25BIO804 Infectious disease immunology 2 1 0 3

Course Description: This course explores the complex interplay between the immune system and infectious pathogens, highlighting both protective responses and mechanisms of immune evasion. It covers innate and adaptive immunity, pathogen-induced cell death, epigenetic regulation, and macrophage polarization. Emphasis is placed on translational aspects, including cytokine therapy, immune modulation, CAR-T cell approaches, and vaccine strategies. The course bridges basic immunology with cutting-edge applications in infectious disease prevention and therapy

Learning Objectives: This module focuses on modern applications of immunology in managing infectious diseases. It covers cytokine therapies (e.g., IFN-γ, IL-2, IL-7), immune checkpoint modulators, and epigenetic drugs as host-directed therapies (HDTs). The potential and current use of CAR-T cell therapy in infectious diseases like HIV is discussed. The module also provides a comprehensive overview of vaccines—including traditional (live, inactivated, subunit), and modern platforms (mRNA, viral vectors, nanoparticle-based)—with a focus on immunological mechanisms, adjuvants, and mucosal immunity. Concepts like vaccine-induced immune memory, herd immunity, and trained immunity-based vaccines are emphasized.

Pedagogy: The pedagogy adopted will be lecture classes as well as active learning methods such as student presentations of recent research papers relevant to the syllabus.

Module 1: Host Immune Responses

Cellular and molecular mechanisms of host defense against pathogens. Roles of innate and adaptive immunity, including PRRs, cytokine signalling, antigen presentation, and lymphocyte activation. Macrophage polarization (M1/M2 phenotypes) and their distinct roles in infection control and immune modulation. Epigenetic regulation of immune responses, including histone modifications, DNA methylation, and non-coding RNAs, particularly in shaping innate memory and adaptive immune tolerance during infection.

Module 2: Pathogen-Induced Cell Death and Immune Evasion

How pathogens manipulate host defense mechanisms to survive and persist. Various forms of infection-induced cell death—including apoptosis, pyroptosis, necroptosis, ferroptosis, and autophagy—and their consequences for immune response and tissue damage. Key immune evasion strategies employed by pathogens, such as suppression of antigen presentation and hijacking of epigenetic processes, are discussed using examples like HIV, *Mycobacterium tuberculosis*, and Salmonella. The dual role of autophagy as an antimicrobial and pathogen subversion pathway is also emphasized.

Module 3: Immunotherapeutics and Host-Directed Therapies and Vaccines
Modern applications of immunology in managing infectious diseases. Cytokine therapies (e.g., IFN-γ, IL-2, IL-7), immune checkpoint modulators, and epigenetic drugs as host-directed therapies (HDTs). T-cell based immunotherapies, Potential and current use of CAR-T cell therapy in infectious diseases like HIV is discussed. The module also provides a comprehensive overview of vaccines—including traditional (live, inactivated, subunit), and modern platforms (mRNA, viral vectors, nanoparticle-based)—with a focus on immunological mechanisms, adjuvants, and mucosal immunity. Concepts like vaccine-induced immune memory, herd immunity, and trained immunity-based vaccines are emphasized.

Reference

Janeway's Immunobiology
Authors: Kenneth Murphy, Casey Weaver
Edition: 10th Edition (2022)
Publisher: W. W. Norton & Company
ISBN: 978-0393884913

Cellular and Molecular Immunology
Authors: Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai
Edition: 10th Edition (2021)
Publisher: Elsevier
ISBN: 978-0323757485

Immunology of Infectious Diseases
Authors: Stefan H. E. Kaufmann, Alan Sher, Rafi Ahmed
Edition: 1st Edition (2002)
Publisher: ASM Press (American Society for Microbiology)
ISBN: 978-1555812534

Kuby Immunology
Authors: Jenni Punt, Sharon Stranford, Patricia Jones, Judith A. Owen
Edition: 9th Edition (2023)
Publisher: Macmillan Learning
ISBN: 978-1319511479

Course Outcomes

Analyze immune responses to infectious agents and explain how immune cells, cytokines, and epigenetic mechanisms coordinate host defense and pathogen clearance.
Evaluate pathogen-induced cell death pathways and immune evasion strategies with relevance to disease progression and therapeutic targeting.
Apply knowledge of immunotherapy and vaccines to propose or assess host-directed interventions such as cytokine therapy, CAR-T cells, and novel vaccine platforms for infectious disease management.