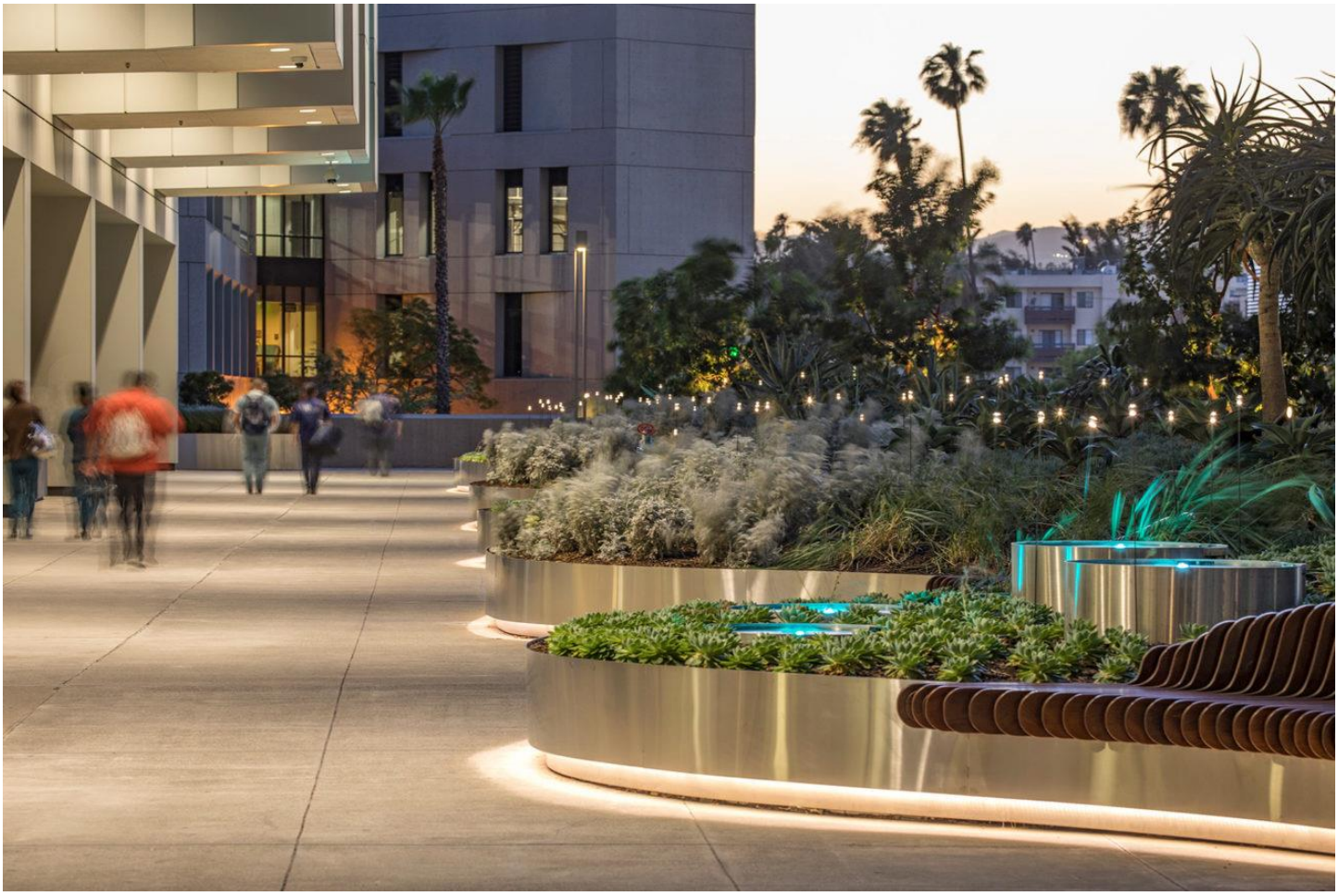
Cedars Sinai

Master of Science
in Magnetic Resonance in Medicine



Student Handbook

2024-2026

Accreditation

The Cedars-Sinai Graduate School in Biomedical and Translational Science is accredited by the Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges (WASC).

985 Atlantic Ave., #100
Alameda, CA 94501
(510) 748-9001

Graduate Education Center (GEC)
8687 Melrose Ave.,
Pacific Design Center, Suite G532-G
Los Angeles, CA 90069

MSMRM Program Director
Dr. Debiao Li, PhD
Pacific Theatres Building, Room 800.
(310) 423-7743 • Debiao.Li@csmc.edu

MSMRM Program Co-Director
Dr. Wafa Tawackoli, PhD
Davis Research Building, Room G-140
(424) 315-2807 • Wafa.Tawacoli@csmc.edu

Academic Registrar
Alysia Caldwell
Alysia.Caldwell@csmc.edu
GRERegistrar@csmc.edu

Student Financial Advisor
Victor Jackson
Victor.jackson@cshs.org

QUESTIONS?

Contact: **Linda King, MA**
Associate Director, GRE
(310) 423-8294
Linda.King@cshs.org
8687 Melrose Ave.,
Pacific Design Center, Suite G532-G
Los Angeles, CA 90069

STEPS TO DEGREE

The Master of Science in Magnetic Resonance in Medicine (MSMRM) program is a focused two-year, lock-step program (six consecutive trimesters) emphasizing technical excellence and creative thinking. We offer a curriculum that balances technical and theoretical knowledge with clinical applications. MSMRM students are immersed in research and clinical work early on to provide hands-on experience in an academic medical environment. Clinical and research mentors teach our students the translational aspects of their imaging research and how to integrate their knowledge and skills into practice throughout the program.

The MSMRM curriculum provides education and training in basic MR physics and hardware system, MR technical development and research methods. Students also will learn the clinical applications of MR through substantial collaborative research projects.
During the first year of study, students will participate in didactic courses, seminars, journal club and lab rotations. In the second year, students also will participate in a clinical rotation, internship rotation, American Board of Medical Physics (ABMP) certification preparatory workshop and culminate their work in a thesis research project.

The MSMRM degree will prepare students for careers such as clinical MR scientist, research/applications scientists, or research associates. It also is excellent advanced training for current healthcare professionals and PhD or MD candidates.

AY 1			AY 2	
FALL - Trimester 1	WINTER - Trimester 2	SUMMER - Trimester 3	FALL - Trimester 4	WINTER - Trimester 5
MRM 510 Seminar/Journal Club Series I	**MRM 520** Seminar/Journal Club Series II	**MRM 530** Seminar/Journal Club Series III	**MRM 610** Seminar/Journal Club Series IV	**MRM 620** Seminar/Journal Club Series V
MRM 511 Introduction to Human Physiology & Anatomy	**MRM 521** MR Imaging: Clinical Applications	**MRM 533** Advanced Imaging and AI	**MRM 618** Clinical Rotation III	**MRM 627** Internship Rotation
MRM 512 Biomedical Imaging	**MRM 624** MR Technical Developments & Advanced Imaging	**MRM 535** MRI: Experimental Design and Planning	**MRM 619** Thesis/Project I	**MRM 629** Thesis/Project II
MRM 513 Principle of Biomedical Signals & MR Imaging	**MRM 527** MRI Lab Rotations II*	**MRM 537** MRI Lab Rotations III*		
MRM 517 MRI Lab Rotation I*	**MRM 528** Clinical Rotation I	**MRM 538** Clinical Rotation II		
10-16 Credits	**9-15 Credits**	**9-15 Credits**	**11 Credits**	**14-15 Credits**

**Students are required to enroll in at least 2 Lab Rotation courses during their graduate studies.*

PROGRAM OVERVIEW

FIRST YEAR OF PROGRAM

Trimester 1 (September to December)

- MRM 510 - Seminar/Journal Club Series I (1 Credit Hour)
- MRM 511 - Introduction to Human Physiology and Anatomy (3 Credit Hours)
- MRM 512 - Biomedical Imaging (3 Credit Hours)
- MRM 513 – Principle of Biomedical Signals and MR Imaging (3 Credit Hours)
- MRM 517 - MRI Lab Rotations I* (6 Credit Hours)

Trimester 2 (January to April)

- MRM 520 - Seminar/Journal Club Series II (1 Credit Hour)
- MRM 521 - MR Imaging: Clinical Applications (3 Credit Hours)
- MRM 624 - MR Technical Developments and Advanced Imaging (3 Credit Hours)
- MRM 527 - MRI Lab Rotations II* (6 Credit Hours)
- MRM 528 - Clinical Rotation I (2 Credit Hours)

Trimester 3 (April to August)

- MRM 530 - Seminar/Journal Club Series III (1 Credit Hour)
- MRM 533 - Advanced Imaging and AI (3 Credit Hours)
- MRM 535 - MRI: Experimental Design and Planning (3 Credit Hours)
- MRM 537 - MRI Lab Rotations III* (6 Credit Hours)
- MRM 538 - Clinical Rotation II (2 Credit Hours)

SECOND YEAR OF PROGRAM

Trimester 4 (September to December)

- MRM 610 - Seminar/Journal Club Series IV (1 Credit Hour)
- MRM 618 - Clinical Rotation III (2 Credit Hours)
- MRM 619 - Thesis/Project I (8 Credit Hours)

Trimester 5 (January to April)

- MRM 620 - Seminar/Journal Club Series V (1 Credit Hour)
- MRM 627 - Internship Rotation (Elective) (1 Credit Hours)
- MRM 629 - Thesis/Project II (13 Credit Hours)

**Students are required to enroll in at least 2 Lab Rotation courses during their graduate studies.*

COURSE DESCRIPTIONS

MRM 510 • Seminar/ Journal Club Series I
MRM 520 • Seminar/ Journal Club Series II
MRM 530 • Seminar/ Journal Club Series III
MRM 610 • Seminar/ Journal Club Series IV*
MRM 620 • Seminar/ Journal Club Series V*

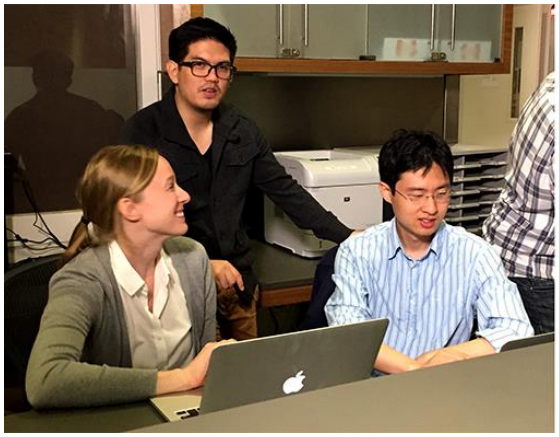
The Structured Journal Club is designed as a monthly gathering of students with their peers for the purpose of discussing current literature in Magnetic Resonance Imaging. This course is required during the student's 1st and 2nd year. This class refines the student's knowledge of scientific literature as well as presentation skills.

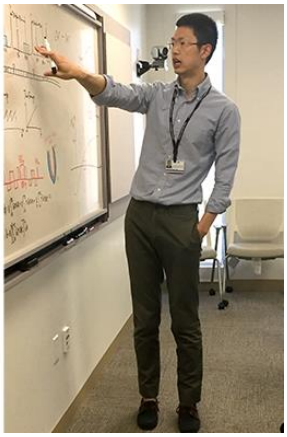
MRM 511 • Introduction to Human Physiology and Anatomy

This course is an introduction to the structure and function of the human body with an emphasis on anatomy. Body structure will be studied by organ systems and will involve a balance between gross anatomical study and physiology. Study of the structure and function of human anatomy, including the circulatory systems, nervous system, musculoskeletal, digestive, urinary, reproductive, and respiratory. Content may be either integrated or specialized.

At the end of the course, students are expected to:

- Identify anatomical features of the body, including cells, tissues, organs and organs systems on models, preserved tissues, microscopic slides, and diagrams.
- Explain very basic physiological processes on an appropriate level (knowledge, comprehension, application)
- Describe the structure, composition and functions of the organ systems of the human body.
- Describe how the organ systems function and interrelate.
- Learn basic technical terminology and language associated with anatomy.





MRM 512 • Biomedical Imaging

This course will introduce the fundamental physical principles of biomedical imaging commonly used clinically and in biomedical engineering research and applications. It will provide an overview of the physical principles and techniques of biomedical imaging, including x-ray photon generation, x-ray imaging, computed tomography, position emission tomography (PET), single photon emission computed tomography (SPECT), ultrasound imaging, and magnetic resonance (MR) imaging, and fluorescence optical imaging.

At the end of the course, students are expected to have:

- A basic but systematic understanding of physical principles of each modality
- A basic understanding of major techniques in biomedical imaging
- General knowledge of clinical applications
- Recognize that there is a need for different imaging modalities. Each student will review and present a recent key clinical study or clinical trial using at least one of the discussed modalities.

MRM 513 • Principle of Biomedical Signals and Imaging

This course will cover the classical “signals and systems” theory taught using images instead of electrical or mechanical signals and systems. The course provides a basic theoretical background on digital signal processing and an overview of linear system theory with emphasis on medical imaging systems. The course will cover discrete-time modeling of imaging systems with examples in biomedical imaging applications. The concepts of imaging resolution, point-spread function, and noise in imaging systems will be described. Finally, analytical aspects of image artifacts and image quality assessment will be covered. The basic theory of image reconstruction in tomographic medical imaging systems (e.g., CT) and Fourier-based imaging systems (MRI) will be covered.

The course will be split into three sections:

- The course begins by providing a basic theoretical background on digital signal processing. We will next provide an overview of linear system theory with emphasis on medical imaging systems.
- In the second section will cover discrete-time modeling of imaging systems with examples in biomedical imaging applications. Next, the concepts of imaging resolution, point-spread function, and noise in imaging systems will be described. Finally, analytical aspects of image artifacts and image quality assessment will be covered.
- In the third section, the basic theory of image reconstruction in tomographic medical imaging systems (e.g., CT) and Fourier-based imaging systems (MRI) will be covered. The course concludes by defining a mini-project for the students on image reconstruction or image analysis using MRI or PET data with minimal emphasis on the underlying physics. The students will provide a 4-page write-up of their projects results.

MRM 521 • MR Imaging: Clinical Applications

This course will build on Physics of Magnetic Resonance Imaging by surveying select MRI approaches that have found practical applications in biomedical or clinical imaging. Blood-Oxygen-Level-Dependent (BOLD) MRI, Diffusion MRI, Perfusion/flow/angiography, Functional MRI of the brain, MR spectroscopy and molecular MRI methods will be covered from basic principles to cutting approaches. This course will provide a solid theoretical basis of how MRI is used to examine key physiological processes with comparison to other imaging modalities (PET, SPECT, Ultrasound, and CT) as needed.

MRM 624 • MR Technical Developments and Advanced Imaging

This course will first introduce the basic physics of MRI, including Physics of Magnetic Resonance Imaging, as well as Advanced MR Imaging. This course will introduce advanced MR imaging including pulse sequence development and imaging reconstruction, as well as advanced MR engineering topics such as coil development. This course will be a combination of lectures, hands on practice, as well as opportunities for modifying and testing MR pulse sequences and associated reconstruction routines.

MRM 517 • MRI Lab Rotations I
MRM 527 • MRI Lab Rotations II
MRM 537 • MRI Lab Rotations III

Throughout the program, students will enroll in a variable amount of research credits depending upon their stage in their graduate career. Students will have the opportunity to perform cutting-edge research in various areas, including ultra-high field MRI, parallel transmission, cardia MRI, multinuclear MRI, diffusion MRI, neuroimaging, MR spectroscopy, MR engineering and molecular imaging.

MRM 533 • Functional Imaging and Image Analysis

The aim of the course is to show how to extract, model, and analyze information from medical imaging data and applications to help diagnosis, treatment and monitoring of diseases through computer science. The course includes major topics in medical image analysis: segmentation, registration, statistical modeling, and applications of computational tools for medicine. It will also include selected topics relating to medical image formation. It will be application oriented. The course will provide the participants with an up to date background in current state-of-the-art in medical image analysis and imaging.

MRM 535 • MRI: Experimental Design and Planning

The first half of this course provides students with an overview of the different processes and players involved in planning, construction, and managing MR sites. It will also focus on professional practices, patient management/care and MRI safety.

The 2nd half of this course will introduce the basic principles of experimental design as applied to research and enrich the student's knowledge and understanding of the statistical method as it pertains to the design and analysis of experiments in imaging. This section will also introduce basic imaging, the concepts and the terminology necessary for a basic understanding of imaging applications. Each topic will be introduced with examples from published clinical research papers; and expose learner to hands-on data analysis using real-life datasets.

MRM 528 • Clinical Rotation I
MRM 538 • Clinical Rotation II
MRM 618 • Clinical Rotation III*

This clinical course will introduce the master student to the day-to-day operations of clinical practice. The first part of the course will be spent introducing the student to the clinical area and assisting the MR technologists. Students may observe MRI studies on patients under the direct supervision of a qualified technologists. In addition, this course will provide a basic understanding of skills needed to allow the student to work comfortably and safely with patients.

MRM 627 • Internship Rotation (Elective - optional) *

This course provides real world experience and an integral part of engineering education. It enables correlation of class room learning with its application in industry and broadens understanding of the types of employment available in the field. This course will allow the students to discover their individual interests and builds resume credentials for the students; and develops relationships between Biomedical Imaging Research Institute and Industrial Firms.

MRM 619 • Thesis/Project I
MRM 629 • Thesis/Project II*

The purpose of the Master's Thesis is to provide a student an opportunity to demonstrate they have successfully mastered the intellectual and performance requirements necessary to obtain their Master's Degree in Magnetic Resonance in Medicine. Successful completion and defense of the Master's Thesis is a requirement of all students in the Master's Degree program.

**course #'s that start with 6 are 2nd year courses except for course MRM 624*

KEY FACULTY

PROGRAM LEADERSHIP DIRECTORS

Debiao Li, PhD
MSMRM Program Director

Wafa Tawackoli, PhD
MSMRM Program Co-Director

COURSE DIRECTORS

Damini Dey, PhD
Course Director for MRM 512

Pascal Sati, PhD
Course Director for MRM 521

Hui Han, PhD
Course Director for MRM 624

Daniel Berman, MD
MD for clinical rotations MRM 528, MRM 538 & MRM 618

Anthony Christodoulou, PhD
Course Director for MRM 513

Barry D. Pressman, MD, FACR
Course Director for MRM 528. MRM 538 & MRM 618

Wei Gao, PhD
Course Director for MRM 533

Mike Thompson, PhD
Course Director for MRM 533

Wafa Tawackoli, PhD
Course Director for MRM 511, MRM 538, MRM 517/527/537, MRM 535
Course Director for Seminar/Journal Clubs 520/530/610/620

Fei Han, PhD
Course Director for MRM 627

Xiaoming Bi, PhD
Course Director for MRM 627

Yibin Xie, PhD
Course Director for MRM 513 and MRM 624

TUITION & FEES CALENDAR

Program tuition	Standard amount	Due date
Trimester 1 (10-16 credit hours)	$750-$1,200	Aug. 3, 2024
Trimester 2 (9-15 credit hours)	$675 - $1,125	Jan. 10, 2025
Trimester 3 (9-15 credit hours)	$675 - $1,125	May 9, 2025
Trimester 4 (11 credit hours)	$825	Sept. 5, 2025
Trimester 5 (14-15 credit hours)	$1,050-$1,125	Jan. 9, 2025
Total program tuition	$4,875 - $5,400	

Student fees	Standard amount	Due date
Document Fee (one-time)	$50	Aug. 3, 2024
Grad Student Association Fee	$25	Per Term
Student Program/ Resource Fee	$100	Per Term
Student Services Fee	$500	Per Term
MR-Computational Fee	$1,775	Per Term
Total student fees (per term)	$2,400 - $2,450	

Total tuition + student fees (all terms)	$16,925 - $17,450

- Tuition ranges from $16,950-$17,450 for the full degree; amount contingent upon enrollment in the 3rd MRI Lab rotation and/or the elective available in final term (refer to course list)
- You are only required to enroll in at least 2 MRI Lab rotations unless otherwise required
- Questions? Contact Victor Jackson, Student Financial Administrator, 310-423-7871