UNIVERSITY OF MALAWI

KAMUZU COLLEGE OF NURSING

MODULE 1

BIO 100 : BIOSCIENCES I

FOR

BSc IN NURSING AND MIDWIFERY

By

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MODULE 1

MODULE TITLE : Biosciences I

MODULE CODE : **BIO. 100**

NUMBER OF HOURS : **100**

NUMBER OF CREDITS : **10**

LEARNING RESOURCES : **Lecturers, Library Books and Practicals**

MODULE OVERVIEW

(i) Module Descriptor

The module introduces you to Human Anatomy and Physiology, Microbiology and Parasitology. These Bio-Sciences will provide you with provide you with a foundational knowledge base supports nursing and midwifery practice.

HOW TO USE THIS MODULE

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

Furthermore, you are required to attend every theory/practical session and submit the relevant assignments/laboratory reports in good time.

(iii) How the Module fits into the Programme

The knowledge contained in this module will assist you appreciate the relationship between Human Anatomy and Physiology, Microbiology and Parasitoloty in order to make informed decisions in nursing and midwifery practice.

LEARNING OUTCOMES	**ASSESSMENT CRITERIA**
When you have successfully completed this module you will:	**To demonstrate that you have achieved the learning outcomes you will:**
Distinguish between the human body structures and their functions	Recognise body structure Describe body functions
Explain the historical background of Human Anatomy and Physiology	Appreciate/Discuss the historical development of Human Anatomy and Physiology and the impact on nursing/medical practice to date
Discuss homeostasis	Define homeostasis and explain negative and positive feedback systems
Describe cells, tissues and membranes	Describe the general features of cells, tissues and membranes

	Describe two types of cell division Identify from charts and microscope slides different types of cells, tissues and membranes
Describe the different body systems and their functions	Describe the structure and functions of body systems
Explain the effects of micro-organisms and parasites	Recognise dysfunctional body systems as a result of microorganisms and parasites invasion

LEARNING CONTRACT

I shall complete this module within the specified period of time in order to gain the appropriate knowledge, skills and attitudes. I am aware that I have to achieve the stipulated learning outcomes in readiness for clinical placement and assessments.

Student's Name: ……

Student's Signature : ……..

Date:……

ASSESSMENT CRITERIA

Assignments and lab reports: 40%
Examination: 60%

PART 1 - HUMAN ANATOMY AND PHYSIOLOGY

Unit I: Introduction to Human Anatomy and Physiology

This unit defines the terms Anatomy and Physiology and explains their importance to nursing practice.

Learning outcomes

- Define Anatomy and Physiology
- Explain why people study Human Anatomy and Physiology
- Name subdivisions of Anatomy and Physiology
- Trace the history of Anatomy and Physiology
- Describe the levels of structural organization that make up the human body
- List the systems of the human body and give the general function of each.
- List and define the main body positions.
- List and define the main regional names of the body.
- List and define the main directional terms of the body.
- List and define the main planes and sections of the body.
- List and define the main cavities of the body.
- Describe homeostasis
- Explain why homeostatic imbalances cause disorders

Hints : You should use charts, models and your body to use as guides, to describe different body parts and their functions

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

Content

- **Definitions of anatomy and Physiology**

o Anatomy (*ana-* = up; *-tomy* = process of cutting) - the science of body structures and the relationships among structures.
o Physiology (*physio-* = nature; *-logy* = study of) - the study of body functions- how the body parts work.

- **Why people study Human Anatomy and Physiology**

Foundation for careers in the health sciences e.g. nursing, medicine, dentistry, radiography, pharmacy, ophthalmology etc.

- **Branches of Anatomy**

o Embryology- Structures that emerge from conception to the eight week.

o Developmental- Structures that emerge from conception to adult form.

o Histology- Microscopic structure of tissues.

o Surface anatomy- Anatomical landmarks on the surface of the body

o Gross anatomy- Structures that can be examined without using a microscope.

o Systemic anatomy- Structure of specific systems of the body e.g. endocrine or reproductive systems.

o Regional anatomy- Structure of specific regions of the body e.g. pelvis or arm.

o Radiographic anatomy- Body structures that can be visualized using x-rays.

o Pathological anatomy- Structural changes (from gross to microscopic) associated with disease.

- **Branches of Physiology**

o Neuropathology- Functional properties of nerve cells.

o Endocrinology- Hormones and how they control body functions.

o Cardiovascular physiology- Functions of the heart and blood vessels.

o Immunology physiology- How the body defends itself against disease-causing agents.

o Respiratory physiology- Functions of the air passage ways and lungs
..
o Renal physiology- Functions of the kidneys.

o Exercise physiology- Changes in cell and organ functions as a result of muscular activity.

o Pathophysiology physiology- Functional changes associated with disease and aging.

- **Levels of Structural Organisation**

o Chemical level- Atoms combine to form molecules.

o Cellular level- cells are made up of molecules.

o Tissue level- Tissues consist of similar types of cells.

o Organ level- Organs are made up of different types of tissues.

o Organ system level- Organ systems consist of different organs that work together closely.

o Organism level- The human organism is made up of many organ systems.

- **Systems of the Human Body**

  - **Integumentary System-** The skin with its associated structures. The external body covering; for protection, vitamin D synthesis, detection of sensations and elimination of some waste. **Dermatology** (*dermato-* = skin; *-logy* = study of) is the medical specialty for diagnosis and treatment of integumentary system disorders.
  - **Skeletal System-** The basic framework of the body; consists of bones and joints. For movement, support and protection. The study of bone structure and the treatment of bone disorders is called **osteology** (*osteo-* = bone; *–logy* = study of). The scientific study of joints is termed **arthrology** (*arthr-* = -joint; *-logy* = study of). The study of motion of the human body is called **kinesiology** (*kinesi* = movement).
  - **Muscular System-** Consists of muscles. For movement, posture and heat generation. The scientific study of muscles is known as **myology** (*myo-* = muscle). The branch of medical science concerned with the prevention or correction of disorders of the musculoskeletal system is called **orthopaedics** (*ortho-* = correct; *pedi* = child).
  - **Nervous System-** Fast acting control system of the body. Consists of brain, spinal cord, nerves and special sense organs. The branch of medical science that deals with the normal functioning and disorders of the nervous system is **neurology** (*neuro-* = nerve).
  - **Endocrine system-** Consists of hormone secreting glands e.g. .pituitary, adrenal, thyroid etc. Hormones are chemical messengers

that regulate body activities. The scientific study of hormones and the endocrine organs is called **endocrinology**.

- **Cardiovascular System-** Consists of the heart, blood and blood vessels. Blood vessels transport blood while the heart pumps blood. The branch of science concerned with the study of blood, blood-forming tissues and the disorders associated with them is is **haematology** (*haema-* or *haemato-* = blood). The study of the normal heart and the diseases associated with it is **cardiology** (*cardio-* = heart).

- **Lymphatic and immune System-** Consists of lymphatic vessels and fluid, spleen, thymus, lymph nodes and tonsils. Protects the body from infection and returns proteins and fluid to blood.
- **Respiratory System-** Consists of lungs and air passageways. Keeps blood constantly supplied with oxygen and removes carbon dioxide.
- **Digestive system-** Consists of organs of the gastrointestinal tract and accessory organs that assist in digestion. The medical specialty that deals with the structure, function, diagnosis, and treatment of diseases of the stomach and intestines is called **gastroenterology** (*gastro-* = stomach; *entero-* = intestines). The medical specialty that deals with the diagnosis and treatment of disorders of the rectum and anus is called **proctology** (*proct-* = rectum).
- **Urinary system-** Consists of the kidneys, ureters, urinary bladder and urethra for the production, storage and elimination of urine (wastes). **Nephrology** (*nephro-* = kidney) is the scientific study of the anatomy, physiology and pathology of the kidneys. The branch of medicine that deals with the male and female urinary systems and the male reproductive system is **urology** (*uro-* = urine).
- **Reproductive systems-** Consist of gonads (testes in males and ovaries in females) and associated organs for the production of gametes and hormones. **Gynaecology** (gynae- = woman) is the specialised branch of medicine concerned with the diagnosis and treatment of diseases of the female reproductive system.

- **Body Positions**

- **Anatomical position-** The standard body position; the body is erect/standing with the alms at the sides and palms turned forward.
- **Prone position-** Body lying face downward.
- **Supine position-** Body lying face upward.

- **Regional Names**

- **Head (Cephalic)-** skull and face.
- **Neck (Cervical)**
- **Trunk-** chest (thoracic), abdomen and pelvis.
- **Upper limb-** shoulder (acromial), armpit (axillary), arm, (brachial) forearm (antebrachial), wrist (carpal) and hand .
- **Lower limb-** buttock (gluteal), thigh (femoral), leg (crural), ankle (tarsal) and foot (pedal).

▪ Directional Terms

- Superior (cranial)- Toward the head.
- Inferior (caudal)- Away from the head.
- Anterior (ventral)- Toward or at the front of the body; in front of.
- Posterior (dorsal)- Toward or at the back of the body; behind
- Medial- Toward or at the midline of the body; on the inner side of.
- Lateral- Away from the midline of the body; on the outer side of.
- Intermediate- Between two structures.
- Ipsilateral- On the same side of the body as another structure.
- Contralateral- On the opposite side of the body from another structure.
- Proximal- Nearer to the attachment of a limb to the trunk.
- Distal.- Farther from the attachment of a limb to the trunk
- Superficial (external)- Toward or at the body surface.
- Deep (internal)- Away from the body surface; more internal.

Exercise: *Give **two** examples of each of the above cited directional terms**.***

▪ Planes and Sections

- Sagittal plane- A vertical plane that divides the body or an organ into left or right sides.
- Midsagittal (median) plane- A sagittal plane that lies in the midline.
- Parasagittal- A sagittal plane offset from the midline.
- Frontal (coronal) plane- Divides the body or an organ into anterior and posterior (front and back) portions.
- Transverse (horizontal) plane (cross section)- Divides the body or an organ into superior and inferior (upper and lower) portions.
- Oblique plane- Passes through the body or an organ at an angle between the horizontal and vertical planes.

▪ Body cavities

- **Dorsal cavity-** Located near the dorsal (posterior) surface of the body and has two subdivisions:-

- Cranial Cavity- Contains the brain.
- Vertebral (spinal) cavity- Encloses the delicate spinal cord.

o **Ventral cavity-** Located on the ventral (anterior) aspect of the body and has also two subdivisions:-

- Thoracic (chest) cavity- Houses the lungs, heart, oesophagus, trachea etc.
- Abdominopelvic cavity- Has two parts:-
  - Abdominal cavity- Contains the stomach, intestines, spleen, liver, and other organs.
  - Pelvic cavity- Contains the bladder, some reproductive organs and the rectum.

- **Abdominopelvic Regions and Quadrants -** Anatomists usually divide the abdominopelvic cavity into nine regions (Abdominopelvic regions)- umbilical, epigastric, hypogastric (pubic), right and left iliac (inguinal), right and left lumbar, right and left hypochondriac regions.
  Medical personnel usually use a simpler scheme to localize the abdominopelvic cavity organs by dividing it into quadrants (four regions) namely right upper quadrant (RUQ), left upper quadrant (LUQ), right lower quadrant (RLQ), right lower and quadrant (LLQ).

Exercise: *Give examples of organs found in:-*
a)Abdominopelvic Regions
b)Quadrants

- **The balance of Body Functions**

All living organisms maintain mechanisms that ensure survival of the body and success of propagating its genes through its offspring. This is achieved through a process called **homeostasis**.

Homeostasis: (staying-*stasis* the same-*homeo*)- The condition of equilibrium in the body internal environment e.g. temperature, glucose, blood pressure, pH, fluid volume etc. To accomplish internal stability (homeostasis) a highly complex and integrated communication control system, called **feed back system**, is required.

A **feed back system** is a cycle of events in which the status of a body condition is continually monitored, evaluated, changed, remonitored, reevaluated, and so on.

- **Components of a feedback system**

- A **receptor-** a sensor that monitors changes in the environment and sends the input to a control center.
- A **control center-** determines the set point (the level or range at which a variable is to be maintained) and determines the appropriate response. It is the body's thermostat.
- An **effector-** receives the output from the control center and produces a response or an effect that changes the controlled condition.

- **Types of feedback systems**

  - In **Negative feedback systems,** the output shuts off the original stimulus or reduces its intensity; hence the condition returns to its normal state. Most homeostatic control mechanisms are negative feedback systems e.g. regulation of body temperature, blood glucose, blood pressure etc.
  - In **positive feedback systems**, the result or response enhances or amplifies the original stimulus so that the activity (output) is accelerated e.g. parturition, blood clotting, vomiting etc.

Exercise:

a) With relevant diagrams describe one example in each case of negative and positive feedback systems.
b) List the general features of homeostasis.

- **Homeostatic imbalance**

When one or more components of the body lose their ability to contribute to homeostasis the normal equilibrium among body processes may be disturbed (homeostatic imbalance). If the homeostatic imbalance is moderate, a disorder or disease may occur; if it is severe death may result. A **disorder** is any derangement or abnormality of function. **Disease** is a more specific term for an illness characterized by a recognizable set of signs and symptoms.

Examples of homeostatic imbalances will be discussed throughout your course (BIO 100 and BIO 105) to enhance your understanding of physiological mechanisms.

Unit 2: Cells, Tissues and Membranes

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

Introduction

Just as bricks and timbers are the structural units of a house, cells are the structural and functional units of all living things. The human being has 50 to 100 trillion of these tiny building blocks. **Cell biology** is the study of cellular structure and function. Cells seldom function as isolated units in the body. Instead, cells usually work together in groups called tissues. A **tissue** (*tissu* = woven) is a group of similar cells that usually has a common embryonic origin and functions together to carry out specialised activities. Flat sheets of pliable tissue that cover or line a part of the body are **called membranes**. **Histology** (*histo-* = tissue; *-logy* = study of) is the science that deals with the study of tissues. Therefore, this unit will introduce you to the different types of cells, tissues and membranes in the human body.

Learning outcomes

- Define cell.
- State the cell theory.
- Describe the two main types of cells (prokaryotic and eukaryotic).
- Describe the different cells found in human beings.
- Identify and describe the basic structure and function of the three major components of a cell.
- Identify and briefly describe the functions of the primary cellular components.
- Describe the processes that transport substances across the plasma membrane.
- Describe the stages of mitosis and explain its importance.
- Describe the stages of meiosis and explain its importance.
- List the differences between mitosis and meiosis.
- Name the four basic types of tissues and describe the characteristics of each.
- Define and classify membranes.
- Describe cell homeostatic imbalances

Hints : You should use charts, models and your body to use as guides, to describe different body parts and their functions

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

Content

- **Cells**

o Definition : A cell is the basic, living, structural and functional unit of the body.

- Cell theory:

1. All known living things are made up of cells.
2. The cell is structural & functional unit of all living things.
3. All cells come from pre-existing cells by division.
   (Spontaneous Generation does not occur).
4. Cells contain hereditary information which is passed from cell to cell during cell division.
5. All cells are basically the same in chemical composition.
6. All energy flow (metabolism & biochemistry) of life occurs within cells.

- Major types of cells: **prokaryotic-** cells that do not have a nucleus and other organelles with membranes around them e.g.bacteria and cyanobacteria (also known as blue-green algae). **Eukaryotic**- cells have nuclei and other organelles with membranes around them; e.g. animal, plant, fungi and protista cells.
- Types of human cells (epithelial, contractile, secretory, nerve, germ, blood and immune cells).
- Structure of the human cell

Exercise: *Draw and label a typical cell listing the functions of the labeled parts.*

- Cell membrane – structure and functions
- Movement of substances across membranes
  - Uniport
  - Antiport
  - Symport
  - Passive processes
  - Active processes

Exercise: *Draw a table of transport of materials into and out of a cell under the following subheadings:- Transport Process, Description of the Process and Substances Transported.*

- Mitosis
- Meiosis

Exercise: *List not less than **eight** differences between mitosis and meiosis.*

Tissues

- Definition- A tissue is a group of similar cells that usually has a common embryonic origin and functions together to carry out specialized activities. The structure and properties of a specific tissue are influenced by a variety of factors

- Types
    - Epithelial tissue
    - Connective tissue
    - Muscle tissue
    - Nervous tissue

Membranes

- Definition- membranes are flat sheets of pliable tissue that cover or line a part of the body.
- Types
    - Epithelial membrane e.g. mucous, serous and cutaneous.
    - Synovial membrane

Homeostatic imbalances

Hypertrophy- increase in size of individual cells
Atrophy- Decrease in size of individual cells
Hyperplasia- Increase in cell reproduction
Anaplasia- Production of abnormal, undifferentiated cells

Exercise: *With relevant examples describe in detail the alterations in cell growth and reproduction listed above.*

Unit 3: The Cardiovascular System

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

Introduction

The **cardiovascular system** (*cardio*- heart; *vascular* = blood vessels) is responsible for transporting materials throughout the entire body. It transports nutrients, water, and oxygen to your billions of body cells and carries away wastes such as carbon dioxide that body cells produce. It is an amazing highway that travels through your entire body connecting all your body cells. The cardiovascular system is composed of the **heart, blood vessels, or vasculature**, and the cells and plasma that make up the **blood**.

Learning outcomes

- ✓ Describe the formation of blood.
- ✓ List the functions of blood.
- ✓ State the composition and physical characteristics of blood.
- ✓ Describe haemostasis and blood clot formation.
- ✓ Mention the different blood groups.
- ✓ Explain the tests used to study blood.
- ✓ Explain homeostatic imbalances associated with blood.
- ✓ Describe the size, shape, location and orientation of the heart in the thorax.
- ✓ Describe the structure and functions of the heart.
- ✓ Describe cardiac cycle.
- ✓ Describe conduction system of the heart.
- ✓ Mention the methods of studying the heart.
- ✓ Describe the major heart disorders.
- ✓ Describe the structure and functions of the major blood vessels.
- ✓ Describe the major circulatory routes.
- ✓ Explain how pulse and blood pressure are measured.
- ✓ Describe the disorders of blood vessels.
- ✓ List the functions of the lymphatic system.
- ✓ Describe lymph vessels, lymph formation and lymphatic circulation.
- ✓ Mention the major lymphatic organs and give the functions of each.

Hints : You should use charts, models and your body to use as guides, to describe different body parts and their functions

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

Content

a) Blood

- ✓ Blood formation and functions
- ✓ Physical characteristics of blood
- ✓ Blood composition

- ✓ Haemostasis and Blood clot formation (intrinsic and extrinsic pathways)
- ✓ Disorders of haemostasis (thrombus, embolus, coronary thrombosis, pulmonary embolus, haemophilia)
- ✓ Anticoagulants
- ✓ Blood groups and Rh
- ✓ Typing and cross matching blood for transfusion
- ✓ Blood studies/tests (haematocrit, haemoglobin tests, complete blood count, differential white count)
- ✓ Glucose tolerance test (diabetes mellitus test)
- ✓ Homeostatic imbalances (anaemia types including erythroblastosis foetalis, sickle cell anaemia and thallasemia; haemophilia, polycythemia, and leukemia)

b) Heart

- ✓ The structure and functions of the heart
- ✓ Conduction system
- ✓ Cardiac cycle
- ✓ Cardiac output
- ✓ Control of heart action/ rate
- ✓ Heart sounds and murmurs
- ✓ Measuring instruments (Stethoscope, Electrocardiograph)
- ✓ Major heart disorders
- ✓ Heart and valvular transplants
- ✓ Cardiac enzyme studies
- ✓ Risk factors in heart disease

c) Blood Vessels and Circulation

- ✓ Structure and functions
- ✓ Capillary circulation and tissue fluid
- ✓ Circulatory routes – coronary, pulmonary, systemic, hepatic portal, and cerebral
- ✓ Foetal circulation
- ✓ Pulse and blood pressure
- ✓ Response to haemorrhage, exercise and hypoxia

d) Lymphatic system

- ✓ Functions of the lymphatic system
- ✓ Lymph vessels
- ✓ Lymphatic circulation
- ✓ Oedema and lymph flow
- ✓ The lymphatic organs (thymus, spleen, lymph nodes and tonsils)

Unit 4: The Respiratory System

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

Introduction

No one needs to be told how important the **respiratory system** is. Of all the substances that cells and therefore the body as a whole must have to survive, oxygen is by far the most crucial. A person can live without food for, a few days without water, but only a few minutes without oxygen. The organs of the respiratory system are designed to perform two basic functions; they serve as an *air distributor* and as a *gas exchanger* for the body. The process of respiration therefore is an important **homeostatic mechanism.**

Learning outcomes

- ✓ Define respiration and describe the three phase of respiration.
- ✓ Name and describe all the structures and functions of the respiratory system.
- ✓ Describe the events that cause inhalation and exhalation.
- ✓ Define the various lung volumes and capacities.
- ✓ Describe the exchange of oxygen and carbon dioxide in external and internal respiration.
- ✓ Describe how the blood transports oxygen and carbon dioxide.
- ✓ Identify and discuss the mechanisms that regulate respiration.
- ✓ Identify and describe major respiratory disorders.

Hints : You should use charts, models and your body to use as guides, to describe different body parts and their functions

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

Content

- ✓ Structure and functions of the respiratory system
- ✓ The mechanism of ventilation
- ✓ The air we breath: inhaled vs exhaled
- ✓ Gaseous uptake and exchange in lungs and tissues: including lung volumes and capacities; gas laws
- ✓ Physiology of respiration
- ✓ Oxygen and carbon dioxide transport
- ✓ Control of respiration i.e. regulation of respiration: nervous, chemical and other influences
- ✓ Response to exercise and hypoxia
- ✓ Respiratory disorders

Unit 5: The Digestive System

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

Introduction

Every body cell needs a constant supply of nutrients to provide energy and to provide the building blocks for the manufacture of body substances. Food is our fuel, and its nutrients give our bodies' cells the energy and substances they need to operate. But before food can do that, it must first be broken down into particles

small enough to pass through the plasma membrane of the cell so that the body can absorb, transport and use. This breakdown process is known as **digestion.**

Learning outcomes

- ✓ Identify and give the functions of the digestive system and accessory organs.
- ✓ Describe the basic processes performed by the digestive system.
- ✓ Explain the role of enzymes in digestion and give examples of enzymes.
- ✓ Define and contrast mechanical and chemical digestion.
- ✓ Name the digestion products of carbohydrates, proteins and fats.
- ✓ Perform experiments to show the properties of enzymes.
- ✓ Describe the major digestive disorders.

Hints : You should use charts, models and your body to use as guides, to describe different body parts and their functions

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

Content

- ✓ The structure and functions of the gastrointestinal tract (GIT) and accessory organs (liver, pancreas, gall bladder)
- ✓ Digestion of foods and absorption & transport of nutrients
- ✓ Defaecation
- ✓ Chemical and mechanical digestion
- ✓ Characteristics/properties of enzymes
- ✓ Food (nutrients) tests
- ✓ Homeostatic imbalances: peptic ulcers, cirrhosis, gallstones, appendicitis, peritonitis, tumours, anorexia nervosa, jaundice.

Unit 6: The Urinary System

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

Introduction

Your body cells utilise nutrients from food and use them to maintain all bodily functions including energy and self-repair. After your body has taken what it

needs from the food, waste products are left behind in the blood. One of the waste products is urine. The organs, tubes, muscles, and nerves that work together to produce, store, carry and eliminate urine are the **urinary system** (also called **excretory system**). The urinary system includes two kidneys, two ureters, the bladder, two sphincter muscles, and the urethra. The urinary system works with the lungs and skin to keep the chemicals and water in your body balanced.

Learning outcomes

- ✓ Describe the parts of the urinary systems and give the functions of each.
- ✓ Identify nephron parts and describe their functions.
- ✓ Explain the process of urine formation.
- ✓ List the physical characteristics and chemical composition of normal urine.
- ✓ List abnormal constituents in urine
- ✓ Perform glucose test of urine (diabetes mellitus test)
- ✓ Describe dialysis methods.
- ✓ List the major renal and urinary disorders and explain the mechanism of each.
- ✓ Explain osmotic regulation of blood.
- ✓ Describe the general principles of electrolyte balance.

Hints : You should use charts, models and your body to use as guides, to describe different body parts and their functions

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

Content

- ✓ The gross structure and functions of the kidneys
- ✓ The structure and functions of the nephron.
- ✓ The process of urine formation
- ✓ Physical characteristics and chemical composition of normal urine
- ✓ Abnormal constituents in urine
- ✓ Glucose test of urine (diabetes mellitus test)
- ✓ Dialysis (haemodialysis and continuous ambulatory peritoneal dialysis)

- ✓ Major renal and urinary disorders
- ✓ Osmotic regulation of blood
- ✓ General principles of electrolyte balance

Required Reading

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PART TWO – MICROBIOLOGY AND PARASITOLOGY

UNIT 1 – INTRODUCTION TO MICROBIOLOGY AND PARASITOLOGY

Introduction

In this unit we are going to discuss microbiology and parasitology which are related fields of study. We are first going to look at the definitions of these terms and then discuss the different types of microorganisms with reference to parasites.

Microbiology

Microbiology is the study of *microorganisms*, which are unicellular or cell-cluster microscopic organisms.

This includes eukaryotes such as fungi and protists, and prokaryotes such as bacteria and certain algae.

Viruses, though not strictly classed as living organisms, are also studied.

Microbiology is a broad term which includes many branches like **virology**, **mycology**, **parasitology** and others.

A person who specializes in the area of microbiology is called a microbiologist.

Although much is now known in the field of microbiology, advances are being made regularly.

We have probably only studied about 1% of all of the microbes on Earth.

Thus, despite the fact that over three hundred years have passed since the discovery of microbes, the field of microbiology could be said to be in its infancy relative to other biological disciplines such as zoology, botany and entomology.

Disciplines of Microbiology

The field of microbiology can be generally divided into several subdisciplines:

i) **Microbial physiology**: The study of how the microbial cell functions biochemically. Study includes the study of microbial growth, metabolism and cell structure.

ii) **Microbial genetics**: The study of how genes are organised and regulated in microbes in relation to

their cellular functions. Closely related to the field of molecular biology.

iii) **Medical microbiology**: The study of the role of microbes in human illness. Includes the study of microbial pathogenesis and epidemiology and is related to the study of disease pathology and immunology.

iv) **Veterinary microbiology**: The study of the role in microbes in veterinary medicine or animal taxonomy.

v) **Environmental microbiology**: The study of the function and diversity of microbes in their natural environments.

vi) **Evolutionary microbiology**: The study of the evolution of microbes. Includes the study of bacterial systematics and taxonomy.

vii) **Industrial microbiology**: The exploitation of microbes for use in industrial processes. Examples include industrial fermentation and wastewater treatment. Closely linked to the biotechnology industry. This field also includes brewing, an important application of microbiology.

viii) **Aeromicrobiology**: The study of airborne microorganisms.

ix) **Food Microbiology**: The study of microorganisms causing food spoilage.

x) **Pharmaceutical microbiology**: the study of microorganisms causing pharmaceutical contamination and spoilage.

Benefits of Microbiology

While microbes are often viewed negatively due to their association with many human illnesses, microbes are also responsible for many beneficial processes such as industrial fermentation (e.g. the production of alcohol and dairy products), antibiotic production and as vehicles for cloning in higher organisms such as plants.

Scientists have also exploited their knowledge of microbes to produce biotechnologically important enzymes such as Taq polymerase, reporter genes for use in other genetic systems and novel molecular biology techniques such as the yeast two-hybrid system.

Microorganisms are beneficial for microbial biodegradation or bioremediation of domestic, agricultural and industrial wastes and subsurface pollution in soils, sediments and marine environments.

The ability of each microorganism to degrade toxic waste depends on the nature of each contaminant.

Since most sites are typically comprised of multiple pollutant types, the most effective approach to microbial biodegradation is to use a mixture of bacterial species and strains, each specific to the biodegradation of one or more types of contaminants.

There are also various claims concerning the contributions to human and animal health by consuming **probiotics** (bacteria potentially beneficial to the digestive system) and/or **prebiotics** (substances consumed to promote the growth of probiotic microorganisms).

Parasitology

Parasitology is the study of parasites and their hosts and how parasites affect the life of the host.

A parasite is an organism that lives a significant period of its life in or on another organism (the host), from which it obtains
nourishment and shelter.

The challenge to the parasite is that it must block or elude host defenses, but the reward is an abundant and reliable source of food.

Many parasites have complex life cycles.

There are many different possible strategies for the parasite to follow.

i) Some have one host whereas others have multiple hosts.

ii) Some use intermediate hosts for transport.

iii) The host may live or be killed by the parasite.

iv) Sometimes the host's life is spared, but the parasite eliminates the host's reproductive abilities.

Parasites can be **viruses, bacteria, fungi, protozoa, arthropods or helminths**.

They can cause a number of medical, veterinary and agricultural problems.

Examples include amoebic dysentery, giardiasis, toxoplasmosis, pinworm and scabies.

It has been estimated that parasitism is more common than all other forms of disease.

It is a major problem in third world countries.

Also included are links to a number of parasitology lecture courses, sites with lots of images and other cool sites

Self Evaluation Activity 1.1.

1) Define microbiology

2) Name three disciplines of microbiology

3) What are the benefits of microbiology

4) Define parasitology

UNIT 2 - CLASSIFICATION OF MICROORGANISMS

Introduction

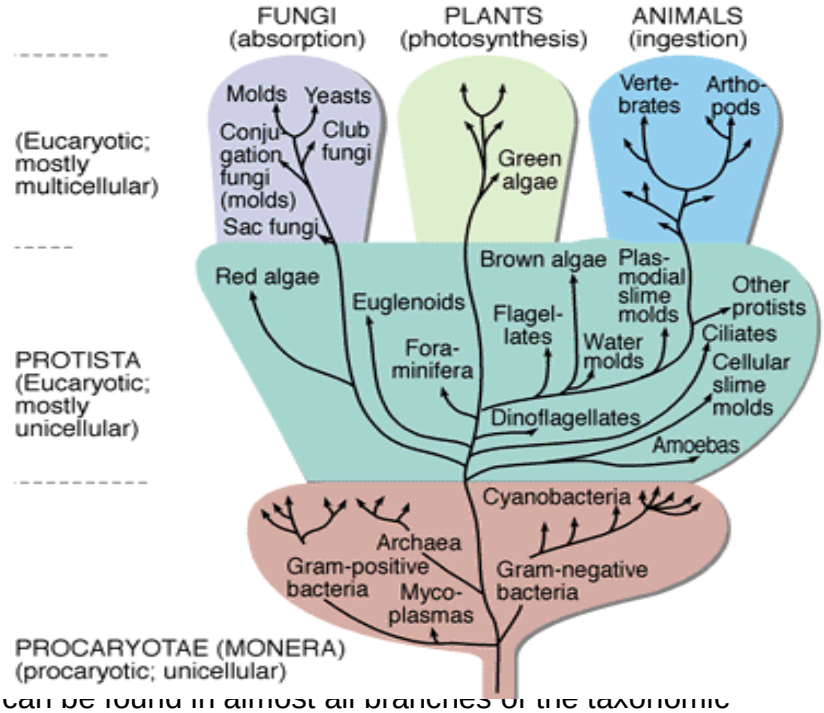
In unit one, we discussed an introduction to Microbiology and Parasitology. Different types of microorganisms were also mentioned.

In this unit we are going to discuss the main classes of microorganisms and their characteristics.

Biological Classification

Five-Kingdom System of Biological Classification (Fig.2.1)
Proposed in 1969 by Whitaker
Kingdoms are;

1) Kingdom Monera (Procaryotae)-Oldest cells
Lack nucleus and nuclear bound organelles
2) Kingdom Protista: Mostly unicellular, lack tissue organization. Most have flagella during life.
3) Kingdom Fungi: May be unicellular (yeasts) or multicellular (molds). Many are saprotrophs.
4) Kingdom Plantae: Multicellular, photosynthetic.
5) Kingdom Animalia: Multicellular, heterotrophs that ingest food through mouth or oral cavity



Microorganisms can be found in almost all branches of the taxonomic organization of life on the planet.

Bacteria and Archaea are almost always microscopic.

Protists and a number of microfungi are microscopic eukaryotes.

Increasingly, the practical identification and classification of micro-organisms is being based on the genetic code, that is, the nucleotide sequence of the RNA in the small ribosome subunit.

Viruses are not classified using this approach because they differ radically from cellular organisms, having no ribosomes or capacity for protein synthesis, and generally no metabolic capabilities.

a) Bacteria

Generally they consist of simple rod-like or spherical (coccus, pl. cocci) cells about 1 micron in size without a defined nucleus (and are thus classified as prokaryotes but also classified as Monera in the alternative five-kingdom taxonomy.

Generalized Structure

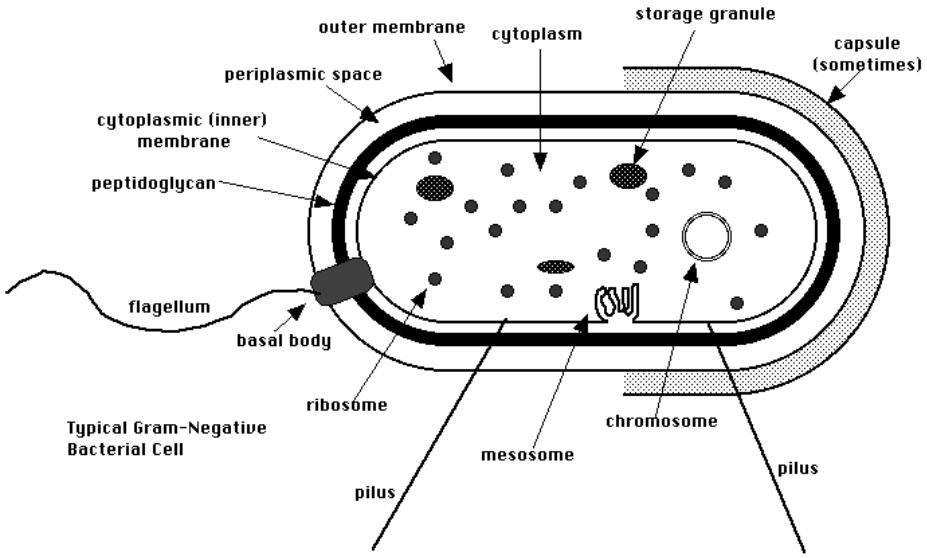


Fig.2.3. Bacterial cell structure.

b) Fungi

Basic Structure and Nutrition

Some fungi exist as single cells and are known as yeasts.

However, most species are multicellular.

The basic structure of a fungus is the **hypha** (pl., hyphae)—a slender filament of cytoplasm and nuclei enclosed by a cell wall (Figure below).

A mass of these hyphae make up an individual organism, and is collectively called a **mycelium**.

A mycelium can permeate soil, water, or living tissue; fungi certainly seem to grow everywhere.

In all cases the hyphae of a fungus secrete enzymes for extracellular digestion of the organic substrate.

Then the mycelium and its hyphae absorb the digested nutrients.

For this reason, fungi are called **absorptive heterotrophs**.

Heterotrophs obtain their energy from organic molecules made by other organisms.

Fungi feed on many types of substrates.

Most fungi obtain food from dead organic matter and are called **saprophytes**.

Other fungi feed on living organisms and are **parasites**.

Many of the parasitic fungi have modified hyphae called **haustoria** (Figure below)**,** which are thin extensions of the hyphae that penetrate living cells and absorb nutrients.

Hyphae of some species of fungi have crosswalls called **septa** that separate cytoplasm and nuclei into cells.

Hyphae of other species have incomplete or no septa (i.e., are aseptate) and therefore are **coenocytic** (multinucleate).

The cell walls of fungi are made of **chitin**, the same polysaccharide that comprises the exoskeleton of insects and crustaceans.

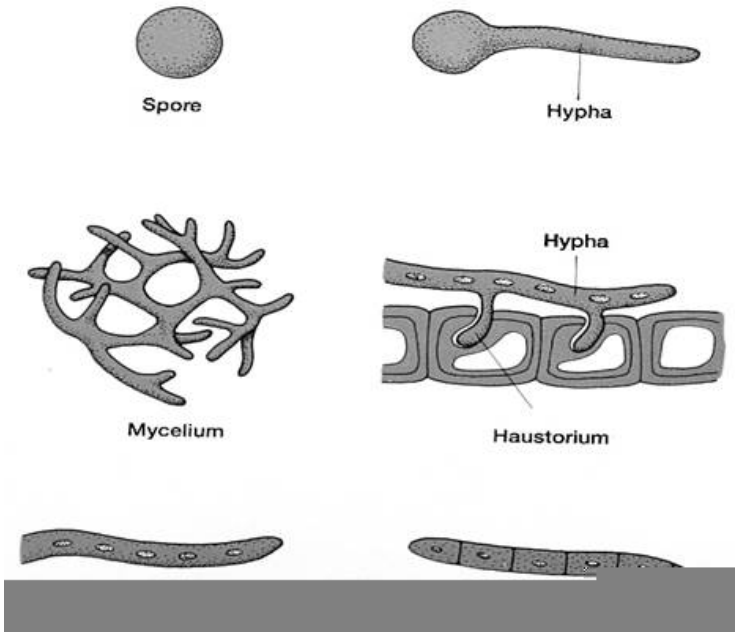


Fig.2.4. Basic structure of fungus.

c) Viruses

Viruses are defined as replicating entities that lack both ribosomes and the capability of metabolism.

Furthermore, they possess only one type of nucleic acid, either DNA or RNA, as their genetic material and, although they depend on cells for their replication, are able to persist independently in an infectious form outside of cells, and evolve and diversify by natural selection.

The main division of viruses is between **RNA viruses** and **DNA viruses**.

Another major distinction is between **enveloped viruses**, with an outer lipid bi-layer membrane, and **non-enveloped viruses**, without a membrane.

In general, DNA viruses tend to be enveloped, while RNA viruses are non-enveloped, although retroviruses are an exception.

General Characteristics of Viruses

Structure
Because most viruses are extremely well adapted to their host organism, virus structure varies greatly.
However, there are some general structural characteristics that all viruses share.

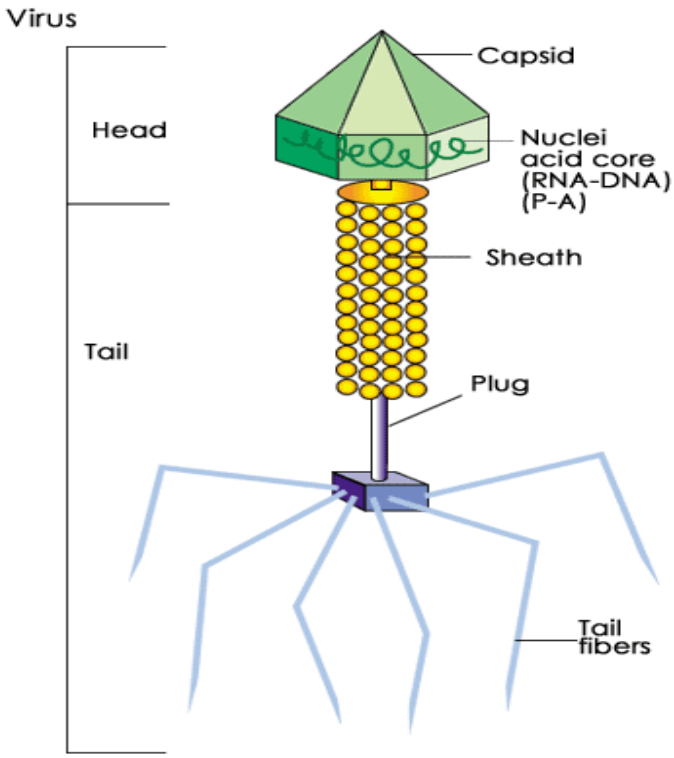


Fig.2.5. General Virus structure

All viruses have a capsid or head region that contains its genetic material.
The capsid is made of proteins and glycoproteins.
Capsid construction varies greatly among viruses, with most being specialized for a particular virus's host organism. Some viruses, mostly of the type infecting animals, have a membranous envelope surrounding their capsid.
This allows viruses to penetrate host cells through membrane fusion.
The virus's genetic (DNA or RNA) material rests inside the capsid.
In addition to the head region, some viruses, mostly those that infect bacteria, have a tail region.
The tail is an often elaborate protein structure.
It aids in binding to the surface of the host cell and in the introduction of virus genetic material to the host cell.

d) Protozoa

Protozoa are single-celled organisms with nuclei, usually showing some animal-like characteristics such as heterotrophy and motility and so originally classified in Animal Kingdom.
There is no sharp dividing line between them and the plant-like algae, though, so many forms are included in both.
Now it is understood that Protozoa and algae are neither plants nor animals, and they are given their own kingdom, the Protista.

Most protozoans are too small to be seen with the naked eye - most are around 0.01-0.05 mm, although forms up to 0.5 mm are still fairly common and can easily be seen under a microscope.

Protozoa are ubiquitous throughout aqueous environments and the soil, and play an important role in their ecology.

A few are also important parasites.

The traditional division of protozoans is on the basis of **movement**, and while this is no longer believed to represent true relationships, it's still a useful way of organizing the many different groups:

i) Flagellates

Use flagella for locomotion

Flagellates are single-celled with one or more flagella.

Originally they were grouped together as the *Mastigophora*, but the different lines do not appear particularly closely related.

Flagellate protists include:

Retortamonads

Diplomonads

Oxymonads

Parabasalia

Heterolobosea (amoeboflagellates)

Euglenozoa (kinetoplastids, euglenids)

Ellobiopsids

Dinoflagellates

Amoeboids

Amoeboids **use pseudopodia for locomotion**

Pseudopodia are false feet, which are temporary cytoplasmic projections that are involved in locomotion and ingesting food.

The main groups of such protists are:

Ramicristates - including most slime mold groups
Pelobionts - giant amoebae
Entamoebae - mostly parasitic forms

ii) Ciliates

Use cilia for locomotion

The ciliates (Ciliophora, Infusoria) are one of the most important groups of Protista, common almost everywhere there is water.

Few are parasitic members.

Ciliates tend to be large protozoa, a few reaching 2 mm in length, and are some of the most complex in structure.

The name "ciliate" comes from numerous, short hairs called **cilia** that are present at some point in every group.

These are the structures that are used for locomotion

e) Sporozoa

This is a large group (30,000 species) of parasitic non-photosynthetic protists that wholly lack flagellated stages with the exception of male gametes.

Life cycle - general features.

In these organisms growth and reproduction are separated.

First the cell grows (often to a huge size) and them proceeds to undergo a process of multiple divisions to produce many progeny cells.

The typical pattern is that nuclei divide first through several rounds of mitosis without cell division.

The nuclei typically are arranged around the periphery of the large cell.

The cytoplasm then cleaves around each of the nuclei.

The cytoskeleton for each daughter cell is assembled from the anterior end of the cell towards the posterior.

As this occurs, the typically banana-shaped daughter cells are cut off of the parental cell mass. Fig.2.6.

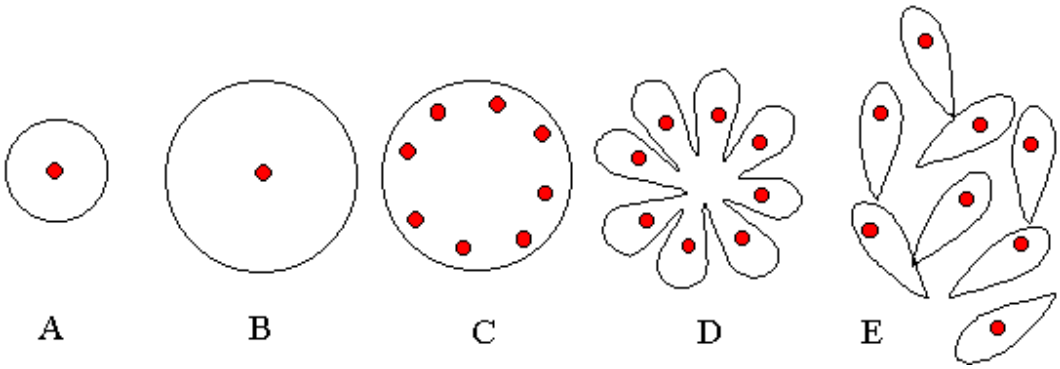


Fig. 2.6. Generalized life-cycle of Sporozoa

Adult sporozoans have no structures for movement

They form spores

Most are **parasitic** using one or more hosts

Immature sporozoans are called **sporozoites** and live in body fluids of hosts

Plasmodium is transmitted by mosquitoes that causes **malaria**

***Plasmodium* sporozoites** enter the **bloodstream**, travel to the **liver**, divide and form spores called **merozoites**

Merozoites attack red blood cells and later form eggs and sperm that fertilize

New sporozoites migrate to the **salivary glands** of mosquitoes where they can be passed on to another person

Exercise

Using a microscope, observe pond water for aquatic organisms. First observe under low power (x10) then go to high power. Try to identify the organisms as fungi, protozoa, bacteria or viruses.

f) Metazoa

Animals are a major group of multicellular organisms of the kingdom **Animalia** or **Metazoa**.

Their body plan becomes fixed as they develop, usually early on in their development as embryos, although some undergo a process of metamorphosis later on in their life.

Most animals are motile - can move spontaneously and independently.

Systematics of Metazoa

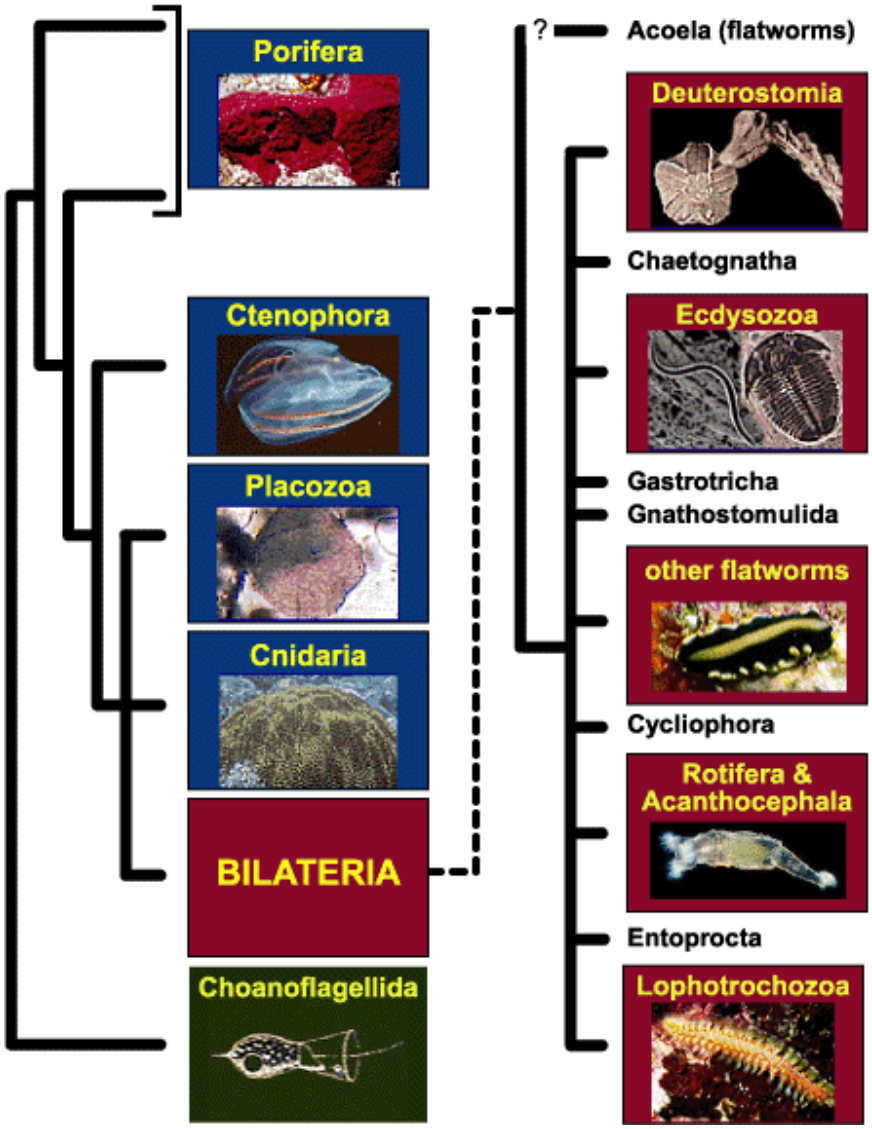


Fig.2.7. Metazoa systematics

i) Flatworms

The **flatworms** (Phylum **Platyhelminthes** from the Greek *platy*, meaning "flat" and *helminth*, meaning worm) are a phylum of relatively simple soft-bodied invertebrate animals.

With about 25,000 known species, they are the largest phylum of acoelomates. Flatworms are found in marine, freshwater, and even damp terrestrial environments.

A troublesome terrestrial example is the New Zealand flatworm, *Arthurdendyus triangulatus*, which rapidly colonized large areas of Ireland and Scotland since its unintentional introduction in the 1960s and has since destroyed most of the indigenous earthworms .

Most flatworms are free-living, but many are parasitic.

There are four classes: Trematoda (flukes), Cestoda (tapeworms), Monogenea, and Turbellaria.

Structure

Flat worms include 3 classes: **Trematoda** and **Cestoda** are all parasites of vertebrates and invertebrates.

The class **Turbellaria** alone includes free living species.

The flatworm's cephalized soft body is ribbon-shaped, flattened dorso-ventrally (from top to bottom), and bilaterally symmetric.

Flatworms are the simplest triploblastic animals with organs.

This means their organ systems form out of three germ layers: an outer **ectoderm** and an inner **endoderm** with a **mesoderm** between them.

Turbellarians generally have a ciliated epidermis, while cestodes and trematodes covered with a cuticle.

There is also no true body cavity (coelom) except the gut; hence, flatworms are classified as acoelomates.

The interior of the acoelomate body is filled with somewhat loosely spaced mesodermal tissue called parenchyma tissue.

Fig. 2.8. Platyhelminth flatworms

Flatworms exhibit an undulating form of locomotion.

Depending on species and age, individuals can range in size from almost microscopic to over 20 m long.

The longest ever recorded flatworm was a tapeworm over 27 m long.

ii) Roundworms

Characteristics and structure

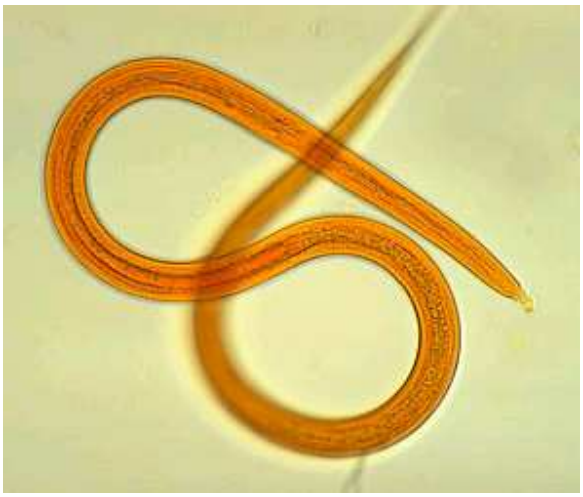


Fig. 2.9. Nematode worm

Nematodes, known as **roundworms**, are in the Kingdom Animalia of the biological classification system known as the Linnean Taxonomic Hierarchy.

Roundworms are one of the most common phyla of animals.

The phylum includes more than 20,000 species (over 15,000 are parasitic).

Only arthropods are more diverse than roundworms.

Roundworms look alike earthworms, but they are completely different.

They live in places where they outnumber other animals in both individual and species counts such as freshwater, marine, and terrestrial environments.

Roundworms are found all the way from Antarctica to North Pole, but they are able to live in warm areas.

There are many kinds of parasitic forms in roundworms.

Hosts include most plants and animals, also humans are included.

Roundworms are one of the simplest animal groups that have a complete digestive system.

Since they have no respiratory or circulatory systems, they use diffusion for respiration and circulation of substances around their body.

Even though they are thin and round, they are actually bilaterally symmetric.

Roundworm's body cavity is a pseudocoel, which lacks the muscle, so that roundworms have to depend on body movement and internal/external pressure to force food down through their digestive tract.

Self Evaluation Activity 2.1

1) Name the Kingdoms in the 5-Kingdom system of biological classification.
2) Group the following organisms in their correct Kingdoms: human, bacteria, virus, tapeworm and snail
3) How can protozoa be conveniently classified?

UNIT 3- HOST-PARASITE INTERACTIONS

Introduction

In unit 2 we looked at the various microorganisms and some macroorganisms which are parasitic in nature.

In this unit we are going to discuss how parasites and hosts interact to cause diseases and how our bodies react to infection by parasites.

Bacteria-Host Interactions

Bacteria are consistently associated with the body surfaces of animals.
There are many more bacterial cells on the surface of a human (including the gastrointestinal tract) than there are human cells that make up the animal.
The bacteria that are consistently associated with an animal are called the **normal flora**.
These bacteria have a full range of **symbiotic interactions** with their animal hosts.

In biology, symbiosis is defined as "life together", i.e. that two organisms live in an association with one -another.

Thus, there are at least three types of relationships based on the quality of the association for the members of the symbiotic association.

Types of Symbiotic Associations

1. **Mutualism**. Both members of the association benefit.

2. **Commensalisms**. There is no apparent benefit or harm to either member of the association.

3. **Parasitism**. One member of the association lives at the expense of the other member.
It is this type of a symbiotic association that draws our attention in this course. For many parasites are or can become pathogens, which are microorganisms that cause disease.

Bacterial Pathogenesis

A **pathogen** is a microorganism (or virus) that is able to produce disease.

Pathogenicity is the ability of a microorganism to cause disease in another organism, namely the **host** for the pathogen.

As implied above, pathogenicity is a manifestation of a host- parasite interaction.

In humans, some of the normal bacterial flora (e.g. *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenzae)* are **potential pathogens** that live in a commensal or parasitic relationship without producing disease.

They do not cause disease in their host unless they have an opportunity brought on by some compromise or weakness in the host's anatomical barriers, tissue resistance or immunity.

Furthermore, the bacteria are in a position to be transmitted from one host to another, giving them additional opportunities to colonize or infect.

There are some pathogens that do not associate with their host **except** in the case of disease.

These bacteria are **obligate pathogens**, even though some may rarely occur as normal flora, in asymptomatic or recovered carriers, or in some form where they cannot be eliminated by the host.

Bacterial Opportunistic Pathogens

Bacteria which cause a disease in a compromised host which typically would not occur in a healthy (noncompromised) host are acting as **opportunistic pathogens**.

A member of the normal flora can such as *Staphylococcus aureus* or *E. coli* can cause an **opportunistic infection**, but so can an environmental organism such as *Pseudomonas aeruginosa.*

When a member of the normal flora causes an infectious disease, it might be referred to as an **endogenous bacterial disease**, referring to a disease brought on by bacteria 'from within'.

Bacterial Infection

The normal flora, as well as any “contaminating” bacteria from the environment, is all found on the body surfaces of the animal; the blood and internal tissues are sterile.

If a bacterium, whether or not a component of the normal flora, breaches one of these surfaces, an **infection** is said to have occurred.

Infection does not necessarily lead to infectious disease. I

In fact, infection probably rarely leads to infectious disease.

Some bacteria rarely cause disease if they do infect; some bacteria will usually cause disease if they infect.

But other factors, such as the route of entry , the number of infectious bacteria, and status of the host defenses, play a role in determining the outcome of infection.

Determinants of Bacterial Virulence

Pathogenic bacteria are able to produce disease because they possess certain **structural** or **biochemical** or **genetic** traits that render them pathogenic or **virulent**.

The term **virulence** is best interpreted as referring to the **degree of pathogenicity**.

The sum of the characteristics that allow a bacterium to produce disease are the pathogen's **determinants of virulence**.

Some pathogens may rely on a single determinant of virulence, such as toxin production, to cause damage to their host.

Thus, bacteria such as *Clostridium tetani* and *Corynebacterium diphtheriae*, which have hardly any invasive characteristics, are able to produce disease, the symptoms of which depend on a single genetic trait in the bacteria; the ability to produce a toxin.

Other pathogens, such as *Staphylococcus aureus*, *Streptococcus pyogenes* and *Pseudomonas aeruginosa*, maintain a large repertoire of virulence determinants and consequently are able to produce a more complete range of diseases that affect different tissues in their host.

Properties of the Host

The **host** in a **host-parasite interaction** is the animal that maintains the parasite.

The host and parasite are in a dynamic interaction, the outcome of which depends upon the properties of the parasite and of the host.

The bacterial parasite has its determinants of virulence that allow it to invade and damage the host and to resist the defenses of the host.

The **host has various degrees of resistance** to the parasite in the form of the **host defenses.**

Self Evaluation Activity 3.1

What does the compound word “host-parasite” mean?

What are obligate parasites?

What does the term pathogenicity mean?

Host Defenses

A healthy animal can defend itself against pathogens at different stages in the infectious disease process.

The host defenses may be of such a degree that infection can be prevented entirely.

Or, if infection does occur, the defenses may stop the process before disease is apparent.

At other times, the defenses that are necessary to defeat a pathogen may not be effective until infectious disease is well into progress.

Typically the **host defense mechanisms are divided into two groups**:

1. Constitutive Defenses. Defenses common to all healthy animals. These defenses provide general protection against invasion by normal flora, or colonization, infection, and infectious disease caused by pathogens. The constitutive defenses have also been referred to as "natural" or "innate" resistance, since **they are inherent to the host**.

2. Inducible Defenses. Defense mechanisms that **must be induced or turned on by host exposure to a pathogen** (as during an infection). Unlike the constitutive defenses, they are not immediately ready to come into play until after the host is appropriately exposed to the parasite. The inducible defenses involve the immune responses to a pathogen causing an infection.

The inducible defenses are generally quite specifically directed against an invading pathogen.

The constitutive defenses are not so specific, and are directed toward general strategic defense.

The constitutive defenses, by themselves, may not be sufficient to protect the host against pathogens. Such pathogens that evade or overcome the relatively **nonspecific constitutive defenses** are usually susceptible to the more **specific inducible defenses**, once they have developed.

The Immune System

The inducible defenses are so-called because they are induced upon primary exposure to pathogen or one of its products.

The **inducible defenses are a function of the immunological system** and the **immune responses**.

The constitutive defenses are innate and immediately available for host defense.

The inducible defenses must be triggered in a host and initially take time to develop.

The type of resistance thus developed in the host is called **acquired immunity**.

The term **immune** usually means the ability to resist infectious disease.

Immunity refers to the relative state of resistance of the host to a specific pathogen.

Acquired immunity, itself, is sometimes divided into two types based on how it is acquired by the host.

i) Active immunity

The host undergoes an immunological response and produces the cells and factors responsible for the immunity, i.e., the host produces its own antibodies and/or immuno-reactive lymphocytes.

Active immunity can persist a long time in the host, up to many years in humans.

ii) Passive Immunity

In this type of immunity there is **acquisition by a host of immune factors which were produced in another animal**, i.e., the **host receives antibodies and/or immuno-reactive lymphocytes originally produced in another animal**.

Passive immunity is typically short-lived and usually persists only a few weeks or months.

Antigens

Antigens are chemical substances of relatively high molecular weight that stimulate the immune response in animals.

Bacteria are composed of various macromolecular components that are antigens or " **antigenic**" in their host and bacterial antigens interact with the host immunological system in a variety of ways.

Natural Antibodies

Studies on germ-free animals have confirmed that a normal bacterial flora in the gastrointestinal tract are necessary for full development of immunological (lymphatic) tissues in the intestine.

Furthermore, the interaction between these immune tissues and intestinal bacteria results in the production of **serum and secretory antibodies** that are directed against bacterial antigens.

These antibodies probably help protect the host from invasion by its own normal flora, and they can cross react with antigenically-related pathogens.

For example, antibodies against normal *E. coli* could react with closely-related pathogenic *Shigella dysenteriae*.

These types of antibodies are sometimes called **natural** or **cross-reactive antibodies**.

Bacterial Antigens made into Vaccines

Bacterial antigens that are the components or products of pathogens are the **substances that induce the immune defenses** of the host to defend against, and to eliminate, the pathogen or disease.

In the laboratory, these bacterial antigens can be manipulated or changed so that they will stimulate the immune response in the absence of infection or pathology.

These isolated or modified antigens are the basis for **active immunization (vaccination)** against bacterial disease.

Thus, a modified form of the tetanus toxin (tetanus **toxoid**), which has lost its toxicity but retains its antigenicity, is used to immunize against tetanus.

Or, antigenic parts of the whooping cough bacterium, *Bordetella pertussis* can be used to induce active formation of antibodies that will react with the living organism and thereby prevent infection.

Antimicrobial Agents

One line of defense against bacterial infection is chemotherapy with antimicrobial agents such as **antibiotics**.

The ecological relationships between animals and bacteria in the modern world are mediated by the omnipresence of antibiotics.

Antibiotics are defined as substances produced by a microorganism that kill or inhibit other microorganisms.

Originally, a group of soil bacteria, the *Streptomyces*, were the most innovative producers of antibiotics for clinical usage.

They were the source of streptomycin, tetracycline, erythromycin and chloramphenicol, to name just a few antibiotics.

Because **bacteria evolve rapidly toward resistance**, and **can exchange genes for antibiotic resistance** or perhaps because we have **overused and misused antibiotics**, many pathogens are emerging as resistant to antibiotics.

There have already been reported infections by *Enterococcus*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* that are refractory to all known antibiotics.

Bacterial resistance to antimicrobial agents has become part of a pathogen's determinants of virulence.

These are examples of genetic means by which bacteria exert their virulence.

The usage of antibiotics to control the growth of parasites is an artificial way to intervene in the natural process of the host-parasite interaction.

But, of course, it is done for the obvious purpose of curing the disease.

The body heals itself: most antibiotics just stop bacterial growth, and the host must rely entirely on its native defenses to accomplish the neutralization of bacterial toxins or the elimination of bacterial cells.

The judicious use of antibiotics in the past five decades has saved millions of lives from infections caused by bacteria.

Self Evaluation Activity 3.2

1) Define symbiosis
2) Name three types of symbiotic relationships
3) What is an endogenous bacterial disease?
4) Define virulence of a pathogen
5) What are constitutive defenses in a host animal?

UNIT 4 - MEDICAL ENTOMOLOGY

Introduction

In the previous unit, we discussed some groups of higher animals which affect humans. Most of these higher animals were included in the kingdom Metazoa.

In this unit we are going to continues discussing Metazoan organisms that interact with humans. We are particularly going to dwell on insects as vectors of diseases.

Entomology

Entomology, from the Greek *entomo*- "that which is cut in pieces or segmented", hence "insect"; and *logos* "knowledge", is the scientific study of insects.
Insects have many kinds of interactions with humans and other forms of life on earth, so it is an important specialty within biology.
Though technically incorrect, the definition is sometimes widened to include the study of terrestrial animals in other arthropod groups or other phyla, such as arachnids, myriapods, earthworms and slugs

Many entomologists specialize in a single order or even a family of insects, and a number of these subspecialties are given their own informal names, typically (but not always) derived from the scientific name of the group:

- Apiology (or melittology) – bees
- Coleopterology – beetles
- Dipterology – flies
- Heteropterology - true bugs
- Lepidopterology - moths and butterflies
- Myrmecology – ant
- Orthopterology - grasshoppers, crickets, etc.
- Trichopterology - caddis flies

The association of insects with disease and pestilence has been recognized since biblical plagues
Recent examples include malaria epidemics, sleeping sickness and others.

Medical Entomology

Medical entomology is the study of insects, inset-borne diseases, and other associated problems affecting humans and public health.
The field of medical entomology includes health-related problems involving **arachnids** (ticks, mites, spiders and scorpions).

Epidemiology

There are two types of vector the microbes that convey infectious organisms to a host: **mechanical** and **biological**.

Microbes do not multiply within mechanical vectors - mechanical vectors only physically transport microbes from host to host.

In contrast, microbes must propagate within a biological vector before the biological vector can transmit

Self Evaluation Activity 4.1

1) Look up the definition of epidemiology and give a concise definition of the term.
2) Insects and arachnids are related. State the relationship between the two.

Classification of Vectors

There are **8 orders of insects** and **4 orders of arachnids** that are important in medical entomology
Accurate identification of the orders is important in determining the types of problems they cause
Table 4.1 below shows the principle orders of insects and arachnids of medical entomology interest.

Table 4.1. Principle Orders of Insects and Arachnids in Medical Entomology

Order	**Common names**
Class Insecta	
Order Blattaria	Cockroaches
Order Phthiraptera	Lice
Order Hemiptera	Bugs, bedbugs, assissin bugs.
Order Coleoptera	Beetles
Order Siphonptera	Fleas
Order Diptera	Flies, mosquitoes, black flies, horse flies, sand flies, tsetse flies, stable flies, horn flies, louse flies, etc.
Order Lepidoptera	Moths and butterflies
Order Hymenoptera	Wasps, hornets, ants, bees

Class Arachnida

Order Scorpionida	Scorpions
Order Solpugida	Solpugids, sun spiders, spiders
Order Acari	Mites, ticks
Order Araneae	
Spiders	

Types of Problems Caused by Insects

a) Annoyance

Insects and their relatives cause severe annoyance because of their biting behaviour

These insects include tsetse flies, mosquitoes, fleas, bedbugs, lice and tick

b) Envenomation

Several members of the insect group can inject venom when the sting

Most notable are bees, wasps, ants, spiders and scorpions

Envenomation results in medical conditions ranging from mild itching to intense debilitating pain

c) Allergic reactions

Many insects which cause envenomation can result in allergic reaction resulting from an overresponsive host immune system

Bites from lice, bedbugs, fleas, bees, ants, wasps and mosquitoes all can result in allergic host reactions

Contact allergies can occur when certain beetles or caterpillars touch the skin

d) Invasion of host tissues

Some arthropods invade body tissue of their host

Various degrees of invasion occurs, ranging from subcutaneous infestations to invasion of organs

Invasion usually involves the immature stages of parasitic insects

The invasion of host tissue by fly larvae, called **myiasis**, is common

Vector-Borne Diseases

The most common and important vectors that transmit pathogens to humans are mosquitoes, followed by ticks.

Viruses and bacteria are the most diverse groups of pathogen transmitted by arthropods.

Table 4.2 lists the principle groups of insects and arachnids involved in vector-borne diseases and the associated types of pathogens.

Table 4.2 Vector-Borne Diseases of Medical Importance

Vector	Diseases grouped by Pathogens
Mosquitoes	Viruses: yellow fever, dengue Protozoans: malaria, filariasis
Black flies	Filarial nematodes: river blindness
Tsetse flies	Protozoans: trypanosomiasis
Lice	Bacteria: typhus, relapsing fever
Fleas	Bacteria: plague, typhus, tularemia
Ticks	Viruses: tick-borne encephalitis
Mites	Bacteria: rickettsial pox

Control of Vectors

Vector control is any method to limit or eradicate the vectors of vector-borne diseases.

The most frequent type of vector control is mosquito control, which uses a variety of strategies, three of which are:

1. Habitat control: stagnant water is avoided, by removal of old tires, empty cans etc., and better management of used water;
2. Insecticides, spread over mosquito breeding zones, sprayed in houses, or insecticide treated nets (ITNs).

Vector Control Strategies

Ecology of Vector

need to establish the habitats of the vector

need to know the environmental requirements of vector

Insecticides

make choice of insecticide for particular vector

establish resistance patterns of vector to insecticide

Reservoir control
use of natural enemies of vectors
manipulation of environment of vector to make it unsuitable

Self Evaluation Activity 4.2

1) What is a vector reservoir?
2) Define envenomation
3) Name 5 problems caused by vectors to hosts

Behaviour and Control of Vectors

Epidemiology is the study of disease behaviour within populations of hosts
It is a discipline with links to ecology
Knowledge of the epidemiology of infectious disease agents can help to control diseases
A complete understanding of the epidemiology of vector-borne diseases requires knowledge of the ecology, physiology and immunology of the parasite, vector and the hosts
The degree of contact between the vector and host ranges from **intermittent (**e.g. mosquitoes) to **intimate (**e.g. lice)
The host provides both food and shelter for the vector

Components of Transmission

These components are

a) A host develops a level of infection with parasite that is infectious to a vector
b) A vector acquires the parasite from the host and capable of transmission
c) One or more hosts are susceptible to the parasite

The Host

The **primary vertebrate hosts** are essential for maintenance of parasite transmission
The **secondary or incidental hosts** are not essential to maintain transmission but contribute to amplification of parasite
Amplification refers to the increase in the number of parasites in an area
A reservoir host supports parasite development, remains infected for long periods. And serves as a source of vector infection

Attributes of a Primary Host

Accessibility – the vertebrate host must be abundant and fed upon frequently by vectors
Susceptibility – a primary host must be susceptible to infection and permit development of the parasite
Transmissibility – susceptible hosts must be available to become infected and thus maintain the parasite

The Vector
A vector s a carrier of parasite from one host to another
Vectors show characteristics that adapt them to their vertebrate hosts
Characteristics include host selection, infection and transmission

Host Selection
Patterns of host selection determine the type of parasite to which vectors are exposed
Anthropophagic vectors feed selectively on humans and transmit human parasites
Anthropophagic vectors which feed on humans indoors are termed **endophlic**
Those which rarely enter houses are termed **exophilic**
Zoophagic vectors feed on feed on vertebrates other than humans
Mammalophagic vectors feed on mammals
Ornithophagic vectors fed on bird (avian) hosts

Infection by Vector
Vector must be susceptible to infection and live long enough for parasite to complete its development

Transmission
Once infected, the vector must reefed on one or more hosts to ensure transmission of parasite

Vector Control
Insects and arachnids are vectors of parasitic diseases through which disease control can be achieved
Vector control can be attempted through **environmental management** to reduce vector populations. This may be achieved through destruction of habitats of reservoirs.
Use of **insecticides** is also used in vector control
Control of vectors can also be achieved by **sanitation**, which involves cleaning surroundings of homes, removing or dredging swampy areas where mosquitoes breed, etc.
Health education is also vital in vector control, where schools and the community are involved in reducing the population of vectors. Effective vector control requires knowledge of the vector biology, its ecology and life cycle.

End of Unit Test

1) What are the attributes of a good primary host?
2) Define transmission
3) In what three ways can vectors be controlled?
4) What are vector-borne diseases?
5) Define medical entomology

1) Envenomation is injection of venom into a victim
2) Annoyance, invasion of host tissue, allergic reactions, envenomation

UNIT 5 - DISEASES OF BODY SYSTEMS

Introduction

In the previous units, we discussed microorganisms with emphasis on parasitic organisms. We also discussed the vectors which carry the pathogens from one host to another. Pathogens are disease causing and can harm the human body in many ways and many organs.

In this unit, we are gong to discuss some important or major diseases of the various body systems.

Diseases

A **disease** is an abnormal condition of an organism that impairs bodily functions.

In human beings, "disease" is often used more broadly to refer to any condition that causes discomfort, dysfunction, distress, social problems, and/or death to the person afflicted.

In this broader sense, it sometimes includes **injuries, disabilities, disorders, syndromes, infections, isolated symptoms deviant behaviors**, and atypical variations of structure and function.

While many diseases are biological processes with observable alterations of organ function or structure, others primarily involve alterations of behavior.

Causes of Diseases

Many different factors intrinsic or extrinsic to a person can cause disease.

Examples of intrinsic factors are genetic defects or nutritional deficiencies.

An environmental exposure, such as second-hand smoke (passive smoking) is an example of an extrinsic factor.

Many diseases result from a combination of intrinsic and extrinsic factors.

For many diseases a cause cannot be identified.

There are many different factors that can cause disease.

These can be broadly categorized into the following categories like social, psychological, chemical and biological.

Some factors may fall into more than one category.

Biochemical causes of disease can be considered as a spectrum where at one extreme disease is caused entirely by genetic factors (e.g. **CAG** repeats in the Huntington gene that causes Huntington's Disease) and at the other extreme is caused entirely by environmental factors.

a) Diseases of the Integument

Integumentary system is the external covering of the body, comprising the **skin**, **hair**, **scales**, **nails**, sweat glands and their products (sweat and mucus).

The integumentary system has a variety of functions

In animals, it may serve to waterproof, cushion and protect the deeper tissues, excrete wastes, regulate temperature and are the location of sensory receptors for pain, pressure and temperature.

The integumentary system is often the largest organ system of an animal by surface area.

It distinguishes, separates, protects and informs the animal with regard to its surroundings.

Anatomy of the Integument

The cutaneous membrane (skin) and its accessory structures (hair, scales, feathers, nails, exocrine glands) make up the integumentary system.

There are three layers of skin:

1. Epidermis
2. Dermis
3. Subcutaneous tissue

Diseases and injuries of the Integument

The specialized treatment of the integumentary system is performed by dermatologists.

Possible diseases and injuries to the human integumentary system include:

a) Rash

A **rash** is a change in skin which affects its color, appearance, or texture.

It may be localized to one part of the body, or affect all the skin.

Rashes may cause the skin to change colour, itch, become warm, bumpy, dry, cracked or blistered, swell and may be painful.

The causes, and therefore treatments for rashes, vary widely.

Diagnosis must take into account such things as the appearance of the rash, other symptoms, what the patient may have been exposed to, occupation, and occurrence in family members.

b) Blisters

A **blister** or **bulla** is a defense mechanism of the human body.

When the outer (epidermis) layer of the skin separates from the fibre layer (dermis), a pool of lymph and other bodily fluids collect between these layers while the skin re-grows from underneath.

Blisters can be caused by chemical or physical injury.

An example of chemical injury would be an allergic reaction.

Physical injury can be caused by heat, frostbite, or friction.

c) Scabies

Scabies is a transmissible ectoparasite skin infection characterized by superficial burrows, intense pruritus (itching) and secondary infection.

The word *scabies* comes from the Latin word for "scratch" (scabere).

Scabies is caused by the mite *Sarcoptes scabiei*, variety *hominis*.

It produces intense, itchy skin rashes when the impregnated female tunnels into the stratum corneum of the skin and deposits eggs in the burrow.

The larvae, which hatch in 3-10 days, move about on the skin, moult into a nymphal stage, and then mature into adult mites. The adult mites live 3-4 weeks in the host's skin.

d) Athlete’s foot

Athlete's foot or **Tinea pedis** is a parasitic **fungal** infection of the epidermis of the foot.

It is typically caused by a mould that grows on the surface of the skin and then grows into the living skin tissue itself, causing the infection.

It usually occurs between the toes, but in severely lasting cases may appear as an extensive moccasin pattern on the bottom and sides of the foot.

The disease affects males commonly than females.

e) Chicken pox

Chickenpox is the common name for *Varicella zoster*, classically one of the childhood infectious diseases caught by and survived by almost every child.

It is caused by the varicella-zoster virus (VZV), also known as **human herpes virus 3 (HHV-3)**, one of the eight herpes viruses known to affect humans.

It starts with conjunctival and catarrhal symptoms and then characteristic spots appearing in two or three waves, mainly on the body and head rather than the hands and becoming itchy.

The disease has a 10-14 day incubation period and is highly contagious through physical contact two days before symptoms appear.

Following primary infection there is usually lifelong protective immunity from further episodes of chickenpox.

Recurrent chickenpox, commonly known as shingles, is fairly rare but more likely in people with compromised immune systems.

Chickenpox is a highly contagious disease that spreads from person to person by direct contact or through the air from an infected person's coughing or sneezing.

Touching the fluid from a chickenpox blister can also spread the disease.

A person with chickenpox is contagious from one to two days before the rash appears until all blisters have formed scabs.

This may take five to 10 days.

It takes from 10-21 days after contact with an infected person for someone to develop chickenpox.

Secondary infections, such as inflammation of the brain, can occur in immunocompromised individuals.

This is more dangerous with shingles

b) Diseases of Eyes

1**) Conjunctivitis**

Conjunctivitis, commonly called "**pinkeye**" or bloodshot eyes is an inflammation of the conjunctiva (the outermost layer of the eye and the inner surface of the eyelids), most commonly due to an allergic reaction or an infection (usually bacterial or viral).

Symptoms

i) Redness, irritation and watering of the eyes are symptoms common to all forms of conjunctivitis.
ii) Acute **allergic conjunctivitis** is typically itchy.
iii) Sometimes distressingly so, and the patient often complains of some lid swelling.
iv) Chronic allergy often causes just itch or irritation, and often much frustration because the absence of redness or discharge can lead to accusations of hypochondria.

v) **Viral conjunctivitis** is often associated with an infection of the upper respiratory tract, a common cold, or a sore throat.
vi) Its symptoms include watery discharge and variable itch.
vii) The infection usually begins with one eye, but may spread easily to the fellow eye.
viii) **Bacterial conjunctivitis** due to the common **pyogenic** (pus-producing) bacteria causes marked grittiness/irritation and a stringy, opaque, grey or yellowish mucopurulent discharge that may cause the lids to stick together (matting), especially after sleeping.
ix) Another symptom that could be caused by Bacterial Conjunctivitis is severe crusting of the infected eye and the surrounding skin.
x) However discharge is not essential to the diagnosis, contrary to popular belief.
xi) Many other bacteria (e.g., *Chlamydia*, *Moraxella*) can cause a non-exudative but very persistent conjunctivitis without much redness.

xii) The gritty and/or scratchy feeling is sometimes localizzed enough for patients to insist they must have a foreign body in the eye.
xiii) The more acute pyogenic infections can be painful.
xiv) Like viral conjunctivitis, it usually affects only one eye but may spread easily to the other eye.
xv) **Irritant or toxic conjunctivitis** is irritable or painful when the infected eye is pointed far down or far up.
xvi) Discharge and itch are usually absent.
xvii) This is the only group in which severe pain may occur

2) Keratitis

Keratitis is a condition in which the eye's cornea is inflamed

Types

a) **Superficial keratitis** involves the superficial layers of the cornea. After healing, this form of keratitis does not generally leave a scar.
b) **Deep keratitis** involves deeper layers of the cornea, leaving a scar upon healing that impairs vision if on or near the visual axis.

Causes

Keratitis has multiple causes, one of which is an infection of a present or previous herpes simplex virus secondary to an upper respiratory infection, involving cold sores.

c) Mouth Infections

i) Candidiasis.
a) A fungal infection commonly called **yeast infection** or **thrush.**
b) The causative fungus belong to the genus Candid, of which *Candida albicans* is the most common

Manifestation

a) In immunocompetent people, candidiasis can usually only be found in exposed and moist parts of the body, such as the oral cavity (oral thrush), the vagina and/or vulva (vaginal candidiasis or thrush), armpit and the foreskin of penis.

ii) Trench Mouth

a) **Trench mouth** is a polymicrobial infection of the **gums** leading to inflammation, bleeding, deep ulceration and necrotic gum tissue.

b) Causative organisms include anaerobes such as *Bacteroides* and *Fusobacterium* as well as spirochetes.

c) The condition is caused by an overpopulation of established mouth bacteria due to a number of interacting factors such as poor hygiene, poor diet, smoking, or other infections.

iii) Oral Ulcer

a) An **oral ulcer** is the name for the appearance of an open sore inside the mouth caused by a break in the mucous membrane or the epithelium on the lips or surrounding the mouth.

b) The types of oral ulcers are diverse, with a multitude of associated causes including: physical or chemical trauma, infection from microorganisms or viruses, medical conditions or medications, cancerous and sometimes nonspecific processes.

c) Once formed, the ulcer may be maintained by inflammation and/or secondary infection.

d) Two common oral ulcer types are aphthous ulcers (canker sores) and cold sores, which are caused by the herpes simplex virus.

d) Diseases of the Respiratory System

i) In mammals, the respiratory system consists of the airways, the lungs, and the respiratory muscles that mediate the movement of air into and out of the body.
ii) Within the alveolar system of the lungs, molecules of oxygen and carbon dioxide are passively exchanged, by diffusion, between the gaseous environment and the blood.
iii) Thus, the respiratory system facilitates oxygenation of the blood with a concomitant removal of carbon dioxide and other gaseous metabolic wastes from the circulation.
iv) The system also helps to maintain the acid-base balance of the body through the efficient removal of carbon dioxide from the blood.

i) Common Cold

Acute viral nasopharyngitis, or **acute coryza**, usually known as the **common cold**, is a highly contagious, viral infectious disease of the upper respiratory system, primarily caused by picornaviruses or coronaviruses.

Common symptoms are sore throat, runny nose, nasal congestion, sneezing and cough; sometimes accompanied by muscle aches, fatigue, malaise, headache, muscle weakness, or loss of appetite.

Fever and extreme exhaustion are more usual in influenza.

The symptoms of a cold usually resolve after about one week, but can last up to 14 days.

Symptoms may be more severe in infants and young children.

Although the disease is generally mild and self-limiting, patients with common colds often seek professional medical help, use over-the-counter drugs.

No vaccines are available for the disease.

The primary method to prevent infection is hand-washing to minimize person-to-person transmission of the virus.

There are no antiviral drugs approved to treat or cure the infection.

Most available medications are palliative and treat symptoms only.

ii) Laryngitis

Laryngitis is an inflammation of the larynx.

It causes hoarse voice or the complete loss of the voice because of irritation to the vocal cords.

Laryngitis is categorized as acute if it lasts less than a few days.

Otherwise it is categorized as chronic, and may last over 3 weeks.

Causes

i) viral infection
ii) bacterial or fungal infection
iii) inflammation due to overuse of the vocal cords
iv) excessive coughing

iii) Upper respiratory tract infection

Upper respiratory infections, commonly referred to the acronym **URI** or **URTI**, is the illness caused by an acute infection which involves the upper respiratory tract, nose, sinuses, pharynx, larynx, or bronchi.

Signs and symptoms

i) Acute upper respiratory tract infections includes rhinosinusitis (common cold), sinusitis, pharyngitis/tonsillitis, laryngitis and sometimes bronchitis.
ii) Symptoms of URI's commonly include congestion, cough, running nose, sore throat, fever, facial pressure and sneezing.
iii) Onset of the symptoms usually begins after 1-3 days after exposure to a microbial pathogen, most commonly a virus.
iv) The duration of the symptoms is typically 7 to 10 days but may persist longer.

v) Influenza (the flu) is a more systemic illness, which can also involve the upper respiratory tract, should be recognized as distinct from other causes of URI.

e) Diseases of the Gastrointestinal System

The **gastrointestinal system** is the body system that eats and digests food. It also gets rid of waste after digestion.

The gastrointestinal system starts at the lips and ends at the anus.

Gastroenterology

Gastroenterology is the branch of medicine where the digestive system and its disorders are studied.

Etymologically it is the combination of Ancient Greek words *gastros* (stomach), *enteron* (intestine) and *logos* (reason).

Diseases affecting gastrointestinal tract are the focus of this specialty.

Doctors specializing in the field are called **gastroenterologists**.

Important advances have been made in the last 50 years, contributing to rapid expansion of its scope.

a) Giardia lamblia

Giardia lamblia (synonymous with *Lamblia intestinalis* and *Giardia duodenalis*) is a flagellated protozoan parasite that colonises and reproduces in the small intestine, causing **giardiasis**.

The giardia parasite attaches to the epithelium by a ventral adhesive disc, and reproduces via binary fission.

Giardiasis does not disseminate haematogenously, nor does it spread to other parts of the gastro-intestinal tract, but remains confined to the lumen of the small intestine.

Giardia trophozoites absorb their nutrients from the lumen of the small intestine, and are anaerobes.

Hosts

Giardia affects humans, but it is also one of the most common parasites infecting cats and dogs.

Mammalian hosts also include cows, beavers, deer, and sheep.

Infection and Life Cycle

Giardia infection can occur through ingestion of dormant cysts in contaminated water, or by the faecal-oral route (through poor hygiene practices).

The Giardia cyst can survive for weeks to months in cold water, and therefore can be present in contaminated wells and water systems, and even clean-looking mountain streams, as well as city reservoirs, as the cysts are resistant to conventional water treatment methods, such as chlorination.

Zoonotic transmission is also possible, and therefore Giardia infection is a concern for people camping in the wilderness or swimming in contaminated streams or lakes.

As well as water-borne sources, faecal-oral transmission can also occur, for example in day care centres, where children may have poorer hygiene practices.

Those who work with children are also at risk of being infected, as are family members of infected individuals.

Not all Giardia infections are symptomatic, so some people can unknowingly serve as carriers of the parasite.

The life cycle begins with a noninfective cyst being excreted with faeces of an infected individual.

Once out in the environment, the cyst becomes infective.

A distinguishing characteristic of the cyst is 4 nuclei and a retracted cytoplasm.

Once ingested by a host, the trophozoite emerges to an active state of feeding and motility.

After the feeding stage, the trophozoite undergoes asexual replication through longitudinal binary fission.

The resulting trophozoites and cysts then pass through the digestive system in the faeces.

While the trophozoites may be found in the faeces, only the cysts are capable of surviving outside of the host.

Exercise

Using the description of the life-cycle given above, construct a diagrammatic life-cycle of the parasite

b) Clostridium difficile

Clostridium difficile is a species of bacteria of the genus *Clostridium* which are Gram-positive, anaerobic, spore-forming rods (bacillus).

C. difficile is the most significant cause of pseudomembranous colitis a severe infection of the **colon**, often after normal gut flora is eradicated by the use of antibiotics.

Treatment is by stopping any antibiotics and commencing specific anticlostridial antibiotics, e.g. metronidazole.

Description

Clostridia are motile bacteria that are ubiquitous in nature and are especially prevalent in soil.

Under the microscope after Gram staining, they appear as long drumsticks with a bulge located at their terminal ends.

Clostridium difficile cells are Gram positive.

Clostridium shows optimum growth when plated on blood agar at human body temperatures.

When the environment becomes stressed, however, the bacteria produce spores that tolerate the extreme conditions that the active bacteria cannot.

C. difficile is a commensal bacterium of the human intestine in a minority of the population.

Patients who have been staying long-term in a hospital or a nursing home have a higher likelihood of being colonized by this bacterium.

In small numbers it does not result in disease of any significance.

Antibiotics, especially those with a broad spectrum of activity, cause disruption of normal intestinal flora, leading to an overgrowth of *C. difficile*.

This leads to **pseudomembranous colitis**.

C. difficile is resistant to most antibiotics.

It flourishes under these conditions.

It is transmitted from person to person by the faecal-oral route.

Because the organism forms heat-resistant spores, it can remain in the hospital or nursing home environment for long periods of time.

It can be cultured from almost any surface in the hospital.

Once spores are ingested, they pass through the stomach unscathed because of their acid-resistance.

They change to their active form in the colon and multiply.

It has been observed that several disinfectants commonly used in hospitals may fail to kill the bacteria, and may actually promote spore formation.

However, disinfectants containing bleach are effective in killing the organisms.

Pseudomembranous colitis caused by *C. difficile* is treated with antibiotics, for example, vancomycin, metronidazole, bacitracin or fusidic acid.

f) Disorders of the Nervous System

Introduction

The nervous system is responsible for the coordination of all body activities.
A defect in the functioning of the nervous system can therefore result in uncoordinated activities.
Many disorders occur to the nervous system, and a few are cited here.

a) Alzheimer's Disease (AD)

Dementia is a brain disorder that seriously affects a person's ability to carry out daily activities.

The most common form of dementia among older people is Alzheimer's disease (AD), which initially involves the parts of the brain that control thought, memory, and language.

Although scientists are learning more every day, right now they still do not know what causes AD, and there is no cure.

AD is named after Dr. Alois Alzheimer, a German doctor.

In 1906, Dr. Alzheimer noticed changes in the brain tissue of a woman who had died of an unusual mental illness.

He found abnormal clumps (now called amyloid plaques) and tangled bundles of fibers (now called neurofibrillary tangles).

Today, these plaques and tangles in the brain are considered signs of AD.

Scientists also have found other brain changes in people with AD.

Nerve cells die in areas of the brain that are vital to memory and other mental abilities, and connections between nerve cells are disrupted.

There also are lower levels of some of the chemicals in the brain that carry messages back and forth between nerve cells.

AD may impair thinking and memory by disrupting these messages.

b) Meningitis

Meningitis is an inflammation of the **meninges**, the membranes that cover the brain and spinal cord.
The inflammation is usually caused by bacteria or viruses (viral meningitis is also called **aseptic meningitis).**
Less common causes include fungi, protozoa, and other parasites.
Sometimes certain medications, cancers, or other diseases can inflame the meninges, although such noninfectious cases of meningitis are much rarer.

Bacterial Meningitis

Introduction

Bacterial meningitis is a contagious and infectious disease of the central nervous system (CNS).

It is caused by **Gram negative and Gram positive bacteria**.

Gram positive bacterial meningitis organisms include *Streptococcus pneumoniae*, *Staphylococcus epidermis*, or *Listeria monocytogenes*.

Gram negative bacterial meningitis is caused by *Neisseria meningitides*, *Haemophilus influenzae*, or *Escherichia coli*.

Cases of bacterial meningitis are commonly due to one of the three species of bacteria: *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Neisseria meningitides*.

Epidemiology

Bacterial meningitis is the inflammation of the meninges that surrounds the brain and spinal cord.

Furthermore, the cerebral spinal fluid (CSF) that surrounds the brain and spinal cord are infected with those Gram positive and Gram negative organisms.

The brain is surrounded by the meninges and cerebrospinal fluid. The meninges consist of three membrane layers: **dura mater, arachnoid mater,** and **pia mater**.

The pia mater covers the brain, whereas the dura mater covers the skull.

The arachnoid mater membrane is between the pia and dura mater.

In between the pia mater and the arachnoid mater is the subarachnoid space where the cerebrospinal fluid resides.

The inflammation of this fluid is a marker of bacterial meningitis.

Primarily, the bacteria enter into the body through direct contact such as coughing, kissing, and sharing of utensils.

As a result, it adheres to the mucosal lining of the nose and throat which provides an environment for rapid growth.

The bacteria penetrate through the mucosal lining and into the bloodstream.

Once into the bloodstream, the bacteria can target other organs as well.

Causes of Bacterial Meningitis

Meningitis may occur due to many risk factors including gender, age, crowded living conditions, exposure to insects and rodents, failure to be immunized against mumps, *Haemophilus influenzae*, *Streptococcus pneumoniae*, failure to be vaccinated against *Streptococcus pneumoniae* as an adult, traveling to areas where meningitis is prevalent, and direct contact to infected persons.

Genetics is a risk factor because a person inherits those genes that cause them to get infected by those organisms that cause bacterial meningitis.

Age is a risk because the elderly, young children, and babies may not have a strong enough immune system to combat the organisms.

Crowded living condition is another risk factor because organisms spread easily from person to person.

Examples of crowded places would be dormitories and child day care centers.

Children in day care centers may not wash their hands after going to the bathroom; therefore, the organisms are spread when other children come into contact with the contaminated hands.

Insects and rodents also are vectors in transporting the bacterial organisms.

Furthermore, failure to be vaccinated does not build the immune system up to fight these bacteria.

Therefore, people are susceptible to being infected by these bacteria.

Meningitis is prevalent in Africa, Mali, and Saudi Arabia.

Direct contact such as coughing, kissing, or even sharing utensils is also a vector in spreading the bacteria into other living systems.

Other risk factors include respiratory tract infection, otitis media, head trauma, alcoholism, sickle cell disease, and weather.

Acute Disseminated Encephalomyelitis (ADEM)

Acute disseminated encephalomyelitis (ADEM) is classically described as a monophasic syndrome occurring in association with an immunization or

vaccination (post vaccination encephalomyelitis) or systemic viral infection (para infectious encephalomyelitis).

Pathologically, there is perivascular inflammation, oedema, and demyelination within the CNS.

Clinically patients present with the rapid development of focal or multifocal neurologic dysfunction.

Prototypical illness arises after acute measles infection or rabies vaccine administration.

Uncertainty regarding the diagnosis occurs when patients with clinical features of ADEM occur in the background of viral infections or vaccine administration not significantly linked with the syndrome by epidemiological criteria.

In addition to measles, a wide array of other viral and bacterial infections have tentatively been associated with ADEM, including rubella, mumps, herpes zoster, herpes simplex and influenza.

Acute encephalomyelitis occurring in the background of nonspecific viral illness is difficult to diagnose with certainty and to distinguish from episodes of mild symptoms.

ADEM also has been associated with vaccines, including pertussis, rubella, diphtheria, and measles.

The association between influenza vaccination, particularly the swine flu vaccine, and ADEM has been the subject of medicolegal controversy.

Clinical features

Clinical features of the postvaccination and parainfectious syndromes are similar, with the exception that the postrabies vaccination complications frequently involve the peripheral nervous system as well as the central nervous system (CNS).

Many patients with postrabies immunization illness have only mild clinical features of fever, headache, or myalgia without cerebral spinal fluid (CSF) pleocytosis.

End of Unit Test

1) What do you understand by “body systems”?
2) What are body systems made up of?
3) Name three diseases of the respiratory system
4) What is demyelination of the central nervous system?
5) Suggest a meaning of the word “medicolegal”

UNIT 6- PREVENTION AND CONTROL OF PARASITIC DISEASES.

INTRODUCTION

In unit 5, we discussed several diseases affecting human body systems. We however did not look at the prevention and control of diseases.

In this unit, we are going to discuss the general prevention and control of parasitic diseases that affect human beings.

Control of Parasite Diseases

The success of control measures against any disease is dependent on knowledge of its **aetiology** (causative agent) and natural history (**epidemiology**). Knowledge of the mode of its transmission, e.g. whether it is vector-borne, water-borne or by orofecal and venereal methods, is vital in disease control

Components of Disease Control

Activities involved in control fall into well-defined categories:
i) Disease surveillance and diagnosis
ii) Definition of strategy by selection of methodology
iii) Planning and resourcing
iv) Implementation of method, e.g.
- a) Chemotherapy and chemoprophylaxis- drugs
- b) Immunoprophylaxis – vaccines
- c) Vector or reservoir control
- d) Environmental management
- e) Health education

The effectiveness of a combination of the above methods fulfils the principles of integrated control

Integrated Control of Parasitic Infections

Parasitic infections are usually associated with particular remedies and methods of control
The strategy, however, must be aimed at alleviating the disease at community level
Integrated control is dependent on planning and execution of high order and should benefit the human population or community
Diagnosis of parasitic infections is difficult on clinical grounds
Currently there is a drive towards the value of self-diagnosis or community diagnosis
Diagnosis in individuals enables a problem to be defined on a community basis

Objectives of Control

The primary objective of disease control is alleviation of discomfort or pain in an individual

The other objective is to reduce transmission of the disease amongst the population

Control versus Eradication

Control is the reduction of a parasite load or vector population

This implies that it is likely for the disease to continue

Control activities should aim at sustaining the reduced incidence of the disease

Eradication implies the elimination of the disease

However, this has been achieved in a few cases in limited geographical areas, like yellow fever in Central and South America, malaria in Italy and small pox

Eradication, therefore, refers to the total removal of a vector

Diagnosis of parasitic diseases

The identification of the cause of a disease is fundamental to control

In large scale mass-control, diagnosis of a disease must be done on a large scale and not on individual

In large-scale vector control, the overall objective would be to reduce the overall prevalence and hence mortality/morbidity of the disease

Diagnosis is important when dealing with

i) organisms which are difficult to detect parasitologically

ii) where treatment is risky due to the toxicity of a drug and frequency of side effects

iii) when initial problems need to be defined

Self Evaluation Activity 6.1

1) Define the following terms;

i) Epidemiology;

ii) Aetiology;

iii) Eradication and

iv) Control

2) What is the importance of diagnosis in disease control?

Methods of Disease Control

Introduction

The control of parasitic diseases is a multifaceted operation

It requires to take into account a number of variables to achieve a particular end

In this part of the unit, we are going to discuss a number of disease control strategies that can be employed community level

a) Vaccination and Chemotherapy

Vaccination

The widespread use of vaccines against childhood diseases has had a dramatic effect on child mortality and morbidity from diphtheria, measles, poliomyelitis and whooping cough
However, there has been lack of acceptance of some of these vaccines, particularly that for whooping cough, which has led to the persistence of the disease
Vaccination against a number of viral and bacterial diseases has been successful
The diversity and complexity of protozoa and helmith parasites have, however, presented many problems in developing viable and acceptable vaccines.

Chemotherapy

Prophylactic chemotherapy is the taking in of a drug to **prevent** infection
The best example is malaria for which chloroquine, pyrimethamine or proguanil have protected millions of people
Mass prophylaxis has been practiced for the control of malaria in Gambia and curative mass treatment has been employed for the treatment of schistosomiasis, to prevent reinfection of snails
Generally mass chemotherapy is expensive and can lead to development of resistance, so it is not widely used.
For infected individual, curative chemotherapy is the best choice of action

b) Health Education

Dissemination of information to populations plays an important role in disease control
Displays of posters, use of the radio, television and video recordings, enable communities to be informed about control activities
In many countries, the health infrastructure can be used to disseminate verbally, by existing political or local government structures
Poster displays should be targeted in local languages, emphasizing the importance of observing symptoms, or refraining from particular practices.

c) Control of Reservoir Hosts and their Infections

Some parasitic diseases have wild or domestic animal reservoir hosts
In such cases, elimination of the infection within the host may be more ideal
Sometimes, destruction of the host may have dramatic effect on transmission of infection to humans

Elimination of game animals was practiced in Zimbabwe to control tsetse fly and hence trypanosomiasis; the principle here was to eliminate the preferred hosts of *Glossina* species

Self Evaluation Activity 6.2

1) What is the difference between chemotherapy and vaccine?
2) Name the type of medication you would use to prevent certain infections
3) How can health education be conveniently exposed to the public?
4) What is a reservoir host?

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