

Ph.D. Molecular Cell Biology of Infectious Diseases



DOCTOR OF PHILOSOPHY IN MOLECULAR CELL BIOLOGY OF INFECTIOUS DISEASES (PhD MCBI)

PROGRAMME STRUCTURE

YEAR 1

SEMESTER 1

CORE

	CREDITS
FASC 700: Special Topics in Science	3
FASC 701: Science and Society	3
BCMB 630: Research Methodology & Scientific Communication	3

ELECTIVES Select maximum of 3 credits

MCBI 710: Laboratory Rotation	3
BCMB 701: Advanced Topics in Bioinformatics	3
MCBI 601: Bacterial and Viral Infections	3
MCBI 603: Experimental Microbiology	3
BCMB 609: Immune Response Mechanisms	3

SEMESTER 2

CORE

FASC 702: Advanced Quantitative Research Methods	3
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ELECTIVES Select 6-9 credits

MCBI 702: Current Vaccine Approaches	3
MCBI 704: Advances in Drug Discovery and Development	3
BCMB 704: Advances in Molecular Biology and Applications	3
BCMB 706: Advances in Natural Product Research	3
BCMB 708: Advances in Biomedical and Infectious Diseases Research	3
FASC 710: Teaching Science at Tertiary Level	3
MCBI 602: Eukaryotic Infections: Protozoan, Helminthic and Fungal	3
MCBI 604: Host and Pathogen Genomics	3
MCBI 606: Antimicrobial Therapeutics: Molecular Mechanisms and Concepts	3
MCBI 608: Molecular Epidemiology of Infectious Diseases	3
BCMB 608: Signal Transduction	3
BCMB 612: Applications of Biotechnology	3
BCMB 614: Eukaryotic Cell Biology	2

YEAR 2

MCBI 700: Thesis	
MCBI 720: Seminar I	3
MCBI 730: Seminar II	3

YEARS 3 & 4

MCBI 700: Thesis	45
MCBI 740: Seminar III	3
MCBI 750: Seminar IV	3

BCMB 608
SIGNAL TRANSDUCTION

This is an advanced course on cell signaling designed to give students insights into the underlying molecular mechanisms and current trends in signal transduction research. The format includes lectures, presentations of original literature by students, and discussions of selected papers with emphasis on experimental approaches and results. Major topics covered include: Types of signaling molecules; Cell Surface and nuclear receptors; Monomeric and heterotrimeric guanine nucleotide binding proteins; Effectors and regulators of receptor tyrosine kinase signaling pathways, G-protein coupled receptor signaling; Cytokine receptor signaling; Signaling through ion channels; Receptor transactivation and Crosstalk.

BCMB 609
IMMUNE RESPONSE MECHANISMS

This course is an advanced study of Immunology and takes a detailed look at the molecular mechanisms through which the immune system responds to pathogens. A major goal of the course is to prepare students for research in the fields of Immunology, disease pathogenesis and vaccine development. The content includes discussions of the mechanisms of antigen processing and presentation, T-cell and B-cell receptor gene rearrangements, recombination of VDJ gene segments, affinity maturation and somatic hypermutation. Current advances in immunological methods such as flow cytometry, and new developments in the search for vaccines for malaria and HIV will also be discussed.

BCMB 612
APPLICATIONS OF BIOTECHNOLOGY

Biotechnology deals with the application of living organisms, biological systems and processes or their derivatives to manufacture or modify a product and to render a service. The course combines knowledge from Biochemistry, Molecular Biology and Genetics, Microbiology, Cell Biology and links up with specialized areas in Chemical Engineering, which is Biochemical/Bioprocess Engineering. The advances in DNA recombinant techniques as well as the sequencing of the Human genome and that of several other organisms have led to the expansion of opportunities in biotechnology. The course will expose students to the advantage of bioprocesses over the traditional methods of manufacturing such low energy demand and limited environmental impact.

BCMB 614
EUKARYOTIC CELL BIOLOGY

This course focuses on membrane systems, organelles, the cell surface, cytoskeleton and extracellular matrix aspects of protozoan and some specialized higher eukaryotic cells. The ultra cellular structures common to all the cell types of interest as well as the key features unique to all the cell types will be described in detail. Specialized organelles used by parasitic protozoan will also be discussed in the context of their role in pathogenesis and the interaction with host cell structures. The course will also cover cellular processes and the dysfunctions that cause disease.

BCMB 630:
RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION

Students will be taken through various topics in research methodology and scientific communication. The major topics to be discussed are: elements of scientific project planning; research design and statistical analysis; laboratory quality assurance; standards for quality research; initial considerations; scientific and technical presentation; professional conduct.

BCMB 701
ADVANCED TOPICS IN BIOINFORMATICS

This course will expose students to all the bioinformatic tools that are being used to acquire and analyse biological data across all the major types of experiments. Software programmes used for genomics, transcriptomics and proteomics/protein networks are considerably different, and hence it is important for students learn the main softwares used in these fields of molecular biology as well as the new and updated versions that will be introduced from time-to-time. In addition to reviews of bioinformatic tools covering these main areas of molecular biology, softwares used in high-content image analysis, lipidomics as well as chemoinformatics will also be included to give students a holistic view of the bioinformatics. The course will be mainly conducted through the use of review articles selected by the lecturer during the period of the course for students to study in groups and present at lectures for discussions. At the beginning of the course, there will be a few lectures to be given by the course instructor to provide general overview of the bioinformatic landscape.

BCMB 704
ADVANCES IN MOLECULAR BIOLOGY AND APPLICATIONS

The goal of this course is to provide graduate-level instruction on molecular biology with detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. The topics will cover current advances in methodological approaches for analyzing the function of cellular macromolecules and macromolecular complexes in DNA replication, recombination, transposition and repair, gene expression and its regulation, mRNA splicing, genome organization, non-coding RNAs, signal transduction, protein synthesis, folding and degradation, growth control, and other life processes. A focus on critical thinking and problem solving will be used to show how fundamental, highly-significant biological problems are solved. We will also explore the logic of experimental design and data analysis.

BCMB 706
ADVANCES IN NATURAL PRODUCT RESEARCH

Compounds and biomolecules derived from nature will continue to represent an important source of new chemical entities for use as medicines, food supplements and other applications. The main source for the search and study of natural products has been plant; this course will cover the use of plants as well as other promising but traditionally unused sources. Efforts will be made to study fungi, actinomycetes, myxobacteria, macroalgae and microalgae as potential sources of new natural products being both primary and secondary metabolites. The main classes of natural products such as alkaloids, polyketides, glycopeptides, aminoglycosides, cyclic peptides, etc will be discussed including their predominant

uses. Product discovery platforms use for the isolation of new compounds will also be discussed, namely the traditional bioassay assisted screening and the modern genome-guide approaches.

BCMB 708
ADVANCES IN BIOMEDICAL AND INFECTIOUS DISEASES RESEARCH

The course is aimed equipping students with knowledge on current methods for studying the transmission, diagnosis, and pathogenesis of diseases that are of public health concern in sub-Saharan Africa. Diseases to be covered include infectious diseases such as Malaria, HIV, and TB, neglected tropical diseases (NTDs) such as Leishmania, Buruli ulcer, and Schistosomiasis. Current knowledge of the biology of the causative agents, as well as progress towards improved therapeutic mechanisms and vaccine development will be discussed. The relevance of genomics and proteomics for research into the various diseases will also be emphasized.

FASC 700
SPECIAL TOPICS IN SCIENCE

The course examines historical and contemporary issues in science, relating to the student's area of specialization and relevance. Such topics are expected to challenge the students into exploring current and relevant research trends/discoveries in scientific approaches. The course will enable students explore scientific knowledge in modern science, and add on to their depth of information in their chosen areas of specialty. It is expected that, the course will complement other courses on the PhD flagship of the various departments in the Sciences and elsewhere. Additionally, it will expose students to current trends of presentations, and foster stronger confidence-building attitude that will enable enhanced international academic competitive spirit.

FASC 701
SCIENCE AND SOCIETY

This course will enable students gain insights on the practice of science as a discipline including major scientific concepts like inductivism are examined as well as the history of science and science itself, an overview of current approaches to research and an understanding of research partnerships, networks and appropriate methods of communicating science depending on the audience. The aim of the course is to help students to fit their research to relevant trends and directions for national development. Course content will cover topics such as the basis for the scientific method; conceptual frameworks; the philosophy of science; ethics in research; pure versus applied science debates; approaches to research; science for development and the merit of broader impact criteria; north south/south south collaboration and partnerships; research networks; communicating science to the policy make, lay audience and to the media.

FASC 702
ADVANCED QUANTITATIVE RESEARCH METHODS

The course will serve as a step up for students who need to add up to their knowledge in quantitative methods of research techniques and analyses. Topics to be covered include: Sampling distributions and hypothesis testing. Sample size determination. Categorical data and chi-square, Non parametric tests. Principles of Design of Experiments. Analysis of variance and its assumptions. Experiments with single and multiple factors. Orthogonal and multiple Comparisons. Completely Randomized, Randomized Complete Block, repeated measures, cross over and Latin square designs. Nested designs. Fixed, random

and mixed effects models. Factorial designs. Confounding. Fractional factorial designs. Split plot designs. Incomplete block designs. Analysis of covariance. Regression models: basic concepts; Regression Model Diagnostics. Categorical data analysis. Logistic regression, univariate and multivariate. Confounding and collinearity in logistic regression. Model selection in logistic regression.

FASC 710 **TEACHING SCIENCE AT THE TERTIARY LEVEL**

It is anticipated that many of the students who go through the PhD programme in the Sciences may nurse special interest in teaching and academia. Focusing on group discussions, this course is expected to equip students with the requisite knowledge in overall management of students at the tertiary level. The course will focus on teaching the methodologies and techniques in handling Science-teaching at the undergraduate level. Topics such as laboratory supervision and safety, grading issues, special needs students, lecturing and tutoring techniques, examination preparation, teacher/student relationship, tertiary education management, will be discussed through reading, class/group discussions as well as presentations.

MCBI 700 **THESIS**

Each student will undertake a major research project and present a written dissertation. In addition, students will present an oral defence of their thesis.

MCBI 702 **CURRENT VACCINE APPROACHES**

This course aims to review recent developments in the design, development and delivery of vaccines against infectious diseases. An overview of the principles of vaccination and discussion of the successes and failures of historical vaccines including the small pox and yellow fever vaccines will be discussed. The strengths and limitations of current approaches to vaccine design will also be reviewed, including live attenuated, peptide and subunit vaccines and the applications of recombinant DNA vectors and idiotypic antibodies will be discussed. In addition, the factors hampering the development of vaccines to major infectious diseases such as malaria and HIV, as well as the promising new strategies for overcoming these challenges will be reviewed

MCBI 704 **ADVANCES IN DRUG DISCOVERY AND DEVELOPMENT**

This course aims to provide students with a deep understanding of the most modern approaches to discovery and development of drugs. Topics to be discussed will include mechanistic disease target discovery and validation, basic disease models, genes to medicines. In addition, advances in the development process will also be covered, including stage-gates from exploratory research targets (ERTs) to drug candidates, late discovery to early development, pre-clinical and candidate validation, clinical phases, post launch and drug surveillances

MCBI 710 **LABORATORY ROTATION**

This course is designed for students who are interested in exploring the research projects available in the various laboratories of the faculty members. Students will be placed on attachment to each laboratory for at least two months to experience research and then submit a written report for assessment.

MCBI 720 **SEMINAR I**

Each student will make a presentation on his/her thesis research proposal. In addition each student will be required to attend all departmental seminars. Students will also be assigned into small groups of five for journal clubs led by a faculty member, where they will review and critique recent seminal articles in a relevant field.

MCBI 730 **SEMINAR II**

For their experiential learning, students will be attached to local, regional, or international research partners, and they may use the period to collect and analyze pilot data, optimise methods or develop protocols. Students will be required to present (oral and written) reports of their attachments, which will be graded. In addition students will be required to attend all departmental seminars when they are not traveling

MCBI 740
SEMINAR III

Students will be required to provide updates on their research projects at least once each semester through a progress report seminar presentation. In addition, students will be required to attend all departmental seminars.

MCBI 750
SEMINAR IV

Students will be required to provide updates on their research projects at least once each semester through a progress report seminar presentation. In addition, students will be required to attend all departmental seminars.



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