

Teaching Unit (TU) or Module: Biotechnology of Innovative Therapies (BIT)

semester hourly volume: 67h30

Credits : 6

Coefficient : 3

Teaching objectives:

To acquire knowledge and know-how in the field of health products derived from biotechnology or new therapies, in the various Sectors of:

- + Innovations: gene and cell therapy,
- + Production : therapeutic proteins, monoclonal antibodies, vaccines, viral vectors, etc. e
- + -Clinical research.

Recommended prior knowledge:

Microbiology, Biochemistry, Molecular Biology and Genetic Engineering, Immunology, Industrial Microbiology.

Module Content :

I. An Introduction to Biotechnology

Biotechnology is a multidisciplinary field.

- **Biotechnology is a real scientific revolution.**
- **History and evolution of biotechnologies.**
- **Biotechnology Color Code:**

- ✓ Health (Red Biotechnology),
- ✓ Environment (Yellow Biotechnology),
- ✓ Agri-food (Green Biotechnology),
- ✓ Industry (White Biotechnology),
- ✓ Aquaculture (Blue Biotechnology),

• Innovative tools for biotechnology.

II. Gene therapy

- What is gene therapy?
- The different types of gene therapies (somatic and germline).
- Vectorization and gene transfer in target cells:
 - ✓ Viral vectors (retroviral, adenoviral and others),
 - ✓ Non-viral vectors,
 - ✓ Use of liposomes,
 - ✓ Plasmid DNA injection.
- Clinical applications of gene therapy (gene therapy drugs).
- Clinical trials.

- The global players in gene therapy.

- Issues Raised by Biotechnology Innovation in Health.

III. Cell Therapy

- What is cell therapy?
- Fundamentals of the different types of stem cells.
- Cells, tissues: preparation, amplification, cryopreservation and quality control.
- Application of cell therapy to different fields:
 - ✓ Cell therapy and regenerative medicine.

IV. Bioprocesses and production of therapeutic proteins:

- General information on molecular engineering.
- Production of recombinant proteins:

- ✓ Steps and strategies for the production of recombinant proteins,
- ✓ Contribution of the prokaryotic cell in the production of biomolecules,
- ✓ Contribution of the eukaryotic cell in the production of biomolecules,
- ✓ Optimization of expression vectors and producing cell lines,
- ✓ Bioprocesses, purification processes, formulation,
- ✓ Therapeutic protein enhancement strategies,
- ✓ Applications: monoclonal antibodies, recombinant allergens, plants and Transgenic animals, growth factors...
- Large-scale production.

V. Vaccines and new vaccine strategies

- General principles of vaccinology: cellular and molecular bases and methods immune response.
- New vaccine technologies and strategies, adjuvants and new pathways of administration. Medical devices.
- Vaccine development, pharmacovigilance, risk management plan.

VI. The challenges of biotechnology

- Socio-economic issues,
- Environmental issues,
- Health issues,
- Ethical issues.

Tutorials or Supervised Work:

Presentations on new therapeutic concepts that emerge from the development of biotechnology,

Suggested Topics

1. **CRISPR-Cas9** : In vivo gene editing for hereditary diseases.
2. **CAR-T Cells**: Engineering immunity against solid tumors.
3. **mRNA Technology**: Beyond COVID-19 (e.g., Personalized Cancer Vaccines).
4. **Monoclonal Antibodies**: Targeted therapy in autoimmune diseases.
5. **Phage Therapy**: Solutions for multi-drug resistant bacteria.
6. **3D Bioprinting**: Generating skin or cartilage grafts.

Method of evaluation: Continuous assessment and semester examination

Bibliographical references:

- Nathalie Lannoy, Cédric Hermans. **Thérapie génique en 2017 : état des lieux et perspectives**,MSD Belgium sprl.
- Didier Hoch, Pierre Tambourin. 2009. **Les biotechnologies, clés de l'innovation thérapeutique dans le domaine de la santé**, MEDECINE/SCIENCES 2009 ; 25 : 13-7.
- Kealey C, Creaven CA, Murphy CD, Brady CB. 2017. **New approaches to antibiotic discovery**. *Biotechnol Lett.* 2017 Jun; 39(6):805-817.
- Zacchigna S1, Giacca M2. 2018. **The global role of biotechnology for non-communicable disorders.***J Biotechnol.* 2018 Oct 10 ;283 :115-119.