BIO SCIENCES II

Module Code: BIO 105

No Of hours: 150

Credits: 20

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Abbreviations:

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Module Overview

(i) Module Descriptor

This module builds on your pre-requisite knowledge of the levels of structural organization, microbiology and parasitology. This pre-requisite knowledge will equip you with an understanding of the interrelatedness of body systems, biochemical/physiological processes, pharmacological principles and further circumstances that lead to homeostatic imbalances.

(ii) How to use this Module

This module has units and each unit has exercises, assignments or laboratory practicals which you must make sure you do. The references quoted in this module are supposed to be read as support for the module. Make sure you read all the required books as these are directly relevant to the achievement of the expected study outcomes. The units are interrelated; make sure that you have competently mastered the concepts of a unit before moving to the next one.

Take note that you are required to attend every theory/practical session and submit the relevant exercises/assignments/laboratory reports in good time. Some work will be required to be submitted individually while the other will be group presentations/work.

(iii) How the Module fits into the Programme

The knowledge contained in this module will assist you appreciate the interrelatedness of body systems, biochemical processes, pharmacodynamics and pharmaco-kinetics in order for you to ably make informed decisions in nursing and midwifery practice.

Learning outcomes/ Assessment Criteria

LEARNING OUTCOMES	**ASSESSMENT CRITERIA**
When you have successfully completed this module you will:	**To demonstrate that you have achieved the learning outcomes you will:**
Explain the different body systems and their functions	Identify body systems Describe body functions
Describe the interrelatedness of the various body systems	Appreciate/Discuss the interrelatedness of the various body systems
Discuss homeostatic imbalances that occur in the human body.	Identify/Explain homeostatic imbalances
Discuss the use, relevance and importance of the major biochemical processes in the physiology of the human body	Describe the biochemical/physiological processes
Demonstrate an understanding of the fundamental principles of pharmacology	Apply the principles of pharmacodynamics and pharmaco-kinetics to nursing and midwifery practice

Learning Contract

Unit I: The Nervous System

Learning Resources: Library, Science Laboratory, Laboratory manuals, models and charts of the human body

Introduction

The task of keeping the body healthy and alive is a job performed by every one of its many trillions of cells. Like the singers in a choir, each cell must perform its role for the good of the whole. The choirmaster of this great choir is the **nervous system**, which provides control and coordination for the cells' many activities. The nervous system is responsible for our perceptions, behaviours, and memories, and it initiates all voluntary movements. Therefore, this unit introduces you to the system which accomplishes the gigantic and enormously complex job of keeping the body alive.

Learning Outcomes

- Describe the functions of the nervous system
- List the organs and divisions of the nervous system
- Identify the major types of cells in the nervous system
- Identify the anatomical and functional components of a three-neuron reflex arc.
- Compare and contrast the propagation of a nerve impulse along a nerve fibre and across a synaptic creft.
- Identify the major anatomical components of the brain and spinal cord and briefly comment on the functions of each.
- Compare and contrast spinal and cranial nerves.
- Discuss the structure and and functions of the two divisions of the autonomic nervous system.
- Describe major nervous system disorders.
- Discuss the special and general sense organs and their functions.
- Describe the disorders of major special and general sense organs.

Hints : You should use charts, models and your body to describe different parts of the nervous system.

:You should use reference books for more information on the terms listed.

Content

Functions of the nervous system

a) Sensory in put- sensory receptors monitor numerous external and internal stimuli, such as touch, temperature, taste , smell, sound, blood pressure and body position.
b) Integration- the brain and spinal cord are the major organs for processing sensory input and initiating responses.
c) Homeostasis- the nervous system plays an important role in the maintenance of homeostasis.
d) Mental activity- the brain is the centre of mental activity, including consciousness, memory and thinking.
e) Control of skeletal muscles- the nervous system controls contraction of skeletal muscles that results in the major movements of the body.

Divisions of the nervous system

Structural Divisions

a) **The central nervous system (CNS)-** consists of the brain and the spinal cord.
b) **The peripheral nervous system (PNS)-** consists of nerves and ganglia, which lie outside the CNS. It includes all the **cranial** and **spinal nerves.**

Functional Divisions

a) **Somatic nervous system (SNS)** is controlled voluntarily (by conscious will), and all the effectors are skeletal muscles. SNS is also referred to as voluntary nervous system.
b) **Autonomic nervous system (ANS)** is controlled involuntarily (usually operates without conscious control) and consists of visceral motor nerve fibres that regulate the activities of smooth muscles, cardiac muscles and glands. ANS is also referred to as involuntary nervous system.

Functional Subdivisions of (ANS)

Sympathetic and parasympathetic nervous systems which typically work in opposition to each other- what one subdivision stimulates, the other inhibits.

Exercise: *Draw a table comparing sympathetic and parasympathetic nervous systems.*

Cells of the nervous system

The two types of cells found in the nervous system are: **neurons** or nerve cells and **neuroglia** or glial cells.

Neurons provide most of the unique functions of the nervous system, such as sensing, thinking, remembering, controlling muscle activity and regulating glandular secretions. Neurons therefore conduct nerve impulses (messages) from one part of the body to another. Neurons have *extreme longevity*- over 100 years, are largely *amitotic* and have an exceptionally *high metabolic rate*.

Parts of a neuron: Most neurons have three parts: cell body, dendrites and axon.

Exercise: *Draw a typical neuron, label and indicate the functions of* ***all*** *parts.*

Structural classification of neurons
This is according to the number of processes extending from the neurons' cell body.

Multipolar neurons- have three or more processes. Most common type (99%).

Bipolar neurons- have two processes- an axon and dendrite.
Unipolar neurons- have a single process that emerges from the cell body.

Functional classification of neurons

This is according to the direction in which the nerve impulse travels relative to the central nervous system.

Sensory (afferent) neurons- carry impulses toward CNS.
Motor (efferent) neurons- carry impulses away from CNS.
Interneurons (association) neurons- conduct impulses from sensory neurons to motor neurons. Interneurons are also called central or connecting neurons.

Neuroglia (*-glia* = glue) or **glia** support, nourish and protect the neurons and maintain homeostasis in the interstitial fluid that bathes neurons. Neuroglia constitute about half the volume of CNS. An important reason for discussing glia is that one of the most common types of brain tumour- called **glioma** develops from them**.** Gliomas tend to be highly malignant and grow rapidly. Of the six types of neuroglia, four – astrocytes, oligodendrites, microglia and epedymal cells-are found only in the CNS. The remaining two types- Schwann cells and satellite cells-are present in the PNS.

Nerves and Tracts

Everywhere in the nervous system, neuron fibers (axons) are collected into bundles of varying size. A bundle of nerve fibres located within the PNS is a **nerve**. A bundle of nerve fibres within the CNS is a **tract**.

Types of nerves

Sensory (afferent) nerves- carry impulses toward CNS.
Motor (efferent) nerves- carry impulses away from CNS.
Mixed nerves- contain both sensory and motor fibres.

The Nerve Impulse

The mechanics of nerve impulse conduction are complex but can be compared to the spread of an electric current along a wire. The cell membrane of unstimulated (resting) neuron carries an electric charge. This charge is maintained by ions (charged particles) concentrated on either side of the membrane. At rest, the inside of the membrane is negative as compared with the outside. In this state, the membrane is said to be *polarized*.

A **nerve impulse** starts with a local reversal in this charge (+ inside and – outside), which then spreads along the membrane like a current. This sudden electric change in the membrane is called **action potential**. When this reversal occurs, the membrane is said to be *depolarized*. Immediately after this the membrane quickly returns to its original state so that the membrane can be stimulated again. When the membrane returns to its resting state, it is said to repolarise*.* Depolarisation and repolarisation are brought about by rapid shifts in sodium and potassium ions across the cell membrane.The action potential arise according to the **all-or-none principle;** it either happens completely or doesn't happen at all. A **stimulus** can be defined as any force (e.g., an electric, chemical or mechanical) that can start an action potential, which then spreads along the membrane as a nerve impulse.

Nerve impulses travel much faster in myelinated than in unmyelinated fibres.This is because in myelinated fibres the action potential "jumps" like a spark from node to node along the sheath (**saltatory conduction**) unlike in unmyelinated fibres that have step-by-step depolarization and repolarisation of each adjacent segment of the plasma membrane (**continuous conduction)**.

Impulses must be transferred between neurons to convey information within the nervous system. The point of junction for transmission of the nerve impulse is the **synapse**. The synapse has chemicals called **neurotransmitters** e.g. epinephrine/adrenalin, norepinephrine/noradrenalin and acetycholine that enable a nerve impulse to cross the synapse.

Disorders of Nervous Tissue

Multiple Sclerosis (MS) the most common primary disease of the CNS characterized by myelin loss and destruction accompanied by varying degrees of oligodendrocyte injury and death. As the myelin around the axons is lost, nerve conduction is impaired, and weakness, incoordination, visual impairment, speech disturbances and incontinence occur. The cause of MS is thought to be related to autoimmunity and to viral infections in some individuals. Until recently there was no known cure till the advent of the so- called disease- modifying drugs including interferon beta- 1a and – 1b, Avonex, Betaseran and Copaxone. These drugs seem to hold the symptoms at bay.

Neuroma is a general term for tumours arising in nervous system structures.
One of the most common types of neuroma is the brain tumour- called **glioma** which develops from glia. Gliomas tend to be highly malignant and grow rapidly.

Multiple neurofibromitosis is an inherited disease characterized by numerous fibrous neuromas throughout the body. The tumours are benign, appearing first as small nodules in the Schwann cells of cutaneous nerves.

Poliomyelitis (polio = grey matter; myelitis = inflammation of the spinal cord) or simply polio, results from the destruction of cell bodies of motor neurons,

especially in the anterior horns of the spinal cord and the nuclei of cranial nerves by the polio virus. Early symptoms include fever, headache, muscle pain and wekness, and loss of certain somatic reflexes. Later, paralysis develops and the muscles served atrophy.

Leprosy (Hansen's disease) a chronic, mildly infectious disease caused by *Mycobacterium leprae,* affecting the sensory neurons of the peripheral nervous system, skin, and nasal mucosa and variously characterized by ulcerations, tubercular nodules, and loss of sensation that sometimes leads to traumatic amputation of the anaesthetised part.

Herpes zoster, commonly known as shingles, is an acute infection of the PNS caused by a varicella zoster virus of chicken pox. Characterized by scaly, painful blisters usually confined to a narrow strip of skin, often on one side of the body trunk. Seen mostly in those over 50 years old and in HIV and AIDS individuals.

The spinal cord

Location

The spinal cord, located within the vertebral canal of the vertebral (spinal) column, extends from the foramen magnum of the skull to the level of the first or second lumbar vertebra, just inferior to the ribs. If you are of average height, your spinal cord is about 42 cm to 45 cm (17 or 18 inches) long and about 1.8 cm (3/4 of an inch) thick.

Structure

The spinal cord has a small, irregularly shaped internal section that consists of grey matter (nerve cell bodies) and a larger area surrounding this grey part that consists of white matter (nerve cell fibres). Two pairs of columns, called the **ventral** and **dorsal horns**, give the grey matter an **H-** shaped appearance in cross-section. In the cetre of the grey matter is a small channel, the central canal, that consists of **cerebrospinal fluid (CSF)**. The bony vertebrae, tough connective tissue meninges and CSF (produced in the brain) surround and protect the delicate nervous tissue of the spinal cord (and the brain as well).

Exercise: *Draw and label a diagram of a spinal cord; make sure to label as many parts as you can.*

Functions

Linking the spinal nerves to the brain though ascending and descending tracts.

Reflex activities: a reflex is a rapid simple and automatic response involving very few neurons. Reflexes are specific; a given stimulus always produces the

same response. A simple reflex arc that passes through the spinal cord alone and does not involve the brain is termed a **spinal reflex** e.g. the patellar (knee jerk) reflex. Therefore, together, the spinal cord and spinal nerves contain neuronal circuits that mediate some of your quickest reactions to environmental changes. If you pick up something hot, the grasping muscles may relax and you may drop it before the sensation of heat or pain reaches your conscious perception.

Exercise:

a) *Draw a reflex arc; label and give the functions of all parts e.g. sensory receptor, sensory neuron, integration centre, motor neuron and effector.*
b) *Design an experiment to prove that some reflexes are purely spinal reflexes.*

Lumbar Puncture (Spinal Tap)

A **lumbar puncture (spinal tap)** is the withdrawal of some CSF from the subarchnoid space in the lumbar region of the spinal cord. Lumbar punctures are often performed to withdraw CSF for diagnostic purposes; to introduce antibiotics or anesthetics; to administer chemotherapy; to reduce pressure in the brain or spinal cord; and to evaluate the effects of treatment.

Spinal nerves

There are 31 pairs of spinal nerves, each pair named and numbered according to the region and level of the vertebral column from which they emerge.

Exercise: *Draw the spinal cord and indicate the spinal nerves.*

The brain

The brain occupies the cranial cavity and is covered by membranes, fluid and the bones of the skull. It is the center for registering sensations, correlating them with one another and with stored information, making decisions, taking actions. It is related to both the spinal cord and the 12 pairs of cranial nerves. The brain consists of four major parts: *brain stem, cerebellum, diencephalon*, and the *cerebrum*. The **brain stem** is continuous with the spinal cord and consists of the medulla oblongata, pons and midbrain. Posterior to the midbrain is the **cerebellum** (little brain). Superior to the brain stem is the diencephalon, consisting mainly of the thalamus and hypothalamus and including the epithalamus and the subthalamus. Supported on the diencephalon and brain stem, the **cerebrum** is the largest part of the brain. There are 12 pairs of cranial nerves. They are numbered, usually in Roman numerals, according to their connection with the brain, beginning at the front and proceeding back.

Exercise:

a) *Draw the brain; label and give the functions of all parts.*
b) *List the 12 pairs of cranial nerves and describe the function of each pair.*

The Blood-Brain Barrier (BBB)

Blood flows to the brain mainly via the internal carotid and vertebral arteries; the internal jugular veins return blood from the head to the heart. The existence of a blood-brain barrier (BBB) protects brain cells and CSF from harmful substances and pathogens by preventing their passage from blood into brain tissue and CSF. BBB consists of specialized brain capillaries and astrocytes (one type of neuroglia).

Exercise:

a) *List down all the substances that are allowed to cross BBB and those that are not allowed to cross.*
b) *What can cause the breakdown of BBB?*

Homeostatic Imbalances of the Brain

Brain dysfunctions are unbelievably varies and extensive. Some of them include:- traumatic brain injury, cerebrovascular accidents (CVA)/strokes/brain attacks, Alzheimer's disease (AD), Parkinson's disease, Huntington's disease (AD) and seizure disorders/epilepsy.

Exercise: *Write short notes on the brain dysfunctions listed above.*

Brain Studies

Biotechnology has produced many methods for studying the brain without the trauma of exploratory surgery. Some of these methods are:- X-ray photography, Computed Tomography (CT), Positron-Emission Tomography (PET), Single-Photon Emission Computed Tomography (SPECT), Ultrasonography, Magnetic Resonance Imaging (MRI), Electroencephalography (EEG) and Evoked Potential (EP) Test.

Exercise: *Write short notes on the methods for studying the brain listed above.*

The Senses

The sensory system serves to protect the individual by detecting changes in the environment. Therefore, our ability to "sense' changes in our external and internal environments are a requirement for maintaining homeostasis and for survival itself. The body has many **sensory receptors** that allow us to respond to a wide variety of **stimuli** such as touch, pressure, temperature and pain. There are basically two types of senses classified according to the distribution of the sensory receptors. These are **special** senses and **general** senses.

Special senses

Special senses are localized in special sense organs. These are:-

- **Vision** from receptors in the eye.
- **Hearing** from receptors in the internal ear.
- **Equilibrium** from receptors in the internal ear.
- **Taste** (gustation) from receptors in the tongue. These tastes are: - sour*, sweet, bitter, salty* and *umami.*
- **Smell** (olfaction) from receptors in the upper nasal cavities.

Ophthalmology (*ophthalmo-* eye; *-logy* = study of) is the science that deals with the eye and its disorders. The other special senses are, in large part, the concern of **ortorhinolaryngology** (*oto-* = ear; *rhino-* = nose; *laryngo-* = larynx).

Exercise:

a) Draw the eye, label it and describe the structure and functions of the labeled parts.
b) Describe the blind spot and design an experiment to prove the existence of a blind spot on the retina.
c) With the aid of relevant diagrams (where necessary) describe the following eye disorders/diseases and explain how they can be corrected/treated:- presbyopia, myopia, hypermetropia (hyperopia), astigmatism, diplobia, strabismus, cataracts, retinaaldetachment, glaucoma, colour blindness, night blindness (nyctalopia), river blindness, chalazion, conjunctivitis and trachoma.
d) Draw the ear, label it and describe the structure and functions of the labeled parts.
e) List the major invents in the physiology of hearing.
f) Identify the receptor organs for equilibrium, and describe how they function.
g) Describe the following ear disorders/diseases and explain how they can be treated: - Deafness, Otitis media, Meniere's disease and tinnitus.
h) Describe motion sickness and explain how it can be overcome/ treated.
i) Describe the gustatory receptors and the neural pathway for gestation.
j) Draw and label the taste map of the tongue.
k) Describe the olfactory receptors and the neural pathway for olfaction.
l) Describe the sensation of chocolate, pepper and coffee.
m) Describe taste aversion and hyposmia.

General senses

General senses are widely distributed throughout the body. These are:-

- **Tactile sensation** (tact- = touch) are those of touch, pressure, vibration, itch and tickle.

- **Thermal sensation** consists of two separate thermoreceptors for cold (10^{o}C to 40^{o}C) and heat (32^{o}C to 48^{o}C). Cold and warm receptors both adapt rapidly at the onset of a stimulus but continue to generate impulses at a lower frequency throughout a prolonged stimulus.
- **Pain sensation-** pain is indispensable for survival. It serves a protective function by signaling the presence of noxious, tissue-damaging conditions. **Nociceptors** (noci- = harmful) are the receptors for pain. Temperatures below 10 and above 48 stimulate mainly nociceptors, rather than thermoreceptors. There are two types of pain: fast and slow. The perception of **fast pain** occurs very rapidly, usually within 0.1 second after a stimulus is applied. The perception of **slow pain**, by contrast, begins a second or more after a stimulus is applied. Sometimes pain can be felt at a site remote from the place of origin; this is called and it is of clinical significance.

Sensory Adaptation

When sensory receptors are exposed to a continuous stimulus, receptors often adjust themselves so that the sensation becomes less acute. The term for this phenomenon is **sensory adaptation**.

Exercises

a) *Compare and contrast fast pain and slow pain as regard alternative names, type of nerve fibres, examples or causes and locality/part of body affected.*
b) *Write short notes on:- superficial somatic pain, deep somatic pain and visceral pain.*
c) *With the aid of relevant diagram(s) describe the clinical significance of referred pain.*
d) *Describe four examples of sensory adaptation.*
e) *Design an experiment to show that free nerve endings are not evenly distributed throughout the body; i.e. some parts of the body are more sensitive than others.*
f) *Patients who have had a limb amputated may still experience sensations such as itching, pressure, tingling or pain as if the limb were there. This phenomenon is called **phantom limb sensation**. Give some explanations for phantom limb sensations.*
g) *Pain sensations sometimes occur out of proportion to minor damage, persist chronically due to injury, or even appear for no obvious reason rather than warning of actual or impending damage. In such cases, **analgesia** (an- = without; - algesia = pain) or pain relief is needed. Give examples of analgesia drugs and explain how they work.*

Unit 2: The Endocrine System

Learning Resources: Library, Science Laboratory, Laboratory manuals, models and charts of the human body

Introduction

Have you ever known anyone with thyroid problems or diabetes? Surely you have seen the dramatic changes that happen to a person's body as they go through puberty. These are all proof of the importance of the endocrine system for normal development and health.

The **endocrine system** performs the same general functions as the nervous system: communication and control. The nervous system provides rapid, brief control by fast-travelling nerve impulses. The endocrine system provides slower but longer-lasting control by **hormones** (chemicals) secreted into and circulated by the blood. The scientific study of hormones and the endocrine organs is called **endocrinology**.

Learning Outcomes

- Distinguish exocrine glands from endocrine glands.
- Compare the effects of the nervous system and the endocrine system in controlling the body.
- Describe the functions of hormones.
- Identify the glands of the endocrine system on a diagram.
- List the hormones produced by each endocrine gland and describe the effects of each on the body.
- Distinguish between circulating hormones and local hormones.
- Describe how hormones are classified chemically.
- Explain how hormones are regulated.
- Explain the primary mechanisms of endocrine disorders.

Hints : You should use charts, models and your body to use as guides, to describe different parts of nervous system.

: You should use reference books for more information on the terms listed.

Content

- Differences between exocrine glands and endocrine glands
- The effects of the nervous system and the endocrine system in controlling the body.
- Functions of hormones.
- Identification of glands of the endocrine system on a diagram.

- Hormones produced by endocrine glands and their effects on the body.
- Distinguish between circulating hormones and local hormones.
- Classification of hormones.
- Hormone regulation.
- Mechanisms of endocrine disorders.

Unit 3: The Skeletal System

Learning Resources: Library, Science Laboratory, Laboratory manuals, models and charts of the human body

Introduction

What would happen if humans didn't have bones? You'd be floppy like a beanbag, you would not stand up, and you would not even walk. Without bones you'd be just a puddle of skin and guts on the floor. When you were born you had over 300 bones. As you grew, some of these bones began to fuse together. The result? An adult has only 206 bones! The entire framework of bones and their cartilages together constitute the **skeletal system.** The skeleton is the flexible, bony framework found in all vertebrate animals. The skeleton maintains a body shape, protects vital organs, and provides a system of muscle levers that allow body movement. The skeletal system is so important that without it we would just be flat on the floor. We would be like a jelly fish. We wouldn't be able to move at all. It gives us posture. It enables us to stand or sit. And it also protects us because most of our body is protected by bones. Without our skeletal system our body would be useless. Our skeleton is indeed very important.

Learning Outcomes

- List functions of the skeletal system.
- Describe the structure of a long bone.
- Describe the histological features of bone tissue.
- Explain how bones are formed, how they grow and how they are remodeled.
- Discuss the organic and inorganic composition of bone.
- Indicate the functional importance of bone markings.
- Describe the blood and nerve supply of bone.
- Describe the sequence of events in repair of a fracture.
- Identify the two major subdivisions of the skeleton and list the bones found in each area.
- List and compare the major types of joints in the body and give an example of each.
- Name and describe major disorders of bones and joints.

Hints : You should use charts, models and your body to use as guides, to describe different parts of nervous system.

: You should use reference books for more information on the terms listed.

Content

- Functions of the skeletal system. Bone tissue and the skeletal system perform several basic functions:
  - Support, Protection, Assistance in movement, Mineral homeostasis, Blood cell production and Triglyceride storage.
- Structure of a long bone.

  Exercise: *Draw a long bone; label and give the functions of the parts*

- Histological features of bone tissue.
- How bones are formed, how they grow and how they are remodeled.
- Organic and inorganic composition of bone.
- Functional importance of bone markings.
- Blood and nerve supply of bone.
- Sequence of events in repair of a fracture.
- Two major subdivisions of the skeleton and the bones found in each area.
- Major types of joints in the body with examples.
- Major disorders of bones and joints.

Unit 4: The Muscular System

Learning Resources: Library, Science Laboratory, Laboratory manuals, models and charts of the human body

Introduction

One of the most amazing things about the human body is the incredible range of movement and mobility it has. This day to day activity is accomplished by our muscles through the extraordinary and fascinating ability of converting chemical energy, energy stored in nutrients, into mechanical energy, energy of movement. Muscles are often viewed as the "machines" of the body. They help move food from one organ to another, and carry out our physical movement. Muscles move you. Without muscles you couldn't open your mouth, speak, shake hands, walk, talk, or move your food through your digestive system. There would be no smiling, blinking, breathing. You couldn't move anything inside or outside you. The fact is, without muscles, you wouldn't be alive for very long. The human body contains more than 650 individual muscles which are attached to the skeleton, which provides the pulling power for the movement of body parts.

Learning Outcomes

- Correlate the three types of muscle tissue with their functions and special properties.
- Describe how skeletal contract muscles.
- Name, identify on a model or diagram, and give the function of the major muscles of the body.
- Define oxygen debt and muscle fatigue. List possible causes of muscle fatigue.
- Explain how muscles work in pairs to produce movement.
- Compare the workings of muscles and bones to lever systems.
- Name and describe the major disorders of skeletal muscles.

Hints : You should use charts, models and your body to use as guides, to describe different parts of nervous system.

: You should use reference books for more information on the terms listed.

Content

- Three types of muscle tissue, their functions and special properties.
    - Types of Muscle tissue
    - skeletal muscle tissue: striated, voluntary
    - Cardiac muscle tissue: striated, involuntary
    - Smooth muscle tissue: nonstriated/smooth, involuntary

    - Functions of Muscle Tissue
        - Producing body movements
        - Stabilising body positions (posture or muscle tone)
        - Storing and moving substances within the body
        - Generating heat

    - Properties of Muscle tissue
        - Electrical excitability
        - Contractility
        - Extensibility
        - Elasciticity

- Contraction of skeletal muscles.
  For muscle contraction to be possible skeletal muscles are well supplied with nerves and blood vessels. Generally, an artery and one or two veins accompany each nerve that penetrates a skeletal muscle. The neurons that stimulate skeletal muscle to contract are *somatic motor neurons*. The structural point of contact and functional site of communication between the

motor neuron and the muscle fibre is termed the **neuromuscular junction.** Muscles contract with the aid of two contractile proteins, **myosin** and **actin.** During contraction thick and thin muscle filaments slide past one another in a **sliding filament mechanism.**

- Names and function of the major muscles of the body.
  A number of different characteristics are used in naming muscles:-
  Location or Position, Size, Shape, Direction of fibres, Number of heads and Action.

  Exercise: *Give examples of muscles under the above criteria.*

  The study of muscles is made simpler by grouping them according to body regions:-
  - Muscles of the head and neck
  - Muscles that move the upper extremities
  - Muscles of the trunk
  - Muscles that move the lower extremities

  Exercise: *Draw a table of 'Principal muscles of the body' and fill it under the following subheadings: Muscle and Function.*

- Oxygen debt and muscle fatigue.
  If muscle cells are stimulated repeatedly without adequate periods of rest, the strength of the muscle contraction decreases, resulting in **muscle fatigue.** After muscle contraction has stopped following prolonged periods of its contraction, heavy breathing continues for a while, and oxygen consumption remains above the resting level. The term **oxygen debt** describes the added oxygen, over and above the resting oxygen consumption, that is taken into the body after exercise. This extra oxygen is used to *"pay back"* or restore metabolic conditions to the resting level by removing the excess lactic acid that accumulated during prolonged exercise i.e. the lactic acid is converted back into glycogen stores in the liver.

  In **anaerobic respiration**: your body compensates for the lack of Oxygen and only uses glucose to produce energy. This would result in the formation of lactic acid

Formula

Glucose = lactic acid + 2 ATP (energy)
$C_6H_{12}O_6$ = $2C_3H_6O_3$ + 2 ATP

During the recovery process the lactic acid vanishes, but is found over again in its original form as glycogen. We may summarize the matter as follows:

Contraction

Glycogen [or glucose] = lactic acid + energy.

Recovery

[Lactic acid + oxygen = carbonic acid and water + energy]
Lactic acid = glycogen ---- energy.
Glycogen + oxygen = 3carbonic acid and water + energy.

- How muscles produce movement.
  Most muscles have two or more points of attachment to the skeleton. **Tendons** attach muscles to bones while **ligaments** attach bones to bones. In moving bones, one end of a muscle is attached to a more freely movable part of the skeleton (**insertion**), and the other end is attached to a relatively stable part (**origin**). When a muscle contracts, it pulls on both points of attachment, bringing the more movable insertion closer to the origin and thereby causing movement of the body part. Many of the skeletal muscles function in pairs (*antagonistic pair of muscles*) e.g. the biceps brachii is the **prime mover** while the triceps brachii is the **antagonist**.

- Muscles and lever systems.
  Proper body mechanics help conserve energy and ensure freedom from strain and fatigue; conversely, such ailments as lower back pain—a common complain----can be traced to poor body mechanics. The body has the lever systems (partnership between the muscular and skeletal systems) that ensure proper body mechanics. In producing movement, bones act as levers, and joints function as the fulcrums of these levers. A **lever** is a rigid structure that can move around a fixed point called a **fulcrum [∆]**. A lever is acted on at two different points by two different forces; the **effort [E]** or **force**, which causes movement, and the **Load [L]** or **resistance [R]** or **weight**, which opposes movement. The effort is the force exerted by muscular contraction, where as the load is typically the weight of the body part that is moved. Levers produce trade-offs between effort and the speed and range of motion. In one situation, a lever operates at a **mechanical advantage**---- has leverage----where a smaller effort can move a heavier load. Here the trade-off is that the effort must move a greater distance (must have a longer range of motion) and faster than the load. Such a lever is called a **power lever**. In another situation, a lever operates at a mechanical disadvantage when a larger effort moves a lighter load. Such a lever system is called a **speed lever.**

  Exercise: *Give examples of power levers and speed levers (in each case-one example from the human body and the other not from the body).*

Types of levers
There are three classes of levers, which differ only in the location of the **F**ulcrum, the **L**oad and the **E**ffort (**FLE**).

In a **first-class lever**, the fulcrum is located between the load and the effort. E.g. a seesaw and a scissors.

In a **second-class lever**, the load is located between the fulcrum and the effort. E.g. a wheelbarrow or a mattress listed on one end.

In a **third-class lever**, the effort is located between the fulcrum and the load. E.g. a forceps or a tweezers.

Exercise: *Give examples from the human body of the three types of levers.*

- Major disorders of skeletal muscles (myopathies).
  Myasthenia Gravis, Muscular Dystrophy, Fibromyalgia

Exercise: *Write short notes on the above named myopathies.*

Unit 5: The Skin and Temperature Regulation

Learning Resources: Library, Science Laboratory, Laboratory manuals, models and charts of the human body

Introduction
Would you be enticed by an advertisement for a coat that is waterproof, stretchable, washable, and permanent press, that automatically repairs small cuts, rips and burns, and that is guaranteed to last a lifetime with reasonable care? Sounds too good to be true, but you already have such a coat---your skin. The skin is easily observed. It gives clues to its own health and reflects the health of other body systems. In addition to the roles of protection and sensation the skin also plays the function of regulation of body temperature. The skin and its accessory organs (sweat and oil glands, muscles, nerves, blood vessels, hairs and nails) form the **integumentary system.**

Learning Outcomes
- Name and describe the layers of the skin.
- Describe the basis for different skin colours.
- List the main functions of the skin.

- Summarise the information to be gained by observation of the skin.
- List and describe major skin disorders and infections.
- Classify burns and describe how to estimate the extent of a burn injury.
- Explain how epidermal wounds and deep wound heal.
- Describe skin grafts.
- Explain how heat is produced in the body.
- List the ways heat is lost from the body.
- Describe the role of the hypothalamus in regulating body temperature.
- Describe homeostatic imbalances of body temperature.

Hints: You should use charts, models and your body to use as guides, to describe different parts of nervous system.

: You should use reference books for more information on the terms listed.

Content

- Layers of the skin
  - Epidermis
  - dermis
- Functions of the skin.
  - Thermoregulation
  - Protection
  - Cutaneous sensation
  - Excretion and Absorption
  - Synthesis of vitamin D
- Basis for different skin colours.
  Three pigments contribute to skin colour: melanin, carotene and haemoglobin. Albinism also contributes to skin colour.
- Observation of the skin.
  Skin colour, texture and other attributes can provide clues for diagnosing certain conditions as jaundice, erythema, syphilis, vitiligo etc

Exercise: *a) Describe at least not less than eight skin disorders/ infections.*
b) List <u>five</u> risk factors for skin cancer

- Burns.
  A burn is tissue damage caused by excessive heat, electricity, radioactivity or corrosive chemicals that denature the proteins in the skin cells.

  Estimating the severity of burns
  - First-degree burns
  - Second-degree burns
  - Third-degree burns

- Estimation of the extent of burn injury (rule of nines).

Exercise:

With the aid of a relevant diagram describe the rule of nines.

- Tissue repair/ wound healing
  When damaged, tissues have varying capacity to repair themselves. Damaged tissue will regenerate or be replaced by tissue we know as scars. Tissues usually repair themselves by allowing the phagocytic cells to remove dead or injured cells, then filling in the gaps that are left. This growth of new tissue is called **regeneration**.

Exercise:

a) *Describe tissue repair under the following subheadings:*
   - *Inflammation sets the stage*
   - *Organisation restores the blood supply*
   - *Regeneration and fibrous effect permanent repair*

b) *Differentiate epidermal wound healing from deep wound healing.*

c) *New skin cannot regenerate if an injury destroys the stratum basale and its stem cells; hence skin wounds of this magnitude require **skin grafts.** Describe skin graft and its different types.*

- Body temperature
  The normal core body temperature of a healthy, resting adult human being is stated to be at 98.6 degrees Fahrenheit or 37.0 degrees Celsius. Though the body temperature measured on an individual can vary, a healthy human body can maintain a fairly consistent body temperature that is around the mark of 37.0 degrees Celsius. Maintaining homeostasis of body temperature, or **thermoregulation**, is the function of the **hypothalamus**.

- Body heat production i.e. factors that affect metabolic rate:
  - Exercise
  - Hormones
  - Nervous system
  - Body temperature
  - Ingestion of food
  - Age
  - Gender
  - Climate

- Body heat loss i.e. factors that affect heat transfer from the body:
  - Conduction
  - Convection
  - Radiation
  - Evaporation

Exercise: *List as many heat gain and heat loss methods under physiological and behavioural subheadings.*

- The hypothalamus and body temperature regulation.

  Exercise: *describe how the hypothalamus regulates body temperature.*

- Homeostatic imbalances of body temperature.

  Exercise: *Describe the following conditions:* Fever, Malignant hyperthermia (MH) Heat exhaustion, Heatstroke, Hypothermia and Frostbite.

Unit 6: The Reproductive System

Learning Resources: Library, Science Laboratory, Laboratory manuals, models and charts of the human body

Introduction

All living things reproduce and the **reproductive system** makes life possible. Reproduction - the process by which organisms make more organisms like themselves - is one of the things that sets living things apart from nonliving matter. The major function of the reproductive system is to ensure survival of the species. Other systems in the body, such as the endocrine and urinary systems, work continuously to maintain homeostasis for survival of the individual. An individual may live a long, healthy, and happy life without producing offspring, but if the species is to continue, at least some individuals must produce offspring. Without the reproductive system, babies would not be born to grow into adults to give birth to more babies. The human cycle would end. Therefore, all living things on the planet reproduce more of their own kind.

Learning Outcomes

- Define reproduction.
- Describe the two types of reproduction.
- List the essential and accessory organs of the male and female reproductive systems and give the functions of each.
- Describe the gross and microscopic structure of the gonads in both sexes and explain the developmental steps in spermatogenesis and oogenesis.
- Discuss the primary functions of the sex hormones and identify the cell type or structure responsible for their secretion.
- Describe the major events from fertilization to parturition.
- Compare the various kinds of birth control methods and their effectiveness.
- List the major disorders of the male and female reproductive systems and briefly describe each.
- Define the term *sexually transmitted disease* and describe the major types.

Hints : You should use charts, models and your body to use as guides, to describe different parts of nervous system.

: You should use reference books for more information on the terms listed.

Content

- Definition of reproduction.
- Two types of reproduction- sexual and asexual.
- Internal and external fertilization.
- Essential and accessory organs of the male and female reproductive systems and the functions of each.
- Gross and microscopic structure of the gonads in both sexes and the developmental steps in spermatogenesis and oogenesis.
- Primary functions of the sex hormones and the cell type or structure responsible for their secretion.
- Major events from fertilization to parturition.
- Birth control methods and their effectiveness.
- Disorders of the male and female reproductive systems.
- Sexually transmitted diseases.

Required Reading

Maliwichi H.E, Mandalazi P, Nyasulu Y and Zulu M. (2005) Laboratory manual for Biomedical Sciences Lilongwe, Capital Printing Press

Marieb, E.N. (2004), Human Anatomy and Physiology, (6th Ed), San Francisco, Pearson Benjamin Cummings.

Thibodeau G.A, Paton K.T, (2005), The Human Body In Health and Desease (4th Ed), St Louis, Elservier Mosby.

Tortora, G. J. and Grabowski, S. R (2003) Principles of anatomy and physiology (10th Ed.) New York, John Wiley & Sons Inc.

Supplementary Reading

Clancy, J. & Mc Vicar, A.J. (2002). Physiology and Anatomy: A homeostatic approach. (2nd Ed.) London, Anold

Coad, J. & Dunstall, M. (2005), Anatomy and Physiology for Midwives. Churchill Elsevier

Cohen B.J & Wood DL (2000) Memmler's Structure and Function of The Human Body, (7th Edition) Philadelphia, J.B. Lippincott.

Creager J.G. (1992) Human Anatomy and Physiology (2nd Ed.) Dubuque, Wm. C. Brown Publishers

Fox, S.I (2004) Human Physiology (8th Ed), Boston, McGraw Hill.

Guyton A.C. (1991), Physiology of Human Body (6th Ed.) Philadelphia, WB Sanders

Seeley, R. Stephens, T.D. and Tate, P. (2002). Essentials of Anatomy and Physiology (4th Ed). New York, McGraw-Hill .