INTRODUCTION TO FUNCTIONAL MAGNETIC RESONANCE IMAGING

NUMBER: GMS 6082 LAST UPDATE: 10/25/2017

CREDIT: 1

LOCATION: L1-101 NEUROSCIENCE CONFERENCE ROOM MCKNIGHT BRAIN INSTITUTE

TIME: SPRING 2018 (03/19/18 - 04/25/18), TUES-THURSDAY 10AM-12PM (3RD MODULE)

"These facts seem to us to indicate the existence of an automatic mechanism by which the blood supply of any part of the cerebral tissue is varied in accordance with the activity of the chemical changes which underlie the functional action of that part"

Cite from: C.S. Roy and C.S. Sherrington, On the Regulation of the Blood Supply to the Brain, Journal of Physiology, 1890

INSTRUCTOR: Marcelo Febo, Ph.D.

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OFFICE HOURS: By prior appointment with Dr. Febo or course TA

COURSE COMMUNICATIONS: A discussion board will be available soon on the UF e-Learning support services: https://elearning2.courses.ufl.edu. For urgent matters, students may also contact professor directly by email or schedule an office hour appointment.

RECOMMENDED TEXT(S): Textbooks are not required but are recommended. One of the following may be used:

Huettel, Song and McCarthy, **Functional Magnetic Resonance Imaging** *2nd Edition* 2009 Sinauer Associates. [Provides basic introduction to fMRI concepts]

Buxton, **Introduction to Functional Magnetic Resonance Imaging: Principles and Techniques**, 2nd Edition, Cambridge. [Provides more advanced and in-depth introduction]

ADDITIONAL RESOURCES: The professor will also assign selected readings from the literature as an advanced supplement to textbook chapters. See below for representative papers under 'Scheduled Topics Overview'.

COURSE DESCRIPTION: Introduction to Functional MRI will provide students with the basic and practical principles underlying fMRI of the brain. Students will complete the course having an in-depth introduction to neurophysiological mechanisms that couple magnetic resonance phenomenon to task- or stimulus-dependent changes in neuronal activity and cerebral metabolism.

PREREQUISITE KNOWLEDGE AND SKILLS: *Consent of instructor.* There are no prerequisite courses. However, it is strongly recommended that students take **Basic Magnetic Resonance Imaging GMS 6080** (Dr. Stephen J. Blackband) for an introduction to basic mechanisms underlying nuclear magnetic resonance.

PURPOSE OF COURSE: To have an in-depth introduction to the neurophysiological mechanisms contributing to *f*MRI signals.

COURSE GOALS AND/OR OBJECTIVES: Upon completion students will (i) critically articulate, write and explain neurophysiological literature applying functional MRI, (ii) have basic experience with fMRI data handling and analysis, and (iii) will learn the basic skills needed to pursue application of fMRI in their own research to investigate neural mechanisms.

TEACHING PHILOSOPHY: We will emphasize basic concepts under a variety of topics in order to explore physiological mechanisms contributing to fMRI signals. Discussions are expected to be carried out at a high level and to be interactive, with students contributing to the topics. Students are encouraged to think how these mechanisms apply to their own area of study and how they may design studies to examine specific questions in their fields using fMRI.

INSTRUCTIONAL METHODS: Learning in the course is intended to be a product of interactive and dynamic discussions, with introductory lectures and discussions by the instructor combined with student presentations on assigned material, critical thinking questions and one hands-on workshop session. Expert faculty/researcher guests may be invited to supplement class lectures/discussions.

COURSE POLICIES:

ATTENDANCE POLICY: Attendance is important. Absence may occur due to personal or health reasons. The student should meet with the professor to discuss and obtain the missed class materials.

QUIZ/EXAM POLICY: Exams will be given either as take home tests to be handed in on specific dates or in class exams.

MAKE-UP POLICY: Requirements for class attendance and make exams, assignments, and other work in this course are consistent with university policies that can be found at:

https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

ASSIGNMENT POLICY: Assignment policies are consistent with university policies. In general, acceptable reasons for absence from or failure to participate in class include illness, serious family emergencies, special curricular requirements (e.g., judging trips, field trips, professional conferences), military obligation, severe weather conditions, religious holidays and participation in official university activities such as music performances, athletic competition or debate. Absences from class for court-imposed legal obligations (e.g., jury duty or subpoena) must be excused. Other reasons also may be approved.

COURSE TECHNOLOGY: Students will access lectures online through the UF e-Learning system. We may hold a practical learning session and may ask students to bring laptop computers, if available.

UF POLICIES:

UNIVERSITY POLICY ON ACCOMMODATING STUDENTS WITH DISABILITIES: Students requesting accommodation for disabilities must first register with the Dean of Students Office (http://www.dso.ufl.edu/drc/). The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation. You must submit

this documentation prior to submitting assignments or taking the quizzes or exams. Accommodations are not retroactive, therefore, students should contact the office as soon as possible in the term for which they are seeking accommodations.

UNIVERSITY POLICY ON ACADEMIC MISCONDUCT: Academic honesty and integrity are fundamental values of the University community. Students should be sure that they understand the UF Student Honor Code at http://www.dso.ufl.edu/students.php.

NETIQUETTE: COMMUNICATION COURTESY: All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats. [Describe what is expected and what will occur as a result of improper behavior]
http://teach.ufl.edu/docs/NetiquetteGuideforOnlineCourses.pdf

MAKE-UP EXAMS: Students may take missing exams. The student will need to coordinate with the professor to take the exam outside of the normal class hours. A reasonable excuse consistent with University Policies listed above under 'Assignment Policy" will be requested from the student.

GETTING HELP:

For issues with technical difficulties for E-learning in Sakai, please contact the UF Help Desk at:

- Learning-support@ufl.edu
- (352) 392-HELP - select option 2
- https://lss.at.ufl.edu/help.shtml

** Any requests for make-ups due to technical issues MUST be accompanied by the ticket number received from LSS when the problem was reported to them. The ticket number will document the time and date of the problem. You MUST e-mail your instructor within 24 hours of the technical difficulty if you wish to request a make-up.

Other resources are available at http://www.distance.ufl.edu/getting-help for:

- Counseling and Wellness resources
- Disability resources
- Resources for handling student concerns and complaints
- Library Help Desk support

Should you have any complaints with your experience in this course please visit
http://www.distance.ufl.edu/student-complaints to submit a complaint.

GRADING POLICIES:

GRADING SCALE: Letter scheme. *For more information, see:* http://www.isis.ufl.edu/minusgrades.html*].* The grading is based on the **total sum** of all the requirements listed in the following section. The percent of the total points is used for establishing the final grade for each student. The following scale is used:

A = 100 - 88; **B** = 87 – 77; **C** = 76 – 68 ; **D** = 67 – 54; **F** = Less than 54

GRADE REQUIREMENTS:

Exam1 *Basic mechanisms*	10%
Exam 2 *Physiological mechanisms*	10%
Exam 3 *Methodological considerations*	10%
Exam 4 *Modern state of the art applications*	10%
Class Presentations	30 %
Class Participation	30 %

*No final exam

COURSE SCHEDULE:

FINAL EXAM: Final exam is not given. Students are graded as indicated above.

SCHEDULED TOPICS OVERVIEW (SUBJECT TO CHANGE):

Mar. 24-26 Introduction to fMRI

- Course overview. Historical overview of fMRI
- Basic mechanisms review (from protons to functional maps)

historical papers assignment

Mar. 31-Apr 2 Exploring The Physiology of the Blood Oxygen Level Dependent (BOLD) signal

- The BOLD effect
- Cerebral Energetics
- Hemodynamic mechanisms
- Neuron-vascular coupling mechanisms

physiological mechanisms influencing BOLD

Apr. 7-9 Methodological Considerations (Practical Session)

- Mapping functional activation in the brain
- Introduction to Study Design, Data Collection, Data Processing and Analysis, Interpretations (*Computer Sessions With Medical Image Visualization and Analysis, Analysis of Functional NeuroImages and/or Statistical Parametric Mapping version 8*)

Take home: 'sample data crunching'

Apr. 14-16 Modern Functional Brain Mapping Techniques

- Invited *Faculty Expert Lecture on Neuro-vascular coupling*

- Cerebral Blood Flow Methods (arterial spin labeling)

- Cerebral Blood Volume Methods (Iron Oxide Contrast Agents)

- Multimodal MRI

Take home: design a study

Apr. 21-23 State of the art Applications

-Resting State *f*MRI, Pharmacological MRI, Comparative/Translational MR Imaging (Animal MRI)

-Psychiatry, Neurology applications.

In class: Study presentation, comparison to published article

Representative Readings:

Malonek, D., Dirnag l,U., Lindauer, U., Yamada, K., Kanno, I.,and Grinvald, A.(1997).Vascular imprints of neuronal activity: relationships between the dynamics of cortical blood flow, oxygenation, and volume changes following sensory stimulation. Proc. Natl. Acad. Sci. U.S.A. 94, 14826–14831.

Malonek, D.,and Grinvald, A.(1996). Interactions between electrical activity and cortical microcirculation revealed by imaging spectroscopy: implications for functional brain mapping. Science 272, 551–554.

Thompson, J.K.,Peterson,M.R., and Freeman,R.D.(2003).Single neuron activity and tissue oxygenation in the cerebral cortex. Science 299, 1070–1072.

Kasischke, K.A.,Vishwasrao, H.D., Fisher,P.J., Zipfel, W.R., and Webb, W.W.(2004). Neural activity triggers neuronal oxidative metabolism followed by astrocytic glycolysis. Science 305, 99–103.

Fox, P.T., and Raichle, M.E.(1986). Focal physiological uncoupling of cerebral blood flow and oxidative metabolism during somatosensory stimulation in human subjects. Proc. Natl. Acad. Sci. U.S.A. 83, 1140–1144.

Fox, P.T., Raichle, M.E., Mintun, M.A., and Dence, C.(1988). Nonoxidative glucose consumption during focal physiologic neural activity. Science 241, 462–464.

Lee,S.P., Duong, T.Q., Yang,G., Iadecola, C.,and Kim,S.G.(2001). Relative changes of cerebral arterial and venous blood volumes during increased cerebral blood flow: implications for BOLD fMRI. Magn. Reson.Med. 45, 791–800.

Logothetis, N.K., Pauls,J., Augath, M., Trinath,T., and Oeltermann,A. (2001). Neurophysiological investigation of the basis of the fMRI signal. Nature 412, 150–157.

Davis, T.L., Kwong, K.K., Weisskoff, R. M., and Rosen, B.R. (1998). Calibrated functional MRI: mapping the dynamics of oxidative metabolism. Proc. Natl. Acad. Sci. U.S.A. 95, 1834–1839.

Attwell, D., and Iadecola, C. (2002). The neural basis of functional brain imaging signals. Trends Neurosci. 25, 621 - 625.

*Disclaimer: Topics outlined in the schedule above are subject to change. The present syllabus represents the instructor's current plans and objectives. As the course progresses, scheduled topics and the instructor's considerations of relevant topics may change in order to enhance the student's learning. Such changes will be communicated clearly and in a timely fashion, and is not unusual or unexpected.