FUNCTIONAL GENOMICS (FGx)

MODULE DESCRIPTION/OVERVIEW

- This one-of-a-kind postgraduate (PG) program provides direct interaction and mentoring needed from an experienced faculty staff to prepare PGs participants to implement an Immune-modulation curricula/style at their own.
- Face-to-face interaction or interactive on-line sessions with expert faculty will enhance the learning experience and strengthen PGs participants' confidence.
- The module describes the main principle, parts, and overview of functional genomics; providing analysis of the genetic code, and the understanding of the role of the different genes and the proteomic implications. In addition, it addresses the main applications of functional genomics as being important step to determine how the individual components of a biological system work together to produce a particular phenotype.
- The module represents an outline approach to the use and applications of transcriptomics in the diagnostic immune-modulation laboratory. It shows how this technique could be used to express thousands of genes measured simultaneously. It provides knowledge on analysis of gene expression data using biclustering algorithms where one of the main research areas of bioinformatics is functional genomics, which focuses on the interactions and functions of each gene and its products through the whole genome.
- This module provides direct information on the differential view of the intricate link between genotype and phenotype and on the different databases showing genotype-phenotype relationships (e.g. Gephebase).
- Beside studying the most common technologies and tools for functional genome analysis, this module also distinguishes between in-silico biology, computational biology, bioinformatics, and systems biology. This information, when combined, give us novel clues into genome analysis and what we could forecast using methods to assist in revealing new targets that could be effective in combating a variety of immunological diseases.
- Moreover, it discusses RNA interference (RNAi) where RNAi is an evolutionarily conserved mechanism that uses short antisense RNAs that are generated by dicing dsRNA precursors to target corresponding mRNAs for cleavage. This module shed the light on genome-wide RNAi screen for the discovery of gene function, novel therapeutical targets, and agricultural applications.
- Additionally, this module identifies bioinformatics tools for analysis of repetitive DNA. The hypervariability of these sequences exhibit a high degree of polymorphism due to variation in the number of their repeat units caused by mutations involving several mechanisms. Besides, it discusses different methodologies for analysis of dynamic proteomics.

MODULE LEARNING OBJECTIVES MLOS

1. Comprehensive understanding of gene expression patterns underlying immunological functioning/dys and phenotype.

2. Provide an outline on the interpretation of bioinformatic data (e.g. genome assembly, analysis of various 'omics' data).

MODULE LEARNING GOALS MLGS

Goal 1: Investigating the role/implication of genomic/epi-genetic/transcriptomic mechanism(s) in modulating the immune response in different disease pathology and diagnosis/prognosis.

Goal 2: Acquiring the theoretical knowledge/basis of the hands-on skills for different/some genomics technique(s).

MODULE INTENDED LEARNING OUTCOMES ILOS

A. Knowledge and Understanding: (Remembering and Understanding)

A1. Identify the crosstalk between the different genotypes and phenotypes and their implication in modulating the immune response in different disease(s).

A2. Describe genetic family history and mapping genetic traits.

A3. State the different genetic modification(s).

A4. State/Explain the significance of the epi-genetic variations together with the genetic variants as diagnostic or prognostic tool.

A5. Identify different epi/genetic/genomics model(s) and mutagenesis approaches.

B. Intellectual Skills: (Application, Analysis, Synthesis, Evaluation)

B1. Predict and analyze the genetic family history.

B2. Identify the fundamental concepts of the Immuno-genomics.

B3. Correlate epigenetic factors with gene expression.

B4. Differentiate between the transcriptomics, proteomics and metabolomics.

B5. Differentiate between genome editing approaches.

C. Professional Skills: (Practical Skills)

C1. Draw genetic maps

C2. Select relevant advanced molecular tests for addressing various diseases diagnosis or prognosis.

C3. Surf gene dataset/database engines and bioinformatics tools serving the selected topics and techniques.

D. GENERAL SKILLS: (ATTITUDES AND COMMUNICATION SKILLS)

D1. Learn the foundational genomics content/skills, at their convenience, using curated materials, guided exercises and discussions.

D2. Use gene dataset/database engines and bioinformatics tools serving the selected topics and techniques.

D3. Perform critical thinking and problem-solving skills.

D4. Display the ability to successfully engage in written and oral communication ways with the scientific community.

D5. Develop self-learning tools to allow for continued education and continued professional education.

D6. Demonstrate honesty and integrity during experimental design, performance and data analysis.

MODULE RESOURCES

Required Module Textbooks and Materials

- Required Module Textbook;

- Functional Genomics; Methods and Protocols, 3rd Ed., 2017, by Springer Nature https://link.springer.com/content/pdf/10.1007%2F978-1-4939-7231-9.pdf

- The Genomics Era: The Future of Genetics in Medicine, by St George's University of London, Link: https://www.futurelearn.com/courses/the-genomics-era

- The most common technologies and tools for functional genome analysis, by Evelina Gasperskaja and Vaidutis Kučinskas, Published: 2017, DOI: 10.6001/actamedica.v24i1.3457

- From discovery to understanding Comprehensive workflow solutions for easier, more accessible genomic analysis, by Illumina, Link: https://www.illumina.com/techniques.html

- Analysis of Gene Expression Data Using Biclustering Algorithms by Fadhl M. Al-Akwaa, Published: September 12th, 2012, DOI: 10.5772/48150

- Beyond the Gene List: Exploring Transcriptomics Data in Search for Gene Function, Trait Mechanisms and Genetic Architecture by Bregje Wertheim, Published: September 12th, 2012, DOI: 10.5772/48239

- Repetitive DNA: A Tool to Explore Animal Genomes/Transcriptomes, by Deepali Pathak and Sher Ali, Published: September 12th, 2012, DOI: 10.5772/48259

- RNAi Towards Functional Genomics Studies by Gabriela N. Tenea and Liliana Burlibasa, Published: September 12th, 2012, DOI: 10.5772/47762

- Genome-Wide RNAi Screen for the Discovery of Gene Function, Novel Therapeutical Targets and Agricultural Applications by Hua Bai, Published: September 12th, 2012, DOI: 10.5772/49945

- Dynamic Proteomics: Methodologies and Analysis, by Sara ten Have, Kelly Hodge and Angus I. Lamond, Published: September 12th, 2012, DOI: 10.5772/50786

- The differential view of genotype–phenotype relationships, by Virginie Orgogozo, Baptiste Morizot and Arnaud Martin, Published: 19th of May 2015, DOI: 10.3389/fgene.2015.00179

- What is computational (in-silico) biology? By Abbas Salavaty, Bioinformatics Systems Biology, Published 27th of January 2019, Link: https://www.abbassalavaty.com/what-is-in-silico-biology/

- Gephebase, a database of genotype–phenotype relationships for natural and domesticated variation in Eukaryotes, by Virginie Courtier-Orgogozo, Laurent Arnoult, St´ephane R. Prigent, S´everine Wiltgen and Arnaud Martin, Published: September 06, 2019, DOI: 10.1093/nar/gkz796

- Required Module websites;

  https://www.genome.gov/about-genomics/fact-sheets

- Required Module journal articles (will be provided to students)

ASSIGNMENTS AND GRADING SCHEME

GRADING SYSTEM

1. Diagnostic: Level assessment before the course

2. Formative: Quizzes, Lecture activities during the course

3. Assignments: eg. presentations, posters

4. Summative: at the end of the course

   - Written theoretical exams: MCQ, SAQ, and True or False to assess student knowledge & understanding as well as intellectual abilities

   - Practice exam: case studies, problem solving to assess student intellectual abilities as well as professional and practical skills gained from the course

GRADING POLICY

Grades can be based on the following:

Presentations and assignments	30
Exams	60