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Training cheques
Ghent University accepts payments by KMO-portefeuille (www.kmo-portefeuille.be; authorisation ID: DV.0103194).

Time
- The programme consists of different sessions. Each session can be followed separately.
- Plenary sessions are organised as follows:
  - 18h00 – 18h30: sandwich and drink
  - 18h30 – 20h00: part 1
  - 20h00 – 20h15: coffee break
  - 20h15 – 21h45: part 2
- Dates may change due to unforeseen reasons.

Location
- Most of the lectures are given in IVPV classroom, building 904, Technologiepark, Zwijnaarde.
- The 7th lesson will be given at Ghent University Hospital with a visit to the INFINITY lab.

Language
- English is used in all presentations, exercises and documentation, so good knowledge of this language is necessary.
livescience is a broad field encompassing different disciplines and expertise, involving biologists, geneticists, biomedical scientists, medical doctors as well as bio- and biomedical engineers and computer scientists. Biomedical technology has acquired a key position in our rapidly evolving high-tech society. In medicine, "translational medicine" has become the new credo; a fast and targeted translation of findings from basic sciences into clinical applications. It should ultimately result in faster application of advanced preventive, diagnostic and therapeutic approaches, personalized and tailored to the specific needs of the individual patient. This novel perspective provides opportunities, both for fundamental research as well as for its translation into medical and industrial applications. The interaction between (molecular) biology and medical technology (micro-electronics ICT, bioinformatics) has led to disruptive and groundbreaking applications in medicine and healthcare.

The aim of the lecture series on "Life Sciences and biomedical technology" is to provide the student, in an accessible and comprehensive way, the essentials of life sciences. Departing from knowledge at the molecular level, we will gradually build up living matter from the micro-(subcellular molecules) to the macro-level (organ and system level), with obviously large attention for the cell and tissue level. Insight will be provided into the molecular and cellular processes that are at the basis of the functioning of the organism, into how genetic information is stored in these cells and how it is coded to synthesize proteins, into cell-cell communication, et cetera. We surpass the descriptive level and update students on recent techniques for the quantitative and qualitative analysis of tissues and cells, with particular attention for the interaction between biology and informatics (bio-informatics), a relatively novel field that emerged from the need for tools for the processing and interpretation of the enormous amounts of data resulting from, for instance, genome analysis.

Who should attend?
The lecture series aims for engineers/physicists (working in industry, government, research, …) with an interest in the broad domain of life sciences, but lack the basic knowledge required to fully grasp the field or to deploy professional activities in the biomedical sector.

At the same time, “Life Sciences and biomedical technology” equally appeals for specialists in the field who wish to update their knowledge and get acquainted with the state-of-the art in life sciences and its quantification and analysis tools.

Scientific Coordination
- Prof. Sofie Belaert, Bimestra-Clinical Research Center Ghent, Faculty of Medicine and Health Sciences, Ghent University
- Prof. Patrick Sengers, Institute Biomedical Technology, Faculty of Engineering and Architecture, Ghent University
- Marc Bracke, Department of Radiation Oncology and Experimental Cancer Research, Ghent University
- Ria Cornelissen, Department of Basic Medical Sciences, Ghent University
- Martine De Vos, Department of Internal Medicine, Ghent University
- Winnok De Vos, Department of Molecular Biotechnology, Ghent University & Department of Veterinary Sciences, University of Antwerp
- Jan Gottenbos, Department of Biochemistry, Ghent University
- Godfriede Gheyser, Department of Molecular Biotechnology, Ghent University
- Filomeen Haenrood, Department of Clinical Chemistry, Microbiology and Immunology, Ghent University
- Geert Leroux-Roels, Department of Clinical Chemistry, Microbiology and Immunology, Ghent University
- Tom Lagahe, Department of Clinical Chemistry, Microbiology and Immunology, Ghent University
- Wim Van Cleirwegh, Department of Mathematical Modelling, Statistics and Bio-informatics, Ghent University
- Tom Van de Wiele, Department of Biochemical and Microbiological Technology, Ghent University
- Mario Vaneechoutte, Department of Clinical Chemistry, Microbiology and Immunology, Ghent University
- Christian Vanhoene, Department of Electronics and Information Systems, Ghent University
- Nadine Van Roy, Department of Pediatrics and Medical Genetics, Ghent University

### PROGRAMME

**1. Architecture and structure of cells**
This first session deals with the architecture, structure and organisation of individual cells, as the smallest unit of an organism. The following topics are covered: the organisation within the cell, the difference between prokaryotic and eukaryotic cells, the elementary building blocks of the cell, biological membranes, et cetera. Date: 25 March 2015 Teacher: Winnok De Vos

**2. Energetic and metabolic aspects of cells**
In this second session, an extensive overview will be given of:
- energetic processes within the cell (e.g. electron transport and functionality role of ATP, phosphorylation, photosynthesis)
- enzymes as catalysts within the cell
- biochemistry and biochemical processes (urea and amino acid processes and phosphorylation)

Date: 1 April 2015 Teacher: Jan Gottenbos

**3. Hereditary information – on DNA and genomes**
This third session focuses on hereditary information and characteristics, and outlines how heritable traits and characteristics are stored within each cell, how this information is transmitted onto next generations, and how these are expressed. In addition, mechanisms of control of gene expression are explained. Date: 22 April 2015 Teacher: Nadine Van Roy

**4. From cell to tissues – techniques for analysis**
Cells with similar shapes and function are organised into subcellular structures, which can be distinguished in an organism, and their most important properties and specific components will be discussed during this lecture. A next level of organisation of tissues results in the formation of organs, interactions between organs ultimately enables the development of an entire system.

In order to render cells and tissues observable under the microscope, they undergo a number of manipulations and preparations that can be summarised as "histological techniques". In the second part of this session, we will focus on the latest recent and state-of-the-art light microscopy based techniques to visualise cells (subcellular organelles) and methods for the quantitative and qualitative analysis of these images. Their role and relevance in the contemporary life sciences research is discussed.

Date: 29 April 2015 Teachers: Ria Cornelissen & Winnok De Vos

**5. Gene technology and molecular diagnostics**
This session offers an overview of methods and techniques has been applied to genetic research in order to manipulate the genome (gene technology) and demonstrates how organisms are identified and their traits and characteristics are analysed (molecular diagnostics).

Topics covered in the gene technology part include how to clone DNA. How to rapidly and add genes to the DNA of an organism (transformation)? How to enhance or inhibit traits & characteristics of specific organisms of the tissue? There will be examples for microorganisms, plants and animals.

Topics treated in molecular diagnostics encompass the earliest generation mass sequencing technologies that allow fast analysis of the entire DNA of an individual, Protonomic rapid and inexpensive techniques to analyse proteins.

Finally, the diagnostic utility of epigenetic markers is elucidated, one of the most recent revolutions in diagnostics. Most (often) tumor cells not only have mutations in the DNA but also dysregulation in the gene expression patterns. These dysregulations cannot be detected at the DNA level, but rather require epigenetic analysis and screening.

Date: 6 May 2015 Teacher: Godfriede Gheyser

**6. Oncology**
Invasive growth and metastasis are crucial mechanisms in the cell during tumor development from benign to malignant tumors. Current knowledge of the underlying molecular signal transduction pathways involved in tumorigenesis and metastasis within individual cells and their environment enables the identification of specific targets for experimental diagnostic and therapeutic applications.

Examples described are: tyrosine kinase inhibitors, PET scan, noninvasive theranostics, exosomes, radiotherapy, vaccination and immune system inhibitors. Ultimately the challenge of therapy resistance will be tackled.

Date: 13 May 2015 Teacher: Marc Braecke

**7. Medical imaging**
Translational research is shaping the practice of modern medicine and the way in which health problems are approached and solved. The use of small-animal models in basic and preclinical sciences is a major keystone for these kinds of research and development strategies, with small animal imaging representing an important bridge between discoveries at the molecular level and the clinical implementation in diagnostics and therapeutics. This lecture will elucidate how the focus in clinical imaging shifted from anatomical imaging to functional and molecular imaging, since the description of the human gene. The importance of small animal imaging, in this era of molecular imaging, will be highlighted.

The lecture will be followed by a visit to the INTRUM (Institute for In Vitro imaging Technology) lab, the small animal imaging facility of Van Beeumen Institute.

Date: 20 May 2015 Teacher: Christian Vanhoene

**8. Introduction into bio-informatics and computational biology**
In the past decades, the complete genome of hundreds of species has been sequenced and mapped. Already to date, available data surpasses the capacity of specialized research teams and their computational resources.

Bio-informatics has emerged as a new field of research, aimed at the design and development of an application of know-how and techniques from informatics and biotechnology: bioinformatics. As such, bio-informatics contributes to a detailed insight in the functioning of living organisms. The field is largely dependent on tools and methods that guarantee an efficient storage, processing and interpretation of enormous amounts of biological data.

It is the goal of this session to familiarise students with the computational, system-biological and algorithmic aspects of the management, analysis and processing of biological data.

Date: 27 May 2015 Teacher: Winnok De Vos

**9. Microbiology and the microbiome**
In the branch of biomedical science that deals with the defense of (host) microorganisms, e.g. potential pathogens (e.g. what is self and what is not). It deals with the defense mechanisms including physical, chemical and biological properties of the organism that help it to combat its susceptibility to infections, treatments, material, etc.

This lecture focusses upon how an infection leads to inflammation (first reaction), and a second line of defense (second reaction). Immune response. Also it is demonstrated how pathogens strive to escape from our immune system, and how this knowledge is translated into novel biomedical applications, like the development of vaccines. Basic knowledge will be provided to understand the consequences of a dysfunctional or failing immune system. In addition, methods and tools to study the immune system and immune response are described in detail. Finally, immune deficiency and related disorders are illustrated.

Date: 3 June 2015 Teachers: Filipien Hamers, Geert Lernout-Boels & Tom Egidi

**10. Microbiology and the microbes**
The last lecture is devoted to microbiology, the broad spectrum of microorganisms bacteria, viruses, fungi, parasites), covering on the human body contains over 10 times more microbial cells than human cells, and they are understood to have an important impact on human health. The human microbiome has gained attention for its role in different diseases, like auto-immune disease, diabetes, rheumatoid arthritis, multiple sclerosis, bowel diseases. Other specific attention is given to dysfunctions of the intestinal microbiome in inflammatory bowel disease and treatment, and tools and methods to study the microbiome.

Date: 13 July 2015 Teachers: Martine De Vos, Tom Van de Wiele & Mario Vaneechoutte

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To receive a certificate, one should attend all the lessons and succeed for the exam.

Post-academic Course Certificate granted by Ghent University

www.ivpv.ugent.be/lifesciences
“Life sciences” is a broad field encompassing different disciplines and expertise, involving biologists, geneticists, biomedical scientists, medical doctors as well as bio- and biomedical engineers and computer scientists. Biomedical technology has acquired a key position in our rapidly evolving high-tech society. In medicine, “translational medicine” has become the new credo; a fast and targeted translation of results from basic sciences into clinical practice. The knowledge and expertise from basic sciences into clinical practice. The knowledge and expertise on the translational axis will increasingly be crucial.

The aim of the lecture series on “Life Sciences and biomedical technology” is to provide the student, in an accessible and comprehensive way, the essentials of life sciences. Departing from knowledge at the molecular level, we will gradually build-up living matter from the micro- (subcellular molecules) to the macro-level (organ and system level), with obviously large attention for the cell and tissue level. Insight will be provided into the molecular and cellular processes that are at the basis of the functioning of the organism, into how genetic information is stored in cells and how it is to be synthesized into proteins, into cell-cell communication, et cetera. We surpass the descriptive level and update students on recent techniques for the quantitative and qualitative analysis of cells and tissues, with particular attention for the interaction between biology and informatics (bio-informatics), a relatively novel field that emerged from the need for tools for the processing and interpretation of the enormous amounts of data resulting from, for instance, genome analysis.

Who should attend?

The lecture series aims for engineers/physicists (working in industry, government, research, …) with an interest in the broad domain of life sciences, but lack the basic knowledge required to fully grasp the field or to deploy professional activities in the biomedical sector.

At the same time, “Life sciences and biomedical technology” equally aims for specialists in the field who wish to update their knowledge and get acquainted with the state-of-the-art in life sciences and its applications and analysis tools.

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Teachers

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1. Architecture and structure of cells

This first session deals with the architecture, structure and organisation of individual cells, as the smallest units of an organism. Cell organelles (mitochondria, centrosomes, etc.) are illustrated.

Date: 29 March 2015
Teacher: Wim De Vos

2. Energetic and metabolic aspects of cells

In this second session, an extensive overview will be given on:

- energetic processes within the cell (electron transport and functionality of ATP, phosphorylation, glycolysis)
- enzymes as catalysts within the cell
- biochemistry and biochemical processes: acentric and acyclic processes and phosphorylations

Date: 1 April 2015
Teacher: Jan Gottenens

3. Hereditary information – on DNA and genes

This third session focuses on hereditary information and characteristics, and outlines how heritable traits and characteristics are encoded within each cell, how this information is transmitted onto next generations, and how these are expressed. In addition, mechanisms of control of gene expression are explained.

Date: 22 April 2015
Teacher: Nadine Van Roy

4. From cell to tissues – techniques for analysis

Cells with similar shapes and function are organised into structures: invertebrates can be divided into an organism, and their most important properties and specific components will be discussed during this lecture. A next level of organisation of tissues results in the formation of organs, interactions between organs ultimately enables the development of an entire system.

In order to render cells and tissues observable under the microscope, they undergo a number of manipulations and preparations that can be summarised as “histological techniques”. In the second part of this session, we will discuss the latest and state-of-the-art light microscopy-based techniques to visualise cells (and subcellular structures) and methods for the quantitative and qualitative analysis of these images. Their role and relevance in the contemporary life sciences research is discussed.

Date: 29 April 2015
Teachers: Jan Cornelissen & Wim De Vos

5. Gene technology and molecular diagnostics

This session offers an overview of methods and techniques that have been applied, in general, to investigate the genetic makeup of an organism (gene technology) and demonstrates how organisms are identified and their traits and characteristics are analysed (molecular diagnostics).

Date: 2 May 2015
Teacher: Sofie Belkaert

6. Oncology

Invasive growth and metastasis are crucial mechanism in the cell during tumor development from benign to malignant tumors. Current knowledge of the underlying molecular gene signal transduction pathways involved in tumorogenesis and metastasis within individual cells and their environment enables the identification of molecular targets, specific compounds (small molecules, peptides, antisense) for experimental and clinical applications.

Examples described are: tyrosin kinase inhibitors, PET scan, nanomotors, therapeutic, RNA interfering, cancer stem cell therapy, molecular signal transduction pathways involved in tumorogenesis and metastasis within individual cells and their environment enables the identification of molecular targets, specific compounds (small molecules, peptides, antisense) for experimental and clinical applications.

Date: 6 May 2015
Teacher: Marthe Boulle

7. Medical imaging

Translational research is changing the practice of modern medicine and the way in which health problems are approached and solved. The use of small-animal models is shown and how progress in translational research can be applied to clinical research.

Date: 9 May 2015
Teacher: Nadine Van Roy

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Date: 27 March 2015
Teacher: Wim Van Creveld

9. Immunology

Immunology is the branch of biomedical science that deals with the response of an organism to exposure to microbial agents, e.g. potential pathogens (infection of what is self and what is not). It deals with the defence mechanisms, including physical, chemical and biological properties of the organism that help it to combat its environment (malignant cells, virus, bacteria, etc.)

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Date: 2 May 2015
Teacher: Filip Meersman, Geert Leroux-Roels & Tom Eglin

10. Microbiology and the microbiome

The first lecture is devoted to microbiology, the broad spectrum of microscopic organisms (bacteria, viruses, fungi, protozoa). The human body contains over 10 times more microbial cells than human cells, and they are understood to have an important impact on human health. The human microbiome has gained attention for its role in different diseases, like auto-immune diseases, diabetes, rheumatological diseases, multiple sclerosis, brain diseases. Specific attention is given to dysbiosis of the intestinal microbiome, inflammatory bowel disease, and treatment, and to tools and methods to study the microbiome.

Date: 17 June 2015
Teacher: Martine De Vos, Tom Van de Wiele & Mario Vaneechoute
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