**Fundamentals of Neuroimaging**

**BENG 485 / 585**

Instructors:               D. S. Fahmeed Hyder <fahmeed.hyder@yale.edu>

                                  203-785-6205 (Fahmeed Hyder) or 203-785-6199 (Lesley Nadeau)

                                  Douglas L. Rothman <douglas.rothman@yale.edu>

                                  203-785-6202 (Douglas Rothman) or 203-785-6199 (Lesley Nadeau)

                                  Elizabeth Goldfarb <elizabeth.goldfarb@yale.edu>

                                  Department of Psychiatry

Time:                         Wednesday, 3:30-5:30 pm (all classes will be hybrid)

Location:                   WLH 116

TAs: Jessica Santana <jessica.santana@yale.edu>

                                  Horace Zhang <horace.zhang@yale.edu>

                                  Rachel Welch <rachel.welch@yale.edu>

### Course Description

To understand the neuroenergetic and neurochemical basis of several dominant neuroimaging methods, including fMRI. Topics will range from technical aspects of different methods to interpretation of the neuroimaging results and data analysis. Controversies and/or challenges for application of fMRI and related methods in medicine will be identified. In addition to scientific topics covered, the course engages the student to actively work on scientific dissemination (written and oral forms) as well as the art of team collaboration.

### Course Format

Class meets once a week in person, and class will be recorded by Zoom for students to refer to material after class. Reading and writing assignments each week. One formal collaborative presentation in a team. Two mid-sized papers, with feedback.

### Enrollment Cap, Selection Process, and Notification (if applicable)

While priority is given to juniors/seniors, freshman/sophomores are also included to represent diversity in STEM backgrounds in each class. Although STEMs major is not necessarily a prerequisite, familiarity with STEM materials will benefit. Please provide the following information (Name, Email, Year of Study, Major, STEM courses, Audit/Credit, Additional Information (50 words max), Level of Enthusiasm by %). An example of the Additional Information could be "I am fascinated by possibility of using brain imaging to read minds." Please send this information by email to Fahmeed Hyder <fahmeed.hyder@yale.edu> using your own Yale email. Our first class meets 1/18/2023 at 3:30pm. The information you provide will help us prioritize the class size in relation to TAs allocated (Jessica Santana <jessica.santana@yale.edu>, Horace Zhang <horace.zhang@yale.edu>, Rachel Welch <rachel.welch@yale.edu>).

### Prerequisites

STEM major is preferred.

### Assessments and Grading

Read 20-40 pages of main text each week. Engage in class discussions. Selected participants will present seminars in class.

                                    Weekly synopsis (double spaced, no figures, 350 words maximum, 200 words minimum)

                                                - Arguments for/against

                                                - Be precise and succinct

                                                - Feedback/questions on synopsis

Two up-to-date reports on chosen or assigned topics. Papers may be proposal style using principles presented in lectures.

- Midterm paper 5 pages (double spaced without figures, 1” margin all around).

- Feedback on midterm paper

- Final paper 10 pages (double spaced without figures, 1” margin all around).

- Feedback on final paper

### Diversity, Equity, Inclusion & Belonging

Collective understanding of any scientific discipline requires pluralistic perspectives, and in no other field is this more appropriate and necessary than in the field of neuroimaging. Brain imaging sciences is an extremely diverse field, as will be demonstrated every day in this course, in terms of range of expertise and topics – and also people. We welcome these diverse ideas and views as we strive for their equal representation, but with careful navigation around flaws and pitfalls. By working within team settings/presentations and also open class discussions, we aim towards being inclusive of views and ideas with mutual respect. Furthermore, the in-person course experience provides a great sense of belonging for students who are generally interested in brain and mind, as the sciences required to understand either or both requires perspectives across multiple disciplines, as the curriculum demonstrates.

### Accessibility

We provide equitable academic experiences for students and other people auditing the course – including with disabilities – to the course materials, using a variety of technological means. Even prior to Covid, this course has always maintained a mind towards access to all materials covered in class and discussions, including the video recordings of each and every class. Any students/persons with questions about challenges to access of materials should feel free to reach out to instructors and TAs.

### Grading

Students taking the course for credit will be graded based upon: weekly class participation which includes attendance (7.5%), discussion (7.5%), 1-page synopsis reports of weekly lectures (15%), a collaborative class presentation (20%), and the two papers (50%).

Due dates for synopsis/papers with -5% of score per day for delays.

Synopsis:                   following Sat at 6 pm

Midterm paper:          Monday 3/27 at 6 pm

Final paper:                Wednesday 5/04 at 6 pm

The word limit is very important to keep in mind. Each of the 12 narratives covers different subjects (see Syllabus). The objective of the narrative is to cover that subject matter as reflected in class. Think of a peer who misses that class but he/she can get a general overview of what was discussed in class by reading your narrative. Goal is to achieve that within the word limit. If you have additional space, then you can provide additional materials pertaining to the subject matter of the class which you deem as important.

### Required Course Materials

Everything will be provided on Canvas

Main text:                   1. “Brain Energetics & Neuronal Activity” (Wiley 2004). Shulman and Rothman

(will be kept on reserve at the MRRC library; contact Lesley Nadeau)

Secondary text:           1. On-line and photocopied materials will also be distributed when needed.

1. “Dynamic Brain Imaging” (Humana Press 2009). Hyder (will be kept on reserve at the MRRC library; contact Lesley Nadeau and specific chapters will be made available in Canvas)

3. “Brain Imaging: What it Can (and Cannot) Tell Us About Consciousness” (Oxford 2013) Shulman (will be kept on reserve at the MRRC library; contact Lesley Nadeau)

### Recording Policy

Class will be recorded by Zoom with permission from students. All materials will be for BENG 485 course requirements for the current semester only.

### Course Video

EMBED VIDEO HERE

(Closed Captioning will be made available for all Welcome Videos)

### Syllabus

**Syllabus for BENG 485 / ENAS 585 “Fundamentals of Neuroimaging”**

1/18     Lecture 1         FH                   Class overview and some introduction to NMR principles

1/25     Lecture 2         EG & DLR     fMRI Data Analysis (out of text) and Energy Metabolism (Chapters 1 and 2)

2/01     Lecture 3         FH         Principles of MRI and MRS (Chapter 3 & parts of Chapter 9)

2/08     Lecture 4         Team 10          Neurotransmission & Neuroenergetics (glutamate, GABA) (Chapter 4-6)

2/15     Lecture 5         Team 9            Bioelectricity & Neuroanatomy (parts of Chapter 7 & 10)

2/22     Lecture 6         Team 7           Bottom up cortical energy budget (Chapter 7)

3/01     Lecture 7         Team 5            17O MRS and calibrated fMRI for energy (Chapter 8 & 9)

3/08     Lecture 8         Team 3            Relationship of energy and activity (Chapter 10)

3/15 Spring Break

3/22 Spring Break

3/29     Lecture 9       Team 4 / EG    Psychology: Long term memory (Chapter 14) + conventional fMRI analysis

4/05     Lecture 10       Team 1 / EG    Psychology: Mind and Brain (Chapters 15-17) + advanced fMRI analysis

4/12     Lecture 11       Team 2            Clinical: Cancer (out of textbook)

4/19     Lecture 12       Team 8            Clinical: Epilepsy (Chapter 11 and 12)

4/26     Lecture 13       Team 6            Clinical: Other + Psychiatric disorders (Chapter 13)