

**GENERAL ELECTIVE (BIOMED-GE- ): HEALTH AND BODY DEFENSE SYSTEM**

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Health and Body Defense System	4	3	-	1	XII Passed	Basic knowledge of Biology

**Learning Objectives**

The Learning Objectives of this course are as follows:

- Characteristics of a healthy body and ways to improve one's health and well-being.
- Body defense system is a comprehensive study of the organization and functioning of the immune system with its network of cells and molecules. Understanding the biology of the immune system is key to developing strategies towards prevention and cure to a number of disorders and diseases that result due to malfunctioning and dysregulation of the immune system.
- This paper covers the organization and functioning of the various branches of immune system, namely, Innate and adaptive Immunity to combat different pathogens. Various Immunological techniques will also be taught to the students.

**Learning outcomes**

The Learning Outcomes of this course are as follows:

- Students learn various aspects of health and immune system in normal and infectious stage which equips students to design better strategies for combating the immunological disorders. Students will be given an overview to various pathogens and immune system in Invertebrates and Vertebrates.
- Students learn historical perspective of the extensive field of Immunology. They are introduced to the important concepts of Immunology.

- Students will be familiarized with origin and maturation of all blood cell types in bone marrow and thymus. They will understand the process of haematopoiesis, functions of various types of cells and roles played by them in generating immune responses against pathogens.
- The unit entails different barriers of Innate Immunity, Cells, Complement system, Patterns on the pathogens recognized by receptors of Innate Immune system, pathogen killing by the immune cells and concept & the importance of the Inflammation in an Immune response.
- Students will learn about the cells of adaptive immune system, the concept of antigen, antibody molecules and role of major histocompatibility complex & associated cells in the processing and presentation of antigen. The students will explore the branches of adaptive immunity - the humoral and cell mediated, their components and interplay of these components in combating the infection. The students will also be able to understand the significance of various kinds of growth factors and cytokines in the activations of various lymphocytes
- The students will be given knowledge about the principle, methodology and applications of various laboratory techniques involving antigen-antibody reaction.
- Vaccine based immunotherapies and their designing will assist them to think about new path for combating with pathogens and working mechanisms of immune system.
- The students will be made aware about the importance of diet and lifestyle in promoting Immunity and health.

## **SYLLABUS**

### **Unit I: Hallmarks of Health**

**(03 Hrs)**

Basic aspects of healthy body: Cells, Tissue and Organ system, difference between prokaryotes and eukaryotes. Key differences between bacteria, fungi, protozoans and viruses.

Requirements for a healthy body according to age and gender. Survival strategies of host against the invading pathogens: bacterial defense against bacteriophage, immune system of Plants, invertebrates (Mollusca) and vertebrates

### **Unit II: Introduction to Immune system:**

**(03 Hrs)**

Historical background, general concepts of the immune system, innate and adaptive immunity; active and passive immunity.

### **Unit III: Organization of Immune System:**

**(03 Hrs)**

Lymphoid Organs: thymus, bone marrow and haematopoiesis, lymph nodes, spleen.

#### **Unit IV: Innate Immune response**

**(08 Hrs)**

- Physical and Chemical barriers
- Cells of the innate immune system: Natural Killer cells, monocytes and macrophages; neutrophils, eosinophils, basophils, mast cells and dendritic cells: Structure, Phenotypic and functional aspects.
- Complement system: Components of the complement activation classical, alternative and lectin pathways; biological consequence of complement activation.
- Mechanisms of pathogen killing by macrophages and neutrophils: Receptor/non receptor mediated endocytosis, phagosome formation, phagolysosome formation, respiratory burst phenomenon, basic pathways of oxygen dependent and oxygen independent killing mechanism.
- Inflammation: concept, hall marks of inflammation.

#### **Unit V: Adaptive Immune Response**

**(10 Hrs)**

- Cells of the adaptive immune system: T and B lymphocytes
- Characteristics of adaptive immune response: self and non-self recognition, specificity, diversity and memory, primary and secondary immune response, allergen/ allergy.
- Antigens: antigenicity and immunogenicity, haptens. Properties (foreignness, molecular size, heterogeneity, route and dose of administration, solubility and degradability); host factors (genotypes, gender, nutrition) Blood group antigens and transfusion reactions.
- Basic function of Major Histocompatibility Complex
- Importance of Antigen presentation
- Types of antibodies and their function,
- Cell mediated immune response: Major steps in T cell differentiation in thymus: thymic selection, self MHC restriction, T cell receptor assembly. Phenotypic characteristics of naïve T-cells (CD4<sup>+</sup> and CD8<sup>+</sup> T-cells). Migration of naïve T-cells from thymus to secondary lymphoid organs. Activation of T-cells, proliferation of clonally selected T cells and their effector functions, concepts of T-helper 1 (TH<sub>1</sub>) and T-helper 2 (TH<sub>2</sub>) cells. Basic introduction to cytokines: IL-2, IL-4 and IFN-γ

- Contribution of MHC, B-cell receptor (BCR) and T-cell receptor (TCR) to diversity in adaptive immune response

#### **Unit VI: Immunological Principles of Various Reactions and Techniques (05 Hrs)**

Basic concepts of antigen-antibody interactions (epitope-paratope), Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immune-electrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), western blotting, immunofluorescence microscopy, immunohistochemistry and lateral flow assay.

#### **Unit VII: Vaccines and Immunotherapeutics (04 Hrs)**

Contributions of Sir Edward Jenner and Louis Pasteur in vaccine development; Major types of vaccine and their characteristics, importance of adjuvants in the development of artificial and active immunity. The concept of passive immunity and immunotherapeutics (Plasma therapy in COVID-19, anti-rabies therapy, anti-toxin therapy), National immunization programme

#### **Unit VIII: Diet, Nutrition and Life style in promoting health and Immunity (09 Hrs)**

Importance of a well- balanced nutrition, the role of Immunity boosters and immunomodulators from kitchen shelf (curcumin , ginseng, lycopene & Giloy), vitamins (Vitamin A, B, C, D and Vitamin B12) and minerals (Zn) in improving health and defense. Role of probiotics, gut microbiota and prebiotics in regulating health and immunity. Role of physical activity and emotional & Mental state in regulation of Immunity status, holistic health and happiness. A primer on our traditional practices, yogic lifestyle and meditation in creating homeostasis in the body (balancing Vatta, Pitta and Kapha) will also be given.

#### **Practical component (30 Hours)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Visualization of antigen-antibody interaction or To perform Immuno-diffusion by Ouchterlony method
2. To perform Immuno-diffusion by Mancini Method
3. To perform Complement fixation assay
4. To perform sandwich dot ELISA
5. To perform Widal test (Indirect/passive agglutination) for the detection of typhoid antigen and blood group determination (direct agglutination)

6. To perform SARS-CoV-2 Rapid Antigen Test(Lateral flow Assay)
7. Project work based on historical research work in the area of immunology.
8. Case studies on hypersensitivity reactions(seafood hypersensitivity, Erythroblastosis Fetalis)

#### **Essential readings:**

- Punt, J. Stranford, S. Jones, P. and Owen, J. (2019). 8<sup>th</sup> Edition. *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN- 13: 978-1464189784.
- Delves, P.J. Martin, S.J. Burton, D.R. and Roitt, I. M. (2017). 13<sup>th</sup> Edition. *Roitt's Essential Immunology*. New Jersey, USA: Wiley-Blackwell Science. ISBN: 13: 978- 1118415771.

#### **Suggestive readings:**

- Ananthanarayan R and Jayaram Paniker CK (Author), Reba Kanungo (Editor) (2020) Ananthanarayan and Paniker's Textbook of Microbiology, Eleventh Edition. Universities Press (India) Pvt. ISBN **9389211433**
- Practical Ayurveda: Find Out Who You Are and What You Need to Bring Balance to Your Life Paperback – 5 June 2018 by Sivananda Yoga Vedanta Centre. Publisher : DK; Illustrated : edition (5 June 2018) ISBN-10 : ISBN-13 ,1465468498 978-1465468499.
- Willey, J. Sherwood, L and Woolverton, C.J. (2016). 10<sup>th</sup> Edition. *Prescott's Microbiology*. New York, USA: McGraw-Hill Education. ISBN-13:978-1259281594.
- Satomi Oshima; Zhen-Bo Cao; Koichiro Oka (2015) 'Physical Activity, Exercise, Sedentary, Behavior and Health' Springer Tokyo Heidelberg New York Dordrecht London ISBN 978-4-431-55333-5 (eBook)
- Guglielmo M Trovato (2012) Behavior, nutrition and lifestyle in a comprehensive health and disease paradigm: skills and knowledge for a predictive, preventive and personalized medicine. Trovato EPMA Journal 2012, 3:8 (Review Article)
- Kindt T. J., Osborne B. A. , Goldsby R. A. (2007). 6th Edition *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN-13: 978-1429202114 ISBN-10: 1429202114.
- Hay, F.C. and Westwood, O.M.R. (2002). 4<sup>th</sup> Edition. *Practical Immunology*. New Jersey, USA: Blackwell Science. ISBN:9780865429611
- BYG-002 Yoga and Health, Block 4 Yogic Lifestyle, School of Health Science, Indira Gandhi National Open University (<https://drive.google.com/file/d/10j00rWXLsCEV5cTbzK-hM43ezlNvn0hl/view>)