Course Package

Bionanotechnology & Advanced Biomanufacturing

Name module	BNT - Bionanotechnology and Advanced Biomanufacturing
Educational programme	MSc Biomedical Engineering
Period	First semester (Quarter 1A+1B)
Study load	30 ECTS

BNT - Bionanotechnology and Advanced Biomanufacturing			
Quarter 1A	**Quarter 1B**	**Quarter 2A**	**Quarter 2B**
Introduction to Bionanotech & Advanced Biomanufacturing track (5 EC)	**Applied Cell Biology** (5 EC)		
In vitro diagnostics (5 EC)	**Biomedical Materials Engineering** (5 EC)		
Controlled Drug and Gene Delivery (5 EC)	**Elective 1/2:** **Nanomedicine** (5EC) **Lab on a chip** (5EC)		

Required preliminary knowledge: Fundamental knowledge and concepts from cell biology, biochemistry, chemistry, physics: - Biology/Biochemistry: Cell structure, organelles, DNA, RNA, proteins, enzymes, antibodies; - Chemistry: fundamentals of inorganic and organic chemistry, standard techniques; - Physics: Fundamentals of optics, thermodynamics; - Math: Statistics (basics)

201600127 **Introduction to Bionanotech & Advanced Biomanufacturing track**

This course consists of a practical and self-study with diagnostic exams and assignments. During the practicals students are familiarized with working safely in an ML-1 laboratory according to Dutch regulations. Students will be trained in essential lab skills such as pipetting, gel electrophoresis, spectrometry, microscopy and safe and sterile working in a biological safety cabinet. Students will perform an actual cell culture experiment. Students will learn to keep a lab journal at advanced level. The practicals will be performed in small groups with ample opportunity for individual feedback. Data from the cell culture experiment will be presented during a poster presentation.

This course also enables students to search, find, and evaluate scientific literature using the digital library. This also includes proper citing and referencing. Students will receive individual feedback on the search process and search results.

A poster workshop will optimally prepare students how to make and present a scientific poster.

Potential gaps in pre-knowledge will be assessed with diagnostic tests in cell biology and chemistry. Starting point will be to acquire the key learning objectives derived from the bachelor BMT which will be

essential to successfully complete the compulsory master courses in Applied Cell Biology, Tissue Engineering, Biomedical Materials Engineering and various chemical courses. From these diagnostic tests individual study programs will be designed to bridge the knowledge gap (if necessary). During the course additional diagnostic tests will be taken to monitor the progression of the students. If necessary, individual meetings with teaching staff can be arranged to provide the individual student with additional feedback. The final test will be poster presentation of the cell culture experiment placed in a broader perspective related to one of the research theme of this master track, namely, cell material interactions. This will be representative for the required entrance level for the successful completion of the compulsory master courses

201700040 **In vitro diagnostics**

In vitro diagnostics (IVD) is the analysis of bodily fluids and tissue samples for the purpose of medical diagnostics.

Main aims of the course are to understand the requirements an IVD device has to fulfil, to understand the processes and concepts employed in existing IVD devices and to apply this understanding to critically assess recent developments and proposed concepts for targeted biomarkers and/or diseases.

Lecture: After an introduction on the purpose of IVD devices and the requirements they have to fulfil, the lectures will focus on the (bio)-chemical and physical processes and technical concepts employed in these devices:

- Sample preparation techniques
  - enrichment/purification/separation
  - amplification
  - labelling
- Detection techniques:
  - label free
  - fluorescence based
  - electrochemical/electrical
- Microfluidics for IVD
- Point-of-care diagnostics

Students will work in groups to prepare a summary a self-chosen topic (challenge) within the context of in-vitro diagnostics in a presentation. They will develop their own concept to address this challenge and present their solution in a poster presentation

193740010 **Controlled Drug and Gene Delivery**

This course gives a general overview about basic drug and gene delivery technologies and the recent advances and directions of future developments in controlled release technology. Topics included are: fundamental principles of controlled drug and gene delivery and their pharmaceutical applications in various delivery routes (oral, pulmonary, nasal, ocular, brain, etc.); delivery from biodegradable polymeric systems (nanoparticles, hydrogels, microspheres, dendrimers, etc.), microstents and nanodevices; delivery in tissue engineering. The course is composed of tutorial lectures, guest lectures and self-learning assignments (based on industrial and theoretical applications).

201400330 **Applied Cell Biology**

This course consists of theoretical and technical lectures on Applied Cell Biology and an in-depth analysis and oral presentation of a research paper on Applied Cell Biology. Moreover, there is a group assignment on cell biological aspects in the development of an organ on chip including poster presentation and an experiment will be designed based on a hypothesis, perform experiment and verbally report.

201400283 **Biomedical Materials Engineering**

This course deals with the basic principles of tissue-biomaterial interactions, surface modification of biomaterials and polymer processing for regenerative medicine. Moreover, groups of 4-5 students draw up a research proposal that has to be defended during a plenary session.

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

Elective (select 1 course out of 2):

- 201200220 **Nanomedicine** (*name might change*)
  Nanomedicine is one of the most dynamic fields, which holds a high potential to make a huge impact on the medical science. Nanomedicine is in general defined as medical applications of nanotechnology. In recent years, nanotechnologies have been applied for drug delivery, imaging/diagnostics, biosensing, in vitro diagnostics, and tissue engineering. One of the largest areas for nanomedicine is the drug delivery/targeting. Conventional medicine, which are either administered orally or with injections, are not always successful for achieving the desired therapeutic effects but rather show high side effects. Therefore, novel drug delivery systems are highly crucial to develop, using which the drugs can be specially delivered at the targeted site or even to the specific cell types. Using these novel approaches, high therapeutic effects and low/no side effects can be achieved. A large part of the course will be devoted to the drug delivery. Besides drug delivery, nanomedicine includes applications of nanomaterials for imaging and diagnostics as well as theranostics (therapeutics + diagnostics), which will be covered up during this course. Applications to drug delivery and imaging are mostly related to applications of nanotechnologies in vivo. In addition, nanomedicine also covers up in vitro applications such as diagnostics using biosensing techniques and microfluidics. Students will also write a research proposal during this course on an assigned topic of nanomedicine, which allows them to further develop their knowledge on this subject. Altogether this course provides a broader and in depth understanding of the emerging field of nanomedicine.

- 191211120 **Lab on a chip** *(Overlap with Biomedical Materials Engineering)*
  The Lab on a Chip course will take the student to the world of miniaturised systems used in various fields of chemistry and life sciences. A "Lab-on-a-Chip" consists of electrical, fluidic, and optical functions integrated in a microsystem, and has applications in (bio)chemical and medical fields. The core of most lab-on-a-chip system is a microfluidic channel structure, through which nanoliter amounts of liquids with dissolved molecules are propelled, separated and reacted by hydraulic, electrokinetic or surface forces. The fluidic structures are machined in materials like fused silica, borofloat glass, or polymers. The course will treat a number of aspects of such microsystems in seven problem-based learning sessions. Groups of 4 students receive the problem on Monday and try to find solutions to the problem during the week, using a.o. the material offered in a reader. They give a presentation of their solution to the other groups and the teachers on Friday, which is followed by a discussion on the subject treated. The problems offered concern the transport of liquid and dissolved molecules in microsystems, aspects of microfabrication, electrochemical and optical detection methods, the manipulation of cells in microfluidic systems and separations in microfluidic systems. The course is aimed at MSc students of Biomedical Engineering, Electrical Engineering, Nanotechnology, Chemical Engineering, Mechanical Engineering or Applied Physics.