

Department of Radiology

The Edward Mallinckrodt Institute of Radiology — more commonly known as Mallinckrodt Institute of Radiology or MIR — serves as the Department of Radiology (<https://www.mir.wustl.edu/>) for Washington University School of Medicine in St. Louis (<http://medicine.wustl.edu/>), helping to guide the consulting physician in the discovery, the treatment, and, ultimately, the healing of disease. Established in 1930, MIR is one of the largest and most scientifically sophisticated radiology centers worldwide.

Internationally recognized for its groundbreaking research, the Institute continues to pioneer new radiological techniques for better patient care.

Milestones

- Development of the first diagnostic test for gallbladder disease
- Design and construction of the first cross-sectional X-ray laminagraph
- Collaboration on design and installation of the first cyclotron located in a U.S. medical center
- Development of positron emission tomography (PET)
- Installation of one of the world's first computed tomography (CT) and magnetic resonance (MR) scanners
- Interfacing of a minicomputer with a gamma camera to improve the accuracy and efficiency of nuclear medicine procedures
- Establishment of the first mobile mammography van west of the Mississippi River
- Integration of CT and MR scans with a three-dimensional technology application of organic chemistry to the preparation of radiopharmaceuticals used in medical imaging
- Measurement of cerebral blood flow and metabolism
- Establishment of one of the largest and most comprehensive interventional radiology services in the United States
- Application of PET for measuring metabolic activity in relation to cardiac blood flow
- Early adoption of sequential PET/MR imaging

The Institute occupies more than 400,000 total square feet and comprises its own 12-story building, with satellite facilities in Barnes-Jewish and St. Louis Children's hospitals; the Clinical Sciences Research and East buildings; the Scott Avenue Imaging Center; the Center for Advanced Medicine; the Knight Emergency and Trauma Center; and the South County Siteman Cancer Center. The department provides diagnostic radiology, nuclear medicine and radiation physics services for all hospitals in the Washington University Medical Center, Barnes-Jewish

West County and Barnes-Jewish St. Peters hospitals. The Institute also provides diagnostic radiology for the Washington University Orthopedic and Barnes-Jewish Hospital Outpatient Orthopedic center.

MIR clinical facilities are on several floors of the Institute, with general diagnostic radiology on the second floor; neuroradiology on the third floor; gastrointestinal and genitourinary radiology and ultrasonography on the fourth floor; and MRI on the fifth floor. A comprehensive interventional radiology center occupies the eighth floor. Nuclear medicine is on the ninth floor of the Barnes-Jewish Hospital West Pavilion. Orthopedic imaging and musculoskeletal radiology services are on the sixth floor of the Center for Advanced Medicine. The Breast Health Center, on the fifth floor of the Center for Advanced Medicine, is a multidisciplinary facility that provides a full range of breast imaging services and interventional procedures. In the north wing of St. Louis Children's Hospital is a complete pediatric radiology facility, offering ultrasound, nuclear medicine, CT and MRI, and interventional radiology.

The Institute has 102 examination rooms used for diagnostic radiology. Clinical and research equipment includes two PET/CT scanners, 13 CT scanners, two PET scanners, one PET/MR scanner, 15 MR scanners (including an 11.7-Tesla research scanner), 12 high-end ultrasound machines (plus seven portable units), nine interventional radiology systems, five digital chest units, 10 computer radiography units, two neurointerventional radiology systems and six mammography units. In addition, as part of the department's community outreach effort, the Institute co-sponsors with the Alvin J. Siteman Cancer Center a mobile mammography van that provides screening services at corporate and public sites in the St. Louis area.

MIR has approximately 200,000 square feet devoted to research, with facilities in the Clinical Sciences Research Building (radiological sciences), in the East Building (electronic radiology), in the Scott Avenue Imaging Center (neurological PET, molecular pharmacology, biomedical MR imaging, optical imaging and cardiovascular imaging), and in the Center for Clinical Imaging Research (a bioimaging facility for basic and translational inpatient and outpatient clinical research).

Administrative, teaching and support functions occupy the sixth floor and the ninth through the 12th floors of the Institute. Information and training related to the use of radioactive materials is handled by Environmental Health and Safety (<https://ehs.wustl.edu/radioactive-material-safety/>); for more information, contact the department's director Maxwell Amurao, PhD, MBA, at 314-362-2988 or maxwell.amurao@wustl.edu.

Website: <https://www.mir.wustl.edu>

Faculty

Richard L. Wahl, MD (<https://wuphysicians.wustl.edu/for-patients/find-a-physician/richard-leo-wahl/>)

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Visit our website for more information about our faculty (<https://www.mir.wustl.edu/patient-care/directory-of-physicians/>) and their appointments.

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Assistant Professor of Radiology (primary appointment)
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T

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MEE University of Texas Arlington 1992

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U

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Professor of Radiation Oncology
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Vice Chair for Diagnostic Radiology Research Facilities in Radiology
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X

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Y

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PHD Institute for Physics and Eng 1973
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D SC Institute for Physics and Eng 1981

Z

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MS School Not Listed 1995

Maria Zulfiqar, MD

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Research Electives

Radiology Research Electives

During the fourth year, opportunities exist for many varieties of advanced clinical or research experiences.

Interested students should contact the appropriate individual in each division regarding the types of research projects available.

Tom Conturo, MD, PhD

East Building, 2nd Floor, Rm 2120
Phone: 314-362-8421

Magnetic resonance (MR) imaging is a noninvasive means of providing images of the human body at high spatial resolution and contrast sensitivity. The contrast can be manipulated to depend on different properties of tissue water, enabling the study of a variety of biological processes. In some cases, endogenous or exogenous paramagnetic MR contrast agents are used to alter the MRI contrast by perturbing the tissue water environment. Recently, new MRI hardware has also enabled techniques having high temporal resolution. Using the unique contrast properties of MRI and the higher spatial/temporal resolution, noninvasive techniques can be devised to study neuronal activity, tissue perfusion, water mobility (diffusion), and neuronal fiber pathways in the human brain. The goals of Dr. Conturo's research lab are to develop and apply MR imaging techniques for quantitative imaging of cerebral perfusion, brain function, water diffusion, and neuronal fiber pathways. These techniques utilize the MR signal effects of exogenous bolus-injected contrast agents, endogenous hemoglobin, and microscopic water diffusion. Long-term goals are to apply these methodologies toward imaging and understanding tissue structure, function, and physiology in the brain and other organs in normal and abnormal conditions. The approaches that are used in this laboratory cover a broad range of areas, including MRI physics, MRI pulse sequence development, theoretical derivations, computer simulations, image-processing, computer graphics, custom contrast agent design and synthesis, phantom studies, animal models, human studies, clinical patient studies, and comparison with other imaging modalities.

Farrokh Dehdashti, MD

Nuclear Medicine PET Facility, 10th Floor, Mallinckrodt Institute of Radiology
Phone: 314-362-1474

Positron emission tomography (PET) is an imaging technique that produces images reflective of biochemical processes of normal and abnormal tissues. PET is complementary to anatomic imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI). The ability of PET to quantify fundamental processes, such as blood flow, oxygen metabolism, glucose metabolism, and receptor density, makes this technique very desirable to both investigators and clinicians. Dr. Dehdashti's research utilizes the conventional PET radiopharmaceutical, F-18 fluorodeoxyglucose (FDG), as well as a variety of unique PET radiopharmaceuticals such as Cu-64-diacetyl-bis(N4-methylthiosemicarbazone) (Cu-64 ATSM), a hypoxic imaging tracer, and 18F-labeled 3'-deoxy-3'-fluorothymidine (FLT), a proliferative imaging tracer. Below is a partial list of the research projects relating to PET: (1) PET assessment of progesterone receptors in

patients with newly diagnosed breast cancer with a new progesterone-receptor imaging tracer, 21-[18F]Fluoro-16,17-[(R)-1'-furylmethylidene)dioxy]-19-norpregn-4-ene-3,20 dione (FFNP); (2) assessment of cell proliferation with a new tracer, N-(4-(6,7-dimethoxy-3,4-dihydroisoquinolin-2(1H)-yl)butyl)-2-(2-[18F]-fluoroethoxy)-5-methylbenzamide ([18F]3c), also called [18F]ISO-1 by imaging sigma receptors in patients with various solid cancers; (3) PET assessment of tumor hypoxia using ⁶⁴Cu-ATSM in patients with cervical cancer (the major goal of this project is to predict prognosis); (4) FDG-PET/CT study in cervical cancer to evaluate the change in tumor FDG heterogeneity and SUVmax during chemoradiation and whether these changes are predictive of response to therapy; (5) PET using [18F]FHBG (9-[4-fluoro-3-hydroxymethyl-butyl]guanine), analog of Penciclovir, an acycloguanosine derivative and antiviral drug, for possible tracking of GvHD in patients who were prior recipients of unrelated allogeneic bone marrow transplant for any hematologic malignancy; and (6) FLT-PET/CT to assess tumor cell proliferation in patient must have histologically or cytologically confirmed ER+ stage IV or metastatic invasive breast cancer.

Rob J. Gropler, MD

East Building, Room 1307
Phone: 314-747-3878

The focus of our lab is on cardiovascular imaging research. The research in the Cardiovascular Imaging Laboratory is designed to better understand the relationship between myocardial perfusion, intermediary metabolism and mechanical function in both normal and abnormal cardiac states. The research involves the integration of several imaging techniques with diverse strengths such as PET, MRI, CT and echocardiography. The success of the research requires several paths of investigation to be pursued in parallel. For example, in order to image the biologic processes of interest requires continued technical developments for each of the imaging methods listed above. There are ongoing efforts to permit more accurate PET measurements of myocardial substrate metabolism. They include the development of novel tracers of extracted substrates, the development of acquisition schemes to assess endogenous substrate metabolism, and the validation of mathematical approaches to correlate the tracer kinetics with the underlying metabolic processes. These studies are being pursued in small and large animal models and then in humans. Another example includes the current efforts to develop approaches to image the coronary arteries noninvasively by MRI using novel contrast agents and acquisition schemes. In addition, techniques are being developed to permit MR guided interventions on the coronary arteries. This undertaking includes the development of novel guide-wire tracking and catheter tracking schemes using both passive and active approaches. Finally, to permit assessments of myocardial oxygenation and thus, perfusion, techniques are being developed to permit BOLD imaging the myocardium. Another path of the research is to determine how

this perfusional-metabolic-functional relation is altered by normal life changes and then determine how disease states alter the relationship. For example, both PET and echocardiography are being used to characterize the age- and gender-related changes on myocardial perfusion, substrate metabolism and function. To study the relationship in disease states, similar studies are being performed in patients with diabetes and obesity. A third path is to determine the mechanisms responsible for these changes in this metabolic-functional relation and identify potential interventions that may reverse or ameliorate them. In this regard, similar imaging studies are being performed to determine the importance of nitric oxide and the PPAR α system in defining this metabolic-functional relation.

Stephen M. Moerlein, PharmD, PhD

East Building, 1st Floor
Phone: 314-362-8466

Our research interests lie in the general area of labeled tracer development for nuclear medicine imaging, especially positron-emission tomography (PET). Developmental effort begins with synthesis of target structures, preclinical screening that involves in vitro biochemistry and pharmacological testing, and ex vivo biodistribution studies in small animals. Promising tracers are then examined by in vivo imaging of animal subjects and tracer kinetic modeling. The final step in the transition of a radiochemical into a labeled drug takes into account radiation dosimetry, pharmaceutical quality, and the development of automated production and GMP production processes to streamline delivery to human subjects. Each of these aspects of radiopharmaceutical development are investigated, with a primary emphasis in novel agents for evaluation of pathological processes in neurology and oncology.

Marc Raichle, MD

East Building, 2nd Floor
Phone: 314-362-6907

We use functional imaging techniques — both positron emission tomography and functional magnetic resonance imaging — to study the normal organization of the human brain and the effect of selected diseases. The research focuses on both the methodology (imaging and experimental) and specific questions in cognitive neuroscience.

Courses

For more information, contact Michelle Miller-Thomas, MD, Coordinator of Radiology Medical Student Education, at miller-thomasm@wustl.edu or 314-362-5949.

Visit online course listings to view offerings for M90 Radiol (<https://courses.wustl.edu/CourseInfo.aspx?sch=M&dept=M90>).

M90 Radiol 701 General Radiology Clerkship

This two-week introductory radiology elective allows students to rotate through two of the following radiology services: Emergency Radiology, Mammography, Pediatrics, Chest, Abdominal Imaging, Musculoskeletal, Neuroradiology, Interventional Radiology, and Nuclear Medicine. The primary course objective is to familiarize students with the scope of diagnostic and interventional radiology, including the consulting role that radiologists provide to primary care and specialty providers; the risks, benefits, and cost-effectiveness of radiologic examinations; the guidelines for ordering common studies; and specific disease entities and their radiologic appearance and workup. Students spend the majority of the day in the radiology reading rooms with residents, fellows, and faculty for interactive teaching based on daily clinical cases. Students will attend morning case-based conferences and noon didactic conferences with the residents. The students will have an observational role in conferences and in the clinical setting. Students have allocated lectures to watch as part of the didactic component of this course. On Thursday afternoons, students will convene with a radiology resident for an interactive Q&A session related to the aforementioned didactic lectures. On Friday afternoons, students will present an interesting case from the week in PowerPoint format. Two of these PowerPoint presentations will be submitted at the end of the rotation for grading. Reading lists, references, and textbooks will be provided. The first and final days of the elective are mandatory. Grades will be based on daily attendance, workshop participation, and submitted PowerPoint presentations. More than three days' absence will require exceptional work for honors. No honors will be awarded if a student is absent for more than five days of the rotation. Credit variable, maximum 77 units.

M90 Radiol 740 Radiation Oncology Clerkship

The four-week clerkship in Radiation Oncology will provide students with the opportunity to participate in the evaluation and management of a broad range of patients referred for consideration of radiation therapy. Clerkship activities will take place at the Barnes-Jewish Hospital/Siteman Cancer Center complex and at our satellite facilities. Students will conduct patient evaluations under the supervision of radiation oncology department residents and faculty. Students will attend many conferences throughout the weeks, with the work day starting between 7:00 a.m. and 7:30 a.m. Students will also have the opportunity to attend the appropriate multidisciplinary clinics, follow-up clinics and multidisciplinary conferences (e.g., pediatric neuro-oncology, cardi thoracic oncology, lymphoma, GYN tumor) pertaining to their rotation schedule. Instructional materials are available for students on the rotation. (Students are not expected to purchase any curricular materials for the clerkship.) Student performance will be evaluated by both resident and faculty members who supervise the student over the course of the clerkship. Credit 154 units.

M90 Radiol 801 General Radiology

This four-week introductory radiology elective -- with a hybrid, predominantly in-person format -- allows students to rotate through four of the following radiology services: Pediatrics, Abdominal Imaging, Musculoskeletal, Neuroradiology, Nuclear Medicine, Emergency Radiology, Mammography, Chest, and Interventional Radiology. Preferences should be emailed at least two weeks prior to the course start date to andrewdr@wustl.edu; these are reviewed on a first-come, first-served basis and cannot

be guaranteed. The primary course objective is to familiarize students with the scope of diagnostic and interventional radiology, including the consulting role that radiologists provide to primary care and specialty providers; the risks, benefits, and cost-effectiveness of radiologic examinations; the guidelines for ordering common studies; and specific disease entities and their radiologic appearance and workup. Students spend the majority of the day in the radiology reading rooms with residents, fellows, and faculty for interactive teaching based on daily clinical cases. Students will attend morning case-based conferences and noon didactic conferences with the residents. The students will have an observational role in conferences and in the clinical setting. On Thursday afternoons, students will attend virtual or in-person conferences with a radiology resident for an interactive workshop on a scheduled topic in radiology. On the days prior to these workshops, students are expected to watch specified lectures from the course material available online (on WUSTL Box). Students will be evaluated on their preparedness for and participation in the afternoon workshops. On Friday afternoons, students will present an interesting case from the week in PowerPoint format. Four of these PowerPoint presentations will be submitted at the end of the rotation for grading. Reading lists, references, and textbooks will be provided. The first day of the elective is mandatory. Grades will be based on daily attendance and interactions, workshop participation, and the PowerPoint presentations. More than three days' absence will require exceptional work for honors. No honors will be awarded if a student is absent for more than five days of the rotation.

M90 Radiol 802 Advanced Radiology

This course is available only to students who have completed the General Radiology Clerkship Selective (M90 701) or the General Radiology Elective (M90 801). This four-week sub-internship in radiology is intended for students who are interested in pursuing radiology as their intended career choice. Students may tailor their experience to focus on one or more services, if desired; this will be considered on a case-by-case basis by the course directors. This elective -- with a hybrid, predominantly in-person format -- allows students to rotate through one or more of the following radiology services: Pediatrics, Abdominal Imaging, Musculoskeletal, Neuroradiology, Nuclear Medicine, Emergency Radiology, Mammography, Chest, and Interventional Radiology. Preferences should be emailed at least two weeks prior to the course start date to andrewdr@wustl.edu; these are reviewed on a first-come, first-served basis and cannot be guaranteed. The objective of this course is for students to have a more hands-on role in the reading room; they will help to investigate the patient's clinical history and the indications for the examination, preview the imaging studies, and communicate with referring teams and providers. Students spend the majority of the day in the radiology reading rooms with residents, fellows, and faculty for interactive teaching based on daily clinical cases. Students will attend morning case-based conferences and noon didactic conferences with the residents. The students will have an observational role in conferences and in the clinical setting. On Thursday afternoons, students will have the option to attend virtual or in-person conferences with a radiology resident for an interactive workshop on a scheduled topic in radiology. On Friday afternoons, students will present an interesting case from the week in PowerPoint format. Four of these PowerPoint presentations will be submitted at the end of the rotation for grading. Reading lists, references, and textbooks will be provided. The first day of the elective is mandatory. Grades will

be based on daily attendance and interactions as well as the PowerPoint presentations. More than three days' absence will require exceptional work for honors. No honors will be awarded if a student is absent for more than five days of the rotation.

M90 Radiol 820 Clinical Nuclear Medicine

The clinical service in Nuclear Medicine (NM) is divided into five sections: outpatient general NM, inpatient general NM, Positron Emission Tomography (PET), Pediatric NM studies, NM Cardiac studies, and radionuclide therapy. The recommended schedule will be to spend weeks 1 and 3 in the Center for Advanced Medicine/BJH North Campus (second floor), where the emphasis will be on outpatient general and pediatric Nuclear Medicine with some time spent in the PET reading room. Week 2 will be in South Campus (West Pavilion 9th floor) and split between inpatient general nuclear medicine, outside PET facilities (morning), cardiac NM services (afternoon), and radionuclide therapy. The schedule for Week 4 will be Monday to Wednesday Center for Advanced Medicine/BJH North Campus and Thursday to Friday in South Campus. This rotation's primary objective is to provide exposure to the full range of clinical nuclear medicine studies. Under the direct supervision of the NM attendings, the student via ZOOM will participate in the planning and interpreting of imaging studies for patients referred to the Division. An opportunity also exists to explore instrumentation techniques, including dedicated computer applications utilized to interpret NM studies. In addition to the clinical experience, the student will attend the NM daily morning conference, held via ZOOM, from 8-9:00 a.m. Also, the student will be excused to attend via ZOOM the daily diagnostic radiology resident noon conference from 12-1:00 p.m. The student will also be able to attend any conferences within the Department of Radiology and case management conferences where NM studies are discussed. The student has to participate by preparing a case for the Friday follow-up conference under an NM faculty member's supervision during the last week of their rotation. The student can find the PowerPoint template to use and examples of prior follow-up cases using the below link; M:\Services\Nuclear Medicine\Nuclear Medicine Follow-Up Conferences Students may keep a log of interesting cases to use as a guide for additional reading or discussions with the Course Director or other NM attendings. Educational material including textbooks and digital teaching file cases are available at the following url: <http://gamma.wustl.edu/index2.html> The first and final days of the elective are mandatory. No honors will be awarded if a student is absent for more than five days of the rotation. Please introduce yourself to Dr. Ponisio, Nuclear Medicine residency program director, and Ms. Bre Vittitow, Nuclear Medicine program coordinator, on the first day of your 4-week NM rotation.

M90 Radiol 830 Interventional Radiology

This elective is designed to give students in-depth exposure to and experience in all clinical and procedural aspects of interventional radiology including: patient evaluation and consultation, preparation of patients for procedures, performance of a wide range of vascular and non-vascular procedures, post-procedure patient management, and longitudinal patient follow-up. Students will actively participate in interventional procedures. Students will attend the departmental noon conference (daily) and morning section conferences including didactic lectures, Quality and Safety conference, Journal club, Interventional oncology conference, multidisciplinary liver tumor conference, and case conferences.

M90 Radiol 840 Clinical Radiation Oncology Subinternship

The clinical division offers an elective with emphasis on the evaluation, planning, and administration of radiation therapy in patients with malignant tumors. The students have the opportunity to enhance their knowledge of the natural history and of the pathological and biological features of cancer and to sharpen their clinical skills by participating in the management of these patients.

M90 Radiol 842 Thoracic Imaging

A four-week elective emphasizing the interactions between cardiothoracic radiologists and the various clinical services, to include thoracic surgery, thoracic oncology, and pulmonary medicine. Learn to read chest radiographs at the viewing console while providing liaison with the clinical teams. This active elective will include the daily chest teaching conference and participation in weekly pulmonary case conference, thoracic surgery, thoracic oncology conferences, as well as the imaging aspects of the clinico-pathological medicine conference. Learn to identify subtle pneumothorax and pneumonia. Learn the limitations of portable chest radiographs. Rotating on cardiac CT and MR service and in the ED service, if interested. The student will be expected to present a single case from what they have seen during the rotation at a 7AM teaching conference.

M90 Radiol 900 Research Elective: Radiology

Research opportunities may be available. If interested, please contact the Departments of Radiology or Radiation Oncology.
