EDO UNIVERSITY, IYAMHO
Department of Microbiology

MCB 316: Immunology

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Lecture Period and Venue: Thursday, 9am – 11 am, NLT4.
Office hours: Tuesday, 8am - 1pm, Wednesday, 9am - 2pm, Friday, 8am – 1pm.
Office: New Faculty of Science Block, Rm B6.

Description: This course is designed to give the students a deep knowledge of the immune system: beginning with introduction to the structure and functions of the immune cells, tissues and organs; then innate and acquired immunity; immunological tolerance and suppression; diagnostic immunology and conclude with the nature of resistance in plants.

Prerequisites: Students should have thorough knowledge of **General Microbiology, Introductory Genetics and Cell Physiology, and Introductory Biochemistry I & II** courses offered in 200 Level.

Assignments: There shall be a minimum of 7 assignments throughout the course in addition to a Mid-Term quiz and a Final Exam. Completed assignments must be submitted at the beginning of the lecture periods on the due dates. Assignments are organized and structured to serve as supplementary materials for the midterm quiz and final exam.

Grading: I will assign 10% of this class grade to assignments, 5% for attendance, 15% for the mid-term quiz and 70% for the final exam. Students should note that minimum of **75% attendance** is required in order to be eligible to sit for examination. Students should adhere strictly to all instructions as there shall be no room for waivers.

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Recommended Textbooks:

(1.) NESTER'S MICROBIOLOGY by Nester *et al*. 5th Edition. Jaypee Publishers.

(2.) KUBY IMMUNOLOGY by Owen, Stunt and Stranford. 7th Edition. W. H. Freeman and Company.

(3.) PRESCOTT'S MICROBIOLOGY by Joanne *et al.* 9th Edition. Mc Graw Hill Education.

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The recommended textbooks above also serve as references from which this lecture note was compiled.

Lectures: Below is a description of the contents.

INTRODUCTION

The discipline of immunology emerged from the observation that individuals who recovered from certain infectious diseases were thereafter protected from the disease. The immune system evolved to protect multicellular organisms from pathogens. The immune system is highly adaptable and defends the body against diverse invaders. The diversity of potential pathogens requires a range of recognition and destruction mechanisms to match the multitude of invaders.

Immunity is a state of protection from infectious disease. The body is protected from infectious agents and other harmful substances by a variety of cells and molecules that make up the immune system. Immunity is the ability of the human body to tolerate the presence of materials indigenous to the body (self) and to eliminate foreign (non-self) materials. Foreign substances such as viruses, bacteria, toxins and parasites are surrounded by antigens that when introduced into the body are capable of inducing a response by the immune system.

Types of Immunity

(a.) Passive Immunity: This is immune protection that is transferred between individuals. Antibodies from another person or animal that can be injected or transferred. It is called *passive* because the individual did not create the antibodies, but instead received pre-formed antibodies. Protection is effective, but duration is short lived and no memory is created. Example, maternal antibodies (trans-placental and breast milk) and injected antibodies (e.g. rabies, varicella, and tetanus immune globulins).

(b.) Active Immunity: This is the production of one's own immunity. There are two categories: **Innate immunity** and **Adaptive immunity**.

(i) Innate or natural immunity (non specific immune response or resistance) offers resistance against any microorganism or foreign material encountered by the vertebrate host. It includes general mechanisms inherited as part of the innate structure and function of each animal. It acts as a first line of defense. It lacks immunological memory.

(ii) Adaptive or acquired immunity (specific immune response or resistance) resists a particular foreign agent. It improves on repeated exposure to foreign agents such as viruses, bacteria and toxins.

The non specific and specific responses usually work together to eliminate pathogenic microorganisms and other foreign agents.

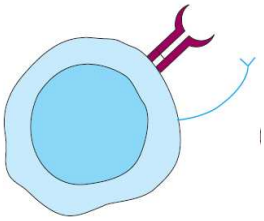
Cells of the Immune System

The leukocytes are the cells responsible for both non specific and specific immunity. All leukocytes originate from the pluripotent stem cells in the fetal liver and in the bone marrow of the animal host, from which they migrate to other body sites, undergo further development, and perform their various functions. These cells of the immune system are present throughout the body of the host. Some become resident within the tissues, where they respond to local trauma and give out signals. Others circulate in the body fluids and are recruited to the sites of infections. Leukocytes cooperate with each other to first recognize the pathogen as an invader and then to destroy it.

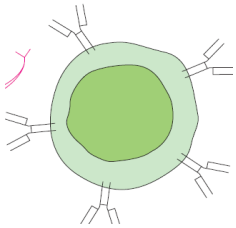
The different leukocytes include: Lymphocytes, Monocytes, Granulocytes, Mast cells and Dendritic cells.

(a) Lymphocytes are the major cells of the specific immune system. They are divided into 3 groups namely T cells, B cells and null cells (e.g. natural killer cells). B cells or B lymphocytes reach maturity within the bone marrow, circulate in the blood, and also settle in various lymphoid organs. T cells or T lymphocytes mature in the thymus, circulate in the blood or reside in lymphoid organs such as spleen. Natural killer cells are important in killing cells infected with either viruses or intracellular pathogens and destroying cancer cells. They do not express antigen-specific receptors.

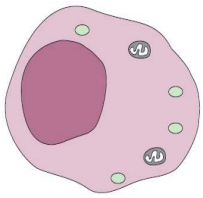
The types of lymphocytes are illustrated below.



T cell

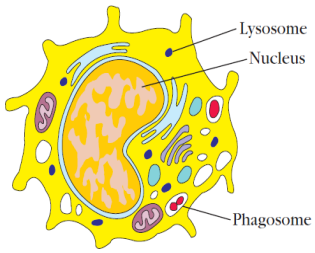


B cell

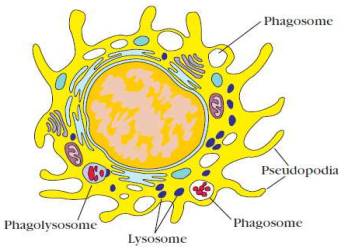


Null cell

(b) Monocytes are mononuclear phagocytic leukocytes with an ovoid or kidney-shaped nucleus and granules in the cytoplasm that stain gray-blue. They are highly phagocytic. Phagocytes are immune cells that engulf and destroy pathogens. They are produced in the bone marrow and enter the blood, circulate for about 8 hours, enlarge, migrate to the tissues and mature into macrophages. Macrophages are highly phagocytic. They have receptors for antibodies and complement. They spread throughout the body and take up residence in specific tissues where they are given special names. Monocytes and macrophages are illustrated below.



Monocyte



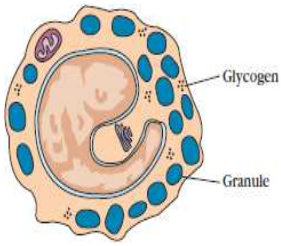
Macrophage

(c) Granulocytes have irregular shaped nuclei with 2-5 lobes, and the cytoplasmic matrix has granules that contain reactive substances that kill microorganisms and enhance inflammation. They can be called polymorphonuclear leukocytes (PMN). Basophils, Eosinophils and Neutrophils are the 3 types of granulocytes.

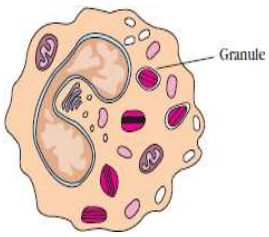
Basophils have an irregular-shaped nucleus with two lobes and the granules stain bluish-black with basic dyes. They are non-phagocytic cells that function by releasing histamine, prostaglandins, serotonin and leukotrienes from their granules upon appropriate stimulation. They constitute <1% of leukocytes.

Eosinophils possess two-lobed nucleus connected by a slender thread of chromatin, and the granules stain red with acid dyes. Unlike basophils, they are mobile cells that can migrate from the bloodstream into the tissue spaces. They are important only in defense against protozoan and helminth parasites. They constitute 1-3% of leukocytes.

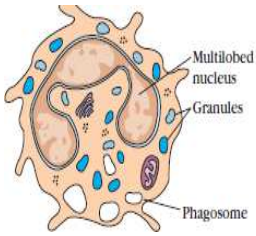
Neutrophils readily stain at neutral pH. They have a nucleus with 3-5 lobes connected by slender threads of chromatin. They contain fine primary and secondary inconspicuous granules. They constitute 50-70% of the circulating leukocytes. See illustrations below.



Basophil

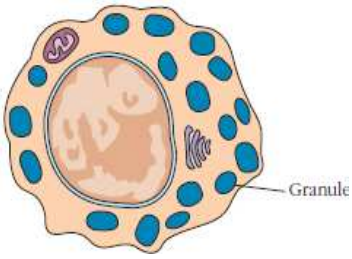


Eosinophil



Neutrophil

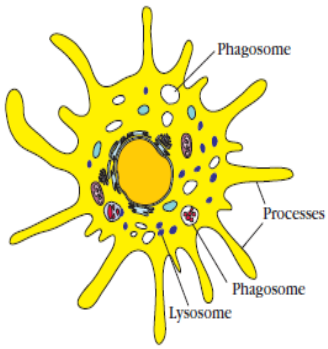
(d) Mast Cells are bone marrow-derived cells found in connective tissue that mature after they leave the blood. They contain granules with histamine and other pharmacologically active substances that contribute to the inflammatory response. Mast cells, along with basophils, play important role in the development of allergies and hypersensitivities.



Mast cell

(e) **Dendritic Cells** constitute only 0.2% of leukocytes in the blood and are present in even smaller numbers in the skin and mucous membranes of the nose, lungs and intestines. They can distinguish between potentially harmful microorganisms and "self" molecules. They can be phagocytic. Some immature dendritic cells can also kill viruses immediately by secreting interferon alpha. After maturing, dendritic cells migrate to the blood stream, lymph nodes and spleen where they interact with other cells of the immune system such as B cells which make antibodies and natural killer cells which attack pathogens and infected cells. They present antigens to T cells thereby play a role in the specific immune response.

A dendritic cell is illustrated below



Dendritic cell

ASSIGNMENT: Briefly discuss the tissues and organs of the immune system.

INNATE IMMUNITY

Innate immunity consists of the defenses against infection that are ready for immediate action when a host is attacked by a pathogen (viruses, bacteria, fungi, or parasites). The innate immune system includes anatomical barriers against infection—both physical and chemical—as well as cellular responses. The main **physical barriers**—the body's first line of defense—are the epithelial layers of the skin and of the mucosal and glandular tissue surfaces connected to the body's openings; these epithelial barriers prevent infection by blocking pathogens from entering the body. **Chemical barriers** at these surfaces include specialized soluble substances that possess antimicrobial activity

as well as acid pH. Pathogens that breach the physical and chemical barriers due to damage to or direct infection of the epithelial cell layer can survive in the extracellular spaces (some bacteria, fungi, and parasites) or they can infect cells (viruses and some bacteria and parasites), eventually replicating and possibly spreading to other parts of the body. The **cellular innate immune responses** to invasion by an infectious agent that overcomes the initial epithelial barriers are rapid, typically beginning within minutes of invasion. These responses are triggered by cell surface or intracellular receptors that recognize conserved molecular components of pathogens. Some white blood cell types (macrophages and neutrophils) are activated to rapidly engulf and destroy extracellular microbes through the process of **phagocytosis**. Other receptors induce the production of proteins and other substances that have a variety of beneficial effects, including direct antimicrobial activity and the recruitment of fluid, cells, and molecules to sites of infection.

This influx causes swelling and other physiological changes that collectively are called **inflammation.** Such local innate and inflammatory responses usually are beneficial for eliminating pathogens and damaged or dead cells and promoting healing.