

BIOTECHNOLOGY & MEDICINE

LEARNING PROGRAMME



Course applicability

Students holding a M.Sc. degree in Biological and Medical Sciences or other related disciplines.

Course structure

L01. Systems Biology and Omics Technologies – Advanced level

L02. The Application of 3D Printing and ICT for Green Products and Processes – Basic & Advanced levels

L03. Biosensors & Biochips for Sustainable Future – Advanced level

L06. Social and political acceptability of modern biotechnology tools – Basic level

L08. Bioethics and modern biotechnology – Advanced level

Course authors

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Course outline

Modern biotechnology has been recognized as the bound of the next technological revolution. It is a forceful machine that offers a range of potential environmental, social, and economic profits and requires stringent attention. “Omics sciences” and their impact in several generic fields, the three-dimensional (3D) bioprinting, the biochip, and biosensor technologies have been applied to diverse analytical problems in medicine and biomedical research, food, and processing industries, environment, security, and defense. However, some ethical and related legal aspects to Synthetic Biology in the sense of the reprogramming, optimization, or "bottom-up"-creation of living beings for agricultural or pharmacological purposes have been raised. In this respect, the educational goals of this course are focused to provide trainees with a reliable background on:

- ✓ Latest applications of OMICS approach for better understanding of the behavior of cells, tissues, organs, and the whole organism at the molecular level.
- ✓ What 3D printing is: basic printing principles of operation.
- ✓ 3D bioprinting application areas from tissue engineering and regenerative medicine to pharmaceuticals and cancer research.
- ✓ Practical applications of specific types of biosensors and biochips.
- ✓ The factors that influence the social attitude towards modern biotechnology, the advantages of societal acceptability, and the bottleneck steps of the process.
- ✓ Ethical and legal aspects or problems of different techniques of cloning in agriculture and food production as well as for the purpose of xenotransplantation; and on all ethical and legal questions related to the use of the different methods of “synthetic biology” for optimizing the “genetic outfit” of bacteria and plants for agricultural or pharmacological purposes as well as for the purposes of gene therapy in humans, especially in the case of germline therapy.

Keywords

System biology; Omics technologies; Medicine; Toxicology; Bioengineering; Biodiversity; Nutrition; 3D Printing; 3D Modelling; Digital services; 3D hardware; 3D software; Tissue engineering; Regenerative medicine; Transplantation; Cancer research; Pharmaceuticals research; Glucose biosensors; Cardiovascular diseases detection biosensors; Cancer detection biosensor; Tuberculosis biochips; Nutrient detection; Nanomaterials; Pathogens detection; Toxins detection; Pesticides detection; Endocrine-disrupting chemicals detection; Modern biotechnology tools; Social perception; Social acceptability; Risks vs. Benefits; Diffusion of biotechnology; Bioethics, Biolaw, Cloning, Synthetic Biology, Safety risks, Zoonosis, Xenotransplantation, Artificial life, Environmental law/regulation, Sustainability, Conflicts of interests, Forest ethics.

Learning outcomes

Knowledge & Skills

- ✓ Differentiate omics approaches and their possible uses.
- ✓ Understand how computational systems can be used for the analysis of different data sets.
- ✓ Apply omics approaches to accelerate discoveries in different areas of research.
- ✓ Match the suitable bioinformatics tool with the specific research area.
- ✓ Process and interpret experimental data.
- ✓ Understand the basic principles of operation of 3D printing process.
- ✓ Recognize and apply different 3D printing materials.
- ✓ Design 3D models.
- ✓ Optimize and slice 3D models.
- ✓ Practice different post-processing methods: assembling, painting, and enhancing a 3D model.
- ✓ Choose a suitable hard/software for 3D printing.
- ✓ Present the advantages and disadvantages of the 3D technology.
- ✓ Know how bioprinting could address fundamental biological questions.
- ✓ Understand how different biofabrication techniques are used to incorporate cells and various biomaterials to create cell-laden structures.
- ✓ Evaluate the existing bioprinting technologies and their specific advantages and disadvantages
- ✓ describe methods to assess cell viability and proliferation.
- ✓ Analyze current challenges in the field of biofabrication.
- ✓ Demonstrate an understanding of how biochips and biosensors could be successfully applied in medical diagnostics.
- ✓ Characterize different medical biosensors and biochips: for the detection of diabetes, cardiovascular diseases, cancer, tuberculosis, etc.
- ✓ Recognize and apply different biochips and biosensors employed in food and agriculture.
- ✓ Define properties and operate with biosensors and biochips utilized for environmental monitoring.
- ✓ Recognize and understand the factors influencing the social perception of modern biotechnology.
- ✓ Distinguish and apply the indices that determine the variety of social acceptance patterns of modern biotechnology: norms, value systems, and cultural backgrounds.
- ✓ Present societal acceptability of benefits and risks imposed by modern biotech applications.
- ✓ Evaluate the societal dilemma: benefits vs. risks.
- ✓ Know and use the structural models to predict attitudes towards biotechnology.
- ✓ Distinguish the tools for measuring public attitudes towards risks and benefits.
- ✓ Identify and formulate issues related to the possible negative impact of biotechnological development on socio-economy, biodiversity, sustainable agriculture, and public welfare.
- ✓ Know and recognize the major biosafety issues of modern biotechnology.
- ✓ recognize the possible safety risks of producing chimeras by cloning;
- ✓ Understand the human-ethical aspects of the xenotransplantation of genetically modified animal organs (problem of the scarcity of transplants, danger of zoonosis, etc.).
- ✓ Recognize the the ethical and related legal aspects related to the "top-down"-reprogramming and optimization of bacteria or the "bottom-up"-creation of living beings.

- ✓ Understand the possible effects of the "creation of life" on our relationship to life in general (concept of life as well as human nature and self-image).
- ✓ Recognize the different legal questions related to the conservation of nature and the protection of species in the sense of "biolaw".
- ✓ Understand the challenges for a legal regulation of measurements in order to a sustainable interaction between humans and nature.
- ✓ Recognize the conflicts between economy and ecology which have been regulated by law.
- ✓ Understand the importance of a law of sustainability on a national as well as on an international level.

Autonomy & responsibility

- ✓ **Problem-solving skills**
- ✓ **Communication skills:** good verbal and written communication skills.
- ✓ **Computing skills:** competencies and skills in the use of modern technological tools.
- ✓ **Use of media:** knowledge of the principles of preparation and delivery of messages through media; ability to develop written and oral presentations.
- ✓ **Personal issues:** logical thinking capabilities; being independent and organized.
- ✓ **Collaborative working:** capable of teamwork.

ECTS points

Successful completion of the course will result in the participant being awarded 15 ECTS (European Credit Transfer System) points.

Credit transfer within Partners' countries

- Bulgaria – 12.5 – 15 ECTS
- Germany - 12.5 – 15 ECTS
- Greece – 12.5 ECTS
- Italy – 15 ECTS