Department of Medical Biophysics
MBP 9518B, "Molecular Imaging"

Calendar Description:
This course will introduce the role of diagnostic imaging in detecting molecules, genes, and cells in vivo. Emphasis will be in how these techniques can help study molecular mechanisms of disease *in vivo*. Topics include DNA/protein synthesis, transgenic mice, novel contrast agents and small animal imaging. Students will be evaluated based on an oral presentation of a journal article and a written literature review.

Recommended Prerequisites: **475A or 515A**
Notes: Directed reading assignments will be necessary for students who do not have some biology in their academic training.

Location: Medical Biophysics Conference Room M493 (Medical Sciences Bldg)
Lecture Hours: Mon and Wed 2:30-4:00

Weight: Half Course (1 term)
When Offered: Winter Term 2017

Learning Outcomes

GOALS:

At the end of this course, students will:
1. Have an understanding of how different imaging modalities can be used to examine molecular and cellular processes.
2. Will be able to apply this knowledge to mechanisms of disease progression and therapy.

OBJECTIVES:

Students will demonstrate their mastery of the course content by:

1. Defining the concept of "molecular imaging."
2. Understanding standard methods and models in molecular and cell biology
3. Understanding how imaging modalities are adapting to image genes, molecules and cells.
4. Combining their knowledge of imaging with methods in molecular and cell biology.
5. Applying concepts of molecular imaging to examining molecular mechanisms of disease, such as cancer, cardiovascular disease, diabetes, and neurological disorders.
6. Critically evaluating the current literature on molecular imaging.
7. Predicting how molecular imaging will advance the understanding of both normal physiology and disease progression, from both scientific and clinical perspectives.

Lecture Schedule

Wed Jan 4	Dhanvantari	Intro
Mon Jan 9	Dhanvantari	DNA & Transcription
Wed Jan 11	Dhanvantari	mRNA translation
Mon Jan 16	Goldhawk	Techniques in molecular biology I
Wed Jan 18	Goldhawk	Techniques in molecular biology II
Mon Jan 23	Ronald	DNA minicircles for imaging
Wed Jan 25	Dhanvantari	Radiogenomics
Mon Jan 30	Dhanvantari	Imaging gene silencing by noncoding RNAs
Wed Feb 1	Dhanvantari	Imaging cellular compartments and transport
Mon Feb 6	Dhanvantari	Imaging cell migration and development
Wed Feb 8	Dhanvantari	Imaging apoptosis
Mon Feb 13	Hoffman	Stem cell biology

Wed Feb 15	Hoffman	Gene targeting and transgenics
Mon Feb 20	Family Day	No Lecture
Wed Feb 22	Foster	Cellular MRI
Mon Feb 27	Foster	MR contrast agents
Wed Mar 1	Foster	Molecular MRI
Mon Mar 6	Thiessen	PET instrumentation
Wed Mar 8	Thiessen	PET/MRI hybrid imaging
Mon Mar 13	Ward	Radiomics
Wed Mar 15	ImNO	No Lecture
Mon Mar 20 *will be held at Lawson, followed by tour of the Nordal Cyclotron and PET Radiochemistry facility	Hicks	SPECT/PET Isotope Generation and Pharmacokinetics
Wed Mar 22	Luyt	Targeted probes for SPECT/PET and optical imaging
Mon Mar 27	Diop	Optics: image quantification in deep tissue
Wed Mar 29	Kerfoot	In vivo fluorescence imaging

Mon Apr 3	Heit	Optics: super-resolution microscopy
Wed Apr 5	Lacefield	Ultrasound
Mon Apr 10	Carson	Photoacoustics
Apr 12, 17	No lecture	
Wed Apr 19	Students!	Oral Presentations

Written Review Due Date: Thursday May 11, 5:00 pm.

Evaluation

- **Oral presentation: 40%**
  - You will choose a journal article to present
  - Article must NOT be related to your thesis topic!!!
  - Article must contain all the elements of molecular imaging: molecular biology (clonal cells, animal models, stem cell biology, protein-protein interactions), chemical probe design, and imaging
  - 15 min presentation, 5 min discussion (20 min total)
  - *Everyone* will participate in evaluation!
  - Sample topics: Image-guided stem cell therapy
    Imaging transplanted islets and islet regeneration
    Imaging cancer and tumours
    Cardiovascular imaging
    Brain mapping
    Imaging infectious disease
    Imaging protein-protein interactions
    Drug delivery applications

Oral Presentation Score Sheet

Name of Presenter and Title of Article:					
Score	**1**	**2**	**3**	**4**	**Totals**
Organization	Audience cannot understand presentation because there is no sequence of information.	Audience has difficulty following presentation because student jumps around.	Information presented in logical sequence .	Information presented in logical, interesting sequence. Tells a "story".	/4
Subject Knowledge	No grasp of information; student cannot answer questions about subject.	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student is at ease with expected answers to all questions directly related to the paper.	Student demonstrates full knowledge of the paper and related literature. Answers all questions with explanations and elaboration.	/4
Use of Audiovisual Equipment	Superfluous graphics or no graphics.	Occasional use of graphics that rarely support text and presentation.	Figures used are directly from the paper and relate to text and presentation.	Use of additional figures/schematics to enhance and reinforce screen text and presentation.	/4
Eye Contact	Student reads all of report with no eye contact.	Student occasionally uses eye contact, but still reads most of report.	Student maintains eye contact most of the time but frequently returns to notes.	Student maintains eye contact and actively engages the audience.	/4
Elocution	Student mumbles and speaks too quietly for students in the back of class to hear.	Student's voice fades in and out. Audience members have difficulty hearing presentation.	Student's voice is clear. Most audience members can hear presentation.	Student uses a clear voice, with appropriate emphasis and enthusiasm.	/4
				TOTAL SCORE	/20

- **Written evaluation: 40%**

Based on the article selected for oral presentation, select up to 10 additional key articles. Based on these articles, a 5-page minireview will be written as follows:

Abstract: 150 word summary (not included in page limit)

Introduction: one paragraph introducing the subject/disease/molecular process

2-3 sections: discuss articles critically; use subheadings to divide up into imaging modalities, different probes within same modality, different biological approaches, etc. Include figures/tables/schematics with appropriate acknowledgements.

Conclusion: Where does the field stand currently? What questions remain unresolved? Where will it move in the future? What improvements in probe development/ imaging parameters are required to answer the next big biological question?

References: Max of 10! Emphasis on primary literature, NOT reviews. (not included in page limit).

The rest of the evaluation….

- Attendance and participation in class: 20%
  - Ask questions, initiate discussion, responding to instructors' prompts/questions
  - Be an Active Participant!

How To Read Scientific Articles: A Guide

- It takes TIME to read an article
- Plan your reading over a few days, NOT in the hour before class!
- Follow the instructor's discussion points.
- Read the details on items you understand; you will lead the discussion on these parts
- Make notes of things you don't understand; others will lead the discussion and you can ask them questions

How To Read Scientific Articles: A Guide

Discussion points:

- What is the biological process being studied? What is the rationale of the study?
- What are the imaging modalities? Why were these modalities chosen?
- What is the probe? How was it designed?
- How did they validate their probe?
- Was the in vivo imaging convincing? Why or why not?
- How would this probe be used to image a biological process?

Reading for the lecture:

In vivo PET imaging of histone deacetylases by ^{18}F-suberoylanilide hydroxamic acid (^{18}F-SAHA)

Hendricks JA, Keliher EJ, Marinelli B, Reiner T, Weissleder R, Mazitschek R 2011 J Med Chem 54:5576-5582

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- What is the biological process being studied? What is the rationale of the study?
- What are the imaging modalities? Why were these modalities chosen?
- What is the probe? How was it designed?
- How did they validate their probe?
- Was the in vivo imaging convincing? Why or why not?
- How would this probe be used to image cancer development/therapy?