IMAGING IN TRANSLATIONAL RESEARCH

STUDY PLAN 2022-23

Coordinated by:

Dr Anna Planas IIBB-CSIC-IDIBAPS Researcher at the team Brain ischemia: Clinical and experimental studies
Dr Guadalupe Soria Assistant Professor at the Laboratory of Surgical Neuroanatomy, Human Anatomy Unit, Health and Life Sciences Faculty, UB

GENERAL INFORMATION

Subject Name	Advanced techniques of image analysis
Code	566667
Type	Optional
Teaching	Second semester
Coordinator	Dr. Anna Planas and Dr Guadalupe Soria
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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) calcium imaging and flow cytometry, to *in vivo* imaging including different types of MRI, nuclear medicine techniques (PET and SPECT), optical imaging, computed tomography, ultrasounds and laser. These techniques will show students the different available tools for clinical and 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 (virtual or face-to face) 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. Flow Cytometry: technical description and applications
5. Calcium Imaging
6. Computed tomography (CT)
7. Magnetic Resonance Imaging (MRI)
8. Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT)
9. PET and MRI image analyses
10. Advances in ultrasound imaging

METHODOLOGY

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

a) Face-to Face (32h): - Lectures
- Seminars

b) Home training (43h): - Individual and group work

EVALUATION

Evaluation criteria:

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

Attendance: 50% of the overall grade (face-to-face classes).
Attendance will be evaluated as: 95%-100% → 50 points / 80% - 95%→ 40 points / 30-80% →20 points / <30% → Subject Failure

Research Project: 50% of the overall score
To pass the subject, students will have to fulfill three requisites: Attendance-score ≥ 20/50, research project-score ≥20/50, and overall score (attendance + research project) ≥ 50/100.

Reevaluation: In case of failing the ordinary evaluation, students will have to critically appraise 2 scientific articles and send the analysis by email to the coordinators. The re-evaluation 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 Toolboxhttp://www.bic.mni.mcgill.ca/software/
- Talairach software (http://www.talairach.org/)