

Course Package

BET Tissue Engineering - 2B

Name module	BET Tissue Engineering - 2B
Educational programme	MSc Biomedical Engineering
Period	Second block of the second semester (block 2B)
Study load	15 ECTS
Coordinator	J. Huttenhuis

BET Tissue Engineering			
block 1A	block 1B	block 2A	block 2B
			Clinical Chemistry 193640050 (5 EC)
			Topics in Human Anatomy & Sports Physiology 200900040 (5 EC)
			Electives: (1 of the 2)
			Tissue Engineering* - 201600237 (5 EC)
			3D Bioprinting - 202100080 (5 EC)
			Bionanotechnology - 193400111 (5 EC)

Required preliminary knowledge: Fundamental knowledge and concepts from Cell Biology, Biochemistry, Chemistry (both inorganic and organic chemistry, standard techniques), Biology, Biomaterials and Cell Material Interactions. Basic anatomy and Physiology. Cell Culture and Molecular Biological, laboratory experience is of eminent importance, Thermodynamics, Basic (molecular) biology, Organic chemistry.

* Mandatory preliminary knowledge: Only if you have passed 'Applied Cell Biology'.

193640050 - Clinical Chemistry

The course clinical chemistry includes the basics of laboratory medicine in chemistry and pathology. Various concepts of clinical chemistry and laboratory medicine will be discussed such as; different measuring principles, sensitivity and specificity. What qualities are required of a laboratory test when it is used for screening purposes, like the current national screen for colorectal cancer. The aim is to explore the principles, techniques and instrumentation involved in quantitative analysis, with special emphasis on their clinical applications.

The start of this course will involve the basic concepts followed by a lab tour. During the remainder of the course you will address a current problem within the field of clinical chemistry. Together with one or more fellow students you will be challenged to make this problem 'your own', by writing a project description and

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a more extensive paper on your vision and ideas on the problem. During this time you will be supervised by a clinical chemist. Furthermore you will teach your fellow students about a subject regarding the project, like lab on a chip, diabetes etc.

This course is especially interesting for students interested in the clinical laboratory, involving multidisciplinary fields of biology, science, chemistry and healthcare.

200900040 - Topics in Human Anatomy & Sports Physiology

This course will focus at different topics in the field of human anatomy and physiology with a focus on sport injuries and sport physiology. Lectures and practical courses will be used alternatively. In addition, guest speakers who are experts in the field of sport injuries and rehabilitation will provide one or more lectures. The course will be examined by a written exam and two assignments throughout the course.

Topics that will be addressed are:

- Anatomy
- Anatomy and pathology of the upper extremities with a focus on injuries of the shoulder
- Anatomy and pathology of the lower extremities with a focus on injuries of the knee
- Anatomy in vivo with a focus on the muscular structures involved in sporting activities
- Clinical anatomy and physiology
- Neuro-anatomy and physiology for motor control
- How imaging can help to detect (sports) injuries?

Physiology of sports and exercise:

- Energy systems and muscle fiber typing in relation to sports
- Fick's law and the Wasserman wheels
- Training physiology and adaptation to training
- Testing of physical capacity
- Movement analysis applied to sports
- Fatigue (and its effect on movement patterns)
- Injuries

Electives: (1 of the 2)

201600327 - Tissue Engineering

The course 'Tissue Engineering' provides students with both basic knowledge as well as state-of-the-art examples of the field of regenerative medicine and tissue engineering in particular. The course will rely on the text book: Tissue Engineering 2nd edition (ISBN13: 9780124201453), which will be available as a downloadable e-book.

The course will be composed of multiple lectures that will cover all essential Tissue Engineering topics, which will be followed by a practical assignment. At the start of the course students will have the opportunity to an non-committal entrance exam, which reveal the presence and gaps in the students' knowledge. The depth and extent of the following lectures will be adjusted based on this preliminary test. Lectures will detail on cells source (stem cell vs mature cell), extracellular matrix (natural and engineered), Growth factors (tissue

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formation and controlled release), construct vascularization (methods and approaches), types of tissue engineering (Top-down vs Bottom-up), and advanced enabling technologies (microtechnology and 3D bioprinting). Internationally leading scientist will perform guest lectures on specific topics. For each lecture a set of questions will be provided via which the students can test their grasp of the topic's content. Lectures will take place over a period of 4 weeks. Every other week there is a dedicated opportunity for discussion on the content and questions of the past lectures. The lectures will be followed by an individual written exam that will count for 40% of the final grade. During these first 4 weeks the student will also work on an assignment, which will be presented by the student. This assignment will count for 10% of the final grade, which will be based on a presentation. This assignment revolves around the formation of a well-argued opinion on the relevance and translatability of a recently published solution that aims to solve a key challenge within the field.

Students will subsequently gain practical experience via lab work that will be performed in a subgroup format. Students will be able to choose between two practical assignments, which are either mostly biological or mostly engineering. Assignment one focusses on the decellularization of a tissue, which will be recellularized to form an engineering tissue. Assignment two focusses on the 3D printing of a designer construct that will be seeded with cells to generate an engineered tissue. For both assignments students will have the choice to engineer liver, skeletal, or heart tissue. The students will be allowed to design their own experiments within the boundaries of the practically feasible. Experts researchers will act as mentors for the experimental design. Students will present their design, which will provide the basis for a go or no-go (revision) decision to proceed with the experimental lab work. Lab work will count for 50% of the final grade, which will be based on an oral presentation, which will be assessed on design, scientific accuracy, data interpretation, originality, contextualization, and future perspective.

202100080 - 3D bioprinting

As with all areas of additive manufacturing, 3D bioprinting has seen tremendous progress and developments in the last decade. 3D bioprinting combines advanced 3D fabrication techniques with biological systems to create designed tissue constructs, which can be applied for tissue engineering, as 3D in vitro biological models, or for other applications. This course will provide the student with fundamental insights on important aspects of 3D bioprinting, with a particular emphasis on extrusion bioprinting. Topics include bio-ink development, rheology of 3D bioprinting, inclusion of cells and 4D bioprinting, tissue engineering and translation, biohybrid robotics, and ethics.

The content that is covered in the course includes:

- Introduction, different methodologies for 3D biofabrication, from medical imaging to G-code to print, complexity in tissues
- Current limitations and main challenges in tissue engineering and 3D biofabrication
- Bio-inks; tissue derived matrices, biomaterial properties design, multiscale functional materials; crosslinking strategies
- Rheology of bio-inks, printability, embedded printing
- Inclusion of cells, tissue remodeling, 4D bioprinting
- Challenge lecture 1: write a 2-page proposal describing a new optimal 3D bioprinting procedure to produce a patterned construct with a complex shape.
- Tissue engineering, translation, in-clinic and in-vivo printing
- Biohybrid robotics

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- Lab-grown meat and leather
- Environmental, economic, and ethical implications of biofabrication
- Challenge lecture 2: write a 2-page proposal describing a bio-printed product addressing a pressing societal problem using non-mammalian cells

193400111 - Bionanotechnology

Bionanotechnology is a field of research and applications that sits at the interface between nanotechnology on the one hand and life sciences on the other.

This course includes:

- An introduction into the field of bionanotechnology field
- Basics of nanobiology, including structure and function of DNA/RNA, DNA supercoiling, chromatin structure, structure and function of proteins, lipids, membranes, molecular motors, biological cells
- (Biological) nanoparticles, including gene therapy and DNA nanoparticles, inorganica and iron oxide nanoparticles, quantum dots, the unfamiliar world at the nanoscale, molecular interactions, Brownian motion, and diffusion
- Methods and techniques to study biology at the nanoscale, including fluorescence microscopy and other fluorescence-based techniques, nanoscopy methods, scanning probe microscopy (AFM), single molecule force spectroscopy, elasticity mapping, optical tweezers, magnetic tweezers.
- Writing of a comprehensive essay on the applications of nanobiotechnology, based on a short literature study.