

IMAGING IN TRANSLATIONAL RESEARCH

STUDY PLAN 2019-2020

Coordinated by:

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GENERAL INFORMATION

Subject Name	Advanced techniques of image analysis
Code	566667
Type	Optional
Teaching	Second semester
Coordinator	Dr. Anna Planas
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ECTS credits	3

OBJECTIVES

The purpose of this subject is to provide students scientific, conceptual, methodological and practical knowledge on biomedical imaging. Students must acquire basic knowledge of a wide range of different imaging modalities applicable in humans and experimental animals. They will be guided by expert teachers through different technologies in order to acquire basic knowledge about imaging techniques and modalities and image analysis. The overall objective of this subject spans from imaging techniques including biological samples for use in microscopy (optical, fluorescence, confocal, and electron microscopy) and flow cytometry, to imaging in vivo including different types of MRI, nuclear medicine techniques (PET and SPECT), optical imaging, fluorescence, chemiluminescence and laser. These techniques will show students the different available tools for biological imaging, from structural to molecular imaging.

COMPETENCES TO BE GAINED DURING THE STUDY

General

- G1: Understand, interpret and discuss issues with clinicians
- G2: Become familiar with bioimaging research progress and learn the tools necessary to access the continuous training
- G3: Read, understand and discuss scientific texts
- G4: Use of spoken and written English

Specific

- S1: Understand the major diagnostic and therapeutic imaging techniques
- S2: Know the latest imaging technology techniques and applications for clinical and basic research as well as their advantages and limitations
- S3: Distinguish, use, and analyze various microscopy and biomedical imaging techniques
- S4: Gain knowledge on processing, quantification and optimization of various types of biomedical images
- S5: Visit experimental units, confocal microscopy, electron microscopy, MRI, and practical demonstration.

THEMATIC BLOCKS

1. Introduction to Imaging Techniques and Analyses
2. Microscopy
 - 2.1. Confocal microscopy
 - 2.2. Microscopic analysis of living cells
 - 2.3. Electron microscopy
 - 2.4. Intravital microscopy
 - 2.5. Microscopy image processing, optimization, and quantification
3. Optical imaging in living animals and humans: laser technology
4. Bioluminescence in experimental research
5. Flow Cytometry: technical description and applications
6. Autoradiography
7. Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT)
8. Magnetic Resonance Imaging (MRI)
9. PET and MRI image analyses

METHODOLOGY

Total training hours: 3 credits ECTS x 25h/credit = 75h

- a) Face-to-face training (32h):
 - Lectures
 - Seminars
- b) Home training (43h):
 - Individual and group work

EVALUATION

To pass the subject, students must obtain a minimum of 50 points. The score will be established as follows:

- **Attendance:** 50% of the overall score
- **Research Project:** 50% of the overall score

To pass the subject, students will have to fulfill three requisites: Attendance-score $\geq 20/50$, research project-score $\geq 20/50$, and overall score (attendance + research project) $\geq 50/100$.

Reevaluation: In case of failing the ordinary evaluation, students will have to send a written report to the coordinator. The re-evaluation the final score will never get over 50 points.

REFERENCES

Books

- Foundation of Medical Imaging, Zang-Hee Cho, J.P. Jones and M. Singh, John Wiley & Sons, Inc, NY, 1993.
- Gonzalez, Woods, Digital image processing. Addison-Wesley
- Confocal Microscopy: Methods and Protocols. Series: Methods in Molecular Biology, Vol. 122 . Paddock, Stephen W. (Ed.) Softcover reprint of hardcover 1st ed. 1999, XII, 446 p. A product of Humana Press. ISBN 978-1-59259-722-2
- Electron Microscopy: Methods and Protocols. Ed. John Ku. ISBN 978-1-59745-294-6
- Electron Microscopy and Analysis, Third Edition. Peter J. Goodhew, John Humphreys, Richard Beanland
- Radiation detection and measurements, G.F. Knoll, John Wiley and sons (1989)
- Current Protocols in Cell Biology. John Wiley and Sons. Somerset, NJ. ISSN 1934-3639. 2012.<http://www.currentprotocols.com/WileyCDA/Section/id-810292.html>

Publications

- James ML, Gambhir SS. A molecular imaging primer: modalities, imaging agents, and applications. *Physiol Rev.* 2012 Apr;92(2):897-965.
- Lopci E, et al. PET radiopharmaceuticals for imaging of tumor hypoxia: a review of the evidence. *Am J Nucl Med Mol Imaging.* 2014 Jun 7;4(4):365-84.
- Czernin J, Ta L, Herrmann K. Does PET/MR Imaging Improve Cancer Assessments? Literature Evidence from More Than 900 Patients. *J Nucl Med.* 2014 May 8;55(Supplement 2):59S-62S.
- Wong FC, Kim EE. A review of molecular imaging studies reaching the clinical stage. *Eur J Radiol.* 2009 May;70(2):205-11
- De Kemp RA et al. Small-animal Molecular imaging methods. *J Nucl Med.* 2010 May 1;51 Suppl 1:18S-32S.
- Niu G, Chen X. Molecular imaging with activatable reporter systems. *Theranostics.* 2012;2(4):413-23.
- Wu JC, et al. Noninvasive optical imaging of firefly luciferase reporter gene expression in skeletal muscles of living mice. *Mol Ther.* 2001 Oct;4(4):297-306.
- Price SJ et al. Methodology of diffusion-weighted, diffusion tensor and magnetisation transfer imaging. *Br J Radiol.* 2011 Dec;84 Spec No 2:S121-6.
- Kamali A et al. Distinguishing and quantification of the human visual pathways using high-spatial-resolution diffusion tensor tractography. *Magn Reson Imaging.* 2014 Apr 13. pii: S0730-725X(14)00126-X. doi: 10.1016/j.mri.2014.04.002
- Walhovd KB et al. Unravelling the secrets of white matter - bridging the gap between cellular, animal and human imaging studies. *Neuroscience.* 2014 Jul 5. pii: S0306-4522(14)00543-0. doi: 10.1016/j.neuroscience.2014.06.058.

Links

- <http://www.bdbiosciences.com/>
- <http://www.leica-microsystems.com/>
- <http://health.siemens.com/>
- <http://www.olympus-global.com/en/corc/history/story/micro/measure/>
- <http://www.olympusmicro.com/primer/techniques/fluorescence/fluorhome.html>
- <http://www.microscopyu.com/articles/fluorescence>
- <http://www.med.harvard.edu/aanlib/home.html>
- <http://www.cis.rit.edu/htbooks/mri/>
- <http://www.imaios.com/en/e-Courses/e-MRI>
- <http://www.humanconnectomeproject.org>
- <http://www.d.umn.edu/~biomed/flowcytometry/introflowcytometry.pdf>

Software

- Image Processing and Analysis in Java (<http://imagej.nih.gov/ij/>)
- FMRIB Software Library v5.0 (<http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/>)
- Statistical Parametric Mapping (<http://www.fil.ion.ucl.ac.uk/spm/>)
- AFNI (<http://afni.nimh.nih.gov/afni>)
- The Brain Imaging Software Toolbox <http://www.bic.mni.mcgill.ca/software/>
- Talairach software (<http://www.talairach.org/>)