Subject Description Form

Subject Code	BME5051
Subject Title	Molecular and Functional Imaging: From Body System to Molecules
Credit Value	3
Level	5
Responsible staff & Department/School	Dr Puxiang LAI (BME)
Pre-requisite / Co-requisite/ Exclusion	None
Objectives	To introduce key concepts, principles and specific applications of a variety of functional imaging techniques that are used to reveal how the body works, to detect abnormalities at molecular, cellular, tissue, organ and body system levels, and to provide insight into how functional and molecular imaging techniques and informatics can help guide development of drugs, drug delivery systems and tissue engineering or replacement.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe the development of a range of imaging techniques used in health science and technology, with emphasis on functional and molecular imaging b. Discuss the applications of selected imaging techniques used in health science and technology, from molecular level to whole body level c. Discuss how selected pathological conditions are investigated by these imaging techniques
Contribution to Programme Outcomes (Refer to Part I Section 2)	Programme Learning Outcome (a): Acquire and apply advanced levels of knowledge and skills in BME discipline. (Teach, Practice, and Measure) Programme Learning Outcome (b): Apply critical analysis and problem-solving skills for situations relating to their professional practice. (Teach, Practice, and Measure) Programme Learning Outcome (e): Demonstrate abilities to continuously develop in professional practice. (Teach, Practice, and Measure)
Subject Synopsis/ Indicative Syllabus	**(1) Introduction of imaging techniques and their significance** • What is functional and molecular imaging? • Application in clinical trials and preclinical studies • Impact on the diagnostic and monitoring approach, treatment strategies, and development of medical devices **(2) Principles of biomedical imaging techniques and their applications from body systems to molecules, with emphasis on functional imaging** The imaging of body systems, organs, tissues, cells and molecules and their biological, biochemical, biomechanical, bioelectrical functions will be discussed systematically. The related image optimization and processing will also be taught in different imaging techniques. The imaging techniques that will be covered are as follows: • X-ray Imaging and Computed Tomography (e.g. peripheral quantitative computed tomography(pQCT), micro-CT) • Magnetic Resonance Imaging (e.g. diffusion, perfusion, functional magnetic resonance imaging, elastography, spectroscopy) • Ultrasound Imaging (e.g. elastography, echocardiography, intravascular imaging, Doppler imaging, perfusion, biomicroscopy, photoacoustic imaging, tissue characterization) • Nuclear Imaging (e.g. positron emission tomography, single photon emission

computed tomography)

- Endoscopic Imaging (e.g. optical endoscopy, ultrasound endoscopy, fluorescence endoscopy, confocal endoscopy, capsule endoscopy)
- Optical and Thermal Imaging (e.g. electron microscopy, confocal microscopy, fluorescence microscopy, optical coherence tomography, infrared microscopy, atomic force microscopy, bioluminescence, near-infrared spectroscopy)

(3) Imaging from man to molecules

The holistic approach will be explored for applications of various imaging techniques and their integration into multi-modality imaging approaches in the study of etiology, diagnosis, monitoring and therapy of selected disease states or organ/tissue functions. This will be achieved in the lectures but mainly through student group presentation on topics about how different imaging modalities benefit the diagnosis and treatment of various diseases.

Teaching/Learning Methodology

Lectures will be used for the topics (1) and (2). Case study presentations will be used for the topic (3).

Teaching/learning methodology	Intended subject learning outcomes					
	a	b	c			
1. Lectures	√	√	√			
2. Case study presentations		√	√			

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c			
1. Assignment	20%	√	√	√			
2. Quiz and in-class performance	10%	√	√	√			
3. Case Study Presentation/Report	20%		√	√			
4. Mid-term quiz	20%	√	√				
5. Written Assessment	30%	√	√	√			
Total	100 %						

Assignment requires the students to recognize the strengths and weaknesses of the various imaging techniques in studying the structure or activities of body systems, tissues/organs, cells and molecules.

In order to strengthen students' understanding of imaging and its application, students are required to write a case report or a review on the application of the various imaging techniques and their integration into multi-modality imaging approaches for one selected cases. It will be a group project.

The written assessment will assess the students' overall understanding of the subject.

<table>
<tr><td rowspan="6">Student Study Effort Expected</td><td colspan="2">Class contact:</td></tr>
<tr><td>▪ Lectures</td><td>33 Hrs.</td></tr>
<tr><td>▪ Case Study and Presentation</td><td>6 Hrs.</td></tr>
<tr><td colspan="2">Other student study effort:</td></tr>
<tr><td>▪ Self-study</td><td>78 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>117 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2">Textbooks
▪ Industrial X-Ray Computed Tomography
Simone Carmignato, Wim Dewulf, Richard Leach
Cham, Switzerland: Springer; 2018

▪ MRI: Basic Principles and Applications
Dale, Brian M; Brown, Mark A; Semelka, Richard C
New York: Wiley; 2015

▪ Diagnostic ultrasound imaging: inside out
Szabo, Thomas L.
Amsterdam: Academic Press, Elsevier; 2014; Second edition

▪ Basics of PET imaging: physics, chemistry, and regulations
Saha, Gopal B.
Cham: Springer; 2016; Third edition

▪ Biomedical optics principles and imaging
Wang, Lihong V; Wu, Hsin-i.
Hoboken, New Jersey: Wiley-Interscience; c2007</td></tr>
<tr><td>Date of Last Major Revision</td><td colspan="2">11 June 2021</td></tr>
<tr><td>Date of Last Minor Revision</td><td colspan="2">19 June 2023</td></tr>
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