DIGIT~Bio~TECH

2019-1-BG01-KA203-062371

M.Sc. PROGRAMME "GREEN BIOTECHNOLOGY AND ICT"

SYLLABUS

COURSE:

THE APPLICATION OF 3D PRINTING AND ICT FOR GREEN PRODUCTS AND PROCESSES

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
This LO presents educational content focused on the fundamentals of 3D printing and the performance of a 3D printing process. The main principles on which the work of 3D printing is based are described. Information from a brief historical overview to the current state of the art in 3D printing is given. The advantages and disadvantages of the technology are revealed and a comparative review of 3D printing technologies vs. traditional manufacturing is given. The variety of 3D printing processes is presented with special emphasis on their principle of operation, main classes of materials and materials requirements, cost-effectiveness, benefits, and limitations regarding end-product quality. Information for the different post-processing methods is also given. Valuable guidelines for the selection of the best 3D printing process for a certain product are also included. Information is provided about the basic rules applicable for design for 3D printing. The main criteria for chose of a suitable hard/software for 3D printing and organizing/using 3D printing services are presented. The opportunities to find designs for 3D printing online are also discussed. An exemplary 3D printing knowledge database is finally offered. Bioprinting of functional organs remains elusive because there are several challenges such as integration of the vascular network from arteries and veins down to capillaries, incorporation of various cell types to recapitulate complex organ biology, and limited structural and mechanical integrity and long-term functionality. Despite these difficulties, a wide variety of tissues have been successfully bioprinted and this LO is focused on the latest innovations in bioprinting of a variety of human tissues. The latest achievements in bioprinting technology and their clinical transplantation potential are also presented. Information is provided on how 3D in vitro assay systems could be used for improving the ability to predict the efficacy and toxicity of drug candidates earlier in the drug discovery process. Bioprinting is introduced as a new advantageous technique that could recapitulate the cancer microenvironment to precisely locate various cell types and microcapillaries and could be applied to study cancer pathogenesis and metastasis.

Educational goals

3D printing encompasses a set of processes and technologies that allow the production of parts and products in different materials, done layer by layer in an additive process. This technology penetrates widely and deeply across industrial, maker, and consumer sectors, and its applications are emerging literally daily. Due to these reasons, the educational goals of this LO are focused to provide trainees with a reliable background in 3D printing in terms of:

- What 3D printing is: basic printing principles of operation?
- Basics of 3D printing processes and materials.
- 3D printing design guidelines.

Three-dimensional (3D) bioprinting is a powerful tool for patterning and precisely placing biological objects, including living cells, nucleic acids, drug particles, proteins, and growth factors, to recapitulate tissue anatomy, biology, and physiology. Due to these reasons, the educational goals of this LO are to review the bioprinting technology and to present a comprehensive overview of its application areas from tissue engineering and regenerative medicine to pharmaceutics and cancer research.

Expected outcomes

Knowledge and Skills:

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

- 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, 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.
- Analyse current challenges in the field of biofabrication.

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 - 3D printing – basic principles and processes**	**25 h**
1.1	3D printing principles of operation: Definitions. A brief history of the field. Advantages and disadvantages of 3D printing as a method of manufacture.	7 h
1.2	Basics of 3D printing processes and materials: Types of 3D printing processes. Post-processing requirements for different 3D printing technologies. Which process for which? Basic considerations when selecting 3D printing technology suited for a particular application. Commonly used software for 3D printing.	6 h
1.3	3D printing design guidelines.	2 h
1.4	Seminars	10 h
2.	**Unit 2 AL - OMICS technologies towards improving the quality of life**	**25 h**
2.1	Tissue engineering and regenerative medicine: Bone tissue. Cartilage tissue. Cardiac tissue. Liver tissue. Lung tissue. Neural tissue. Pancreas tissue. Skin tissue. Vascular tissue. Other tissue types.	6 h
2.2	Transplantation and clinics.	3 h
2.3	Pharmaceutics and high-throughput screening.	3 h
2.4	Cancer research.	2 h
2.5	Concluding remarks and future outlook.	1 h
2.6	Seminars	10 h