INTEGRATED SCIENCE FOR TTCs

STUDENT'S BOOK

YEAR 2

OPTIONS: Languages Education (LE)

&

Social Studies Education (SSE)

FOREWORD

Dear Student- teacher,

Rwanda Basic Education Board is honoured to present to you this Integrated Science book for Year Two of TTC, Languages Education **(LE)** & Social Studies Education **(SSE)** Options which serves as a guide to competence-based teaching and learning to ensure consistency and coherence in the learning of Integrated Science subject. The Rwandan educational philosophy is to ensure that you achieve full potential at every level of education which will prepare you to be well integrated in society and exploit employment opportunities.

The government of Rwanda emphasizes the importance of aligning teaching and learning materials with the syllabus to facilitate your learning process. Many factors influence what you learn, how well you learn and the competences you acquire. Those factors include the instructional materials available among others. Special attention was paid to the activities that facilitate the learning process in which you can develop your ideas and make new discoveries during concrete activities carried out individually or with peers.

In competence-based curriculum, learning is considered as a process of active building and developing knowledge and meanings by the learner where concepts are mainly introduced by an activity, a situation or a scenario that helps the learner to construct knowledge, develop skills and acquire positive attitudes and values. For effective use of this textbook, your role is to:

- Work on given activities including laboratory experiments which lead to the development of skills;
- Share relevant information with other learners through presentations, discussions, group work and other active learning techniques such as role play, case studies, investigation and research in the library, from the internet or from your community;
- Participate and take responsibility for your own learning;
- Draw conclusions based on the findings from the learning activities.

I wish to sincerely extend my appreciation to the people who contributed towards the development of this book, particularly REB staff who organized the whole process from its inception. Special gratitude goes to teachers, illustrators and designers who diligently worked to successful completion of this book.

Dr. MBARUSIMANA Nelsom

Director General of Rwanda Basic Education Board

ACKNOWLEDGEMENT

I wish to express my appreciation to all the people who played a major role in development of this Integrated Science book for Year Two of TTC, Languages Education **(LE)** & Social Studies Education **(SSE)** Options. It would not have been successful without active participation of different education stakeholders.

I owe gratitude to different Universities and schools in Rwanda that allowed their staff to work with REB in the in-house textbooks production project. I wish to extend my sincere gratitude to lecturers, teachers, tutors, illustrators, designers and all other individuals whose efforts in one way or the other contributed to the success of writing of this textbook.

Finally, my word of gratitude goes to the Rwanda Education Board staff particularly those from the Curriculum, Teaching and Learning Resources Department who were involved in the whole process of in-house textbook writing.

Joan MURUNGI

Head of Curriculum, Teaching and Learning Rersources Department

TABLE OF CONTENT

UNIT 1

CELL DIVISION

Key Unit competence: Describe the stages of the cell cycle and explain the significance of cell and nuclear division in organisms

1.0. INTRODUCTORY ACTIVITY

This huge house was constructed from many single small bricks. Likewise, our body is made from many single small cells.

Figure 1.1: A house in bricks

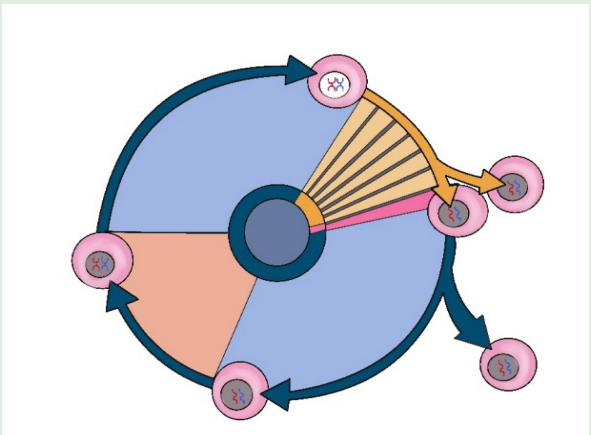
a) Explain what happened for this house to grow up and increase in size.

b) Bricks to build a house were made from the clay in the valleys, what about the origin of the cells that make up human tissues or repair any part of our body in case of damage?

1.1. Cell cycle

ACTIVITY 1.1

The chart below shows the main phases of cell cycle.



Conduct a research from the school library or search engine and then label the diagram above using correctly the following terms: Mitosis (M) - The first growth process (G1), The second growth process (G2), -The synthesis process (S), and - Cytokinesis -

The **cell cycle** is the process through which a cell replicates all of its material and divides itself from one cell into two identical cells.

The cell cycle includes three main stages: Preparation stage or **interphase (G1, S and G2)** – nuclear division or **karyokinesis (M)** – and cytoplasm division or **cytokinesis**.

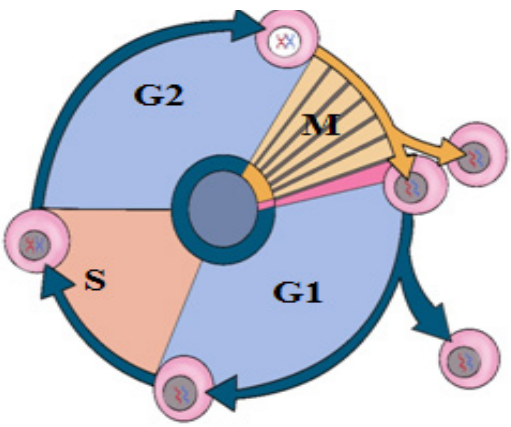


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Figure 1.2: Cell cycle

1.1.1. Interphase

This is when the cell gets ready for its division. The events in interphase are divided into three phases:

i) The first growth process (G_1)

During this phase, a cell undergoes rapid growth and the cell performs its routine functions. The cell spends most of its life in the **G_1 process**. If the cell is not dividing, it remains in this phase. The time taken for the completion of **G1 process** varies among species and the type of cells. But on an average, it takes around 11 hours for the completion of this phase.

ii) The synthesis process (S)

DNA synthesis or DNA replication takes place in this phase. The S phase takes around 8 hours to complete.

iii) The second growth process (G_2)

It is the short period, in which the cell continues to grow, making proteins and manufacturing many organelles necessary for cell division. This phase serves as an intermediate between the synthesis phase and the mitotic phase. It takes around four hours to complete

NB. The **interphase stage** (G1, S, and G2) of the cell cycle take place between two mitotic divisions

1.1.2. Karyokinesis or Mitosis

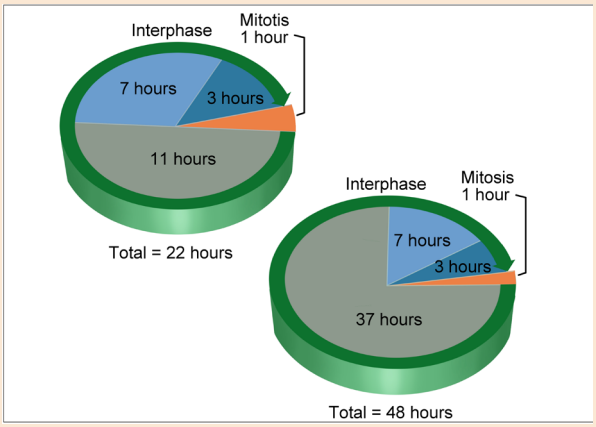
This is the phase of nuclear division in which one nucleus divides through four phases (prophase, metaphase, anaphase and telophase) and becomes two nuclei.

1.1.3. Cytokinesis

In this phase, the cytoplasm divides in half, producing two daughter cells, each containing a complete set of genetic material.

APPLICATION ACTIVITY 1.1

Examine the cell cycle diagrams of two different types of cells. Observe the total length of each cell cycle and the length of time each cell spends in each phase of the cell cycle



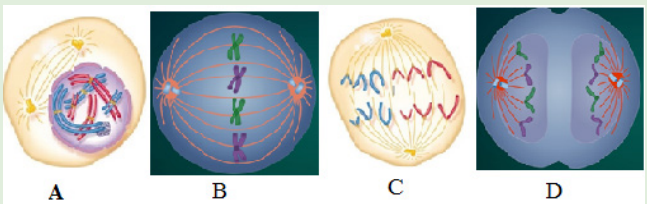
a) Which part of the cell cycle is most variable in length?

b) Why do you think the cycle of some types of cells is faster than in others? Explain your answer.

1.2. Mitosis and Meiosis

ACTIVITY 1.2

The following figure represents the stem cells and their origin and different phases of cell in division.



Observe the figures A, B, C and D above and discuss what happen in each phase by using school library textbook or search engine.

1.2.1. Mitosis

Mitosis is a type of cell division that produces two daughter cells having the same number and kind of chromosomes as the mother cell. It takes place only in eukaryotes, where the **nuclear division** (karyokinesis) occurs. This phase takes around 1 hour to complete. The mitotic cell division is more rapid at the meristematic region of plant and root tip as it is the growing region of the plant. The **mitotic stage** is divided into *four phases* that include **Prophase, Metaphase, Anaphase and Telophase.**

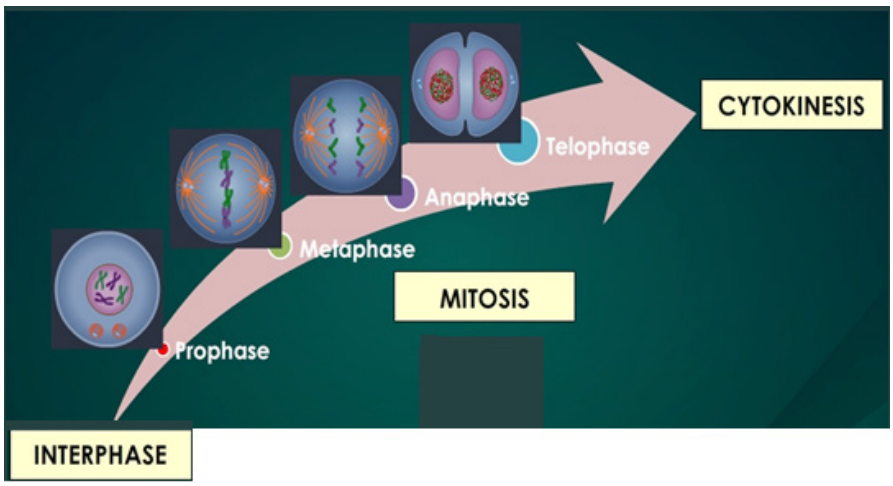
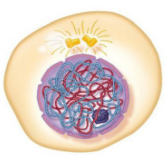


Figure 1.3. The process of mitosis

a) Prophase

Prophase is the first and longest phase of mitosis. During prophase:

- The DNA and histone proteins coil up into visible chromosomes, each made up of two sister chromatids held together by the centromere.
- The nucleus disappears as the nuclear envelope and nucleolus break apart.
- The centrioles begin to move to opposite ends, or poles, of the cell.
- As the centrioles migrate, the fiber-like spindle begins to elongate between the centrioles. In plant cells, the spindle forms without centrioles. The spindle plays an essential role moving chromosomes and in the separation of sister chromatids.



End of interphase

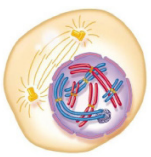


Figure 1.4: Prophase

b) Metaphase

During metaphase, the spindle which attaches to the centromere of each chromosome helps the chromosomes to line up at the center of the cell by forming the equatorial plate also known as the metaphase plate. Each sister chromatid is attached to a separate spindle fiber, with one fiber extending to one pole, and the other fiber extending to the other pole.

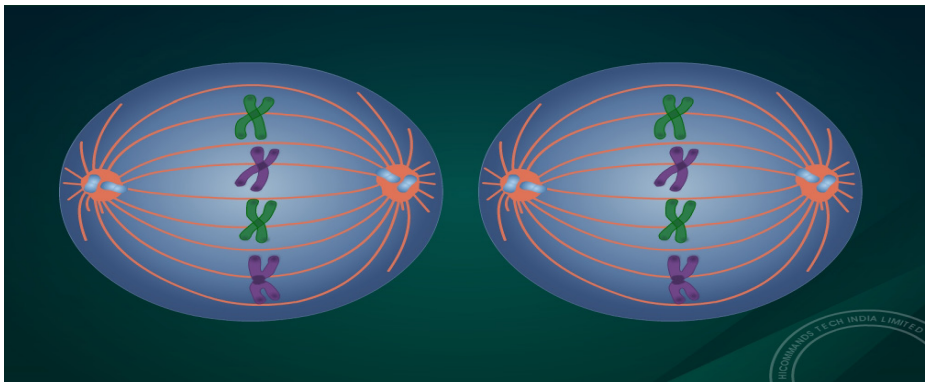


Figure 1.5: Process of metaphase

c) Anaphase

During Anaphase:

- Centromeres divide,
- The sister chromatids separate and pulled apart by the shortening of the spindles,
- One sister chromatid moves to one pole of the cell, and the other sister chromatid moves to the opposite pole, (sister chromatids take the name of chromosomes as soon as they separate).
- At the end of anaphase, each pole of the cell has a complete set of chromosomes, identical to the amount of DNA at the beginning of G1 of the cell cycle.

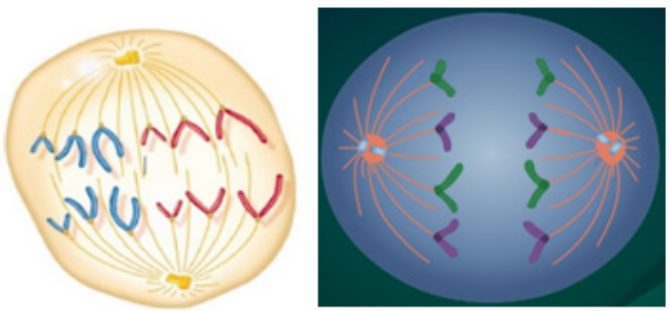


Figure 1.6: Process of Anaphase

d) Telophase

During telophase which is the opposite of prophase:

- The spindle disappears,
- Formation of two nuclei,
- The nuclear envelopes surround the two nuclei.

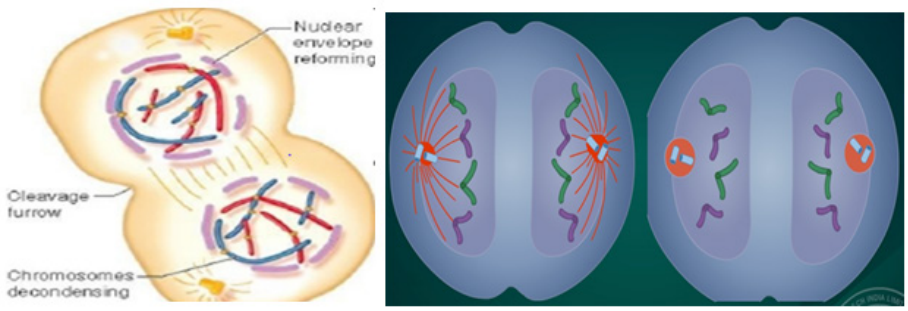


Figure 1.7: The process of telophase

e) Cytokinesis

During this stage of cell division, the cytoplasm divides in half, producing two daughter cells, each containing a complete set of genetic material as the mother cell.

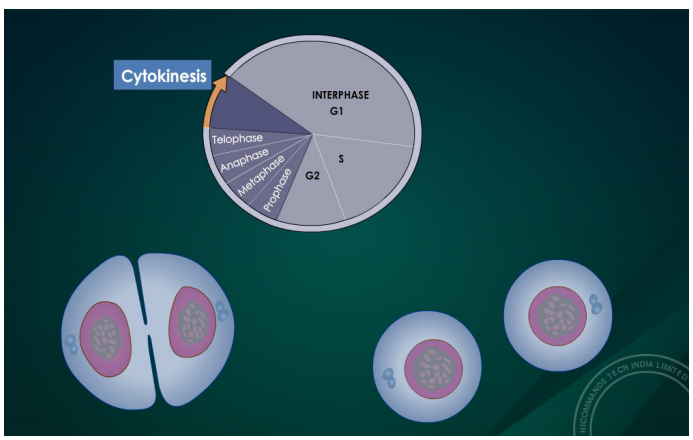


Figure 1.8: The process of cytokinesis

1.2.2. Meiosis

Meiosis is a special type of cell division that reduces the chromosome number by half, creating haploid cells, each genetically distinct from the parent cell that gave rise to them. This process occurs in all sexually reproducing single-celled and multicellular eukaryotes, including animals, plants, and fungi.

In sexual reproduction, meiosis produces haploid gametes that fuse together during fertilization to produce a diploid zygote. Meiosis involves two divisions without an interphase in between, starting with one diploid cell and generating four haploid cells. Each division, named meiosis I and meiosis II, has four stages: prophase, metaphase, anaphase, and telophase.

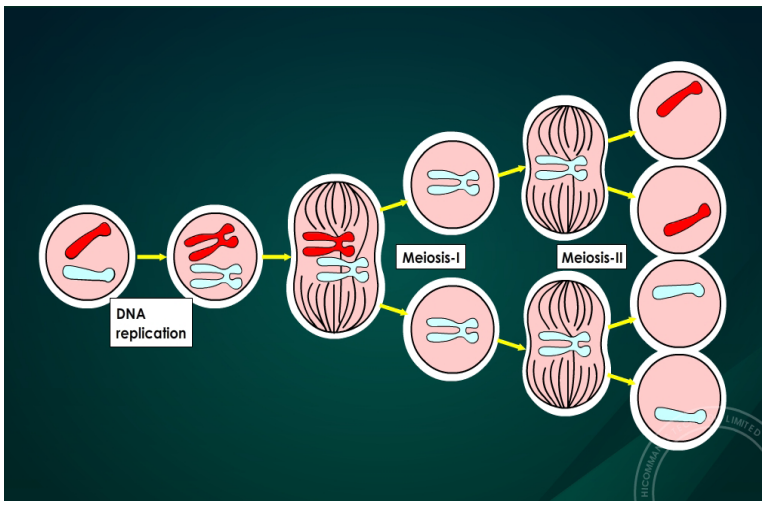


Figure 1.9: Process of meiosis

During meiosis the number of chromosomes is reduced from a diploid number (2n) to a haploid number (n). During fertilization, **haploid gametes** come together to form a **diploid zygote**, and the original number of chromosomes (2n) is restored. Phases of meiosis are summarized below:

a) Early meiosis or meiosis I

It includes the following phases:

i) Prophase I

Prophase-I is very similar to prophase of mitosis, but with one very significant difference. In prophase-I, the nuclear envelope breaks down, the chromosomes condense, and the centrioles begin to migrate to opposite poles of the cell, with the spindle fibers growing between them.

During this time, **the homologous chromosomes** separate to form homologous chromosomes pairs. These homologous chromosomes line up gene-for-gene down their entire length, allowing the crossing-over to occur. This process permits the exchange of genetic material between maternal and paternal chromosomes. Thus, crossing-over results in genetic recombination by producing a new mixture of genetic material. This is an important step in creating genetic variation.

ii) Metaphase I

In metaphase I, the pairs of homologous chromosomes line up along the equator of the cell.

iii) Anaphase I

During anaphase I the spindle fibers shorten, and the homologous chromosome pairs are separated from each other. One chromosome from each pair moves toward one pole, with the other moving toward the other pole, resulting in a nucleus with **n** chromosomes at one pole and the other **n** at the other pole. The sister chromatids remain attached at the centromere.

iv) Telophase I

The spindle fibers disappear and the nucleus reforms. This is quickly followed by cytokinesis and the formation of two haploid cells, each with a unique combination of chromosomes, some from the father and the rest from the mother.

After cytokinesis, both cells immediately enter meiosis II, without replication of the DNA. In fact, **Meiosis I** is described as **Reductional Division** as it reduces by half the number of chromosomes of the mother cell.

b) Latter meiosis or meiosis II

The second of the two consecutive divisions of the nucleus of eukaryotic cell during meiosis is composed of the following phases:

i) Prophase II

Once again the nuclear membrane breaks down, and the spindle begins to reform as the centrioles move to opposite sides of the cell.

ii) Metaphase II

The **n** chromosomes, each made out of two sister chromatids, occupy the equator of the cell.

iii) Anaphase II

The centromere divides and sister chromatids are separated and move to opposite poles of the cell. As the chromatids separate, each is known as a chromosome. Anaphase II results in a cell with **n** chromosomes at each end of the cell; each chromosome contains half as much genetic material as at the start of anaphase II.

iv) Telophase II

The nucleus reforms and the spindle fibers break down. Each cell undergoes cytokinesis, producing **four haploid cells**, each with a unique combination of genes and chromosomes.

Likewise, **Meiosis II** is **Equational Division**, and it occurs like a normal mitosis, *separating the sister chromatids* from each other.

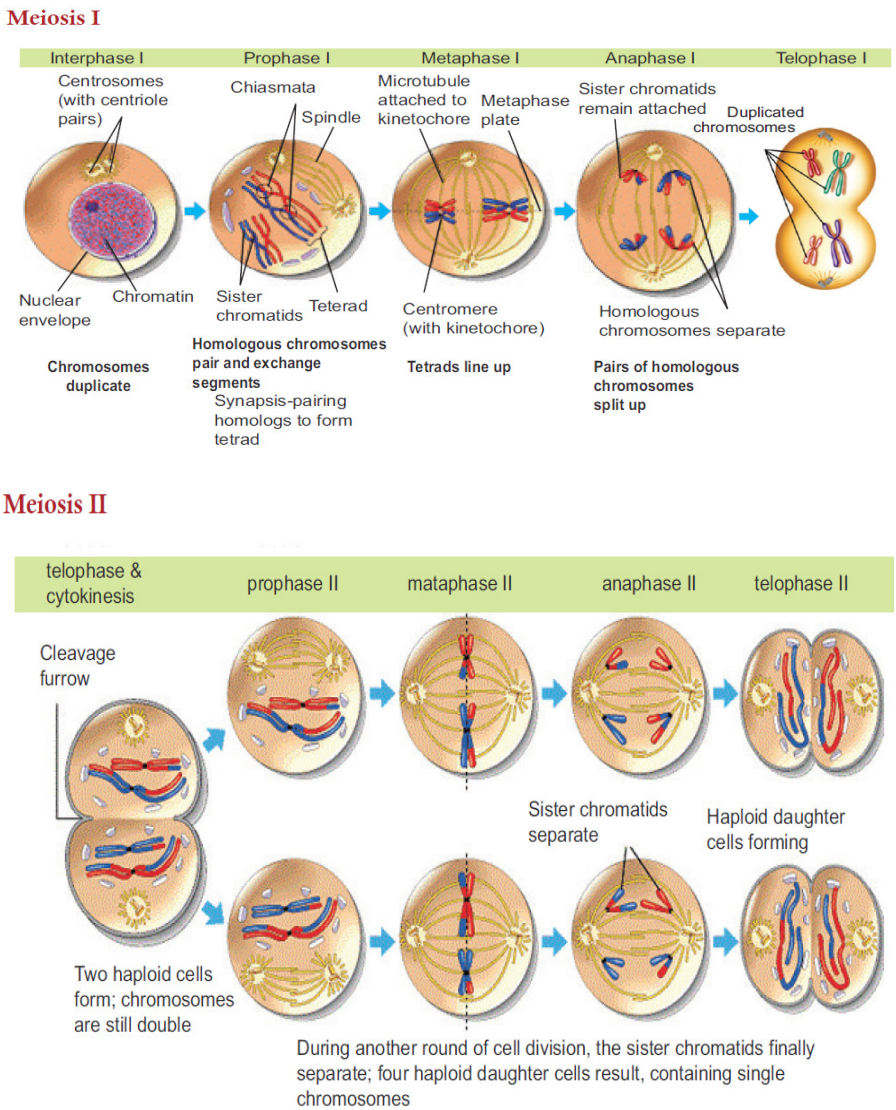


Figure 1.10: The process of meiosis

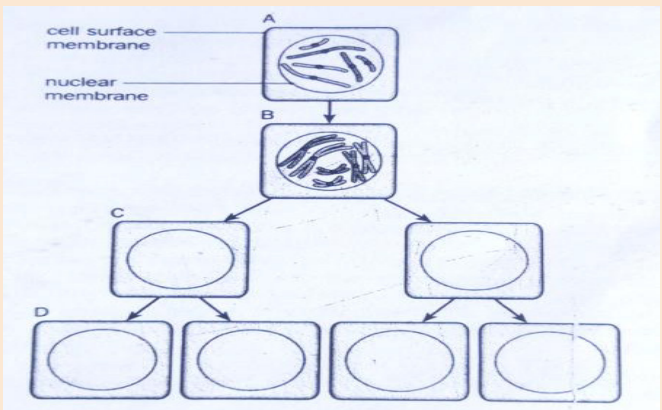
Table 1.1: Comparison between mitosis and meiosis

S. No.	Property	Mitosis	Meiosis
1.	Occurrence	Somatic cells	Germ cells/sex cells
2.	Number of daughter cells	Two diploid cells (2n)	Four haploid cells (1n)
3.	Genetic composition	– The two daughter cells are genetically identical to the parent cell. – It is equational division	– The four daughter cells are genetically different from parent cell and form each other. – It is reduction division
4.	Number of divisions	Prophase, prometaphase, metaphase, anaphase, and telophase	– Meiosis I: Prophase I, Metaphase I, Anaphase I, Telophase I – Meiosis II: Prophase II, Metaphase II, Anaphase II, Telophase II
5.	DNA Replication	Occurs during S phase of interphase prior to mitosis	Occurs during S phase of interphase prior to meiosis I
6.	Functions in the animal body	– It enables multicellular adult to arise from zygote – It helps in production of cells in growth and repair – Asexual reproduction in some animals	– It produces gametes (sperms and eggs) – It reduces the number of chromosome by half from diploid (2n) to haploid (1n) – It introduces genetic variation among the gametes
7.	Synapsis	It does not occur	Synapsis through synaptonemal complex
8.	Crossing over	It does not occur	Crossing over occurs between two non-sister chromatids during meiosis I
9.	Chiasmata	No chiasmata formation	Chiasmata, sites of crossing over, formation occurs

10.	Homologs on the metaphase plate	Individual chromosomes aligned at metaphase plate	Homologous pairs of chromosomes are aligned at metaphase plate during metaphase I
11.	Sister chromatids	Sister chromatids separate at anaphase	During meiosis I, the replicated chromosomes of each homologous pair move toward opposite poles at anaphase I; however, sister chromatids separate only at anaphase II
12.	Cytokinesis	Cytokinesis occurs after mitosis	Cytokinesis doesn't occur after meiosis I but occurs after meiosis II
13.	Centromeres	Division of centromeres take place at anaphase	Division or cleavage of centromeres takes place only at anaphase II
14.	Chromosomes at metaphase plate	Chromosome pairs are aligned at metaphase plate	Duplicated chromosome pairs are aligned at metaphase plate

APPLICATION ACTIVITY 1.2

Observe the diagram of an animal cell in meiotic division



a) What are the stages of cell division represented in A and B? Justify your answer.

b) What event occurs between B and C?

c) What is the diploid number of chromosomes in this cell?

d) Where do you think this cell could be found in an animal?

1.3. Role of mitosis and meiosis in living organisms

ACTIVITY 1.3

Observe figures below and explain the significance of mitosis in living organisms

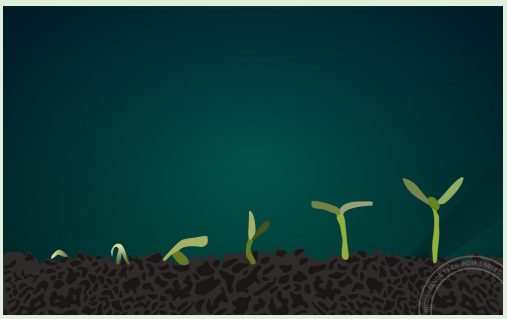


Figure 1.11. Growth by mitosis A

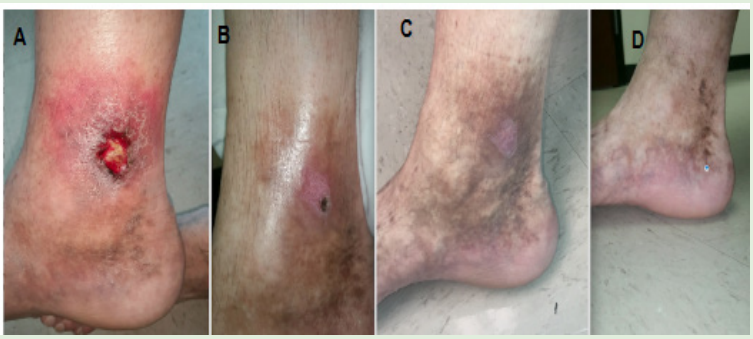


Figure 1.12. Repair of tissue by mitosis (Healing of wound)

Significance of Mitosis

1. **Mitosis allows growth**

   The number of cells within an organism increases by mitosis and this is the basis of growth in multicellular cells.

2. **Mitosis allows healing of wounds and repair or replacement of damaged cells**

   Replacement of cells and tissues also involves mitosis. Cells are constantly dying and are being replaced, for example, in the skin.

3. **Mitosis is involved in asexual reproduction**

   A single parent cell divides into two genetically identical offspring.

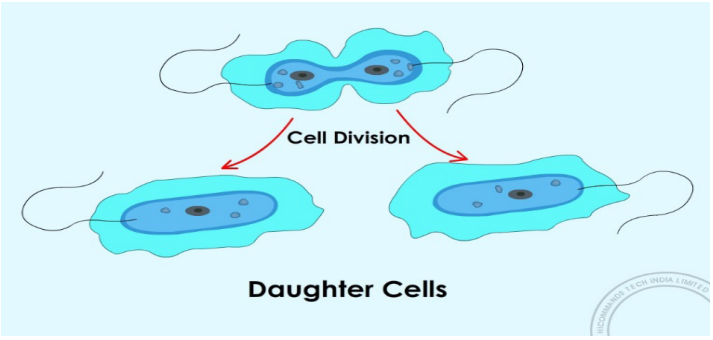


Figure 1. 13: Asexual reproduction by mitosis

4. **Mitosis allows genetic stability**

   By producing two nuclei which have the same number of chromosomes as the parent cell.

5. **Mitosis allows regeneration**

   Some animals are able to regenerate whole parts of the body, such as legs in crustacean and arms in starfish. Production of the new cells involves mitosis.

Note: Tumors and cancer

Many cancers result from uncontrolled cell division, when the regulation of the cycle is lost. Cancerous cells divide much more rapidly than healthy cells. These cells use the blood and nutrients that other cells need and they can stress the environment of the healthy cells. Cancerous cells do not provide any useful function to the organism, they are extremely harmful. If cancerous cells are allowed to grow uncontrolled, they will kill the host organism.

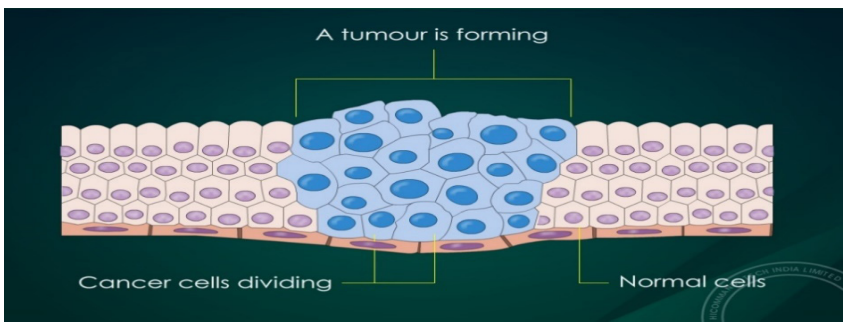


Figure 1.17: Tumour formation

The problem begins when a single cell in a tissue undergoes transformation, the process that converts a normal cell to a cancer cell. The body's immune system normally recognizes a transformed cell as an abnormal and destroys it.

However, if the cell escapes immune system, it may proliferate to form a tumor (a mass of abnormal cells within an otherwise normal tissue). There are three types of tumors: benign tumors, malignant tumors and metastasis.

- **Benign tumor**

  It is a lump of the abnormal cells that remains at the original site. Most benign tumors do not cause serious problems and can be removed by surgery.

- **Malignant tumors**

  These are abnormal cells that have become invasive enough to impair with the functions of one or more organs. An individual with a malignant tumor is said to have cancer.

- **Metastasis**

  Cancer cells may also separate from the original tumor, enter the blood and lymph vessels, and invade other parts of the body, where they proliferate to form more tumors. This spread of cancer cells beyond their original site is called **metastasis**.

Many **cancers can be inherited**, such as breast cancer, others are triggered by **viral infections**, **tobacco smoke** (e.g. lung cancer) and **radiations** (e.g. skin cancer). All cancers have one thing in common: the control over the cell cycle has broken down.

Significance of Meiosis

1. **Cells undergo Reduction Division Prior to Sexual Reproduction**

   Generally, a cycle of reproduction consists of meiosis and fertilization. Before sexual reproduction occurs, gametes undergo meiosis and produce haploid cells. Thus, during sexual reproduction, one haploid (1n) gamete comes from the paternal side and another haploid (1n) gamete comes from the maternal side; then, they both fuse to form a zygote, which is diploid (2n). The fusion of gametes to form zygote or new cell is called as fertilization or syngamy. If meiosis does not occur before sexual reproduction, the chromosome number would double up in each fertilization.

2. **Role and Significance of Meiosis in Producing Gametes**

   Gametogenesis is a biological process by which diploid cells undergo cell division and differentiation to form mature haploid gametes. It occurs through meiosis. In humans, the male gamete (sperm) is produced by a process called spermatogenesis and the female gamete (egg) is produced by a process called oogenesis through meiotic division. Here gametes

function takes place soon after meiosis but in plants it happens after gametophyte formation sexual reproduction of plants starts with spore formation. Sporophyte is a diploids generation of flowering plant where haploid spores are produced by meiosis which in turns undergoes mitosis to form multi-celled haploid gametophytes. These haploid gametophytes differentiate to produce gametes sperm and egg cells. Similarly, embryo sac is formed by reduction division. Each of the cells of embryo sac is haploid. Two of the nuclei fuse to produce diploid nucleus.

3. Independent Assortment of Chromosomes

Specifically, at metaphase I, each homologous pair of chromosomes positioned independently of the other pairs. As a result, each homologous pair sorts out its maternal and paternal homologue into daughter cells independently of every other pair. This act of separating homologous pairs independently is called independent assortment. The random orientation of homologous pairs of chromosomes due to independent assortment in meiosis I (metaphase) increases genetic variation in organisms.

4. Crossing Over and Random Fertilization

During crossing over, DNA segments of the two parents-paternal and maternal are combined into a single chromosome producing recombinant chromosomes, which are non-identical with their sister chromatids. In humans, an average of one to three crossing over events occurs per chromosome pair, depending on the position of their centromeres and on the size of the chromosome. Thus, crossing over is an important event of meiosis that brings genetic variation in sexual life cycles.

Besides independent assortment and crossing over, the random fertilization during sexual reproduction also increases genetic variation in organisms. During random fertilization, the male gamete and female gamete fuse to form zygote. The most interesting thing is that this zygote has the possibility of about 70 trillion diploid combinations.

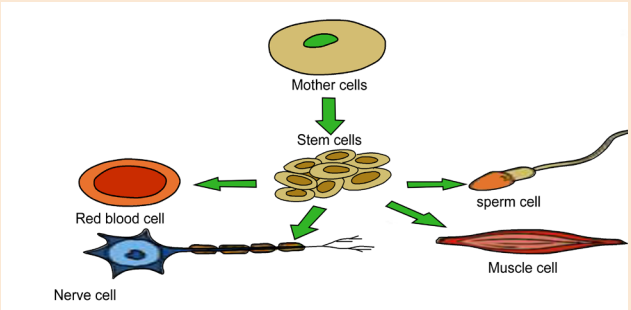
5. Non-disjunction of Chromosomes

Proper separation of chromosomes during meiosis is essential for the normal growth in humans. Any set of chromosomes that do not separate properly during meiosis results in improper separation of chromosomes or non-disjunction, which is a serious issue in human genetics. Non-disjunction is a condition in which the homologues or sister chromatids fail to separate properly during meiosis. It can lead to the gain or loss of chromosome, a condition called as aneuploidy. Example: Down syndrome is an autosomal trisomy. It is also called as trisomy 21, where non-disjunction results in an embryo with three copies of chromosome 21

instead of the usual two copies of chromosome 21. The origin of trisomics condition is through non-disjunction of chromosome 21 during meiosis. Failure of paired homologues to separate during either anaphase I or II may lead to gametes with 23 + 1 chromosome composition instead of the normal 23 gamete chromosome composition. Therefore, instead of 46 normal chromosomes, Down syndrome patient will have 47 chromosomes with three copies of chromosome 21 instead of the normal 2 copies. It was first discovered by John Langdon Down. The chance of occurrence is one infant in every 800 live births.

APPLICATION ACTIVITY 1.3

Observe the figure below showing that different cells take origin on the same cell.



a) If mother cell has 46 chromosomes, suggest the number of chromosomes that sperm cell and red blood cell have? Justify your answer.

b) In which way stem cell can lead to the formation of tumors.

SKILL LAB 1

Vegetative reproduction is any form of asexual reproduction occurring in plants in which a new plant grows from a fragment of the parent plant or grows from a specialized reproductive structure. It is especially used to maintain genetic character and to grow plants rapidly as a result of mitosis. Grafting method has traditionally led to the improvement of crop production and has both a functional and an inherent value.

Procedure:

- Making vertical incisions
- Prepare the Scion
- Connect Scion and Rootstock
- Secure the Graft and if it is live
- Protect the Graft
- Secure the Plastic

Evaluation sheet

Items	Number	None
Number of spoiled graft		
Number of non-spoiled graft		
Number of grown graft		

END UNIT ASSESSMENT 1

I. Choose whether the following statements are true (T) or false (F)

1. A typical cell spends most of its time in interphase.
2. Mitosis is a process where a single cell divides into three identical daughter cells.
3. Cytokinesis is a division of cytoplasm.
4. The process of mitosis is basically divided into 5 phases.
5. Meiosis is divided into three stages: Meiosis I, Meiosis II and Meiosis III.
6. The unrestrained, uncontrolled growth of cells in human beings results into a disease called cancer.
7. Cancer occurs due to failure in controlling cell division.
8. Proper separation of chromosomes during meiosis is not essential for the normal growth in humans.
9. The life span of blood cells ranges from less than one day to a few months.

II. Multiple choice questions

1. In telophase, the nuclear envelope re-forms around the..... set of haploid daughter chromosomes.

   a) one b) two c) three d) four

2. ..... is a condition in which the homologues or sister chromatids fail to separate properly during meiosis.

   a) Disjunction b) Non-disjunction c) Down syndrome
   d) None of these

3. Which of the event is correct in anaphase

   a) Sister chromatids separate and give rise to daughter chromosomes.

   b) Chromosomes are aligned at metaphase plate.

   c) Cytokinesis starts occurring.

   d) Chromosomes begin to uncoil.

4. One round of oogenesis produces

   a) One egg b) Two eggs c) Three eggs d) Four eggs

5. In mitosis, which of the following occurs?

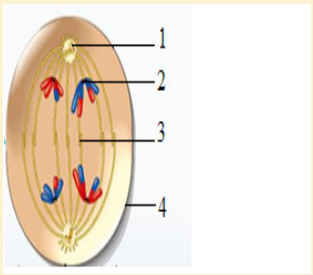
   a) Chiasmata formation c) Synapsis

   b) DNA replication d) None of these

III. Long answer type questions

1. Describe the main stages of cell cycle.
2. In your own words, explain what is meant by homologous pairs of chromosomes.
3. In your own words, describe the process of mitosis.
4. In your own words, describe the process of meiosis.
5. What is the need for reduction prior to fertilization in sexual reproduction?
6. Outline the role of meiosis in gametogenesis in humans and in the formation of pollen grain and embryo sacs in flowering plants.
7. Explain how crossing over and random assortment of homologous chromosomes during meiosis and random fusion of gametes at fertilization leads to genetic variation, including the expression of rare recessive alleles.

8. Analyse the following diagram and answer the questions below



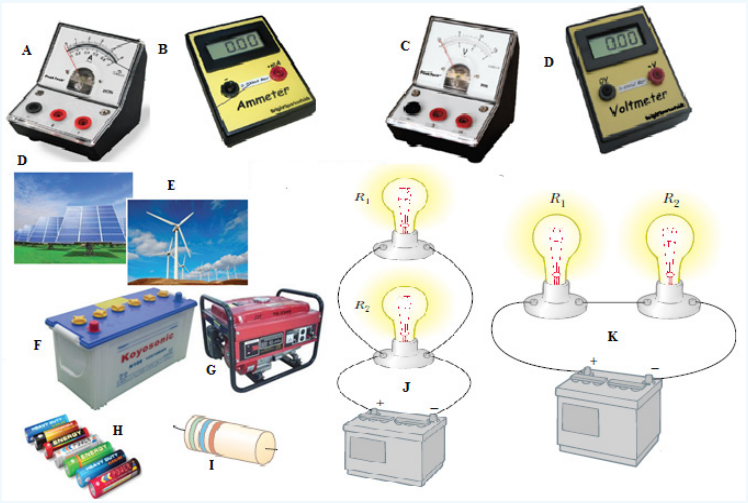
a) Identify the stage of cell division shown in the figure.
b) Label the structures marked as (1), (2), (3) and (4).
c) Which type of cell is involved in this division?
d) What will happen if the structure marked (3) is not formed?

UNIT 2

KIRCHHOFF'S LAW IN ELECTRICAL CIRCUIT

Key Unit competence: Apply Kirchhoff's law in electrical circuit analysis

2.0. INTRODUCTORY ACTIVITY



Look at the illustration given above.

a) What type of devices available in the illustration above?

b) Can you suggest the names of the available devices in the illustration above?

c) Is there any complete circuit in the illustration above?

d) What kind of electrical circuits identified in the illustration above?

e) Have you ever used or connected these electrical components somewhere? If yes, what were the difficulties in handling these electrical components in circuit construction?

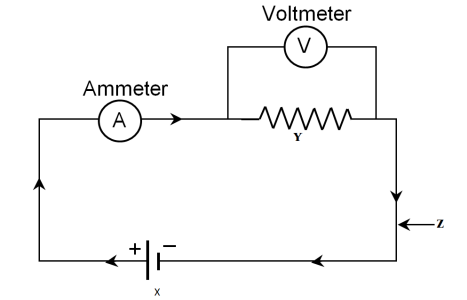
f) What can be considered to select the best electrical device(s) to be used in electrical circuit construction?

g) What can be put in recognition to minimize risks when connecting these electrical components in the circuit?

2.1. Simple electric circuit

ACTIVITY 2.1

Observe the following diagram and answer the next questions



a) Explain the role of part X, Y, Z

b) Give any example of device that is represented by X and Y.

c) Are ammeters and voltmeters necessary in creation of simple electric circuit? Explain.

d) Give other necessary devices in simple electrical circuit.

2.1.1. Elements of simple electric circuit and their application

Current electricity is the flow of the electrical charge carries like electrons. Current flows from negative to positive points. The SI unit for measuring electric current is the Ampere (A). One ampere of current is defined as one coulomb of electrical charge moving past a unique point in a second $I = \frac{Q}{t}$ where I is current, Q is charge, and t time

Resistance is the opposition that a substance offers to the flow of an electric current when an electric current of one ampere passes through a component across which a potential difference (voltage) of one volt exists, the resistance of that component is one Ohm. By ohm's law $R = \frac{V}{I}$ where R: resistance, V: voltage and I: current

Resistivity is a measure of the resistance of a given size of a specific material to electric conduction (high resistivity designates poor conductors). The resistivity of a particular material is measured in units of Ohm meters (Ωm)

$$R = \rho\frac{L}{A} \Rightarrow \rho = \frac{AR}{L}$$

Example 2.1

If the cross-section area of the live rail of an electric railway is $50\,cm^2$ and the resistivity of steel is $1.0\times10^{-7}\Omega m$ then and its length is 1km. find the resistance

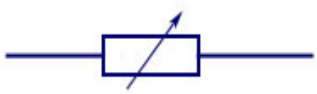
Answer:

$$R=\rho\frac{L}{A}\Leftrightarrow R=\frac{(1.0\times10^{-7}\ \Omega m)\times(10^{3}\ m)}{\left(50\times10^{-4}\ m^{2}\right)}$$

$$=\left(\frac{1.0\times10^{-7}\times10^{3}}{50\times10^{-4}}\right)\frac{\Omega mm}{m^{2}}$$

$$R=2.0\times10^{-2}\Omega$$

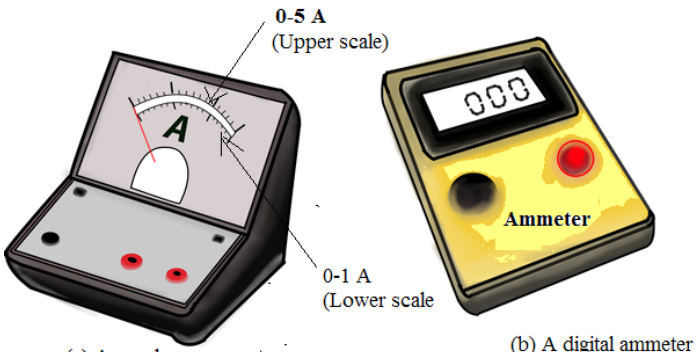
Table 2.1 below shows some of the components, their symbols and definition that are used in electric circuit diagrams.

Component	Circuit symbol	Definition/ description
Connecting wire		Joins two or more components in electric circuit.
Ammeter		Measures electric current
Resistor		Is used to restrict the amount of current flow through a device.
Rheostat		It is used to control the current flow with two contacts. Applicable in controlling lamp brightness, capacitor charge rate, etc

2.1.2. Measurement of electric current and voltage in a simple electric circuit

Measurement of electric current

Ammeter has two positive terminals and one negative terminal. Fig. (a) Shows an analogue ammeter and (b) shows a digital ammeter.



(a) An analogue ammeter (b) A digital ammeter

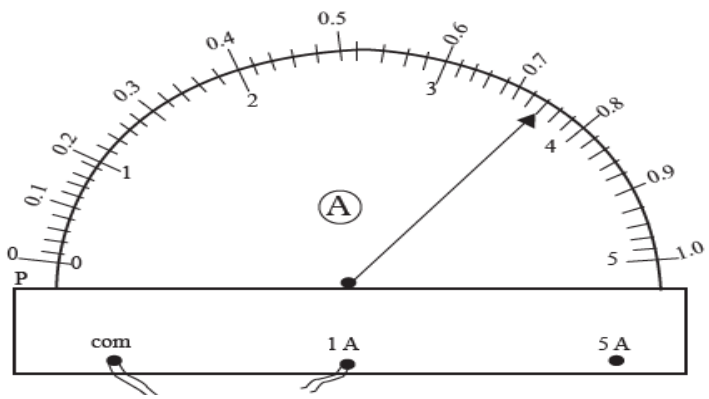
An analogue ammeter may have more than one scale (Fig. (a)). The magnitude of the current determines the scale to be used. Smaller currents are measured in milliamperes (mA) and microamperes (A).

1 mA = 1/ 1 000 A = 1 x10^{-3} A, 1μ A = 1 10^{-6} A.

How to use an ammeter to measure current in a circuit

Reading an analogue ammeter

Figure below shows the scale on an analogue ammeter that measures current in the range 0– 1A, or 0–5A.



When connected to the 1 A terminal, the upper scale running from 0 - 1 A should be used.

We determine the current represented by each smallest division on the upper scale as follows:

5 divisions correspond to..... 0.1 A

1 division corresponds to .....0.1/5A = 0.02 A

In Figure, the pointer is on the second mark after the 0.7 mark, hence the ammeter reading is:

0.7 A + (2 divisions × 0.02 A) = 0.7A + 0.04 A = 0.74 A

Potential difference (p.d)

Potential difference is defined as the work done in moving one coulomb of charge from one point to the other in an electrical circuit. The SI unit of potential difference is the volt (V).

In the electric circuit, the electrons move towards the positive terminal of the battery. The battery lifts the electrons up through an electrical height. This electrical height is called a potential.

The positive and the negative terminals have a difference in potential. The potential difference is also known as the voltage.

$$Volt = \frac{Work\ done(joule)}{Charge(coulomb)}$$

1 volt is therefore defined as the energy needed to move one coulomb of charge from one point to another.

APPLICATION ACTIVITY 2.1

In a circuit, 5 joules are used to drive 2 coulombs of charge across a bulb in a simple circuit. Find the potential difference across the bulb?

2.2. Arrangement of resistors

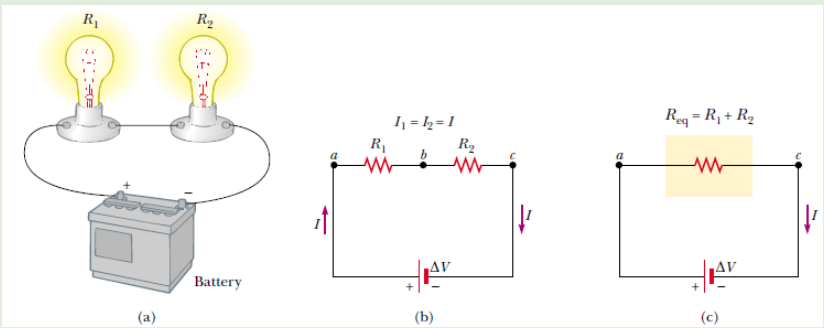
ACTIVITY 2.2

Task1: Series circuits

Provided materials: Battery cells, three torch light bulbs and conducting wires

Technical procedures:

- Arrange the battery cells as shown in figure below.
- Connect all the two bulbs in series and switch on.
- Remove one bulb and discuss your observations.
- Arrange the circuit to have two bulbs, and then to have one bulb and discuss the observation.



Series circuit

Use your observations to answer the following questions:

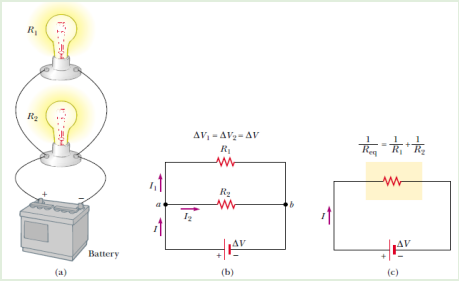
1. What happens in the circuit with three bulbs when one bulb is removed?
2. What happens when the circuit has two bulbs?
3. What happens when the circuit has one bulb only?

Task 2: parallel circuits

Materials: Battery cells, two torch light bulbs and conducting wires

Technical procedures:

- Arrange the battery cells as shown in figure below.
- Connect all the three bulbs in parallel and switch on.
- Remove one bulb and discuss your observations.
- Remove the second bulb and discuss your observations.



Parallel circuit

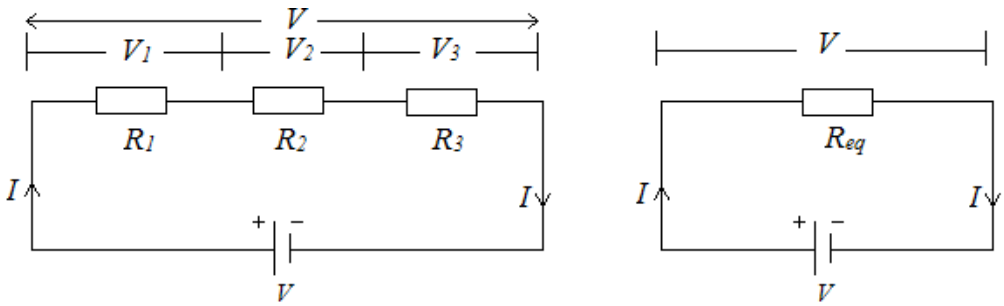
Use your observation to answer to questions below:

1. What happens in the circuit with two bulbs when one bulb is removed?
2. What happens when the circuit has two bulbs?
3. What happens when the circuit has one bulb only?

Circuits consisting of just one battery and one load resistance are very simple to analyze, but they are not often found in practical applications. Usually, we find circuits where more than two components are connected together. There are two basic ways in which to connect more than two circuit components: series and parallel.

2.2.1. Resistors in series

The defining characteristic of a series circuit is that there is only one path for electrons to flow. Consider three resistors R_1, R_2 and R_3 connected in series across a battery of potential difference V. Across the resistors the potential difference drops are V_1, V_2 and V_3 but the current flow I is constant due to the same amount of charges flowing across each resistor.



$V_1 = IR_1, \quad V_2 = IR_2 \quad \text{and} \quad V_3 = IR_3$

The total potential difference across the series combination is

$$V = V_1 + V_2 + V_3 = I(R_1 + R_2 + R_3) \qquad (1)$$

If R is the equivalent or effective resistance of the series combination, and has same charge Q, then $V = IR_{eq}$.

Substituting V in equation (1)

$$IR_{eq} = I(R_1 + R_2 + R_3)$$

$$R_{eq} = R_1 + R_2 + R_3 \qquad (2)$$

For any n resistors connected in series combination, the effective resistance is

$$R_{eq} = R_1 + R_2 + R_3 + ... + R_n$$

Example

Three resistances $R_1 = 8\,\Omega, R_2 = 3\,\Omega, R_3 = 6\,\Omega$ are connected in series. Find the equivalent resistance.

Answer:

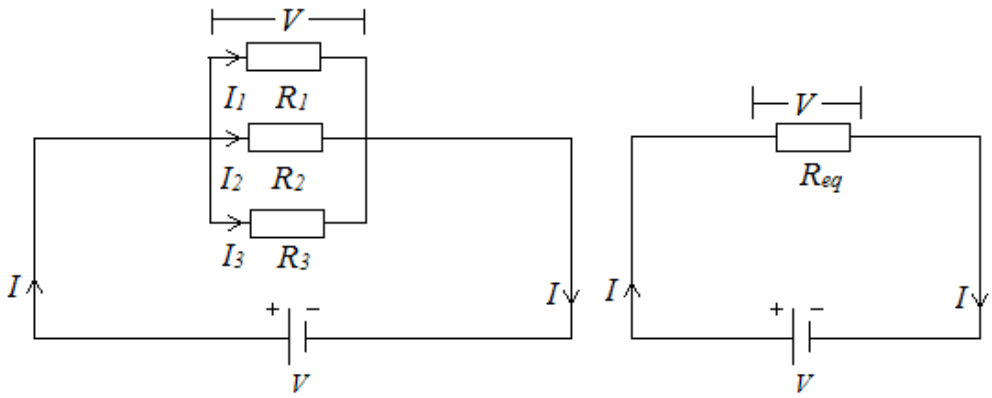
$$R_{eq} = R_1 + R_2 + R_3$$

$$R_{eq} = 8\,\Omega + 3\,\Omega + 6\,\Omega = 17\,\Omega$$

2.2.2. Resistors in parallel

The defining characteristic of a parallel circuit is that all components are connected between the same set of electrically common points and the resistors form more than one continuous path for electrons to flow.

Assume three resistors of resistance R_1, R_2 and R_3 connected in parallel across a battery of potential difference V. The potential difference across each resistor is the same and is equal to the potential difference V across the battery, but the current flow splits into three parts I_1, I_2 and I_3 due to the separation of charges



$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2} \text{ and } I_3 = \frac{V}{R_3}$$

The total current $I = I_1 + I_2 + I_3$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_2}\right)$$

If R_{eq} is the resistance of the equivalent resistor,

$$I = \frac{V}{R_{eq}}$$

Hence, $$\frac{V}{R_{eq}} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

For *n* resistors connected in parallel combination, the effective resistance is

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_n}$$

Example

Find the resistance quivalent to three resistances in parallel:

$R_1 = 12\ \Omega, R_2 = 12\ \Omega, R_3 = 6\ \Omega$

Answer:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \frac{1}{R_{eq}} = \frac{1}{12} + \frac{1}{12} + \frac{1}{6} = \frac{1}{12} + \frac{1}{12} + \frac{2}{12} = \frac{4}{12}$$

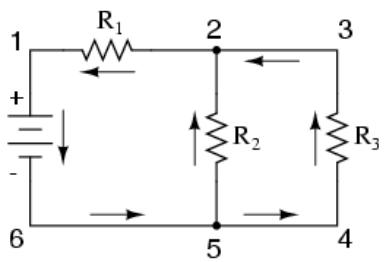
$$R_{eq} = 3\,\Omega$$

Household circuits are always wired in such a way the lights and appliances are connected in parallel. In this way each device operates independently from the others, so if one is turned off the others remain on. This also had the advantage that the voltage supplied to each element is the same.

Resistors in mixture

We can have circuits that are a combination of series and parallel, too:

Series-parallel



In this circuit, we have two loops for electrons to flow through: one from 6 to 5 to 2 to 1 and back to 6 again, and another from 6 to 5 to 4 to 3 to 2 to 1 and back to 6 again. Notice how both current paths go through R_1 (from point 2 to point 1). In this configuration, we›d say that R_2 and R_3 are in parallel with each other, while R_1 is in series with the parallel combination of R_2 and R_3.

To calculate the equivalent resistance in a mix-up resistors circuit, the resistors that are in parallel are combined in a single resistor which will be in series with other resistors and the equivalent resistance is calculated like in series circuit.

Advantages of parallel connection resistors

- Every unit that is connected in a parallel circuit gets equal amount of voltage
- It becomes easy to connect or disconnect a new element without affecting the working of other elements
- If any fault happened to the circuit, then also the current is able to pass through the circuit through different paths

Disadvantages of parallel connection resistors

- It requires the use of lot of wires
- We can increase or multiply the voltage in a parallel circuit
- Parallel connection fails at the time when it is required to pass exactly same amount of current through the units

Advantages of series connection resistors

- To control the current in a circuit, series connection is useful
- The total circuit resistance increases and thus the current decreases
- To add additional power devices, usually using batteries in order to increase the overall force of output by giving more power

Disadvantages of parallel connection resistors

If a bulb were broken, the other bulbs would go out too

APPLICATION ACTIVITY 2.2

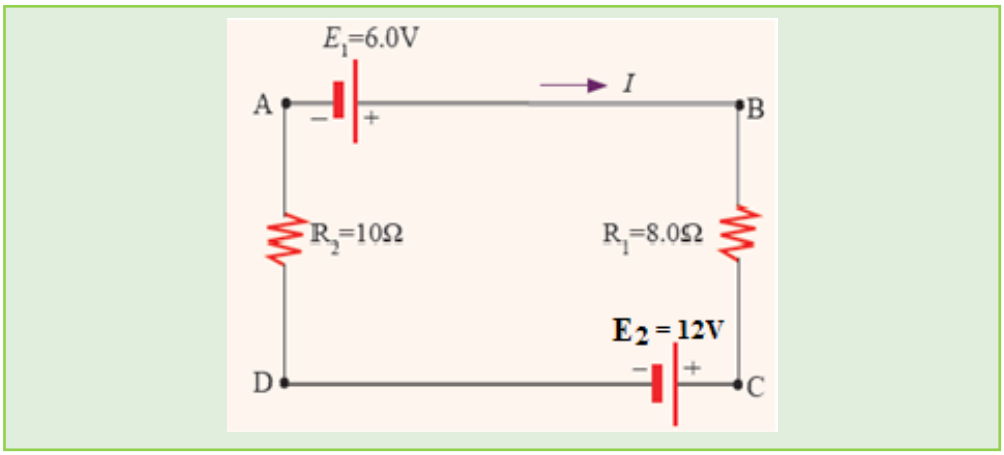
Three resistors of 12, 16, and 20 Ω are connected in parallel. What resistance must be connected in series with this combination to give a total resistance of 25 Ω.

2.3. Kirchhoff's laws and its applications

ACTIVITY 2.3

A single-loop circuit contains two resistors and two batteries, as shown in the following figure (neglect the internal resistances of the batteries).

a) Find the current in the circuit.
b) What power is delivered to each resistor?
c) What power is delivered by the 12V battery?



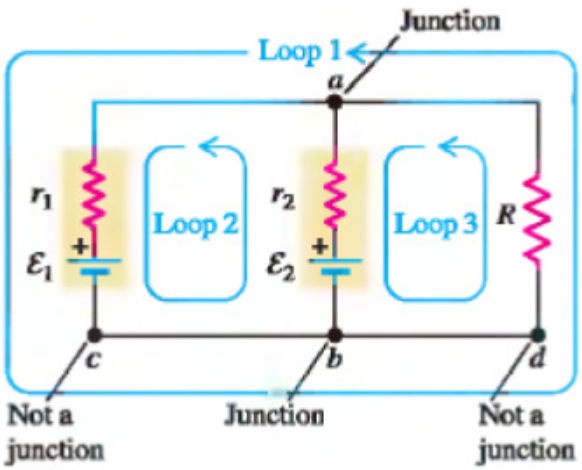
2.3.1. Kirchhoff's laws

Simple circuits can be analyzed using the expression V = IR and the rules for series and parallel combinations of resistors. Very often, however, it is not possible to reduce a circuit to a single loop.

The procedure for analyzing more complex circuits is greatly simplified if we use two principles called Kirchhoff's rules developed by the German Physicist Gustav Robert Kirchhoff (1824-1887).

First, here are two terms that we will use often. A **junction** in a circuit is a point where three or more conductors meet. Junctions are also called nodes of branch points. A **loop** is any closed conducting path.

In figure below, the points **a** and **b** are junctions, but points c and d are not. The curved lines show some possible loops in this circuit.



Kirchhoff's junction rule: the algebraic sum of the currents into any junction is zero. That is,

$$\sum I = 0$$

i.e The sum of the currents entering the junction must equal the sum of the currents leaving the junction.

Kirchhoff's loop rule: the algebraic sum of the potential differences in any loop, including those associated with e.m.fs and those of resistive elements, must equal zero. That is,

$$\sum V = 0$$

Kirchhoff's first rule is a statement of conservation of electric charge. All charges that enter a given point in a circuit must leave that point because charge cannot build up at a point.

Kirchhoff's second rule follows from the law of conservation of energy.

The sum of the increases in energy as the charge passes through some circuit elements must equal the sum of the decreases in energy as it passes through other elements. The potential energy decreases whenever the charge moves through a potential drop $-IR$ across a resistor or whenever it moves in the reverse direction through a source of emf. The potential energy increases whenever the charge passes through a battery from the negative terminal to the positive terminal.

When applying Kirchhoff's second rule in practice, we imagine traveling around the loop and consider changes in electric potential, rather than the changes in potential energy.

Problem solving strategy:

1. **Junction rule:** Assign symbols and directions to the currents in the various junctions. If you guess the wrong direction for a current, it does not matter. The end result will be a negative answer for that current and the magnitude will be correct.
2. **Loop rule:** You must choose a direction for moving around the loop. As you move around the loop the voltage drops and increases should be recorded according to the rules (a-d) below.
   a) If a resistor is traversed in the direction of the current, the change in potential across the resistor is $-IR$.

b) If a resistor is traversed in the direction opposite the current, the change in potential across the resistor is $+IR$.

c) If a source of *emf* is traversed in the direction of the *e.m.f* (from – to +) the change in potential is $+\boldsymbol{\varepsilon}$

d) If a source of *emf* is traversed opposite the direction of the *e.m.f* (from + to –) the change in potential is $-\boldsymbol{\varepsilon}$

(a) Sign conventions for emfs

(b) Sign conventions for resistors

+ ε: Travel direction from − to +:

−ε: Travel direction from + to − :

+*IR*: Travel opposite to current direction:

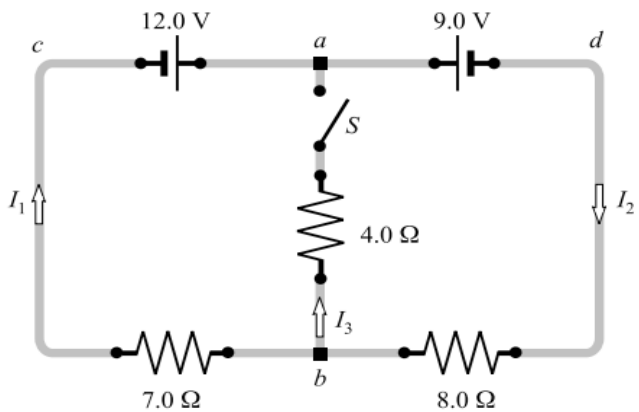
−*IR*: Travel opposite to current direction:

Example 2.2

1. In figure below, find I_1, I_2, and I_3 if S is

a) Open

b) Closed



Answer:

a) When S is open, $I_3 = 0$ because no current can flow through the open switch. Applying the node rule to point a gives

$$I_1 + I_3 = I_2 \text{ or } I_2 = I_1 + 0 = I_1$$

Applying the loop rule to loop **acbda** gives

$$-12.0 + 7.0I_2 + 8.0I_2 + 9.0 = 0$$

Because $I_2 = I_1$

$15.0I_1 = 3.0 \; or \; I_1 = 0.20A$

Also $I_2 = I_1 = 0.20A$

b) With S close, I_3 is no longer known to be zero. Applying the node rule to point a gives

$I_1 + I_3 = I_2$ (1)

Applying the loop rule to loop **acba** gives

$-12.0 + 7.0I_1 - 4.0I_3 = 0$ (2)

And to loop **adba** gives

$-9.0 - 8.0I_2 - 4.0I_3 = 0$ (3)

We must solve (1), (2) , and (3) for I_1, I_2 and I_3 From (3)

$I_3 = -2.0I_2 - 2.25$

Substituting this in (2) also gives

$-12.0 + 7.0I_1 + 9.0 + 8.0I_2 = 0 \; or \; 7.0I_1 + 8.0I_2 = 3.0$

Substituting for in (1) also gives

$I_1 - 2.0I_2 - 2.25 = I_2 \; or \; I_1 = 3.0I_2 + 2.25$

Substituting this value in the previous equation finally gives

$21.0I_2 + 15.75 + 8.0I_2 = 3.0 \; or \; I_2 = -0.44A$

Using this in the equation for I_1 gives

$I_1 = 3.0(-0.44) + 2.25 = 0.93A$

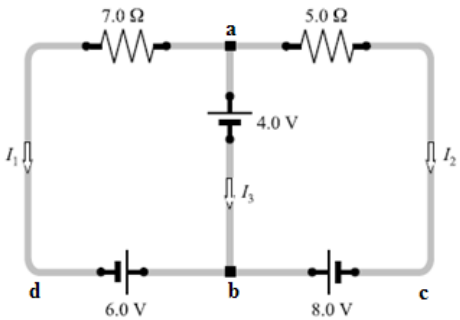
From (1)

$I_3 = I_2 - I_1(-0.44) - 0.93 = -1.37A$

2.3.2. Application of Kirchhoff's laws in solving problems in complex electric circuits

Example 2.3

1. Find the currents in the circuit given below:



Answer:

This circuit cannot be reduced further because it contains no resistors in simple series or parallel combinations. We therefore revert to Kirchhoff's rules. If the currents had not been labeled and shown by arrows, we would do that first. No special care needed to be taken in assigning the current directions, since those chosen incorrectly will simply give negative numerical values.

We apply the node rule to node b in the figure above.

Current into b = Current out of b.

$$I_1 + I_2 + I_3 = 0 \qquad (1)$$

Next we apply the loop rule to loop adba. In volts,

$$-7.0I_1 + 6.0 + 4.0 = 0 \; or \; I_1 = \frac{10.0}{7.0} A$$

(why must the term 7.0I1 have a negative sign?) we then apply the loop rule to loop abca. In volts,

$$-4.0 - 8.0 + 5.0I_2 = 0 \; or \; I_2 = \frac{12.0}{5.0} A$$

(Why must the signs be as written?)

Now we return to equation (1) to find:

$$I_3 = -I_1 - I_2, I_3 = (-\frac{10.0}{7.0} - \frac{12.0}{5.0})A, I_3 = \frac{-50-84}{35}A \text{ and } I_3 = -3.8A$$

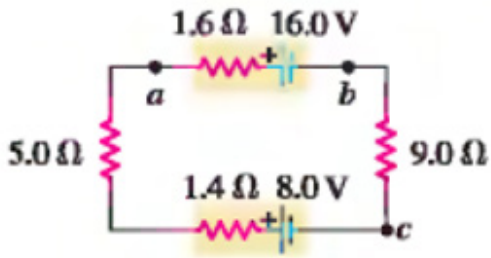
The minus sign tells us that I_3 is opposite in direction to that shown in the figure.

2. The circuit shown in figure below contains two batteries, each with an emf and an internal resistance, and two resistors. Find

   a) The current in the circuit (magnitude and direction);

   b) The terminal voltage V_{ab} of the 16.0 V battery;

   c) The potential difference V_{ac} of a with respect to point c.



Answer:

a) The current is counterclockwise, because the 16 V battery determines the direct

$$+16.0\,V - 8.0\,V - I(1.6\,\Omega + 5.0\,\Omega + 1.4\,\Omega + 9.0\,\Omega) = 0$$

$$I = \frac{+16.0\,V - 8.0\,V}{(1.6\,\Omega + 5.0\,\Omega + 1.4\,\Omega + 9.0\,\Omega} = 0.47A$$

$$v_b + 16.0\,V - I(1.6\,\Omega) = v_a \; so \; v_{ab} = 16.0V - (0.47\;A)(1.6\,\Omega) = 15.2\,V$$

$$V_c + 8.0 - I(1.4\,\Omega + 5.0\,\Omega = V_a \; so \; V_{ac}$$

$$= (5.0\,\Omega)(0.47\;A) + (1.4\,\Omega)(0.47\;A) + 8.0\;\text{V} = 11.0\,V$$

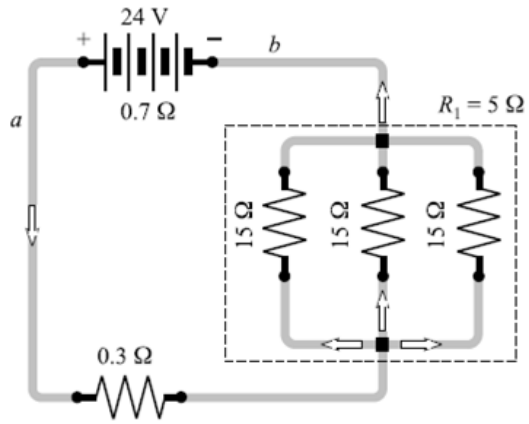
3. In figure below, the battery has an internal resistance of $0.7\ \Omega$.

Find

i). the current drawn from battery,

ii). the current in each $15\ \Omega$ resistor,

iii). the terminal voltage of the battery.



Answer:

For parallel group resistance R_1 we have

$$\frac{1}{R_1} = \frac{1}{15\ \Omega} + \frac{1}{15\ \Omega} + \frac{1}{15\ \Omega} = \frac{3}{15\ \Omega}$$

$$R_1 = 5.0\ \Omega$$

Then $R_{eq} = 5.0\ \Omega + 0.3\ \Omega + 0.7\ \Omega = 6\ \Omega$

And $I = \frac{E}{R_{eq}} = \frac{24\ V}{6.0\ \Omega} = 4.0\ A$

i). Method 1

The three resistor combination is equivalent to $R_1 = 5.0\ \Omega$ A current of 4.0 A flows through it. Hence, the p.d across the combination is

$$IR_1 = (4.0\ A)(5.0\ \Omega) = 24\ V$$

This is also the p.d across each resistor. Therefore, the current through each 15 Ω resistor is

$$I_{15} = \frac{V}{R} = \frac{20\,V}{15\,\Omega} = 1.3\ A$$

ii). Method 2

In this special case, we know that one –third of the current will go through each resistor. Hence

$$I_{15} = \frac{4.0\,V}{3} = 1.3\ A$$

We start at a and go to b outside the battery:

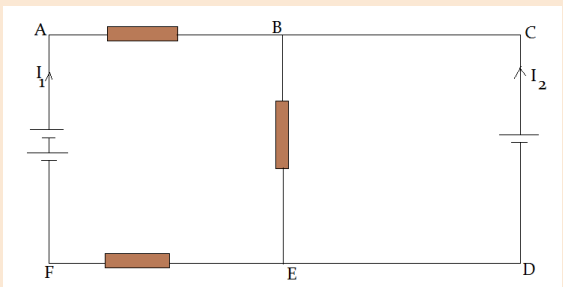
$$V_{ab} = -(4.0\ A)(0.3\,\Omega) - (4.0\ A)(5.0\,\Omega) = -21.2V$$

The terminal p.d of the battery is. Or,

$$Ter\min al\ \ p.d = E - Ir = 24\,V - (4.0\ A)(0.7\,\Omega) = 21.2\,V$$

APPLICATION ACTIVITY 2.3

1. In the circuit below, each cell has e.m.f of 1.5 V and zero internal resistance. Each resistor has a resistance of 10 Ω * MERGEFORMAT. There are currents I_1 and I_2 in the branches as shown.



a) Use Kirchhoff's first law to write down an expression for the current in BE, in terms of I1 and I2

b) Use Kirchhoff's first law to write down equations for the circuit loops:

i). ABEFA

ii). CBEDC

2. A resistor rated $10\,\Omega$ allows a current of 2 A to flow through it in a simple circuit. The resistor is replaced with another one of $30\,\Omega$.
   a) Calculate the amount of current passing the $30\,\Omega$ resistor if the source of voltage is the same
   b) The voltage and current through a device in a circuit are 2 V and 0.02 A respectively. Calculate the resistance of the device.
   c) In a circuit, 5 joules are used to drive 2 coulombs of charge across a bulb in a simple circuit. Find the potential difference across the bulb?
   d) Find the amount of current passing through a lamp, if 600 Coulomb of charge flows through it in 4 minutes.

SKILLS LAB 2

Conduct a survey to electrical engineers and find out how they construct electric circuits and apply Kirchhoff's laws in analysis of complex electric circuits before installation process.

Collect and analyze data about when, where, and why people use Kirchhoff's laws in dealing with complex electric circuits.

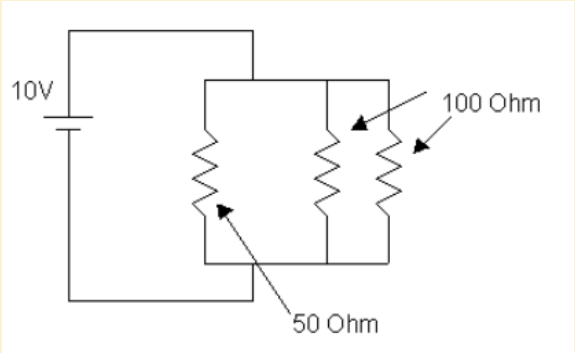
To complete this project you must

- Develop a survey sheet about electric components, demonstration of Kirchhoff's laws and complex electric circuit.
- Distribute your survey sheet to other student-teachers, family members and neighbors.
- Compile and analyze your data.
- Create a report to display your findings in your sheet.

Plan it! To get started, think about the format and content of your survey sheet. Brainstorm what kinds of questions you will ask. Develop a plan for involving student-teachers in your class or other classes to gather more data.

END UNIT ASSESSMENT 2

1. State Kirchhoff Current Law and Kirchhoff Voltage Law
2. Distinguish between electric sources of currents from receptors.
3. Find the current across the 10V battery



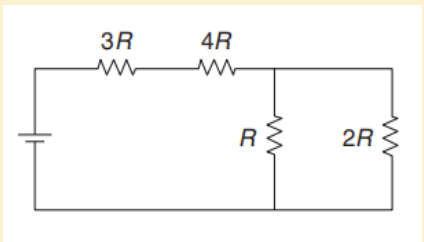
4. The figure below shows four resistors connected in a circuit with a battery.Which of the following correctly ranks the potential difference, ΔV, across the four resistors?

(A) $\Delta V_{4R} > \Delta V_{3R} > \Delta V_{2R} > \Delta V_{R}$

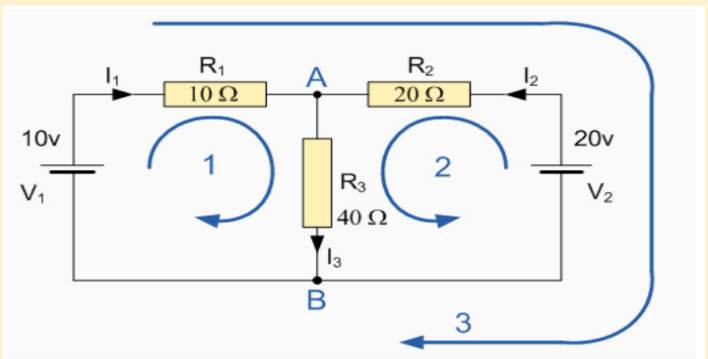
(B) $\Delta V_{4R} > \Delta V_{3R} > \Delta V_{2R} = \Delta V_{R}$

(C) $\Delta V_{4R} = \Delta V_{3R} > \Delta V_{R} > \Delta V_{2R}$

(D) $\Delta V_{2R} = \Delta V_{R} > \Delta V_{3R} > \Delta V_{4R}$



5. Determine the values of the the current flowing through each of the resistors.

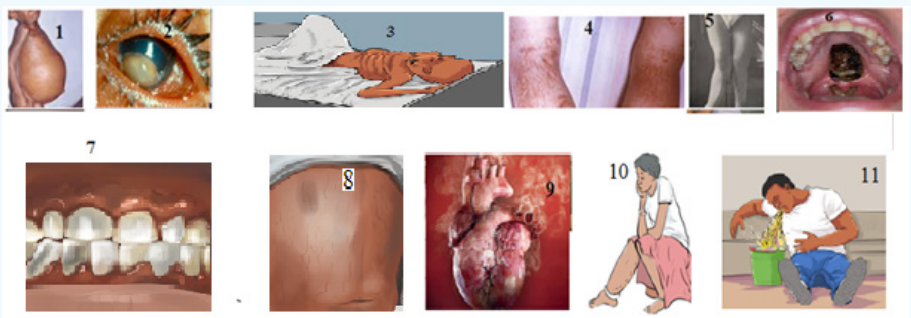


UNIT 3

CLASSIFICATION AND PATTERNS OF DISEASES

Key Unit competence: Explain symptoms of diseases, their treatment and prevention.

2.0. INTRODUCTORY ACTIVITY



According to what you observe on the illustration above:

a) Are their physical appearances normal? Justify your answer.
b) What do you think is the cause of each case on the figure?
c) What can you do in community for limiting those situations?

3.1. Common diseases

ACTIVITY 3.1

The pictures below represent two different patients suffering from tuberculosis and cholera respectively.

a) Using search engine or library textbook differentiate between infectious disease and non-infectious diseases. Give examples in each case

b) Conduct research on the disease in figure 3 and that on Figure 11. For each, write short notes on its cause, mode of transmission and signs and symptoms, and measures of prevention.

Disease is any harmful deviation from the normal structural or functional state of an organism, generally associated with certain signs and symptoms and differing in nature from physical injury.

Infectious diseases are caused by microorganisms known as pathogens which may include viruses, bacteria, fungi and protozoa. Those diseases are called communicable diseases as they can be transmitted from one person to another. They include cholera, malaria, typhoid, HIV and AIDS...Malaria is one of the most dangerous infectious diseases, endemic in Latin America, Africa and South-East Asia.

Some infectious diseases can also be from animals to humans.

Key words used when discussing about infectious diseases are:

- **Epidemiology**: The study of all the factors that contribute to the appearance of a particular disease.
- **Causative agent**: The organism which causes the disease.
- **Vector**: An organism which carries the causative agent of the disease from one person to another or from infected animal to human.
- **Incubation period**: The period of time between the original infection and the appearance of signs and symptoms.
- Infective period: The time during which a person is capable of passing the disease on to another person.
- Carrier: The person who has been infected but develop no signs and symptom, the carrier can pass the disease on to another person.
- **Prevention**: Measures taken to prevent diseases.
- **Treatment:** Measures taken to cure diseases.
- **Antibody**: Is a protein produced by the body's immune system when it detects harmful substances called antigen.
- **Antigen:** Is any substance that causes your immune system to produce antibodies against it.

- **Host:** A host can be anything living organism ion which pathogens can survive.
- **Hygiene:** Practices that help to maintain health and prevent the spread of diseases.
- **Immunity**: Is the ability of the body to resist to infections.

Some groups of communicable diseases

- **Bacterial diseases**: These are diseases caused by bacteria. They include cholera, typhoid, tetanus, tuberculosis, etc.
- **Viral diseases**: These are diseases caused by viruses. They include AIDS, polio, measles, Ebola, etc.
- **Protozoan diseases**: these are diseases caused by protozoa. They include malaria, sleeping sickness, trichomoniasis, etc.
- **Fungal diseases**: These are diseases caused by fungi. They include candidiasis, athlete's foot, ring worms, etc.
- **Worm diseases:** these are diseases caused by worms. They include elephantiasis, bilharzias, etc.
- **Sexually transmitted diseases**: These are diseases transmitted through sexual contact. They include HIV-AIDS, syphilis, gonorrhea, etc. c.

Pathogens can spread when you have direct contact with an infected person. For example, if you have contact with the person's blood, body fluids or open wounds. Pathogens can also be spread through contaminated food, water or air. Infected animals can spread pathogens to people.

3.1.1. Cholera

Cholera is a good example of a waterborne disease. It is endemic in parts of Asia, particularly India. The organism which causes cholera is a comma shaped motile bacterium called *Vibrio cholerae*.

The main source of infection is water contaminated by feces with Vibrios. It is estimated that only about one infected person in 50 develops the disease, the rest being carriers. Drinking contaminated water, or washing food or utensils in it, is the most common means of transmission. Direct contamination of food with feces as a result of poor hygiene is also possible, house flies being the main vector in this last case.

Figure 3.1: People using and drinking contaminated water

Vibrio cholerae multiply in the intestine, releasing a powerful toxin which results in violent inflammation of the intestine and production of the watery diarrhea.

The main sign of the disease is **severe diarrhea** due to irritation of the bowel by toxins from the vibrios. The liquid of the feces is so profuse and cloudy like "rice water". **Abdominal pain** and **vomiting** are also common

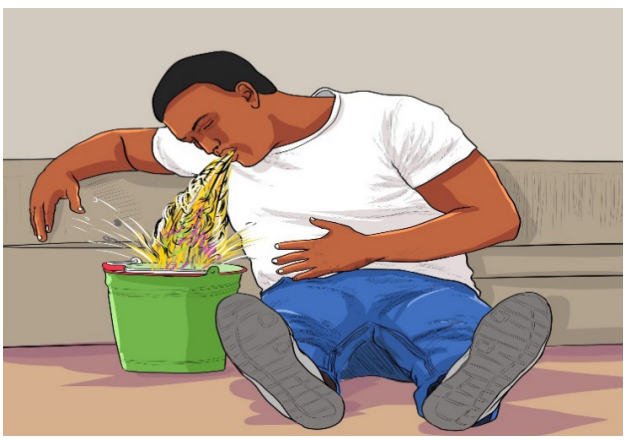


Figure 3.2: Abdominal pain and vomiting signs of cholera

Dehydration is rapid and quickly results in death unless rehydration treatment is given. Fever is absent; in fact, the skin feels deathly cold and often damp.

Table 3.1: The features of cholera

Pathogen	*Vibrio cholera*
Methods of transmission	Food-borne, water-borne
Global distribution	Asia, Africa, Latin America
Incubation period	Two hours to five days
Site of action of pathogen	Wall of small intestine
Clinical features	Severe diarrhea ('rice water'), loss of water and salts, dehydration, weakness
Method of diagnosis	Microscopical analysis of faeces

The prime cause of death from cholera is dehydration i.e. loss of water with its minerals salts. For that it is obligatory to rehydrate with oral serum which contain mineral salts and sugar, the fluid loosed may be replaced by administration of a drip food into a vein. Various antibiotics, such as tetracyclines and chloramphenical, are used to treat cholera. Chloramphenical is effective against tetracycline-resistant vibrios.

Cholera can be prevented through:

- Use clean drinking water,
- Proper treatment of sewage and sanitation,
- High standards of public and personal hygiene

Figure 3.3: A person washing hands with soap after living toilet

- Health education
- Vaccination is recommended for people visiting areas where cholera is endemic and for those living in such areas. But this vaccine lasts few months.
- Isolation of patients and hygienic disposal of feces and vomit from patients.

Note: Failure to eradicate cholera induct to:

- Unsuccessfulness of vaccination.
- waterborne disease i.e. transmitted through contaminated water
- Poor sanitation condition in camps.

3.1.2. Tuberculosis

Tuberculosis is caused by bacterium called *Mycobacterium tuberculosis*, first discovered by Robert Koch in 1882. It is sometimes referred to as the tubercle bacillus, bacilli being rod-shaped bacteria. The common form is pulmonary T.B which infects the lungs, although other organs may be affected.

Figure 3.4: Mycobacterium tuberculosis

Two strains of the bacterium may cause the disease, the human and the bovine forms. The latter can be present in cattle and can enter the milk of cows. It is very resistant and can remain alive for long time in milk products as well as in durst.

Table 3.2: The features of TB

Pathogen	*Mycobacterium tuberculosis*; *Mycobacterium bovis*
Methods of transmission	Airborne droplets (*M. tuberculosis*); via under-cooked meat and unpasteurised milk (*M.bovis*)
Global distribution	Worldwide
Incubation period	Few weeks or up to several years
Site of action of pathogen	Primary infection in lungs; secondary infections in lymph nodes, bones and gut
Clinical features	Racking cough, coughing blood, chest pain, shortness of breath, fever, sweating, weight loss
Methods of diagnosis	Microscopic examination of sputum for bacteria, chest X-ray

Tuberculosis is mainly airborne disease. The infection is done through the droplets from the patient.

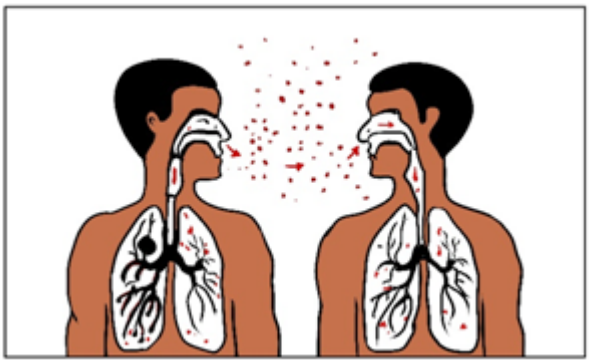


Figure 3.5: Patient transmitting TB germ to another through coughing

It is much less infectious than the common cold and requires prolonged contact between people, poor ventilation and overcrowded living conditions. Other factors include poverty, bad housing, malnutrition, age, smoking and AIDS. In addition, TB is an opportunistic infection, striking many people with a depressed immunity.

The disease frequently shows itself by vague symptoms such as: loss of appetite; loss of weight; excessive sweating; coughing, appearance of blood in the sputum, pains on the chest, shortness of breath (case of lung tuberculosis).

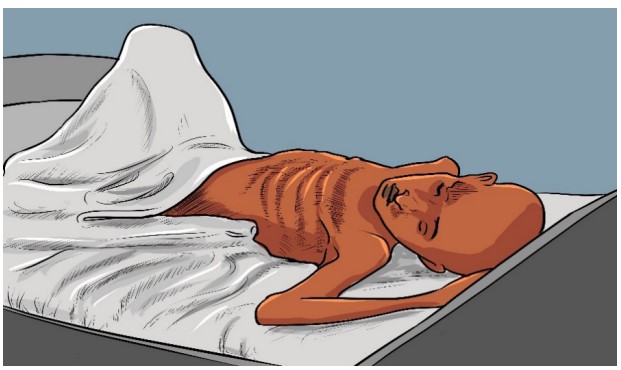


Figure 3.6: showing a patient on bed suffering from a TB

The development of an effective vaccine against the disease result of the work of Abert Calmette and Camile guérin (BCG). A cure for people already affected by T.B did not come until 1843 when the antibiotic streptomycin was discovered. The number of cases started to fall more rapidly after this and continued to decline aided by introduction of further antibiotics such as rifampicin, isoniazid and others.

Note: Failure to eradicate tuberculosis induct to:

- Patients can carry pathogen and infection without showing symptoms. Therefore they are difficult to identify and isolate / long period of incubation
- Germs of tuberculosis can survive longer in the house dust
- The disease is related to poverty where many people share the same room and have malnutrition.
- The disease is associated with AIDS that reduced the body immunity
- Long period of medication (6-8 moths), hence patients give up when not yet fully healed. The pathogens then form endospores that resists to medicines.
- The disease is also spread through milk from infected animals. Hence it is difficult to vaccinate.
- Tuberculosis is an airborne disease i.e. spread in air.

3.1.3. Malaria

Human malaria is caused by infections from four species of plasmodium: *Plasmodium falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*, each responsible for a different form of the disease.

The *parasite*, **Plasmodium** is transmitted by the bite of female mosquitoes (the *vector*) belonging to the genus **Anopheles.**

The **life cycle** of Plasmodium involves both sexual reproduction within the host mosquito, and asexual reproduction within the human being. It is the reproductive activity of the parasite within the human bloodstream that produces the characteristic recurrent attacks of the disease.

The infection begins when a mosquito vector injects parasite particles (infectious stages) called **sporozoites**, present in the mosquito's saliva, into the bloodstream when it feeds on a human blood.

Malaria is a very serious disease characterized by ***severe chills, fever, sweating***, ***fatigue*** and ***great thirst***. Victims die of **anemia**, **kidney failure** or **brain damage**. The genus Plasmodium infects humans, and all have life cycles that involve the female anopheles mosquito.

It is the reproductive activity of the parasite within the human bloodstream that produces the characteristic recurrent attacks of the disease. The infection begins when a mosquito vector injects parasite particles (infectious stages) called sporozoites, present in the mosquito's saliva, into the bloodstream when it feeds on a human blood.

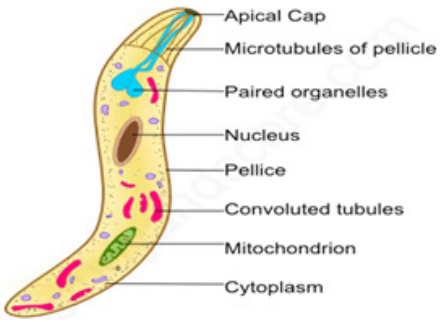


Figure 3.7: Structure of Sporozoite

These enter liver cells where they multiply by asexual reproduction for about 7 to 14 days (the incubation period of the disease) before producing daughter cells called merozoite, which invade red blood cells. The parasites multiply in the red cells, again by asexual reproduction, to produce between 8 and 16 merozoites every 48 or 72 hours, depending on the species of Plasmodium. These merozoites are released by the bursting of the infected red blood cells and the cycle is repeated.

The bursting of the red blood cells and the release of toxic substances cause the characteristic fever of malaria. After a number of such cycles, sexual stages, male and female gametocytes, are produced, and these are taken up by a feeding mosquito, in which the *Plasmodium* life cycle is completed by sexual reproduction, resulting in new sporozoites.

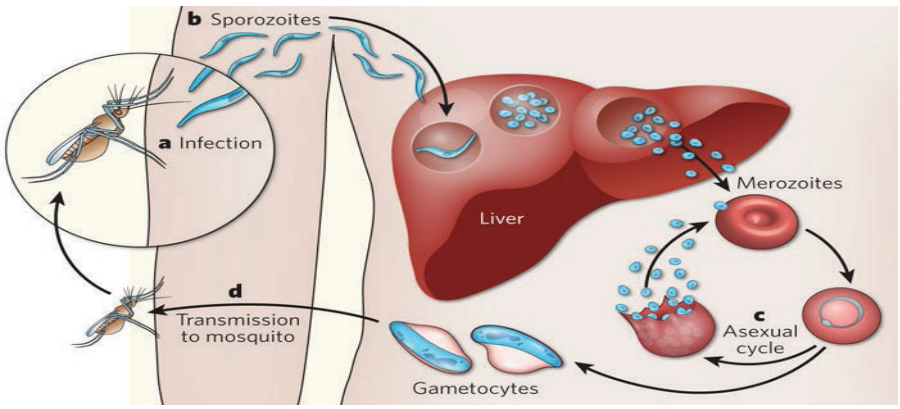


Figure 3.8: Life cycle of Plasmodium

Prevention of malaria is currently based on different methods:

- Drainage of stagnant water: The larval stages of the mosquito live in stagnant water, so drainage removes breeding sites. This has had some success.

- Destruction of the breeding sites of the mosquito: The larvae and pupae of mosquitoes obtain their oxygen by means of small tubes which are pushed through the water surface film. Thus any method of blocking these tubes will result in the death of the intermediate life stages of the mosquito (petrol, oil….)
- Destruction of the adult mosquitoes: This is aimed at killing the mosquitoes that enter houses. Thus, the indoor surfaces are sprayed with a persistent insecticide.
- Use of mosquito nets.

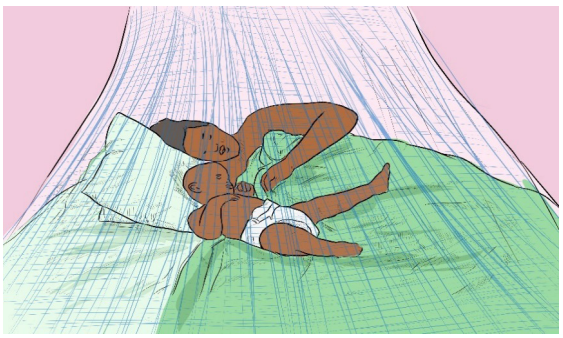


Figure 3.9: Sleeping under mosquito nets.

The disease now occurs in tropical and subtropical regions of the world, and its distribution is limited by conditions that are inimical to the development of the mosquito vector, such as temperature and altitude.

Malaria is endemic in tropics because:

- Tropical climate provides the best breeding and living conditions for the Anopheles mosquito which transmits malaria
- The Anopheles cycle requires areas of stagnant water and these are common within tropics
- In the tropical areas there is presence of bushes or abundant vegetation which makes suitable habitat for mosquitoes

Plasmodium needs temperature in excess of 20°C for it to complete its cycle within the mosquito.

Table 3.3: The features of malaria

Pathogen	*Plasmodium falciparum, P. vivax, P. malariae*
Methods of transmission	Insect vector: female anopheles mosquito
Global distribution	Throughout the tropics and subtropics (endemic in 106 countries)
Incubation period	From a week to a year
Site of action of pathogen	Liver, red blood cells, brain
Clinical features	Fever, anemia, nausea, headache, muscle pain, shivering, sweating, enlarged spleen.
Method of diagnosis	Microscopic examination of blood; dip stick test for malaria antigens in blood.

The common drugs used in treatment of malaria include the following: Chloroquine, Atovaquone-proguanil (Malarone), Artemether-lumefantrine (Coartem), Mefloquine, Quinine, Doxycycline (used in combination with quinine)

Failure to eradicate malaria induct to:

- There is no effective vaccine against malaria
- The pathogens are transmitted by mosquitoes which are not eradicated.
- The plasmodium have become resistant to different anti-malarial drugs
- Ignorance of some people toward the disease and how it is spread.

3.1.4. HIV/AIDS and other sexual transmission diseases (STD)

AIDS (Acquired Immune Deficiency Syndrome) is a disorder which damages the human body's immune system. It is caused by the HIV virus (Human Immunodeficiency Virus).

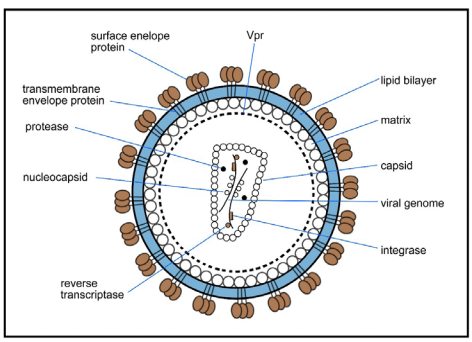


Figure 3.10: Structure of HIV

This is an RNA virus. The virus replicates inside the T4 lymphocytes or helper T cells. Thus these cells can no longer help or induce other T cells, called killer cells, to fight invaders. The body's immune system breaks down leaving the patient exposed to a variety of diseases called opportunistic infections. AIDS is not a disease; it is a collection of these opportunistic diseases associated with immunodeficiency caused by HIV infection. It is important to realize, however, that the infection with the HIV virus does not necessarily result in AIDS. As with other diseases, some people remain symptomless and are therefore called carriers.

The HIV virus can only survive in body fluids and is transmitted by blood or semen. In 90% of cases the transmission is achieved by sexual contact. People can contract the disease as follows:

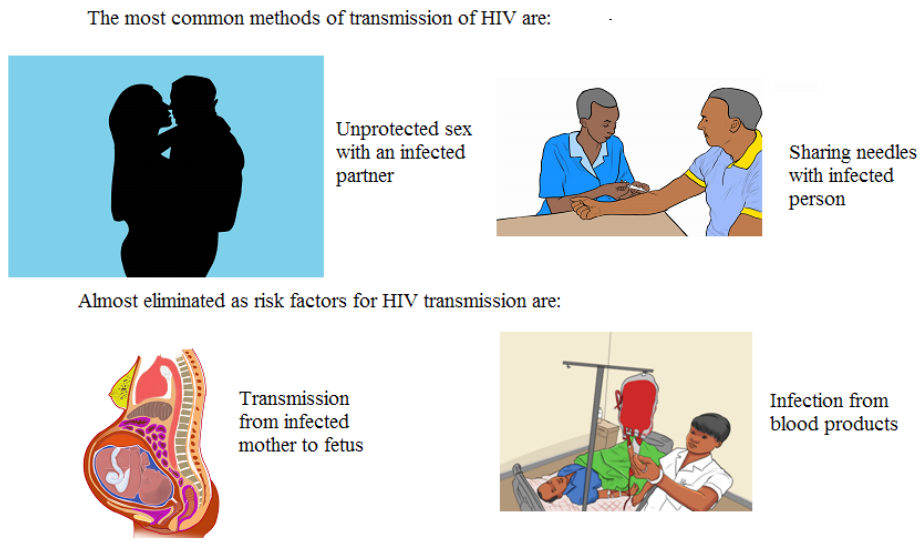


Figure 3.11: Modes of AIDS transmission

- Intimate sexual contact. The most frequent mode of transmission of HIV is through unprotected sexual contact with an infected person.
- Infected blood entering bloodstream: by means of unsterilized needles and syringes. Unfortunately the disease can be contracted after being given blood or blood products already infected with HIV. Close contact between infected and non-infected people through cuts and open wounds has also been known to pass on the virus.
- From mother to baby: An infected pregnant woman can pass on the virus to her baby through the placenta, at birth or through breast milk during suckling. The chances of infection being transmitted from the mother to her baby are currently estimated to be 25-50%.

A blood test is used to tell whether or not a person has been infected by the HIV virus. Under normal circumstances the immune system reacts to infection by producing antibodies and when the HIV virus enters the body, anti-HIV antibodies are produced. The blood of the person being tested is added to HIV proteins which have been commercially prepared. If there are anti-HIV antibodies in the blood sample they will bind to the viral proteins and the person is described as HIV positive. However, if the test proves negative that person may still be infected. This is because it takes up to three months or longer for HIV antibodies to be produced after infection.

There are many precautions which can be followed in trying to prevent the disease:

- Abstinence
- Fidelity or restriction to one sex partner and the absence of promiscuity will also clearly reduce the risk of infection.
- Use of a sheath or condom during intercourse can prevent the virus from infecting through blood or semen.
- A reduction in the spread of HIV can be brought about by the use of clean needles and syringes by drugs addicts.
- The blood donated should be tested for the presence of antibodies to HIV which indicates whether or not the donor is infected. Blood containing these antibodies is not used.
- Educating the people about the disease.
- Taking antiretroviral during pregnancy and delivery.
- To avoid breastfeeding and to administer antiretroviral drugs to the newborn.

Figure 3.12: illustrating a girl saying no to sex

Table 3.4: The features of HIV/AIDS

Pathogen	*Human immune deficiency virus*
Methods of transmission	In semen and vaginal fluids during sexual intercourse, infected blood or blood products, contaminated hypodermic syringes, mother to fetus across the placenta, at birth, mother to infant in breast milk
Global distribution	Worldwide, especially in sub-Saharan Africa and South-East Asia
Incubation period	Initial incubation a few weeks, but up to ten years or more before symptoms of AIDS may develop
Site of action of pathogen	T helper lymphocytes, macrophages, brain cells
Clinical features	HIV infection-flu-like symptoms and then symptomless AIDS-opportunistic infections including pneumonia, TB and cancers; weight loss, diarrhoea, fever, sweating, dementia.
Method of diagnosis	Testing blood, saliva or urine for the presence of antibodies produced against HIV.

Other sexual transmission diseases (STDs)

Sexually transmitted diseases (STDs), also referred to as sexually transmitted infections (STI) and venereal diseases (VD), are illnesses that have a significant probability of transmission between humans by means of unprotected sexual intercourse, including vaginal intercourse, anal sex and oral sex. Some STIs can also be contracted by using drug needles after their use by an infected person, as well as through any incident involving the contact of a wound with contaminated blood or through childbirth or breastfeeding.

Sexually transmitted infections have been well known for hundreds of years, and venereology is the branch of medicine that studies these diseases. While in the past, these illnesses have mostly been referred to as STDs or VD, the term *sexually transmitted infections* (*STIs*) has been preferred by many up-to-date medical sources, as it has a broader range of meaning; a person may be *infected*, and may potentially infect others, without having a *disease*.

There are 19 million new cases of sexually transmitted infections every year in the United States, and, in 2005, the World Health Organization estimated that 448 million people aged 15–49 were being infected a year with curable STIs (such as syphilis, gonorrhea and chlamydia).

Until the 1990s, STIs were commonly known as ***venereal diseases***, the word venereal being derived from the Latin word venereus, and meaning relating to sexual intercourse or desire, ultimately derived from Venus, the Roman goddess of love. *Social disease* was a phrase used as a euphemism.

While many people with STDs show no signs or symptoms of their infection, when there are signs of STDs they are most likely to be in the genital area. The genital area in women includes the vulva (the area around the vagina including the lips), vagina (the opening where menstrual blood comes out), buttocks, urethra (the opening above the vagina where urine comes out) and anus (the opening where a bowel movement comes out). The genital area in men includes the penis, scrotum ("balls"), urethra, and anus.

What are the symptoms of STDs?

Sometimes, there are no symptoms of STDs. If symptoms are present, they may include one or more of the following:

- Bumps, sores, or warts near the mouth, anus, penis, or vagina.
- Swelling or redness near the penis or vagina.
- Skin rash.
- Painful urination.
- Weight loss, loose stools, night sweats.
- Aches, pains, fever, and chills.
- Yellowing of the skin (jaundice).
- Discharge from the penis or vagina. (Vaginal discharge may have an odor.)
- Bleeding from the vagina other than during a monthly period.
- Painful sex.
- Severe itching near the penis or vagina.

Examples of these diseases are chlamydia, gonorrhoea, syphillis and, HIV and AIDS.

1. Chlamydia

Chlamydia is caused by the bacterium *Chlamydia trachomatis*.

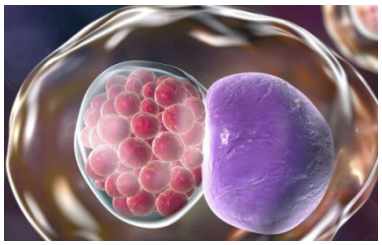


Figure 3.13: Chlamydia trachomatis

The disease is spread by oral, vaginal or anal sex, and also through touch, for example, touching the eyes with a contaminated hand, may lead to conjunctivitis. Chlamydia can also be passed to the infant during birth.

It causes inflammation of the cervix in women, urethra and rectum in both men and women. Occasionally, other parts of the body like eyelids and throat may be affected. Any sexually active person is at risk of contracting the disease. However, it is more common in young people.

The disease is known as a 'silent' infection because it is mainly asymptomatic, thus the symptoms can be mild or be confused with gonorrhea.

Signs and symptoms of chlamydia

In males

- Pain when passing out urine.
- White discharge from the penis.
- The testicles may be painful or swollen.
- Swelling of skin around the anus.

In females

- Painful and frequent urination.
- Smelly yellowish and abnormal vaginal discharge.
- Pain in the lower abdomen.
- Swollen skin in the vagina or around the anus.

Treatment

Chlamydia is easily treated using antibiotics usually Azithromycin or doxyclyne.

2. Gonorrhoea

Gonorrhoea is transmitted through sexual contact with the penis, vagina, mouth or anus of an infected partner. Gonorrhoea can also be spread from mother to baby during childbirth. Gonorrhoea is caused by a bacterium called *Neisseria gonorrhoeae*.

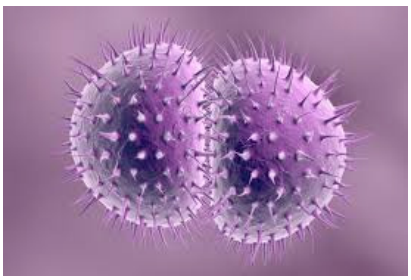


Figure 3.14: Neisseria gonorrhoeae

The bacteria attaches on the epithelial cells of the vagina or male urethra. This results in inflammation and discharge of pus. If left untreated, the infection spreads to the other reproductive parts and may eventually block the passages resulting to infertility.

Signs and symptoms of gonorrhea.

Some men with gonorrhea may have no symptoms at all. However, men who do have symptoms may have:

- A burning sensation when urinating.
- A white, yellow, or green discharge from the penis.
- Painful or swollen testicles (although this is less common).

Most women with gonorrhea do not have any symptoms. Even when a woman has symptoms, they are often mild and can be mistaken for a bladder or vaginal infection.

Women with gonorrhea are at risk of developing serious complications from the infection, even if they do not have any symptoms.

Symptoms in women can include:

- Painful or burning sensation when urinating.
- Increased vaginal discharge.
- Vaginal bleeding between periods

Treatment

Gonorrhea can be treated using antibiotics like penicillin.

3. Syphilis

Syphilis is transmitted from person to person by direct contact with a syphilitic sore, known as a chancre. Chancres occur mainly on the external genitals, vagina, anus or in the rectum. Chancres also can occur on the lips and in the mouth. Transmission of syphilis occurs during vaginal, anal or oral sex. Syphilis is caused by bacteria called *Treponema pallidum*.

Figure 3.15: Treponema pallidum

The bacterial infection progresses through several stages:

- In the primary stage, small hard painless sores develop at the site of infection usually the penis and the vagina.
- The disease enters secondary stage several weeks later characterized by rashes on the skin and mild fever. These symptoms subside after a few weeks followed by a latent asymptomatic period.
- In the tertiary stage, lesions develop and cause extensive tissue damage that may lead to paralysis, insanity, blindness and eventually death.

Treatment

Antibiotics like penicillin, erythromycin or tetracycline are used to treat syphilis although some strains can be resistant to certain antibiotics.

The following are general ways of reducing STDs and HIV infection:

- Abstinence is the only sure way to prevent STDs.
- Being faithful to one trusted partner.
- Using condoms every time when engaging in sexual intercourse. Condoms are not 100% effective at preventing disease or pregnancy. However, they are extremely effective if used properly.
- Reduce the number of sexual partners.
- Avoid sharing towels or underclothing.
- Get a vaccination for hepatitis B.

- Get tested for HIV.
- Avoiding alcohol consumption and abuse of drugs. Individuals who are drunk or on drugs often fail to have safe sex.

Table 3.5: Summary of sexual transmitted infections

STI	Causative agent	Symptoms
Chlamydia	Bacterium called *Chlamydia trachomatis*	Most women have no symptoms. Women with symptoms may have: – Abnormal vaginal discharge – Burning when urinating – Bleeding between periods Infections that are not treated, even if there are no symptoms, can lead to: – Lower abdominal pain – Low back pain – Nausea – Fever – Pain during sex
Genital herpes	Herpes simplex virus type 2 (HSV-2)	Some people may have no symptoms. During an "outbreak," the symptoms are clear: – Small red bumps, blisters, or open sores where the virus entered the body, such as on the penis, vagina, or mouth – Vaginal discharge – Fever – Headache – Muscle aches – Pain when urinating – Itching, burning, or swollen glands in genital area – Pain in legs, buttocks, or genital area Symptoms may go away and then come back. Sores heal after 2 to 4 weeks.

STI	Causative agent	Symptoms
Gonorrhea	Bacterium called *Neisseria gonorrhoea*	Symptoms are often mild, but most women have no symptoms. If symptoms are present, they most often appear within 10 days of becoming infected. Symptoms are: – Pain or burning when urinating – Yellowish and sometimes bloody vaginal discharge – Bleeding between periods – Pain during sex – Heavy bleeding during periods Infection that occurs in the throat, eye, or anus also might have symptoms in these parts of the body.
AIDS	Retrovirus called HIV	Some women may have no symptoms for 10 years or more. About half of people with HIV get flu-like symptoms about 3 to 6 weeks after becoming infected. Symptoms people can have for months or even years before the onset of AIDS include: – Fevers and night sweats – Feeling very tired – Quick weight loss – Headache – Enlarged lymph nodes – Diarrhoea, vomiting, and upset stomach – Mouth, genital, or anal sores – Dry cough – Rash or flaky skin – Short-term memory loss
Syphilis	Bacterium called *Treponema pallidum*	Syphilis progresses in stages. Symptoms of the primary stage are: – A single, painless sore appearing 10 to 90 days after infection. It can appear in the genital area, mouth, or other parts of the body. The sore goes away on its own.

STI	Causative agent	Symptoms
		If the infection is not treated, it moves to the secondary stage. This stage starts 3 to 6 weeks after the sore appears. Symptoms of the secondary stage are: – Skin rash with rough, red or reddish-brown spots on the hands and feet that usually does not itch and clears on its own – Fever – Sore throat and swollen glands – Patchy hair loss – Headaches and muscle aches – Weight loss – Tiredness
Trichomoniasis	Protozoan called *Trichomonas vaginalis*	Many women do not have symptoms. Symptoms usually appear 5 to 28 days after exposure and can include: – Yellow, green, or gray vaginal discharge (often foamy) with a strong odor – Discomfort during sex and when urinating – Itching or discomfort in the genital area – Lower abdominal pain (rarely)
Candidiasis	Fungus called *Candida albicans*	Severe irritation, extreme itching in the vaginal area, soreness and redness in the vaginal area, painful intercourse in females. In men the symptoms include: red rash on penis, itching or burning on the tip of the penis.
Chancroid	Coccobacilusbacteria. Called *Haemophilus ducreyi*	Symptoms may include genital sores, vaginal discharge, a burning feeling when urinating, and swollen lymph nodes in the groin. It can be spread by vaginal or anal sex or skin-to-skin contact with sores. Chancroid can be treated with antibiotics.

APPLICATION ACTIVITY 3.1

A national surveillance officer informed you about the detection of an infectious disease outbreak of unknown origin in a forested area that has caused the death of three people and left 14 seriously ill. Initial symptoms include sudden high fever, asthenia, headache, pharyngitis, profuse vomiting, diarrhea and loss of appetite. Clinical findings that occur after about four days include unexplained bleeding, hypovolemia, renal failure, encephalopathy and multisystem organ failure. Most of those who died did so within 1-2 weeks of onset of symptoms. One patient who died tested positive for malaria. A team of infectious disease epidemiologists is currently in the field for investigation. Blood samples have been sent to the National Laboratory for confirmation but results are still pending.

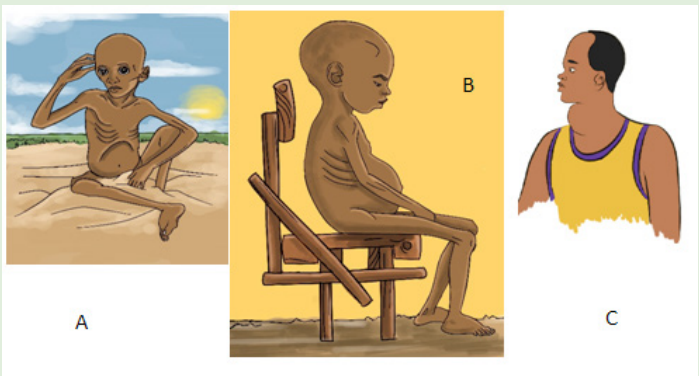
a) Identify three suspected diseases.

b) Suggest preventive measures to the suspected diseases while waiting for the laboratory results.

3.2. Deficiency diseases

ACTIVITY 3.2

Observe carefully the figures below and answer the questions that follow:



a) The figures above show people suffering from diseases. Based on your observation, what type of disease are they suffering from?

b) Name diseases in figure A, B and C. What are the cause, the signs and symptoms, and preventive measures of the mentioned diseases?

Deficiency diseases are diseases that are caused by a dietary deficiency of specific nutrients, especially a vitamin or mineral, possibly stemming from insufficient intake, digestion, absorption, or utilization of a nutrient. The examples of common deficiency diseases are Kwashiorkor, Marasmus, Vitamin deficiencies.

3.2.1. Kwashiorkor

Kwashiorkor is a form of severe protein malnutrition characterized by edema, and an enlarged liver with fatty infiltrates.

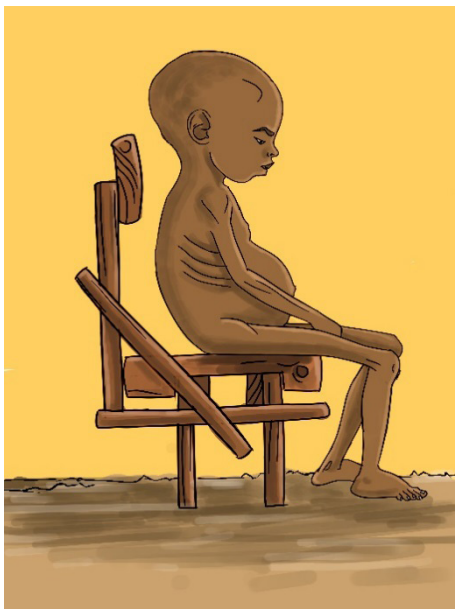


Figure 3.16: Child suffering from kwashiorkor picture adapted from

The following are well defined symptoms and signs of kwashiorkor:

- Pitting oedema (swelling of the ankles and feet).
- Distended abdomen,
- An enlarged liver with fatty infiltrates,
- Thinning of hair,
- Loss of teeth,
- Skin depigmentation and dermatitis.

Children suffering from kwashiorkor often develop irritability and anorexia.

The person should be given small but frequent rations in every two to four hours. During the first week, he or she must be given a diet high in sugar and enriched in protein as well as essential elements: sweet milk with mineral salts

and vitamins. The diet may include lactases so that children who have developed lactose intolerance can ingest dairy products and antibiotics to compensate for immunodeficiency.

After two to three weeks, the milk is replaced by boiled cereals fortified with minerals and vitamins until the person's mass is at least 80% of normal weight.

Generally, kwashiorkor can be treated by adding protein to the diet; however, it can have a long-term impact on a child's physical and mental development, and in severe cases may lead to death

3.2.2. Marasmus

Marasmus is a form of severe malnutrition. It usually occurs in children. It typically occurs in developing countries. Marasmus can be life-threatening, but you can get treatment for it.

Nutrient deficiency is the main cause of marasmus. It occurs in children that do not eat enough protein, calories, carbohydrates, and other important nutrients. This is usually due to poverty and a scarcity of food.

In children with marasmus, the following are symptoms: chronic diarrhoea, respiratory infections, intellectual disability, being underweight, stunted growth, subcutaneous fat is the layer of fat just under the skin, dry skin and brittle hair, children may look older and children are short-tempered and irritable

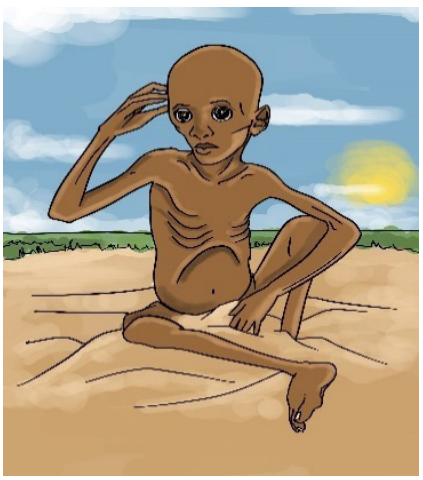


Figure 3.17: Child suffering from marasmus

3.2.3. Other deficiency diseases

1. Goitre

The goitre is the swelling in the neck caused by lack of inadequate iodine in the diet the pregnant mother

Goitre is prevented through getting enough iodine by using iodized salt or eating seafood or seaweed and avoids excess iodine consumption. Treatment involves getting the thyroid hormone level back to normal, usually with medication. However, a large nodular goitre with a lot of internal scar tissue will not shrink with treatment. When the goitre is uncomfortable, and causes overproduction of thyroid hormone unresponsive to meditations, the entire grand thyroid may have to be surgically removed be

2. Anaemia

The disease is due to lack of an adequate Iron mineral in the diet. The iron is essential for formation of haemoglobin pigment of blood contained by red blood cells. If haemoglobin is not formed due to lack of iron, the oxygen will not be transported into the body; hence the person with anaemia becomes tired easily and has little energy to do a given work due to inadequate oxygen in the body.

- Iron-deficiency varies depending on the severity of the anaemia, how quick it develops your age and current state of health. In some cases, people experience no symptoms. The most symptoms are:
- Filling weak and tired quickly, this happens because your body needs iron to make a protein called haemoglobin, which is found in red blood cells. Indeed, less oxygen reach your tissues and muscles (Shortness of breath), depriving them of energy alongside weakness, feeling cranky, difficulty concentrating or poor productivity at work. The heart also has to work harder to move oxygen-rich blood around your body, which can make tired.
- Paleness : pale skin and pale colouring of the inside of the lower eyelids and tongue looks pale , because the haemoglobin in red blood cells gives blood its red colour , so low levels during iron deficiency make the blood less red. This paleness can appear all over the body, or it can be limited to one area eg. face, gums, inside of the lips or lower eyelids and eve nails.

Anaemia is prevented through:

- Regular taking lots of leafy vegetables to provide iron
- Eat food with plenty of calcium and vitamin D

3.2.4. Vitamin deficiencies

1. Scurvy

Figure 3.18: Scurvy

Scurvy happens when there is a lack of vitamin C, or ascorbic acid. The deficiency leads to symptoms of weakness, anemia, gum disease, and skin problems.

This is because vitamin C is needed for making collagen, an important component in connective tissues. Connective tissues are essential for structure and support in the body, including the structure of blood vessels. A lack of vitamin C will also affect the immune system, absorption of iron, metabolism of cholesterol and other functions.

Signs and Symptoms

Symptoms of vitamin C deficiency can start to appear after 8 to 12 weeks. Early signs include a loss of appetite, weight loss, fatigue, irritability, and lethargy.

Within 1 to 3months, there may be signs of:

- Anemia
- Myalgia, or pain, including bone pain
- Swelling, or edema
- Petechiae, or small red spots resulting from bleeding under the skin
- Corkscrew hairs
- Gum disease and loss of teeth
- Poor wound healing
- Shortness of breath
- Mood changes, and depression

The treatment involves administering vitamin C supplements by mouth or by injection.

The recommended dosage is:

- 1 to 2 grams (g) per day for 2 to 3 days
- 500 milligrams (mg) for the next 7 days
- 100 mg for 1 to 3 months

Within 24 hours, patients can expect to see an improvement in fatigue, lethargy, pain, anorexia, and confusion. Bruising, bleeding, and weakness start to resolve within 1 to 2 weeks.

After 3 months, a complete recovery is possible. Long-term effects are unlikely, except in the case of severe dental damage.

Scurvy can be prevented by consuming enough vitamin C, preferably in the diet, but sometimes as a supplement. During pregnancy, women should consume 85 mg of vitamin C, rising to 120 mg while breastfeeding. Smokers need 35 mg more than non-smokers every day.

2. Rickets

Figure 3.19: Rickets

Rickets is a skeletal disorder that's caused by a lack of vitamin D, calcium, or phosphate which are nutrients important for the development of strong, healthy bones. The sufferer of rickets may have weak and soft bones, stunted growth, and, in severe cases, skeletal deformities.

The symptoms of rickets include:

- Pain or tenderness in the bones of the arms, legs, pelvis, or spine
- Stunted growth and short stature
- Bone fractures
- Muscle cramps
- Teeth deformities, such as: delayed tooth formation, holes in the enamel, abscesses, defects in the tooth structure, an increased number of cavities

- skeletal deformities, including: an oddly shaped skull, bowlegs, or legs that bow out, bumps in the ribcage, a protruding breastbone, a curved spine, pelvic deformities

Treatment for rickets focuses on replacing the missing vitamin or mineral in the body. This will eliminate most of the symptoms associated with rickets. The exposure to sunlight, if possible is recommended. To consume food products high in vitamin D, such as fish, liver, milk, and eggs is also necessary.

If skeletal deformities are present, the child may need braces to position their bones correctly as they grow. In severe cases, the child may need corrective surgery.

For hereditary rickets, a combination of phosphate supplements and high levels of a special form of vitamin D are required to treat the disease.

The best way to prevent rickets is to eat a diet that includes adequate amounts of calcium, phosphorous, and vitamin D. People with kidney disorders should have their calcium and phosphate levels monitored on a regular basis by their doctors.

Rickets can also be prevented with moderate sun exposure. We need to expose the hands and face to sunlight a few times a week during the spring and summer months to prevent rickets.

3. Beriberi

Beriberi is a disease caused by a vitamin B-1 deficiency, also known as thiamine deficiency. There are two types of the disease: wet beriberi and dry beriberi. Wet beriberi affects the heart and circulatory system. In extreme cases, wet beriberi can cause heart failure.

Dry beriberi damages the nerves and can lead to decreased muscle strength and eventually, muscle paralysis. Beriberi can be life-threatening if it isn't treated.

Today, beriberi mostly occurs in people with an alcohol use disorder. Still, the disease can be seen in women who have extreme nausea and vomiting in pregnancy, in people with AIDS, and after bariatric surgery.

The symptoms of beriberi vary depending on the type. Wet beriberi symptoms include:

- Shortness of breath during physical activity
- Waking up short of breath
- Rapid heart rate
- Swollen lower legs

Dry beriberi symptoms include:

- Decreased muscle function, particularly in the lower legs
- Tingling or loss of feeling in the feet and hands
- Pain
- Mental confusion
- Difficulty speaking
- Vomiting
- Involuntary eye movement
- Paralysis

Beriberi is easily treated with thiamine supplements. Doctor may prescribe a thiamine shot or pill. For severe cases, a healthcare professional will administer intravenous thiamine.

To prevent beriberi, eat a healthy, balanced diet that includes foods rich in thiamine. These include: beans and legumes, seeds, meat, fish, whole grains, nuts, dairy, certain vegetables, such as asparagus, acorn squash, Brussels sprouts, spinach, and beet greens and breakfast cereals that are enriched with thiamine

Cooking or processing any of the foods listed above decreases their thiamine content.

Always be sure to purchase infant formula from a reliable source.

Limiting alcohol consumption will reduce your risk of developing beriberi

4. Pellagra

Pellagra is a disease caused by low levels of niacin, also known as vitamin B-3. It's marked by dementia, diarrhea, and dermatitis, also known as "the three Ds". If left untreated, pellagra can be fatal.

The main symptoms of pellagra are dermatitis, dementia, and diarrhea. Dermatitis related to pellagra usually causes a rash on the face, lips, feet, or hands. In some people, dermatitis forms around the neck.

Additional dermatitis symptoms include:

- Red, flaky skin
- Areas of discoloration, ranging from red to brown
- Thick, crusty, scaly, or cracked skin
- Itchy, burning patches of skin

As the disease progresses, possible dementia symptoms include: apathy, depression, confusion, irritability, or mood changes, headaches, restlessness or anxiety, disorientation or delusions

Other possible pellagra symptoms include: sores on the lips, tongue, or gums, decreased appetite, trouble eating and drinking, nausea and vomiting

There are two types of pellagra, known as primary pellagra and secondary pellagra. Primary pellagra is caused by diets low in niacin or tryptophan. Tryptophan can be converted to niacin in the body, so not getting enough can cause niacin deficiency. Secondary pellagra occurs when your body can't absorb niacin.

There are things that can prevent from absorbing niacin like: alcoholism, eating disorders, certain medications, including anti-convulsants and immunosuppressive drugs, gastrointestinal diseases, such as ulcerative colitis, cirrhosis of the liver, carcinoid tumors, Hartnup disease

Primary pellagra can be treated by dietary changes and a niacin or nicotinamide supplement. Nicotinamide is another form of vitamin B3. If left untreated, primary pellagra usually causes death after four or five years. Treating secondary pellagra usually focuses on treating the underlying cause. However, some cases of secondary pellagra also respond well to taking niacin or nicotinamide either orally or intravenously.

5. Night blindness

This is a disease caused by lack of Vitamin A in the diet. The main sources of vitamin A are green leafy vegetables, liver, egg yolk and milk products.

Figure 3.20: Sources of Vitamin A

It leads to inability of seeing during night

It is prevented through providing diet with a plenty of vitamin A

3.2.5. Worm diseases

In our country, even in other African country many people suffer from worm diseases. There are many worms that can infest people due to poor sanitation. Worms causing infection in people are parasites that live and breed mostly in the intestine. Infection is caused by worms such as roundworms, hookworms and tapeworms.

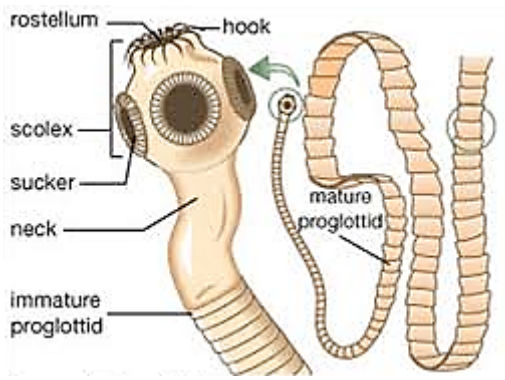


Figure 3.21: Tapeworm structure

1. Ascariasis

Ascariasis is most common in places without modern sanitation. People get the parasite through unsafe food and water. The infection usually causes no symptoms, but a high number of roundworms (heavier infestations) can lead to problems in the lungs or intestines.Causes an ascariasis infection

You can become infected with ascariasis after accidentally ingesting the eggs of the *Ascaris lumbricoides* roundworm. The eggs can be found in soil contaminated by human feces or uncooked food contaminated by soil that contains roundworm eggs.

Figure 3.22: structure of Ascaris lumbricoides worm

Children often become infected when they put their hands in their mouths after playing in contaminated soil, even it can also be passed directly from person to person.

People with ascariasis often have no symptoms. Symptoms become more noticeable when the roundworm infestation grows.

Roundworms in your lungs can cause: coughing or gagging, wheezing or shortness of breath, aspiration pneumonia (rarely), blood in mucus, chest discomfort and fever.

Roundworms in your intestines can cause: nausea, vomiting, irregular stools or diarrhea, intestinal blockage, which causes severe pain and vomiting, loss of appetite, visible worms in the stool, abdominal discomfort or pain, weight loss and growth impairment in children due to malabsorption.

Life cycle of the roundworm

After ingestion, the *A. lumbricoides* roundworm reproduces inside your intestine. The worm goes through several stages:

- Swallowed eggs first hatch in the intestine.
- The larvae then move through the bloodstream to your lungs.
- After maturing, the roundworms leave your lungs and travel to your throat.
- You'll either cough up or swallow the roundworms in your throat. The worms that are swallowed will travel back to your intestine.
- Once they're back in your intestine, the worms will mate and lay more eggs.
- The cycle continues. Some eggs are excreted through your feces. Other eggs hatch and return to the lungs.

Environmental risk factors for ascariasis include:

- Lack of modern hygiene and sanitation infrastructure.
- Use of human feces for fertilizer.
- Living in or visiting a tropical or subtropical climate.
- Exposure to an environment where dirt might be ingested.

It's important to:

- Always wash your hands with soap and water before eating or preparing food.
- Boil or filter your water.

- Inspect food preparation facilities.
- Avoid unclean common areas for bathing.
- Peel or cook unwashed vegetables and fruit in regions that lack sanitation infrastructure or that use human feces for fertilizer.

Dangerous complications, including:

- **Intestinal blockage:** Intestinal blockage occurs when a mass of worms blocks your intestines, causing severe pain and vomiting. Intestinal blockage is considered a medical emergency and requires treatment right away.
- **Duct blockage:** Duct blockage occurs when the worms block the small passageways to your liver or pancreas.
- **Nutritional deficiency:** Infections that lead to loss of appetite and poor absorption of nutrients put children at risk of not getting enough nutrients, which can affect their growth.

Children are more likely to have gastrointestinal complications because the smaller size of their intestines increases their chances of having an intestinal blockage.

Treatments of ascariasis

Doctors usually treat roundworm with antiparasitic drugs. Medications most commonly used include:

- Albendazole (Albenza)
- Ivermectin (Stromectol)
- Mebendazole (Vermox)

2. Schistosomiasis

This disease is also known as snail fever and bilharzia, is a disease caused by parasitic flatworms called schistosomes.The urinary tract or the intestines may be infected.

Symptoms include abdominal pain, diarrhea, bloody stool, or blood in the urine. Those who have been infected for a long time may experience liver damage, kidney failure, infertility, or bladder cancer. In children, it may cause poor growth and learning difficulty

Infected individuals release *Schistosoma* eggs into water via their fecal material or urine. After larvae hatch from these eggs, the larvae infect a very specific type of freshwater snail (Vector of the disease). The *Schistosoma* larvae undergo the next phase of their life cycles in these snails, spending their time reproducing

and developing. Once this step has been completed, the parasite leaves the snail and enters the water column. The parasite can live in the water for only 48 hours without a human host. Once a host has been found, the worm enters its blood vessels. For several weeks, the worm remains in the vessels, continuing its development into its adult phase. When maturity is reached, mating occurs and eggs are produced. Eggs enter the bladder/intestine and are excreted through urine and feces and the process repeats. If the eggs do not get excreted, they can become engrained in the body tissues and cause a variety of problems such as immune reactions and organ damage.

Humans encounter larvae of the *Schistosoma* parasite when they enter contaminated water while bathing, playing, swimming, washing, fishing, or walking through the water.

The disease is prevented through:

- Avoiding drinking or coming into contact with contaminated water in areas where schistosomiasis is common.
- Increasing access to clean water and sanitation
- Snail control
- Health education.

There are two drugs available, praziquantel and oxamniquine for the treatment of schistosomiasis. They are considered equivalent in relation to efficacy against *S. mansoni* and safety. Because of praziquantel's lower cost per treatment, and oxaminiquine's lack of efficacy against the urogenital form of the disease caused by *S. haematobium*, in general praziquantel is considered the first option for treatment. Schistosomiasis is treatable by taking by mouth a single dose of the drug praziquantel annually.

3. Elephantiasis lymphatic filariasis

Figure 3.23: swelling and thickening of skin

Elephantiasis, also known as Lymphatic filariasis, is a human disease caused by parasitic worms known as filarial worms. Most cases of the disease have no symptoms. Some people, however, develop a syndrome called elephantiasis, which is marked by severe swelling in the arms, legs, breasts or genitals. The skin may become thicker as well, and the condition may become painful.

The worms are spread by the bites of infected mosquitoes. Three types of worms are known to cause the disease: Wuchereria bancrofti, Brugia malayi and Bruggia timori with Wuchereria bancrofti being the most common. These worms damage the lymphatic system. The disease is diagnosed by microscopic examination of blood collected during the night. The blood is typically examined as a smear after being stained with Giesma stain.

Figure 3.24: Wuchereria bancrofti

Table 3.5: The features of Elephantiasis

Symptoms	None, severe swelling of the arms, legs, or genitals
Causes	Filarial worms
Vector	Mosquitos
Prevention	Bed nets, mass deworming
Diagnostic method	Microscopic examination of blood
Treatment	Albendazole with ivermectin or diethylcarbamazine

4. Ankilostomiasis

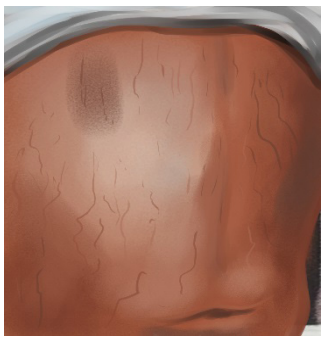


Figure 3.25: Victim of ankilostomiasis

Ankilostomiasis is a hookworm disease caused by infection with Ancylostoma hookworms. Ankilostomiasis is caused when hookworms, present in large numbers, produce an iron deficiency anemia by sucking blood from the host's intestinal walls.

Depending on the organism, the signs and symptoms vary. *Ancylostoma duodenale* and *Necator americanus* can enter the blood stream while Ancylostoma braziliensis cannot.

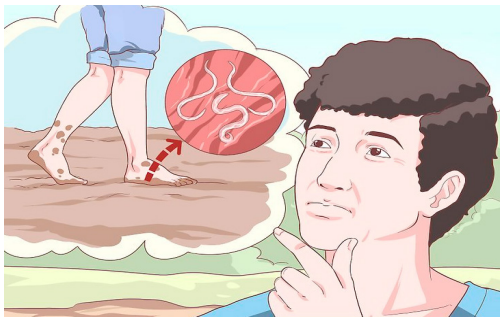


Figure 3.26: One way of hookworm infection

The infection is usually contracted by people walking barefoot over contaminated soil. In penetrating the skin, the larvae may cause an allergic reaction. It is due to the itchy patch at the site of entry that the early infection gets its nickname "ground itch". Once larvae have broken through the skin, they enter the bloodstream and are carried to the lungs (however, unlike ascaris, hookworms do not usually cause pneumonia). The larvae migrate from the lungs up the windpipe to be swallowed and carried back down to the intestine. If humans come into contact with larvae of the dog hookworm or the cat hookworm, or of certain other hookworms that do not infect humans, the larvae may penetrate the skin. Sometimes, the larvae are unable to complete their migratory cycle in humans. Instead, the larvae migrate just below the skin producing snake-like markings.

It is prevented through:

- Control of this parasite should be directed against reducing the level of environmental contamination.
- Treatment of heavily infected individuals is one way to reduce the source of contamination.
- improve access to sanitation, e.g. toilets
- Wearing shoes when you walk outdoors, especially in areas that might have feces in the soil
- Drinking safe water

- Properly cleaning and cooking food
- Practicing proper hand washing

The drug of choice for the treatment of hookworm disease is mebendazole which is effective against both species, and in addition, will remove the intestinal worm Ascaris also, if present. The drug is very efficient, requiring only a single dose and is inexpensive.

An infection of *N. americanus* parasites can be treated by using benzimidazoles, albendazole and mebendazole.

APPLICATION ACTIVITY 3.2

The table shows the number of cases of marasmus and deaths from the disease for the five countries as reported by the WHO in 2010.

Country	**Region**	**Total number of cases**	**Number of deaths**	**Case fatality rate %**
Haiti	Caribbean	179 379	3 990	
Cameroon	West Africa	10 759	657	6.10
Nigeria		44 455	1 712	3.85
Democratic Republic of Congo		13 884	182	1.31
Papua New Guinea	Australasia	8 997	95	1.06
Total	All regions of the world	317 534	7 543	2.38

a) With reference to the table:
   i) Calculate the case of fatality rate for Haiti in 2010.
   ii) Suggest why the case of fatality for rate varies between countries.
   iii) Explain why it is important for the WHO to collect data on marasmus.
   iv) Describe the causes of marasmus.

b) Explain why there is no marasmus in highly economically developed countries such as Australia, Malaysia and USA

3.3. Hygiene practices and their importance

ACTIVITY 3.3

A student had an exam and then he waked up early in the morning without practicing the morning hygiene and went to school. When he/she arrived at school, the teacher sent him/her back to do the morning hygiene. Discuss the possible hygiene practices that the student was supposed to do.

It is important to understand family health issues, because poor personal and environmental hygiene may cause hygiene related diseases. It is therefore important to acquire knowledge and skills on personal and environmental hygiene in order to avoid such diseases.

3.3.1. Personal hygiene

Personal hygiene and sanitation is very important because:

- It insures proper growth and development of children.
- It helps to prevent diseases especially hygiene related diseases.
- It prevents bad smell; it helps to keep the environment clean, tidy and beautiful.
- It makes the environment appealing and attractive.

The personal hygiene may be maintained through the hygiene practices below:

- Washing the body regularly with clean water and soap.
- Wearing clean clothes.
- Living in clean environment with adequate fresh air.
- Eating adequate balanced diet. Young children should be fed between 5 to 6 times per day. Their diet should be rich in proteins.
- Having regular exercises.

Care of the feet

- Washing the feet regularly with water and soap.
- Keeping the feet dry to avoid fungi or foot rot and bad smell.
- Wearing clean socks.
- Avoid sharing socks.
- Keep nails short and clean.

- Airing your feet daily.
- Apply some oil like Vaseline to keep the feet smooth.

Care of hands

- Wash hands regularly with clean water and soap.
- Keep nails short and clean.
- Wash hand before touching and preparing the food
- Wash hand before eating.
- Wash hand after visiting the toilet.
- Apply some oil like Vaseline to keep the hands smooth.

Care of hair

- Wash your head regularly with clean water and soap.
- Keep your hair well combed.
- Oil your hair to prevent dandruff.

Care of teeth

- Brush your teeth daily with a tooth brush, clean water and tooth paste.
- Avoid eating too many sweets, biscuits and sugary foods, as they can cause tooth decay and dental cavities.
- Eating foods that help build strong teeth like milk, eggs, vegetables, fruits and fish.
- To visit dentist regularly for checkups.
- To avoid putting sharp dirty objects in the mouth.
- Pregnant mothers should feed on dies rich in Calcium which is used to make teeth.

Care of the eyes

- Wash eyes with clean water.
- Protect your eyes from foreign objects and dusts.
- Protect your eyes from too much or too low light. You always read under adequate light.

Care for ears

- Wash ears with clean water and soap.
- Never insert hard objects in the ear, this may damage your ear and cause deafness.

- Avoid very loud noise.
- Clean ears with cotton around a matchstick or use ear buds and use it gently.

Care for the nose

- Never insert hard objects in the nose.
- Keep the nose clean by blowing it regularly.
- Avoid being hit in the nose.

3.3.2. Environmental hygiene

Our surrounding environment including water, air and soil should be protected and kept clean. There should be different hygiene practices to prevent soil pollution, water pollution and air pollution.

Public health system across nations is a conglomeration of all organized activities that prevent disease, prolong life and promote health and efficiency of its people. The overall vision is to promote greater health and well-being in a sustainable way, while strengthening integrated public health services and reducing inequalities. In order to achieve this vision, the public health approach involves working with other sectors to address the wider determinants of health, and with health professionals.

APPLICATION ACTIVITY 3.3

Nursery kids wants to make their personal body hygiene, suggest the possible hygiene activities and materials required. Demonstrate how he/she can care for eyes, nose, feet, hands and teeth.

3.4. Human immune system

ACTIVITY 3.4

Case study

Mr. NDABISHOBOYE was 20 years muscular and handsome boy. His weight was 70 Kg and his height 1.70 m. He could carry 100Kg on his head for a distance of 1Km. He never got tired.

Mr. NDABISHOBOYE could drink muddy water and eat remains of food picked from the garbage with no fear. He never accepted to sleep under mosquito net because he said he was too strong as indicates his name.

One day, Mr. NDABISHOBOYE was found admitted to the hospital with Typhoid and wound infected with tetanus. Mr. NDABISHOBOYE attributed his sickness to the witchcraft and argued "I used to live my life without a single problem" – he said.

a) According to you, what is the causal agent of the sickness of Mr. NDABISHOBOYE

b) Read the note below and find explanation to the questions below:

i). Why Mr. NDABISHOBOYE never got any health problem before?

ii). Why Mr. NDABISHOBOYE now became sick?

iii). How could he prevent the tetanus?

Immunity is a process by which the body of a living organism defends itself against pathogens.

The immune system is a protective system that is made of a series of defenses that fight against diseases by: recognizing, attacking, destroying and remembering each type of pathogen that enters the body. It does this by producing specialized cells which inactivate pathogens.

Defense mechanisms against infections

The immune system includes two general categories of defense mechanisms against infections: **non-specific defense and specific defense**

3.4.1. Nonspecific defences

They include physical barriers (skin) and chemical barriers (mucus, tears and sweat) which prevent foreign pathogens from entering the body. Nonspecific defenses occur into two lines of defense:

a) **First line of defense**: its function is to keep pathogen out of the body. This role is carried out by: the skin, sweat, tears and mucus. The most important nonspecific defense is the skin. The skin epidermis consists of layers of dead cells called keratinocytes (which have been keratinized: their cytoplasm is replaced by a protein called keratin). The keratinized layers of dead cells act as an effective barrier to pathogens and cannot normally be penetrated by bacteria or viruses.

   Likewise, the mucous that line the digestive, respiratory, nose and genitals block the entry of harmful microbes. Beyond their role as a physical barrier, the skin and mucous membranes counter pathogens with chemical defenses. For example, secretions from sebaceous and sweat glands give the skin an acidic PH ranging from3 to 5, which kills bacteria. Many secretions of the body including: tears, mucus and saliva contain lysozyme, an anti-microbial enzyme that breaks the walls of bacteria. Also, stomach acid and digestive enzymes destroy many pathogens which are swallowed with the food.

b) **The second line of defense**: Microbes which have managed to penetrate the first line of defense face the second line of defense which depends mainly on phagocytosis, inflammatory response and on certain antimicrobial proteins.

i) Phagocytosis

When pathogens are detected in the body, the immune system produces millions of white blood cells which fight the infection. Many of the white blood cells are phagocytes, which engulf and destroy bacteria.

Thus phagocytes are cells that engulf and destroy pathogens.

There are two types of phagocytes:

- Neutrophils are the common phagocytes produced in bone marrow and carried in blood to be released in tissue fluid. They will be released in large number as a result of infection.

  The phagocytic cells called neutrophils constitute about 60 % to 70% of all white blood cells (leucocytes). The neutrophils enter the infected tissue, engulfing and destroying microbes there.

- Macrophages are large cells manufactured in bone morrow and travel in blood as monocytes. They tend to be settle in lymph nodes, liver and in spleen.

How phagocytes work

When pathogens enter the body, phagocytes move towards them, they engulf and destroy them. Once the phagocyte is bound to the pathogen, it will envelop it by folding its membrane inwards. The pathogen is trapped inside the vacuole called phagosome. Lysosomes fuse with the phagosome and release enzymes called lysins into it. These enzymes digest pathogens and the end products are harmless nutrients that can be absorbed into the cytoplasm.

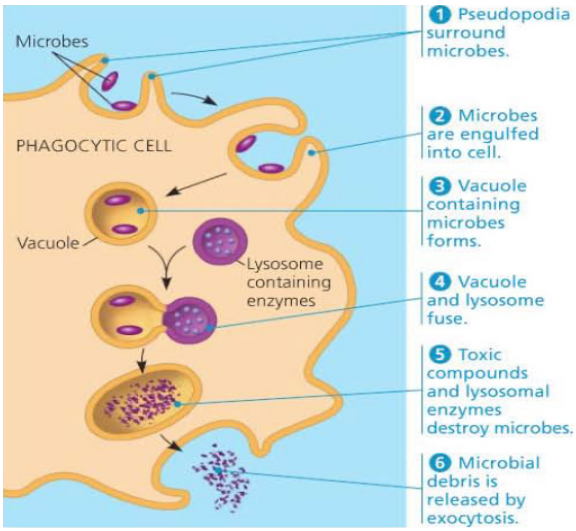


Figure 3.27. Phagocytosis of microbes

ii) The inflammatory response

One result of phagocytosis is inflammation or inflammatory response that is characterized by: redness, hotness, swollen and painful at the site of local infection. An inflammatory response is a nonspecific defense reaction to tissue damage caused by injury or infection.

The tissues injured by bacteria or physical damage (like a cut) release chemicals such as histamine and prostaglandins. These chemicals work as signals which induce an increased heart rate and increased blood capillary permeability (so that white blood cells get to the site of infection faster).

Infected cells also release chemicals which attract phagocytes. When phagocytes and macrophages arrive at the site of injury, they engulf and destroy pathogens and the tissues heal.

The inflamed tissues contain many bacteria and phagocytes, many of which die and form the pus. The increased body temperature slows or stops the growth of pathogens. The fever and increased number of leucocytes are two indications that the body is working hard at fighting infections.

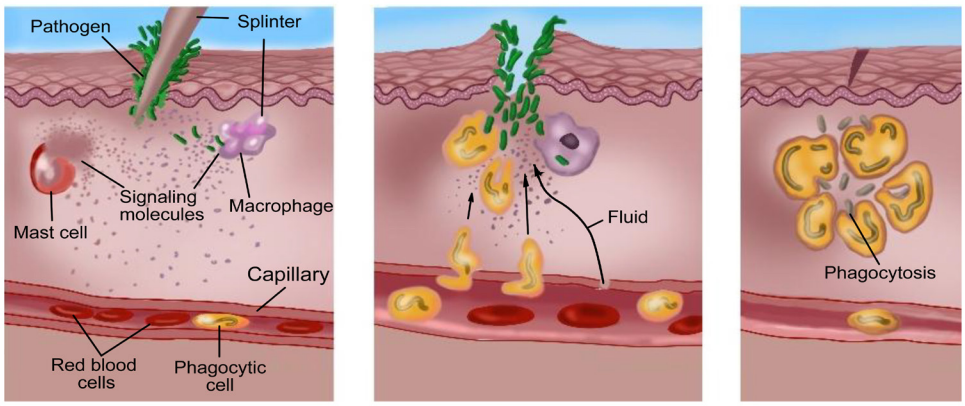


Figure 3.28. Inflammatory response at the injury site

iii) Anti-microbial proteins

Two groups of proteins: interferons and the complement system provide short-term, nonspecific defense to viral and bacterial infections. Interferons are proteins secreted by virus-infected cells which inhibit the synthesis of viral proteins in affected cells and help to block viral replication. They diffuse to neighboring cells and stimulate them to produce antiviral proteins, which prevent viruses from multiplying within them.

Interferons also activate natural killer cells and macrophages, which destroy infected host cells before they release more viruses. Interferons can also promote destruction of cancer cells. The complement system consists of about 30 proteins in blood plasma that function together to fight infections. These proteins circulate in an inactive state and are activated by substances on the surface of many microbes. Activation results in a cascade of biochemical reactions leading to lysis (bursting) of invading cells. The complement system also functions in inflammation.

3.4.2. Specific defense / immunity

When pathogens are able to get past the body's non-specific defenses, the immune system reacts with a series of specific defenses that attack the particular disease causing agent. These defenses are called **immune response (***third line of defense*). A substance that triggers (causes) this response is known as an antigen. Viruses, bacteria and other pathogens may serve as antigens. The cells of the immune system that recognize specific antigens are two types of lymphocytes:

a) B lymphocytes (*B cells*): which originate in the bone marrow and migrate to the lymph nodes where they proliferate into plasma cells which produce antibodies. B cells provide immunity against antigens and pathogens in the body fluid. B lymphocytes give rise to the humoral immunity or antibody-mediated immunity.

b) T lymphocytes (*T cells*): originate in bone marrow and migrate into the thymus. They don't produce antibodies, but they themselves provide defense against antigens and pathogens inside living cells. T lymphocytes give rise to the cell-mediated immunity.

When pathogens invade the body, their antigens are recognized by few B cells of the body. These B cells grow and divide rapidly, producing large number of plasma cells and memory cells. Plasma cells produce and release antibodies. Antibodies are proteins that recognize and bind to antigens. They are carried in the bloodstream to attack the pathogen at the site of infection. As antibodies overcome pathogens, the plasma cells die out and stop producing antibodies.

Once the body has been exposed to a pathogen, millions of memory B cells remain capable of producing antibodies specific to that pathogen. These memory B cells, greatly reduce the chance that the disease could develop a second time. If the same antigen enters the body a second time, a second response occurs. The memory B cells divide rapidly, forming new plasma cells. Plasma cells produce the specific antibodies to destroy the pathogen as faster as possibl

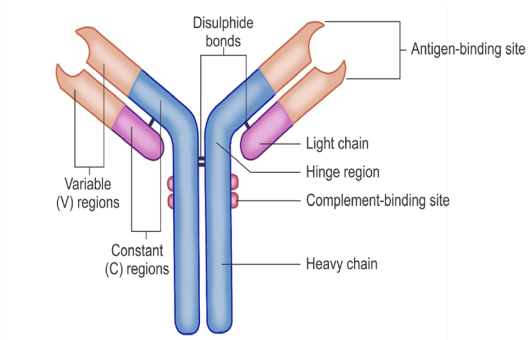


Figure 3.29. Structure of an antibody

An antibody is shaped like the letter Y, and has two identical antigen-binding sites. The shape of the binding site allows the antibody to recognize a specific antigen with a complementary shape. The different shapes give antibodies the ability to recognize a large variety of antigens. A healthy adult can produce about 100 million different types of antibodies.

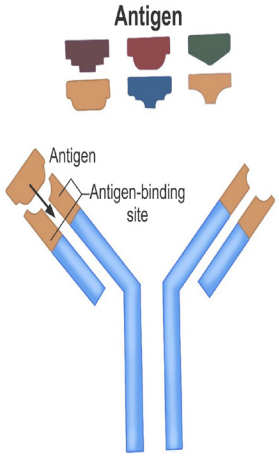


Figure 3.30. Antigen-biding site of an antibody and corresponding antigen

Cell-mediated immunity

It is the body's primary defense against its own cells when they have become cancerous or infected by viruses. The cell-mediated immunity is also important in fighting infection caused by fungi and protists. When viruses and other pathogens get inside living cells, antibodies alone cannot destroy them. During cell-mediated immunity, T cells divided and differentiated into: killer T cells (cytotoxic T cells), helper T cells, suppressor T cells and memory T cells.

Killer T cells track down and destroy bacteria, fungi, protozoa and foreign tissues containing antigens. Helper T cells produce memory T cells. The memory T cells, like memory B cells, will cause a secondary response, if the same antigen enters the body again. As pathogens are brought under control, suppressor T cells release substances that shut down the killer T cells.

Types of immunity

Immunity can be active or passive. In active immunity, the body makes its own antibodies after exposure to an antigen, whereas in passive immunity, the body acquires antibodies produced by other person or other animals. Either active immunity or passive immunity can be naturally or artificially. Thus, there are four types of immunity:

a) Natural active immunity

In natural active immunity, the body makes its own antibodies, in response to an antigen.

b) Artificial active immunity

In artificial active immunity, the body makes its own antibodies, as a result of vaccination against diseases. Vaccination (immunization) is the production of immunity as a result of injection of weakened pathogens which cannot cause diseases to the body, but which can induce production of specific antibodies to those pathogens.

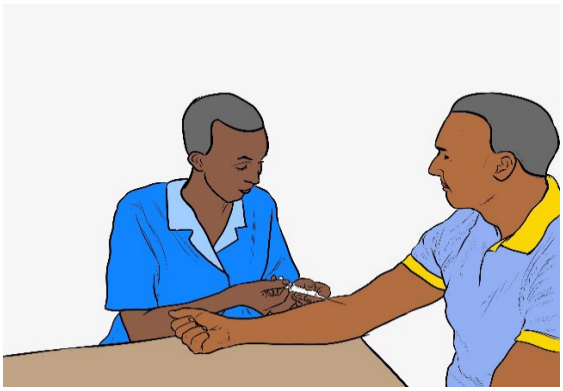


Figure 3.31: Immunity and Vaccination

c) Natural passive immunity

Natural passive immunity is a temporary immunity resulting from acquiring antibodies produced by another individual. The only natural passive immunity is when a foetus acquires antibodies from the mother, either through the placenta before birth, or through the breast feeding after birth. This immunity protects the child against most infectious diseases for the first few months of its life, or longer, if the infant is breast-fed.

d) Artificial passive immunity

It is a temporary immunity that results from the injection of the serum containing antibodies from another organism. In this passive form of immunity, a recipient is not induced to produce his or her own antibodies, but is supplied with them, from an outside source. For example: the horse serum well prepared, can then be used to protect humans against diseases.

The trouble with the protection induced by this immunity is that it is short-lived. Nowadays, the passive immunity is normally used only in emergencies, when is too rate for active immunization to work quickly enough.

APPLICATION ACTIVITY 3.4

You are informed that four fatal cases of adverse events occurred in recent weeks following administration of yellow fever vaccine manufactured by a company abroad. This vaccine is prequalified by WHO and supplied to several countries for routine immunization, campaigns, outbreak control, and for immunization of travelers. All four cases were recipients of a single lot of vaccine, during a yellow fever vaccination campaign in the Northern Province. Yellow fever vaccination has been suspended by national authorities, following the report of the first fatal case. It is estimated that 34,674 persons have been vaccinated with the specified lot.

a) Why is it necessary to vaccinate people?
b) Give examples of any four diseases vaccinated in Rwanda.
c) What can happen to people who do not get vaccinated?
d) When vaccination can have bad effect on vaccinated people?

3.5. Common addictive substances and their effects

ACTIVITY 3.5

Carefully, analyze the substances **1-7** in figure below and answer to the following questions

1. Among those substances which one do you use in your daily life?
2. Which substances are dangerous to life?
3. Suggest one effect of each of the dangerous substances.

Tobacco, Alcohol and drugs addiction is the physical and psychological need to continue using these substances, despite its harmful or dangerous effects. The signs and symptoms of drug addiction drug vary according to the individual and the substances he or she uses.

3.5.1. Tobacco smoking and its effects

Smoking harms nearly every organ in your body. Among heavy smokers, two in three will die from a disease caused by smoking. Tobacco smoke is made up of thousands of chemicals and many of them are very harmful. Around 70 of them cause cancer. Cigarette smoke contains over 4000 different chemicals. Many of them are harmful. The most harmful substances in cigarette smoke include: nicotine, carbon monoxide and tar.

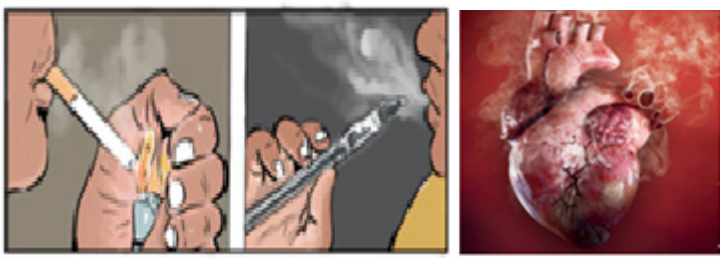


Figure 3.32: Tobacco smoking and heart attack

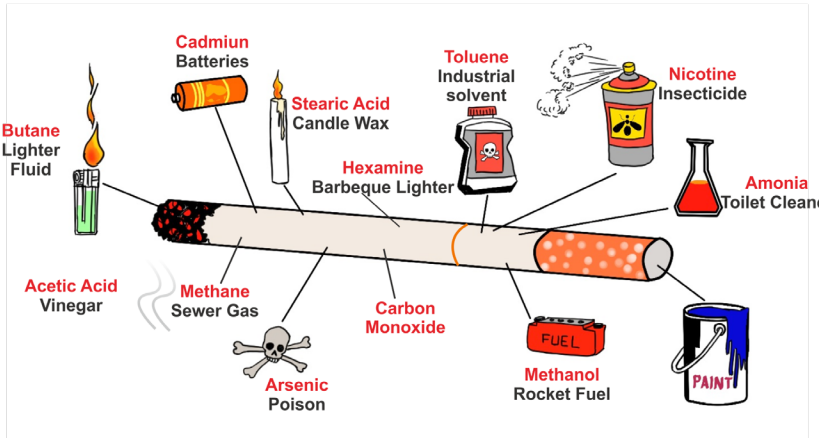


Figure 3.33: Cigarette smoke chemicals

Cigarette smoke contains over 4,000 chemicals, including 43 known cancer-causing (carcinogenic) compounds and 400 other toxins. These cigarette ingredients include nicotine, tar, and carbon monoxide, as well as formaldehyde, ammonia, hydrogen cyanide, arsenic, and DDT. Nicotine is highly addictive

3.5.2. Effects of Tar and carcinogens in tobacco smoke on the gas exchange system

Tar is a combination of severe chemicals lying on the lining of the airways and alveoli. This increases the diffusion distance for Oxygen entering the blood and CO_2 that leaves the blood. The lumen of airways gets smaller and this restricts the flow of air to the alveoli.

The tar paralyses or destroys the cilia on the surface the airways, so they are unable to move the mucus away. Bacteria and viruses trapped in mucus are not removed. They can multiply in the mucus and may block the bronchioles and affect breathing process. A combination of bacteria, viruses and mucus in airways and alveoli causes the lungs to be more susceptible to infections. Smokers are more likely to be attacked by influenza and pneumonia.

Tar contains also the carcinogen compounds which cause cancer. When the tar lies on the surfaces of airways, carcinogens enter the cells of lung tissues. They enter the nucleus of these cells and have direct effects on their genetic material. Any change on genetic material is called mutation, if mutations affect the genes that control cell division, then uncontrolled cell division take place. This is cancer. Lung cancer often takes 20-30 years to develop, and a cancer may grow for many years before it is discovered.

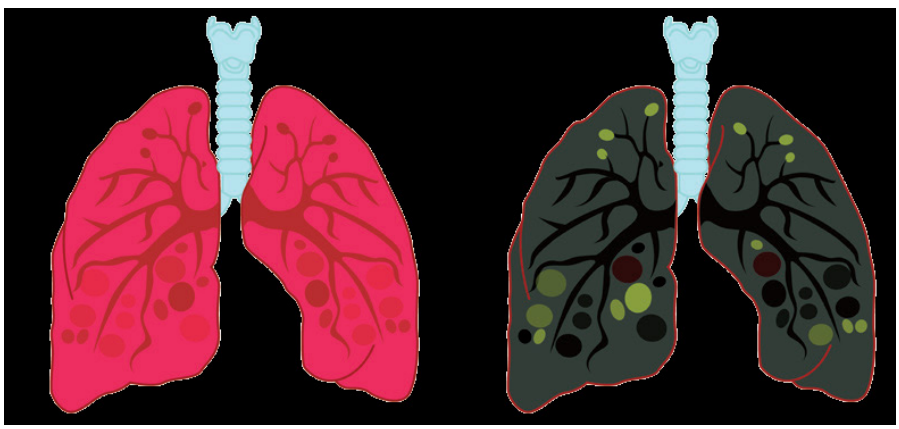


Figure 3.34: Healthy (Left) and tar coated lung (Right)

3.5.3. Effects of Nicotine and carbon monoxide on the cardiovascular system

a) Carbon monoxide (CO): is fatal in large amount. This poisonous gas is also found in car exhaust fumes. CO enters the red blood cells and combines with hemoglobin more rapidly than Oxygen, and form the carboxyhemoglobin.

This reduces the oxygen-carrying capacity of blood, preventing your lungs, heart, and other organs from getting oxygen they need to function properly. CO can also damage the lining of arteries, and may rise the heart beat rate.

b) Nicotine: is a poisonous alkaloid drug that is additive. 60 mg of nicotine placed on the tongue would kill an individual within minutes. It is absorbed by the body very rapidly, reaching the brain in less than 30 seconds.

It is a highly toxic chemical and its manufacture, use and sale is controlled under the State Poisons Acts, except where it occurs in tobacco. This exception of tobacco is for political reasons, not because nicotine is deemed 'safe' in cigarettes. Nicotine, once inhaled, affects the body very quickly. It causes changes to the structure and the working of the brain, which lead to nicotine addiction. Nicotine also *raises heart rate, blood pressure*, releases hormones (adrenaline) affecting the central nervous system, and *constricts small blood vessels (arterioles)* under the skin. In the long term, nicotine may be a factor in *causing coronary disease.* It is believed to be involved in the development of gastrointestinal disorders and problems during pregnancy, and is linked with the development of cancers.

3.5.4. Contribution of tobacco smoking to atherosclerosis and coronary heart disease

Atherosclerosis is the deposition of fatty substances in the walls of the arteries. The CO in the cigarette smoke can damage the inner lining of arteries. This encourages the deposit of fatty substances like cholesterol on the walls of arteries. This reduces the lumen of arteries, which reduces blood flow, and causes high blood pressure.

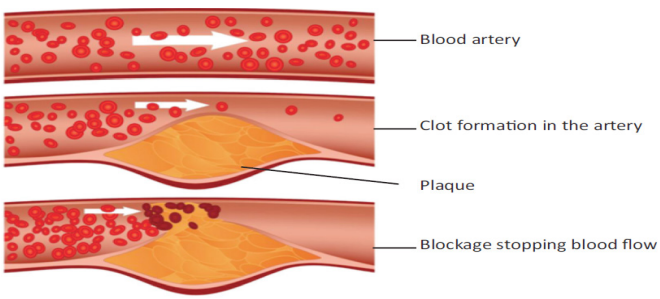


Figure 3.35: Showing the process of blocking arteries by plaque in coronary heart disease

Coronary heart disease (CHD) is a disease of the heart caused by malfunction of the coronary artery. Coronary arteries are the arteries which carry blood to the heart.

The nicotine and carbon monoxide found in cigarette enter the lungs and diffuse into blood in blood capillaries, that conducting them into coronary arteries. This causes the atherosclerosis in coronary arteries, which reduces the blood flow in the heart muscles which receive less oxygen for respiration. This can lead to coronary heart diseases, which take three forms: In circulatory system, they cause changes which lead to cardiovascular diseases like:

a) Angina: a severe pain in the chest, which may extend down the left arm or up into the neck.

b) Heart attack or myocardial infections: caused by a clot in the coronary arteries, blocking the flow of blood to the heart muscles.

c) Heart failure: when the heart cannot sustain its pumping action. This can be caused by the blockage of the major coronary arteries.

3.5.5. Symptoms of lung cancer and chronic obstructive pulmonary diseases (COPD)

a) Chronic obstructive pulmonary disease: is a combination of diseases that include chronic bronchitis, emphysema and asthma. The symptoms of COPD are a combination of symptoms of chronic bronchitis, and of emphysema.

   i). Chronic bronchitis: is the inflammation of the airways. This is accompanied by damage to the cilia and the over production of mucus. The symptoms are: irritation in lungs, continual coughing, and coughing up mucus that is often filled with bacteria and white blood cells.

   ii). Emphysema: is the loss of elasticity in alveoli, which causes the alveoli to bust. The symptoms are: short breath, hard exhalation, the blood is less well oxygenated and fatigue occurs.

b) Lung cancer: the symptoms of lung cancer can be recognized by: continual coughing, shortness of breath, pain in the chest and the blood coughed up in the sputum is often the first sign of the lung cancer.

3.5.6. Alcohol

Alcohol is any organic compound in which the hydroxyl functional group (–OH) is bound to a carbon. The term **alcohol** originally referred to the primary **alcohol** ethanol (ethyl **alcohol*)*** which is used as a drug and is the main **alcohol** present in **alcoholic** beverages. Alcohol is produced by adding yeast on a liquid that contains sugar in absence of oxygen. This yeast ferment sugar to produce energy and alcohol. Most popular alcohol containing drinks include fermented drinks such as beer and wine, other drinks such as vodka, whiskey, scotch, and gin are made by distillation

Figure 3.36: Different fermented and distilled alcoholic drinks

The effects of alcohol vary from person to person. While some people may be able to limit their drinking, others have a difficult time controlling their alcohol consumption.

Effects of alcohol include: Slurred speech, vision impairment, lack of coordination, extreme shifts in mood, memory lapses and slowed breathing.

The most immediate alcohol effects are on the nervous system. The small dose of alcohol slows down the rate of nervous system functions. So, alcohol is a depressant.

The pregnant women, who drink regularly, run the risk of "fetal alcohol syndrome" or damage to the developing babies due to the effect of alcohol.

People who have become addicted to alcohol suffer from a disease called alcoholism. If someone cannot work effectively without alcohol, that indicates an alcohol abuse problem.

Taking alcohol in excess leads to damage of neurons in the brain, cells in the liver. The damage of liver cells causes the liver to become less able to deal with high amount of alcohol, and then the formation of the scar tissue known as cirrhosis in liver occurs. Finally the drinker may die from the chronic liver failure.

Basing on the effect of alcohol on nervous system, driving can lead to sudden accident that may kill people.

Figure 3.37: Accident as bad effect of alcohol

3.5.7. Drugs

Drug is any substance that causes a change in the body. Drugs affect the body in different ways, because some are very powerful and dangerous and their possession is not allowed. Other drugs like penicillin and codeine are drugs that can be used under the supervision of doctor.

All drugs (legal and illegal ones) have the capacity of harming life if they are abused. In this section, some of the most commonly abused drugs and the way they affect the body will be considered.

Drugs affect the particular system of the body like digestive and circulatory systems.

Fugure 3.38: Marijuana /Hashishor Hashplantation and hallucinogens (LSD and PCP)

Negative effects of using marijuana

- **Addiction**: Marijuana is physically addictive and psychologically addictive, especially as it concerns younger.
- **Memory loss**: People who always use marijuana developed a poorer verbal memory in middle age than people who didn't smoke.

- **Social anxiety disorders:** Regular use of marijuana can lead to mental health issues such depression, anxiety and even schizophrenia.
- **Paranoia** : researches indicated that the use of marijuana can lead users to feel a sense of paranoia as a result of the changes in their sensory perception
- **Heart damage**: Marijuana can also significantly raise a person's heart rate for up to three hours. Even, people who use marijuana are more likely to have a stroke at some point in their lives than people who didn't use it.
- **Other effect are: lung problems, low testosterone, appetite irregularities, risk of greater potency, decrease in motor responses, poor decisions.**

Hallucinogens

Hallucinogens are drugs that cause hallucinations. Users see images, hear sounds and feel sensations that seem very real but do not exist. Some hallucinogens also produce sudden and unpredictable changes in the mood of those who use them.

There are many types of hallucinogens but the two common types such as LSD (Lysergic acid diethylamide) and PCD (Phencyclidine) are the ones which are used.

LSD is a powerful hallucinogen that interferes with the normal transmission of nerve impulses in the brain. Its effects vary from person to person and all people who use LSD regularly have a bad trip. Some of LSD users have lost touch with reality after only one single dose.

PCP produces fillings of strength and great power. High dose of PCP heart attacks. The users of PCP often become extremely violent and are danger to themselves and others.

Stimulants

These are drugs that speed up the actions of nervous system. The most powerful stimulants are amphetamines, these chemically resemble natural neurotransmitters found in the body (Compounds that pass nerve impulse from one neuron to another). Once amphetamine enters the blood stream, it floods the body and behaves like neurotransmitters. This causes the nervous system to increase its activity producing a feeling of strength and energy in the user body. Later the user suffers from fatigue and depression as the nervous system becomes unable to handle the overstimulation produced by amphetamines after their dose wears off. Long-term use of amphetamines causes hallucinations, circulatory problems and psychological difficulties.

Depressants

These are drugs that reduce the rate of nervous system activity. These drugs are also known as downers. People become dependent on them as long as they use them. Example of downers is barbiturates. Use of the barbiturates with alcohol is fatal, because the nervous system becomes so depressed and breath stops.

Cocaine

This drug is compound extracted from leaves of coca plant. Users supply it to the body by smoking it, sniffing it or inject it into the bloodstream.

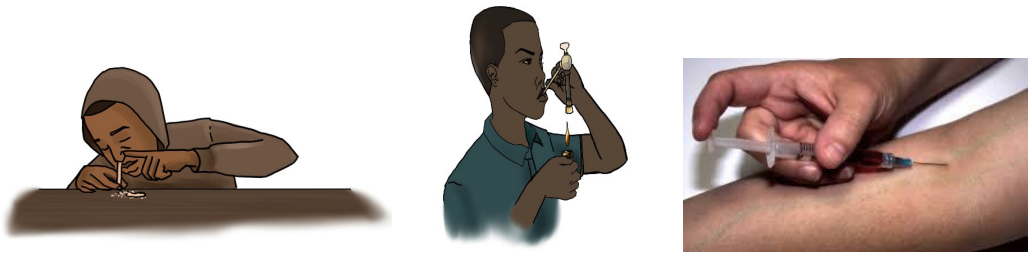


Figure 3.39: People sniffing, smoking and injecting cocaine

Cocaine stimulates the release of neurotransmitter called dopamine which is normally released by the brain if person is satisfied during lunch or dinner. So, cocaine creates feeling of pleasure and satisfaction

Effects of using cocaine

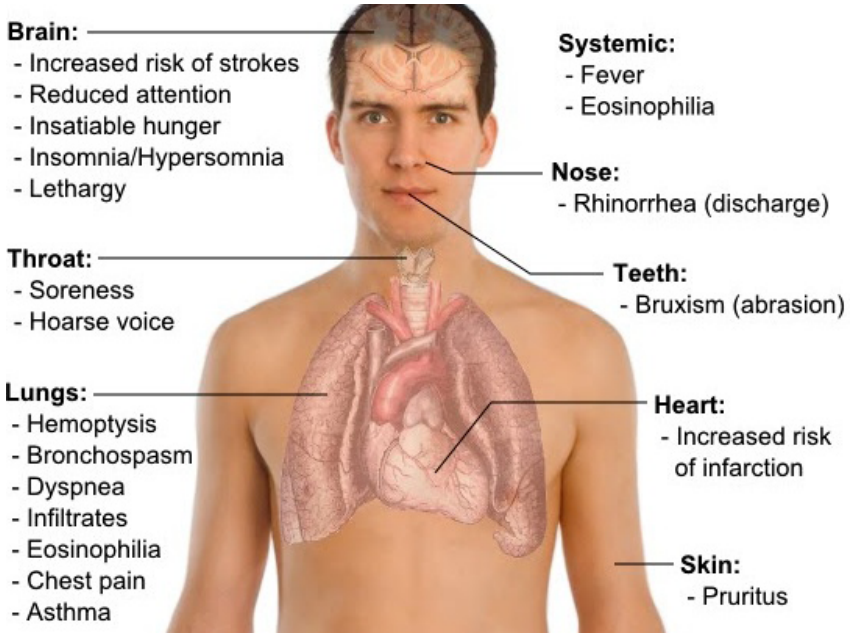


Figure 3.40: Some negative effects of using cocaine

- Heavy use of cocaine leads to lung damage similar to emphysema. Overdose stops breathing.
- Use of cocaine increases the heart rate and blood pressure leading to risk of irregular heartbeat or even heart attack.
- Cocaine causes extreme mood changes, irritability. Long-term use can lead to psychological problems.
- Cocaine causes the users to experience the sensation of bugs crawling over the skin.
- Cocaine usage reduces a desire for food, leading to body weight loss.

Opiates

This is a group of drugs produced from the opium poppy. The most common opiates are opium produced directly from the opium poppy. Other examples of opiates are morphine and heroin which are forms of opium. Apart from heroin, other opiates can be used under supervision of doctor to reduce severe pain as they are used as pain killers. If opiates are taken in large dose, they can result to death.

In addition, opiates such as heroin, are example of drugs that cause a strong physical dependence. The regular user becomes addicted and the nervous system becomes also dependent on the supply of drugs. Any attempt of withdrawal or stopping the use of drug will cause severe pain, nausea, chills and fever.

APPLICATION ACTIVITY 3.5

Cigarette brands that are heavily advertised on TV, in magazines, on billboards, and on T-shirts are the brands more teens buy. But everywhere people meet correctively either on airport, in public transport and snacks bar it is not allowed to smoke. Suppose you are a smoker, why it is not allowed to smoke in public. Provide four reasons that justify your answer.

SKILLS LAB 3

School hygiene is a study of school environment influence; it explores the impact of schooling to mental and physical health of student-teachers. The primary aims of school hygiene education is to improve behavior through useful practices connected to personal, water, food, domestic and public hygiene.

Procedure:

- Use clean water and liquid soap to wash the hand before and after eating
- Use clean water and liquid soap to wash the dinning materials (plate, spoon, cup)
- Clean the dining room using clean water, soap and clean tissue
- Drink clean boiled water.

Evaluation sheet

ITEMS	Agree	Strongly agree	Disagree
Regular wash of hand before eating			
Regular wash of hand after eating			
Regular use of clean water and liquid soap while cleaning dinning dining materials			
Regular cleaning of dining room using clean water, soap and clean tissue.			
Regular drink of clean water			
Regular use of clean cup, plate and spoon			

END UNIT ASSESSMENT 3

I. Choose whether the given statements are True (T) or False (F)

1. Innate immunity is present at birth.
2. Breast milk confers protection to newborn by providing IgE type of antibodies.
3. Antibodies can work by promoting phagocytosis of microbial agents.
4. Antibiotics help a patient in mounting an effective immune response.
5. Treating tuberculosis is becoming difficult because Mycobacterium tuberculosis has become resistant to a number of antibiotics.
6. High fever is a generalized allergic reaction caused by release of active mediators from mast cells.
7. Secondary immune response appears much faster because of the presence of memory cells persisting from previous infection.
8. Vaccination against snakebite is an example of passive immunization.
9. Immunities are of two types: innate and adaptive.
10. Beta-lactam antibiotics kill bacteria by blocking synthesis of their cell walls.

II. Long answers type question

1. Analyse and relate the molecular structure of antibodies to their functions.
2. Explain the following:
   a) Phagocytes
   b) Lymphocytes
   c) Immune response
3. Differentiate between the following: Active and passive immunity
4. State why vaccination programs are able to eradicate smallpox but not measles, TB, malaria or cholera.
5. Compare roles of B cells and T cells in the immune response.

6. Name organism which have the following effects on health

	Name
Cause Malaria	
Transmit Malaria	
Cause Influenza	
Cause Ancylostomiasis	
Provide penicillin	
Elephantiasis	
Transmits venereal disease	
Scurvy	
Cause body's bad smell	
Create a feeling of pleasure and satisfaction	

UNIT 4

EFFECTS OF HUMAN ACTIVITIES ON ECOSYSTEMS

Key Unit competence: Evaluate the effects of human activities on the environment

4.0. INTRODUCTORY ACTIVITY

Study the pictures below and answer the questions that follow.

1. How does the activity taking place in each picture affect the environment?
2. Is it good or bad? Why?
3. Based on what you have seen in the pictures, what do you think you will learn in this unit?

The increase in human population size cause changes in natural ecosystems through different activities done with the main purpose of satisfying human primary needs. Intentionally and unknowingly, human activities on Earth have negative impacts for all kind of form of life on ecosystem. This unit intends to describe different human activities on the Earth's natural ecosystems and their effects. It also informs different biodiversity conservation methods and indicates how disturbed ecosystems can be restored. It raises the awareness towards the restoration of degraded environments as well as biological conservation.

4.1. Negative impact of human activities on ecosystems

ACTIVITY 4.1

The following figures indicate different impacts of human activities on ecosystems.

From your observations on illustration above:

1. Discuss how mining natural resources and industrialization have different impact on ecosystems?
2. Assess the negative impacts of monoculture and intensive livestock on ecosystems.
3. Discuss the contribution of deforestation on flooding/ overflowing and desertification.
4. Explain how fishing and deforestation can have impact aquatic on ecosystems.

1. Intensive cropping practices and its impacts on ecosystem

A key component of agricultural intensification is monoculture, the cultivation of a single crop species in a given area. Unlike traditional polyculture which mix crop varieties or intersperse crops with trees or domesticated animals, monoculture allows farmers to specialize in crops that have similar growing and maintenance requirements. Monoculture is increasingly adopted by farmers to achieve higher yields through economies of scale. However, monoculture may negatively impact biodiversity, soil, water and air.

a) Impacts on Biodiversity

By reducing natural plant biodiversity to include only one crop, monoculture affects the composition and abundance of associated biodiversity. For example, the balance of plant pests and their natural enemies that may exist in polyculture fields can be disrupted in monoculture systems, which provide habitat for a narrower range of insects. Populations of bees, flies, moths, bats, and birds, which provide important pollinating and pest pressure services to crops, also tend to be lower in monocultures than in fields containing diverse forage and nesting sites.

b) Impact on soils

Continuous cropping impacts soils properties whereby soil fertility declines as consecutive crop cycles reduce the amount of nutrients from soils. As plants grow, they absorb nutrients from the soil such as nitrogen, phosphorous, potassium, and calcium. Harvesting crops is another mechanism contributing to the removal of these nutrients from the soil. In addition, when monoculture is continuously applied in the same area, it affects soil organisms due to soil pesticides. Natural soil properties including aeration and water infiltration might be affected due to the loss of soil organisms that increase these soil properties and hence soil fertility.

In addition, due to population pressure and land scarcity, farmers in some areas are increasingly adopting intensive cultivation methods on hillside areas characterized by steep slopes with the soils often inherently poor quality. As rainfall hits loose or unprotected soil on cultivated sloping land, soils erode and carry away sediments and nutrients. The resulting redistribution of nutrients may leave upward sloping soils less fertile than lower areas, and fertilizers or other chemical particles in run-off may negatively impact aquatic ecosystems and water quality.

c) Greenhouse effects

Tillage as one of the practice in continuous cropping, impacts on greenhouse emissions whereby increases carbon dioxide (CO_2) emissions by causing decomposition of soil organic matter (SOM) and soil erosion. Intensive tillage practices also emit CO_2, a greenhouse gas that contributes to climate change. Mechanical tillage release CO_2 and stimulates CO_2 emissions by enhancing decomposition of soil organic matter. The tendency for tillage to increase erosion also contributes to CO_2 emissions. A large percentage of soil carbon particles carried by erosion are emitted into the atmosphere as CO_2 rather than buried and sequestered in deposit sites.

2. Intensive livestock farming and its impacts on ecosystem

Livestock play an important role in agricultural systems. Cattle, sheep, and goats can provide manure for soil fertilization and a diversified source of food and income generation. Traditional livestock management involves mixing animals and crops on the same farm or grazing livestock on grasslands. Intensive livestock systems exacerbate the impacts that livestock activities have on the environment, including effects on soil conditions, biodiversity, water quality and quantity, and greenhouse gas emissions.

a) Impacts on Soils

Increased animal stocking rates puts pressure on grazing lands, leading in some cases to soil compaction, erosion, grasslands degradation, and desertification in semi-arid areas. Concentrated "hoof action" compacts wet soils, making them less able to absorb water and more prone or more likely to run-off and erosion. Livestock grazing between land and streams can destabilize stream banks and release large amounts of sediment into fragile aquatic ecosystems. Additionally, high rates of nitrogen contained in bovines' manures can lead to topsoil acidification.

b) Impacts on Biodiversity

Intensive grazing impacts biodiversity in several ways. Populations of birds, rodents, and other wildlife that depend on grasslands for food and habitat may decline as livestock densities increase. In addition, intensive grazing often involves reseeding natural meadows, resulting in a loss of native grassland plants. Higher rates of organic or inorganic fertilizer application typically accompany reseeding, which may degrade water quality through nitrogen or phosphorous leaching. Nutrient contamination in water bodies reduces oxygen levels and harms fish and plant populations.

Leaching of nitrogen and other fertilizer nutrients into fresh and saltwater environments can lead to a state of eutrophication (overabundant nutrient concentrations), resulting in increased algae blooms and oxygen depletion. Thus, dead zones may develop in these areas, whereby decreased oxygen levels dramatically reduce fish populations and species diversity.

c) Impacts on water quality and quantity

Untreated livestock waste causes high nutrient concentrations in water bodies, also known as **eutrophication**. Untreated livestock waste can significantly impact water quality. Livestock manure contains high amounts of nitrogen, phosphorous, and potassium and may enter water directly when livestock graze near streams or indirectly through run-off or percolation into groundwater. Confined livestock systems present high risks of water pollution due to difficulties containing and treating large quantities of manure. Degraded water quality may also pose health risks to humans who rely on water for drinking and household uses.

d) Impacts on greenhouse gas emissions

Enteric fermentation and livestock manure are significant sources of methane (CH_4) and nitrous oxide (N_2O) greenhouse gases emissions. Ruminant livestock such as cattle and sheep release CH_4 during enteric fermentation

and the microbial digestion of fibrous plants. Animal manure emits N_2O and CH_4 during storage and after application to croplands or grazing areas. Additional activities related to raising livestock are responsible for emissions such as releases of CO_2 in producing fertilizer for grazing lands and animal feed, N_2O emissions from applying fertilizer, and CO_2 emissions from overgrazing and land degradation.

e) Impacts on air quality

Nitric gas contributes to smog, ozone, and acid rain. During the microbial processes of nitrification and denitrification that take place in fertilized soils, nitric gas is released. Nitric emissions impact local and regional air quality by contributing to the formation of smog, ozone, and acid rain.

3. Fishing and their impacts on the ecosystem

Techniques for catching fish include hand gathering, spearing, and netting, angling and trapping. It is normally done in fish farms including ponds, rivers, lakes, seas, oceans where fish are raised commercially.

With the advancement in technology, rearing of aquatic animals is known as "aquaculture" aiming at producing more aquatic food due to the drastic increase of the population. Despite the significance of fish farming and harvesting technologies, fisheries are in danger of collapsing, due to overfishing and pollution.

Fishing nets called ghost nets used by fishermen are sometimes left or lost in oceans whereby they can entangle fish, dolphins, sea turtles, sharks, dugong, crocodiles, seabirds, crabs, and others. These living things are restricted from movement which led to laceration (cut in skin), infection, starvation and suffocation sometimes causing the death.

Other effects include overfishing which is a form of overexploitation where fish stocks is reduced to below accepted levels. It can result in resource depletion, reduced biological growth rates and low biomass levels. Since organisms ecologically depend each other, overfishing of one species decreases the presence of other species and favors the invasive species.

For example, with the shark population reduced, in some sea places almost totally, the rays have been free to dine on scallops to the point of greatly decreasing their numbers. Since then, a variety of sharks have fed on rays, which are the main predator of scallops.

4. Deforestation and its effects on ecosystem

Deforestation is the permanent clearing or removal of trees and undergrowth. Deforestation happened in the past and continues extensively today particularly in tropical area. The forests are cut mostly for mainly searching agricultural land.

In Rwanda like elsewhere, deforestation was driven by the need for food, charcoal, and timber, especially for commercial products. Worldwide agriculture continues to be the main cause of the loss of natural forests.

Other reasons include supplying firewood as fuel, constructing houses, industrial buildings, roads, and dams, removal of trees for pulp and paper, cutting trees for timber used in the construction industry, replacement of native trees with fast growing species such as conifers, eucalyptus, and rubber trees.

a) Effects of deforestation on biodiversity

Deforestation has the dramatic effect on biodiversity particularly in tropical rainforests. Complete replacement of native plantations with introduced species or keeping only a few native species, leads to a reduction in biodiversity. Organisms are being driven to extinction by the loss of their suitable habitat. In tropical rainforest, attention should paid to species with great human value including medicines, where forest plant products are used as anticoagulants, tranquillizers, and antibiotics.

b) Effect of deforestation on nutrients cycles

Deforestation is contributing to an increase in carbon dioxide due to the removal of forests which actually use this gas for photosynthesis. Forests burning release huge amounts of carbon dioxide directly and very quickly into the atmosphere and is probably a major contributor to rising carbon dioxide levels. Burning trees was also found to significantly reduce the nitrogen held in the ecosystem. In addition, tree roots bind soil particles together, and tree canopy prevents rain beating down on the soil. Deforestation therefore causes nutrients to be lost through leaching and runoff.

c) Desertification

Deforestation is also one of the process speeded by deforestation even though some scientists believed that it was caused mainly by climatic changes. Deforestation disrupts water cycle and soil structure. Reduction in tree cover means reduced transpiration, few clouds, and less rain fall in the area. Removing trees increases the risk of flooding following heavy rains. Agricultural land becomes heavily populated, it is likely to be over cultivated or overgrazed, and the soil will be less fertile and more easily eroded during periods of droughts.

5. Mining and industrialization

a) Effects of Mining on the Ecosystem

Mining as one of economic activity applied on natural ecosystem plays an important role to humans. It is at the same time affecting environmental ecosystem through soil compaction, lowering overall soil fertility, erosion, soil pollution and minimizing the availability of nitrogen and phosphorus. Soil compaction is one of the most severe effects mining has on ecosystems and it is often the result of large machines.

As the soil is compacted, there are fewer pore spaces for oxygen and water to move through the soil profile, minimizing the potential for plant establishment. Mining operations often contaminate the soil with toxic heavy metals and acids, preventing plants and soil microorganisms from thriving

b) Effects of industrialization on ecosystem

Industrialization contributes for the nation economic development and prosperity by providing employment opportunities and generating wealth. It is also one of the human activities that negatively deteriorate ecosystems.

The major negative effects of industrialization include depletion or reduction of natural resources, air, water and soil pollution, global warming and climatic changes. Industrialization expose living organisms to acid rain and it is among the major causes of land degradation. Thus poor land quality, and issues generated by hazardous waste lead to some diseases including silicosis and pneumoconiosis, tuberculosis, skin diseases and deafness.

By metallic contaminant like Cd, Zn, Hg, radioactive industrial pollutant bacteria and beneficial microorganisms in the soil are exposed to death. There are also a number of undesirable effects caused by toxins from industrial wastes that enter in the food chain. Moreover, industrial effluent damages the natural biological purification mechanism of sewage treatment causing several soil and water borne diseases.

APPLICATION ACTIVITY 4.1

Refer to modern agriculture which uses machines instead of man power and extraction of natural resources to explain the reasons for habitat destruction and effect of the excessive use of fertilizers and pesticides on environment.

4.2. Pollution

ACTIVITY 4.2

The pictures below show a polluted area; observe them and answer related questions.

a) Analyze the pictures and identify the sources of water and land pollution.

b) Suggest any other sources and effects of the pollution of air, water and land

c) Explain the causes and effects of acid rain, eutrophication of water and non-biodegradable plastics

d) Demonstrate ways of reducing pollution shown on the pictures and protecting the environment

Pollution is the effects of undesirable changes in our surroundings that have harmful effects on plants, animals, and human beings. Pollution occurs when substances or energy are released into the environment in amounts large enough to harm anything of human value or other livings.

A pollutant may be physical (for example, noise, heat, and other form of radiation), chemical (such as heavy metals in industrial wastes), or biological (sewage for example).

A pollutant may be a substance of natural origin present in excess(such as a volcanic dust or particles of sea salt)), but the term is more used often used to describe changes brought about by human activities such as the emission of industrial pollutants, or the discharge of domestic wastes. The pollutant can be in any part of the biosphere: in air, land, or water. No natural phenomenon has led to ecological changes than have been made by mankind.

1. Air pollution and its effect on the ecosystem

Air pollutant may be gases (such as carbon monoxide from car exhausts), or aerosols (soil or liquid particles suspended in the atmosphere).

Pollutants have many and different effects on the health of humans and other organisms, as well as on the natural and built environments. Oxides of nitrogen and sulphur emitted as industrial gases can form acid precipitation. Some pollutants can cause the greenhouse effect once increased as well as ozone depletion.

a) Greenhouse effect

Solar energy reaches the Earth in the form of short-wave radiation. When the radiation strikes a surface, much of its energy is converted into heat, a form of radiation which has a long wavelength. CO_2, H_2O vapour, and other gases present in the atmosphere absorb and retain long wave radiation or reflect it back toward the surface of the earth. These gases therefore act like panes of glass in a greenhouse, letting light in, but retaining some of the heat before it escapes into space, hence the term greenhouse effect.

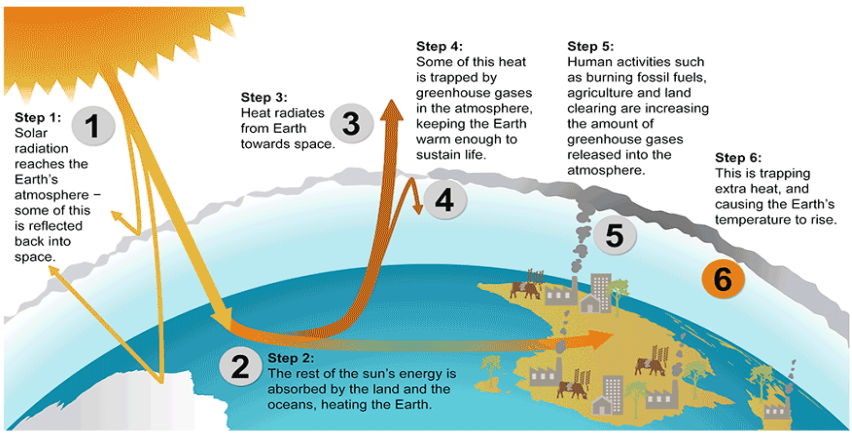


Figure 4.1: Illustration of the greenhouse effect

The retention of heat by the greenhouse effect is a natural process, essential for the evolution of life on the earth. It has been calculated that without it, average surface temperatures would be between -17 and -23^{0}C; the actual average surface temperature being +15^{0}C. However, the greenhouse effect appears to be increased by emission of certain industrial gases, called greenhouse gases, the most important being carbon dioxide, water vapours, chlorofluorocarbons, methane, and ozone.

b) Global warming

The increase in the concentration of greenhouse gases in the atmosphere causes a rise in global temperatures, and hence could bring about changes in climate. The global warming was detected to raise the sea levels; increase melting of ice, cause changes in vegetation, and contributes to unusual weather patterns.

c) Acid precipitation

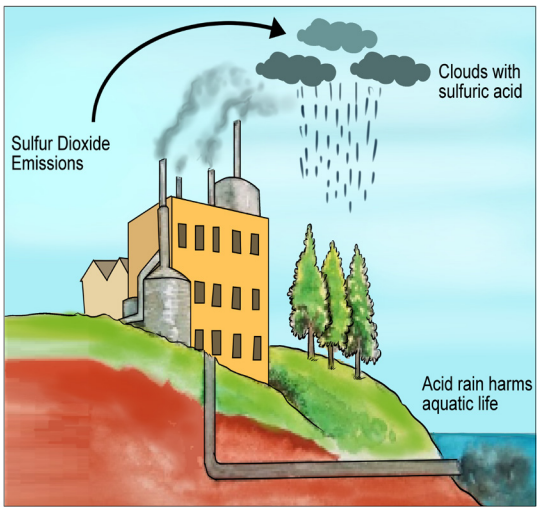


Figure 4.2: Illustration of the formation of acid rain

The burning of wood and fossil fuels, including coal and oil, releases oxides of sulphur and nitrogen that react with water in the atmosphere, forming sulphuric and nitric acid, respectively and forming acid precipitation or rain, snow, sleet, or fog that has a pH less than 5.2. Acid precipitation lowers the pH of streams and lakes and affects soil chemistry and nutrient availability.

d) Depletion of Atmospheric Ozone

Life on Earth is protected from the damaging effects of ultraviolet (UV) radiation by a layer of atmospheric ozone (O_3) layer located in the stratosphere, around 17–25 km above Earth's surface. Like carbon dioxide and other greenhouse gases, ozone has also changed in concentration because of human activities.

The destruction of atmospheric ozone results primarily from the accumulation of chlorofluorocarbons (CFCs) widely used in refrigeration and manufacturing. In the stratosphere, chlorine atoms released from CFCs react with ozone, reducing it to molecular O_2. Subsequent chemical reactions liberate the chlorine, allowing it to react with other ozone molecules in a catalytic chain reaction

The decrease of ozone thickness in the stratosphere increases the intensity of ultraviolet (UV) rays reaching Earth's surface. The consequences of ozone depletion for life on Earth may be severe for plants, animals, and microorganisms.

Some scientists expect increases in both lethal and nonlethal forms of skin cancer and in cataracts among humans, as well as unpredictable effects on crops and natural communities, especially the phytoplankton that are responsible for a large proportion of Earth's primary production.

The most severe consequence of ozone depletion is DNA damage which could occur if ozone layer is continually destroyed or when filters to decrease or block the UV radiation in sunlight are not used as ecologists reported based on their experiments using filters.

2. Water pollution and its effects

When water vapour is formed by evaporation or transpiration, it is as pure and clean as the distilled water in science laboratories. However, as soon as it enters atmosphere and continues its journey in the water cycle, it can become polluted.

The source of pollution may be industrial, domestic, or agricultural, and the pollutant maybe thermal, chemical or nuclear.

Water can become polluted even if no substances are added to it. In many industries, water is used as a coolant. Excess heat is discharged into a nearby waterway, causing thermal pollution. Discharges from power stations, for example, may raise the temperature of rivers and estuaries by several degrees above their normal level.

Warm water may carry much less oxygen than cooler water. Thermal pollution can therefore kill fish by depriving them of oxygen. It may also cause their death indirectly by encouraging the increased growth of parasites. However, thermal effluent can also be beneficial where it increases the growth rate of some commercial shellfish and allows some warm- water organisms, for example tropical prawns or shrimps, to be culture in temperate regions such as Britain.

Water is also polluted by industrial sewage from abattoirs, factories, hospitals and or domestic waste such as human faeces, urine and detergents. Sewage is carried through pipes called sewers. Adding organic material to water stimulates the growth of microorganisms which feed on the material. As the density of microorganisms increases, their demand for oxygen also rises. This demand is called the biological oxygen demand (BOD) and is measured as the mass in mg of oxygen used by 1 dm cube of water stored in darkness at 20 degrees for 5 days. The BOD of unpolluted river water is about 15 mg O_2 dm^{-3},

the BOD of raw sewage is about 100 times higher: water that is very heavily polluted with raw sewage become deoxygenated and this can lead to the death of aerobic organisms such as fish.

Eutrophication occurs when organic material or inorganic nutrients, especially nitrates or phosphates, enter a freshwater habitat, either naturally or as a result of pollution by sewage or agricultural runoff containing fertiliser. The additional nutrients encourage the rapid growth of photosynthesizing organisms, especially algae.

Dramatic, fast growths of algae are called algal blooms. A bloom can smother or completely cover plants, reduce light intensity in the water, and produce toxins which kill fish. When the algae die, their composition by bacteria may lead to the complete deoxygenation of the water, causing the death of aerobic organisms.

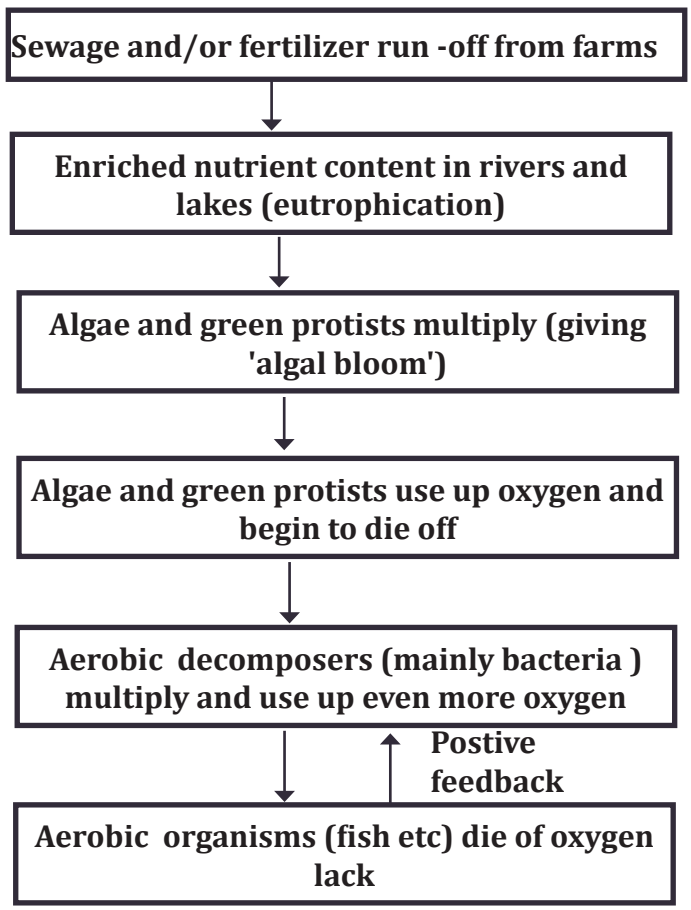


Figure 4.3: Flowchart showing the sequence of events which may result from eutrophication

Oxygen depletion and eutrophication are not only caused by sewage pollution, they may be caused by any pollutant containing high concentrations of organic or inorganic nutrient, such as fertilisers (inorganic or organic), slurry (animal faeces and urine), or silage (a fermented grass product used to feed cattle in winter) effluent which can leach off farmland and pollute water.

Water particularly marine water by oil spills which is the most water pollutant in occidental countries due to huge amounts of oil from large sea tankers. The oil threatened fisheries, tourism, and many important environmental sites. Crude oil contains volatile components which are highly toxic and can kill invertebrate larvae, limpet, edible snail, bivalve molluscs and fish depending to their concentration. A reduction in the population of one species due to oil brings changes in food chain. In addition, oil on the feathers of sea birds impairs flight and reduces insulation, making birds vulnerable to hypothermia. If the oil is taken into the stomach during preening, it can poison the birds.

Marine water like fresh water is contaminated by agricultural fertilisers which have negative effects on aquatic livings. For example, seal population had become infected with the virus after being weakened by the effects of marine pollutants including nitrogen and phosphorus fertilisers and polychlorinated biphenols (PCBs). The pollutants were not at a high enough concentration to cause death, but they may have greatly weakened the immune system of the seals. The highest mortality of seals occurred in areas with the highest levels of PCB pollution

3. Soil pollution and its effects

Soil is formed from different factors including physical, bio-chemical and edaphic. The soil might be sandy, clay and silty, or loam. Sandy soils are light with relatively large particles with large air spaces. This type of the soil quickly gains and loses heat and drains water faster.

Figure 4.4. Water polluted by home garbage "Ikimoteri"

Soil as land components is polluted as a result of human activities, and it is polluted by both inorganic and organic pollutants. The two main origin of soil pollutants are human-made chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals, or improper disposal of waste such as plastics bottles and bag. The most common chemicals involved are petroleum hydrocarbons, polynuclear aromatic hydrocarbons such as naphthalene, solvents, benzopyrene, pesticides, lead, and heavy metals including cadmium, chromium, lead, mercury, nickel, and zinc, cited amongst others. Contamination is correlated with the degree of industrialization and intensity of chemical usage.

APPLICATION ACTIVITY 4.2

1. Make a trip to polluted sites near the school and assess the impact of industrial sewage and fertilizer application to the environment. Explain how that area was polluted.
2. Investigate how increasing atmospheric carbon dioxide concentration cause global warming and affect ecosystems
3. Explain how plastic bags and polythene bags are dangerous for farmers and other soil dwelling animals
4. Suggest ways of mitigating water, soil, and air pollution. How can you implement the suggested strategy in your school area?

4.3. Bioindicators of pollution

ACTIVITY 4.3

1. Make a field visit of lake or river or forest near the school; observe the environment of the visited site.
2. Is the water of lake natural or polluted?
3. If polluted, what are the indicators of pollution observed in water lake?

Bioindicators are living organisms such as plants, planktons, animals, and microbes, which are utilized to screen the health of the natural ecosystem in the environment. They are used for assessing environmental health and biogeographic changes taking place in the environment.

Each organic entity inside a biological system provides an indication regarding the health of its surroundings such as plankton responding rapidly to changes taking place in the surrounding environment and serving as an important biomarker for assessing the quality of water as well as an indicator of water pollution. Even the health of aquatic flora is best reflected by plankton, which acts as an early warning signal.

Naturally occurring Bioindicators are used to assess the health of the environment and are also an important tool for detecting changes in the environment, either positive or negative, and their subsequent effects on human society. There are a certain factors which govern the presence of Bioindicators in environment such as transmission of light, water, temperature, and suspended solids.

Natural, biological, and biodiversity markers can be found in various organisms occupying different types of environments. Lichens (a symbiosis among Cyano bacteria, algae, and/or fungi) and Bryophytes (liverworts) are frequently used to monitor air contamination.

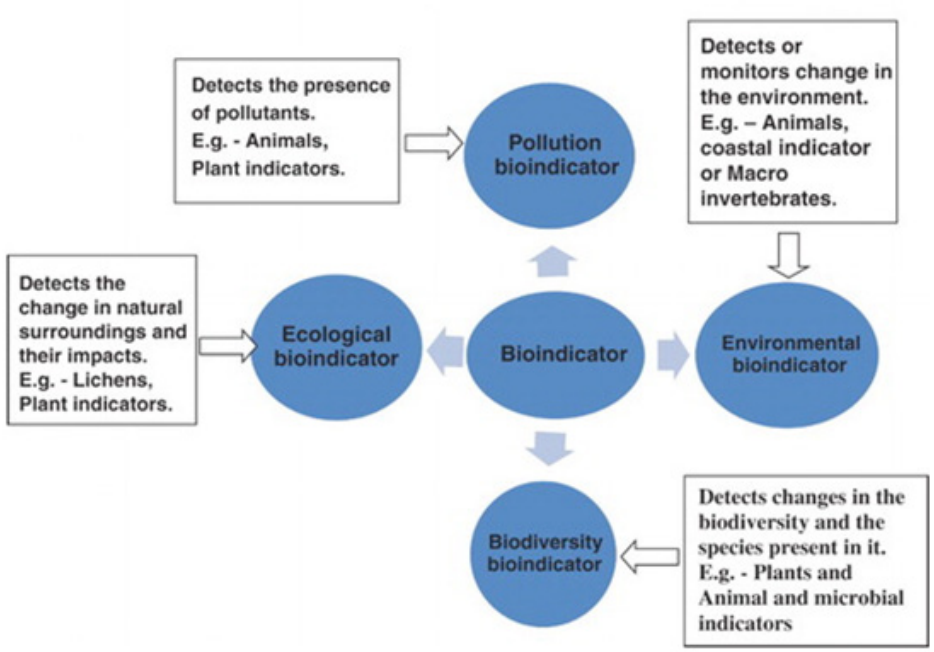
Both, Lichens and Bryophytes are powerful Bioindicators of air quality on the grounds that they have no roots, no fingernail skin, and acquire all their supplements from immediate introduction to the climate. Their high surface region to volume ratio further supports the theory of their use as a bioindicator, or supports their ability to capture contaminates from the air.

The presence or absence of some specific plants or other vegetation provides ample information about environmental health. Lichens generally found on the trunks of trees and rocks are composed of algae and fungi both. They react to ecological changes in forests, including changes in the structure of the

forest, air quality, and climate. Environmental stress can be indicated by the disappearance of lichen in forests, as caused by changes such as increases in the level of sulfur dioxide (SO_2), pollutants of sulfur and nitrogen (N_2).

The expression 'Bioindicator' is used as an aggregate term referring to all sources of biotic and abiotic reactions to ecological changes. Instead of simply working as gauges of natural change, taxa are utilized to show the impacts of natural surrounding changes, or environmental change. They are used to detect changes in natural surroundings as well as to indicate negative or positive impacts.

They can also detect changes in the environment due to the presence of pollutants which can affect the biodiversity of the environment, as well as species present in it. The bioindicators have different functions on environmental health as indicated in *figure 4.5.*



The advantages associated with using **Bioindicators** are as follows:

a) Biological impacts can be determined.

b) To monitor synergetic and antagonistic impacts of various pollutants on a creature.

c) Early stage diagnosis as well as harmful effects of toxins to plants, as well as human beings, can be monitored.

d) Can be easily counted, due to their prevalence.

e) Economically viable alternative when compared with other specialized measuring systems.

APPLICATION ACTIVITY 4.3

The photo below shows the **stagnant water,** observe it, use search engine and answer questions that follow:

a) Identify the bioindicators present in this stagnant water. How the bioindicators mentioned tell about the environmental health?

b) Suppose you are in field trip in forest and found the lichens, explain how are able lichens to act as bioindicators?

4.4. Biological conservation and conservation method

ACTIVITY 4.4

1. Why should we care about loss of biodiversity?
2. Carry out research on the African species endangered by human actions.
3. Explain the main methods of the conservation of resources.
4. Describe an example of conservation in action.

To date, scientists described and formally named about 1.8 million species of organisms and about 10 million more species not yet identified currently exist, even if this number is estimated to be as high as 100 million.

A greatest portion of species is found in tropics particularly in the tropical forests. Additionally, over half of all accessible surface water is used for

different purposes. Throughout the biosphere, human activities altered trophic structures, energy flow, chemical cycling, and natural disturbance of ecosystem processes on which different species depend on for survival. Considering the above background, it is now time to rethink about and seek how to preserve life on the Earth.

a) Biological conservation

Biological conservation integrates ecology, physiology, molecular biology, genetics, and evolutionary biology to conserve biological diversity at all levels. It is aimed to maintain the quality of natural environments and their biological resources.

Unlike preservation which tries to prevent human interference, conservation involves actively managing biotic and abiotic components to ensure the survival of the maximum number of species and genetic diversity. Common reasons for conserving wildlife are:

Utilitarian reasons: Species are conserved due to their benefits to humans in terms of food, medicines including quinine and codeine among plants, and snake venom used as anticoagulants and anaesthetics, aspirin to antibiotics are made from natural resources, and alkaloids that inhibit cancer cell growth), industrial use (timber, fuel, gums, dyes, and oils), natural genetic resistance to pests, and whether they provide new variety.

Aesthetic reasons: Wild animals and plants biodiversity are conserved for the pleasure they provide human well-being.

Ecological reasons: biodiversity is conserved due to the complex ecosystem goods and services they provide including network of relationships which maintain biogeochemical cycles in the biosphere and the energy flow in an ecosystem.

Ethical reasons: most of the people conserve biodiversity due to the moral duty to look after the environment and that all species have right to live. It is therefore morally wrong to destroy ecosystems or to allow species to become extinct.

b) Conservation methods

i) Bioremediation

It involves the use of organisms usually prokaryotes, fungi or plants to detoxify polluted ecosystems. In this practice, restoration ecologists can introduce such species to the sites polluted by mining and other

human activities and then harvest these organisms to remove the metals including lead and cadmium from the ecosystem. The species that grow on soil polluted by different minerals are called bio-indicator or biological monitor and also a remediator.

ii) Biological augmentation

In contrast to bioremediation, biological augmentation uses organisms to add essential materials to a degraded ecosystem. The determination of which factors needed such as chemical nutrient lost from a system and limiting its recovery is a prior exercise.

Encouraging the growth of plants such as nitrogen fixing often speeds up succession and ecosystem recovery. Once these nitrogen-fixing plants become established, other native species are better able to obtain enough soil nitrogen to survive.

Other ways that conservationists use to restore natural habitats involve mowing, grazing, or burning to halt succession, coppicing, or the control of water levels. Biological restoration is practical when the habitats are not severely destroyed; since then, in extreme cases, the physical structure of an ecosystem may need to be restored before biological restoration can occur.

iii) Zoned reserves or protected areas approach

A zoned reserve is an extensive region that includes areas relatively undisturbed by humans surrounded by areas that have been changed by human activity and are used for economic gain. In Rwanda, there are now four national parks namely, Akagera National Park, Nyungwe National Park, Volcano National Park, and Mukura-Gishwati National Park which are the reserves for natural wildlife.

The key challenge of the zoned reserve approach is to develop a social and economic climate in the surrounding lands that is compatible with the long-term viability of the protected core. These surrounding areas called buffer zones continue to be used to support the human population, but with regulations that prevent the types of extensive alterations likely to impact the protected area. As a result, the surrounding habitats serve as buffer zones against further intrusion into the undisturbed area. The neighboring communities should be involved in ecotourism activities as one way of benefiting from ecosystem services.

iv) Eco-farming approaches

Eco-farming is a modern method for conserving natural ecosystems. It combines science and innovation with respect for nature and biodiversity. It ensures healthy farming and healthy food. It protects soil, water and the climate from pollutants. It does not contaminate the environment with chemical inputs or use genetically engineered crops. And it places people and farmers, consumers and producers at its very heart rather than the corporations who control the food now. It is envisioned for sustainability and food sovereignty in which food is grown with health and safety first and where control over food and farming rests with local communities, rather than transnational corporations. The methods have seven principles which are:

1. **Food sovereignty** in which producers and consumers, not corporations should control the food chain and determine how food is produced.
2. **Rewarding rural livelihoods** for ensuring food security and fighting poverty in rural development.
3. **Smarter food production and yields** which aimed at creating higher yields to help feed the world.
4. **Biodiversity** for promoting diversity in crops, instead of monocultures like corn and soy, essentially to protecting ecosystem.
5. **Sustainable soil** fertility is improved using eco-farming methods and refraining from chemical fertilizers and inputs.
6. **Ecological pest protection** where farmers can control pest damage and weeds effectively through natural means instead of chemical pesticides.
7. **Food Resilience** where diverse and resilient agriculture, not monoculture crops, is the best way to protect communities from shocks from climate and food prices

v) Other conservation practices

In additional to the conservation methods, there are other practices that can be applied for biological restoration since the above methods may be difficult and expensive for some countries. They include:

- Restricting urban and industrial development and reclaiming derelict sites or other areas
- Legally protecting endangered species and prohibiting the release or introduction of non-native animals and plants into an area

- Controlling pollution in sensitive environments in which species are at risk of extinction
- Recycling materials such as paper, glass bottles, clothes, and limiting the exploitation of renewable resources to sustainable yields
- Restricting trade of endangered species and providing breeding programs for endangered species for example in zoos and botanic garden
- Avoiding poaching and forest fires and voids habitat loss
- Not introducing new species or exotic species and avoid overharvesting and or overfishing
- Preventing global change
- Cleaning up of oil spill by leaving it alone and let it degrade naturally, mechanical recovery, burning, or using aerial dispersants and or by bioremediation.

Biodiversity conservation improves the quality of life for local people and leads to a sustainable development. Many nations, scientific societies, international and local NGOs embraced the concept of sustainable and economic development that meets the needs of people today without limiting the ability of future generations to meet their needs. In Rwanda, the Rwanda Environmental Management Agency (REMA) and Rwanda Development Board (RDB) aims at protecting and conserving ecosystems. Few of them like forbidding people to use swamps, not cultivating near the streams, rivers, and lakes, reforestation, eco-tourism, buffer zones, polythene or plastic bags not allowed to be used and enter in the country are highlighted.

APPLICATION ACTIVITY 4.4

1. Conduct a survey of a nearby site that is suffering from degradation and suggest measures to implement protection.
2. As the population continues to increase, what should happen to Nyungwe national park and other protected areas if the government of Rwanda does not put in place Rwanda Environmental management Authority (REMA)
3. What if soil eroded from hillsides keeps on being reaching and taken by Nyabarongo river which is ecosystem of a number of aquatic wildlife. Suggest how ecological state of wildlife of Nyabarongo could be restored

SKILLS LAB 4

Protected areas are one of the most important tools in conservation science and management. They have long been regarded as important for maintaining species and habitat diversity, as well as protecting specific landscapes or sacred areas. Conservation strategies have traditionally taken the view that biodiversity should be protected because species have both a functional and an inherent value.

Procedure:

- Protect the existing garden through fencing the destroyed environment
- Add new species in the garden
- Plant fruit trees in school compound
- Improve social skills by cultivating empathy and teamwork through a symbol tree for each formed group formed.
- Plant tree around the toilet for aerating the area

Evaluation sheet

Items 1	**Number of planted tree**	**Number of grown tree**	**Number of dead planted trees**
New species added in the garden			
New planted trees in school compound			
New planted of fruit trees in school compound			
Planted symbol tree for group formed			
Planted tree around the toilet.			
Items 2	**Agree**	**Strongly agree**	**Disagree**
School garden is well protected			
Student-teachers are involved in protecting school garden			
Regular supervision of new added species			
Student-teachers take care of planted trees			

END UNIT ASSESSMENT 4

1. Discuss how human actions have negative impacts on ecosystem
2. What are the major causes of deforestation in tropical area?
3. What are the advantages and disadvantages of agricultural practices (deforestation, applying nitrogenous fertilizers to crops, burning agricultural wastes, growing crop plants with genetically engineering resistance to herbicide eg glyphosate)
4. Zoologists and conservationists fear that many if not all species of amphibians would distinct since they are in deep trouble due to global pollution and climate change. Explain how global pollution and climate change contribute to the extinction of amphibians.
5. How can the addition of excess nutrients to a lake threaten its fish population?
6. In the face of biological magnification of toxins, is it healthier to feed at a lower or higher trophic level? Explain.
7. Describe how the newly introduced species damage natural ecosystem
8. Appreciate how modern agricultural technologies are an issue as well as a solution

UNIT 5

WORK, ENERGY AND POWER

Key Unit competence: Differentiate work, energy and power and criticize the management of energy and natural resources.

5.0. INTRODUCTORY ACTIVITY

Observe different pictures in the figure above and answer the following questions:

a) Why do you think there was a need to employ machines and people to do activity illustrated in the figure above?

b) Imagine you are the overall supervisor of the activity, what would you consider (give at least 3 ideas) to pay the workers?

5.1. Concept of Work, Energy and Power

ACTIVITY 5.1

The picture above shows how machines are used to simplify work. Clearly observe it and answer the following questions

a) The crane shown in the figure above is used to lift heavy objects from one point to another usually over a height. What scientific phenomenon can be used to describe the whole process of lifting the body/mass indicated in the diagram?

b) According to the diagram, when do we say work is done?

c) Assuming the lift took 30 minutes to lift the body instead of 5 minutes. Comment on the efficiency of the crane. Is this machine powerful?

d) If not, how can you estimate the power of a given machine?

5.1.1. Work

Work done by a Force

Work results when a force acts upon an object to cause a displacement (or a motion) or, in some instances, to hinder a motion or simply to modify it. Three variables are of importance in this definition - force, displacement, and the extent to which the force causes or hinders the displacement. Each of these three variables find their way into the equation for work. That equation is:

Work = Force x Displacement x Cosineθ

W = Fx d x cosθ

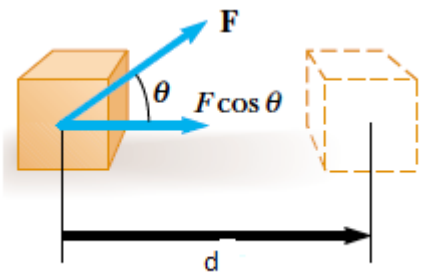
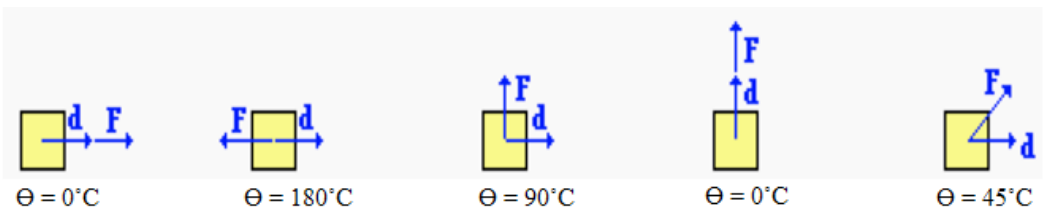


Fig.5.1. Work done by a constant force F

Since the standard metric unit of force is the Newton and the standard metric unit of displacement is the meter, then the standard metric unit of work is a Newton meter, defined as a Joule and abbreviated with "**J**".

The most complicated part of the work equation and work calculations is the meaning of the angle theta in the above equation. The angle is not just any stated angle in the problem; it is the angle between the F and the d vectors.

In solving work problems, one must always be aware of this definition - theta is the angle between the force and the displacement which it causes. If the force is in the same direction as the displacement, then the angle is 0 degrees. If the force is in the opposite direction as the displacement, then the angle is 180 degrees. If the force is up and the displacement is to the right, then the angle is 90 degrees. This is summarized in the graphic below.



Example 5.1

A force 3N acts through a distance of 12m in the direction of thee force. Find the work done.

Answer:

force and displacement are in the same direction $W = F \times d$

$W = 3\ N \times 12\ m = 36\ J$

Example 5.2

An object is pulled along the ground by a 75N force directed 28^0 above the horizontal. How much work does the force do in pulling the object 8m?

Answer:

$$W = (75\ N) \times (8\ m) \cos 28^0$$

$$W = 530\ J$$

Because of the way the force and displacement vectors are combined in Equation above, it is helpful to use a convenient mathematical tool called the scalar product of two vectors. We write this scalar product of vectors A and B as $A.B$ (Because of the dot symbol, the scalar product is often called the **dot product**.)

The SI unit of work is the Joule, which is the work done when a force of 1 N acts trough a distance of 1m. Thus $1\ J = 1\ Nm$

There are two types of forces:

- Positive work when the direction of motion and that of the force are the same. **Example:** when a person is pushing on a car, he does a positive work
- When the direction of motion is opposite to direction of the force, the work is negative. **Example:** when a stone is thrown up vertically, the work of the force of gravity are negative.

5.1.2. Energy

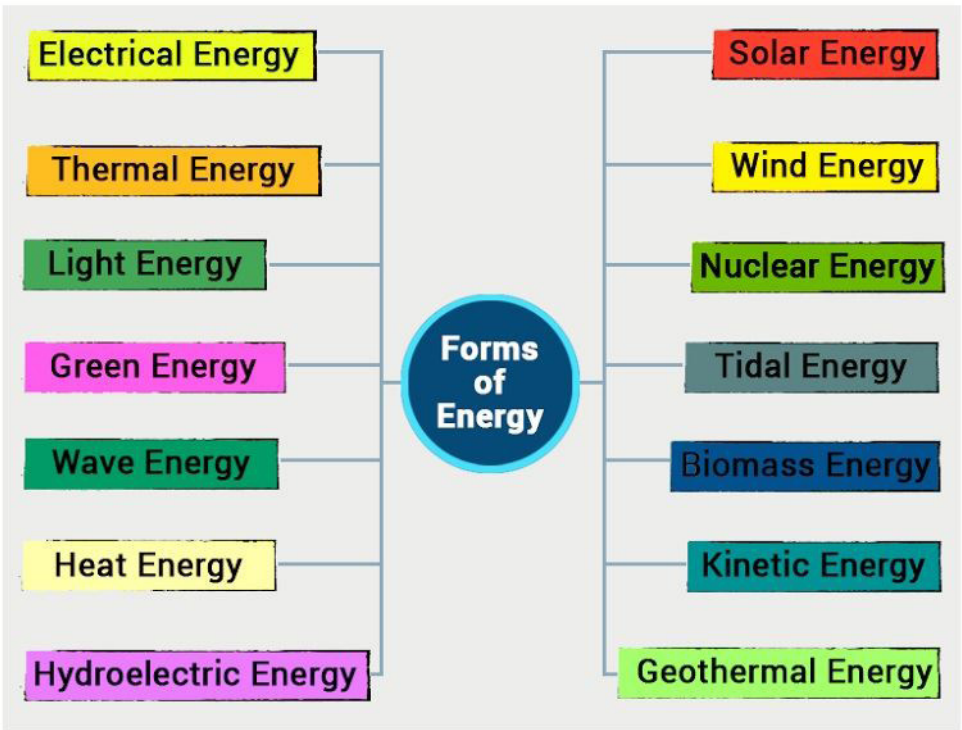
Energy, in physics, the capacity for doing work. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other various forms. There are, moreover, heat and work—i.e., energy in the process of transfer from one body to another. After it has been transferred, energy is always designated according to its nature. Hence, heat transferred may become thermal energy, while work done may manifest itself in the form of mechanical energy.

All forms of energy are associated with motion. For example, any given body has kinetic energy if it is in motion. A tensioned device such as a bow or spring, though at rest, has the potential for creating motion; it contains potential energy because of its configuration. Similarly, nuclear energy is potential energy because it results from the configuration of subatomic particles in the nucleus of an atom.

Energy can be neither created nor destroyed but only changed from one form to another. This principle is known as the conservation of energy or the first law of thermodynamics. For example, when a box slides down a hill, the potential energy that the box has from being located high up on the slope is converted to kinetic energy, energy of motion. As the box slows to a stop through friction, the kinetic energy from the box's motion is converted to thermal energy that heats the box and the slope.

Energy can be converted from one form to another in various other ways. Usable mechanical or electrical energy is, for instance, produced by many kinds of devices, including fuel-burning heat engines, generators, batteries, fuel cells, and magnetohydrodynamic systems.

In the International System of Units (SI), energy is measured in joules. One joule is equal to the work done by a one-newton force acting over a one-metre distance.



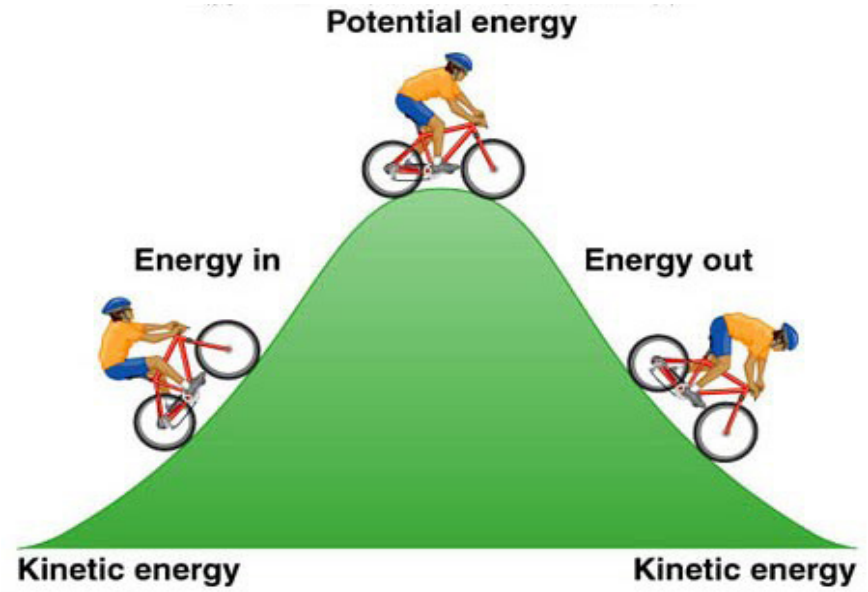


Figure 5.1 Potential energy

Potential energy may be defined as the energy possessed by an objects or bodies due to their position or state of strain or the position of their parts

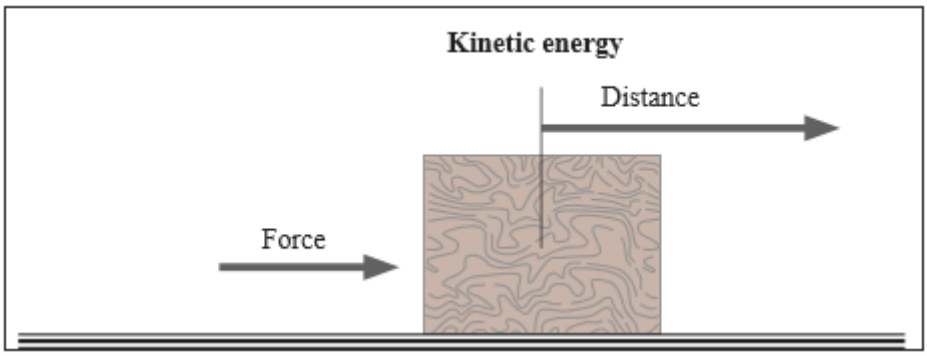
The potential energy when a body of mass m is at height h above ground level equals to the work which must be done against the downward pull of gravity to raise the body to this height.

A force equal and opposite to $w = mg$ has to be exerted on the body over displacement h assuming g is constant near the earth's surface. Therefore, work done by external force against gravity $potential\ energy = force \times displacement$

$$PE = mgh$$

Kinetic energy

Kinetic energy is the form of energy possessed by moving bodies. Such bodies have the ability to do work e.g. a flying bullet can kill a dangerous wild animal. Wind (a moving mass of air) flowing streams, falling rocks, heat flowing from a body at high temperature to one at a lower temperature, electricity (flowing electrons), moving cars, lorries, busses, etc, all have kinetic energy. Kinetic energy of a body is dependent upon both the body's mass and speed.



In mechanics, for a point particle, it is mathematically defined as the amount of work done to accelerate the particle from zero velocity to the given velocity *v:*

$$K = \frac{1}{2}mv^2$$

For extended objects composed of n particles, the kinetic energy of the composite body is the sum of the kinetic energies of the particles:

$$K = \sum_{i=1} \frac{1}{2} m_i v_i^2$$

Work – kinetic energy theorem

Suppose that a single constant force F acts on a particle in its direction of motion and causes it to accelerate, increasing the speed from an initial value u up to a final value v. recall that for an object with constant acceleration,

$$v^2 - u^2 = 2ax$$

Substitute $a = \frac{F}{m}$ then $v^2 - u^2 = 2\frac{F}{m}x \Leftrightarrow Fx = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

The work done by the force is $W = Fx$ so $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

According to the **work-kinetic energy theorem** if an external force acts upon a rigid object, causing its kinetic energy to change from K_1 to K_2, then the mechanical work (W) is given $W = \Delta K = K_2 - K_1 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

These relationships are the basis of **the work-energy theorem.**

Work-Energy Theorem

The total work done on an object equals the change in the object's kinetic energy, provided there is no change in any other form of energy (for example, gravitational potential energy).

Example 5.3

A 145 g baseball is thrown with a speed of 25 m/s.

a) What is its kinetic energy?
b) How much work was done on the ball to make it reach this speed, if it started from rest?

Answer:

a) The kinetic energy is $K = \frac{1}{2}mv^2 = 45J$
b) Since the initial kinetic energy was zero, the net work done is just equal to final kinetic energy, 45 J

Energy conservation

Law of conservation of energy

This law states that: "in all energy conversions or transformations, energy is neither created nor destroyed, but it may be converted from one form to another, but the total amount remains constant."

This means that energy does not disappear but is either transferred to another place or transformed (changed) into some other form. This law tells us when one form of energy is converted to another form during an energy conversion, energy in put always equals energy out.

The law of conservation of energy can also be stated as follow: "*during transformation of energy from one form to another, the total amount of energy is unchanged i.e. the amount of the new form which appears is equal to the amount of the old form which disappeared"*

Conservation of Mechanical energy

Mechanical energy can either be potential energy (stored energy of position) or kinetic energy (energy of motion)

Objects have mechanical energy if they are in motion and/or if they are at some position relative to a zero potential energy position (for example, a brick held at a vertical position above the groundor zero height position).

A moving car possesses mechanical energy due to its motion. A moving baseball possesses mechanical energy due to both its high speed and its vertical position above the ground

We call **Mechanical energy**, the sum of kinetic energy and all forms of potential energy associated with an object or group of objects i.e. $E = K + U$

Conservation of mechanical energy: Initial mechanical energy = final mechanical energy in the absence of friction i.e.

$$\sum ME_i = \sum ME_f \qquad \sum E = \sum K + \sum U \quad \text{is constant in time.}$$

This is a statement of conservation of mechanical energy for an isolated system. An isolated system is one for which there are no energy transfer across the boundary.

Mechanical energy is not conserved in the presence of friction, but there is a relationship between the work done and the change in kinetic energy. This relationship is known as the **work-kinetic energy theorem** and is written as follows:

$$W_{net} = \Delta K \qquad \textbf{i.e. network = change in kinetic energy}$$

Example 5.7

An object, which is 5 m above the ground, is released from rest. Determine the speed of the object when it is 3 m above the ground (Assume $g = 10\ m/s^2$)

Answer:

$$(K_i + U_i \ at \ \ 5\ m = (K_f + U_f)\ at\ 3\ m$$

$$0 + mgh_i = \frac{1}{2}mv^2 + mgh_f \quad (K_i = 0\ because\ initialspeed = 0)$$

$$v^2 = 2g(h_i - h_f) = 2(10)(5-3) = 40$$

$$v = 6.3\ m/s$$

Energy degradation

Energy degradation in physics is the process by which energy becomes less available for doing work compared conservation of energy and dissipation of energy

5.1.3. Power

Often it is interesting to know not only the work done on an object, but also the rate at which this work is done. For example, imagine two cars of same mass but different engines. Both the cars climb roadway up a hill. But one car takes less time whereas another one takes more time to reach the top. So, it is very interesting to know not only the work done by the vehicles but also the rate at which it is done.

Power in Physics is defined as the rate at which work is done upon an object. Like all rate quantities, power is a time-based quantity. Power is related to how fast a job is done. Thus, two identical jobs or tasks can be performed at different rates - one slowly or and one rapidly. The work is the same in each case (since they are identical jobs) but the power is different. The equation for power shows the importance of time:

$$\textbf{Power = Work / time}$$

$$\textbf{P = W / t}$$

The unit for standard metric work is the Joule [J]and the standard metric unit for time is the second [s], so the standard metric unit for power is a Joule / second [J/s], defined as a Watt and abbreviated as "W" in honor of James Watt (1736-1819).

Special attention should be taken so as not to confuse the unit Watt, abbreviated "W", with the quantity work, also abbreviated by the letter "W".

Combining the equations for power and work can lead to an alternative equation for power.

Power is W/t and work is $F \bullet d \bullet \cos\theta$

Substituting the expression for work into the power equation yields $P = F \bullet d \bullet \cos\theta / t$.

If this equation is re-written as:

$$\textbf{P = F } \bullet \textbf{ cos}\theta \bullet \textbf{ (d/t)}$$

It is noticed a simplification which could be made. The d/t ratio is the speed value for a constant speed motion or the average speed for an accelerated motion. Thus, the equation can be re-written as:

$$P = F \bullet v \bullet \cos\theta$$

Where **v** is the constant speed or the average speed value.

APPLICATION ACTIVITY 5.1

1. Computer the power output of machine that lifts a 500kg crate through a height of 20m in a time of 60s
2. A driver of a 1200kg car notices that the car slows from $20\ m/s$ to $15\ m/s$ as it coasts a distance of 130 m along level ground. How large a force opposes the motion?
3. A car is moving at $100\ km/h$. If the mass of the car is 950 kg, what is its kinetic energy?
4. How large a force is required to accelerate a 1300 kg car from rest to a speed of $20\ m/s$ in a distance of 80m?

5.2. Energy production and related issues

ACTIVITY 5.2

This activity is aimed at making research in a given area about energy sources and consumption. You are required to follow the following procedures.

a) Select any area of study of your choice. You should first talk to the leaders of that area and inform them about your mission.

b) Move around that selected area interviewing each family different sources of energy the use in their daily life.

c) Ask them to list the natural sources of energy and manmade sources of energy.

d) Inquire from them if they are used once and do not use them again or if there are some of them that can be re-used again.

e) Let them tell you which one is better to use. The ones that are used once and are depleted or those ones that are used again and again.

f) From the findings make a report about energy sources.

5.2.1. Renewable and non-renewable energy sources

Energy exists freely in nature. Some of them exist infinitely (never run out, called **renewable**).

Non-renewable energy is energy from fossil fuels such as **Natural gas, coal, crudeoil anduranium**. Fossil fuels are mainly made up of Carbon. It is believed that fossil fuels were formed over 300 million years ago when the earth was a lot different in its landscape. It had swampy forests and very shallow seas. This time is referred to as '***Carboniferous Period***'

The examples can be summarised in the table below:

Table 5. 1. Classification of Renewable and non-renewable energy sources

Renewable resources	Non-renewable resources
Solar power	Natural gas
Biomass	Crude oil (Petroleum)
Wind power	Coal
Hydro-power	Uranium
Geothermal energy	
Ocean energy	
Water energy	

5.2.2. Renewable and non-renewable energy in Rwanda

Energy sector in Rwanda has greatly improved over the recent past but there is still plenty of room for further improvement. The aim of the sector is to create conditions for the provision of safe, reliable, efficient, cost effective and environmentally appropriate energy services to households and to all economic sectors on a sustainable basis. Rwanda has abundant unexploited energy sources including renewable and non-renewable energy sources **Renewable (Hydro, wind,** Geothermal, Peat, Solar and methane) and **Non-renewable (**Natural gas, Petroleum, Coal, Uranium).

Renewable resources

Geothermal gradient is the difference in temperature between the core (interior) of the earth (planet) and its surface brings about conduction of heat from the core to the surface. The earth's internal heat is generated from radioactive decay and continual heat loss from the earth's formation. From hot

springs, geothermal energy has been used for bathing to heal some diseases as in some cultures. Geothermal energy is also used to generate electricity at geothermal power stations where heat is used to heat water to get steam which in turn is used to turn the turbines to generate electricity

Biomass is the total mass of organic matter in plant or animal. It is used to generate energy e.g. through burning to give heat energy. When bacteria act on biomass, a gas called biogas is produced which is flammable hence is used as fuel to produce heat. It is a mixture of **65%** methane and **35%** carbondioxide. A biogas plant or digester collects and directs the gas through pipes to the kitchen for cooking in a house or to a generator where electricity is produced.

Chemical energy is stored in the chemical bonds of atoms and molecules. It can only be seen when it is released in a chemical reaction. When chemical energy is released, from a substance, the substance is entirely changed into an entirely different substance.

Some substances that store and release chemical energy are:

i). **Electrolytes** – the chemical reactions in an electrolyte in the batteries produce electricity;

ii). **Petroleum** – petroleum is made of molecules containing carbon and hydrogen. In vapor form, its natural gas and in liquid form, it is crude oil. Energy from petroleum is used to drive vehicles and to produce electricity. Examples include jet fuel, gasoline and electricity.

iii). **Wood** – dry wood acts as a store of chemical energy. This chemical energy is released when wood burns and it's converted into heat and light energy.

iv). **Food** – the chemical energy in food is released while the food is being digested. As the bonds between the atoms of the food break, new substances are created and chemical energy is given out.

Thermal energy is the internal energy in a system by virtue of its temperature. It is the average translational kinetic energy possessed by free particles in a system of free particles in a thermodynamic equilibrium. It can also include the potential energy of a system's particle which may be an electron or an atom. Thermal (heat) energy is transferred of heat across the system boundaries. Thermal energy is important in our daily life, for example in warming the house, cooking, heating the water and drying the washed clothes.

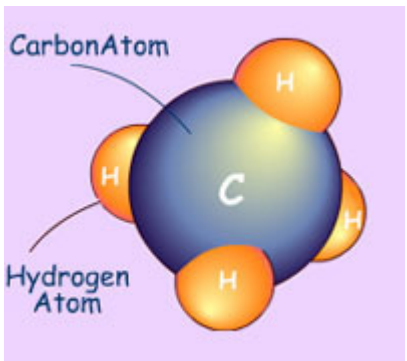
Solar energy is radiant light and heat from the sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy

Non-renewable resources

1. Coal

Coal is a combustible black or brownish-black sedimentary rock composed mostly of carbon and hydrocarbons. Coal is made of the remains of ancient trees and plants that grew in great swampy jungles in warm, moist climates hundreds of millions of years ago. The chemical and organic process these dead organisms undergo to become coal is known as **Carbonization**. Coal is ranked very high if it has undergone a longer carbonization period.

2. Natural Gas



Natural Gas is colorless, shapeless, and odorless in its pure form. Unlike other fossil fuels, natural gas is clean burning and emits lower levels of potentially harmful byproducts into the air. It is therefore called "Clean Gas'.

While natural gas is formed primarily of methane, it can also include ethane, propane, butane and pentane. It is one of the gases that are formed by the same formation of fossil fuels.

The main ingredient in natural gas is methane, a gas (or compound) composed of one carbon atom and four hydrogen atoms. Gas is extracted by drilling wells deep into the ground, through many layers or rock to reach the gas deposits.

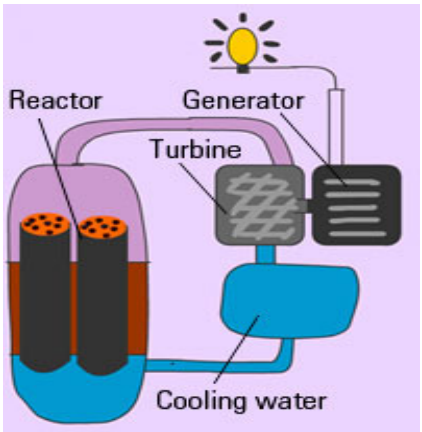
Natural gas comes in two main types:

- The first and conventional type is found in permeable sandstone reservoirs.
- The second, unconventional types are found in other places such as in coal deposits (eg. Coal Steam Gas) or shale rock formations (eg. Shale Gas).

3. Uranium (Nuclear Energy)

Nuclear energy is energy in the nucleus (core) of an atom. Atoms are tiny particles that make up every object in the universe. There is enormous energy in the bonds that hold atoms together.

It is usually in a form of heavy metal, naturally occurring in most rocks, soil, and even in the ocean! It is found in many places in the world. Energy from uranium is called nuclear energy. Power generated from a nuclear reaction is similar to that of fossil fuels because they all use heat to turn blades (turbines) to generate power.



A nuclear power plant uses uranium as fuel. Uranium pellets are combined into large fuel assemblies and placed in a reactor core. In that chamber (reactor), uranium atoms can be made to split, or fission, to release heat. 'Fission' is the process of splitting the uranium atom to form smaller atoms. A kilogram of natural uranium produces as much heat as 20 tons of coal. This is harnessed to make steam and generate power. The chamber in which the fission takes place is called a Reactor. In this reactor, uranium fuel is assembled in such a way that a controlled fission chain reaction can be achieved. It is believed that Uranium was named after the planet Uranus, and it provides the main source of heat inside the earth. Uranium is NOT a fossil fuel. Nuclear power plants are very expensive to build.

5.2.3. Management of energy and natural resources

Many definitions have been offered for "Energy management" one definition that captures the key principles as follows: "the judicious and effective use of energy to maximize profits (that is, minimize coasts0 and enhance competitive positions" Therefore, any management activity that affects the use of energy falls under this definition. The primary objective of energy management is to maximize profit and minimize costs by optimizing energy procurement and utilization, throughout the organization to minimize energy costs without affecting production and quality and to minimize environmental effects.

Eliminate waste: Ensure that energy is used at the highest possible efficiency.

Maximize efficiency: Utilize the most appropriate technology to meet organizational needs.

Optimize supply: Purchase or supply energy at the lowest possible cost.

Energy management practices many vary from simple maintenance and operational activities that ensure equipment and systems use energy efficiency and effectively, to capital intensive installation of new, more efficient technology.

Some desirable sub-objectives of energy management programs include:

1. Conserving energy, thereby reducing cost
2. Cultivating good communication on energy matters
3. Developing and maintaining effective monitoring, reporting and management strategies for efficient energy usage
4. Ending new and better ways to increase returns from energy investments through research and development
5. Developing interest in and dedication to energy management program from all employees

APPLICATION ACTIVITY 5.2

By understanding the Renewable and non-renewable energy sources. Analyze the following table then write the letter matching the best corresponding on it. Write the letter of the term that best matches the definition.

1. The care and wise use of natural resources	a) Biomass
2. A device for collecting solar energy to convert it to heat	b) Conservation
3. Fuels formed from the remains of ancient plants and animals	c) Fossil fuels
4. Energy collected from the natural heat from the earth.	d) Geothermal energy
5. A device that converts radiant energy into electrical energy.	e) Hydroelectric power.
6. An organic substance that can be turned into fuel	f) Nonrenewable resource.
7. A natural resource that can be easily replaced.	g) Renewable resource.
8. Fuels made by a chemical process	h) Solar cell
9. Electrical energy produced by water-powered generators.	i) Solar collector.
10. Energy given off by the sun.	j) Solar energy.
	k) Synthetic fuels.
	l) Tidal energy
	m) Wind energy

SKILLS LAB 5

By the end of this activity, you should be able to find how much power can be used to move a body from one point to another.

Materials you require.

Meter rule, Masking tape, 100g object, spring balance (of 10N), a string, stop watch

Procedures

a) Measure a length of 5 meters on the floor. Mark the beginning and the end of 5m with masking tape.

b) Attach the object to the spring balance with a piece of spring. Slowly pull the object/mass across the floor using a steady amount of force. Record the force (from the spring balance) and the time it takes you to pull the object.

Questions

i) How much power did you use to pull the mass through a distance of 5 meters?

ii) How do you think you could increase the power you used? Decrease the power?

iii) How quickly would you have to drag the object along the floor to produce 50 watts of power?

END UNIT ASSESSMENT 5

1. Which of the following is non-renewable resource?
   a) Coal
   b) Forests
   c) Water
   d) Wildlife
2. Which among the following is not a renewable source of energy?
   a) Solar energy
   b) Biomass energy
   c) Hydropower
   d) Geothermal energy
3. Identify the none-renewable energy resource from the following:
   a) Coal
   b) Fuel cells
   c) wind power
   d) Wave power

4. Which of the following is a disadvantage of most of the renewable energy sources?
   a) Highly polluting
   b) High waste disposal coast
   c) unreliable supply
   d) High running coast
5. Photovoltaic energy is the conversion of sunlight into:
   a) chemical energy
   b) Biogas
   c) Electricity
   d) Geothermal energy
6. Example of renewable resource could be….
   a) Coil
   b) Sunlight
   c) Natural gas
   d) Petrol
7. Wind is a
   a) Natural but non-renewable resource
   b) Natural and renewable resource
   c) Artificial and non-renewable resource
   d) Artificial but renewable
8. Calculate the power required, to pump 50000 litres of water per minute to a vertical height of 72 m.
   a) 360 kW
   b) 49.05 kW
   c) 588.6 kW
   d) 706.32 kW
   e) 69.44 kW
9. The capacity of a body to do work is defined as
   a) energy
   b) power
   c) pressure
   c) force
   d) mass
10. An object at rest with a mass of 68.5 kg is at a height of 65m above the earth's surface. What is its kinetic energy?
   a) 4.45 kJ
   b) 4.37 kJ
   c) 34.25 kJ
   d) 38.6 kJ
   e) one of the above
11. A body with a mass of 88 kg is moving at a velocity of 13.89m/s. What is its kinetic energy?
   a) 8,488 J
   b) 1.22 kJ
   c) 13.89 kJ
   d) 611.11 J
   e) 6.9 kJ

12. An object of mass 95 kg is at a height of 36 m above the ground. What is its potential energy?
    a) 3.42 kJ
    b) 33.55 kJ
    c) 1.71 kJ
    d) 931.95 kJ
    e) 348.62 J
13. Calculate potential energy possessed by a mass of 100 kg located 40 m above ground level.
    a) 4000 kJ
    b) 2.5 MJ
    c) 981 kJ
    d) 392.4 J
    e) 39.24 kJ
14. What is the kinetic energy possessed by a car, having a mass of 1500 kg and travelling at a velocity of 50 km/h?
    a) 30 kJ
    b) 25 kJ
    c) 25 J
    d) 144.7 kJ
    e) 289.4 kJ
15. A body with a mass of 2 tonnes is moving at 100 km/h. What would be the vertical height that the body could climb before coming to rest?
    a) 27.8 km
    b) 5.10 m
    c) 1.41 m
    d) 1.18 km
    e) 39.3 m
16. An object is allowed to free fall from rest from a height of 9 m. What will be its velocity on striking the ground?
    a) 14.07 m/s
    b) 14.00 m/s
    c) 13.53 m/s
    d) 13.29 m/s
    e) 13.00 m/s
17. A body is moving 12 m/s. What would be the vertical height that this body could climb to before it comes to rest?
    a) 5.10 m
    b) 5.50 m
    c) 6.10 m
    d) 7.00 m
    e) 7.34 m

Part 2:

1. A 7.00 kg bowling ball moves at 3.00 m/s. How much kinetic energy does the bowling ball have? How fast must a 2.45 g table-tennis ball move in order to have the same energy as the bowling ball?
2. A 193 kg curtain needs to be raised 7.5 m in as close to 5.0 s as possible. Three motors are available. The power ratings for the three motors are listed as 1.0 kW, 3.5 kW, and 5.5 kW. Which motor is best for the job?
3. Starting from rest, you push your 1.000 kg car over a 5 m distance, on a horizontal ground, applying an also horizontal 400 N force.

a) What is the car kinetic energy change?

b) What is its final velocity at the end of the 5 m displacement? Disregard any friction force.

4. Define (a) Energy, (b) kinetic energy, (c) potential energy and (d) Power.
5. a) A lorry tows a trailer of mass 1800 kg at a speed of 45 km/h along a straight road. If the tension in the coupling is 900 N, find expended by the lorry's engine.

   b) If the trailer is pulled along a stretch of 800 m at a new speed of 60 km/h, find the new power output required to create a tension of 1200 N in the coupling.

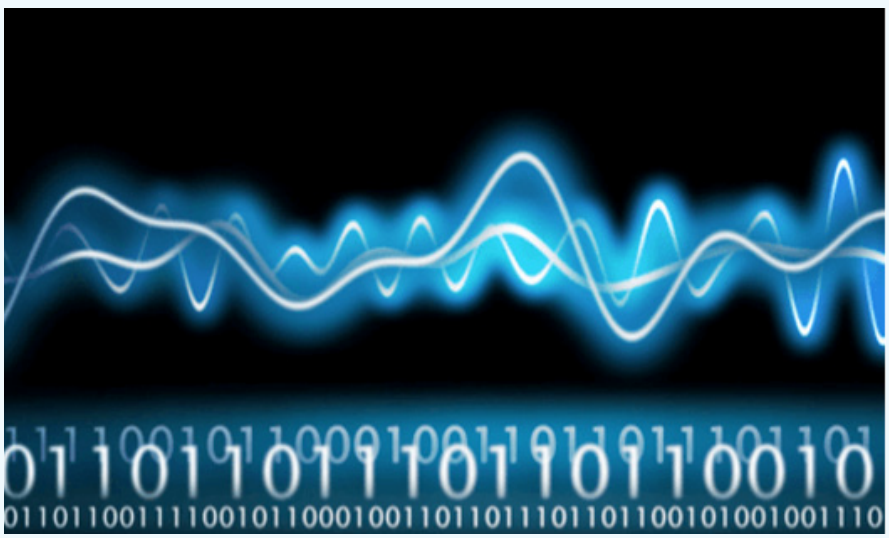
6. A 5.2 kg object speeds up from $3.1\,m/s$ to $4.2\,m/s$. What is the change in kinetic energy?

UNIT 6

ANALOG AND DIGITAL SIGNALS

Key Unit competence: Compare analogue and digital signal systems

6.0. INTRODUCTORY ACTIVITY



There has been a move by the government of Rwanda to make her citizens to change from using analog devices to digital devices. Analog devices transmit and receive signals in analog form whereas digital devices transmit and receive signals digitally.

a) What are different forms of signals you know that you normally use in daily life?

b) Why do you think there is a need to change from analog to digital signal transmission?

c) Mutesi communicates to her brother Ndayisenga who studies abroad using Facebook. Is the flow of information analog or digital? Explain your argument.

6.1. Introduction to Information

ACTIVITY 6.1

Take the case of two people talking on telephone (see Fig.7.1). Use it to answer the questions below.

1. Discuss what the two people are doing.
2. Explain reasons why there is always need to do what they are doing.

6.1.1. Classification of types of Information

Information is any entity or form that resolves uncertainty or provides the answer to a question of some kind. It is thus related to data and knowledge, as data represents values attributed to parameters, and knowledge signifies understanding of real things or abstract concepts.

Some types of information: Instructions, Command, Advisory, Answers, Historical, Predictive.

Information Source

As we know, a communication system serves to communicate a message or information. This information originates in the information source. In general, there can be various messages in the form of words, group of words, code, symbols, sound signal etc. However, out of these messages, only the desired message is selected and communicated. Therefore, we can say that the function of information source is to produce required message which has to be transmitted.

6.1.2. Communication terms and concepts

A **communication system** is a system in which information is transmitted from one physical location (**sender/transmitter**) to a second physical location (**receiver**) through channel.

Any communication system is made up of three parts, shown in Fig.6.1:

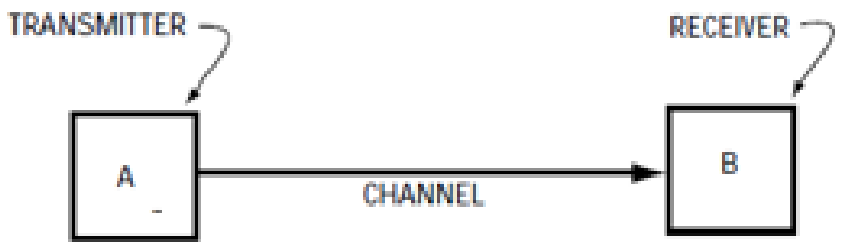


Fig.6. 1 Parts of communication system

The sender is a party that plays the specific role of initiating communication. To communicate effectively, the sender must use effective verbal as well as nonverbal techniques. Such as:

- Speaking or writing clearly.
- Organizing your points to make them easy to follow and understand.
- Maintaining eye contact.
- Using proper grammar.
- Giving accurate information.

The information in the form of sound, picture or data signals cannot be transmitted as it is. A **transducer** is a device which converts one form of energy into another form.

For example in radio broadcasting the electrical signal obtained from sound signal, is processed to restrict its range of audio frequencies (up to 5 kHz in amplitude modulation radio broadcast) and is often amplified.

The message is the most crucial element of effective communication which includes the content a sender conveys to the receiver. A message can come in many different forms, such as an oral presentation, a written document, an advertisement or just a comment

The **message** from the information source may or may not be electrical in nature. In a case when the message produced by the information source is not electrical in nature, an **input transducer** is used to convert it into a time-varying

electrical signal. For example, in case of radio-broadcasting, a **microphone** converts the information or massage which is in the form of sound waves into corresponding electrical signal.

The receiver means the party to whom the sender transmits the message. A receiver can be one person or an entire audience of people. In the basic communication model, the receiver is directly connected with the speaker. The receiver can also communicate verbally and nonverbally. The best way to receive a message is:

- To listen carefully.
- Sitting up straight.
- Making eye contact.
- Don't get distracted or try to do something else while you're listening.
- Nodding and smiling as you listen.
- Demonstrate that you understand the message.

The main function of the receiver is to reproduce the message signal in electrical form from the distorted received signal. This reproduction of the original signal is accomplished by a process known as the **demodulation** or **detection.** Demodulation is the reverse process of modulation carried out in transmitter.

Destination is the final stage which is used to convert an electrical message signal into its original form i.e. sound or TV pictures etc. For example in radio broadcasting, the destination is a **loudspeaker** which works as a transducer i.e. converts the electrical signal in the form of original sound signal.

The channel is a medium through which a message travels from the sender to the receiver. The message travels from one point to another via a channel of communication.

The channel is a physical medium stands between the sender and receiver. Many channels or types of communication exist, such as:

- The spoken word,
- Radio or television,
- An Internet site
- Something written, like a book, letter or magazine.

Every channel of communication has its advantages and disadvantages. For example, one disadvantage of the written word, on a computer screen or in a book, is that the receiver cannot evaluate the tone of the message. For this reason, effective communicators should make written word communications clear so receivers don't rely on a specific tone of voice to convey the message

accurately. The advantages of television as a channel for communication include its expansive reach to a wide audience and the sender's ability to further manipulate the message using editing and special effects.

Feedback describes the receiver's response or reaction to the sender's message. The receiver can transmit feedback through asking questions, making comments or just supporting the message that was delivered. Feedback helps the sender to determine how the receiver interpreted the message and how it can be improved.

While the message signals propagate through the channel, noise signals arise and also channel **attenuation** degrades the signal strength, so signal power decreases with distance. These signals along with noise will reach the receiver end, where message signal is filtered from the transmitted signal along with noise. To some extent, the noise signals can be filtered out and the message signal can be reproduced.

Noise is any unwanted signals that interfere with the information, which includes atmospheric changes, lighting and thunderstorms, other communication systems etc. that can cause noises in the transmitted signal

Signals sent through the communication channel reaches the receiver, where it is decoded or demodulated to extract the message. Since channel attenuation degrades the signal power, amplifier is used at the receiver to compensate for the transmission losses.

Both **selectivity** (ability of a receiver to select the exact **message** signal while rejecting other noise signals) and **sensitivity** (ability of a receiver to pick up weak signals which get affected by channel attenuation) of a receiver should be high only then the message signal can be extracted from the received signal.

Attenuation is a general term that refers to any reduction in the strength of a signal. Attenuation occurs with any type of signal, whether digital or analog. Sometimes called loss, attenuation is a natural consequence of signal transmission over long distances.

When it is necessary to transmit signals over long distances via cable, one or more **repeaters** can be inserted along the length of the cable. The repeaters boost the signal strength to overcome attenuation. Repeaters remove the unwanted noise in an incoming signal. This greatly increases the maximum attainable range of communication.

APPLICATION ACTIVITY 6.1

1. Complete the chart below. If the left column is blank, give the correct term. If the right column is blank, give a brief description.

Term	Brief description of the term
1. Telecommunication	
2	the information signal is a continuous signal in both amplitude and time
3. Digital communication	
4	Communication channel is defined as the medium through which the signal is send from transmitter to receiver

2. Briefly describe the following:
   a. Communication system and telecommunication system
   b. The difference between a communication system and a telecommunication system .

6.2. Signal of System

ACTIVITY 6.2

Investigating the function of wireless microphone

Materials

- Wireless microphone set
- Connecting wires
- Amplifier and mixer
- Speaker

Procedure

1. Connect the full sound system such that the signal will be transmitted to the speakers using wireless microphone. Then, answer to related questions:
   a) How is your voice getting to the speakers?
   b) Where else this system is used?

2. Using a case study of communication using telephones.
   a) Discuss how the information flows from the caller to the receiver?
   b) Imagine there was a need to have our phones be connected to others using physical wires would this be bad or good? Explain your reasoning.

6. 2.1. Analog signal System

A system is a physical set of components that take a signal and produces a signal. In terms of engineering, the input is generally some electrical signal and the output is another electrical signal.

Even without defining information formally, we intuitively understand that speech, audio, and video signals contain information. We use the term ***message signals*** for such signals, since these are the messages we wish to convey over a communication system. In their original form– both during generation and consumption–these message signals are ***analog****:* they are continuous time signals, with the signal values also lying in a continuum.

Analog systems operate with values that vary continuously and have no abrupt transitions between levels. For a long time, almost all electronic systems were analog, as most things we measure in nature are analog. For example, your voice is analogous; it contains an infinite number of levels and frequencies. Therefore, if you wanted a circuit to amplify your voice, an analog circuit seems a likely choice.

Analog signal is a continuous signal that contains time varying quantities. An analog signal is a continuous wave denoted by a sine wave and may vary in signal strength (amplitude) or frequency (time). The sine wave's amplitude value can be seen as the higher and lower points of the wave, while the frequency (time) value is measured in the sine wave's physical length from left to right.

Frequency is a parameter that determines how often the sinusoidal signal goes through a cycle. It is usually represented with the symbol *f*, and it has the unit hertz.

$$f = \frac{1}{T}$$

Where *T* is a periodic time, time used to make one complete turn or complete oscillation and is measured in seconds. The difference between the highest and

the lowest frequencies contained in that signal is termed as Bandwidth

Mathematically, the bandwidth is given by:

$$B_W = \Delta f = f_{usb} - f_{lsb}$$

Where f_{usb} and f_{lsb} stand for upper side band and lower side band respectively

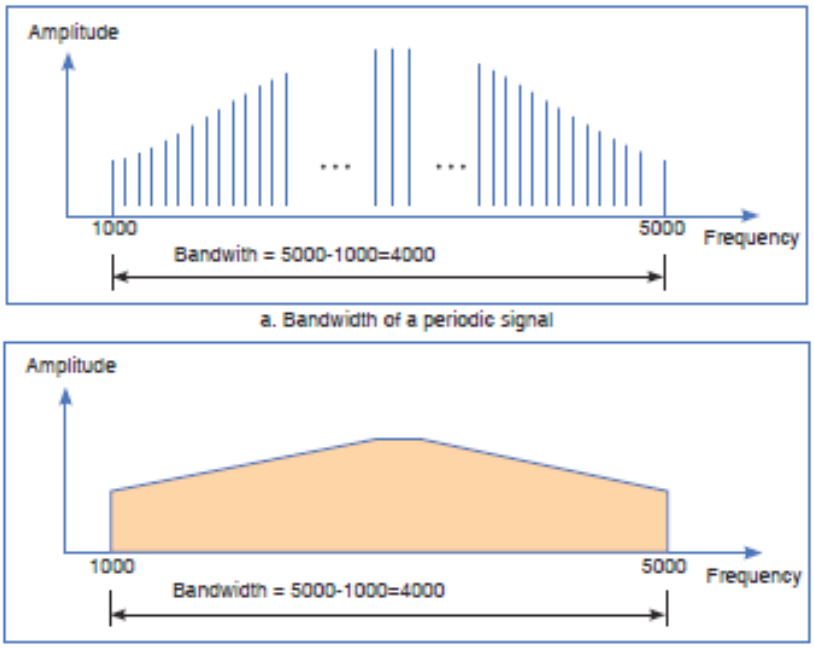


Fig.6. 2

The distance moved by wave in one period is called wavelength, λ

Wavelength of a sinusoidal waveform traveling at constant speed *v* and frequency *f* are related by wave equation:

$$\lambda = \frac{v}{f} = vT$$

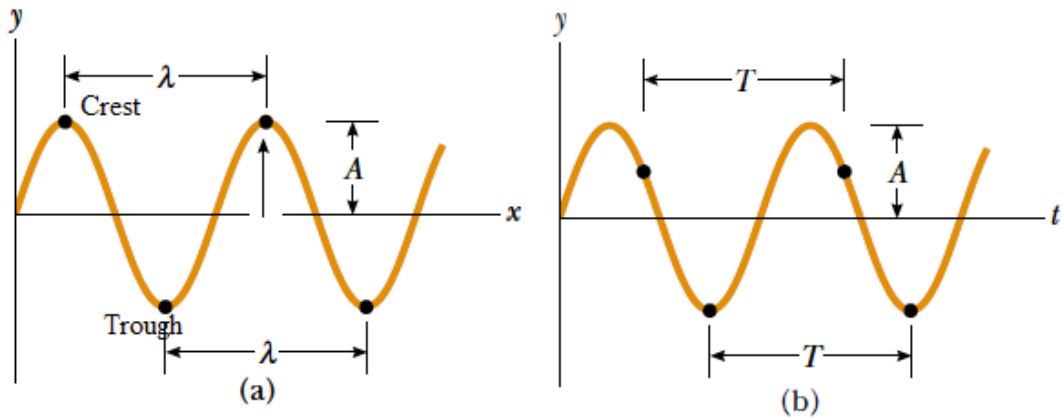


Fig.6. 3 Analog signals: *(a) The wavelength λ of a wave is the distance between adjacent crests or adjacent troughs. (b) The period T of a wave is the time interval required for the wave to travel one wavelength.*

Amplitude A is define as the maximum displacement from equilibrium position to the peak (trough or crest)

Example1. The velocity of sound in seawater is 1531 m/s. Find the wavelength in seawater of a sound wave whose frequency is 256 Hz.

Answer:

The wavelength: $\lambda = \frac{c}{f} = \frac{1531}{256} = 5.98\ m$

Analog signal can be used to measure changes in physical phenomenon such as light, sound, pressure, or temperature. For instance, **microphone** can convert sound waves into analog signal. Even in digital devices, there is typically some analog component that is used to take in information from the external world which will then get translated into digital form –using analog to digital converter.

Analog signal shows some advantages and disadvantages such as:

a) Advantages of analog signals

- Uses less bandwidth than digital sounds.
- More accurate representation of sound.
- It is the natural form of sound.
- Because of editing limitations, there is little someone can do to tinker with the sound, so what you are hearing is the original sound.

b) Disadvantages

- There are limitations in editing.
- Recording analog sound on tape is expensive.
- It is harder to synchronize analogous sound.
- Quality is easily lost if the tape becomes ruined.
- A tape must always be wound and rewound in order to listen to specific part of sound which can damage it.
- Analog is susceptible to clipping where the highest and lowest notes of a sound are cut out during recording.

6.2.2. Digital signal system

In electronic signal and information processing and transmission, digital technology is increasingly being used because, in various applications, digital signal transmission has many advantages over analog signal transmission. Numerous and very successful applications of digital technology include the continuously growing number of Personal Computers, the communication network ISDN as well as the increasing use of digital control stations (Direct Digital Control: DDC).

Unlike analog technology which uses continuous signals, digital technology encodes the information into discrete signal states. When only two states are assigned per digital signal, these signals are termed binary signals. One single binary digit is termed a bit - a contraction for binary digi t.

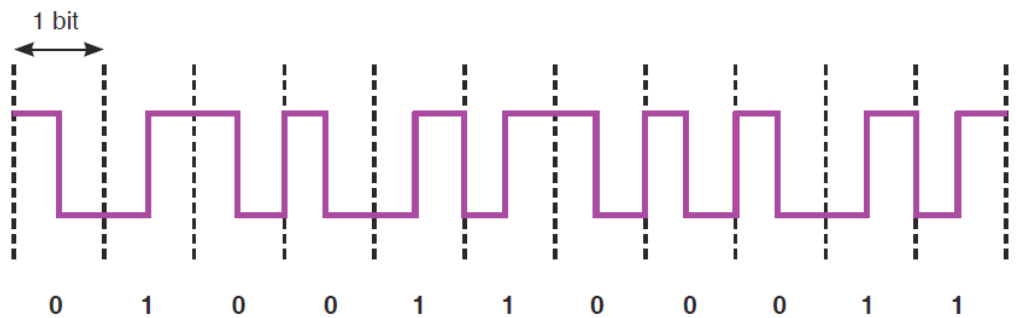


Fig.6.3. *Digital signal*

More capacity from the same number of frequencies; that is, they provide superior Spectral Efficiency. This is a result of the modulation methods used, and the fact that, in many cases more than one 'conversation' can be accommodated within a single radio channel:

Consistent voice clarity at low received signal levels near the edge of coverage: The general consensus is that digital radios provide better audio quality than analog ones. With analog FM radios, the audio quality steadily declines as the received signal strength gets weaker. Digital radios however, will have a consistent audio quality throughout the full service area. The edges of the coverage area in a digital radio system are similar to those experienced with cellular telephones.

Data is defined in the standard: This means data implementation is no longer proprietary, there are a wide variety of data mechanisms and inter-operability can extend into the data domain. With the accepted increase of efficiency by using data communications over voice, this will further increase the usability and effectiveness of digital radio systems.

Secure transmissions: In digital technologies, data and voice can be secured using encryption without impacting voice quality using industry standard encryption techniques.

Analog and **digital** signals are used to transmit information, usually through electric signals. In both these technologies, the information, such as any audio or video, is transformed into electric signals. The **difference between analog and digital** technologies is that in analog technology, information is translated into electric pulses of varying amplitude. In digital technology, translation of information is into binary format (zero or one) where each bit is representative of two distinct amplitudes.

Comparison between digital and analog signals

	Analog	**Digital**
Signal	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
Waves	Denoted by sine waves	Denoted by square waves
Representation	Uses continuous range of values to represent information	Uses discrete or discontinuous values to represent information
Example	Human voice in air, analog electronic devices	Computers, CDs, DVDs and other digital electronic devices.

Technology	Analog technology records waveforms as they are	Samples analog waveforms into a limited set of numbers and records them.
Data transmission	Subjected to deterioration by noise during transmission and write/ read cycle	Can be noise-immune without deterioration during transmission and write / read cycle
Flexibility	Analog hardware is not flexible	Digital hardware is flexible in implementation
Response to noise	More likely to get affected by noise, reducing accuracy	Less affected since noise response are analog in nature
Uses	Can be used in analog devices only. Best suited for audio and video transmission	Best suited for Computing and digital electronics
Applications	Thermometer	PCs, PDAs
Bandwidth	Analog signal processing can be done in real time and consumes less bandwidth.	There is no guarantee that digital signal processing can be done in real time and consumes more bandwidth to carry out the same information
Memory	Stored in the form of wave signal	Stored in the form of binary bit
Power	Analog instrument draws large	Digital instrument draws only negligible power
Cost	Lower cost and portable	Cost is high and not easily
Errors	Analog instruments usually have a scale which is cramped at lower end and give considerable observational errors	Digital instruments are free from observational errors like parallax and approximation errors

6.2.3. Principles of signal systems

A message carrying signal has to get transmitted over a distance and for it to establish a reliable communication; it needs to take the help of a high frequency signal which should not affect the original characteristics of the message signal.

The high frequency signal which has a certain phase, frequency, and amplitude but contains no information is called a **carrier signal**. It is an empty signal. It is just used to carry the signal to the receiver after modulation without getting affected by external disturbances

Modulation is the process of varying the characteristics of carrier signal with the modulating signal or **modulation** is defined as the superimposition of low frequency baseband signal (modulating signal) over high frequency carrier signal by varying different parameters of the carrier signals. Based on the types of parameters that are varied in proportion to the baseband (low frequency) signal, modulation is of different types.

In digital modulation, the message signal is converted from **analog** into digital. In **digital modulation** techniques, the analog carrier signal is modulated by discrete signal. The carrier wave is switched on and off to create pulses such that signal is modulated.

Low frequency signal (Baseband) communication is not commonly used for distance communication. Low frequency baseband signals, having low energy, if transmitted directly will get distorted. So baseband signal must be modulated with high frequency signal to increase the range of transmission.

Demodulation is the reverse process of modulation, which is used to get back the original message signal. Modulation is performed at the transmitting end whereas demodulation is performed at the receiving end.

There are many types of modulations. Depending upon the modulation techniques used, they are classified as

a) Amplitude modulation (AM)

It is a modulation technique used for transmitting information using carrier wave. In this method, amplitude of the carrier signal is varied with respect to the message signal. *Carrier frequency* used for amplitude modulation will be at least ten times more than baseband frequency.

It is a type of modulation, where the amplitude of the carrier wave is changed in accordance with the intensity of the signal. However, the frequency and the phase shift of the modulated wave remains the same.

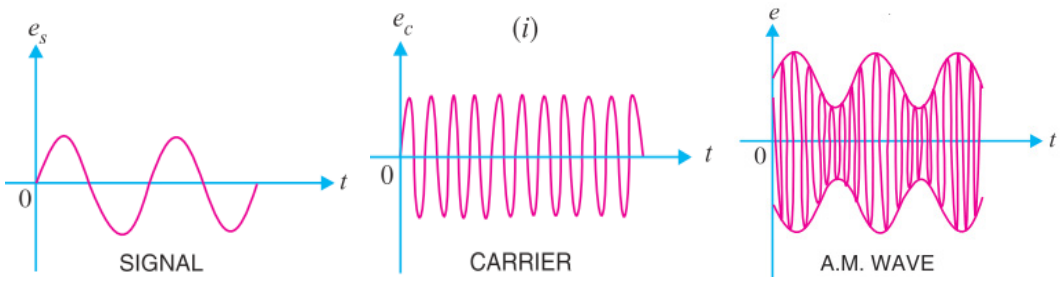


Fig.6. 4 In amplitude modulation (AM), the amplitude of the carrier signal is made to vary in proportion to the audio signal's amplitude.

b) Frequency Modulation

Frequency modulation method is also used to improve the range. In this method, *instantaneous frequency* of the carrier wave is varied in proportion to the amplitude of the message signal. One important advantage of frequency modulation over amplitude modulation is that, it can be used for both analog and digital signals. But amplitude modulation can only be used in analog signals.

It is a type of modulation, where the frequency of the carrier wave is changed in accordance with the intensity of signal.

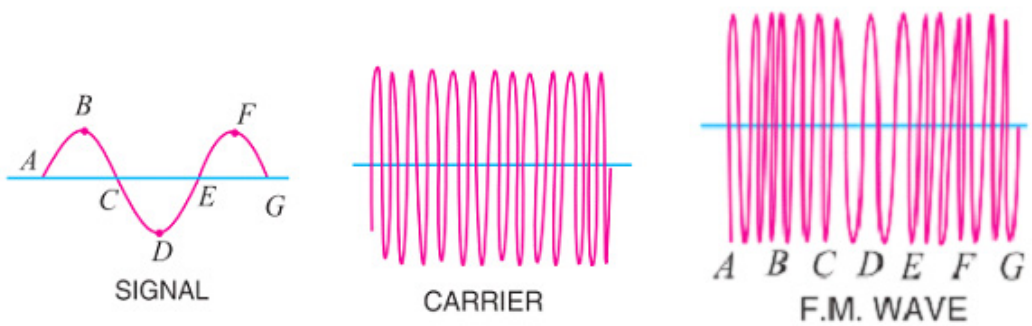


Fig.6. 5 In frequency modulation (FM), the frequency of the carrier signal is made to change in proportion to the audio signal's amplitude. This method is used by FM radio and television

c) Phase Modulation

In this modulation technique, the phase of the carrier wave is varied according to the information signal.

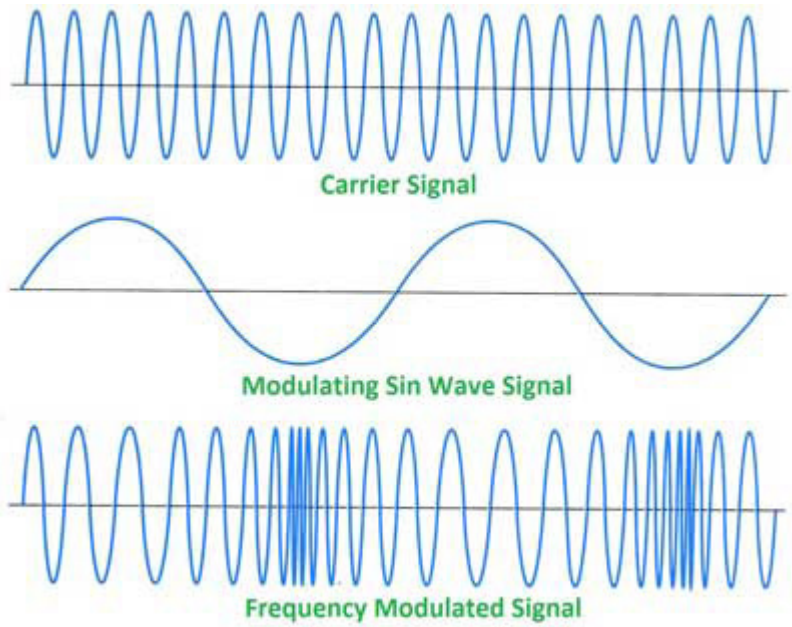


Fig.6. 6 Phase modulation

Need for modulation

Following are some of the advantages for implementing modulation in the communication systems.

a) To reduce the antenna height: The antenna used for transmission, had to be very large, if modulation was not introduced. The range of communication gets limited as the wave cannot travel to a distance without getting distorted.

The message signal has low frequency. As frequency decreases, the wavelength increases.

Height $h = \frac{\lambda}{4}$

So as wavelength increases, **antenna** height need to be increased

b) To multiplex the various signals: In one channel, several signals can be transmitted using multiplexing. Using modulation various signals can be allotted to different frequencies. It avoids the interference of signals.

c) To reduce noise and interference: At some frequencies, the effect of noise will be high and low at some other frequencies. If some frequency has high noise, then by using modulation technique the spectrum is shifted to another frequency where noise is less.

d) Communication range increases.
e) Adjustments in the bandwidth is allowed.
f) Reception q1uality improves.

APPLICATION ACTIVITY 6.2

1. What is the difference between frequency and wavelength?
2. Decrease in strength of signal is known as

A. tuning C. modulation

B. attenuation **D.** amplification

3. ……. Is a link between the transmitter and receiver

A. Microphone C. Transducer

B. transmission channel D. Telephone

4. The antenna of a cell phone is often ¼ wavelength long. A particular cell phone has an 8.5 cm-long straight rod for its antenna. Estimate the operating frequency of this phone .

SKILLS LAB 6

In this activity you will make a survey in any selected Umudugudu of your choice. The survey is about the usage of Digital and analog devices by local people in the specified area.

Procedures

a) Select a Mudugudu of your interest either around your school or where you stay.
b) Move around asking people whether they have/use the following gadgets: Phones, Computers, Radios, Televisions and others
c) Ask them whether these devices operate by wireless or they need to be connected to wires that come from serving centers.
d) Make a suitable chart indicating all the data recorded or attained
e) Make a general comment about your findings

END UNIT ASSESSMENT 6

1. The two basic types of signals are analog and……

   A. Digilog

   B. Digital

   C. Vetilog

   D. Sine wave

2. Which of the following characterizes an analog quantity?

   A. Discrete levels represent changes in a quantity.

   B. Its values follow a logarithmic response curve.

   C. It can be described with a finite number of steps.

   D. It has a continuous set of values over a given range.

3. Which type of signal is represented by discrete values?

   A. Noisy signal

   B. Nonlinear

   C. Analog

   D. Digital

4. Digital data refers to information that is

   A. Continuous

   B. Discrete

   C. Bits

   D. Bytes

5. In data communications, non- periodic signals

   A. Sine wave

   B. Digital Signals

   C. Analog Signals

   D. None of the above

6. Completion of one full pattern is called a

A. period

B. Cycle

C. Frame

D. Segment

7. Term that refers to infinite no of values in range is

A. Peak

B. Analog Signal

C. Digital Signal

D. None of the above

8. In…….transmission, the carrier signal modulated so that its amplitude varies with the changing amplitudes of the modulating signal

A. **AM** B. PM

B. FM D. None of the above?

9. To transmit 1 kHz frequency signal, wavelength of the signal should be ……m

A. $3x10^3$ B. $3x10^5$

C. $3x10^7$ D. $3x10^{10}$

10. Device which transforms one form of energy into another form of energy is called a ……..

A. Microphone C. transponder

B. transformer D. Transistor

11. What is meant by carrier wave in telecommunication?

12. What is the application of a carrier wave in a telecommunication system?

13. Distinguish between Amplitude modulation and frequency modulation

14. Find the range in wavelengths (in vacuum) for visible light in the frequency range between 4.0×10^{14} *Hz* (red light) and 7.9×10^{14} *Hz* (violet light). Express the answers in nanometers..

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