# Cellular & Molecular Immunology

## First Semester

**CMI 5010 - Overview of the Immune System: 1 Credit**
**(Lectures - 15 h)**

- **Intended Learning Outcome**
  After successfully completing this course students will be able to,
  - Describe the components of the immune system and their respective roles in immunity
  - Define and compare the structure and function of primary, secondary and tertiary lymphoid tissues and organs

- **Course Content**
  Introduction to the immune system, innate and adaptive immunity, general properties of the immune responses, introduction to cellular and molecular immunology, cells, tissues and organs of the immune system, hematopoiesis, cells of the immune system; granulocytes, lymphocytes, antigen presenting cells; dendritic cells and mononuclear phagocytes etc.

  Anatomy and functions of primary, secondary and tertiary lymphoid tissues (bone marrow, thymus, lymph nodes and lymphatic system, spleen, cutaneous associated lymphoid tissue, and mucosal associated lymphoid tissue)

  Evolution of immunity, variations on anatomical themes, plant innate immune responses, evolution of recombined lymphocyte receptors, MHC diversity

- **Reference materials**
  *Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
  *Immunology*, Male et al, Elsevier Ltd, Philadelphia, USA
  *Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
  *Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
  *Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

- **Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 20% |
| End of Semester Examination | 80% |

**CMI 5020 - Molecular Immunology: 3 Credits**
**(Lectures - 30 h & Practical classes, Assignments & Tutorials - 30 h)**

- **Intended Learning Outcome**
  After successfully completing this course students will be able to,
  - List the molecules of the immune system and describe their respective roles in immunity
  - Describe the origin, structure and function of immunoglobulins
  - Explain the principles of standard methods used in antibody cloning and engineering
  - Describe the involvement of receptors and signaling molecules in immune mechanisms

- **Course Content**

  Molecules of the immune system (acute phase proteins, cytokines, chemokines, complement components, immunoglobulins), acute phase proteins: C-reactive protein, serum amyloid A, fibrinogen, mannose-binding lectin, Cytokines: properties of cytokines, cytokine receptors, cytokine antagonists, cytokine secretion, cytokine network, cytokine-related diseases and therapeutic uses, complement system: functions of complement, components, regulation of complement system, biological sequences and deficiencies), immunoglobulin structure and function, organization and expression of immunoglobulin genes, monoclonal antibodies, antibody cloning and engineering

  Antigens, immunogenicity vs antigenicity, factors that influence immunogenicity, antigenic determinants, T and B epitopes, haptens

  Pattern recognition receptors

  B-cell Receptor, co-receptors

  Cell adhesion molecules, molecules of Ig superfamily, and accessory membrane molecules

  The Major Histocompatibility Complex (The general organization and inheritance, MHC molecules and genes, genomic map of MHC genes and MHC and disease susceptibility), structure and function of MHC class I and class II, mechanism of antigen processing and presentation

  T-cell Receptor: structure and roles of TCRs, organization and rearrangement of TCR genes, TCR-CD3 complex, alloreactivity of T cells

- **Reference materials**

  *Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
  *Immunology*, Male et al, Elsevier Ltd, Philadelphia, USA
  *Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
  *Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
  *Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

- **Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

**CMI 5030 - The Immune Response: 2 Credits**
**(Lectures - 30 h)**

- **Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe the components of innate and adaptive immune systems
- Discuss how the innate and adaptive immunity protects the host from infections

- **Course Content**

  Innate immunity, innate immune response, features and components of the innate immune system; barriers; anatomic, physiologic, phagocytic & inflammatory, circulating effector cells, circulating effector proteins and cytokines, Toll-like receptors

  Inflammation, mediators of inflammation, role of innate immunity in local and systemic defense against microbes and role of innate immunity in stimulating adaptive immune responses

  Pathways and mechanisms of lymphocyte recirculation and homing, recirculation of naive T lymphocytes and B lymphocytes, & migration of lymphocytes to sites of inflammation

  Adaptive immunity, T-cell maturation, activation and differentiation, B-cell generation, activation and differentiation, regulation of B-cell development & immune effector functions

  Effector mechanisms of Cell-Mediated immunity and Humoral immunity

  Collaboration between innate & adaptive immunity and regulation of the immune effector response, immunological tolerance

- **Reference materials**

  *Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
  *Immunology,* Male et al, Elsevier Ltd, Philadelphia, USA
  *Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
  *Immunobiology,* Janeway et al, Garland Science, Taylor & Francis Group, LLC
  *Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

- **Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

**CMI 5040 - Immunological Techniques-1: 8 Credits**
**(Practical classes, Assignments & Tutorials - 240 h)**

- **Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe the fundamentals of immunological techniques
- Demonstrate practical skills in immunological techniques
- Analyze and interpret the results

- **Course Content**

General immunological techniques: sterile techniques & biosafety aspects, preparation of buffers, reagents & culture media, separation of serum & plasma, partial purification and quantification of immunoglobulins, WBC: identification of cells, total and differential counts, primary & secondary lymphoid organs of rats/mice, assay for complement activity
Cell isolation and culture techniques: isolation of total human leukocytes, separation of human mononuclear cells and neutrophils, isolation of rat peritoneal cells and *in vitro* culture, *in vitro* culture of human leukocytes

Cell based assays/bioassays: assessments of cell viability & toxicity to leukocytes, *in vitro* assays for phagocytosis & neutrophil function, *in vivo* assay for anti-inflammatory activity, assay for anti-oxidant activity

**Reference materials**

*Practical Immunology - Hay and Westwood*

**Evaluation procedures**

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|---|---|
| Continuous Assessments | 40% |
| End of Semester Practical Examination | 60% |

**CMI 5050 - Guided Independent Study-1: 1 Credit**
**(Practical classes, Assignments & Tutorials - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Demonstrate competence in literature search pertaining to a given topic
- Appraise the available literature on previous studies, current status and future directions pertaining to a given topic

**Course Content**

Critical Appraisal of given study topics by literature search

**Evaluation procedures**

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|---|---|
| One-page brief report | 30% |
| Final Report | 70% |

## Second Semester

**CMI 5060 - Antigen-Antibody interactions: Principles and Applications and Immunological techniques : 2 Credits**
**(Lectures - 15 h & Practical classes, Assignments & Tutorials - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe the principles and compare different immunodiagnostic methods
- Evaluate the applications of immunodiagnostic techniques

**Course Content**

Basic structure of antigens and antibodies and their specific reactions, antibody affinity and avidity, cross reactivity

Immunoassays & immunodiagnosis, antigen-antibody interactions, (precipitation reactions, agglutination reactions, radioimmunoassay, ELISA, Western blotting, Immunoprecipitation, Immunofluorescence)

Identification of cell populations (Flowcytometry & fluorescence, Immunohistochemistry, Immunoelectronmicroscopy), isolation of cell populations (Fluorescent activated cell sorting (FACS), density-dependent centrifugations, panning)
Functional assays (Complement activity, phagocytic assay, lymphocyte proliferation, cytotoxicity assays, antigen stimulation assays, assays for antibody and cytokine production)

**Reference materials**

*Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
*Immunology*, Male et al, Elsevier Ltd, Philadelphia, USA
*Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
*Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
*Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

**CMI 5070 – Immunopathology: 1 Credit**
**(Lectures - 15 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe the immunological basis of autoimmune diseases and hypersensitivity
- Explain the principles of transplantation immunology
- Classify and compare different types of immunodeficiencies

**Course Content**

Autoimmune diseases (spectrum of autoimmune diseases, organ-specific and systemic autoimmune diseases, genetic factors and pathogenesis, animal models, aetiology, mechanisms of induction of autoimmunity and therapeutic approaches)
Transplantation Immunology (immunologic basis of graft rejection, clinical manifestations of graft rejection, general immunosuppressive therapy, immune tolerance to allografts, clinical transplantation)
Immunodeficiencies (primary immunodeficiencies: lymphoid immunodeficiencies, immuno-deficiency of myeloid lineage, defects in complement proteins, experimental models of immunodeficiencies, AIDS and other acquired or secondary immunodeficiencies)
Hypersensitivity (IgE-mediated (Type I) hypersensitivity, antibody-mediated (Type II) hypersensitivity, immune complex-mediated (Type III) hypersensitivity and Type IV or delayed-type hypersensitivity (DTH)

**Reference materials**

*Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
*Immunology*, Male et al, Elsevier Ltd, Philadelphia, USA
*Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
*Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
*Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 20% |
| End of Semester Examination | 80% |

**CMI 5080 - Immunity to Infectious Diseases: 2 Credits**
**(Lectures - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Compare immune mechanisms evoked by different pathogens
- Explain the immune evasion mechanisms of pathogens

**Course Content**

Immune mechanisms induced by microbes; immunity to extracellular and intracellular bacteria; mechanisms of immunity related to bacterial surface structures
First and second line defenses, antigen specific protective mechanisms
Immunity to viruses; innate immune responses, host defense involving B and T cells
Strategies for evading immune defenses
Immunopathology
Immunity to fungi, parasites (protozoans & nematodes), features of parasitic infections role of T cells in development of immunity

**Reference materials**

*Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
*Immunology,* Male et al, Elsevier Ltd, Philadelphia, USA
*Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
*Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
*Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

**CMI 5090 - Immunological Techniques-2: 5 Credits**
**(Practical classes, Assignments & Tutorials - 150 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe the fundamentals of immunological techniques
- Demonstrate practical skills in immunological techniques
- Analyse and interpret the results

**Course Content**

Indirect ELISA (Detection of anti-BSA antibodies), indirect ELISA (Detection of infectious diseases), ELISA–sandwich/reduction sensitive, immunofluorescence assay, assay for membrane stabilization activity, SDS-PAGE, staining and immunoblotting, Haemoagglutination assay. immunization and screening for immune responses

**Reference materials**

*Practical Immunology – Hay and Westwood*

**Evaluation procedures**

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|---|---|
| Continuous Assessments | 40% |
| End of Semester Practical Examination | 60% |

**CMI 5100 - Basic Molecular Biology and Bioinformatics: 1 Credit**
**(Lectures - 15 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Explain principles of basic Molecular Biology and recombinant DNA technology
- Discuss basic Bioinformatics tools

**Course content**

DNA replication in prokaryotes and eukaryotes, transcription and translation, introduction to recombinant DNA technology, introduction to DNA cloning, cloning vectors, construction of DNA molecules, genetic transformation, expression of cloned genes, overview of PCR technology and DNA sequencing, introduction to Bioinformatics

**Reference materials**

*Gene Cloning and DNA Analysis: An Introduction* - TA Brown

**Evaluation procedures**

Continuous Assessments 30%
End of Semester Examination 70%

**CMI 5110 - Guided Independent Study-2: 4 Credits**
**(Practical classes, Assignments & Tutorials - 120 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Review and appraise literature pertaining to a given study
- Design methodology for a given research question/topic
- Analyze, interpret and make conclusions on a given set of data/results

**Course Content**

Designing methodology for diagnosis of a given disease/ Immunological condition and interpretation of results generated from an analogous study.

**Evaluation procedures**

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|---|---|
| Report on literature review | 20% |
| Report on designing methodology | 30% |
| Final Report | 50% |

## Third Semester

**CMI 6010 - Research Project: 15 Credits**
**(Research 1500 h)**

**CMI 6010 Part I - Literature Review for Research Project**

**Intended Learning outcome**

After successfully completing this course students will be able to

- Review and appraise literature pertaining to the selected research question
- Design methodology for a given research question
- Demonstrate presentation and communication skills
- Demonstrate scientific writing skills

**CMI 6010 Part II - Research Project & Dissertation (will be continued in the 4th Semester)**

**Evaluation procedures**

Given under CMI 6010 Part II

**CMI 6020 - Special Topics: 1 Credit (15 L)**
**(Lectures - 15 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Discuss the applications and current trends in genetically modified organisms (GMO)
- Explain possible uses of transgenics in vaccine development
- Describe the principles of translational immunology

**Course Content**

Genetically modified organisms; history and production of GMO, uses and needs of GMOs and GM foods, development of transgenic crops, GM components in food production: labeling, consumer choice, regulation and testing of GMOs and GMFs.
Transgenic organisms and vaccine development; transgenic plants, edible vaccines for immunotherapy
Introduction to translational immunology

**Reference materials**

*Relevant Research articles*

**Evaluation procedures**

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|---|---|
| Report-I | 30% |
| Report-II | 70% |

**CMI 6030 - Immunomodulation: 3 Credits**
**(Lectures - 30 h & Practical classes, Assignments & Tutorials - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe immunotherapeutic applications
- Explain the basic principles of vaccination
- Compare and contrast different vaccine strategies
- Describe the regulatory mechanisms for vaccines used in Sri Lanka
- Describe the immunization and eradication/ elimination programs in Sri Lanka

**Course Content**

Immunotherapy
Vaccines: principles of vaccinology; active and passive immunization
Designing vaccines for active immunization: whole-organism vaccines, different types of antigens used as vaccines, purified macromolecules, recombinant vector vaccines, DNA vaccines and multivalent subunit vaccines
Safety and effectiveness of vaccines and vaccines of the future
Immunization programmes and eradication/ elimination programmes in Sri Lanka
Combination vaccines and Regulatory mechanisms in Sri Lanka
Immunization programmes in other regions & global vaccine initiatives

**Reference materials**

*Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
*Immunology,* Male et al, Elsevier Ltd, Philadelphia, USA
*Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
*Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
*Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA
Sri Lanka Medical association (SLMA) guidelines on vaccines

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

**CMI 6040 - Research Methodology, Biostatistics and Ethics: 3 Credits**
**(Lectures - 30 h & Practical classes, Assignments & Tutorials - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe different research methodologies
- Identify statistical techniques and demonstrate analytical skills
- Describe ethics in scientific research

**Course Content**

Formulating a research question; general and specific objectives; study designs
Conducting a literature review, validation and quality assurance of methodology
Descriptive statistics-presentation of data and numerical methods of describing data
Inferential statistics: sample/population concept, confidence intervals, formulating and testing a hypothesis, tests of significance: parametric and non-parametric, one sample tests, two sample tests, comparison of more than two groups, ethical issues in animal and human experimentation, informed consent and confidentiality ethical, legal and social implications of genetic research, genetic testing, genetic manipulations

**Reference materials**

*CIOMS Guidelines*
*Review Articles provided*

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 40% |
| End of Semester Examination | 60% |

**CMI 6050 - Advanced Immunological Techniques: 6 Credits**
**(Practical classes, Assignments & Tutorials - 180 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe the principles of advanced immunological techniques
- Demonstrate practical skills in advanced immunological techniques
- Analyse and interpret the results
- Design experiments and develop protocols

**Course Content**

Immunohistochemistry assay, flowcytometry & fluorescence, immunoprecipitation, Skin-prick test for hypersensitivity, protocol development, practical experience in hospital laboratory environment
Techniques in bacteriology (bacteria culture methods, serological and molecular diagnostics), mycology (diagnostics), virology (molecular diagnostics) and clinical immunology (allergy tests, diagnosis of immunodeficiencies and autoimmune diseases) laboratories at medical Research Institute

- **Reference materials**

*Practical Immunology – Hay and Westwood*

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 40% |
| End of Semester Practical Examination | 60% |

**CMI 6060 - Cancer Immunology and Cancer Genetics (Optional) : 2 Credits**
**(Lectures - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Explain genetic basis of cancer
- Discuss cancer diagnostics and therapies available
- Describe cancer antigens and explain the use of cancer markers

**Course Content**

Cancer: origin and terminology & malignant transformation of cells, overview of cell cycle and genetic basis of cancer, cancer epidemiology, tumors of the immune system, therapies available in Sri Lanka, current diagnostics & research needs, Immune response to tumors, tumor evasion of the

immune system, Tumor antigens and markers, cancer immunotherapy, gene therapy and stem cell therapy

**Reference materials**

*Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
*Immunology*, Male et al, Elsevier Ltd, Philadelphia, USA
*Roitt's Essential Immunology,* Delves et al, Blackwell Publishing Ltd, Oxford, UK
*Immunobiology*, Janeway et al, Garland Science, Taylor & Francis Group, LLC
*Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

**CMI 6070 - Immunoparasitology and Immunogenetics (Optional): 2 Credits (Lectures - 30 h)**

**Intended Learning Outcome**

After successfully completing this course students will be able to

- Describe basic concepts of parasitism
- Classify different parasites
- Identify control strategies based on life cycle of the parasite
- Explain the principles of immunogenetics
- Appraise the use of different immunodiagnostics

**Course Content**

Introduction to parasitology and parasitism; course overview, Protozoa parasites (Amoebae, Flagellates, Hemoflagellates, Sporozoa), Helminthic infections, Trematoda, Cestoda and Eucestoda, Nematoda, physiology of flat worms and roundworms, medically important Arthropods, control strategies for parasitic and vector-borne diseases, overview of diagnostic methods, Host-pathogen interactions, immunogenetics, immune evasion mechanisms

**Reference materials**

*Kuby Immunology*, Owen et al, WH Freeman & Company, New York, USA
*Immunology*, Male et al, Elsevier Ltd, Philadelphia, USA
*Cellular and Molecular Immunology*, Abbas et al, Elsevier Ltd, Philadelphia, USA

**Evaluation procedures**

| | |
|---|---|
| Continuous Assessments | 30% |
| End of Semester Examination | 70% |

## Fourth Semester

**CMI 6010 Part II - Research Project: 15 Credits**
**(Research 1500 h)**

**Intended Learning Outcome**

After successful completion of the research project, students will be able to

- Review and appraise literature pertaining to a given study
- Formulate the objectives for the research project
- Design methodology for a given research question/topic
- Plan the activities of the research project
- Analyze, interpret and make conclusions on data/results obtained
- Demonstrate statistical skills
- Demonstrate presentation and communication skills
- Demonstrate scientific writing skills

**Course Content**

Conduct the approved project, data analysis, writing and submission of dissertation for examination, final project presentation and oral examination.

**Evaluation procedures**

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|---|---|
| Literature Review | 10% |
| Dissertation | 45% |
| Viva/Presentation | 45% |