DIGIT~Bio~TECH

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M.Sc. PROGRAMME "GREEN BIOTECHNOLOGY AND ICT"

SYLLABUS

COURSE:

BIOSENSORS & BIOCHIPS FOR SUSTAINABLE FUTURE

AUTHORS:

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Academic work	Type	Number of classes
In-class work	Lectures	30
	Seminars	20
Total in-class work		**50**
Out-of-class work	Presentations	25
	Projects	20
	Self-guided library/database work	30
Total out-of-class work		**75***
Total of academic work		**125**
ECTS credits in-class work		**2.0**
ECTS credits out-of-class work		**3.0**
Total ECTS credits		**5.0**

№	Grading	% of the grade
1.	Workshops/discussions of reports and papers	20 %
2.	Case studies	20 %
3.	Homework assignments and tests	10 %
4.	Exams	50 %

* One credit corresponds to 25 hours of work.

Outline of the course
Biosensors are becoming increasingly important practical tools in pathogen detection, molecular diagnostics, environmental monitoring, food safety control as well as in homeland defense. In this LO recent advances in biosensors development and their potential applications are reviewed. Different types of biosensors are presented like electrochemical biosensors, enzyme-based biosensors, immunological biosensors, and DNA biosensors. The future perspectives of their applications are also introduced. Biochip, a bio-microarray device, is another extensively studied technology. It is developed to enable large-scale genomic, proteomic, and functional genomic analyses. This part of the LO deals with a theoretical background of what is biochip and how it operates. Different types of biochips are described: DNA microarray, Microfluidic chip, and Protein microarray. The main advantages and disadvantages of their use are also presented. A brief overview is given on the most emerging applications of biochips. In the past two decades, the biological and medical fields have seen great advances in the development of biosensors and biochips capable of characterizing and quantifying biomolecules. Here, an overview is provided of the various types of biosensors and biochips that have been developed for biological and medical applications. Special attention is paid to glucose biosensors in diabetic management, biosensors for cardiovascular disease detection, a biosensor for detection of cancer, as well as multi-functional biochips for medical diagnostics and pathogen detection. As the application of the biosensor technique in the field of food processing and quality control is also promising, a review of the potential application of biosensor & biochip technology in food industries, its current situation, and its potential is given. Some biosensors recently described in the literature for rapid detection of nutrients, food pathogens, and other contaminants such as carcinogens, toxins, and pesticides are described. Special attention is paid to the use of biochips for GMO detection in agricultural products. An update is made on recent progress in biosensors & biochips for the monitoring of air, water, and soil pollutants in real conditions such as pesticides, potentially toxic elements, and small organic molecules including toxins and endocrine-disrupting chemicals.

Educational goals

In the last decade, rapid strides have been made to take advantage of the applications of nanotechnology across various fields. The idea of designing the next generation of technological devices that integrate the knowledge coming from various fields such as biology, chemistry, electronics, and engineering is already gathering increasing attention. In this respect, the educational goals of this LO are focused to provide trainees with a reliable background on:

- basic overview of biochip and biosensor technology
- classification of different types of biosensors and biochips
- biosensors and biochips working principles

In the recent past biochip and biosensor technologies have made significant progress across various application areas, thanks to nanotechnology. They have been applied to diverse analytical problems in medicine and biomedical research, food and processing industries, environment, security, and defense. In this respect, the educational goals of this LO are to provide trainees with a reliable background on:

- practical applications of specific types of biosensors and biochips
- advanced tools and methodologies for dealing with the data generated.

Expected outcomes

Knowledge and Skills:

As a result of the training students will be able to:

- explain the biosensors and their basic properties
- demonstrate an understanding of fundamental principles of biochips design and operation
- recognize and apply different biochip and biosensor technology
- recognize the types of biosensors/biochips
- define properties of ideal biosensor/biochip and their measurement systems
- analyze and match needs with available technology
- 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.

Problem-solving skills: Decision making, creative thinking, analytical, research and interpreting skills

Digital competencies and skills: strategic web and database searching; data analysis and presentation; data management and preservation; digital communication; networks and file management.

Personal skills: initiative and independence, time management, good oral and written communication skills, teamwork.

Syllabus

№	Topic	Number of classes
1.	**Unit 1 BL - Biosensors & Biochips: An overview**	**25 h**
1.1	Blueprints for Biosensors: Design & Operation: Electrochemical biosensors. Enzyme-based biosensors. Immunological biosensor. DNA biosensors. The future of clinical biosensors.	6 h
1.2	Blueprints for Biochips: Design & Operation: DNA microarray. Microfluidic chip. Protein microarray.	6 h
1.3	Applications of biochips.	3 h
1.4	Seminars	10 h
2.	**Unit 2 AL - Biosensors & Biochips Technologies: Contribution to the Future Sustainable Life**	**25 h**
2.1	Biosensors & biochips: advances in medical diagnostics: Glucose biosensors in diabetic management. Cardiovascular disease detection using biosensors. Biosensor for detection of cancer. Biochip in diagnostics. Biochip in Tuberculosis epidemic. Biochip in cancer.	5 h
2.2	Biosensors & Biochips applied in food and agriculture: Nanomaterials in biosensing technology. Nutrient and quality detection. Detection of pathogens. Detection of toxins.	5 h
2.3	Biosensors & Biochips for environmental monitoring: Pesticides. Pathogens. Potentially toxic elements. Toxins. Endocrine disrupting chemicals. Other environmental compounds.	5 h
2.4	Seminars	10 h