COURSE OF STUDIES

for

Doctor of Philosophy

in

<Immunology>

UNIVERSITY OF HEALTH SCIENCES, LAHORE PAKISTAN

Program Rationale:

The immunology program aims at developing knowledge and providing basic and clinical research and learning opportunities in the field of immunology. Students of this program will be able to enhance their critical thinking, practical, and analytical skills which will help them become good researchers.

Mission Statement:

The mission of an immunology program is to educate students about the principles and concepts of immunology, enabling them to understand the immune system's complexities and its impact on human health and disease.

Program Educational Objectives:

1. To provide students with a strong foundation that emphasizes applying the fundamental and clinical principles of Immunology.
2. To equip the students with laboratory instruments and techniques for basic and applied research and develop interdisciplinary research expertise.
3. To develop competencies in assimilating scientific information, writing, research execution, and data presentation on scientific forums.
4. Develop and practice transferable skills during the practicals, including teamwork, software applications, and data analysis.
5. To provide students with skills to enter the workplace well-prepared in the core competencies of the discipline.

Program Learning Outcomes:

1. **Knowledge:** Students will gain a deep understanding of immunological concepts and mechanisms.

2. **Critical thinking:** Students will develop skills of critical thinking to analyze immunological clinical data, evaluate research findings, and apply knowledge in practical scenarios.
3. **Research skills:** Students will learn to design, conduct, and present immunological research data, contributing to the advancement of the field.
4. **Clinical applications:** Students will understand the lab diagnosis and report interpretation for the management of immune-related diseases.
5. **Collaboration:** Students will develop skills to work effectively with interdisciplinary teams, fostering communication and collaboration between researchers and clinicians.
6. **Career readiness:** Students will be prepared for careers in academia and healthcare.
7. **Lifelong learning:** Students will develop a foundation for continued learning, staying current with emerging trends, technologies, and discoveries in immunology.

Compulsory Teaching Skills

For a thorough evaluation of students' understanding and critical thinking abilities, all PhD students in their respective disciplines will;

1. Design a comprehensive set of 50 Multiple Choice Questions (MCQs) and 25 Short Essay Questions (SEQs) for M. Phil students.

2. Plan 20 observed lectures focusing on key topics.

These assessments will provide Ph.D. students valuable experience in educational design and delivery. These will also enhance their interactive learning with the provision of real-time feedback.

SCHEME OF STUDIES (3-Year)

PhD (Immunology)

Semester #	Course code	Course title	Credit hours		
			Theory	Practical	Total
1		Research Methodology	2	0	02
		Advance Biostatistics	2	0	02
		a) Fundamentals of Immunology b) Bioethics, biosafety and biosecurity	2 1	1 1	05
2		Advanced Laboratory Techniques			02
		a) Immunological basis of	2 2	1 1	07

		disease b) Immunopharmacology and immunotoxicology c) Epigenetics and immune modulation	1	0	
3	Research (thesis)		30		30
				(Total: 48)	

Course Title: Fundamentals of Immunology

Contact Hours: 5

Theory = 2

Practical =3

Total = 5

Credit Hours: 2+1

Theory = 2

Practical = 1

Total = 3

Course Objective:

In this course, students will be introduced to the fundamental concepts of innate and adaptive immunity.

Learning Outcome:

At the end of this course, students will be able to have a comprehensive understanding of:

1. Components and functions of the innate and adaptive immune system.
2. Recognition of the antigen by the innate immune system and mounting of effector immune responses.
3. Characteristics of antigens.
4. Development and maturation of lymphocytes in the bone marrow.
5. Generation of diverse antibody repertoire.
6. Properties and effector functions of antibodies during primary and secondary immune responses.
7. Processing and presentation of antigens by antigen-presenting cells to T cells.
8. Different types of T cell receptors.
9. Effector T cells and their functions.
10. MHC/HLA genes and their diversified products.
11. Immune regulation and orchestration by various cytokines.
12. Signal transduction mechanisms in the immune receptor activation

Course Outline:

Overview of the immune system, Cells, organs and microenvironments of the immune system, B cell and T cell receptor signalling, Cytokines and chemokines receptor signalling, Innate immunity, complement system, Organization and expression of lymphocyte receptor genes, The major histocompatibility complex and antigen presentation, T-cell development, B-cell development, T-cell activation, differentiation, and memory, B-cell activation, differentiation, and memory generation, Effector

responses: Cell-and antibody-mediated Immunity, The immune response in space and time

Practicals:

- Agglutination tests (CRP, RF, ASOT, Widal test, Immunochromatographic tests)
- Precipitation test and Nephelometry
- Spectrophotometry
- ELISA
- Immunophenotyping by Flow cytometry
- Clinical results interpretation skills

Recommended Books (Latest Editions):

- Virella Gabriel Medical Immunology, 7th Edition
- Janeway's Immunobiology 9th ed.
- Essentials of Clinical Immunology by Mansel Haeney, Neil Snowden, Siraj A. Misbah, Helen Chapel, 6th Edition
- Medical Immunology, by Parslow, Tristram G., Stites, Daniel P 10th Edition
- Manual of Molecular and Clinical Laboratory Immunology. Editor(s): Barbara Detrick, John L. Schmitz, Robert G. Hamilton. 2016
- Immunology, A Short Course, Fourth Edition Eli Benjamini, Richard Coico, and Geoffrey Sunshine
- Roitt's Essential Immunology, 13th edition
- Kuby Immunology, 8th edition

Course Title: Bioethics, Biosafety and Biosecurity

Contact Hours: 4	Credit Hours: 1+1
Theory = 1	Theory = 1
Practical = 3	Practical = 1
Total = 4	Total = 2

Course Objective:

In this course, students will be introduced to the fundamental concepts of bioethics, biosafety and biosecurity

Learning Outcome:

At the end of this course, students will be able to have a comprehensive understanding of:

- list the routes of exposure for a pathogen to a human being
- demonstration and assess the proper use of PPE, best practices, biological containment, and be prepared to conduct research safely
- identification of the role of the Biosafety Professional in Biomedical Research Laboratories
- ethical considerations in research

Course Outline:

Science Ethics and Values, Attitudes to science, The development of ethics, The growth of bioethics, Bioethics in 21st century, Making ethical decisions, The place of human in nature, Valuing the Environment, Themes in environmental ethics, Current issues in environmental ethics, The ethics of animal research, code of ethics for biologist, Patient-physician relationship, patient rights and responsibilities, informed consent, Patients advance directives, Management of information, Problems of moral justification, Refusal of treatment, Ethics and genetic modification, Biotechnology and risk factors, Human genome project, Genetic diagnosis, screening, discrimination, counselling, Stem-cell debate, Biosafety, Biosecurity, Bioweapons, Biohazard, Lab safety protocols, Classification of pathogens, Containment, Safe handling of biological spills, Sterilization and disinfection, Biohazards-animal handling, Handling of lab equipment, Report of accidents, Water disposal, Lab biosafety level criteria, Biosafety level 1, Biosafety level 2, Biosafety level 3, Biosafety level 4, Biosafety measures for TB lab, Safety Equipment, Personal Protective Equipment, Plans for Emergency, Transport of Infectious Material, Hazardous chemicals, Fire Hazard, Electrical Hazards, Ionizing radiation, Biosafety officer, Biosafety committee, Safety for support staff, Safety checklist, WHO biosafety collaborating centers, Biosecurity legislations, regulations, and guidance, Design biosecurity plan, Objectives of lab biosecurity, Biosecurity and bioterrorism, Pakistan biosecurity system, Risk assessment methodology, Evaluate pathogens and toxins, Evaluate scenarios, Components of biosecurity, Physical security, Physical security elements, Integration with lab biosafety, Personnel security, Personnel security elements, Transport Security, Information Security, Biosafety Rules for Virology Labs,

Fire Extinguishers, Fire Exit, National Biosafety Rules, Efforts to mitigate Biological threats, High Containment biological Labs, Public participation and Access to information, International framework on Biosafety

Practicals:

- Demonstration of hand washing and hand rubbing technique.
- Demonstration of cleaning and disinfection of working premises.
- Demonstration of cleaning and disinfection of biosafety cabinets.
- Demonstration of how to handle spills and aseptic handling.
- Management of needle prick injury
- Emergency response exercise
- Donning and doffing of PPEs
- Discussion on case scenarios

Recommended Books (Latest Editions):

- Biosafety Resource Book: risk analysis, Module C, Food and Agriculture organization of the United Nations Rome, 2011
- Laboratory biosafety manual, Latest edition, World Health Organization, Geneva,
- Biosafety in Microbiological and Biomedical Laboratories, 5th Edition, U.S. Department of Health and Human, CDC

Course Title: Immunological basis of disease

Contact Hours: 5 Credit Hours: 2+1

Theory = 2	Theory = 2
Practical = 3	Practical = 1
Total = 5	Total = 3

Course Objective:

In this course, students will be introduced to the fundamental concepts of hypersensitivity, tolerance, autoimmunity, immunodeficiency, infection and immunity, transplantation, and immunity against tumours. Besides they will be introduced to methods involved in the clinical immunology labs.

Learning Outcome:

At the end of this course, students will

1. Understand the principles of immunological testing and interpretation

2. Identify and diagnose immunological disorders, such as autoimmune diseases and immunodeficiencies

3. Gain knowledge of immunological mechanisms to understand disease pathogenesis

4. Interpret laboratory results, including serology, molecular diagnostics, and flow cytometry

5. Understand the clinical applications of immunological tests, including allergy testing

6. Develop skills in critical thinking and problem-solving in diagnostic immunology

7. Integrate knowledge of immunology and laboratory medicine to diagnose and manage diseases

8. Understand the limitations and pitfalls of immunological testing

9. Apply evidence-based medicine to diagnose and manage immunological disorders

10. Communicate effectively with patients, families, and healthcare professionals regarding immunological disorders and test results.

Course Outline:

Allergy, Hypersensitivities, Chronic Inflammation, Tolerance, Autoimmunity, and Transplantation, Infectious Diseases and Vaccines, Immunodeficiency Disorders, Cancer and the Immune System, Experimental Systems and Methods

Practicals:

- Integration strategies to implement MSDS guidelines in laboratory settings and research laboratory
- Skills to report and interpret lab reports generated in the Immunology lab
- Radial Immunodiffusion for microbial antigens
- Ouchterlony double diffusion to identify fungal antigen (*Candida*)

- Anti Streptolysin O Titer
- Detection of HBsAg by ELISA
- HLA Typing
- Mixed lymphocyte reactions for transplantation
- Luminex assay demonstration
- Immunophenotyping by Flow Cytometry for B cells, T cells, and Natural killer cells
- Serum protein electrophoresis
- Immunophenotyping of leukemias
- Skin prick test for allergens
- Measurement of immunoglobulins
- Fluorescent staining for deposition of immune complexes
- Antinuclear antibodies (ANA) in SLE patients
- Double-stranded DNA in SLE Patients
- Slide agglutination test for the detection of rheumatoid factor
- Anti-HCV antibody by ELISA
- Rocket Immunoelectrophoresis to quantitate immunoglobulins
- Immunoelectrophoresis for the detection of myelomas, Waldenström's macroglobulinemia, malignant lymphomas
- Immunofixation electrophoresis for Waldenström's macroglobulinemia and multiple myeloma
- Direct immunofluorescence assay
- Indirect immunofluorescence assays for autoimmune diseases
- Western blot for identification of HIV antigens

Recommended Books (Latest Editions):

- Virella Gabriel Medical Immunology, 7th Edition
- Janeway's Immunobiology 9th ed
- Essentials of Clinical Immunology by Mansel Haeney, Neil Snowden, Siraj A. Misbah, Helen Chapel, 6th Edition

- Medical Immunology, by Parslow, Tristram G., Stites, Daniel P 10th Edition
- Manual of Molecular and Clinical Laboratory Immunology. Editor(s): Barbara Detrick, John L. Schmitz, Robert G. Hamilton. 2016
- Immunology, A Short Course, Fourth Edition Eli Benjamini, Richard Coico, and Geoffrey Sunshine
- Roitt's Essential Immunology, 13th edition
- Kuby Immunology, 8th edition

Course Title: Immunopharmacology and immunotoxicology

Contact Hours: 5	Credit Hours: 2+1
Theory = 2	Theory = 2
Practical = 3	Practical = 1
Total = 5	Total = 3

Course Objective:

Students will be introduced to the immunopharmacological and immunotoxicological concepts concerning hypersensitivity, autoimmunity, transplantation, and tumours.

Learning Outcome:

At the end of this course, students will be able to:

1. Understand the basic principles of immunology and pharmacology.
2. Describe the different types of immune responses and how they are affected by pharmacological agents.
3. Explain the mechanisms of action of various immunopharmacological drugs, including immunosuppressants, immunomodulators, and immunostimulants.
4. Discuss the clinical applications of immunopharmacological drugs in various diseases and conditions, such as autoimmune disorders, transplant rejection, and cancer
5. Analyze the potential benefits and risks of immunopharmacological interventions, including side effects and toxicities.

Course Outline:

Immune Dysfunction and Basic Toxicology Review, Immunotoxicological methods, mechanisms Occupational Immunotoxicological drugs, including immunosuppressants, immunomodulators, and immunostimulants, potential benefits and risks of immunopharmacological interventions, Monoclonal antibodies as therapeutic agents, Chemicals Related to Autoimmunity, Chemicals Related to Hypersensitivity, Chemicals Related to Transplantation, Chemicals Related to tumours, Chemicals Related to neuroimmunoendocrinology, Immunosuppression I: Intentional Modulation of the

Immune System, immunosuppression II: Benzene, Immunosuppression III: Dioxin, other immunosuppressive compounds, Immunopharmacology, Immunomodulation by Edible Thing, Immunotoxicological Data in Risk Assessment, Immunogenetics and Immunotoxicity Susceptibility, Endocrine/Immune Interactions, Neuro/Immune Interactions, Occupational Immunotoxicology, Asthma and the Environment.

Practicals:

- Isolation of immune cells (e.g., T cells, B cells, macrophages) from blood or tissue samples.
- *In vitro* assays (e.g., ELISA, flow cytometry) to measure immune cell activation, proliferation, and cytokine production.
- Analysis of immune cell surface markers using flow cytometry or immunohistochemistry.
- *In vivo* experiments (e.g., mouse models) to study immune responses and immunopharmacological interventions.
- Measurement of immune-related biomarkers (e.g., cytokines, antibodies) in serum or tissue samples.
- Cell culture experiments to study the effects of immunopharmacological drugs on immune cells.
- Western blot analysis to study protein expression and signaling pathways in immune cells.
- PCR and qPCR analysis to study gene expression in immune cells.

- Immunofluorescence microscopy to study immune cell interactions and tissue architecture.
- Case studies and group discussions on immunopharmacological treatments for various diseases (e.g., autoimmune disorders, cancer).

Recommended Books (Latest Editions):

- Parnham MJ, editor. Nijkamp and Parnham's principles of immunopharmacology. Springer International Publishing; 2019 Dec 10.
- Vilvanathan S. Immunopharmacology. Introduction to Basics of Pharmacology and Toxicology: Volume 2: Essentials of Systemic Pharmacology: From Principles to Practice. 2021:1113-27.

Course Title: Epigenetics and immune modulation

Contact Hours: 1	Credit Hours: 1+0
Theory = 1	Theory = 1
Practical = 0	Practical = 0
Total = 1	Total = 1

Course Objective:

Students will be introduced to the basic concepts of epigenetics in health and diseases

Learning Outcome:

At the end of this course, students will be able to:

1. Describe the epigenetic mechanisms that regulate immune cell development, differentiation, and function.
2. Explain how epigenetic modifications influence immune responses and immune-related diseases.
3. Discuss the role of epigenetic regulators (e.g., histone-modifying enzymes, non-coding RNAs) in immune modulation.
4. Explain the influence of epigenetics in immune system-related pathologies

Course Outline:

Epigenetics, mechanisms in epigenetic regulation, chromatin biology, gene regulation, and current research of epigenetics in cell reprogramming, regenerative medicine, and disease, DNA Methylation, histone modifications, chromatin remodelling, epigenetic inheritance, epigenetics and disease, epigenetic therapies, computational epigenetics, epigenetic mechanisms that regulate immune cell development, differentiation, and function, epigenetics and trained immunity, epigenetic regulation of the immune response in transplantation, epigenetic modification and danger signaling in host inflammatory response, epigenetics and cancer

Recommended Books (Latest Editions):

- Handbook of epigenetics The New Molecular and Medical Genetics 3rd Edition - September 8, 2022 Editor: Trygve O Tollefsbol
- Introduction to Epigenetics Paro, Renato Grossniklaus, Ueli Santoro, Raffaella Wutz, Anton. 2021
- Zhang L, Lu Q, Chang C. Epigenetics in health and disease. Epigenetics in allergy and autoimmunity. 2020:3-55.

Compulsory Teaching Skills

For a thorough evaluation of students' understanding and critical thinking abilities, all PhD students in their respective disciplines will;

1. Design a comprehensive set of 50 Multiple Choice Questions (MCQs) and 25 Short Essay Questions (SEQs) for M. Phil students.

2. Plan 20 observed lectures focusing on key topics.

These assessments will provide Ph.D. students valuable experience in educational design and delivery. These will also enhance their interactive learning with the provision of real-time feedback.