

5BIO3TISSUE ENGINEERING

Lecturers: Assistant Prof. Conor Buckley (conor.buckley@tcd.ie)

Semester: 2

Prerequisite Modules: 4B19 Biomechanics and 4B20 Biomaterials

Module Organisation

The module runs for 12 weeks of the academic year and comprises three lectures and one tutorial per week (except the study week). Total contact time is 44 hours.

Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
1	12	3	33	1	11

Module Description

This module builds upon 4B20 Biomaterials, with the explicit objective to provide students with extensive knowledge on the fundamentals, enabling technologies and applications to generate new tissues through the combination of cells, biocompatible materials and suitable biochemical and biophysical factors to improve or replace biological functions that have been compromised through disease. An overview of contemporary approaches to tissue and cell engineering will be given, including tissue scaffold design, use of bioreactors in tissue engineering, and molecular surface modifications for integration of engineered tissues in situ. Ethical considerations related to clinical application of tissue and cell engineering technology will also be explored.

Learning Outcomes

On successful completion of this module, students should have developed:

1. Understanding of the fundamental principles of tissue engineering
2. Understanding of animal/human cell culture processes
3. Awareness of current “state of the art”, emerging technologies and advances in the field
4. Ability to understand cell bioengineering processes and its applications to tissue engineering and regenerative medicine
5. Insight on biomaterial properties and integration of biomaterials with engineered tissues
6. Ability to integrate the knowledge on biomaterial fundamentals and cell and tissue biology toward the development of biomedical applications
7. Ability to design and conduct experiments, as well as to measure, analyse and interpret data from living systems.
8. Ability to function on multidisciplinary teams
9. Ability to identify, formulate and adapt engineering solutions to unmet biological needs
10. Ability to analyze biological systems as engineering systems

11. Knowledge of the commercial market and understanding of the regulatory hurdles in tissue engineering
12. Appreciation of ethical issues and considerations for regenerative medicine

Module Content

- Fundamental Principles of Tissue Engineering
- Stem Cells for Tissue Engineering
- Cell Culture for Tissue Engineering
- Colony-Forming Unit Assays, Cell Proliferation and Migration Kinetics
- Scaffolds for Tissue Based Repair I
- Scaffolds for Tissue Based Repair II
- Decellularised Matrices
- Bioreactor Systems and Design
- Diffusion & Nutrient Transport Limitations in Tissue Engineered Constructs
- Mechanobiology- Response of Cells to Mechanical Forces
- Skin Tissue Regeneration
- Cartilage Tissue Engineering & Regeneration
- Bone Tissue Engineering
- Cardiovascular Tissue Engineering
- Corneal Tissue Engineering and Replacement
- Tissue Engineering of the Intervertebral Disc (IVD)
- Peripheral Nerve Repair
- Cell Separation Technology
- Gene Therapy
- Regenerative Surgery in Orthopaedics & Sports Medicine
- Ethical Issues and Considerations for Tissue Engineering

Module Notes

Provided via Blackboard

Teaching Strategies

The module is taught using a combination of lectures, laboratories and tutorials. Students are tasked with an independent or group learning assignment to research a specific area in the field of tissue engineering and regenerative medicine which introduces the student to research skills necessary for life-long learning.

Assessment Modes

Written Exam (70%), laboratory experiment (15%) and individual/group learning assignment (15%)

Recommended Texts

- Tissue Engineering, Fisher, Mikos & Bronzino, 2007, (CRC Press)
- Principles of Tissue Engineering, 3rd Edition, Lanza, Langer & Vacanti, 2007 (Elsevier)
- Tissue Engineering, Palsson & Bhatia, 2004, (Pearson Prentice Hall)

Laboratory Practical

3D Bioprinting of Alginate Hydrogels for Tissue Engineering Applications