains 46 chromosomes in its nucleus that are grouped into 23 pairs. Each chromosome carries a certain number or set of **genes** and each gene is responsible for controlling the development of a certain specific characteristic.

Similar or the same type of chromosomes exists in pairs called **homologous pairs.** For every chromosome, there is always another similar chromosome with the same shape and structure that carries the same set of genes in the nucleus. Each ordinary human cell contains 23 pairs of chromosomes, which is sometimes called a **diploid number** of chromosomes. Each gene controlling a particular characteristic has a similar or an alternative form of a gene located in its partner chromosome in the homologous pair called its **homologue**. Alternative forms of genes controlling a particular characteristic are called **alleles.**

Karotype

A karotype is a picture that shows an organised profile of a person's chromosomes. It is used to show potential genetic disorders in chromosomes that might be passed on to children. In order to prepare a karotype, chromosomes are removed from a cell, stained and then photographed.

Each chromosome is cut from an enlarged photograph and matched with a photograph of its homologue (same or similar chromosome). This analysis of matched chromosomes enables the spotting or identification of abnormalities between the two sets of chromosomes. Couples that show genetic risks may have to undergo genetic counselling to inform them about problems that might affect their offspring (babies).

Formation of sex cells and distribution of chromosome and genes

Sex cells are formed in sex organs that include testes in males and ovaries in females. The process of cell division called **meiosis** forms sex cells (gametes). During meiosis, chromosomes of each homogonous pair separate so that each sex cell will contain half the number of chromosomes in the form of 23 unpaired single chromosomes. This involves a parent cell containing 46 chromosomes splitting to form four daughter cells (sex cells or gametes) each containing 23 unpaired (single) chromosomes.

The number of chromosomes in sex cells is called a **haploid number** of chromosomes. When fertilisation occurs, the 23 chromosomes in the sperm join with the 23 chromosomes in the egg to form a zygote with a full set of 46 chromosomes.

Each chromosome in the sperm will pair with a similar or the same type of a chromosome from the egg forming a zygote with a full set of genetic information for the development of same characteristics from each parent. The 23-paired number of chromosomes in a newly formed zygote is called a diploid number of chromosomes.

The instructions for building all the different cells in humans are contained in the 46 chromosomes of a single cell, the zygote. These instructions are genetic information and must be carefully copied every time the cell divides. This ensures

that all the cells of a fully-grown human have a complete set of *identical* instructions.

Cell division

There are two types of cell division, namely mitosis and meiosis.

Mitosis

When a cell divides and each chromosome makes an identical copy of itself, the copied chromosomes then separate into two new cells. This type of cell division is known as **mitosis** and is important for the growth and development of organisms. Mitosis cell division is used to replace worn out cells and heal wounds.

Mitosis is shown in the diagram below.

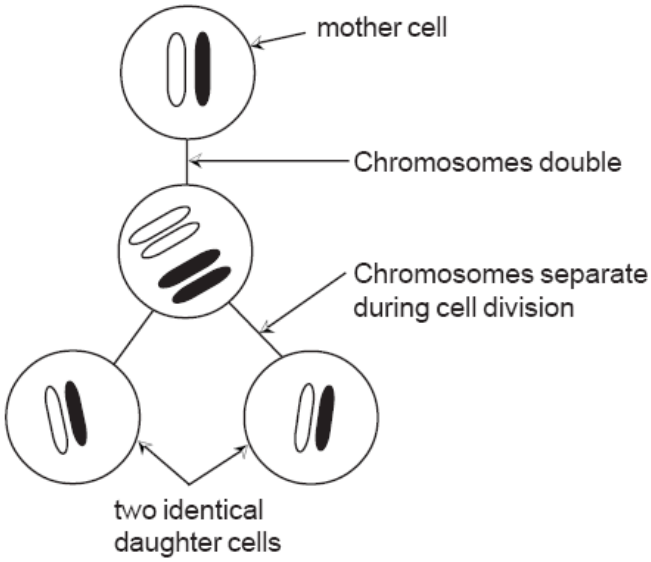


Diagram: Mitosis

Meiosis

Gametes (sperm and egg cells with only 23 chromosomes) are produced by a special type of cell division that separates homologous chromosomes into four different cells. This type of cell division is known as meiosis. It occurs only in the testes and ovaries. After meiosis, the mother cell divides and reproduces into non-identical daughter cells.

The number of chromosomes in a normal cell of a person is 46, arranged into 23 **homologous** pairs. These 46 chromosomes in a body cell are known as **diploid** numbers. The sex cells, the sperm and the egg are not exactly the same as a body cell. All our body cells are produced by the division of a single cell, the

zygote.The zygote is formed by the union of the sperm and the egg cell and has 46 chromosomes.

This means that the sperm cell and the egg cell contain half the diploid number of chromosomes.The sperm cells and egg cells are called gametes. Gametes have only 23 chromosomes. This is the **haploid** number. Only one member of each homologous pair of chromosomes is present in each gamete.

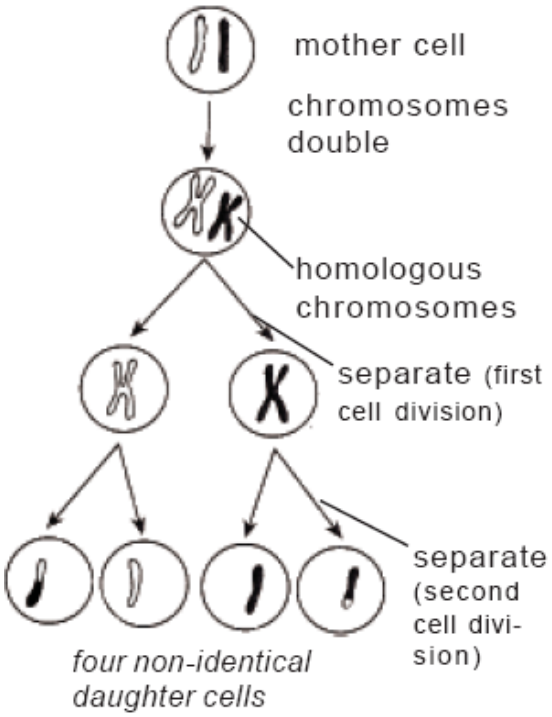


Diagram: Meiosis

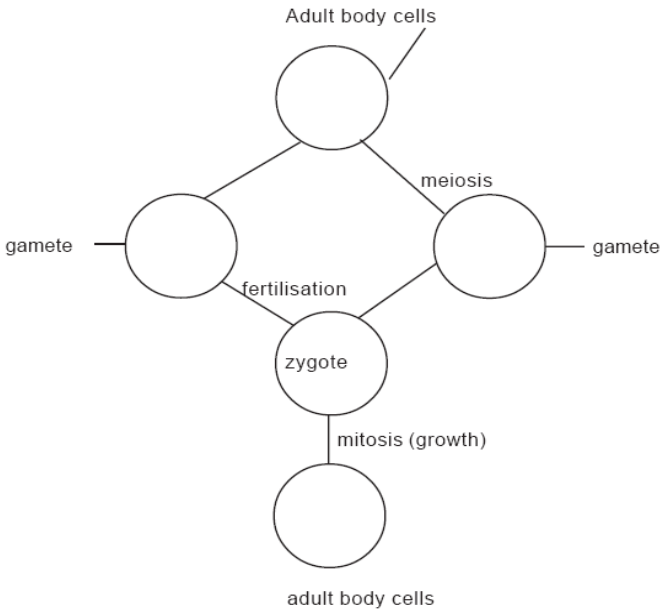
Importance of meiosis

- gamete formation;
- reduces diploid to haploid chromosome numbers; and
- variation within a species.

Now is time to check your progress. Do the following activity in your notebook. Do not forget that the feedback is given at the end of the unit.

Activity 4

In this diagram of the human cycle, the circles represent the cells during the process of meiosis and mitosis. Complete the diagram below by writing in the circles the number of chromosomes found in each cell.



Click here for feedback ☺

Which chromosomes determine the sex of a baby?

Human cells have 46 chromosomes (diploid) that are arranged in 23 pairs.Of the 23 pairs of chromosomes in the nucleus of a human cell, the 23rd pair contains genes controlling the sex of an individual. This pair of chromosomes is called **sex chromosomes** because they determine the sex of an individual. There are two types of sex chromosomes. One is called the X-chromosome and the other is called the Y-chromosome.The sex chromosomes carry gene X for the female sex and gene Y for male sex. The X and Y chromosomes differ in size; the **X** chromosome is much longer than the **Y** chromosome.

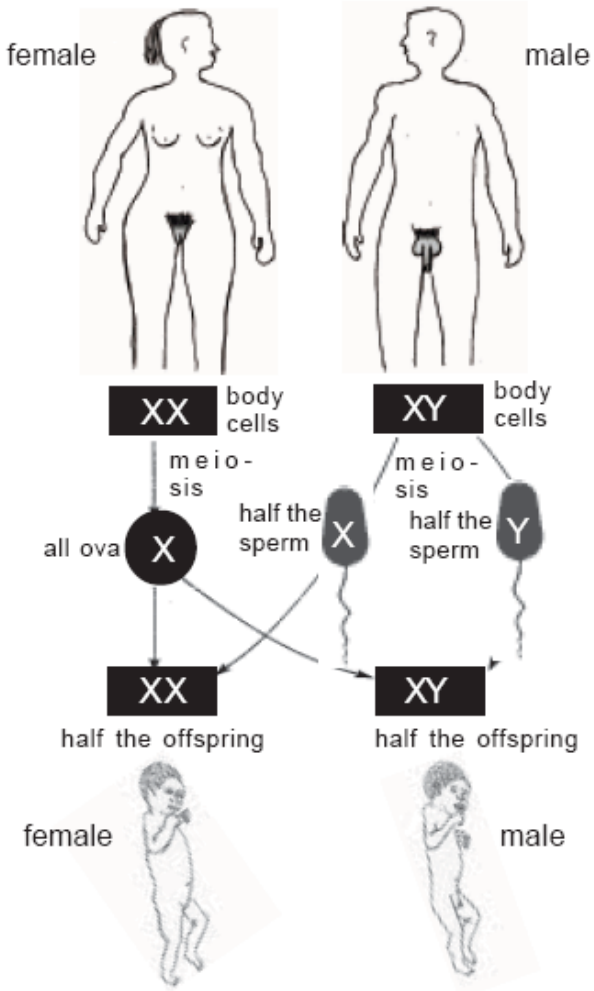
Male sex chromosomes are composed of an X gene carrying chromosome (X-chromosome) and a Y gene-carrying chromosome (Y-chromosome). Females have two X chromosomes for controlling female sex.

The genetic factors (or genetic constitution) of an individual controlling a particular characteristic is called **genotype**. A woman's chromosomes are both

alike and are called **X** chromosomes. She has the **genotype XX.** A man has only one **X** chromosome. The other, smaller one is a **Y** chromosome. He has the **genotype XY.**

It is the sperm that determines the sex of children. During meiosis, the sex chromosomes separate and half of the sperms will be carrying X chromosomes while the other half carry Y-chromosomes which means that half of the sperm carry genes that will make the child a girl, and half carry genes that will make the child a boy. If a sperm carrying an X chromosome fertilises an egg, the child will be female. On the other hand, if a sperm contains a Y-chromosome fertilisation will result in a male child. There is a 50 per cent chance of a boy and a 50 per cent chance of a girl.

Determination of sex:



According to the diagram above, when an X-chromosome sperm fertilises the egg the zygote will be a female with XX-chromosomes. When a Y-chromosome sperm fertilises the egg a male zygote with XY-chromosomes will be formed. Theoretically, the chances of having baby boys or baby girls are 50/50 or 1:1 meaning that there are equal chance of having baby boys or baby girls.

Tip	This is why approximately half of the world's population are women and the other half men!

How are you coping so far? Complete the following assignment in your notebook and compare your answers with those provided.

Assignment

Assignment 2

1. What is the difference between chromosomes and genes?

2. Below is a drawing of a chromosome of an organism.

Answer the questions that follow.

a) How many chromosomes are there in this organism?
b) How many matching pairs are there?
c) What is one matching pair called?

3. Write down five inherited characteristics.

	4. Write down three acquired characteristics. To check feedback, click on the icon 

Genetic Variation

Why do individuals vary?

If you look at your family again, you will notice some characteristics that you, your brothers and sisters possess which differ from the characteristics of your parents. Why is there variation in a family? We will attempt to answer this question in the part that follows.

Family members do not inherit the same characteristics from their parents. In the same family brothers and sisters may not look alike. **Variation** is the differences that exist between individual members of the same species (a group of plants or animals of the same kind). Children of the same family may not be identical. They may show some differences (variation) in terms of height, complexion, weight or even behaviour.

The following are some of the reasons for variation:

- we have different genes caused by genetic reshuffling, the meiosis process and the fertilisation process;
- difference in environment; and
- a difference in diet may affect our height, weight, etc.

It is now time for reflection. Answer the following questions in your notebook.

 **Activity 5**	Use yourself as an example, list three characteristics for each of the following. Write your answers in your notebook. a) characteristics that you inherited; b) characteristics that you have acquired (got later in life)

Variations can be genetic or environmental. **Environmental variations** are differences that arise due to influences of environmental factors such as climate, upbringing or friends. For example, people living in the hot equatorial region have darker skin than those living in a cooler climate.

Genetic variations are differences in inherited traits (characteristics) that exist among members of the same species. It can be found that even members of the same or different families may have differences in inherited characteristics such as sex, height, skin colour, eye colour and tongue rolling. Remember that a genotype is the set of genetic factors (or genetic constitution) of an individual that control a particular characteristic. The observable characteristics showing

variation differences are called **phenotype**. The genotype controls or determines the phenotype of an individual.

Tip	Your **genotype** is the characteristics you have inherited from your parents. Your **phenotype** is what you look like.

Dominant and recessive genes

A **dominant gene** is a powerful gene whose effect always shows its characteristics even if paired with a recessive gene. A **recessive gene** is a weak gene and the characteristics of the recessive gene can appear only if two recessive genes are paired together.

When a mother and a father both have a pair of genes for brown eyes, their children will also have brown eyes. In the same way, parents who each have a pair of genes for blue eyes will pass these genes on to their children who will have blue eyes.

However, the children of a brown-eyed father (with a pair of genes for brown eyes) and a blue-eyed mother (with a pair of genes for blue eyes) will inherit genes for both blue eyes and brown eyes. However, most of the children will have brown eyes, because the gene for brown eyes is the dominant gene. This means that the gene for brown eyes is 'stronger' than the gene for blue eyes. The gene that is 'weaker' is called the recessive gene. If one of the genes of the pair for eye colour is blue and the other is brown, the eye colour is likely to be brown.

Dominant characteristics and recessive characteristics

Diagram: Dominant and Recessive Characteristics

Recessive genes means that people can have the genes for characteristics that you cannot see just by looking at them. When two parents have brown eyes and they both carry the recessive gene for blue eyes along with the dominant gene for brown eyes, it is possible for their children to have blue eyes. Through meiosis,

sperm and egg cells may carry the recessive gene When these two cells with recessive genes combine, then a baby will have blue eyes.

Many inherited characteristics are determined by genes that are dominant or by a combination of two recessive genes.

Albino genes

The pigment **melanin** determines the colour of skin (brown, black or white). Sometimes, both black and white people have children who are **albinos**. Albinos lack the ability to produce the pigment melanin that determines the colour of hair, skin and eyes. An albino has whitish hair, a very pale skin and reddish eyes.

The albino gene is recessive and people may carry the gene without being albinos themselves. A carrier gene is carried by a human, but is not a physical attribute of that human. The person carrying the gene, can pass it on to their children. When a child gets an albino gene from each of its parents, then he or she will be an albino.

Co-dominant genes

Co-dominant genes are genes that are neither recessive nor dominant. This means that these genes are equal in 'strength' and that they have an equal influence in determining characteristics. An example of a characteristic determined by co-dominant genes is skin colour.

 Tip	Co-dominance is sometimes referred to as incomplete dominance.

Different types of variation

Continuous variation

When you look at people in your community or country, you will notice many different features. People differ in terms of height and weight. Their hair and eyes are different in colour and their faces have different shapes. Their eye colour and hair colour show variation.

When you arrange them in a line according to their height with the *shortest* to the *tallest*, you will find that they form a complete range. This type of variation is known as **continuous variation**. Another example of continuous variation is intelligence.

Photo: People's height shows continuous variation

Discontinuous variation

Discontinuous variation occurs when organisms either have or do not have certain characteristics that are distinct such as being able to roll your tongue or having ear lobes. Blood groups are another example. Your blood belongs to only one of the following groups - A, B, AB or O.

Acquired variation

Changes in the environment such as different amounts of food, light and space can have an effect on the way individuals develop. Variations caused by environment are called **acquired variation**. Height and weight can be influenced by the sort of food we eat and how much sunlight we are exposed to.

Mutation

A **mutation** is a sudden change in a gene or a chromosome. Mutations in sex cells may affect the inheritance of characteristics and the way in which a child develops. Sometimes, when cells divide, the structure of a chromosome may be altered or a gene copied incorrectly.

Mutations can either be recessive or dominant. If a mutation simply inactivates a protein, it generally results in recessive mutation. Since we have a pair of chromosomes each carrying a copy of the genes, the non-mutated gene can compensate for the mutated gene. Only when both chromosomes contain the

mutation will the phenotype be affected. If the mutation results in a protein that is toxic and the other gene on the other chromosome cannot counteract the mutation, such mutation is said to be dominant.

Dominant and recessive mutations result in different patterns of inheritance. In dominant mutation, every individual with the mutated gene will have a mutated phenotype. In a recessive mutation, individuals with only one mutated gene will have a normal phenotype but are said to be carrier of the mutation. When two carrier individuals have children those that will have inherited mutated genes from both the mother and father will display the mutated phenotype.

Mutation may occur naturally, but many causes of mutation are man-made. Mutation can be caused by X-rays, mutagens, ultraviolet rays, radiation and chemicals such as nitrosamine found in cigarette smoke. Gamma rays, alpha and beta particles from radioactive decay also cause mutation. Many mutagenic hydrocarbon compounds occur in car exhaust fumes. That is why there is interest in catalystic converters for cars. These converters change hydrocarbons in the exhaust gases to carbon dioxide and water, which are far less harmful.

Not all of these factors may cause mutations but will increase the rate at which mutations occur. This is why some forms of radiation are so dangerous. It is also why there is so much debate over the safety of the nucleur power industry.

A mutation in the DNA by definition alters the genotype of the individual, however it may not affect the phenotype (it may or may not have a functional effect). There are two main kinds of mutation, namely **chromosome mutation** and **gene mutation**, which will be discussed in the next section.

Chromosome mutation

Sometimes chromosomes are altered during meiosis, causing **chromosome mutations**. A section of a chromosome may break off and the chromosome piece may be lost or it may attach itself to another chromosome. Sometimes the addition or loss of a whole chromosome occurs when a pair of homologous chromosome fails to separate during meiosis. They both move into the same gamete. If this gamete is fertilised, the zygote will have an extra chromosome, making the total number of chromosomes 24. When this happens during the development of the ovum, the result is Down's syndrome.

Down's syndrome is associated with deformed facial structure and low mental development. Children with Down's syndrome often have a flattened face and slanted eyes. Their life expectancy may be reduced because of diseases such as leukaemia and heart disease. They are usually below average in height and intelligence but are affectionate and very contented.

 Tip	There is an increased chance of a baby being born with Down's syndrome to a woman over 35. Blood screening is now available to all pregnant women to detect whether or not the fetus has Down's syndrome.

Check your progress once again. Compare your answers with those provided.

Activity 6	1. What is the cause of Down's syndrome? 2. List four environmental factors that can cause mutation. For feedback click here ☺

Gene mutation

A chemical change that alters the message carried by a single gene is called **gene mutation**. Gene mutation that occurs in gamete-producing cells is transmitted to all the cells of the offspring and may therefore affect the future of the species.This does not happen very often, although some genetic diseases may be caused by gene mutation.

A gene mutation may be the cause of extra fingers and toes. Haemophilia is a genetic disease that stops blood from clotting when a blood vessel is cut. The albino gene is a mutation that prevents the formation of the skin pigment melanin. Melanin is a dark coloured pigment that protects us from the sun's powerful ultraviolet rays. An albino lacks the allele in skin cells.

The diagram below shows a baby's hand with an extra finger.

Diagram: Hand with extra finger

Do the assignment that follows to check how you are progressing so far. Compare your answers with mine at the end of the unit. You should not spend more than 2 hours on this assignment.

Assignment

Assignment 3	
	1. Define the term variation. 2. Define the term mutation. 3. Intelligence shows continuous variation. What does this mean? 4. Blood groups show discontinuous variation. What does this mean? 5. Explain the difference between a chromosome mutation and a gene mutation. 6. a) An albino man marries a normal woman who has one parent who was an albino. How likely is it that their first child will be an albino? Give two reasons. b) Certain individuals in this family are carriers. Which ones are carriers and what does this word mean? To check feedback, click on the icon 

The next slot will deal with the evolution of human beings.

Human evolution

In Unit 3, we explored evolution, and how certain species evolved from previous species and subspecies. Now we will further explore human evolution. Where do human beings come from? In this section we will look at evolution, human evolution and the mechanism of biological evolution.

What is evolution?

Evolution is the gradual change in inheritable **traits** of a population over many generations.A trait is a particular characteristic that distinguishes something. It is a word that is commonly used in genetics and evolutionary science. It is determined by changes in the number of times a particular gene is found in a population.

There are over 200 million different species of plants and animals on earth. People have always searched for explanations as to how this variety of life came into existence. One such explanation is that organisms have changed gradually from one generation to the next and that over millions of years, one species has changed to produce a large number of different species. This process began about 4,000 million years ago when single-celled organisms first appeared on

earth. The process by which living things gradually develop through progressive inheritable change is known as **evolution.**

The basic mechanism of evolution is **natural selection.** Natural selection is a process through which individual organisms with characteristics that are favourable to their environment are more likely to survive and reproduce offspring..

A scientist named Charles Darwin explained this theory (in a book called *The Origin of Species,* 1859) of how evolution could have come about by a process of **natural selection.**

The theory of natural selection maintains that more advantageous characteristics are being passed on to the next generation in the gene production than genes producing less advantageous phenotypes. When offspring inherit these favourable characteristics and in turn, survive and reproduce, then these favourable characteristics will be passed on to successive generations.

Darwin's theory can be summarised as follows:

- Variation occurs causing gradual change;
- survival of the fittest;
- struggle for existence;
- over-production; and
- advantageous characteristics passed on to offspring.

One of the ways in which organisms adapt to their surroundings is mutation. Mutation changes the characteristics of an organism that may result in better resistance to threats and hardships in its environment. For example, an antelope with the most powerful leg muscles will be the one that is most likely to escape from a fast-moving predator.

Natural selection does not always result in "change". Darwin noticed that animals and plants are never exactly the same and that they show variation. He realised that all living things struggle to survive. Darwin concluded that those animals or plants that survive to breed are those whose variation best suits their environment. The survivors will pass on the successful variation to their offspring. Gradually, new types or species of animals and plants would evolve that are better adapted to the environment. For example, hares that run the fastest will escape foxes. Genes for powerful leg muscles will be selected and over many generations the performance of the species will be enhanced.

How do we know that evolution has occurred?

The process of evolution happens over millions of years so no one has lived long enough to observe it. We do have evidence, however, that strongly suggests that evolution has occurred.

This evidence includes:

1. Series of fossil remains have been found in rocks of different ages

They tell the story of gradual change over time. For example, Horse fossils show a series of changes from the ancient grey hood size horse to the modern one.

2. Evidence from anatomy

Similar patterns are found in related groups of organisms. All mammals have the same type of heart, gut, etc. All vertebrates have limbs with a similar bone structure. This implies that organisms may have common ancestors.

3. Plant and animal geography

Volcanic islands were colonised and the isolated population evolved in a unique way. Darwin studied these islands and described new species of finches.

The process of evolution is a combination of the potential of a species to increase in number and the genetic variability of offspring due to mutation and the recombination of genes.

Evolution of human species

There are more humans on earth than any other large animal. Humans live in the hottest as well as the coldest parts of the planet. In fact, our species *Homo sapiens* has evolved into the most successful species on earth. This is because we are the most intelligent species in the world.

Where did the human race come from?

Our ancestors are not alive today. There is some convincing evidence to support the view that humans and apes of today (such as the gorilla, orangutan and chimpanzee) may share a common ape-like ancestor that lived 50 million years ago. From skeletons and fossils, scientists and artists have been able to produce the drawings shown below that indicate that we (humans) may have evolved by principles of descent (same ancestors)

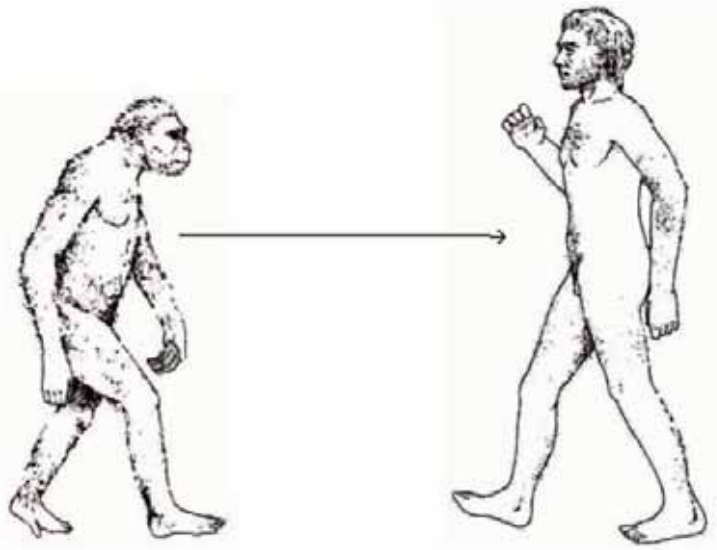


Diagram: Demonstration of human evolution

We will never know why a group of ape-like creatures moved down from trees to grasslands millions of years ago, although one possible explanation could be that

a small group was driven out of the forest by the rest because of competition for food and space. In the grasslands, our ancestors had no protection and so environmental pressure selected only those individuals who were better adapted to the new surroundings. Over millions of years a new kind of animal, *Homo sapiens*, evolved.

To complete this section, do the following self-mark assignment in your notebook. *Feedback is given at the end of the unit.*

Assignment

 **Assignment 4**	1. Explain the term 'human evolution.' 2. How does it help species to survive? 3. How did human beings evolve? Explain your answer. 4. What do you understand by the process of natural selection? To check feedback, click on the icon 

Read the summary that follows to complete Unit 7.

Unit summary

Summary

In this unit you learned that:

- family planning occurs when a couple decides when they should have children and how many children they want and a couple takes action so that unwanted pregnancies are prevented.
- contraception is any method that prevents pregnancy.
- contraception methods based on traditional medicine are used in some regions in Namibia.
- a condom is a method that can be used by males. It prevents sexually transmitted disease including HIV/AIDS.
- the 'safe period' and 'withdrawal' are not reliable methods to prevent pregnancy or sexually transmitted diseases.
- there are various forms of female contraceptives including pills, injections, diaphragms, loops, femidoms and sterilisation.
- the femidom is the only contraceptive used by women that protects women against sexually transmitted diseases.
- sterilisation is a very reliable contraceptive method. This method is recommended for people who have decided not to have any more children.
- abortion entails the removal of a fetus.
- abortion is legal only if a pregnancy was caused by rape or when it will endanger a mother's life. Otherwise, abortion is illegal in Namibia.
- the passing on of characteristics from one generation to the next is called inheritance.
- inherited characteristics are characteristics that are passed on from parents to their children by gametes/sex cells.
- genetics is the study of inheritance.
- all human beings share certain characteristics. These ensure continuity within the human race.
- the environment influences acquired characteristics.
- chromosomes are found in the nucleus of a cell.
- a human body cell has 46 chromosomes. Each chromosome has pairs known as homologous pairs.
- each chromosome is made up of huge numbers of chemical structures called genes.
- mitosis is cell division that takes place to form new body cells. The human body cell has 46 chromosomes in 23 pairs, known as diploid numbers.

	• the gametes, namely sperms and eggs, have only 23 chromosomes, which are known as haploid numbers. • the gametes are formed by a type of cell division known as meiosis. • meiosis is cell division that takes place in the sex organs and forms the egg and sperm cells. Four haploid daughter cells, genetically different, are formed from one diploid cell. • one pair of chromosomes in human beings has XX- or XY-chromosomes. These are called sex chromosomes. • after fertilisation, the zygote will develop into a girl if it has XX sex chromosomes. When the sex chromosomes consist of X- and Y-chromosomes, then the zygote will develop into a boy. • for each inherited characteristic there is a pair of genes – one from the father and one from the mother. Alleles can be dominant and determine the characteristics that will develop. Some alleles can be recessive. • inherited characteristics are mostly determined by dominant genes or by a combination of two recessive genes • the albino allele is a recessive allele and some people carry the allele without being albinos themselves. • a genotype consists of instructions that determine the characteristics of the individual. • a phenotype is a characteristic that will be visible in an individual. • co-dominant alleles are genes that are neither recessive nor dominant and they have equal influence in determining characteristics. • variation within a species may be inherited or acquired. • continuous variation is usually controlled by a number of genes affecting the same characteristics. • continuous variation can be influenced by the environment. • discontinuous variation results from a sharp distinction between individuals with no in-between. • discontinuous variation cannot be changed by the environment. • mutation in sex cells may affect inherited characteristics and the way in which a child develops. • the change of species over a long period of time is called evolution. • this has happened in humans, plants and animals. • the theory of evolution tries to explain how present day plants and animals came into existence. • organisms adapt to their surroundings through advantages of mutation. This changes the characteristics of an organism, which may result in the organism being able to withstand difficult environmental conditions. • natural selection is the process whereby individuals that are best adapted to their environment survive and have the most offspring.

	• human evolution refers to changes that have happened to human beings slowly over millions of years.

Now that you have gone through the summary, complete the tutor-based assessment exercise that follows. Remember that this will contribute to your continuous assessment marks.

Assessment

Assessment

Choose the correct answer. Circle the correct one. There are four possible answers: A, B, C or D.

1. STDs can be prevented by:

   A having more than one sexual partner.

   B sterilisation

   C using a condom during sexual intercourse

   D using oral contraceptives [1]

2. The diagram shows a six-fingered hand.

   This is an example of:

   A evolution

   B mutation

   C variation

   D evolution [1]

3. What is the chance of parents producing a female baby?

   A 25%

   B 50%

   C 75%

   D 100% [1]

4. The number of chromosomes found in human body cells and sex cells are:

	Body cells	Sex cells	
A	46	46	
B	46	23	
C	23	23	
D	23	46	[1]

5. What is always found in human egg cells and may be found in human sperm cells?

A one Y chromosome

B one X chromosome

C two X chromosomes

D one X and one Y chromosome

[1]

6. What determines the sex of a child?

A age of the mother

B chromosome content of gametes

C diet of the mother during pregnancy

D number of days between ovulation and fertilisation

[1]

7. Children of the same parents may possess different characteristics. The cause of these differences is:

A evolution

B environment

C inheritance

D mutation

[1]

8. Although children come from the same parents, they may look different. This is called.

A evolution

B continuity

C evolution

D variation

[1]

9. The alleles for a certain characteristic are co-dominant. Which of the following characteristics is this likely to be?

A ability to roll the tongue

B blood type

C sex

D skin colour

[1]

10. The evidence to support the theory of evolution comes from.

A ancient books
B study of fossils, anatomy and embryology
C the study of ancient forests
D traditions handed down from generation to generation [1]

11. List any three (3) effective methods to prevent pregnancy.

……..

……..

…….. [3]

12. Although the female contraceptive pill is a very reliable method to prevent pregnancy, it has some disadvantages. State four disadvantages of the pill.

……

……

……

……

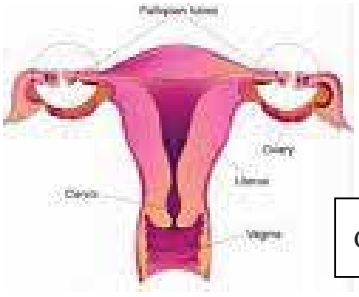
[4]

13. The diagrams show four methods of birth control.

A

B

B



C

D

a) Identify the four methods shown in the diagram.

A .....

B .....

C .....

D .....
[4]

b) Which method can reduce the spread of STDs?

..... [1]

c) List two disadvantages of method D.

.....

.....

[2]

d) Describe three reasons why contraceptives are important to the Namibian society.

.....

.....

.....
[3]

e) Define the terms:

i) abortion:.....

.....

.....

[2]

ii) rape: .....

.....

.....

.....

[3]

f) State two situations where abortion is legal in Namibia.

.....

.....

[2]

14. Genetic information is carried from one generation to the next by chromosomes.

a) Give one example of variations among human beings caused by:

i) recessive genes

..... [2]

ii) co-dominant genes

..... [2]

b) Define the term mutation.

.....

.....

[2]

15. The diagram shows variations in the characteristics between the woman and her husband.

a) List four (4) visible inherited characteristics between the woman and her husband.

……

……

……

…… [4]

b) State the name of the structures in cells which carry genetic information.

…….. [1]

16. State what is meant by the term **evolution**.

……

…… [2]

17. Outline how “survival of the fittest” is a means of natural selection.

……

……

……

……

…… [3]

TOTAL: 50

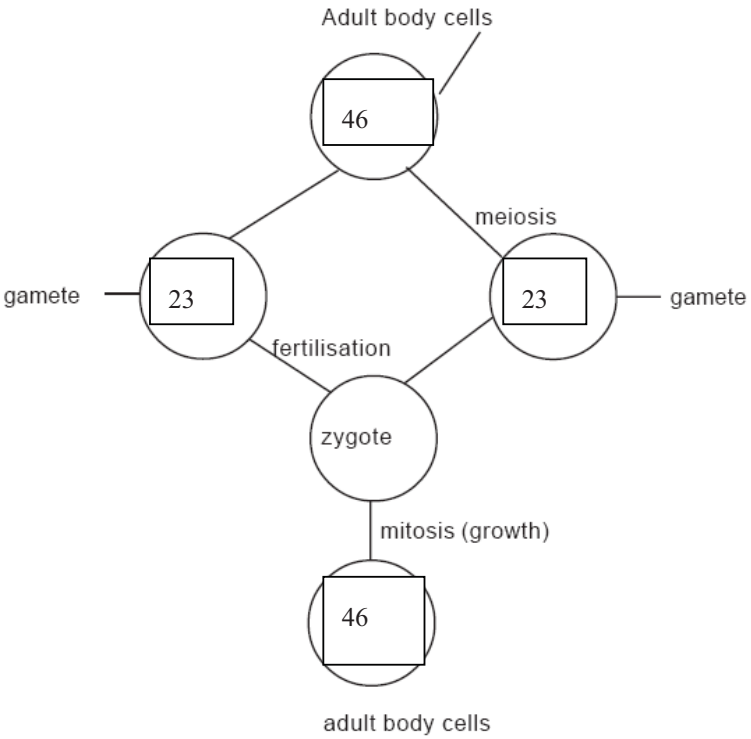
Feedback

 **Feedback** **Activity 1**	1. Family planning is good for married couples because they can decide how many children they want. b) Family planning is good for teenagers since they can avoid unwanted pregnancies. c) Family planning is good for the world, because the population of the world can be reduced in this way. 2. Spermicide is a cream that is put into the vagina before intercourse. This cream kills the sperm. 3. Women with liver disease or diabetes may find contraceptive pills harmful. 4. **Advantages** • very reliable • easy to use **Disadvantages** • need to be taken regularly • possible long-term effects • will not prevent HIV/AIDS To go back, click here.

 **Feedback Assignment 1**	Survey guidelines: 1. Collect all types of contraceptives, at least one of each type. This can be empty packets with clear labels on. Use a clean poster and fix your samples on it clearly indicating names and functions 2. Write down your questions on a piece of paper. Ask your friends and family members about the type of contraceptives they prefer and why. Record the answers and the number of respondents for each type. 1. To go back, click here.

Feedback

Activity 4



To go back, click here.

Feedback

Assignment 2

1. Chromosomes are fine threads of material found in a nucleus which carries information about our characteristics. Genes are pieces of information found on chromosomes.
2. a) there are 8 chromosomes

   b) there are four matching pairs

   c)homologous pairs

3. Five inherited characteristics are:

colour of hair

colour of eyes

shape of ears
colour of skin
shape of nose
shape of mouth
hair type

4. Three acquired characteristics are:

- swimming
- scar on a body from an injury
- playing piano

To go back, click here.

Feedback Activity 6	1. The presence of an extra chromosome in the ovum. 2. Ultraviolet radiation (UV), X-rays, gamma rays, alpha and beta particles, chemicals such as nitrous acid and colour of hair many hydro-carbon compounds are mutagens. To go back, click here.

Feedback Assignment 3	1. Variation is the differences that exist between individual members of the same species. When brothers and sisters inherit different characters from those of the parents. 2. Mutation is the change in structure of a gene or number of chromosomes. 3. Continuous variation means gradual change in a characteristic of an individual. Intelligence in individuals varies gradually. 4. A blood group in humans is either A, B, AB or O. There is no in between. That means an individual cannot have a gradual range of blood group A to B. 5. A chromosome mutation is a change in the number of chromosomes or size of chromosomes in the cells of an organism whereas a gene mutation is a chemical change occurring inside an individual gene. 6. a) There is a 50 per cent chance for the first child to be an albino, since one of the woman's parents was an albino and was homozygous recessive for this gene. Since she is normal the other gene must be for normal skin colour. There is a 50 per cent chance that one of her eggs will have an albino gene. b) The woman is the carrier. She possesses an albino gene, which is recessive and she may pass it on to her children. Therefore she is described as a carrier of the recessive gene. To go back, click here.

Feedback Assignment 4	1. Human evolution refers to changes that have happened to human beings over a long period of time. These changes have happened slowly over millions of years. 2. An organism which can struggle for survival is better adapted to the environment than others. 3. There is evidence that human beings evolved from ape-like creatures 50 million years ago. The skull, limbs and brain show some similarities. 4. Natural selection is the process whereby individuals that are best adapted to their environment, survive and have the most offspring. To go back, click here.

Optional Multimedia Resources:

1. **Audio clip – use of contraceptives**
2. **Power point – types of contraceptives**
3. **Audio clip – effects of abortion**
4. **Audio clip - inheritance**

Internet Resources

1. chromosomes: health.allrefer.com/health/riley-day-syndrome

2. karyotype: www.contexo.info/DNA_Basics/chromosomes.htm

3. dom & res mutation: www.ucl.ac.uk/~sjjgsca/DNAmutation.html

4. gene mutation: ghr.nlm.nih.gov/.../xlinkrecessivemother

5. hemophelia: faculty.washington.edu/.../13Hemophilias.ppt

6. natural selection www.field-studies-council.org/.../evolution.htm

7. natural seldection: www.daviddarling.info/.../N/natselect.html

8. evolution nearemmaus.wordpress.com/.../

The human body cannot function properly unless the environment is conducive to human life. The last unit of this course will look at the interaction between human beings and the environment.

Unit 8 Ecology

Introduction

In this unit we will look at global and local ecological effects of global warming on the environment. We will also look at how people's health can be affected by the physical and psychological dimensions of the environment.

What is in this unit?

This unit consists of 3 topics:

Topic 1: Global warming
Topic 2: Depletion of the ozone layer
Topic 3: Human biology and health

It is very important to study the objectives before you proceed to know exactly what is required of you in this unit.

 **Outcomes**	Upon completion of this unit you will be able to: ▪ distinguish between the greenhouse effect and global warming. ▪ identify carbon dioxide, methane, CFCs and nitrous oxide as gases causing global warming. ▪ list and describe activities that release carbon dioxide, methane, CFCs and nitrous oxide into the atmosphere. ▪ suggest and discuss ways to reduce the release of gases causing global warming. ▪ describe local and global ecological effects of global warming. ▪ predict and discuss how life in Namibia might be changed by global warming and nitrous oxide into the atmosphere. ▪ describe local and global ecological effects of global warming. ▪ discuss how people's health depends on and can be affected by psychological imbalances like stress and physical conditions. ▪ discuss how an understanding of social living conditions and the functioning of the human body can contribute to healthy living.
 **Study time**	You need to spend about 5 hours on this unit. Don't worry if it takes you longer because we all learn at a different pace. The important thing is to achieve the set objectives.

 Terminology	**global warming**	the increase in the temperature of the earth and its atmosphere due to the greenhouse effect
	greenhouse effect	a process by which heat from the sun is trapped within the earth's atmosphere
	greenhouse gases	atmospheric gases that are effective at trapping heat energy within the earth's atmosphere
	hormone	a chemical substance secreted by the endocrine gland
	methane	a gas given off by the decomposition of dead plants material which is a powerful greenhouse gas
	nitrous oxide	a gas which contributes to the greenhouse effect and is produced by micro-organisms that live in soil and water, the gas is also produced when nitrogen fertilisers are used
	ozone	functions as a greenhouse gas when found in the lower atmosphere and is produced by the interaction of car fumes, sunlight and smog, it is also found in the upper atmosphere in the ozone layer
	ozone layer	a thin layer of ozone gas in the stratosphere about 20 to 30 km from the surface of the earth
	stratosphere	the second layer of the atmosphere that extends 30 km above the earth
	stress	a feeling of excitement, a feeling of anxiety and or physical tension that occurs when demands placed on an individual exceed his or her ability to cope
	ultraviolet rays	energy from the sun in shorter wavelengths which can cause damage to living organisms

Global warming

In this section, we will talk about global warming. What is global warming? What causes global warming? How can we solve this problem? We will try to answer these questions in this section.

Audio clip - Global warming.mp3

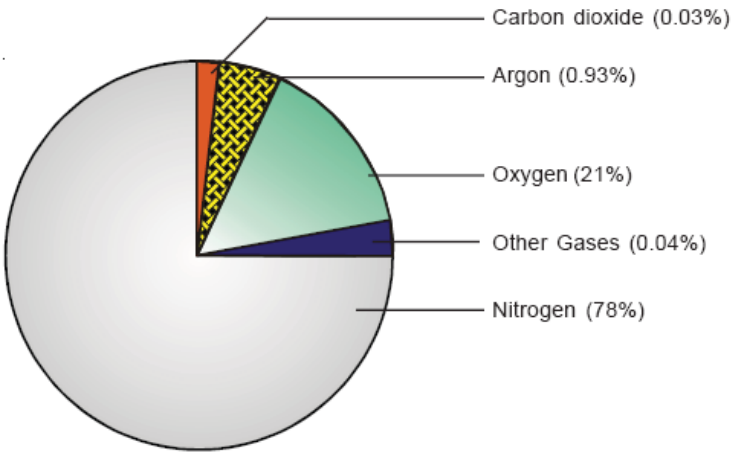
Double click to hear audio.

Listen to the audio by clicking on the icon.

The **atmosphere** forms a thick layer around the planet that acts as a blanket and protects the earth from harm. The atmosphere is approximately 90 km above sea level.

The composition of air

The pie chart below gives the composition and the percentages of gases in the atmosphere. There is water vapour in the air, but it is not shown on the pie chart due to the fact that the amount of water vapour in the air varies a lot.



According to the given pie chart, oxygen makes up about 21 per cent and carbon dioxide about 0.03 per cent of the atmosphere. Scientists have discovered that changes in the percentage of different types of gases can affect temperatures in the atmosphere and, therefore, the climate that we experience on the earth's surface.

Scientists have also observed that certain pollutants change the percentages of the different gases in the air. A number of natural events such as volcanic eruptions and forest fires can affect the composition of air. However, one of the

most important causes of atmospheric changes during the last century has been human activities.

Human activities that release chemicals into the air have started to interfere with the natural balance of gases in the atmosphere and has caused increases in what are called greenhouse gases. Human activities include industry and transportation that use fossil fuels (coal, oil and natural gas), power stations, cutting down of trees (deforestation) and the burning of trees.

Scientists have noticed that, since 1850, the earth's temperature has risen about 0.5 degrees Celsius. They predict that it could rise by another 4.5 degrees Celsius by the year 2050.

This slow increase of the earth's temperature is called **global warming**. Global warming is the observed increase in the average temperature of the earth's atmosphere. Global warming is due to the greenhouse effect.

The greenhouse effect

Audio clip - Greenhouse effect.m

Double click to hear audio.

Listen to the audio by clicking on the icon.

The greenhouse effect is a natural process caused by the presence of gases that trap heat in the atmosphere and prevent it from escaping into space. A similar effect occurs in a car where all the windows are closed. This process is known as the **greenhouse effect.**

In the case of the earth, the greenhouse effect is produced mainly by gases in the atmosphere such as carbon dioxide, water vapour, methane, nitrous oxide and ozone. The listed gases form a layer or a type of 'blanket' that keeps the surface of the earth warm. Gases that trap heat energy are called greenhouse gases.

Can you think of a few activities that release these gases into the atmosphere? Your answer could include the burning of fossil fuels in cars, lorries, trains and power stations releases a lot of carbon dioxide and water vapour into the atmosphere.

How does the greenhouse effect impact us?

The greenhouse gases allow heat radiation from the sun (short wavelength energy) to pass through the atmosphere and warm the earth. The warmed earth, in turn, gives off heat radiation as long wavelength energy. The gases then absorb most of the heat radiation and emit some of it back towards the earth.

Carbon dioxide does not let all of the long wavelength radiation through the atmosphere and keeps much of it in the atmosphere, increasing the atmospheric temperature. The greenhouse effect increases day-by-day due to the increasing levels of carbon dioxide and other gases in the atmosphere.

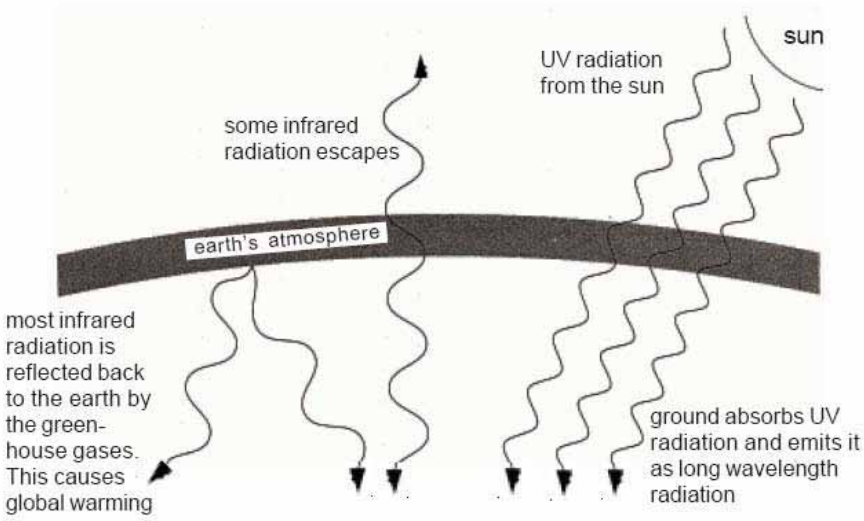


Diagram: Greenhouse Gas Effect

The heating of the globe (the earth) by the greenhouse effect is called **global warming.**

Click on the link below to view slides.

The main greenhouse gases

Research has shown that there is a steady increase in the concentration of greenhouse gases in the earth's atmosphere. **Carbon dioxide** is the most common greenhouse gas in the atmosphere. Carbon dioxide in the atmosphere has increased due to deforestation and the burning of fossil fuels such as coal, oil and natural gas.

Methane: Methane is a more powerful greenhouse gas than carbon dioxide, which means that very little of the gas can have a large effect on the atmosphere. The main source of methane is the decomposition of dead plants when forests are chopped down. Rice production and other agricultural schemes also contribute to the production of methane. During the fermentation of food in animals' stomachs, methane is produced. The amount of methane released into the atmosphere, increases as the number of domestic animals increase throughout the world.

Nitrous oxide: This gas is naturally produced by micro-organisms that live in the soil and water. The amount of nitrous oxide in the air has increased rapidly over the last few decades because of the wide use of artificial nitrogen fertilisers. The nitrogen in fertilisers is broken down into nitrous oxide, which escapes into the atmosphere. Nitrous oxide is also produced when fossil fuels are burned. This gas can last for up to 150 years in the atmosphere.

Chlorofluorocarbons (CFCs): CFCs do not occur naturally in the environment. They are produced by certain industries and CFCs are mainly used as coolants in fridges, air conditioners, spray cans (aerosol) as well as in the production of polysterene and foam products.

CFCs are powerful and can last up to 130 years in the atmosphere. Like methane, the concentration of CFCs in the atmosphere is much lower than the concentration of carbon dioxide, but they are very much efficient in trapping heat.

Ozone: Ozone is a gas that mostly occurs in the upper atmosphere. Ozone found in the lower part of the upper atmosphere nearest to the earth's surface, and is also one of the most powerful greenhouse gases. One way in which ozone is produced in the lower atmosphere is when car fumes interact with sunlight and smog.

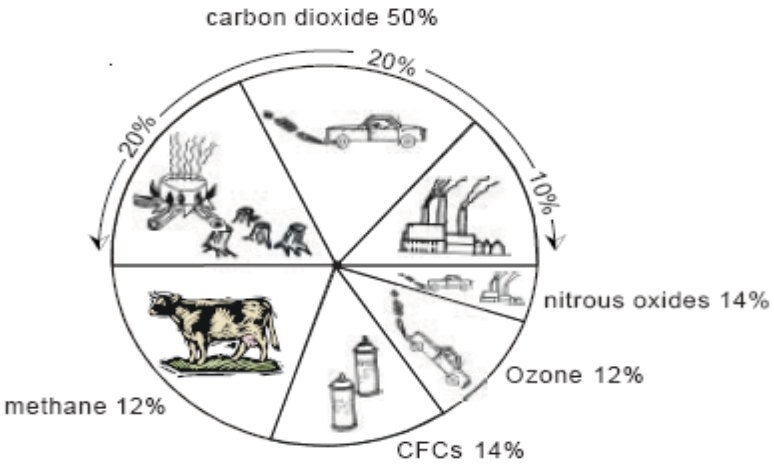


Diagram: The pie chart shows the main sources for each of the greenhouse gases that contribute to global warming.

Ways and means to stop global warming

The list below contains some suggestions to stop global warming.

- Reduce emissions of new greenhouse gases by reducing the burning of fossil fuels.
- Stop deforestation. Reduce the cutting down and burning of trees and reduce the decay of trees.
- Reduce nitrous oxides by burning fewer fossil fuels and by cutting down on the use of nitrogen-based fertilisers.
- Reduce the formation of methane by reducing the volume of rubbish thrown away.

Global and local effects of global warming

Global effects

As the greenhouse gases trap more and more heat, scientists estimate that the earth's global temperature will rise by as much as 3 to 5 per cent over the next century. This does not seem like much, but it could have serious effects. Here are some of the predicted changes that scientists think could occur.

- As a global temperature rises, world weather patterns will change. Droughts are expected to increase in some areas while changes in rain

patterns may cause flooding in other areas. Both droughts and flooding will affect agriculture and food production.

- An increase in world temperature could result in the melting of large amounts of ice at the North and South Poles. This could gradually lead to a rise in the sea level of up to 2 m. This means that some islands will disappear under the sea and some very low-lying coastal areas will be flooded.
- Climatic changes may affect the ability of certain plants and animals to survive. Plants and animals are specially adapted to particular conditions and may find that their survival is threatened when the temperature changes. This could lead to the extinction of some species.
- Warmer conditions may encourage the growth of fungi and bacteria in soil and water as well as increase the reproduction of insects. Increases in fungi and bacteria may cause diseases in animals and plants. Insect pests are a threat to agriculture. Disease-carrying insects on the other hand can affect the health of people and animals.

Let us see how global warming may affect Namibia.

The possible effects of global warming on Namibia

Namibia is a **semi-arid country**, meaning that the rainfall is normally low and long, hot periods occur.It will become hotter and drier because of global warming. Any changes in the temperature and rainfall will affect the lives of animals and plants so that they may die.This may lead to the global extinction of living organisms.

Try the practical activity that follows.

Practical Activity

How does a greenhouse work?

Try this activity at home. When you cannot do it, read through it to help you understand the function of a greenhouse.

What you need

- pillars made of aluminium rod
- glass sheets (for walls and roofs)
- screws
- pot plant
- lamp

What to do

1. Use the aluminium rods to build the frame of a small house.
2. Use the glass sheets for walls, door and roof.
3. Use the screws and tighten the model house.
4. Keep the model house inside your home.
5. Use a battery-operated lamp inside the model house.
6. Keep the pot plant inside the model house.
7. Switch on the lamp and leave it on for 2 days.

What did you observe?
Click on the link below.

Observation and conclusion

Now do the assignment to check your progress.

Assignment 1

1. State any three greenhouse gases.

2. Read the following statements and decide whether each of them is **true** or **false**.

a) CFC chemicals are produced by human activities and are involved in global warming.

b) Nitrous oxide is a natural gas that is produced by organisms that live in the soil.

c) Driving a car releases carbon dioxide into the atmosphere.

d) The average temperature of the earth over the past 50 years has decreased.

To check feedback, click on the icon ☺

This brings us to the end of topic 1. In the next section we will look at the **depletion of the ozone layer**.

Depletion of the ozone layer

You were introduced to ozone in the previous section. We sometimes hear politicians and scientists talk about ozone in the atmosphere, but we do not know how it affects us and the environment. In this section, we will discuss the ozone layer in more detail and its implications for the environment

The ozone layer

One of the gases that is naturally part of the atmosphere is ozone. Ozone is a special form of oxygen that consists of three oxygen atoms. A molecule of ordinary oxygen on the other hand, consists of two atoms. The formula for ozone is O^3. Ozone is formed when ultraviolet light with a short wavelength hits an oxygen molecule. The two oxygen atoms break apart, forming separate and very reactive individual oxygen atoms. Each of these can then combine with an oxygen molecule to form an ozone molecule.

Ozone occurs in very low concentrations and makes up a very small portion of the total volume of the atmosphere. Most of the naturally occurring ozone is concentrated high above the earth's surface in a part of the atmosphere called the **stratosphere.** The highest concentrations of ozone are found between 20 and 30 kilometers above sea level. The ozone forms a thin layer in the stratosphere that surrounds the whole planet. We call this the **ozone layer.**

The importance of the ozone layer

The ozone layer in the stratosphere is very thin, but it is very essential for life on earth. The stratosphere is important to all living and non-living things on earth because the ozone layer protects living organisms from harmful effects of the sun's **ultraviolet rays.** It acts as a filter to absorb most of the sun's harmful rays and prevents them from reaching the earth's surface. Not only living organisms are protected by the ozone layer. Many synthetic substances such as paints and plastics that are used in building industries and farming can also be damaged by ultraviolet rays. Replacing and repairing such damage can be inconvenient and costly.

Depletion of the ozone layer

Human activities damage the ozone layer. The rate of formation of ozone is usually equal to the rate of breakdown, so there is normally a constant amount of ozone absorbing ultraviolet radiation. However, the steady destruction of ozone has resulted in a thinning of the layer. In some areas such as over the North and South poles, the layer is so thin that scientists call it the ozone hole.

It was discovered that chemicals used in industry and in household items escape into the atmosphere. It is these chemicals that cause damage to ozone molecules. Chlorofluorocarbons (CFCs) are the main cause of damage to the ozone layer. CFCs are chemicals that are artificially manufactured by industry. They are used in aerosol cans, refrigerators, polystyrene products and air conditioners. When these chemicals are released into the air they slowly move up through the atmosphere and remain in the air for 100 years. Once they reach the stratosphere, they destroy the ozone layer.

In the ozone layer, UV radiation breaks the CFCs molecules apart and releases chlorine that reacts with ozone and reduces the amount of ozone in the atmosphere. Since CFCs stay in the atmosphere for a long time, it is still going to take a long time before the amount of ozone gets back to normal even if we stop using CFCs immediately,

Negative consequences of the thinning of the ozone layer

Introduction to section.

Humans and animals

- Skin damage in humans, due to ultraviolet rays. This may cause skin cancer. People, unlike animals, do not have an outer covering of fur or scales. Our skin, therefore, is more exposed to harmful effects of ultraviolet rays.
- Eye damage. Exposure to higher levels of ultraviolet rays appears to be linked to a form of eye damage called **eye cataracts**. Eye cancer in cattle is also thought to be linked to greater exposure to ultraviolet rays.
- Increased exposure to the harmful rays of the sun may weaken the human defence system that could reduce our ability to fight off diseases.

Plants

- Crop damage. Food crops appear to be negatively affected by high levels of ultraviolet rays. Cereal crops such as maize, rice and wheat are smaller than they normally would be and seeds have difficulty germinating.
- Damage to algae in the oceans. Damage to the algae results in a decrease in their numbers. Since these plants form the basis of the ocean's food chain, it eventually means that the oceans will produce less food. The algae also contribute to the removal of carbon dioxide from the atmosphere through photosynthesis. Fewer algae may increase the greenhouse effect.

How can the release of CFCs be reduced?

It is the responsibility of individuals, as well as industry and governments, to reduce the damage to our atmosphere. It will not help when one nation bans CFC production while another country continues to pollute the global environment with the same chemical because air travels across borders.

Damage to the ozone layer caused by CFCs can be avoided completely when we:

- stop producing CFCs.
- stop buying products packed in CFC-containing packages. Make sure egg containers, polystyrene cups and fast food containers are CFC-free before you buy them.
- stop buying spray cans that contain CFCs, instead buy spray cans that are ozone-friendly.
- stop buying refrigerators and air conditioners that contain CFCs. Air conditioners in cars and buildings are some of the greatest sources of

CFC releases. Alternative coolants are available and should be used instead.

To check your progress, do Assignment 2 in your notebook.
Compare your answers with mine at the end of the unit.

 **Assignment 2**	1. a) What are the possible effects of a thinned ozone layer? b) Give a reason for these effects. 2. a) Name the substance that contributes to the destruction of the ozone layer. b) How can we stop damaging the ozone layer? c) Make a list of things that every Namibian could do to help reduce the use and release of CFCs. To check feedback, click on the icon 

Now, you can proceed to the next topic, which is, human biology and health.

Human Biology and Health

Human beings are well adapted to their environment and are a very successful species. However, we are still subject to the stresses and strains of daily life and we need to recognise this and apply measures that will minimise this stress.

Good health is something that many of us take for granted. Being healthy requires that we take care of our bodies. Keeping your body healthy, involves good nutrition and a healthy lifestyle.

In this section we will look at how the condition of our health can be affected by physical and psychological conditions in the environment. We will talk about psychological imbalances and physical conditions, especially stress and the importance of exercise.

What is stress?

Stress is a negative feeling of anxiety and or physical tension that occurs when demands placed on an individual exceed his of her ability to cope.

What does stress do to you?

Stress can makes people anxious, afraid and unable to think clearly. In some situations, stress can be useful when it helps us to perform a difficult task well. Stress can even be enjoyable and some people enjoy the stressful feeling produced by driving a car at high speed.

Let us look at the other components of the stress cycle.

When you are challenged in your studies or in a job, your body undergoes a progressive series of responses that are first triggered by an external stimulus known as the **stressor**. Your body struggles to maintain internal body functions in response to external changes. We say the body is under strain. This results in an emotional and or physical disruption in normal functioning.During this time, your heart beats quicker and you breathe faster .You become nervous, anxious and even irritable. This is the **stress reaction**. The process of dealing with the stress reaction by solving problems or taking action is called **coping with stress**.

Causes of stress

- a disrupted lifestyle. For example, after the birth of a baby, your sleep is disturbed. You wake up at odd times and you get tired and irritable.
- changes in life such as moving to a new location, changing schools, getting married or divorced or significant losses e.g., death of a spouse, child or friend.
- frustration and unhappiness about past events, excessive noise, heat and family problems.
- concerns about money.
- concerns about the well-being of loved ones and family.
- being out of work.

Due to stress one or all of the following physical symptoms may occur.

- heartbeat increases
- dizziness
- loss of appetite
- vomiting
- headaches
- constant tiredness

The effects are all part of our body's 'fight-or-flight' responses to stress. Remember the roles of different hormones you have learned in Unit 5. The hormone adrenalin plays a vital role when we are under stress. Adrenaline is secreted by the adrenal gland that is situated close to the kidneys. This hormone passes into the bloodstream and is carried all around the body. There are short-term and long-term effects of adrenaline.

Short-term effects:

- heartbeat increases
- the brain is alert for any action
- extra blood flows to the muscles and the brain to supply more oxygen and glucose
- in the stomach and intestines, the rate of digestion decreases and waste products are egested
- the metabolic rate increases and more energy is released for activities such as running

The overall short-term effect is that your body prepares to react to an emergency.

Long-term effects

- the muscles become tense and painful
- causes continuous headaches

- causes high blood pressure (hypertension)
- causes pains in the stomach and intestines

How can you cope with stress?

Once you know the causes of stress, you must decide what you are going to do about it. Here are some suggestions of what you can do. You can relax by doing simple exercises. Try to eat a balanced diet.

Can you think of exercises that you do daily? Write these down in your notebook.

Exercise and health

Our modern lifestyle means that very few people are regularly physically active. It is only people who continue to work on the land or who are builders or other physical labourers who get enough exercise every day. The rest of us have to actually decide to exercise regularly.

Why should we exercise regularly? Our physical environment does not provide us with automatic opportunities to exercise. We drive cars, use lifts and we park close to shopping malls that have shops right next to each other. However, lack of exercise has serious effects on our health.

Effects of Lack of Exercise.

- people become overweight or obese;
- an increased risk of heart disease;
- increase risk of **type 2 diabetes** (the type of diabetes that happens when the body no longer uses insulin correctly); and
- a greater risk of arthritis and more problems when people do develop arthritis.

Benefits of regular exercise

- Exercise strengthens the heart.
- Heart diseases are less likely to occur.
- It increases the strength of bones and allows them to grow properly.
- It keeps the joints movable and more flexible.
- The ligaments and tendons become stronger, which allow you to move with greater ease as your joints gradually stiffen.
- Poor muscle tension results in the body sagging into a bad posture. Muscle tension means muscular tension that holds your body in position.
- When a particular muscle is not used, it will waste away. Exercising your body muscles strengthens them and helps you cope with the normal strain of lifting and carrying heavy objects.
- Exercise is relaxing. It relieves stress, tension and aggressive feelings.

Do the assignment that follows in your notebook. Do not forget that the feedback is given at the end of the unit.

Assignment

Assignment 3

1. List three negative effects of stress.
2. Name the hormone that responds to stress.
3. Give two short-term effects of stress.
4. Give two long-term effects of stress.
5. Name four physical symptoms of stress.
6. Name four benefits of physical exercise.

To check feedback, click on the icon. 

To complete this unit, study the summary that follows.

Unit summary

 Summary	In this unit you learned that: • the earth's atmosphere is made up of nitrogen (78%), oxygen (21%), argon (0.93%) carbon dioxide (0.03%) and other gases (0.04%). • changes in the percentages of the different gases can affect the temperature in the environment and the climate on the earth's surface. • the greenhouse effect is a process by which heat from the sun is trapped within the atmosphere and is reflected to the earth. • gases that trap heat energy in the atmosphere are called greenhouse gases. • the main greenhouse gases are carbon dioxides, water vapour, methane, nitrous oxide and ozone. • methane is released from decaying organic matter. • carbon dioxide is produced by deforestation and burning of fossil fuels. • CFCs are produced by certain industries and are the main cause of damage to the ozone layer • ozone is formed when ultraviolet light with a short wavelength hits an oxygen molecule. • ozone is important for all living organisms, because it protects them from the harmful effects of the sun's ultraviolet rays. • the destruction of ozone has resulted in a thin layer in some areas and it is referred to as the ozone hole. • chemicals used in industry and household items that escape into the atmosphere cause the thinning of the ozone layer. • a thinned ozone layer has the following effects on living organisms: skin damage in humans that leads to skin cancer, eye cataracts and a weakened defense system, damage to crops such as maize, rice and wheat, damage to algae in the oceans and disturbance of the food chain. • The use of CFCs can be reduced by not buying products made of CFCs.

You have come to the end of this unit.

It is now time for the final tutor-based assessment of this unit. Do not forget to submit it as required.

Assessment

Section A

Multiple Choice

There are four possible answers: A, B. C and D. Circle the correct answer.

1. The increase of temperature of the earth and its atmosphere is called.

   A global warming
   B greenhouse effect
   C greenhouse gases
   D radiation [1]

2. A gas given off by decomposition of dead plant material.

   A CFCs
   B methane
   C nitrous oxide
   D ozone [1]

3. A gas given off by spraying artificial fertilisers is called.

   A carbon dioxide
   B CFCs
   C nitrous oxide
   D ozone [1]

4. In recent years the ozone layer has become …..

   A thinner
   B thicker
   C darker
   D brighter [1]

5. Ozone is a form of oxygen that has …. oxygen atoms.

   A two
   B three

C five
D eight [1]

6. The ozone layer can be found in the …….

A atmosphere
B stratosphere
C mesosphere
D troposphere [1]

7. The rays from the sun reaching the earth are called.

A infra-red rays
B gamma rays
C X-rays
D ultraviolet rays [1]

8. The fight or flight hormone is called.

A adrenalin
B insulin
C growth hormone
D thyroxin [1]

9. Which one is NOT an advantage of exercise?

A flexibility of joints
B increases stamina
C stronger muscles
D poor body posture [1]

10. One effect of global warming is …..

A bacterial and fungal growth will decrease
B disease-carrying insects will increase

C growth of animals and plants will increase

D insect pests like locusts will decrease [1]

11. Deforestation is one of the processes that increase the carbon dioxide in the atmosphere.

i) List two other processes that also increase the carbon dioxide in the atmosphere.

……

…… [2]

ii) Name one process that decreases the carbon dioxide in the atmosphere.

…….. [1]

iii) Suggest how governments can contribute to the prevention of deforestation.

……

……

……

……

……

……

[3]

12. Suggest the effects that global warming can have on Namibia.

……..

……..

……..

……..

……

……

[3]

13. Sometimes human activities can damage the ozone layer which causes UV-rays to reach the earth.

i) Give the name of the gas that can deplete the ozone layer.

…….. [1]

ii) List any three activities that release this gas into the atmosphere.

……

……

……[3]

iii) Explain the importance of the ozone layer in protecting living organisms.

……..

	…….. …… …… …… …… [3]

14. How can we stop damaging the ozone layer?

……..

……..

……..

……..

[4]

15. The destruction of Namibian woodlands may lead to global warming.

i) Suggest the role of trees in the prevention of global warming.

……

……

……

…… [2]

ii) Describe two ways in which global warming affects world climates.

……

……

……

…… [2]

16. Explain what is meant by the greenhouse effect.

……

……

…… [3]

17. The destruction of the ozone layer can have harmful effects on the health of living organisms. List the harmful effects that ultraviolet rays can have on:

i) people:

.....

.....

..... [3]

ii) plants

.....

.....[2]

iii) animals:

..... [1]

18. Why, on a global scale, does Namibia not contribute much to global warming?

.....

..... [2]

19. Give two long-term effects of stress.

.....

..... [2]

20. Name three benefits of physical exercise.

.....

.....

..... [3]

TOTAL: 50

You have completed the Life Science Course. Good luck for your examinations.

Feedback

 **Feedback Assignment 1**	1. Carbon dioxide Methane Nitrous oxide CFCs Ozone 2. a) True b) True c) True d) False To go back, click here

Feedback

Assignment 2

1 a) skin damage in humans:

eye cataracts;

crop damage and damage to algae in oceans

b) Reasons

skin damage in humans due to the exposure to ultraviolet rays. This could lead to skin cancer.

eye cataracts: exposure to higher levels of ultraviolet rays.

crop damage in cereals such as maize, rice and wheat due to exposure to high levels of ultraviolet rays.

2.

a) CFCs

b) Avoid completely the use of CFCs by not buying products packed in polysterene containers manufactured with CFCs.

c) Stop buying spray cans that contain CFCs. Don't buy air conditioners and refrigerators that contain CFCs.

To go back, click here.

Feedback
Assignment 3

1. Stress can make people anxious, afraid and unable to think clearly.

2. Adrenaline.

3.

- heartbeat increases.
- brain is alert for any action.
- extra blood flows to the muscles in the brain to supply more oxygen and glucose. In the stomach and intestines, the rate of digestion decreases and waste products are egested.
- metabolic rate increases and more energy is released for activities such as running.
- overall effect is that the body prepares for an emergency.

4.

- muscles become tense and painful
- causes continuous headaches
- causes high blood pressure that results in hypertention, which may cause stroke and heart diseases
- pains in stomach and intestines

5.

- vomiting
- dizziness
- headaches
- loss of appetite
- constant tiredness

6.

- lungs of people who exercise regularly can absorb oxygen more efficiently
- strengthens the heart
- increases the strength of bones
- keeps joints movable and more flexible
- exercising strengthens the muscles and helps you cope with the normal strain of lifting and carrying heavy objects
- can be relaxing, can relieve stress and tension and aggressive feelings, e.g., competitive sport

To go back, click here

Optional Multimedia Resources:

1. **Audio clip –global warming**
2. **Audio clip – greenhouse effect**
3. **PowerPoint slide – main greenhouse gases**
4. **Word document – observation and conclusion**

Internet Resource

1. Stress relief www.new-oceans.co.uk/.../stressconsult.htm