

## Bio-imaging and Image Informatics (1002617)

**Cursusomvang** (nominale waarden; effectieve waarden kunnen verschillen per opleiding)

**Studiepunten 4.0** **Studietijd 120 u**

**Aanbodsessies in academiejaar 2023-2024**

A (semester 1) Engels Gent

**Lesgevers in academiejaar 2023-2024**

Skirtach, Andre LA25 Verantwoordelijk lesgever  
De Vos, Winnok Medelesgever

**Aangeboden in onderstaande opleidingen in 2023-2024**

	stptn	aanbodsessie
<a href="#">Master of Science in Bioinformatics(afstudeerrichting Bioscience Engineering)</a>	4	A
<a href="#">Master of Science in Bioscience Engineering: Cell and Gene Biotechnology</a>	4	A
<a href="#">Master of Science in de bio-ingenieurswetenschappen: levensmiddelenwetenschappen en voeding</a>	4	A
<a href="#">Uitwisselingsprogramma bio-ingenieurswetenschappen: cel- en genbiotechnologie (niveau master-na-bachelor)</a>	4	A
<a href="#">Uitwisselingsprogramma Bioinformatics (niveau master)</a>	4	A

**Onderwijstalen**

Engels

**Trefwoorden**

Bio-imaging, Microscopy, Image Processing, Image Analysis

**Situering**

The goal of this course is to provide a broad overview of different modalities for acquiring images and analyzing image data sets from biological material at the *nano-, micro- and macroscopic level*, with an eye on extracting qualitative as well as quantitative information.

**Inhoud**

We start off with a module explaining the basic concepts in microscopy-based image formation to define the possibilities and limitations of the available imaging technologies. In this module, standard fluorescence- and transmission light- as well as more advanced electron- and label-free Raman/IR (infrared), AFM (Atomic Force Microscopy) technologies are discussed. Their application ranges, recent developments in research as well as industrial applications (e.g. holographic microscopy) are also considered. The increase in throughput and variability in human interpretation calls for objective, automated image analyses, which will be treated in a second module. Finally, a third module will focus on the state-of-the-art of multimode microscopy integration methods and applications, emphasizing their multidisciplinary character and integration with bio- and nano- technologies.

**Breakdown**

Chapter I. Imaging modalities

- Light Microscopy
  - Basics of Optical Microscopy (bright-field, phase contrast, fluorescence)
  - Advanced Light Microscopy Techniques (confocal, live-cell, non-linear)
  - Fluorophores
  - Single molecule imaging and Superresolution
- Label-free imaging
  - Atomic Force Microscopy (AFM)
  - Raman scattering and IR (infrared) Microscopy
- (cryo)-Electron Microscopy

- Scanning Electron Microscopy
- Transmission Electron Microscopy

#### Chapter II. Image Analysis

- Image Properties and Image Processing
- Raster versus Vector Images
- Pixel, Neighbourhood, Morphological Operations. Kernel
- Frequency Domain and Image Reconstruction
- Image Analysis
- Feature Extraction and Elements of Machine Learning Algorithm

#### Chapter III. Interaction and integration

- Medical Imaging and Photo-manipulation (optical tweezers)
- Correlative, Multimodal (for example, Light and Electron) Microscopy
- High-throughput and lab-on-chip technologies

#### **Begincompetenties**

Basics of cell biology, optics and informatics

#### **Eindcompetenties**

- 1 Understand the basic principles of modern imaging technologies, their components and methods, and their advantages and disadvantages.
- 2 Apply imaging methods including selecting appropriate imaging techniques and sample preparation methods for a biological problem.
- 3 Apply basic image processing in ImageJ, analysis tools, and workflows for image analyses.
- 4 Know bio-chemical and biomolecular principles of fluorescence of molecules.
- 5 Be familiar with modern and recent developments in the area of instrumentation used in biological image formation.
- 6 Know and apply optical ray tracing and propagation in a lens system and a microscope.
- 7 Know the resolution limits of optical, label-free and electron microscopy in regard with applicaiton to cells and biological objects.
- 8 Understand the atomic structure, molecular mechanisms and principles of vibrations of atoms in bio-molecules and thier effect on the scattering of light and electrons.
- 9 Be able to choose appropriate operation conditions and perform alignment of a microscope.
- 10 Know complementarity and applicability of label-free methods versus fluorescece microscopy in biological image formation.

#### **Creditcontractvoorwaarde**

Toelating tot dit opleidingsonderdeel via creditcontract is mogelijk mits gunstige beoordeling van de competenties

#### **Examencontractvoorwaarde**

Dit opleidingsonderdeel kan niet via examencontract gevolgd worden

#### **Didactische werkvormen**

Hoorcollege, Practicum, Zelfstandig werk

#### **Toelichtingen bij de didactische werkvormen**

The course consists of theoretical lectures, which are accompanied by practical sessions/demonstrations (including PC). Hand-out and references contain comprehensive information about all subjects.

A number of practicum sessions are planned. In one of them students build their own microscope based on their calculations. Other practicums involve either direct hands-on work or demos with commercially available instruments.

There are also presentations by groups of students on a chosen subject, which is covered in the course. Some other groups are expected to ask a question or questions related to the subject of the presentation.

#### **Leermateriaal**

Hand-out material; syllabus and slides, open source software (freeware) is used for the excercises; books and references

#### **Referenties**

Most references are in the handout material

#### **Vakinhoudelijke studiebegeleiding**

#### **Evaluatiemomenten**

periodegebonden en niet-periodegebonden evaluatie

**Evaluatievormen bij periodegebonden evaluatie in de eerste examenperiode**

Schriftelijke evaluatie

**Evaluatievormen bij periodegebonden evaluatie in de tweede examenperiode**

Schriftelijke evaluatie

**Evaluatievormen bij niet-periodegebonden evaluatie**

Participatie, Werkstuk

**Tweede examenkans in geval van niet-periodegebonden evaluatie**

Examen in de tweede examenperiode is mogelijk

**Eindscoreberekening**

end-of-term evaluation (90%) continuous assessment (10%)