COURSE DESCRIPTION
TISSUE ENGINEERING

SSD: BIOINGEGNERIA INDUSTRIALE (ING-IND/34)

DEGREE PROGRAMME: BIOINGEGNERIA INDUSTRIALE (P16)
ACADEMIC YEAR 2022/2023

COURSE DESCRIPTION

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: U1580 - BIOMATERIALS AND TISSUE ENGINEERING
MODULE: U1590 - TISSUE ENGINEERING
CHANNEL: FG A-Z
YEAR OF THE DEGREE PROGRAMME: II
PERIOD IN WHICH THE COURSE IS DELIVERED: SEMESTER I
CFU: 6

REQUIRED PRELIMINARY COURSES

There are no required preliminary courses.

PREREQUISITES

There are no required prerequisites.

LEARNING GOALS

This course aims at providing the student with the principles of tissue engineering and regenerative medicine and at illustrating relevant examples of engineered tissues that are used in clinical practice as replacements for damaged or diseased tissues, for research applications and as testing platforms, alternatively to animal testing, for screening of drugs and therapeutics. The course focuses on providing the student with knowledge of materials and manufacturing processes for functional scaffolds to be used for *in vitro* and *in vivo* tissue regeneration. In this context, the student will acquire knowledge on the biosynthetic and metabolic activity of cells, on the interactions that are established between cells and materials, and on the culture conditions

that promote, through biochemical and/or biomechanical stimulation, generation processes of *in vitro* three-dimensional tissues.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

At the end of the course the student will acquire advanced knowledge to strategically identify and combine cells, scaffolds and chemical-physical signals for a fine control of the regeneration process of three-dimensional biological tissues in *in vitro* condition. In particular, the student will acquire the necessary knowledge (i) to design and implement the use of scaffolds in the field of tissue regeneration and (ii) to define the most effective process conditions to promote tissue biosynthesis also with the aid of FEM or FVM softwares.

Applying knowledge and understanding

At the end of the course the student will be able to apply the acquired knowledge to define the most suitable cell-scaffold-signals-process condition combination for the *in vitro* regeneration of specific tissues. In particular, the student will be able to identify fabrication techniques of porous scaffold, micro- and nano-structuring processes and surface functionalization to give the material the features that define a fine controlled cellular behavior *in vitro* and biosynthesis process. Furthermore, the student will be able to apply the knowledge of biochemistry and transport to define the optimal conditions of the cell culture process and promote tissue growth.

COURSE CONTENT/SYLLABUS

6 cfu

1. Cells in tissue engineering: sources, extraction methods and cell culture.
2. Techniques of cellular expansion: 2D and dynamic suspension.
3. Techniques to build-up 3D engineered tissues:
   3.1. Top-down techniques: cell seeding in microporous scaffolds and hydrogels.
   3.2. Bottom-up techniques presentation of different building blocks (scaffold-free: sferoidi; fogli cellulari; scaffold-based: techniques of microscaffolds scaffolds (batch and continuous) / cell-laden microgels, bioprinting; cell-seeded microcarriers).
4. Techniques to process engineered tissues: bioreactors in tissue engineering.
5. Tissue process design: coupling process variables and in vitro tissue growth:
   5.1. Fluid and mass transport: Navier-Stockes and Darcy approach.
   5.2. Responses of 3D cell culture to process parameters (fluid-dynamic, mechanical, biochemical stimuli).
   5.3. Oxygen consumption models.
6. Organs on chips: commercially available solutions; literature examples; design dynamic cultures-on chips.
7. Tissue analyses: destructive and non-destructive techniques.

READINGS/BIBLIOGRAPHY

Saltzman “Tissue Engineering Engineering Principles for the Design of Replacement Organs and Tissues”
Blitterswijk “Tissue Engineering”
Presentation and notes

TEACHING METHODS OF THE COURSE (OR MODULE)

Lectures.

EXAMINATION/EVALUATION CRITERIA

a) Exam type

- ☐ Written
- ☑ Oral
- ☑ Project discussion
- ☐ Other

In case of a written exam, questions refer to

- ☐ Multiple choice answers
- ☐ Open answers
- ☐ Numerical exercises

b) Evaluation pattern