NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: CHS 201

COURSE TITLE: ANATOMY

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COURSE GUIDE

CONTENTS PAGE

Introduction

CHS 201: Anatomy is a first semester two-credit course. It will be available to all students to take toward the course module of their B.Sc. programme.

This course will give you a better understanding of the anatomy of the human body. This course guide tells you briefly what the course is about, what course materials you will be using, and how you can work your way through these materials. It suggests some general guidelines for the amount of time you are likely to spend on each unit of the course in order to complete it successfully. It also gives you some guidance on your tutor-marked assignments. Detailed information on tutor-marked assignments is similarly made available. There are regular tutorial classes that are linked to the course. You are advised to attend these sessions.

What You Will Learn in this Course

The overall aim of CHS 201: Anatomy is to enable you to learn and understand the basic anatomy and physiology of the human body, which includes: the human skin, the skeletal system, the nervous system, the endocrine system, the reproductive system, and the circulatory system.

Course Objectives

To achieve the aims set out above, the course sets overall objectives. In addition, each unit also has specific objectives. The unit objectives are always included at the beginning of the unit; you should read them before you start working through the unit. You may want to refer to them during your study of the unit to check on your progress. You should always look at the unit objectives after completing a unit. In this way you can be sure that you have done what was required of you by the unit.

Set out below are the wider objectives of the course as a whole. By meeting these objectives, you should have achieved the aims of the course as a whole.

On successful completion of the course, you should be able to:

· **define** the concept of anatomy and physiology
· **describe** levels of organisation in the body
· **describe** the skin and skeletal system
· **explain** the digestive, respiratory and circulatory systems
· **discuss** the nervous and endocrine system
· **explain** the constituents and role of the immune system and
· **describe** the sexual organs.

Working through this Course

To complete this course you are required to read the study units and books and other materials provided by the National Open University of Nigeria (NOUN). Each unit contains self-assessment exercises. At the end of the course is a final examination. The course should take you about 14 weeks to complete. Below you will find listed all the components of the course, what you have to do, and how you should allocate your time to each unit in order to complete the course

successfully on time.

Course Materials

Major components of the course are:

1. The Course Guide
2. Study Units
3. References
4. The Presentation Schedule

Study Units

The study units in this course are as follows:

The Course Guide

Module 1

Unit 1 Basic Concepts in Anatomy and Physiology
Unit 2 Levels of Organisation

Module 2

Unit 1 The Integumentary System
Unit 2 The Skeletal System
Unit 3 The Nervous System
Unit 4 The Endocrine System

Module 3

Unit 1 The Digestive System
Unit 2 The Respiratory System
Unit 3 The Circulatory System

Module 4

Unit 1 The Immune System
Unit 2 The Urinary System
Unit 3 The Reproductive System

Each study unit consists of some work, and includes introduction, specific objectives, reading materials, conclusion, summary, tutormarked assignments (TMAs), references and further readings. The units direct you to work on exercises related to the required readings. In general, these exercises are on the material you have just covered. Together with tutor-marked assignments, these exercises will assist you in achieving the stated learning objectives of the individual units and of the course.

The Assignment File

The course assignment will cover:

· Basic anatomy of the human body; concept, meaning and the relationship between these sub specialties of basic biology
· Levels of organisation of the human body and basic organic chemistry
· The organs and the regulatory roles of the nervous and endocrine systems
· The skeletal, circulatory, digestive, nervous systems, etc. and their functions.

Assessment

There are two aspects to the assessment of the course. First are the tutor marked

assignments, second, there is a written examination.
In tackling the assignments, you are expected to apply information, knowledge and strategies gathered during the course. The assignments must be submitted to your tutor for formal assessment in accordance with the deadlines stated in the Presentation Schedule and the Assignment File. The work you submit to your tutor for assessment will count for 40% of your course mark.
At the end of the course, you will need to sit for a final written examination of a two hour duration. This examination will also account for 60% of your total course work.

Tutor-Marked Assignment

There are some tutor-marked assignments. You are encouraged, however, to submit the assignments to be given to you at the study centre for this course. The assignment counts towards 40% of the total course mark. You should be able to complete your assignments from the information and materials contained in your reading and study units.
However, it is desirable to demonstrate that you have read and researched more widely than the required minimum. Using other references will give you a broader viewpoint and may provide a deeper understanding of the subject.
When you have completed the assignment, send it together with a TMA (tutor-marked assignment) form, to your tutor. Make sure that each assignment reaches your tutor on or before the deadlines given in the Presentation Schedule and Assignment File. If, for any reason, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances.

Final Examination and Grading

The final examination for CHS 201 will be for hours and it has a value of 60% of the total course grade. The examination will consist of questions which reflect the types of self-testing, practice exercises and tutor-marked problems you have previously encountered. All areas of the course will be similarly assessed.
Use the time between finishing the last unit and sitting for the examination to revise the entire course. You might find it useful to review your self-assessment questions, tutor-marked assignments and comments on them before the examination. The final examination covers information from all parts of the course.

Course Marking Scheme

The following table lays out how the actual course marking is broken down.

Assessment Marks

Assignment 4 TMAs of 10 marks each = 40% of course marks
Final Examination 60% of overall course marks

Total 100% of course marks

Table 1: Course Marking Scheme

Course Overview

This table brings together the units, the number of weeks you should take to complete them, and the assignments that follow them.

Unit	Title of Work	Weeks Activity	Assessment (End of Unit)
	Course Guide	1	
	Module 1		
1	The Basic Concept of Anatomy and Physiology	2	1
2	Level of Organisation	3	2
	Module 2		
1	The Integumentary System	4	3
2	The Skeletal System	5	4
3	The Nervous System	6	5
4	The Endocrine	7	6
	Module 3		
1	The Digestive System	9	7
2	The Respiratory System	10	8
3	The Circulatory System	11	9
	Module 4		
1	The Immune System	12	10
2	The Urinary System	13	11
3	The Reproductive System	14	12

How to Get the Most from this Course

These specially designed study materials should be used at your pace, and at a time and place that suit you best. Think of it as reading the lecture instead of listening to a lecturer. The study units tell you when to read your course material. Just as a lecturer might give you an in-class exercise, your study units provide exercises for you to do at appropriate points.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. You should use these objectives to guide your study. When you have finished the unit you must go back and check whether you have achieved the objectives. If you make a habit of doing this, you will significantly improve your chances of passing the course. The main body of the unit guides you through the required reading from other sources. This will usually be either from a reading section or some other courses.

Self-tests are interspersed throughout the units, and answers are given at the end of units. Working through these tests will help you to achieve the objectives of the units and prepare you for the assignments and the examination. You should do each self-test as you encounter it in the study unit. There will also be numerous examples given in the study units; work through these when you come across them too.

The following is a practical strategy for working through the course. If

you run into any trouble, telephone your tutor. Remember that your tutor's job is to help you; so when you need help, don't hesitate at all to ask your tutor to provide it.

1. Read this **Course Guide** thoroughly.
2. Organise a study schedule. Refer to the "course overview" for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information, e.g. details of your tutorials, and the date of the first day of the semester, is available. You need to gather all this information in one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working on each unit.
3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course work. If you get into difficulty with your schedule, please let your tutor know before it is too late for help.
4. Turn to Unit 1 and read the introduction and the objectives for the unit.
5. Assemble the study materials. Information about what you need for a unit is given on the contents page at the beginning of each unit. You will almost always need both the study unit you are working on and one of the materials for further reading on your desk at the same time.
6. Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit you will be instructed to read sections from other sources. Use the unit to guide your reading.
7. Keep in mind that you will learn a lot by doing all your assignments carefully. They have been designed to help you meet the objectives of the course and, therefore will help you pass the exam. Submit all assignments not later than the due date.
8. Review the objectives for each study unit to confirm that you achieved them. If you feel unsure about any of the objectives, review the study materials or consult your tutor.
9. When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.
10. When you have submitted an assignment to your tutor for making do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also on the written assignment. Consult your tutor as soon as possible if you have any question or problems.

11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives. (Listed at the beginning of each unit) and the course objectives (listed in the **Course Guide).**

Facilitators/Tutors and Tutorials

There are 8 hours of tutorials provided in support of this course. You will be notified of the dates, times and location of these tutorials, together with the name and phone numbers of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignment, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail or discussion board if you need help. Contact your tutor if:

· you do not understand any part of the study units or the assignment

· you have difficulty with the self-tests or exercises

· you have a question or problem with an assignment, with your tutor's comments on an assignment, or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance for face to face contact with your tutor and to ask questions which are answered instantly. You can raise any problem you encounter in the course of your study. To gain maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating and discussing actively. Best wishes.

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MODULE 1

Unit 1 Basic concepts in Anatomy and Physiology
Unit 2 Levels of Organization

UNIT 1 BASIC CONCEPTS IN ANATOMY AND PHYSIOLOGY

CONTENTS

1.0 INTRODUCTION

You have gone through the basic biology course where you learnt that all living things share basic characteristics, some of which include the following:

· Movement
· Reproduction
· Nutrition
· Irritability
· Growth
· Excretion
· Respiration

The basic biology includes *anatomy* and *physiology* as sub-specialties. These are biological subjects with slightly different perspectives, which we shall study in this unit.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· define anatomy
· define physiology
· describe the various specialties of each discipline
· explain the relationship between anatomy & physiology.

3.0 MAIN CONTENT

3.1 Definition of Anatomy and Physiology

The word "anatomy" has Greek origin. A literal translation would be "a cutting open" Anatomy is the study of internal and external structures of the body and the physical relationships among body parts, for example studying how a particular muscle attaches to the skeleton. Physiology, which also has Greek origin, is the study of how organisms perform their vital functions. An example is the study of how a muscle contracts or what kind of forces contracting muscles exert on the skeleton.

3.2 Relationship between Anatomy and Physiology

Anatomy and physiology are closely integrated both theoretically and practically. Anatomical information provides clues about probable functions, and physiological mechanisms can be explained only in terms of the underlying anatomy. This observation leads to a very important concept: All specific functions are performed by specific structures. Anatomists and physiologists approach the relationship between structure and function from different perspectives.

Carefully read through this simple non-biological analogy.

Assume that this class is made up of anatomists and physiologists, and we are asked to consider an electric bulb. The anatomists may begin by describing and measuring the shape of the bulb and, if possible, take it apart ("dissect it") and put it back together. The physiologist could then explain its key structural relationships.

SELF ASSESSMENT EXERCISE 1

1. Recap the basic functions of all living things.
2. Define anatomy.
3. Define physiology.

3.3 Divisions of Anatomy

Anatomy can be divided into different specialties based on:

· Degree of structural detail under consideration
· Specific processes
· Medical application

On the basis of structural detail we have:

· Microscopic Anatomy
· Gross (Macroscopic) Anatomy

Microscopic Anatomy

Microscopic anatomy deals with structures that cannot be seen without magnification. The limits of the equipment used determine the boundaries of microscopic anatomy. For example, with a light microscope, you can see basic details of cell structure; with an electron microscope, you can see individual molecules that are only a few nanometres across. It includes cytology and histology. As we go through the course, we will consider details at all levels, from macroscopic to microscopic.

Cytology is the analysis of the structure of individual **cells,** the simplest units of life. Cells are composed of chemical substances in various combinations, and our lives depend on the chemical processes occurring in the trillion cells in the body.

Histology is the examination of tissues, groups of specialized cells and cell products, that work together to perform specific functions. Tissues combine to form organs, such as the heart, kidney, liver or brain. Many organs are easily examined without microscopic anatomy, by using gross anatomy.

Gross Anatomy (Macroscopic Anatomy) is the examination of relatively large structures and features usually visible with the unaided eye. There are many ways to approach gross anatomy:

· Surface anatomy: Study of general form and superficial markings.

· Regional anatomy: Focuses on anatomical organization of specific areas of the body, such as the head, neck or trunk

· Systemic anatomy: Study of the structure of organ systems, such as the skeletal system or the muscular system. Organ systems are groups of organs that function together in a co-ordinated manner.

For example the heart, blood and blood vessels form the cardiovascular system, which distributes oxygen and nutrients throughout the body. The human body has 11 organ systems, and they will be introduced later in this course.

· Developmental anatomy: This deals with the changes in forms that occur during the period between conception and physical maturity. The study of these early developmental processes is called **Embryology.**

Other anatomical specialties with focus on clinical settings include:

· Mechanical anatomy (anatomical features that change during illness).

· Radiographic anatomy (anatomical structures as seen by using specialised imaging techniques.

· Surgical anatomy (anatomical landmarks important in surgery).

3.4 Divisions of Physiology

As earlier stated, physiology is the study of the function of anatomical structures. Human physiology is the study of the functions of the human body. These functions are complex and much more difficult to examine than most anatomical structures. As a result, there are even more specialties in physiology than in anatomy, which include the following:

· Cell physiology: This is the cornerstone of human physiology; it is the study of the functions of cells. It deals with events at the chemical and molecular levels.
· Special physiology: This is the study of the physiology of special organs. For example, renal physiology is the study of kidney function.
· Systemic physiology: This includes all aspects of the functions of specific organ systems. Cardiovascular physiology, respiratory physiology and reproductive physiology are examples of systemic physiology.
· Patho-physiology: This is the study of the effects of diseases on organ or system functions (*pathos* is the Greek word for "disease"). Modern medicine depends on an understanding of both normal physiology and patho-physiology.

SELF ASSESSMENT EXERCISE 2

Name the factors that determine the divisions of anatomy.

4.0 CONCLUSION

Physicians normally use a combination of anatomical and psychological information when they evaluate patients. Full details in relation to physiology shall be discussed in Physiology lectures.

5.0 SUMMARY

This unit teaches that:
· Human beings share basic characteristics of living things.
· Human anatomy is the study of body structures and the physical relationship among body parts of human beings.
· Human physiology is the study of the functions of the human body.
· Anatomy and physiology are closely integrated, both theoretically and practically.
· Modern medicine depends on an understanding of physiology and anatomy.

ANSWER TO SELF ASSESSMENT EXERCISE 1

Basic functions of living things include Movement, Respiration, Nutrition, Irritability, Growth, and Reproduction.

ANSWER TO SELF ASSESSMENT EXERCISE 2

Factors that determine divisions in anatomy are:
· Degree of structural detail under consideration
· Specific processes
· Medical application

6.0 TUTOR-MARKED ASSIGNMENT

Briefly describe the following:
a. Microscopic anatomy.
b. Macroscopic anatomy.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K & Hutchings, R.T.

(2001). *Fundamentals of Anatomy and Physiology* (5th ed), New Jersey: Prentice-Hall, Inc.
Oxford Concise Medical Dictionary.
Thibodeau, G.A. & Patton, K.T. (1996). *Anatomy and Physiology* (3rd ed), Mosby.

UNIT 2 LEVELS OF HUMAN BODY ORGANISATION

CONTENTS

1.0 INTRODUCTION

This concept of Anatomy and Physiology should be learned and *understood*. Our study of the human body will begin with an overview of microscopic and then proceed to the gross, anatomy of each organ system. When considering events from the microscopic to the macroscopic scale, we will examine several interdependent levels of organization.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· give an overview of the microscopic anatomy of the human body
· describe the basic gross anatomy of each organ system in the body
· describe the several independent levels of organization in the body
· identify the six levels of organization of the body.

3.0 MAIN CONTENT

3.0 MAIN CONTENT

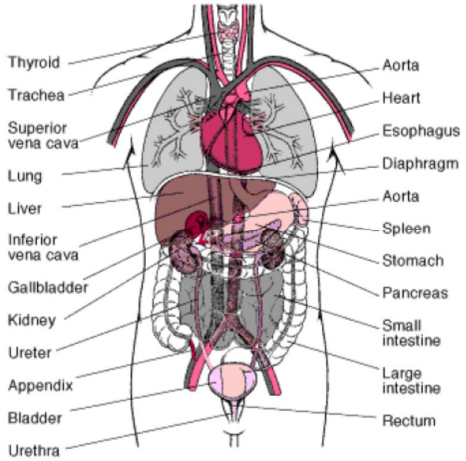

Fig. 1: Organs of the human body

Source: *1999 Encyclopedia, Britanica*, Inc

3.1 Different Levels of Organization

1. The Chemical or Molecular Level: Atoms, the smallest stable units of matter, can combine to form molecules with complex shapes. Even at this simplest level, the specialized shape of a molecule determines its function.

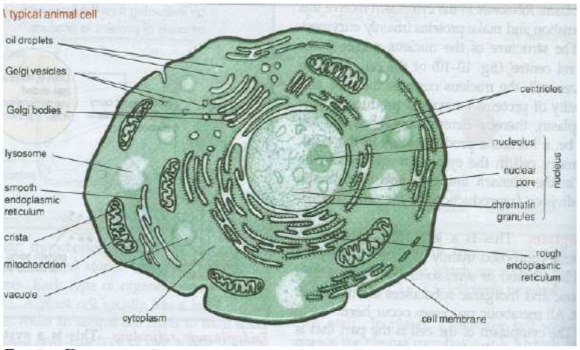

Fig.2: Diagram of a typical mammalian cell
Source: *1999 Encyclopedia, Britannica*, Inc

2. The Cellular Level: Molecules can interact to form organelles, such as the protein filaments found in muscle cells. Each type of organelle has specific functions. For example, interactions among protein filaments produce the contractions of muscle cells in the heart. Cells are the smallest living units in the body, and organelles are their structural and functional components.

3. The Tissue Level: A tissue is a group of cells working together to perform one or more specific functions. Heart muscle cells, or cardiac muscle cells, interact with other cell types and with extracellular materials to form muscle tissues.

4. The Organ Level: Organs consist of two or more tissues working in combination to perform several functions. Layers of cardiac muscle tissue, in combination with connective tissue, another tissue type, form the bulk of the wall of the heart, a hollow three-dimensional organ.

5. The Organ System Level: Organs interact in organ systems. Each time the heart contracts, it pushes blood into a network of blood vessels. Together the heart, blood and blood vessels form the cardiovascular system, one of 11 organ systems of the body.

6. The Organism Level: All organ systems of the body work together to maintain life and health. This brings us to the highest level of organization, that of the organism – in this case, the

human being.

3.2 Interrelationships between the Levels of Organization

The organization at each level determines the characteristics and functions of higher levels. For example, the arrangement of atoms and molecules at the chemical level creates the protein filaments that, at the cellular level, give cardiac muscle cells the ability to contract powerfully. At the tissue level, these cells are linked, forming the cardiac muscle tissue. The structure of the tissue ensures that the contractions are coordinated, producing a heart-beat. When that beat occurs, the internal anatomy of the heart, an organ, enables it to function as a pump. The heart is filled with blood and connected to the blood vessels and the pumping action circulates to the blood vessels, of the cardiovascular system. By interacting with the respiratory, digestive, urinary, and other systems, the cardiovascular system performs a variety of functions essential to the survival of the organism.

Something that affects a system will ultimately affect each component. For example, the heart cannot pump blood effectively after a massive blood loss. If the heart cannot pump and blood cannot flow, oxygen and nutrients cannot be distributed. Very soon, the cardiac muscle tissue begins to break down as individual muscle tissue cells die from oxygen and nutrient starvation. All cells, tissues, and organs in the body will be damaged.

SELF ASSESSMENT EXERCISE 1

List the six levels of organization in the human body.

3.3 Organs/Systems in the Body

This is an introduction to the organ systems in the human body. These organ systems are interdependent, interconnected, and packaged together in a relatively small space. The cells, tissues, organs, and organ systems of the body live together in a shared environment, like the inhabitants of a large city. Just as city dwellers breathe the city air and drink the water provided by the local water company, cells in the human body absorb oxygen and nutrients from the fluids that surround them. If a city is blanketed in smog or its water supply is contaminated, the inhabitants will become ill. Similarly, if body fluid composition becomes abnormal, cells will be injured or destroyed. Suppose the temperature or salt content of the blood changes, the effect on the heart could range from a minor adjustment (heart muscle tissue contracts more often, so the heart rate goes up) to a total disaster (the heart stops beating, so the individual dies).

Various physiological mechanisms act to prevent potentially damaging changes in the composition of body fluid and the environment inside our cells.

Homeostasis

(*homeo,* unchanging + stasis, standing) refers to the existence of a stable internal environment. To survive, every organism must maintain homeostasis.

Table 1

Table 1

Organ/System	**Functions**
The Integumentary System	Protects against environmental hazards; helps control body temperature
Epidermis	Covers surface; protects deeper tissues
Dermis	Nourishes epidermis; provides strength; contains glands
Hair follicles	Produce hair; innervations and provide

	sensations
	Provide some protection for the head
Sebaceous glands	Secrete lipid coating that lubricate hair shaft and epidermis
Sweat glands	Provide perspiration for evaporative cooling
Nails	Protect and stiffen distal tips of digits
Sensory receptors	Provide sensations of touch, pressure, temperature, pain
	Store lipids; attach skin to deeper structures
The Skeletal System	Protects tissues; stores minerals; forms blood; provides support
Bones, cartilages and joints	Support, protect soft tissues and store minerals
Axial skeleton (skull, vertebrae, ribs, sternum, sacrum, cartilages, and ligaments)	Protects brain, spinal cord, sense organs, and soft tissues of thoracic cavity; supports the body weight
Appendicular skeleton (limbs and supporting bones and ligaments)	Provides internal support and positioning of the limbs; supports and moves axial skeleton
Bone marrow	Acts as primary site of blood cell production (red blood cells, white blood cells)
Skeletal muscles	Provide skeletal movement; control entrances and exits of digestive tract; produce heat; support skeletal position; protect soft tissues
Axial muscles	Support and position axial skeleton
Central Nervous System (CNS)	Acts as control centre for the nervous system; processes information; provides short-term control over activities of other systems
Brain	Performs complex integrative functions; controls both voluntary and autonomic activities
Spinal cord	Relays information to and from the brain; performs less-complex integrative functions and directs many simple involuntary activities

Pineal gland	May control timing of reproduction and set day-night rhythms
Pituitary gland	Controls other endocrine glands; regulates growth and fluid balance
Thyroid gland	Controls tissue metabolic rate; regulates calcium levels Regulates calcium levels (with thyroid)
Parathyroid glands	Control maturation of lymphocytes
Thymus	Adjusts water balance, tissue metabolism, cardiovascular and respiratory activity
Adrenal glands	Control red blood cell production and elevates blood pressure
Kidneys	Transports cells and dissolved materials, including nutrients, wastes and gases.
Pancreas	Regulates blood glucose levels
Testes	Support male sexual characteristics and reproductive functions.
Ovaries	Supports female sexual characteristics reproductive functions
The Cardio-vascular System	
Heart	Propels blood and maintains blood pressure
Blood vessels	Distribute blood around the body.
Arteries	Carry blood from the heart to the capillaries
Capillaries	Permit diffusion between the blood and interstitial fluids
Veins	Return blood from capillaries to the heart
Blood	Transports oxygen, carbon dioxide, and blood cells; delivers nutrients and hormones; removes waste products; assists in temperature regulation and defense against disease

Source: *Fundamentals of Anatomy and Physiology*, (5th ed), Prentice-Hall. Inc.

SELF ASSESSMENT EXERCISE 2

1. Define homeostasis.
2. Mention three characteristics of the organ system.

4.0 CONCLUSION

The relationship at each level determines the characteristics and functions of different organs in the human body.

5.0 SUMMARY

This unit shows that there are six (6) levels of organization of the body, with certain levels of relationships among these various levels of organization. It also shows the structure and functions of the systems in the body as well as homeostasis.

ANSWER TO SELF ASSESSMENT EXERCISE 1

The six levels are:

1. Chemical or molecular level
2. Cellular level
3. Tissue level
4. Organ level
5. Organ system level

6. Organism level

ANSWER TO SELF ASSESSMENT EXERCISE 2

1. Homeostasis refers to the existence of a stable internal environment. To survive, every organism must maintain homeostasis.

2. Three characteristics of organ systems

· Interdependent
· Interconnected
· Packaged together

6.0 TUTOR-MARKED ASSIGNMENT

Enumerate the levels of human body organization.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology* (5th ed), New Jersey: Prentice-Hall, Inc.

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MODULE 2

UNIT 1 THE INTEGUMENTARY SYSTEM

CONTENTS

3.0 INTRODUCTION

The integumentary system consists of the skin, which is the largest organ of the body. Alterations in the skin will affect the overall wellbeing of an individual. The skin is a highly underestimated organ. It performs many vital functions, and has a complex structure which most people are unaware of. This unit provides a basic overview of the anatomy and physiology (structure and function) of the human skin, which is essential to accurate patient assessment.

4.0 OBJECTIVES

At the end of this unit, you should be able to:

· explain the functions of the skin
· describe the structure of the skin
· describe the appendages of the skin.

3.0 MAIN CONTENT

3.1 The Anatomy of the Skin

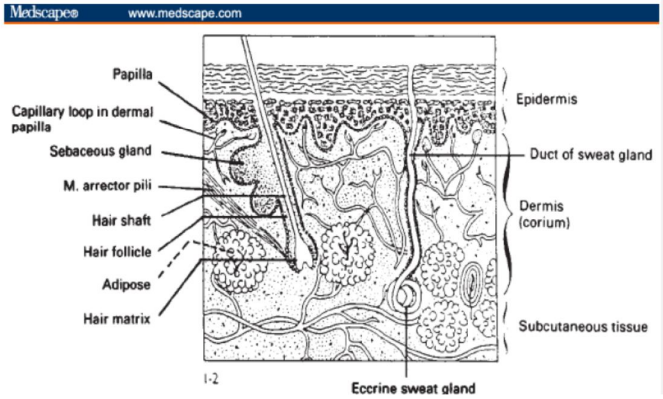

Fig. 3: The anatomy of the skin

The skin is an organ because it consists of different tissues that are joined to perform specific activities. It is one of the largest organs of the body in surface area and weight. In adults, the skin covers an area of about 2 square meters, and weighs 4.5 to 5 kg. It ranges in thickness from 0.5 to 4.0 mm, depending on location. The skin is not just a simple, thin coat that keeps the body together and provides protection. It performs several essential functions. Dermatology is the medical specialty that deals with diagnosing and treating skin disorders.

Structurally, the skin consists of two principal parts. The outer, thinner portion, which is composed of epithelium, is called the epidermis. The epidermis is attached to the inner, thicker, connective tissue part called the dermis. Beneath the dermis is a subcutaneous (subcut) layer. This layer, also called the superficial fascia or hypodermis, consists of areola and adipose tissues. Fibers from the dermis extend down into the subcutaneous layer and anchor the skin to it. The subcutaneous layer, in turn, attaches to underlying tissues and organs.

3.2 Functions of the Skin

1. Regulation of body temperature

In response to high environmental temperature or strenuous exercise, the evaporation of sweat from the skin surface helps lower an elevated body temperature to normal. In response to low environmental temperature, production of sweat is decreased, which helps conserve heat. Changes in the flow of blood to the skin also help regulate body temperature.

2. Protection

The skin covers the body and provides a physical barrier that protects underlying tissues from shocks, physical abrasion, bacterial invasion, dehydration, and ultraviolet (UV) radiation. Hair and nails also have protective functions.

3. Sensation

The skin contains abundant nerve endings and receptors that detect stimuli related to temperature, touch, pressure, and pain and relate the

information to the nervous system.

4. Excretion

Besides removing heat and some water from the body, sweat also is the vehicle for excretion of a small amount of salts and several organic compounds by integumentary glands.

5. Storage of nutrients

Lipids are stored in adiposities in the dermis and in adipose tissue in the subcutaneous layer. These are made available to the body when there is depletion which may be due to starvation.

6. Blood reservoir

The dermis of the skin houses extensive networks of blood vessels that carry 8 to 10% of the total blood flow in a resting adult. In moderate exercise, skin blood flow may increase, which helps dissipate heat from the body. During hard exercise, however, skin blood vessels constrict (narrow) somewhat, and more blood is able to circulate to contracting muscles.

7. Synthesis of Vitamin D

Vitamin D is a group of closely related compounds. Synthesis of vitamin D begins with activation of a precursor molecule in the skin by ultraviolet (UV) rays in sunlight. Enzymes in the liver and kidneys then modify the molecule, finally producing calcitriol, the most active form of vitamin D. Calcitriol contributes to the homeostasis of body fluids by aiding absorption of calcium in foods. According to the synthesis sequence just described, vitamin D is a hormone, since it is produced in one location in the body, transported by the blood, and then exerts its effect in another location. In this respect, the skin may be considered an endocrine organ.

SELF ASSESSMENT EXERCISE 1

1. List five functions of the skin.
2. ……and……..are two principal parts of the skin.

3.3 The Epidermis

The epidermis is composed of stratified squamous epithelium. It contains four principal types of cells:

· Keratinocytes: About 90% of the epidermal cells are keratinocytes. They produce the protein keratin that helps waterproof and protect the skin and underlying tissues.

· Melanocytes: They produce the pigment melanin, which comprise about 8% of the epidermal cells. Their long, slender projections extend between and transfer granules of melanin to keratinocytes. Melanin (melan = black) is a brown-black pigment that contributes to skin colour and absorbs ultraviolet (UV) light.

· Langerhans: These are the third type of cell in the epidermis. These cells arise from bone marrow and migrate to the epidermis. They interact with white blood cells called helper T cells in immune responses and are easily damaged by UV radiation.

· A fourth type of cell found in the epidermis is called Merkel cells. These cells are located in the deepest layer (stratum basale) of the epidermis of hairless skin, where they are attached to keratinocytes by desmosomes. Merkel cells make contact with the flattened portion of the ending of a sensory neuron (nerve cell), called a tactile (Merkel) disc, and are thought to function in the sensation of touch.

Four or five distinct layers of cells form the epidermis. In most regions of the body the epidermis is about 0. 1 mm thick and has four layers. Where exposure to friction is greatest, such as in the palms and soles, the epidermis is thicker (l to 2 mm) and has five layers. Constant exposure of thin or thick skin to friction or pressure stimulates formation of a callus, an abnormal thickening of the epidermis.

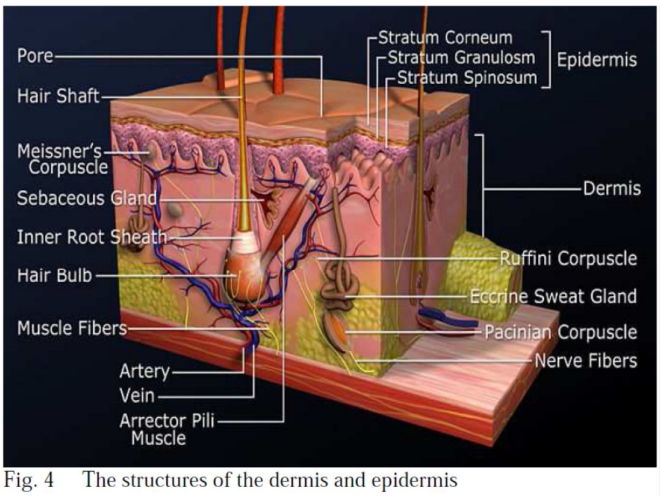

Fig. 4 The structures of the dermis and epidermis

(http://en.wikipedia.org/wiki/commons/a/a5)

The names of the five layers (strata), from the deepest to the most superficial are:

1. Stratum Basal: This single layer of cuboidal to columnar cells contains stem cells, which are capable of continued cell division, and Melanocytes. The stratum basal also contains tactile (Merkel) discs that are sensitive to touch.

2. Stratum Spinosum: This layer of the epidermis contains 8 to 10 rows (sheets) of polyhedral (many sided) cells that fit closely together. The cells here appear to be covered with prickly spines (spinosum prickly) because the cells shrink apart when the tissue is prepared for microscopic examination.

3. Stratum Granulosum: The third layer of the epidermis consists of three to five rows of flattened cells that develop darkly staining granules of a substance called keratohyalin. This compound is the precursor of keratin, a protein found in the outer layer of the epidermis. Keratin forms a barrier that protects deeper layers from injury and microbial invasion and makes the skin

waterproof.

4. Stratum Lucidum: Normally, only the thick skin of the palms and soles has this layer. It consists of three to five rows of clear, flat, dead cells that contain droplets of an intermediate substance that is formed from keratohyalin and is eventually transformed to keratin.

5. Stratum Corneum: This layer consists of 25 to 30 rows of flat, dead cells completely filled with keratin. These cells are continuously shed and replaced by cells from deeper strata. The stratum corneum serves as an effective barrier against light and heat waves, bacteria, and many chemicals.

In the process of keratinisation, cells newly formed in the basal layers undergo a developmental process as they are pushed to the surface. As the cells relocate, they accumulate keratin. At the same time the cytoplasm, nucleus, and other organelles disappear, and the cells die. Eventually, the keratinised cells slough off and are replaced by underlying cells that, in turn, become keratinised. The whole process by which a cell forms in the basal layer, rises to the surface, becomes keratinised, and sloughs off takes two to four weeks. Epidermal growth factor (EGF) is a protein hormone that stimulates growth of epithelial and epidermal cells during tissue development, repair, and renewal.

3.4 The Dermis

The second principal part of the skin, the dermis, is composed of connective tissue containing collagen and elastic fibres. The few cells in the dermis include fibroblasts, macrophages, and adipocytes. The dermis is very thick in the palms and soles and very thin in the eyelids, penis, and scrotum. It also tends to be thicker on the dorsal than the ventral aspects of the body and thicker on the lateral than the medial aspects of the extremities. Blood vessels, nerves, glands, and hair follicles are embedded in the dermis.

The outer portion of the dermis, about one-fifth of the thickness of the total layer, is named the papillary region (layer). It consists of areola connective tissue containing fine elastic fibers. Its surface area is greatly increased by small, finger like projections called dermal papillae.

The deeper portion of the dermis is called the reticular region (layer). It consists of dense, irregular connective tissue containing interlacing bundles of collagen and coarse elastic fibres. Within the reticular region, bundles of collagen fibres interlace in a netlike manner. Spaces between the fibres are occupied by a small quantity of adipose tissue, hair follicles, nerves, oil glands, and the ducts of sweat glands. Varying thicknesses of the reticular region contribute to differences in the thickness of skin.

The combination of collagen and elastic fibres in the reticular region provides the skin with strength, extensibility, and elasticity. (Extensibility is the ability to stretch; elasticity is the ability to return to original shape after stretching.) The ability of the skin to stretch can

readily be seen in pregnancy, obesity, and oedema. Small tears that occur in the dermis during extreme stretching are initially red and remain visible afterward as silvery white streaks called striae (STRI-e) or stretch marks.

The reticular region is attached to underlying organs, such as bone and muscle, by the subcutaneous layer, also called the hypodermis or superficial fascia. The subcutaneous layer also contains nerve endings called lamellated or Pacinian corpuscles that are sensitive to pressure. Nerve endings sensitive to cold are found in and just below the dermis, while those sensitive to heat are located in the middle and outer dermis.

SELF ASSESSMENT EXERCISE 2

1. List the cells of the epidermis.
2. Mention three cells found in the dermis.

4.0 CONCLUSION

The skin performs many vital functions and has a complex structure. It is hoped that you have gained a deeper understanding and respect for the skin, and understood why it is so important to take care of the skin and maintain its health, through the use of a regular skin care regime.

5.0 SUMMARY

This unit teaches that:

· The skin is the largest organ of the body.
· Alterations in the skin will affect the overall well-being of an individual.
· Knowledge of the anatomy and physiology of the skin is essential to accurate patient assessment.
· Functions of the skin include protection, homeostasis, excretion, temperature regulation, vitamin D production, sensory perception, psychosocial function, and wound healing.
· Structure of the skin includes the epidermis, cells in the epidermis, basement membrane zone, dermis, and cells in the dermis, dermal vasculature, lymphatic nerves, and subcutaneous tissue.
· Appendages of the skin include nail, hair and sebaceous glands.

ANSWER TO SELF ASSESSMENT EXERCISE 1

1. Regulation of body temperature, protection, sensation, excretion, immunity, blood reservoir.
2. Epidermis and dermis.

ANSWER TO SELF ASSESSMENT EXERCISE 2

1. Keratinocytes, Melanocytes, Langerhans and Merkel cell.
2. Fibroblasts, macrophages, and adipocytes.

6.0 TUTOR-MARKED ASSIGNMENT

With a well labelled diagram, describe the epidermis.

7.0 REFERENCES/FURTHER READINGS

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UNIT 2 THE SKELETAL SYSTEM

CONTENTS

1.0 INTRODUCTION

The skeletal system serves many important functions. It provides the shape and form for our bodies in addition to supporting, protecting, allowing bodily movement, producing blood for the body, and storing

minerals. The term skeleton comes from a Greek word meaning "dried up".

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· describe the different types of bones
· explain the composition of bones
· explain the functions of the skeletal system
· describe the divisions of the skeletal system

3.0 MAIN CONTENT

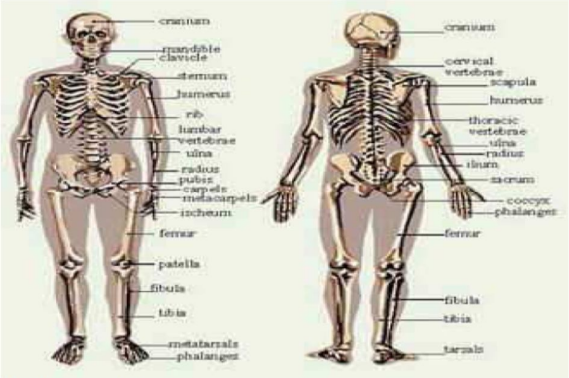


Fig. 5: The human skeleton

(http://en.wikipedia.org/wiki/skeleton)

3.1 Functions of the Skeletal System

1. Its 206 bones form a rigid framework to which the softer tissues and organs of the body are attached.
2. Vital organs are protected by the skeletal system. The brain is protected by the surrounding skull as the heart and lungs are encased by the sternum and rib cage.
3. Bodily movement is carried out by the interaction of the muscular and skeletal systems. For this reason, they are often grouped together as the musculo-skeletal system. Muscles are connected to bones by tendons. Bones are connected to each other by ligaments. Where bones meet one another is typically called a *joint.* Muscles which cause movement of a joint are connected to two different bones and contract to pull them together. An example would be the contraction of the biceps and a relaxation of the triceps. This produces a bend at the elbow. The contraction of the triceps and relaxation of the biceps produce the effect of straightening the arm.
4. Blood cells are produced by the marrow located in some bones.

An average of 2.6 million red blood cells are produced each second by the bone marrow to replace those worn out and destroyed by the liver.

Bones serve as a storage area for minerals such as calcium and phosphorus. When an excess is present in the blood, a build up will occur within the bones.

When the supply of these minerals within the blood is low, it will be withdrawn from the bones to replenish the supply.
The human skeleton is divided into two distinct parts: The axial skeleton and the appendicular skeleton.

3.2 The Axial Skeleton

The axial skeleton consists of bones that form the axis of the body and support and protect the organs of the head, neck, and trunk. It is made up of the following:
1. The Skull: The skull is the bony framework of the head. It consists of eight cranial and fourteen facial bones.

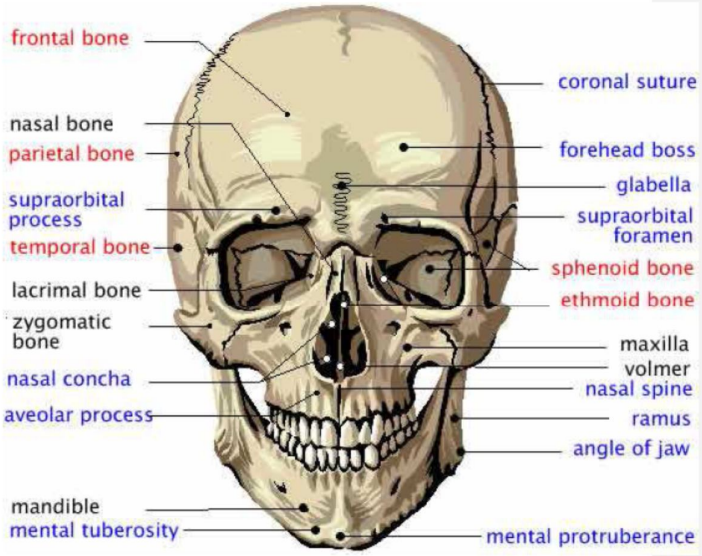


Fig. 6; The human skull

(http://en.wikipedia.org/wiki/skull)

(a) The cranial bones make up the protective frame of bone around the brain. The cranial bones are as follows:
· The frontal forms part of the cranial cavity as well as the forehead, the brow ridges and the nasal cavity.
· The left and right parietal forms much of the superior and lateral portions of the cranium.
· The left and right temporal form the lateral walls of the cranium as well as housing the external ear.
· The occipital forms the posterior and inferior portions of the cranium. Many neck muscles attach here, as this is the point of articulation with the neck.
· The sphenoid forms part of the eye orbit and helps to form the floor of the cranium.
· The ethmoid forms the medial portions of the orbits and the roof of the nasal cavity.
(b) The facial bones makeup the upper and lower jaw and other facial structures. The facial bones are as follows:
· The mandible is the lower jawbone. It articulates with the

temporal bones at the temporomandibular joints. This forms the only freely moveable joint in the head. It provides the chewing motion.
· The left and right maxilla are the upper jaw bones. They form part of the nose, orbits, and roof of the mouth.
· The left and right palatine forms a portion of the nasal cavity and the posterior portion of the roof of the mouth.
· The left and right zygomatic are the cheek bones. They form portions of the orbits as well.
· The left and right nasals forms the superior portion of the bridge of the nose.
· The left and right lachrymals help to form the orbits.
· The vomer forms part of the nasal septum (the divider between the nostrils).
2. The Sternum: The sternum is a flat, dagger shaped bone located in the middle of the chest. Along with the ribs, the sternum forms the rib cage that protects the heart, lungs, and major blood vessels from damage.
The sternum is composed of three parts:
· The manubrim, also called the “handle”.
· The body, also called the “blade” or the “gladiolus”, is located in the middle of the sternum and connects the third to seventh ribs directly and the eighth through tenth ribs indirectly.
· The xiphoid process, also called the “tip”, is located on the bottom of the sternum. It is often cartilaginous (cartilage), but does become bony in later years.
These three segments of bone are usually fused in adults.

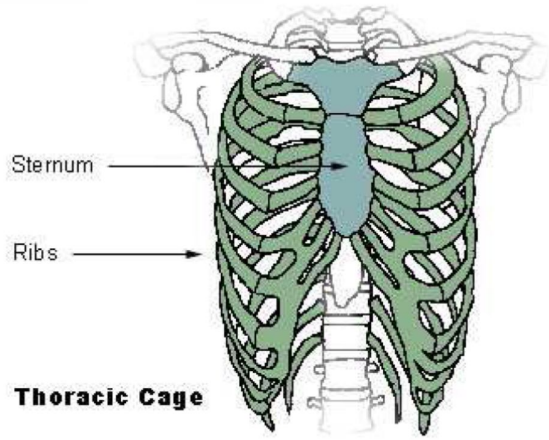


Fig. 7: The thoracic cage

(http://en.wikipedia.org/wiki/Thoracic)

The Ribs: The ribs are thin, flat, curved bones that form a protective cage around the organs in the upper body. They are comprised of 24 bones arranged in 12 pairs. These bones are divided into three categories:

· The first seven bones are called the true ribs.
· The next three pairs of bones are called false ribs
· The last two sets of rib bones are called floating ribs. Floating ribs are smaller than both the true ribs and the false ribs.
The ribs form a kind of cage that encloses the upper body. They give the chest its familiar shape.
3. The ribs serve several important purposes:
· They protect the heart and lungs from injuries and shocks that might damage them.
· They also protect parts of the stomach, spleen, and kidneys.
· The ribs help you to breathe. As you inhale, the muscles in between the ribs lift the rib cage up, allowing the lungs to expand. When you exhale, the rib cage moves down again, squeezing the air out of your lungs.
4. The Vertebral Column:

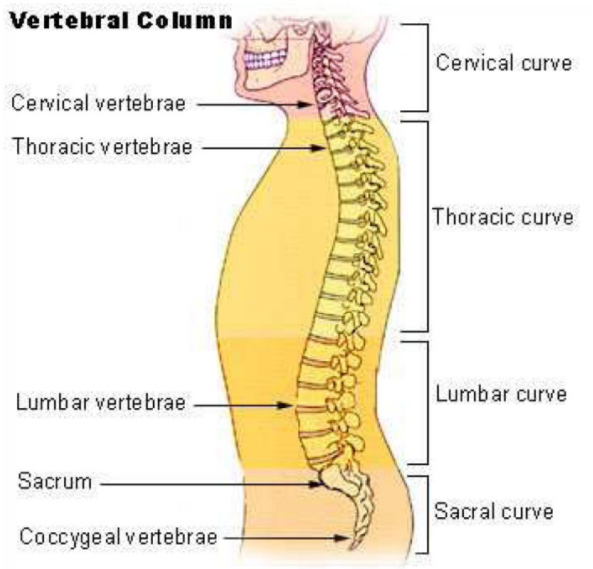


Fig. 8: The vertebral column

http://en.wikipedia.org/wiki/vertebral column)
The vertebral column (also called the backbone, spine, or spinal column) consists of a series of 33 irregularly shaped bones, called vertebrae. These 33 bones are divided into five categories depending on where they are located in the backbone.
· The first seven vertebrae are called the cervical vertebrae. Located at the top of the spinal column, these bones form a flexible framework for the neck and support the head. The first cervical vertebra is called the atlas and the second is called the axis.

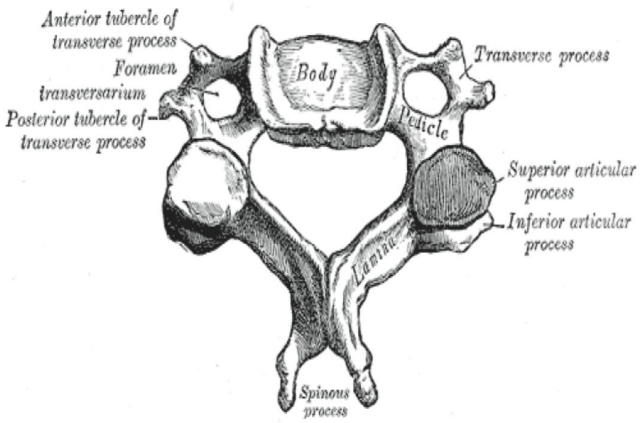


Fig9: The cervical vertebrae

(http://en.wikipedia.org/wiki/Cervical vertebra)

The next twelve vertebrae are called the thoracic vertebrae. These bones move with the ribs to form the rear anchor of the rib cage.

· After the thoracic vertebrae, come the lumbar vertebrae. These five bones are the largest vertebrae in the spinal column.

· The sacrum is a triangular bone located just below the lumbar vertebrae. It consists of four or five sacral vertebrae in a child, which becomes fused into a single bone after age 26.

The bottom of the spinal column is called the coccyx or tailbone. It consists of 3-5 bones that are fused together in an adult. Many muscles connect to the coccyx.

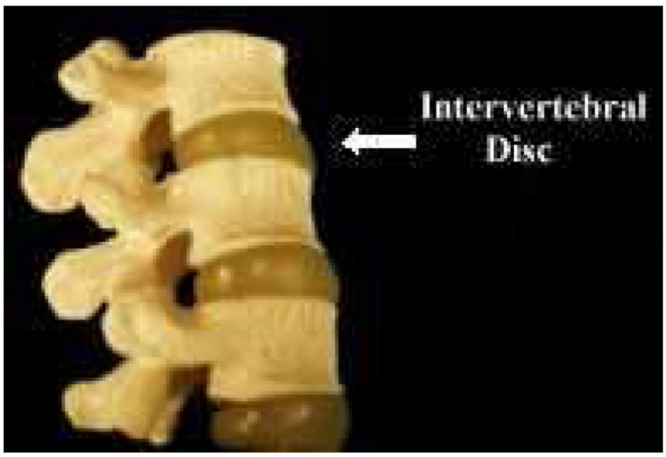


Fig. 10: The intervertebral disc
http://en.wikipedia.org/wiki/disc

These bones compose the vertebral column, resulting in a total of 26 movable parts in an adult. In between the vertebrae are intervertebral

discs made of fibrous cartilage that act as shock absorbers and allow the back to move. As a person ages, these discs compress and shrink, resulting in a distinct loss of height (generally between 0.5 and 2.0cm) between the ages of 50 and 55.

When looked at from the side, the spine forms four curves. These curves are called the cervical, thoracic, lumbar, and pelvic curves. The cervical and lumbar curves are not present in an infant. The cervical curves form around the age of 3 months when an infant begins to hold its head up and the lumbar curve develops when a child begins to walk.

In addition to allowing humans to stand upright and maintain their balance, the vertebral column serves several other important functions. It helps to support the head and arms, while permitting freedom of movement. It also provides attachment for many muscles, the ribs, and some of the organs, and protects the spinal cord, which controls most bodily functions.

SELF ASSESSMENT EXERCISE 1

1. What are the basic functions of the human skeleton?

2 ----------, ---------- and ---------- are the parts of the sternum.

3.3 The Appendicular Skeleton

The appendicular skeleton is composed of bones that anchor the appendages to the axial skeleton.

1. The Upper Extremities

1. The Upper Extremities

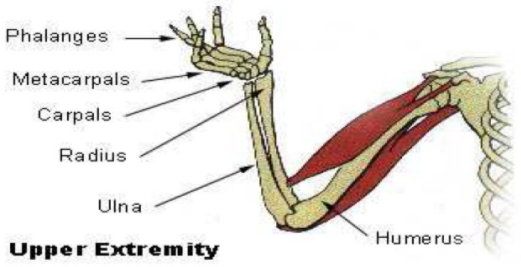


Fig. 11:The upper extremities

(http://en.wikipedia.org/wiki/upper extremity)

The upper extremity consists of three parts: the arm, the forearm, and the hand. The arm, or brachium, is technically only the region between the shoulder and elbow. It consists of a single long bone called the humerus. The humerus is the longest bone in the upper extremity. The top, or head, is large, smooth, and rounded and fits into the scapula in the shoulder. At the bottom of the humerus, are two depressions where the

humerus connects to the ulna and radius of the forearm. Together, the humerus and the ulna make up the elbow. The bottom of the humerus protects the ulnar nerve and is commonly known as the "funny bone" because striking the elbow on a hard surface stimulates the ulnar nerve and produces a tingling sensation.

The forearm is the region between the elbow and the wrist. It is formed by the radius on the lateral side and the ulna on the medial side when the forearm is viewed in the anatomical position. The ulna is longer than the radius and connected more firmly to the humerus. The radius, however, contributes more to the movement of the wrist and hand than the ulna.

The hand consists of three parts (the wrist, palm, and five fingers) and 27 bones. The wrist, or carpus, consists of 8 small bones called the carpal bones that are tightly bound by ligaments. These bones are arranged in two rows of four bones.

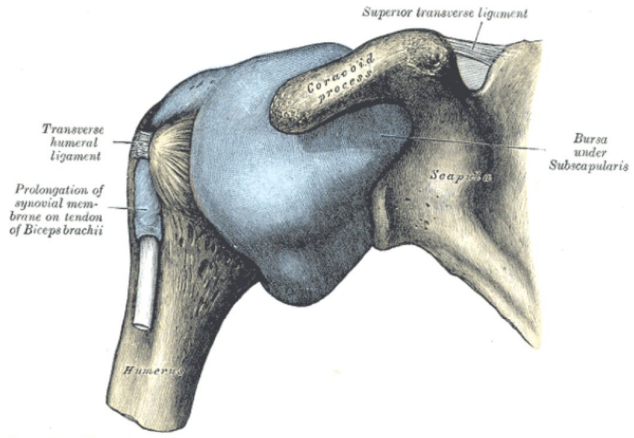


Fig. 12: The shoulder joint

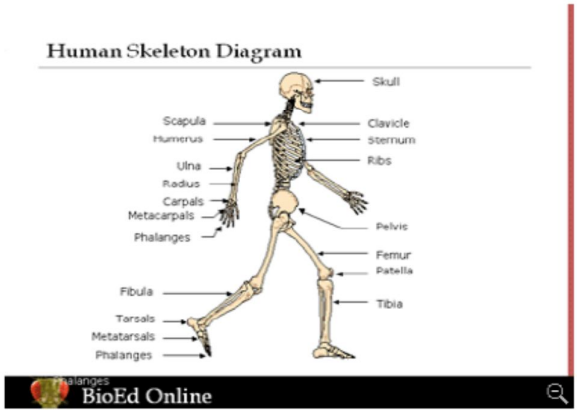
Source:http://en.wikipedia.org/wiki/shoulder

2. The Lower Extremities

Fig.13: The lower extremities

Fig. 15: A diagram of the human skeleton

Fig.13: The lower extremities



The lower extremity is composed of the bones of the thigh, leg, foot, and the patella (commonly known as the kneecap).
The thigh is the region between the hip and the knee and is composed of a single bone called the femur or thighbone. The femur is the longest, largest, and strongest bone in the body.

The leg is technically only the region from the knee to the ankle. It is formed by the fibula on the side away from the body (lateral side) and the tibia, also called the shin bone, on the side nearest the body (medial side). The tibia connects to the femur to form the knee joint and with the talus, a foot bone, to allow the ankle to flex and extend. The tibia is larger than the fibula because it bears most of the weight, while the fibula serves as an area for muscle attachment.
The foot, or pes, contains the 26 bones of the ankle, instep, and the five toes. The ankle, or tarsus, is composed of the 7 tarsal bones which correspond to the carpals in the wrist. The largest tarsal bone is called the calcaneus or heel bone. The talus rests on top of the calcaneus and is connected to the tibia. The metatarsal and phalanges bones of the foot are similar in number and position to the metacarpal and phalanges bones of the hand.
The patella or kneecap is a large, triangular sesamoid bone between the femur and the tibia. It is formed in response to the strain in the tendon that forms the knee. The patella protects the knee joint and strengthens the tendon that forms the knee.

The bones of the lower extremities are the heaviest, largest, and strongest bones in the body because they must bear the entire weight of the body when a person is standing in the upright position.
3. The Shoulder Girdle: Also called the pectoral girdle, is composed of four bones: two clavicles and two scapulae.
The clavicle, commonly called the collarbone, is a slender S-shaped bone that connects the upper arm to the trunk of the body and holds the shoulder joint away from the body to allow for greater freedom of movement.
The scapula is a large, triangular, flat bone on the back side of the rib cage commonly called the shoulder blade. It has a shallow depression called the glenoid cavity that the head of the humerus (upper arm bone) fits into.
Usually, a “girdle” refers to something that encircles or is a complete ring. However, the shoulder girdle is an incomplete ring. In the front, the clavicles are separated by the sternum. In the back, there is a gap between the two scapulae.
The primary function of the pectoral girdle is to provide an attachment point for the numerous muscles that allow the shoulder and elbow joints to move. It also provides the connection between the upper extremities (the arms) and the axial skeleton.
The Pelvic Girdle-(the sacrum and coccyx are considered part of the vertebral column).

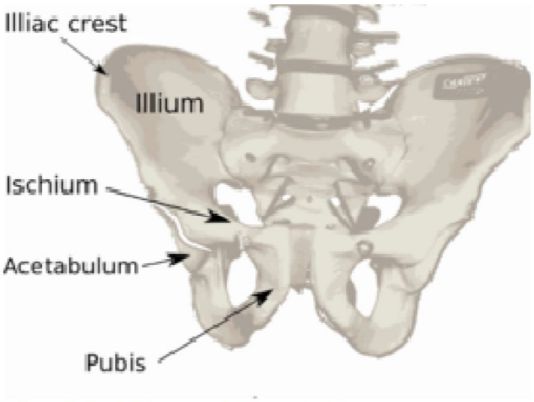


Fig 16: The pelvic girdle
Source: http://en.wikipedia.org/wiki/pelvis

It is also called the hip girdle, and is composed of two coxal (hip) bones. During childhood, each coxal bone consists of three separate parts: the ilium, the ischium, and the pubis. In an adult, these three bones are firmly fused into a single bone.
The pelvic girdle serves several important functions in the body. It supports the weight of the body from the vertebral column. It also protects and supports the lower organs, including the urinary bladder,

the reproductive organs, and the developing fetus in a pregnant woman. The pelvic girdle differs between men and women. In a man, the pelvis is more massive and the iliac crests are closer together. In a woman, the pelvis is more delicate and the iliac crests are farther apart. These differences reflect the woman's role in pregnancy and delivery of children. When a child is born, it must pass through its mother's pelvis.
If the opening is too small, a cesarean section may be necessary.

3.3.1 Types of Bones

The bones of the body fall into four general categories: long bones, short bones, flat bones, and irregular bones. Long bones are longer than they are wide and work as levers. The bones of the upper and lower extremities (e.g. humerus, tibia, femur, ulna, metacarpals, etc.) are of this type. Short bones are short, cube-shaped, and found in the wrists and ankles. Flat bones have broad surfaces for protection of organs and attachment of muscles (e.g. ribs, cranial bones, bones of shoulder girdle). Irregular bones are all others that do not fall into the previous categories. They have varied shapes, sizes, and surface features, and include the bones of the vertebrae and a few in the skull.

3.3.2 Bone composition

Bones are composed of tissues that may take one of two forms. Compact, or dense bone, and spongy, or cancellous, bone. Most bones contain both types. Compact bone is dense, hard, and forms the protective exterior portion of all bones. Spongy bone is inside the compact bone and is very porous (full of tiny holes). Spongy bone occurs in most bones. The bone tissue is composed of several types of bone cells embedded in a web of inorganic salts (mostly calcium and phosphorus) to give the bone strength, and collagenous fibers and ground substance to give the bone flexibility.

SELF ASSESSMENT EXERCISE 2

1. Describe the patella.
2. List the categories of bones in the human body.

4.0 CONCLUSION

Bone mass accounts for 20 per cent of the body weight. The strength of bone comes from its inorganic components of such durability that they resist decomposition even after death. The clavicle in the shoulder is the most commonly broken bone in the body because it transmits forces from the arm to the trunk.

5.0 SUMMARY

This unit shows the following:

· The different types of bones
· The composition of bones
· The functions of the skeletal system
· The divisions of the skeletal system

ANSWER TO SELF ASSESSMENT EXERCISE 1

1. The functions of the skeletal system include the following:

· It provides the shape and form for our bodies.
· It provides support and protection for delicate body organs.
· It allows bodily movement.
· It produces blood for the body and stores minerals.
2. The sternum is made up of the manubrim, the body and xiphoid process.

ANSWER TO SELF ASSESSMENT EXERCISE 2
1. The patella or kneecap is a large, triangular sesamoid bone between the femur and the tibia.
2. The bones of the body fall into four general categories: long bones, short bones, flat bones, and irregular bones.

6.0 TUTOR-MARKED ASSIGNMENT
Describe the cranial and facial bones.

7.0 REFERENCES/FURTHER READINGS
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UNIT 3 THE NERVOUS SYSTEM
CONTENTS

6.0 Tutor-Marked Assignment
7.0 References/Further Readings

1.0 INTRODUCTION

In the next two units, our attention will shift to mechanisms that coordinate the activities of the body's organ systems. These activities are adjusted to meet changing situations and environmental conditions. You sit, stand, or walk by controlling muscular activities; your body temperature remains stable on a cold winter day or in a warm kitchen because your rates of heat generation and heat loss are closely regulated.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· explain the activities of the nervous system
· give a general overview of the nervous system
· describe the anatomical divisions of the nervous system and their functions
· describe the structure of the brain

3.0 MAIN CONTENT

The nervous system, which accounts for a mere 3 per cent of the total body weight, is the most complex organ system. It is vital not only to life but also to our appreciation of life. This unit details with the structure and function of neural tissue and introduces principles of neurophysiology that are vital to an understanding of the nervous system's capabilities and limitations.

3.1 An Overview of the Nervous System

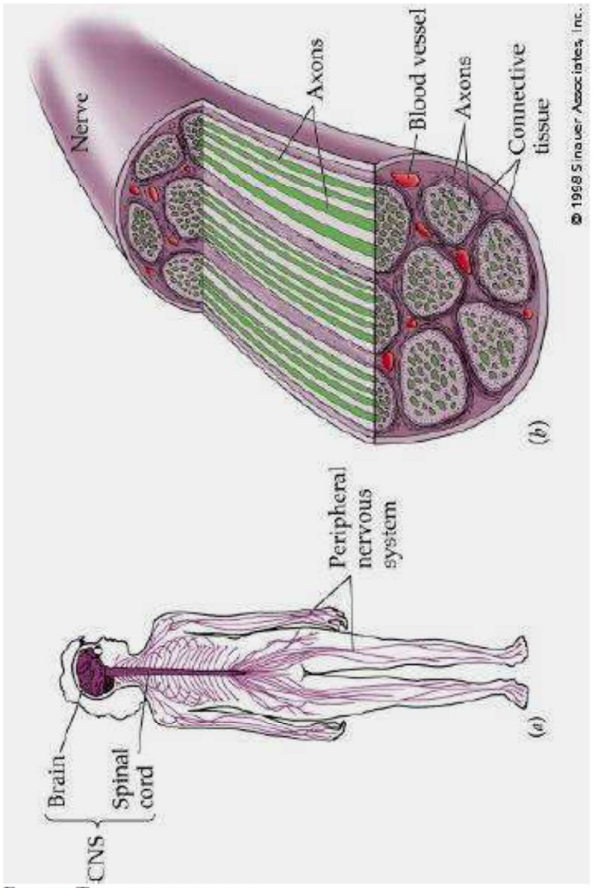

Fig. 17: The nervous system

http://en.wikipedia.org/wiki/CNS

Fig. 17: The nervous system
http://en.wikipedia.org/wiki/CNS

The nervous system includes all the neural tissue in the body. The basic functional units of the nervous system are individual cells called neurons. Supporting cells or neuroglia separate and protect the neurons, provide a supportive framework for neural tissue, act as phagocytes, and help regulate the composition of the interstitial fluid. Neuroglia, also called glial cells, far outnumber neurons, and account for roughly half the volume of the nervous system.

Neural tissue, with supporting blood vessels and connective tissues, forms the organs of the nervous system: the brain; the spinal cord; the receptors in complex sense organs, such as the eye and ear; and the nerves that interconnect these organs and link the nervous system with other systems. In Unit 2, we introduced the two major anatomical divisions of the nervous system; (1) the central nervous system and (2) the peripheral nervous system.

Nervous systems of man consist of 2 main parts:

1. The central nervous system consisting of the brain and spinal cord.
2. The peripheral nervous system consisting of:
a. The sensory system.
b. The motor system.
c. The somatic nervous system.
d. The autonomic nervous system, which is subdivided into the parasympathetic system and the sympathetic system.
The central nervous system
· co-ordinates the activities of the nervous system.
· receives constant input of impulses relating to changes in animals' internal and external environment.
· processes and integrates information and sends out impulse to relevant effectors for action. Impulses transmitted along sensory nerves are called sensory impulses.

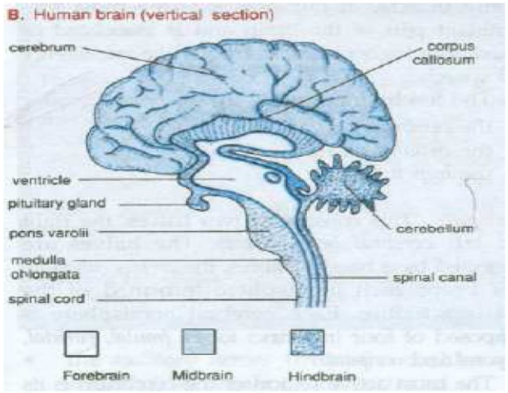

Fig. 18: The features of the human brain

Source: *NNmda Manual*

The Brain
· The human brain weighs about 1.2 to 1.4kg
· It consumes 25% of the body oxygen supply to generate energy
· It is covered by a membrane called the meninges
· It is enclosed in a bony case called the skull or cranium
· It is made up of 2 types of nervous tissues, (nerves cells or grey matter and nerves fibers or white matter.).
The Human Brain is divided into 3 parts:
a. The fore brain (i.e. large, forward part).
b. The mid brain (i.e. narrow brain).
c. The hind brain (i.e. rare path).
The Fore Brain: It consists mainly of cerebrum, thalamus and hypothalamus.
The Mid Brain: It links the forebrain to the hind brain. It controls auditory and visual reflexes.
Hind Brain: It is composed of 3 parts, namely:
a. Cerebellum

b. Pons varolii
c. Medulla oblongota

SELF ASSESSMENT EXERCISE 1

1. The autonomic nervous system consists of ---------- and ----------.
2. Mention two portions of the hind brain.

3.2 Functions of the Parts of the Brain

· The cerebrum controls all the body's voluntary action and consciousness.

· The frontal lobe is the seat of intelligence, memory, imagination, thought, judgment, emotional reaction and movement of skeletal muscles.

· The parietal lobe receives and interprets the sensations of pressure, temperature and position.

· The temporal lobe is concerned with hearing, memory and understanding of speech.

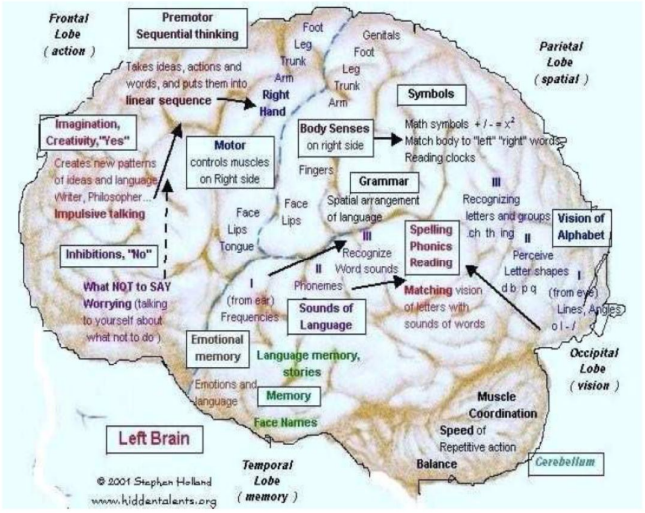

Fig. 19: Functions of the different parts of the human brain

3.4 Integration with Other Systems

To function effectively, every cell in the body must communicate with its neighbours and with cells and tissues in distant portions of the body. In a few specialised cases, cellular activities are coordinated by the exchange of ions and molecules from one cell to the next across gap junctions. This direct communication occurs between cells of the same type, and the two cells must be in extensive physical contact. The two cells communicate so closely that they function as single entity. For example, gap junctions (1) coordinate ciliary's movement among epithelial cells, (2) coordinate the contractions of cardiac muscle cells, and (3) facilitate the propagation of action potential from one neuron to

the next at electrical synapses.
Direct communication is highly specialised and relatively rare. Most of the communications between cells involve the release and receipt of chemical messages. Each cell continuously “talks” to its neighbours by releasing chemicals into the extra cellular fluid. These chemicals tell what their neighbours are doing at any moment; the result is the coordination of tissue function at the local level. The use of chemical messengers to transfer information from cell to cell within a single tissue is called paracrine communications. The chemicals involved are called paracrine factors, also known as cytokines, or local hormones. Examples of paracrine factors include the prostaglandins.

SELF ASSESSMENT EXERCISE 2

1. What is the function of the temporal lobe?
2. ---------- is an example of paracrine factors.

4.0 CONCLUSION

The nervous system includes the neural tissues that make up the autonomic nervous system and the peripheral nervous system. The neurons are the basic functional unit. The nervous system and the endocrine systems are closely linked.

5.0 SUMMARY

We have considered the two major anatomical divisions of the nervous system: (1) the central nervous system (2) peripheral nervous system; their divisions and various functions.

ANSWER TO SELF ASSESSMENT EXERCISE 1

1. The autonomic nervous system consists of parasympathetic and sympathetic systems.
2. Two portions of the hind brain are cerebellum, pons varolii and medulla oblongata.

ANSWER TO SELF ASSESSMENT EXERCISE 2

1. The temporal lobe is concerned with hearing, memory and understanding of speech.
2. Prostaglandin is an example of paracrine factors.

6.0 TUTOR-MARKED ASSIGNMENT

Describe the anatomy and physiology of the human brain.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K. & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology*, (5th ed). New Jersey: Prentice-Hall, Inc.

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UNIT 4 THE ENDOCRINE SYSTEM

CONTENTS

1.0 INTRODUCTION

This unit introduces the components and functions of the endocrine system and explores the interactions between the nervous and endocrine systems. We shall consider specific endocrine organs, hormones, and

functions.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· describe the endocrine system
· identify the components of the endocrine system
· describe the three categories of hormones
· explain the integration between the endocrine system and the nervous system.

3.0 MAIN CONTENT

3.1 An Overview of the Endocrine System

The endocrine system includes all the endocrine cells, and tissues of the body. Endocrine cells are glandular secretory cells that release their secretions into the extracellular fluid. This characteristic distinguishes them from exocrine cells, which secrete their products onto epithelia's surfaces generally by way of ducts. The chemicals released by endocrine cells may affect only adjacent cells, as in the case of most paracrine factors, or they may affect cells throughout the body.

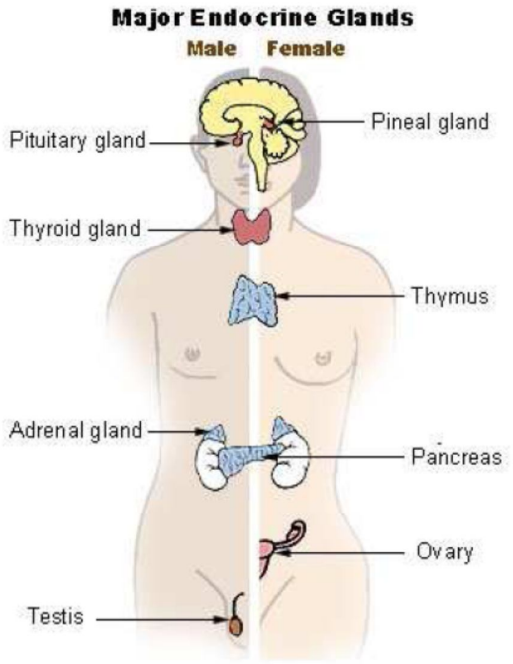

Fig. 20: Major endocrine glands

Source:http://en.wikipedia.org/wiki/endocrine

3.2 Components of the Endocrine System

The components of the endocrine system are introduced in fig. 20. Some of these organs, such as the pituitary gland, have endocrine secretion as a primary function others. Others, such as the pancreas have other functions in addition to endocrine secretion. Other endocrine organs include the hypothalamus, the adrenal medullae, the heart, the thymus, the pancreas and digestive tract, the kidneys, the reproductive organs),

and placenta .
Paracrine factors enter the bloodstream, but the concentrations are usually so low that distant cells and tissues are not affected. However, some paracrine factors, including several of the prostaglandin's and related chemicals, have primary effects in their tissues of origin and secondary effects in other tissues and organs. When secondary effects occur, the paracrine factors are also acting as hormones.

SELF ASSESSMENT EXERCISE 1

1. What are endocrine cells?
2. List the four endocrine organs that you know.

3.3 Hormones

Hormones are chemical messengers that are released in one tissue and transported in the bloodstream to reach specific cells in other tissues. Whereas most cells release paracrine factors, typical hormones are produced only by specialised cells. In intercellular communications, hormones are letters and the circulatory system is the postal service. A hormone released into the bloodstream will be distributed throughout the body. Each hormone has target cells, specific cells that respond to its presence. These cells posses the receptors needed to bind and "read" the hormonal message. Although every cell in the body is exposed to the mixture of hormones in circulation at any moment, each individual cell will respond to only a few of the hormones present. The other hormones are treated like junk mail and ignored, because the cell lacks the receptors to read the messages they contain. The use of hormones to coordinate cellular activities in tissues in distant portions of the body is called *endocrine communications.*

Because the target cells can be anywhere in the body, a single hormone can alter the metabolic activities of multiple tissues and organs simultaneously. These effects may be slow to appear, but they typically persist for days. Consequently, hormones are effective in coordinating cell, tissue, and organ activities on a sustained, long-term basis. For example, circulating hormones keep body water content and levels of electrolytes and organic nutrients within normal limits 24 hours a day throughout our entire lives.

While the effects of a single hormone persist, a cell may receive additional instructions from other hormones. The result will be a further modification of cellular operations. Gradual changes in the quantities and identities of circulating hormones can produce complex changes in physical structure and physiological capabilities. Examples include the processes of embryological and foetal development, growth, and puberty. Hormones can be divided into three groups on the basis of chemical structure: (1) amino acid derivatives, (2) peptide hormones, and (3) lipid derivatives.

3.4 Integration between the Endocrine System and the Nervous System

The nervous system also relies primarily on chemical communication, but it does not use bloodstream communications for message delivery like the endocrine system. Instead, neurons release a neurotransmitter at a synapse very close to the target cells that bear the appropriate receptors. The command to release the neurotransmitter rapidly travels from one location to another in the form of action potential propagated along axons. The nervous system thus acts like a telephone company, carrying high-speed “messages” from one location in the body to another and delivering them to a specific destination. The effects of neural stimulation are generally short lived, and they tend to be restricted to specific target cells – primarily because the neurotransmitter is rapidly broken down or recycled. This form of synaptic communication is ideal for crisis management: if you are in danger of being hit by a speeding bus, the nervous system can coordinate and direct your leap to safety. Once the crisis is over and the neural circuit quiets down, things soon return to normal.

When viewed from a general perspective the differences between the nervous and endocrine systems seem relatively clear. In fact, these broad organisational and functional distinctions are the basis for treating them as two separate systems. Yet, when we consider them in detail, the two systems are organised along parallel lines. For example:

· Both systems rely on the release of chemicals that bind to specific receptors on their target cells.

· The two systems share many chemical messengers; for example, nor epinephrine and epinephrine are called hormones when released into the bloodstream but neurotransmitters when released across synapses.

· Both systems are regulated primarily by negative feedback control mechanisms.

· The two systems share a common goal: to preserve homeostasis by coordinating and regulating he activities of other cells, tissues, organs, and systems.

SELF ASSESSMENT EXERCISE 2

Hormones can be classified into 3 groups: ----------, ---------- and ----------.

4.0 CONCLUSION

You should have seen that the endocrine system includes all the endocrine cells and tissues of the body. They have glandular secretory cells that release their secretions into the extra cellular fluid. The main function of the endocrine system is to preserve homeostasis by coordinating and regulating the activities of other cells, tissues, organs, and systems.

5.0 SUMMARY

In this unit we have considered the fact that endocrine cells are different from exocrine cells; the latter secrete their products onto epithelia’s

surfaces generally by way of ducts. Also, there are several similarities as well as distinction between the endocrine system and the nervous system.

ANSWER TO SELF ASSESSMENT EXERCISE 1

The endocrine organs include hypothalamus, the adrenal medullae, the heart, the thymus, the pancreas and digestive tract, the kidneys, the reproductive organs, and placenta.

ANSWER TO SELF ASSESSMENT EXERCISE 2

Hormones can be classified into (a) amino acid derivatives, (b) peptide hormones, and (c) lipid derivatives.

6.0 TUTOR-MARKED ASSIGNMENT

Discuss the synergistic relationship of the endocrine and nervous systems.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology*, (5th ed.) New Jersey: Prentice-Hall, Inc.

Oxford Concise Medical Dictionary.

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MODULE 3

UNIT 1 THE DIGESTIVE SYSTEM

CONTENTS

1.0 INTRODUCTION

The digestive system is a group of organs and tissues involved in the breaking down of ingested food in the alimentary canal into a form that can be absorbed and assimilated by the tissues of the body.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· describe the general anatomy of the digestive system
· describe the major organs of digestion and absorption
· explain the mechanism of digestion.

3.0 MAIN CONTENT

3.1 General Anatomy of the Digestive System

· The gastrointestinal tract, also known as the “alimentary canal” consists of all organs through which food passes (from the mouth to the anus)
· Accessory structures that assist in digestion include teeth, salivary glands, liver, gall bladder, and pancreas.
· Four major layers of the gastro intestinal tract are:
· Mucosa - innermost lining of the gastro intestinal organs
· Submucosa
- areolarCT
- blood vessels

- autonomic nerves
· Muscularis
- smooth and skeletal muscles
· serosa-outermost

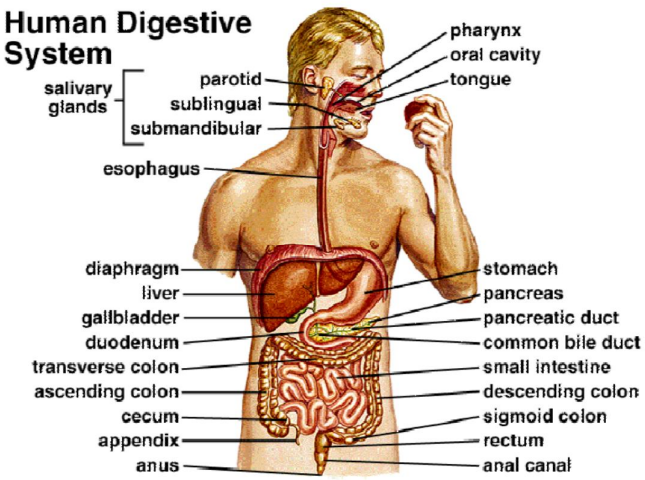


Fig. 21: The human digestive system

3.2 Major Organs of Digestion and Absorption in Man

The Stomach

1. General anatomic regions: *Cardiac, fundus, body* and pyloric *region*
2. The stomach is important in the process of physical digestion
3. *Rugae* are undulations in stomach wall to help grind
4. *Gastric pits* contain four major secretory cells:

(a) Chief cells which produce pepsinogen, activate and pepsinogen by low pH to form pepsin (a protease for protein digestion),

(b) Parietal cells which produces hydrochloric acid (HCl). The secretion is enhanced by histamine via H2 receptors,

(c) G-cell which secretes gastrin hormone; gastrin activates gastric juice secretion and gastric smooth muscle "churning". It also activates *gastroileal reflex* which moves chyme (liquefied digested material) from the ileum to colon,

(d) Mucus cell which plays the protective role of mucus against acids and digestive enzymes.

5. *Pyloric sphincter* regulates entry of food into the duodenum.

The Small Intestine

This is the major site of chemical digestion and absorption. It has three major segments: duodenum, jejunum and the ileum. The histology is as follows:

(a) Mucosa has intestinal glands (cavities) for secretion of intestinal juice.

(b) Mucosa also has *circular folds, villi* and *microvilli* for increased surface area.

The Pancreas

The pancreas produces approximately 1.5 litres a day of pancreatic secretions, the secretions enter the duodenum via two pancreatic ducts and there are many different components in these secretions like NaHCO3 (buffers pH of chyme), pancreatic amylase, trypsinogen, chymotrypsinogen and carboxypeptidase.

The Liver

The liver is the largest gland in the body. Its functions include:

· To "filter" and process nutrient-rich blood delivered to it.

· To receive nutrient-rich blood from the small intestine via the *hepatic portal vein*.

· To regulate carbohydrate metabolism.

The Large Intestine

The major function is to absorb water and eliminate indigestible matter. Major structures are:

(a) Caecum with vermiform appendix,

(b) Ascending, transverse, descending colon,

(c) Sigmoid colon, rectum,

(d) The haustra which and are pouches in the wall of the large intestine.

SELF ASSESSMENT EXERCISE 1

1. ----------, ---------- and ---------- are accessory structures in human digestion.

2. ---------- regulates entry of food into the duodenum.

Fig. 22: The wall of the human digestive tract

3.3 The Process of Digestion

Digestion of food starts in the mouth. Saliva is secreted by the salivary gland. It contains an enzyme called ptyalin. Ptyalin acts on cooked starch, converting it into complex sugars. It also helps to increase the surface area of the food substance.

Food passes down from the mouth through the gullet (oesophagus) into the stomach. In the stomach, food is further broken down into smaller pieces by the action of enzymes mentioned above (see 3.2). Food is retained in the stomach for 3-4 hours.

Food passes down from the stomach to the small intestine where actual digestion, absorption and assimilation takes place by the action of some enzymes.

From the small intestine, undigested food passes into the large intestine. Here water is absorbed this concentrates the waste products and makes it semi-solid. In this state the waste products are called faeces. The faeces pass into the rectum and out of the body through the anus.

3.4 Nutrient Absorption

Carbohydrates are enzymatically digested to form monosaccharides (glucose, fructose, and galactose). They are absorbed in the small intestine by active transport or facilitated diffusion and enters the blood capillary in villi, then directed to the *hepatic portal vein.*

Proteins are enzymatically digested to amino acids or di- and tripeptides, absorbed in SI by active transport or facilitated diffusion, enter blood capillaries in villi, then directed to the hepatic portal vein.
Lipids are enzymatically digested to short or long chain fatty acids; they are suspended in the small intestine in the form of micelles with bile salts, while inside the epithelial cells, lipids bind into chylomicrons for transport to *lacteal villi*; then into *lymphatics*, and then to venous circulation.

SELF ASSESSMENT EXERCISE 2

1. Describe the role of the saliva in digestion.
2. Describe the absorption of lipids.

4.0 CONCLUSION

The digestive organs, tissues and enzymes are involved in the breaking down of ingested food in the alimentary canal into a form that can be absorbed and assimilated by the tissues of the body. Malfunctioning of any one of them will grossly affect the well being of an individual.

5.0 SUMMARY

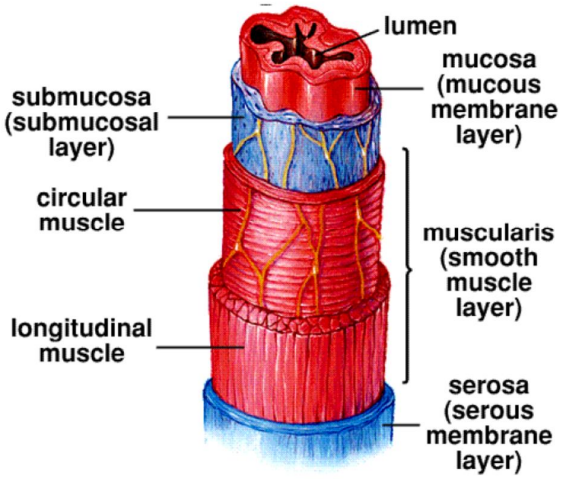
This unit has looked at the definition of digestion, the organs involved in digestion and the enzymes that are involved in the digestion and absorption of nutrients.

ANSWER TO SELF ASSESSMENT EXERCISE 1

1) Teeth, salivary glands, liver, gall bladder, and pancreas are the major accessory organs of digestion.
2) Pyloric sphincter regulates entry of food into the duodenum.

ANSWER TO SELF ASSESSMENT EXERCISE 2

Description of the absorption of lipids: It is enzymatically digested to short or long chain fatty acids. It is suspended in Small Intestine in the form of micelles with bile salts, while inside epithelial cells; lipids bind into chylomicrons for transport to *lacteal villi*; then into *lymphatics*, and then to venous circulation.



6.0 TUTOR-MARKED ASSIGNMENT

With a well labelled diagram, describe the stomach.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology*, (5th ed). New Jersey: Prentice-Hall, Inc.

Oxford Concise Medical Dictionary.

Thibodeau, G.A. & Patton, K.T. (1996). *Anatomy and Physiology*, (3rd ed), Mosby.

UNIT 2 THE RESPIRATORY SYSTEM

CONTENTS

1.0 INTRODUCTION

The respiratory system is the combination of organs and tissues associated with breathing (gaseous exchange). It consists of a pair of lungs enclosed in the

thorax and connected to the air outside by a series of branch air tubes (trachea, bronchi and bronchioles) and air pathways (nasal cavity, pharynx and larynx). The ribcage, intercostal muscles and diaphragm work together, to draw air into and out of the lungs.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· explain the respiratory process
· describe the types of respiration
· explain the anatomy of the respiratory system
· describe pulmonary ventilation.

3.0 MAIN CONTENT

3.1 The Concept of Respiration

Respiration is the chemical breakdown of glucose, accelerated by enzymes inside the body cells to liberate energy. Carbon dioxide and water or alcohols are given off as waste products.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \rightarrow \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{water}}{H_2O} + \underset{\text{Kinetic and heat energy}}{674\ \text{Kcal}}$$

Respiration can also be described as:

· The intake and absorption of oxygen from the surrounding environment.
· The transport of oxygen to individual cells of the body.
· Using oxygen to release energy in the form of adenosine triphosphate (ATP).

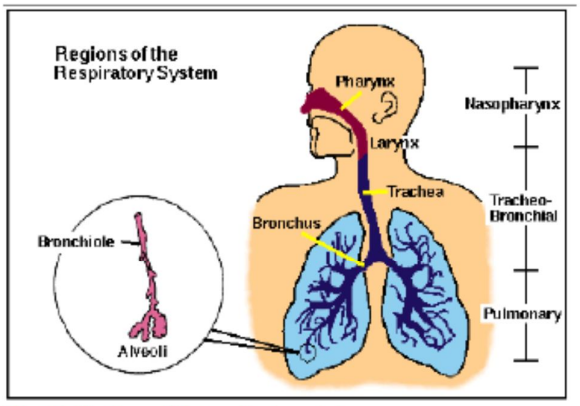


Fig. 23: Regions of the respiratory system

http://en.wikipedia.org/wiki/Respiratory.

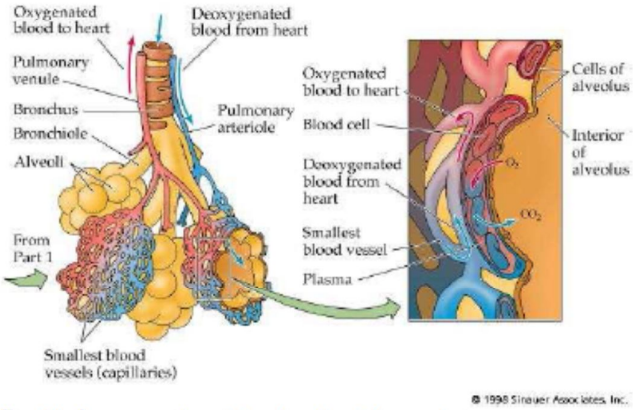


Fig. 24: A cross-section of the alveoli and the respiratory process

3.2 Types of Respiration

1. Internal respiration
2. External respiration

Internal or Tissues Respiration

· Air (Oxygen) enters the body through the nostril where it is cleaned, moistened and heated to the body temperature and passes through: Trachea→ bronchi→ bronchioles→ alveoli. Internal respiration involves two breathing processes or mechanisms. These are:

- Inhalation or Inspiration

- Exhalation or Expiration

· In alveoli the oxygen combines with the haemoglobin in the red blood corpuscles to form oxyhaemoglobin. This is carried away in the pulmonary vein to the heart and then distributed to all parts of the body. When the blood reaches an active organ the oxyhaemoglobin dissociates again, giving up its oxygen for respiration to produce energy.

· Carbon dioxide produced as one of the end products combines with sodium carbonates in the plasma to form bicarbonates.

· In the lungs the bicarbonates are broken down by the enzymes to liberate carbon dioxide.
· This diffuses into the alveoli and eventually expelled through the nostrils or the mouth.

SELF ASSESSMENT EXERCISE 1

1. Internal respiration consists of ----------and----------.
2. What is respiration?

3.3 Respiratory System Anatomy

Upper Respiratory Tract (URT):
1. Paranasal structures like external nares, nasal cavity and septum, nasal conchae, nasal meatuses, olfactory epithelium, paranasal sinuses and ciliated pseudostratified epithelium.
2. Pharynx: Internal nares, auditory tubes, oropharynx and laryngopharynx.

Lower Respiratory Tract (LRT):
1. Larynx: Thyroid and cricoid cartilage, vocal box and hyoid
2. Trachea: Bronchi and other structures.
3. Lungs (right lung = three lobes; left lung = two lobes), consist of pleural membranes, bronchi, bronchioles, terminal bronchioles, smooth muscles within bronchiole walls, alveolar ducts, alveolar sacs and alveoli.

3.4 Pulmonary Ventilation

Inspiration: This process is influenced by Boyle's Law (air pressure in closed space inversely correlate with volume). Increased volume = decreased pressure; decreased volume = increase pressure.
Differences in air pressure between air and lungs drive the movement of air into/out of lungs. Normal inspiration is an active process. Inspiratory muscles involved are:
1. Diaphragm (75% normal inspiratory action). It is activated by the phrenic nerve.
2. External intercostals (25% normal inspiratory action).It is activated by intercostal nerves.
3. Accessory muscles can also enhance inspiration. Examples are sternocleidomastoid and scalenes. Normal breathing (“eupnoea”) consists of moving approx 0.5 L (tidal volume) into/out of lungs. Not all air inspired actually enters the lung because there is an anatomic “dead space” (approx 150 ml) which includes URT and trachea and bronchi. Only air within alveoli (approx 350ml) can exchange gases.
Expiration: This is a passive process; it involves the relaxation of the diaphragm and external intercostals. The ribs are depressed and the diaphragm curves upwards. Expiration can become an active process by contraction of abdominals and internal intercostals. Major factors driving expiration are elastic recoil of lungs and surface tension of alveolar fluid (lessened by surfactant) .These factors create high “compliance”, that is ease of lung expansion. Low compliance results

from pulmonary scarring, oedema, surfactant deficiency (especially in premature babies). Compliance can become too high in conditions like emphysema.

Intrapleural pressure: This is the pressure within the pleural cavity; it must stay approx 4 mmHg LESS than intrapulmonary pressure. Any condition that equalises Intrapleural and intrapulmonary pressures causes immediate lung collapse.

Certain terms associated with pulmonary ventilation include:

· Dyspnea – painful, difficult breathing;
· Hypoxia - decreased oxygen delivery to tissues;
· Hypercapnia - increased carbon dioxide levels in blood.

SELF ASSESSMENT EXERCISE 2

1 The upper respiratory tract consists of ----------, ---------- and----------

2 ----------and----------are inspiratory muscles involved in normal inspiration.

4.0 CONCLUSION

We can conclude this study by emphasising that respiration is the exchange of gases (oxygen/carbon dioxide) from the atmosphere between blood and tissues. It is made up of many physical and chemical processes.

5.0 SUMMARY

This unit examines the organs of the respiratory tract, and the respiratory processes. Normal inspiration is an active process, while expiration is a passive process.

ANSWER TO SELF ASSESSMENT EXERCISE 1

1. Internal respiration consists of inhalation/inspiration and exhalation/expiration.
2. Respiration is the chemical breakdown of glucose, accelerated by enzymes inside the body cells to liberate energy. Carbon dioxide and water or alcohol are given off as waste products.

ANSWER TO SELF ASSESSMENT EXERCISE 2

1. The upper respiratory tract consists of: (a) Para nasal structures like external nares, nasal cavity and septum, nasal conchae, nasal meatuses, olfactory epithelium, paranasal sinuses and ciliated pseudostratified epithelium; (b) Pharynx: internal nares, auditory tubes, oropharynx and laryngopharynx
2. The diaphragm and external intercostals are muscles involved in normal inspiration.

6.0 TUTOR-MARKED ASSIGNMENT

Describe the internal and external respiration system.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K. & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology*, (5th ed), New Jersey: Prentice-Hall, Inc.

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UNIT 3 THE CIRCULATORY SYSTEM
CONTENTS

5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Readings

1.0 INTRODUCTION

In this unit, we will discuss how the composition of the interstitial fluid in tissues throughout the body is kept stable through continuous exchange between the peripheral tissues and the bloodstream. Blood can help to maintain homeostasis only if it stays in motion. Thus all the functions of the cardiovascular system ultimately depend on the heart which beats approximately 100,000 times each day, pumping roughly 8,000 litres of blood.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· describe the hierarchy of the vascular system
· describe movement of materials across capillaries
· explain blood pressure
· describe the anatomy and the functions of the heart.

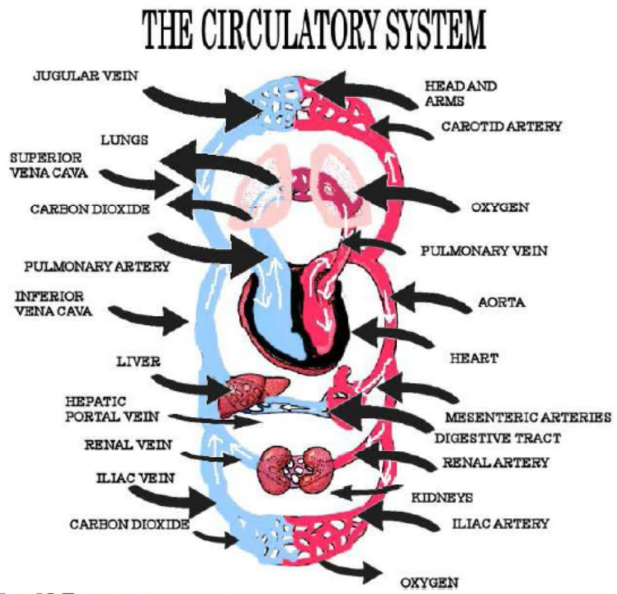

Fig. 25:The circulatory system

Source: http://en.wikipedia.org/wiki/circulatory system

3.0 MAIN CONTENT

3.1 Hierarchy of the Circulatory System

Arteries:

1. Outer coat (tunica external)
2. Middle coat (tunica media), usually the thickest and is made up of elastic fibers and smooth muscle which has sympathetic innervations.
3. Inner coat (tunica internal). It is made up of endothelium and basement membrane.
4. Large arteries (conducting) which have more elastic fibres.

5. Medium arteries (distributing) they have more smooth muscle and thicker and most vasodynamic.
6. Arterioles: regulate blood into capillaries.
Capillaries: These are endothelial sites of nutrient/gas/waste exchange.
Venules and veins: They have few smooth muscles

3.2 Movement of Materials across Capillaries

Diffusion: This is most important for solutes. It takes place through plasma membranes, fenestrations and clefts. It is concentration dependent.
Vesicular: This type of movement entails large hydrophilic molecules e.g. IgG.
Bulk flow: This regulates volume of plasma and interstitial fluid.
Clinical implication of abnormal movement of material across Capillaries is oedema. This is caused by:
1. Increased venous flow
2. Cardiac failure
3. Poor circulation
4. Increased fluid uptake
5. Plasma protein loss (kidney disease)
6. Increase capillary permeability due to toxins

SELF ASSESSMENT EXERCISE

1 ----------, ----------, and ---------- are the main hierarchy of the cardiovascular system.
2 List the methods of the movement of materials across capillaries.

3.3 The Human Heart

This is a hollow, muscular, coneshaped organ, lying between the lungs, with a pointed end directed downward, forward and to the left. It is about the size of a closed fist. The normal functional capacity of the heart includes the following:
(i) Approx. 100,000 heartbeats/day,
(ii) Approx. 2,760,000,000 heartbeats/lifetime
(iii) Approx. 4,000 gallons (15,000 litres) blood pumped/day. Blood that leaves the heart is called oxygenated blood because it contains oxygen. Blood that comes back to the heart is called deoxygenated blood because it does not contain oxygen.

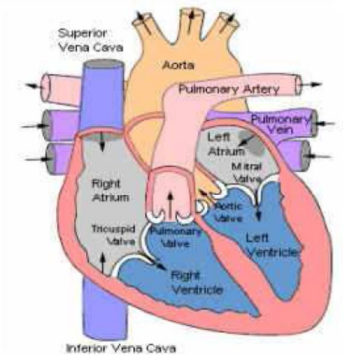

Fig. 26: A diagram of the human heart showing the left and right ventricles along with each of the four valves [Heart Cenre Online 2002

The human heart works continuously throughout the life of a person. It weighs about 300 grams. It is divided into four chambers: two upper chambers, the left and right auricles (atria) and two lower chambers, the left and right ventricles. The chambers are separated by walls called septum. The walls are thick and muscular. The ventricles have thicker walls than the auricles to ensure that enough pressure is generated to pump the blood to the body and lungs. The left ventricle whose force of contraction pumps the blood to all parts of the body has the thickest wall compared to all other chambers.

3.5 Blood Circulation within the Heart

The contraction and relaxation of the heart to pump blood is called heartbeat.

At rest the average heartbeat is about 70 times per minute.

During exercise, this rate goes up to over 100 times, thereby increasing the supply of oxygen that goes to the body cells.

· Heartbeats occur in two stages: systole and diastole.

· At systole, the two ventricles contract, while at diastole they both relax.

· At systole, deoxygenated blood enters the right auricle (atrium) through the superior and anterior, and inferior and posterior vena cavae.

· The tricuspid valve is closed.

· The right ventricles pump deoxygenated blood to the lungs through the pulmonary artery.

· Oxygenated blood enters the left atrium from the lungs through the pulmonary veins.

· The bicuspid valve is closed.

· The left ventricle pumps oxygenated blood through the semilunar valve and the aorta to the body.

· The tricuspid and bicuspid valves auricles and ventricles (left and right) prevent the back flow of blood into the auricles when the ventricles contract. The thick wall of left ventricles enables it to

pump blood with sufficient pressure around the body.
· Ventricles relax at diastole.
· The tricuspid and bicuspid valves open.
· Deoxygenated blood enters the right ventricle from the right atrium.
· Oxygenated blood enters the left ventricle from the left atrium.
· Systole restarts when the ventricles are filled.
Circulation is divided into systemic and pulmonary circulation

Directions of blood circulation

Blood from arteries → arteriole → capillaries
Venules → veins→ heart.

4.0 CONCLUSION

We can see that all the functions of the cardiovascular system depend on the heart. The cardiovascular system is the most hardworking of all the systems in the body because, unlike other systems, its components do not rest. Not surprisingly, then, any substantial interruption or reduction in the flow of blood to this system has grave consequences: what we commonly call a heart attack.

5.0 SUMMARY

This unit has explained the hierarchy of the vascular system and the movement of materials across capillaries.

ANSWER TO SELF ASSESSMENT EXERCISE

1. Arteries, capillaries, venules and veins are the main hierarchy of the cardiovascular system.
2. Methods of the movement of materials across capillaries consist of diffusion and vesicular movements.

6.0 TUTOR-MARKED ASSIGNMENT

Describe the human heart showing clearly, the directions of blood circulation.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K. & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology,* (5th ed). New Jersey: Prentice-Hall, Inc.
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MODULE 4

UNIT 1 THE IMMUNE SYSTEM

CONTENTS

1.0 INTRODUCTION

The immune system consists of the organs responsible for the body's ability to resist infections, afforded by the help of circulating antibodies and white blood cells (that are mentioned in a previous unit on hematology).

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· describe the cells of the immune system
· define immunity and types of immunity
· define transplant immunology

· describe autoimmunity and related conditions.

3.0 MAIN CONTENT

3.1 Cells of the Immune System

1 Leukocytes: 5-10,000 cells/mm3 in blood; **and Granulocytes**:

a. Neutrophils (50-70%); 3-day lifespan: major phagocyte and granulocyte; attracted by inflammatory factors and complement; granules with hydrolytic enzymes; cell dies after degranulation/phagocytosis.

i) "Band" is immature neutrophil (band-shaped nucleus);

ii) "Seg" is mature neutrophil (segmented nucleus).

iii) Neutrophilia: increased percentage; common with acute bacterial infections

iv) Neutropenia: decreased percentage; common with anaemias, viral infections, radiation/chemotherapy.

b. Eosinophils (2-4%): major anti-helminthes protection (**myelin basic protein** released); it also contributes to some hypersensitivity reactions and phagocytosis of bacteria.

c. Basophils (<1%): granulocytic, nonphagocytic; major inflammatory cell, releases histamines, proteases and granulocyte-attracting factors.

d. Mast cells: non-circulating, reside in connective tissues, similar function as basophils; initiate inflammatory reactions.

2. Monocytes (2-8%): only last 8-12 hrs in circulation. then migrate to tissue = major function to become macrophage in tissue; play key role in "antigen presentation".

3. Platelets (240-400,000/mm3): crucial to help activate blood clot formation; spleen acts as reserve site.

4. Lymphocytes (20-30%) mononuclear cells: mediate/regulate specific immune responses (antibody formation, anti-viral and anti-tumor protection)

a. B-cells: produce immunoglobulins (mature in bone marrow).

b. T-cells: activate/regulate B-cells, major immune regulatory cells (mature in thymus).

c. NK cell: natural killer cell; non-specific anti-tumor cytolytic cell.

3.2 Innate Immunity

Innate immunity is genetically determined. It is present at birth and has no relationship to previous exposures to the antigen involved. For example, people do not get the same disease as fishes. Innate immunity only breaks down in the case of AIDS or other conditions that depress all aspects of specific resistance.

3.3 Types of Specific Immune Response

There are two types of specific immune response: Humoral and Cellular Immunity

Humoral Immunity

1. *Immunoglobulin* (Ig): Production by activated B-cells
2. *Antigen (Ag):* Any molecule capable of eliciting a specific immune response.

3. *Antigen presentation*: Macrophage (or B-cell) ingests antigen, degrades into fragments, and re-expresses antigen fragments on the surface in context of *major histocompatibility complex II (MHC class II)*. During this process, the macrophage releases *Interleukin 1*, a potent cytokine which acts as a *pyrogen* and activator of T-helper cells.
4. *T-helper (CD4+) cell* specific for that antigen binds to MHC-Ag using *T-cell receptor (TCR)* and is stimulated by binding and by Interleukin-1 released from antigen-presenting cell. This presentation usually occurs in lymph node or spleen. T-cell clone is activated, proliferates, and secretes *Interleukin-2* which enhances T-cell activation. B-cell bearing Ig specific for that antigen binds antigen, and presents it to T-cell in the context of MHC-II. Binding of activated T-helper cell to B-cell and release of B-cell growth factors including *Interleukins 4 and 6* from Tcells activate B-cells to proliferate and produce more Ig.
5. *Clonal selection* of Ag-specific T-cell (with TCR) and B-cell (with Ig) provides specific immune response.
6. *Memory B- and T-cells* are also produced with the ability to be activated easily upon second exposure to Ag, provide long-term "immune protection", allows for very large and rapid response to second exposure (secondary immune response).
7. *Immunoglobulins*: "Y" shape monomer, two *Ag-binding sites*, one "tail" region (Fc region), made of two *heavy chain* proteins, two *light chains* proteins, produced only by B-cells. The immunoglobulins include:
a. *IgG:* most abundant Ig, long-lasting in serum, usually produced upon second exposure to Ag; can cross placenta.
b. *IgM:* second most abundant Ig, pentamer, produced upon first exposure to Ag.
c. *IgA:* most abundant Ig in secretions (saliva, tears and mucus).
d. *IgE*: involved in allergic reactions by binding of mast cells and basophils and triggering to degranulate upon Ag exposure.
e. *IgD*: is seen on resting B-cells, not seen in serum (<0.1%).
Neutralisation: This is the binding of Ig to virus, toxins, and bacteria to block activity or infectivity.
Agglutination: clumping of cells by Ig binding, aids in phagocytosis.
Opsinisation = coating cell with Ig, enhances binding of macrophage by binding to the tail region of Ig (Fc region).
Precipitation: clumping of soluble molecules by Ig binding, aids in phagocytosis.
Complement activation: Ig bound to cell surfaces activates complement cascade to attack targeted cell.

Cellular Immunity

*General Description***:** Specific anti-viral, anti-tumor immune response mediated by *cytolytic T-cells (CD8+).* All normal cells express major

histocompatibility complex I *(MHC-I)* (only antigen presenting cells express MHC-II). MHC-I is your molecular "ID card" and is used to present antigens produced within the cell (not brought in from outside). Virus-infected cells express viral antigens in the context of MHC-I Tcytotoxic (CD8+) bearing TCR specific for a particular antigen bind to Ag/MHC-I on virus-infected cells and are activated. T-cytotoxic cells release cytolytic molecules *(lymphotoxin*, *perforin*) to kill target cells. Activation of T-cytotoxic cells is enhanced by cytokines released by Thelper cells (IL-2, *gamma interferon*). T-cytotoxic cells also act against tumour cells in similar way; tumour cells express tumor-Ag in the context of MHC-I and become targets for T-cytotoxic cells. The immune system constantly checks all tissues for "altered cells" (foreign, virusinfected, tumors) in a process called "*immune surveillance*". The use (necessity) of expressing most antigens in the context of MHC (class I or II) to initiate an immune response is termed *"MHC Restriction"*.

3.4 Hypersensitivity Reactions

Hypersensitivity reactions of the immune system include:

1. *Type I:* Anaphylactic Reactions (typical bee-sting or hay fever allergic responses).
2. *Type II:* Cytotoxic Reactions (as in mismatched ABO transfusion reaction).
3. *Type III:* Immune Complex Reactions (as in rheumatoid arthritis or in "serum sickness").
4. *Type IV*: Cell-mediated Reactions (seen with positive tuberculin (TB)-skin test reaction).

Autoimmunity

This is "self/non-self" discrimination (**self-tolerance**) of the immune system developed during thymic maturation. It consists of positive and negative selection processes. Autoimmunity can occur in the following conditions:

1. Graves disease
2. Rheumatoid arthritis
3. Systemic lupus erythematosus (SLE)
4. Myasthenia gravis
5. Insulin-dependant diabetes: Auto-reactive T-cytotoxic cells destroy pancreatic beta-cells (the insulin producing cells).

SELF ASSESSMENT EXERCISE

1. What are the two arms of specific immune response?
2. List the four types of hypersensitive immune reactions of the immune system.

4.0 CONCLUSION

Cells of the immune system (Leucocytes and granulocytes) provide immunity that is resistant to injuries and diseases caused by foreign compounds, toxins or pathogens.

5.0 SUMMARY

In this unit we examined the cells of the immune system, immunity and

types of immunity.

ANSWER TO SELF ASSESSMENT EXERCISE

1. The two arms of specific immune response are humoral and cellular immunity.
2. The four types of hypersensitive immune reactions of the immune system are:

(a) Type I: Anaphylactic reactions (typical bee-sting or hay fever allergic responses).

b) Type II: Cytotoxic reactions (as in mismatched ABO transfusion reaction)

(c) Type III: Immune Complex reactions (as in rheumatoid arthritis or in "serum sickness")

d) Type IV: Cell-mediated reactions (seen with positive tuberculin (TB)-skin test reaction).

6.0 TUTOR-MARKED ASSIGNMENT

Enumerate the cells of the immune system.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology*, (5th ed). New Jersey: Prentice-Hall, Inc.

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UNIT 2 THE URINARY SYSTEM

CONTENTS

1.0 INTRODUCTION

The urinary system is the entire system of ducts and channels that conduct urine from the kidneys to the exteriors. It includes the ureters, the bladder and the urethra. The main function of the urinary system is to maintain homeostasis of blood composition, volume and pressure.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

· discuss the overall function of the urinary system
· identify the major organs of the urinary system and describe their functions
· describe the mechanism of action of the urinary system.

3.0 MAIN CONTENT

3.1 The Major Organs of the Urinary System

· Kidneys
· Ureters
· Urinary bladder
· Urethra

3.2 The Structure and Function of the Kidney

· Hilum –This is the entrance to renal sinus.
· Renal pelvis – An expansion of the ureter. Calyces (major and minor) – These are tubes emanating from renal pelvis. Inner medullary region – This contains renal columns and pyramids (site of nephrons).
· Outer cortex - Forms the outer cover and renal columns.
· Renal columns –This is the portion of cortex extending between renal pyramids
· Renal pyramids – The number is approximately 8-18 regions per

kidney.

The Major Functions of the Kidney

The kidney

· regulates blood volume and composition

· regulates blood pressure as it monitors renal blood pressure and the secretion of rennin

· regulates certain aspects of metabolism like gluconeogenesis.

SELF ASSESSMENT EXERCISE 1

1. What are the three major functions of the kidneys?
2. The four major organs of the urinary system are ----------, ----------, ---------- and ----------.

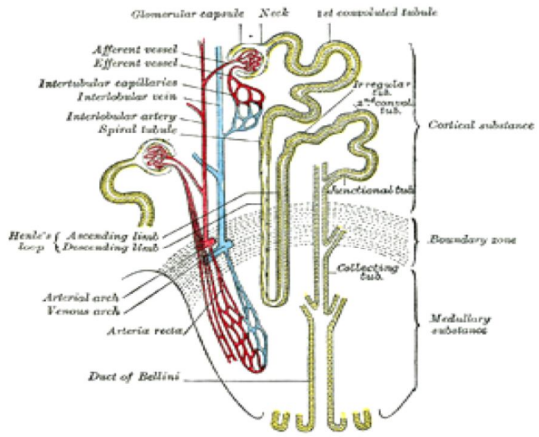

Fig. 27: The nephron of the human kidney
http://en.wikipedia.org/wik

3.3 An Overview of the Nephron

There are two principal types of nephrons: cortical nephron and juxtamedullary nephron.

Each nephron has two major portions:

1. Renal corpuscle.
2. Renal tubule.

The basic function of the nephron is to filter blood and produce filtrate.

3.4 Filtrate Production

This is a three-step process:

1. Glomerular filtration: Filters fluid and waste solutes out of the blood.
2. Tubular reabsorption: Returns important solutes to the blood.
3. Tubular secretion: Selective secretion of more solutes into filtrates.

The one major factor affecting the glomerular filtration rate (GFR) is the glomerular hydrostatic pressure (HPg), which is determined by the diameter of afferent/efferent arterioles. The major mechanisms regulating GFR are:

1. Renal autoregulation
2. Hormonal regulation, like aldosterone and antidiuretic hormone (ADH)
3. Neuronal regulation

SELF ASSESSMENT EXERCISE 2

1. What is the basic function of a nephron?
2. Write out the three steps of renal filtration.

4.0 CONCLUSION

The kidney is very essential to life because it helps to get rid of substances that are toxic to the body, and also helps to maintain homeostasis.

5.0 SUMMARY

This unit has shown that the urinary system consists of the kidneys, the ureters, the urinary bladder and the urethra. The important role played by the nephron is the process of glomerular filtration.

ANSWER TO SELF ASSESSMENT EXERCISE 1

1. The major function of the urinary system is to maintain homeostasis of blood composition, volume and pressure.
2. The four major organs of the urinary system are kidneys, ureters, urinary bladder and urethra.

ANSWER TO SELF ASSESSMENT EXERCISE 2

1. The basic function of the nephron is to filter blood and produce filtrate.
2. The three steps of renal filtration are:

· Glomerular filtration
· Tubular reabsorption
· Tubular secretion

6.0 TUTOR-MARKED ASSIGNMENT

Describe the process of filtrate production.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K. & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology* (5th ed). New Jersey: Prentice-Hall, Inc,

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UNIT 3 REPRODUCTIVE SYSTEM

CONTENTS

3.2 Female Reproductive Organs
3.3 The Reproductive Process
4.0 Conclusion
5.0 Summary
6.0 Tutor-Marked Assignment
7.0 References/Further Readings

1.0 INTRODUCTION

The reproductive system is the only system that is not essential to the life of the individual, although its activities do impact on other systems. The system ensures the continuous existence of the human race. Sexually mature males and females produce individual reproductive cells that come together and produce new beings.

2.0 OBJECTIVES

At the end of this unit, you should be able to:
· explain reproduction
· describe the male reproductive organs
· describe the female reproductive organs
· describe the hormones involved in reproduction.

3.0 MAIN CONTENT

3.1 Male Reproductive Organs

1. The testes: The structures include epididymis, straight tubules, ciliated rete testes, lobules and seminiforous tubules (2-3 per lobule) which consist of the following:
· Leydig cells
· Sertoli cells
· Spermatogonia

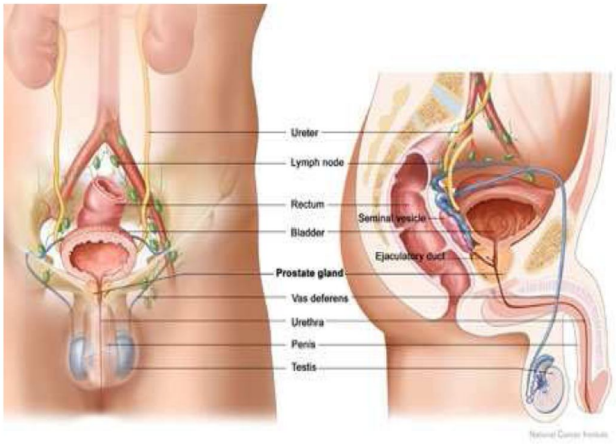

Fig. 28:Male reproductive organs
Source: http://en.wikipedia.org/wiki/Reproductive

Other reproductive structures include:
1. *Vas deferens* - muscular walls that propel spermatozoa towards the urethra

2. *Seminal vesicle* - contributes 60% seminal volume
3. *Prostate gland* - contributes 25% of seminal volume
4. *Cowper's gland* – produces mucus

Hormones of the male reproductive system include:

1. Gonadotropin releasing hormone (GnRH)-triggers FSH & LH release from anterior pituitary.
2. Follicle stimulating hormone (FSH) - triggers spermatogenesis, inhibits.
3. Lutenising hormone (LH)-stimulates testosterone secretion
4. Testosterone - induces secondary male characteristics, stimulates late spermatogenesis steps.
5. Androgen binding protein (ABP)-binds testosterone, concentrates it in seminal tubules.
6. Inhibin-inhibits FSH secretion (part of spermatogenesis negative feedback)

SELF ASSESSMENT EXERCISE 1

1. Highlight the importance of the reproductive system.
2. What are the components of the testes?

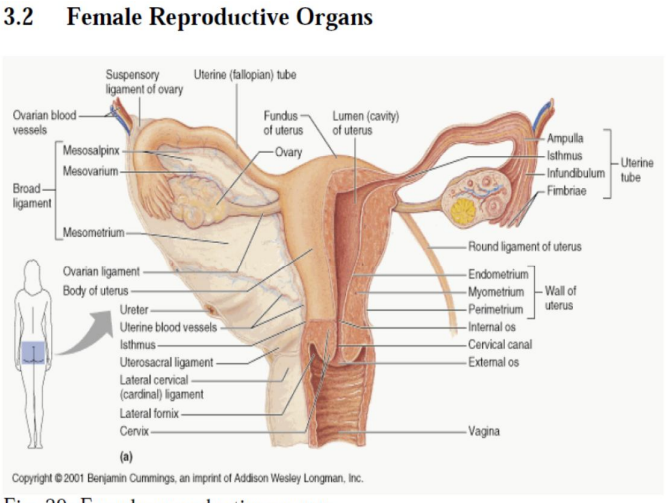

Fig. 29: Female reproductive organs

· *Ovaries*: Produce oocytes and hormones: Oestrogens and Progesterone.
· *Uterine tubes*: Deliver oocytes or embryo to uterus; normal site of fertilisation
· *Uterus*: Site of embryonic development and exchange between maternal and embryonic bloodstreams

· *Vagina*: Site of sperm deposition; acts as birth canal at delivery; provides passageway for fluids during menstruation
· *External genitalia* (Clitoris): Contains erectile tissue; produces pleasurable sensations during sexual activities
· *Labia*: Contain glands that lubricate entrance to vagina
· *Mammary glands*: Produce milk that nourishes newborn infants

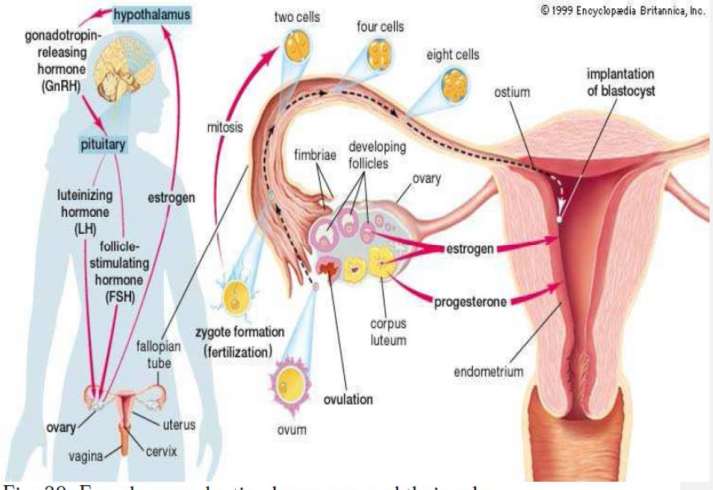

Fig. 30: Female reproductive hormones and their roles
Source: *1999 Encyclopedia Britannica*, Inc

The reproductive process

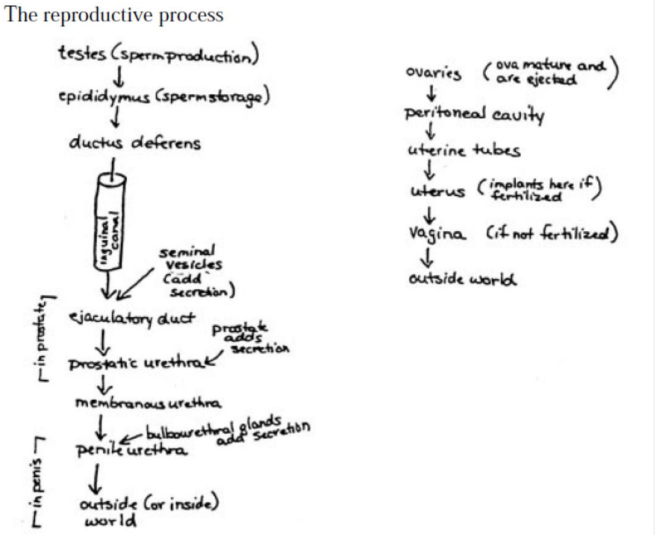

Fig. 31: Illustration of the reproductive process
Source: www.relief/manual

SELF ASSESSMENT EXERCISE 2
1. Name five parts of the female reproductive system.

2. What is the role of the uterus?

4.0 CONCLUSION

The reproductive system, though not important to being alive, is very important for procreation**.**

5.0 SUMMARY

The reproductive system for the male is different from that of the female; the reproductive hormones are also different.

ANSWER TO SELF ASSESSMENT EXERCISE 1

1. The importance of the reproductive system includes ensuring the continuous existence of the human race. Sexually mature males and females produce individual reproductive cells that come together to produce new beings.
2. The components of the testes include epididymis, straight tubules, ciliated testes, lobules and seminiforous tubules.

ANSWER TO SELF ASSESSMENT EXERCISE 2

1. Five parts of the female reproductive system are ovaries, uterine tubes, uterus, vagina, external genitalia (Clitoris), labia and mammary glands.
2. The uterus is the site of embryonic development and exchange between maternal and embryonic bloodstreams.

6.0 TUTOR-MARKED ASSIGNMENT

With a clearly labelled diagram, describe the male reproductive system.

7.0 REFERENCES/FURTHER READINGS

Martini, F.C; Ober, W.C; Garrison, C.W; Welch, K. & Hutchings, R.T. (2001). *Fundamentals of Anatomy and Physiology* (5th ed). New Jersey: Prentice-Hall, Inc.

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