EDO UNIVERSITY, IYAMHO
Department of Microbiology

MCB 316: Immunology

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Lecture Period and Venue: Monday, 11:00am–12:00pm; Wednesday, 10:00am–12:00pm, ML 1.
Office hours: Tuesday, 1pm - 4pm, Thursday, 1pm - 4pm, Friday, 8am – 1pm.
Office: New Faculty of Science Block, Rm B2.

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; cellular 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.

Learning outcomes: At the completion of this course, students are expected to:

(i) Recognize the features of the cells, tissues and organs of the immune system.
(ii) Be able to differentiate between innate and acquired immunity.
(iii)Understand the roles of antigens and antibodies.
(iv)Be acquainted with Immunological tolerance and suppression, Surgical grafting, Complement System, Hypersensitivity, Immunological anomalies, Diagnostic immunology, Vaccines, effector systems of parasite killing and nature of resistance in plants.

Assignments: There shall be a minimum of 3 assignments throughout the course in addition to a Mid-Term test 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, 10% for participation in oral presentations, 10% for the midterm test and 70% for the final exam. The Final exam is comprehensive.

***Recommended Textbooks**:
(1.) NESTER'S MICROBIOLOGY by Nester *et al*. 5th Edition. Jaypee Publishers.
(2.)BROCK BIOLOGY OF MICROORGANISMS by Madigan *et al*., 14th Edition. Pearson Education Inc.

(3.) KUBY IMMUNOLOGY by Owen, Stunt and Stranford. 7th Edition. W. H. Freeman and Company.
(4.) 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.

CELLULAR IMMUNITY

- Cellular immunity (also known as Cell-Mediated immunity) is an adaptive immune response that is primarily mediated by thymus-derived small lymphocytes (T cells).
- There are **two classes** of T cells:
- **T helper** cells and **T killer** cells.

(1.) **T HELPER** CELLS (T_HCells):

- They are particularly important because they maximize the capabilities of the immune system.
- They do not destroy infected cells or pathogens, but they activate and direct other immune cells to do so, hence are called T helper cells.
- Their major roles are to **stimulate B cells** to secrete antibodies, to **activate phagocytes**, to **activate T killer cells** and to **enhance the activity of natural killer cells**.
- Another term for T helper cells is $CD4^+$ cells because they express the surface protein CD4.
- T helper cells are subdivided on the basis of the cytokines they secrete after encountering a pathogen:

➢ **T Helper 1 cells** (TH1 cells) and **T Helper 2 cells** (TH2 cells)

- T Helper 1 cells (TH1 cells) secrete many different types of cytokines, the principal being **interferon gamma** (IFN-ϒ), **interleukin-2** (IL-2) and **interleukin-12** (IL-12).
- IFN-ϒ has many effects including activation of macrophages to deal with intracellular bacteria and parasites.
- IL-2 stimulates the maturation of killer T cells and enhances the cytotoxicity of NK cells.

- IL-12 induces the secretion of INF-ϒ
- The principal cytokines secreted by **T Helper 2 cells** (TH2 cells) are **interleukin-4** (IL-4) and **interleukin-5** (IL-5) for helping B cells.
- An infection with the human immunodeficiency virus (HIV) demonstrates the importance of helper T cells. The virus infects $CD4^+$ cells.
- During an HIV infection, the number of $CD4^+$ cells drops, leading to the disease known as the acquired immune deficiency syndrome (AIDS).

(2.) <u>T KILLER</u> <u>CELLS (T_KCells)</u>:

- The major function of *T killer cells* is cytotoxicity to recognize and destroy cells infected by viruses, but they also play a role in the defence against intracellular bacteria and certain types of cancers.
- Intracellular pathogens are usually not detected by macrophages and antibodies, and clearance of infection depends upon elimination of infected cells by cytotoxic lymphocytes.
- T killer cells are specific, in the sense that they recognize specific antigens.
- Alternative terms for T killer cells are $CD8^+$ T cells (CD8 positive T cells), cytotoxic T cells and CTLs (cytotoxic T lymphocytes).
- $CD8^+$ T cells secrete INF and the inflammatory cytokine tumour necrosis factor (TNF).

ASSIGNMENT
Discuss Immunological Tolerance And Suppression.

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.

(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.

(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.

(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.

(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.

ASSIGNMENT: HIGHLIGHT ALL YOU KNOW ABOUT INNATE IMMUNITY.