2EL2030 – Genomics and synthetic biology in health and industrial biotechnology

Instructors: Behnam Taidi
Department: DÉPARTEMENT MÉCANIQUE ENERGÉTIQUE PROCÉDÉS
Language of instruction: ANGLAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Engineering Sciences
Advanced level : No

Description

The recent advent of high-throughput molecular biology techniques and the in-depth understanding of genetics based on advances in sequencing methods have overwhelmed medical and industrial biotechnology. In addition, synthetic biology (where novel biological and biologically based parts, devices and systems are (re)designed and constructed to perform new functions that do not exist in nature) has opened up a whole new field of opportunities where the engineers interact with biologists, chemists and computer scientists to conceive and make diagnostic and therapeutic devices.

A course is provided for the students to immerse themselves in the universe of genetics and synthetic biology where the latest concepts and industrial applications are unveiled and discussed.

The aim of this course is to teach the future engineer the structure, functioning and regulation of the genome and how this can be related to industrial and medical applications. In addition, by learning the nature of analogue signals and digital genetic data, the engineer will be able to choose the most pertinent methods for data processing and interpretation. This will transform the pool of information into informative knowledge that could be used for the provision of new products and services.

Thus, at the end of the course, students will have a strategic vision on how to progress in the field of genomics and synthetic biology: from the exploration of unprecedented data accumulation to the extraction of innovative knowledge and the transformation of the data into new rational and useful knowledge.

Quarter number

SG6

Prerequisites (in terms of CS courses)

An interest in Biology and modelling biological phenomena.

General notions of biology at the level of general knowledge.

Syllabus

The syllabus consists of four modules; two of these are common foundation courses that pave the way for the subsequent two modules that focus on the application of synthetic biology to human health and the industrial biotechnology business.

Introduction: Genome structure and regulation, cloning techniques, Synthetic Biology

Genomic analyses by high-throughput methods: From genomic DNA to RNA

Human health applications: Modifying and reprogramming the genome as a basis for gene and cellular therapy, based on stem cells and induced pluripotent stem cells (IPSC).

Industrial-Biotechnology applications: Engineering the genome, the cellular chassis, allocation of resources, circuits engineering, metabolic engineering, the role of computer aided design in synthetic biology and metabolic engineering, introduction to iGEM

Class components (lecture, labs, etc.)

The course module is organized in lectures, to introduce knowledge and methodological tools

Grading

Continuous assessment for the lectures given by Marie-Anne DEBILY so attendance is obligatory for all these lectures that cover half of the course. Final written exam of 2 hours duration (no documents and no computer allowed) for the second half of the lectures.

Course support, bibliography

Course slides available online

Resources

• Teaching staff (instructor(s) names): Behnam TAIDI (CS-LGPM), Marie-Anne Debily (Gustave Roussy), Jean Loup FAULON (INRA), Ioana POPESCU (University of Evry-val-d'Essonne), Matthieu JULES (AgroParisTech)

• Maximum enrollment : 40

• Equipment-specific classrooms : Computer room equipped with desktop (Linux or Windows OS) for a 4 hour module

- Contrôle continu pour une partie du cours avec un examen final de 2 heures pour la seconde moitié du cours.

Learning outcomes covered on the course

On completion of the course, students should be able to:

- aware of technical tools and developments that enable to better understand how genomes are structured and have a control action
- understand the contributions of genomes to one's identity and understand the general principles that drive physiologic and pathologic immune evolution
- appreciate how genomic information can be used for developing improved therapeutics
- learn about the current status of stem cells and the new therapeutic developments
- have a strategic vision of the way to get ahead in the field of genomics: from data mining to the extraction of innovative knowledge

Description of the skills acquired at the end of the course

C1.1. : Examine problems in their entirety and beyond their immediate parameters. Identify, formulate and analyse the scientific, economic and human dimensions of a problem Milestone 1

C1.2. : Develop and use appropriate models, choosing the correct modelling scale and simplifying assumptions when addressing a problem Milestone 1

C1.4. : Design, detail and corroborate a whole or part of a complex system. Milestone 1