Course Package

BET Manufacturing - 2B

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

BET Manufacturing			
block 1A	**block 1B**	**block 2A**	**block 2B**
			Microphysiological Systems 202300079 (5 EC)
			3D Bioprinting 202100080 (5 EC)
			Electives: choose 5 EC
			Topics in Human Anatomy; Physiology and Movement Disorders - 202200365 (5 EC)
			Clinical Chemistry - 193640050 (5 EC)
			Tissue Engineering* - 201600327 (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.

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

202300079 - **Microphysiological Systems**

Microphysiological Systems (MPS) are miniaturized 3D cell culture platforms, such as spheroids, organoids, bioprinted tissues and organs-on-chips. MPS are used as investigational and predictive tools in (patho-)biology, pharmacology, toxicology, and efficacy assessments, and are essential, for example, for understanding mechanisms of disease and for accelerating drug development. This course will instruct students how to develop MPS and related technologies from conceptualization to validation, with an intentional emphasis on organs-on-chip technologies. Identifying MPS applications and routes towards implementation of MPS are major learning goals, which will be explained from both academic and industrial perspectives. The course will focus on understanding the relevance and development steps involved in establishing more physiologically realistic model systems, particularly with regard to developing organs-on-chip platforms. Lectures focusing on organ models will be provided, including liver, brain, kidney, heart, lung, and articular joint tissues. Furthermore, it will be discussed how key functions of organs/tissues can be emulated, including biochemical, electrical and/or mechanical features. In parallel, technologies that are used for designing, fabricating, and validating MPS will be discussed in depth, with the perspective of applying the

knowledge in a project/practical exercises. The interaction between organ/tissue systems will be a key concept to be addressed in group brainstorming sessions, to enable student-directed active learning on systemic-like and complex disease models. In turn, this will enable students to identify and conceptualize organ/tissue elements to mimic in a MPS, envisioning an end application as model of (diseased/damaged) organs or tissues, such as the heart, the kidney, cartilage and blood vessels. Lastly, the combination of in vitro and in silico model systems will also be a main topic for discussion, to broaden the perspectives on technology complementarity. The advantages and bottlenecks of using MPS will be debated, to provide potential directions for further developments of these advanced technological platforms.

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
- Environmental, economic, and ethical implications of biofabrication
- Practical: Convert a filament printer into an extrusion hydrogel printer. Investigate the relationship between hydrogel rheological properties and printability.

Electives: choose 5 EC

202200365 - Topics in Human Anatomy, Physiology and Movement Disorders

This course will focus at different topics in the field of human anatomy and physiology with a focus on sport injuries and sport physiology. Next to that there will be a focus on gait analysis and movement disorders in patients with stroke, SCI and amputations. Lectures and one more practical course will be used alternatively. In addition, guest speakers who are experts in the field of rehabilitation will provide one or more lectures. The course will be examined by a written exam.

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 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.

The modules are tentative and subject to change. Please check the website regularly.

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

The maximum number of participants of this course is 15.

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 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 an 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.