

**BIBB 421**  
**Human Brain Imaging**  
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**Course Syllabus**

1/21/15 General and Historical Introduction: The first class will lay the framework for the remainder of the course by considering the history of the study of the mind and brain. Definitional issues will be considered in terms of the difference between the mind and brain and consciousness. What are the different types of imaging studies that are available will be discussed and how they relate to clinical and research applications. All reviews are intended to provide insight into the development of techniques and expand upon the students' prior education in imaging studies and place emphasis on translational research and ultimately clinical utility. Furthermore, less common applications of these techniques will also be considered such as medicolegal issues.

1/28/15 Introduction to Brain Function: This will review basic concepts of brain function specifically with regard to how brain imaging techniques are currently utilized. This discussion will review how different nerve cells work, the synapse, metabolic and neurotransmitter measures and some review of disease states and psychopharmacology. This entire review will bridge the molecular biology with molecular imaging. Thus, issues pertaining to specific neurophysiological processes will be demonstrated by exploring the development of imaging techniques designed to study such processes.

2/4/15 Basics of Magnetic Resonance Imaging: This session will review the basic physics of MRI instrumentation and image acquisition. Much of the focus will be on functional MRI. Current applications and developments in research will be discussed. This might include a guest speaker from the MRI center. Since students will likely have some working knowledge of MRI, this session will delve into more specific issues with the use of this imaging modality for research and clinical purposes. Cutting edge developments at Penn and other institutions will be discussed as well as the limitations of this technique and comparison with other techniques. The discussion will frequently be clinically oriented.

2/11/15 Basics of Nuclear Medicine (Shortened Class Day): This class will review instrumentation, image acquisition, and radiopharmaceuticals for positron emission tomography and single photon emission computed tomography. The use of these techniques for various types of studies as well as the strengths and weaknesses of each technique, also in comparison to fMRI, will be discussed. Students will likely have less knowledge of nuclear medicine basics, and while it will not be expected that students develop technical expertise in these techniques, issues will be emphasized that may have an impact on deciding which type of imaging modality to use for a particular study and how that modality will actually be used including its advantages and disadvantages. A number of clinical and research studies performed at Penn and other institutions will provide the underlying setting for this discussion.

2/18/15 Basics of Nuclear Medicine II and Image analysis, statistical problems, and study design: This will introduce the topic of how studies are actually interpreted. The various methods for evaluating scans both quantitatively and qualitatively will be discussed. We will also review various statistical methods and how they can be utilized to analyze various types of imaging studies. This session will enhance the students analytical understanding of the advantages and disadvantages of analytical

modalities they will encounter in the literature. This will include a review of traditional and non-traditional methods. A particular focus will be how such studies can lead to clinical applications in psychiatric and neurological disorders. Basic concepts regarding how to critically analyze articles, what problems and issues need to be considered, and data interpretation and statistical analysis will be covered. Issues pertaining to ethical research and various regulatory problems related to radiation exposure and investigational new drugs will be discussed.

2/25/15 Introduction to activation studies: This session will review activation studies, what they are, what has been their impact, how they are performed, and what are their implications. Particular attention will be given to the specific types of results that can be obtained and how they can be interpreted. Students will likely have some knowledge of activations studies in the brain, but this session will explore issues pertaining to study design as well as how such designs may ultimately have clinical applications. The use of activation studies in various disease states such as ADHD, stroke, and seizure patients to determine which areas of the brain are most affected will frame the discussion.

3/4/15 Imaging of Neurological Disorders: This class will review the imaging findings from the various modalities in a variety of common neurological disorders. Emphasis will be on diagnosis, follow-up, management, and the development of future therapeutic interventions. Neurological disorders that will be a primary focus will include Alzheimer's disease, Parkinson's and other movement disorders, seizure disorders, stroke, head injury, and infectious diseases such as Lyme disease. Current clinical and basic research applications of imaging studies will be discussed to demonstrate how imaging can be utilized from the bench top to general practice.

3/11/15 Spring Break, No Class.

3/18/15 Journal Article Presentation: Each student will make a 10 minute presentation describing a research article that they have chosen. They will review the article and critically analyze its findings. They will also suggest the research and clinical implications of such findings.

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4/1/15 No Class

4/8/15 Imaging of Psychiatric Disorders: This class will review the imaging findings from the various modalities in a variety of common psychiatric disorders including depression, bipolar disease, obsessive compulsive disorder, schizophrenia, anxiety, and eating disorders. Emphasis will be on diagnosis, follow-up, management, and the development of future therapeutic interventions.

4/15/15 Tour of Functional Imaging Facility (tentative): This session will explore how experiments designed to explore the human mind during spiritual experiences are developed and performed. The tour will be of the imaging facilities at the Hospital of the University of Pennsylvania.

4/22/15 Miscellaneous Brain Imaging Modalities: This class will explore a variety of other imaging modalities that can assess overall or specific brain function. Such modalities will include NMR spectroscopy, optical imaging, transcranial magnetic resonance imaging, and EEG spectroscopy.

4/29/15 Implications for Understanding the Human Mind: This final class will consider how imaging studies of the human mind have led to many different interpretations about human behavior. The focus here will be on the more complex types of human behaviors and cognitions such as moral thinking,

religion and spirituality, happiness, sexuality, and emotions. Other fields including law, anthropology, economics, and philosophy will be considered. Neuroimaging of complex behaviors and cognitive processes will reveal an underlying complexity of human society and human consciousness. Issues pertaining to ethics, consciousness, and epistemology will be reviewed with a final discussion about the future of neuroimaging both in terms of techniques, possibilities and limitations.

### **Course Requirements**

Class attendance and participation and the readings are required and constitute 15% of the grade. Unexcused absence from more than two classes may result in failure from the course. There will be a “letter of intent” (2-3 pages in length which will be due on February 25<sup>th</sup>) that will briefly describe your plans for your research proposal (this will constitute 15% of your grade). A journal article presentation will constitute 20% of the grade and the final paper will constitute 50%. The final paper will be a 15-20 page research proposal that will address a particular issue and determine which type of imaging modality is most appropriate, how the study will be designed and analyzed, and how the study might ultimately be performed. This project will be initiated during the first class and each subsequent class will be utilized to further develop the project proposal. The proposal will be written in the form of an NIH proposal and topics must be approved by the instructor. It will include a specific aims, background section, methods, limitations, and interpretation sections. Students must develop the proposal ideas and determine which imaging modalities will be best and how they will be applied. The paper must be adequately referenced.

All readings will be from a large bulk pack prepared for the class and available at the copy center or on the Canvas.