University of Pittsburgh

School of Medicine

FACT BOOK » 2020 / 2021

UNIVERSITY OF PITTSBURGH 2020–21
SCHOOL OF MEDICINE FACT BOOK

ABOUT THE COVER: Scaife Hall exhibit featuring eminent School of Medicine faculty.

Overview

The University of Pittsburgh School of Medicine has a mission to educate science-based, skilled, and compassionate clinicians prepared to meet the challenges of practicing medicine in today's dynamic health care environment and to conduct cutting-edge biomedical research that betters the human condition and advances the fundamental understanding of medical science.

The school is committed to excellence in shaping a culture of teaching, learning, research, and patient care that is rooted in collaboration, empathy, compassion, and respect for the human dignity of all involved.

In the only truly objective metric by which the overall stature of research-focused institutions can be assessed in a nationally competitive context, the University of Pittsburgh became one of the top 10 recipients of National Institutes of Health (NIH) funding in 1998 and has remained within this enviable echelon ever since. In an analysis of NIH funding for federal fiscal year 2019, **the faculty of the University of Pittsburgh received more than $582 million in funding—approximately 80% of which went to the School of Medicine.**

The School of Medicine operates on a global stage, with active collaborations connecting Pittsburgh with China, France, Ghana, Honduras, India, Italy, Kazakhstan, Malawi, the Philippines, Vietnam, and many other nations.

About the Dean

ANANTHA SHEKHAR, MD, PHD, is senior vice chancellor for the health sciences and John and Gertrude Petersen Dean of the School of Medicine at the University of Pittsburgh. He is a nationally recognized educator, researcher, and entrepreneur with major contributions in medicine and life sciences.

Innovation, transformation, and sweeping and successful collaborations across the private, public, and philanthropic sectors have defined Dr. Shekhar's distinguished career, which spanned more than three decades at Indiana University School of Medicine (IUSM) and Indiana University Health before he began his leadership roles at the University of Pittsburgh in June 2020.

Dr. Shekhar's areas of expertise include basic and clinical research on the effects of stress, stress-induced psychiatric and medical conditions, and clinical psychopharmacology. His laboratory has developed some of the best translational models for panic and related anxiety disorders. His work focuses on the role of brain abnormalities that could lead to stress and psychiatric disorders and to the discovery of new treatments.

Dr. Shekhar is a member of the National Academies of Sciences, Engineering, and Medicine's Forum on Drug Discovery, Development, and Translation. The forum provides a unique platform for dialogue and collaboration among thought leaders in government, academia, industry, foundations, and disease and patient advocacy groups, serving as a catalyst for nurturing new ideas and partnerships to advance critical policy discussions on biopharmaceutical innovation at the global level.

Dr. Shekhar earned his medical degree at St. John's Medical College, India, and PhD in neuroscience at Indiana University. He has published more than 200 original scientific papers in leading basic science and clinical journals.

Demographics

As of the 2020–21 academic year, 599 MD students are registered in the School of Medicine, including 327 (55%) women and 272 (45%) men. Of these, 211 (35%) are Pennsylvania residents; approximately 18% of Pitt medical students are from groups that are underrepresented within the medical profession.

There are 368 registrants in PhD programs (including those in the Medical Scientist Training Program), 152 students in MS programs, and 34 students in certificate programs.

For 2020, 7,177 applications for admission were received and 734 prospective students were interviewed for a first-year class of 149 medical students.

The School of Medicine has 2,424 regular and 2,190 volunteer faculty members. Of these, 81 are current members of the Academy of Master Educators, an organization that recognizes and rewards excellence in medical education.

Curriculum

Students experience a variety of teaching methods at Pitt. During the first two years, students spend only about one-third of their time in lectures and team-based learning sessions. Another third is spent in small-group sessions; the remainder includes self-directed learning, computer-based study, community visits, clinical experiences, and other activities.

Patient/Doctor Relationship

In addition to the rigorous traditional study of the basic sciences in the first two years of medical school, Pitt offers courses that deal with the human side of medicine from the very beginning of the medical school experience. In these courses, students encounter real patients, learn how to establish a patient/doctor relationship, and develop patient interviewing skills as well as the techniques for conducting a physical examination. Starting in their first year, students are exposed to medicine being practiced in primary care ambulatory settings, including clinics and physicians' offices.

Longitudinal Research Project

All medical students engage in a scholarly research project that has been incorporated longitudinally throughout the curriculum. A wide range of opportunities includes traditional laboratory-based or clinical research experiences—as well as alternatives, such as health policy, epidemiology, and comparative effectiveness research—that appeal to individual students' interests and long-term career aspirations. Projects aim to illustrate the mechanics of scientific investigation; teach students how to develop a hypothesis and how to collect, analyze, and interpret data to test it; encourage students to pursue research opportunities; and help students understand the fundamental thought processes that lead to success in clinical medicine.

The Class of 2020 was the 14th class to complete the four-year longitudinal research project experience. Their endeavors resulted in 41 fellowships, grants, or other national or state awards; 146 School of Medicine or local awards, coauthorship of 50 papers submitted to peer-reviewed journals, and 239 presentations at national or international meetings.

For more information: http://scholarlyproject.medschool.pitt.edu

Simulation Training

Simulation training allows medical students to engage in comprehensive learning activities using whole-body simulators; most students seek additional elective time with these sophisticated training tools, which help them to develop resuscitation, defibrillation, auscultation, airway management, and other clinical skills. Task-specific models are used to develop proficiency in vascular access and suturing, among other procedures, and the proper techniques for conducting breast, pelvic, and prostate exams. Pitt's Peter M. Winter Institute for Simulation Education and Research (WISER) is considered one of the world's leading academic medical simulation training centers, featuring highly sophisticated and lifelike computer-based simulation technology designed to enable students to learn, practice, and perfect clinical procedures before performing them on actual patients.

For more information: www.wiser.pitt.edu

Small Group Learning

Small group learning includes a variety of different evidence-based formats. Most notably, students pursue problem-based learning, or PBL, a modality that engages small, faculty-mentored groups of primarily first-year students in clinical diagnostic exercises built from actual cases of graduated difficulty. PBL builds collaborative problem-solving skills and teaches students how to "mine" vast information resources and apply them to specific clinical cases. In PBL sessions, faculty members serve as facilitators rather than traditional instructors. Pertinent facts are presented in such a way that students must continuously analyze and re-evaluate them, seek supporting evidence, and focus their thinking to reach a differential diagnosis. This mode of instruction is an important, well-integrated component of the curriculum and catalyzes the development of students' cognitive skills. As students move to the second year, they participate in more case-based workshops, which focus on clinical presentations facilitated by active clinicians and are designed to "bring alive" content from the Organ Systems Pathophysiology block. Case-based workshops enhance active learning and student engagement. Periodically throughout the curriculum, students also participate in team-based learning (TBL), a teaching method that emphasizes independent study immediately, followed by intensive application of concepts to challenging problems by small teams of students.

Integrated Life Science Program

The fourth-year integrated life science (ILS) program includes courses that revisit some aspect of basic science. The level of sophistication that students have developed by this stage in their medical education promotes a deeper understanding of the relevance of basic science to clinical problems. Among the more than half a dozen ILS options are "Changing Science, Changing Society: A Guide to 21st Century Medicine," which includes ethical, legal, and social issues related to health care; "Clinical Pharmacology," "Neurosurgery and Head and Neck Dissection," including imaging and exposure to surgical procedures; and "Science of Resuscitation."

Standardized Patients

Throughout their medical education, students encounter standardized patients—actors who are specially trained to present realistic and consistent behavior, symptoms, and medical histories in simulated doctor-patient interactions. These sessions are designed to help students develop their clinical skills and learn how to deal with unusual or unexpected circumstances in a safe and constructive environment. Students find that these experiences reinforce lessons they have learned through other components of the curriculum and, in a realistic way, make them relevant. A standardized patient can contribute to the learning process by stepping out of character to offer feedback on the encounter and an assessment of the student's performance.

Evidence-Based Medicine

Evidence-based medicine—an ongoing focus of the curriculum—teaches students how to critically evaluate and judiciously apply the best research evidence, in combination with the patient's own values, in making decisions about the care of individual patients. Evidence-based medicine can also draw on medical databases and treatment protocols as resources for clinical decision-making. The practice of evidence-based medicine requires the application of formal rules of evidence in evaluating clinical research literature, as well a commitment to life-long learning as new evidence emerges.

Through a variety of methods, including small-group learning and online modules, students learn how the medical literature is generated and used to formulate a scientifically rigorous approach for taking care of the patient.

Addiction Medicine, Chronic Pain, and the Opioid Epidemic

Health professionals from all disciplines have joined forces to address pain and substance abuse, with a particular focus on opioids. Students begin learning about these conditions early in the first year and continue the process throughout the curriculum during sessions that provide essential knowledge and patient-counseling skills in pain management and addiction. Web-based instructional modules have been introduced to provide students with added exposure to patient cases in these areas.

Social Medicine, Racial Injustice, and Health Equity

Diversity is a priority in the curriculum. Pitt has active "threads" on social medicine, cultural competence, and women's health, with heavy coverage of topics like health disparities, LGBTQ health, race and medicine, and social determinants of health. This focus begins during orientation with a "diversity shuffle" and breakout groups to discuss issues of diversity in medicine, runs through virtually every course and block, and concludes in a boot camp at the end of fourth year. The Patient, Physician, and Society (PPS) block during MS1-2 particularly emphasizes diversity in courses related to ethics/professionalism, behavior, and population health, with sessions on gun violence, implicit bias, poverty, and racism in health care. Didactic content is supplemented with communication skills training, such as bystander- and harassment-response training. Students who have a particular interest in this area may join the Social Medicine Fellows Program or pursue an Area of Concentration on Underserved Populations.

Longitudinal Patient Experiences

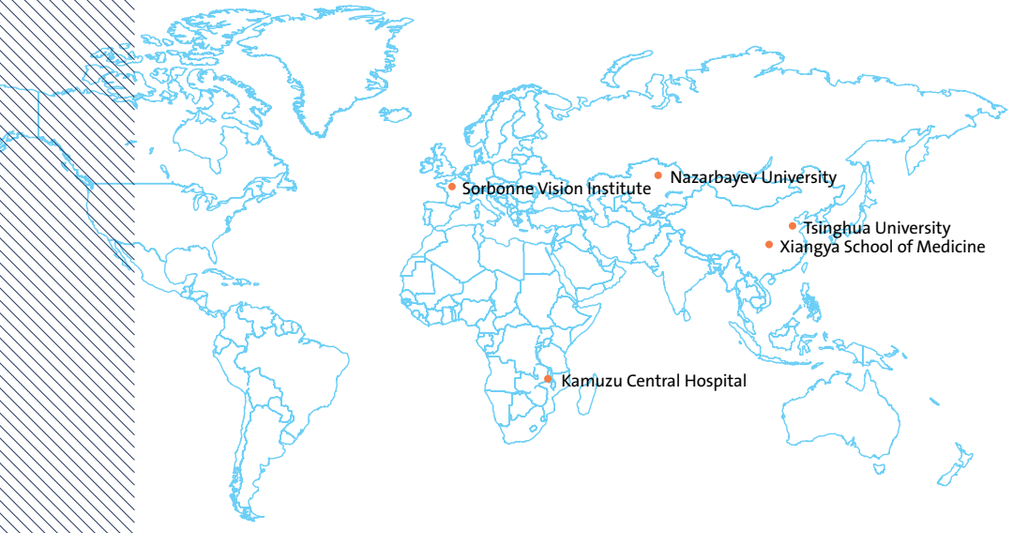
Students may opt to have additional patient experiences through the Longitudinal Alliance Project, which pairs a student with a patient. Faculty from the Department of Family Medicine choose moderately complex cases, and the students maintain relationships with these patients throughout the course of their education. Students grow in knowledge and experience as they accompany the patients to medical visits and observe the course of their health over time. The clinical experience is supported by a program of physician-mentored small group sessions, where students debrief on what they've experienced and learned from the perspectives of their colleagues.

Global Engagement

The School of Medicine operates on a global stage, with active collaborations connecting Pittsburgh with China, France, Ghana, Honduras, India, Ireland, Italy, Kazakhstan, Malawi, the Philippines, and many other nations. Medical students and young investigators who train in this milieu encounter a wide variety of influences and discover a great many opportunities to broaden their horizons. Here are a few examples:

The School of Medicine has renewed its historic agreement with **Tsinghua University**—one of China's elite institutions of higher learning for science and technology—for a second five-year term. Since 2012, a significant proportion of students from Tsinghua's medical school spend two years in Pittsburgh immersed in biomedical research. Pitt's Tsinghua Scholars program now has 79 alumni and 38 active scholars on campus. In 2017, the original group of Tsinghua Scholars graduated from Tsinghua University's medical school, becoming the first Pitt-trained Tsinghua Scholars to earn their medical degrees.

Also in 2012, the School of Medicine began a collaboration with China's prestigious Central South University **Xiangya School of Medicine**. Under the agreement, now in its second five-year term, Pitt provides two years of rigorous biomedical research training to medical students, most of whom have already undergone six years of medical school, including clinical clerkships. As of August 2020, 24 of these medical students are on campus, with 70 program alumni. In 2014, Xiangya Hospital formed a partnership with UPMC to establish an international medical center, which has improved access to high-quality care for patients in the region since opening in 2015.



In 2017, the School of Medicine and UPMC partnered with the **Sorbonne's Vision Institute in Paris**, a global leader in basic and clinical vision research that is developing treatments for currently untreatable retinal diseases and vision disorders. The School of Medicine then entered an agreement with three additional world-renowned French research institutions: the Université Pierre et Marie Curie of the Sorbonne Universités in Paris, the Institut National de la Santé et de la Recherche Médicale (Inserm), and the Centre National de la Recherche Scientifique (CNRS). These partnerships have enabled collaborative ophthalmology, vision, and neuroscience research, as well as extensive scientific and educational exchange.

The School of Medicine has also maintained a robust relationship with Malawi. School of Medicine residents recently completed rotations at Kamuzu Central Hospital, a government referral and teaching hospital in Lilongwe, Malawi. These residents, along with other School of Medicine personnel, have been critical to inpatient hospital care and to teaching and training initiatives for Malawian medical students and trainees.

In 2012, the School of Medicine was selected to guide the **Republic of Kazakhstan's Nazarbayev University** (NU) as it established its own medical school, which aims to educate physician-scientists to become this Central Asian nation's next leaders in health care, medical education, and biomedical research. Pitt has partnered with NU to institute a U.S.-style curriculum; design and develop teaching facilities; recruit and train school leadership and faculty; plan organizational and administrative structures, policies, and procedures; and develop courses, syllabi, and clinical experiences with the participation of physician-educators from Kazakhstan and around the globe. The NU School of Medicine welcomed its first class in 2015 and began accepting international students in 2017. The inaugural class of NU MDs graduated in May 2019.

Opportunities for In-Depth Study

Optional **areas of concentration** enable students to cultivate their enthusiasm for a particular aspect of medicine through hands-on experiences, faculty mentoring, research projects, and other activities throughout all four years. Topics include disabilities medicine, medical humanities, geriatric medicine, women's health, health care to underserved populations, neuroscience, global health, resuscitation medicine, public health, and patient safety and quality improvement.

The **Medical Scientist Training Program** (MSTP) provides an opportunity for medical students interested in a biomedical research career to undertake doctoral work at either the University of Pittsburgh or Carnegie Mellon University in basic science, engineering, or public health. After two years of medical school, students complete PhD work before returning to medical training. Both degrees are completed in an average of seven to eight years. The program, funded by a grant from NIH with support from the Office of the Dean, offers full tuition and a yearly stipend.

For more information: www.mdphd.pitt.edu

The **Clinical Scientist Training Program** (CSTP) is a competitive one-year research training program that provides medical students interested in clinical research careers an opportunity to learn clinical research approaches and skills through mentored research and coursework provided through the Institute for Clinical Research Education. Students apply to the CSTP in January of the year they plan to commit to full-time research (typically between their third and fourth years of medical school). Applications include a personal statement describing the student's interest and commitment to research, a research project proposal, and letters of support and an NIH biosketch from the student's mentor(s). Selected students are appointed as research fellows and receive a living stipend, travel funds, health insurance, and tuition toward a graduate certificate in clinical research. After successful completion of the fellowship year, students receive a CSTP scholarship toward their final year of medical school.

For more information: www.icre.pitt.edu/cstp/

The **Physician Scientist Training Program** (PSTP) is a five-year program for exceptionally talented students who, in addition to the regular curriculum, dedicate a year and two summers to laboratory-based research training and enrichment courses that prepare them for careers in academic medicine. PSTP students receive partial tuition assistance for the four years of medical school plus a stipend during the two research summers and the research year.

For more information: www.pstp.pitt.edu

Other Research Opportunities

Upon completing their first year of medical studies, approximately 96% of the students in the Class of 2023 engaged in various summer research programs. In addition, some medical students take a year off at some point to earn a master's degree in public health, biomedical ethics, or a related field; others participate in a year-long program of specialized study or research available through Pitt's CSTP, PSTP, or an individual department; and still others take part in prestigious national fellowship programs like those sponsored by NIH, the Sarnoff Cardiovascular Research Foundation, or the Howard Hughes Medical Institute.

Degree Programs

The **Interdisciplinary Biomedical Graduate Program** (PhD) combines a core curriculum with research and a dissertation focused on a choice of cell biology and molecular physiology, cellular and molecular pathology, molecular genetics and developmental biology, or molecular pharmacology.

The cross-campus **Center for Neuroscience Graduate Training Program** (PhD) introduces students to the fundamental issues and experimental approaches in neuroscience and trains them in the theory and practice of laboratory research.

The **Biomedical Informatics Training Program** (PhD, MS, or certificate) applies modern information technology to health care, education, and biomedical research.

Offered by the University of Pittsburgh and Carnegie Mellon University, the **Joint Program in Computational Biology** (PhD) is designed to develop expertise in the use of computational methods to identify and solve complex biological problems.

The **Molecular Biophysics and Structural Biology Graduate Program** (PhD) trains students in a broad range of cutting-edge technologies used to study the function of biological macromolecules in physical terms and covers a diversity of research topics in molecular biophysics and structural biology.

The goal of the **Integrative Systems Biology Program** (PhD) is to train students in emerging transformative methodologies that emphasize genomics, proteomics, complex cellular pathways, and the dynamics of cellular and organismal function. Students in this program operate at the exciting interface between basic bench-top biology, computational analysis of big data sets, and the emergence of 21st century clinical translation.

The **Program in Microbiology and Immunology** (PhD) aims to train highly motivated graduate students as self-reliant scholars in an environment with ready access to the breadth of expertise, approaches, and sub-disciplines that constitute the diverse fields of microbiology and immunology.

The **Biomedical Master's Program** (MS) is designed for students who desire additional training, mentoring, and advising to strengthen their academic and professional credentials for admission to health professional schools or for entry into the biomedical workforce.

The **Computational Biomedicine and Biotechnology Program** (MS) focuses on the interface between computer science and applied biology and will generate leaders who can translate cutting-edge computational technologies into real-world advances in biomedicine and biotechnology.

Since 2005, Pitt's **Institute for Clinical Research Education** (ICRE) has offered high-caliber training and education in clinical and translational research to more than 1,000 students at all career stages, with more than 300 currently enrolled. Fifteen degree and career development programs are customizable to meet the needs of students from diverse training backgrounds conducting research in a variety of areas. Degree programs include:

- **Clinical and Translational Science** (PhD), a rigorous program that teaches advanced knowledge of concepts needed to conduct independent and innovative research
- **Clinical Research** (MS or certificate, with five specialty tracks), which provides intensive training in the design and implementation of high-quality clinical research involving human participants
- **Medical Education** (MS or certificate), which prepares academically oriented health care professionals to become outstanding teachers of medicine
- **Comparative Effectiveness Research** (certificate), a multidisciplinary, comprehensive, and individualized training program.

Also offered are clinical research training programs for junior faculty, pre- and postdoctoral students, medical students and residents; and diversity-focused mentoring and skills-development programs for medical students, postdoctoral fellows, and faculty at Pitt as well as fellows and faculty at minority serving institutions.

Institutes and Centers

Aging Institute
Toren Finkel, MD, PhD, Director

Brain Institute
Peter L. Strick, PhD, Scientific Director
Arthur S. Levine, MD,
Executive Director

Center for Military Medicine Research
Ronald Poropatich, MD, MS, Director

Center for Vaccine Research
W. Paul Duprex, PhD, Director

Clinical and Translational Science Institute
Steven E. Reis, MD, Director

Drug Discovery Institute
D. Lansing Taylor, PhD, Director

Institute for Clinical Research Education
Doris Rubio, PhD, Director

Institute for Precision Medicine
Adrian Lee, PhD, Director

Magee-Womens Research Institute
Yoel Sadovsky, MD, Director

McGowan Institute for Regenerative Medicine
William R. Wagner, PhD, Director

Pittsburgh Institute for Neurodegenerative Diseases
J. Timothy Greenamyre, MD, PhD, Director

Thomas E. Starzl Transplantation Institute
Fadi G. Lakkis, MD, Scientific Director

UPMC Hillman Cancer Center
Robert L. Ferris, MD, PhD, Director

Vascular Medicine Institute
Stephen Chan, MD, PhD, Director

Research Strengths

Within the School of Medicine, areas of research concentration include the biology of aging; neuroscience; vision and vision restoration; comparative effectiveness research; genome stability and tumorigenesis; regenerative medicine and biomedical device development; vascular, developmental, structural, computational, and systems biology; immunology, including immunological approaches to cancer; cancer virology; and clinical research/clinical trials, among others.

Imaging

Imaging technologies are important tools for Pitt faculty investigating all facets of biology. The University's Center for Biologic Imaging is the largest optical imaging facility in the country. The center provides a truly cutting-edge environment, including electron, super-resolution, live-cell, and high-speed confocal microscopes. These tools enable the visualization of life ranging from the individual molecule to the whole body. Recent advances in high-speed confocal imaging made at Pitt enable the collection of truly massive three-dimensional data sets that push the limits of data collection and visualization. One exciting advance in visualization is that these data can be explored through virtual reality. For example, researchers can wander the brain at a cellular level, meander through blood vessels, track a virus as it invades the brain, and observe the structural complexities of a pig's eye. The technology gives scientific data sets an undeniable "wow factor." More importantly, it provides a striking visual perspective that can lead to new observations and new questions.

Immunotherapy

The University of Pittsburgh and UPMC are partners in efforts to harness the body's natural defenses and improve treatment outcomes through immunotherapy. The UPMC Immune Transplant and Therapy Center (ITTC), announced in early 2018, is an integral part of this collaboration. With a $200 million investment by UPMC, the University is creating a world-class space for labs, offices, start-up companies, and industry partners. The property, adjacent to the UPMC Hillman Cancer Center and UPMC Shadyside, represents Pitt's largest development project to date aimed at strengthening the city's innovation district. Building on Pitt and UPMC's longstanding record of success in patient care and research, ITTC investigators will seek ways to fine-tune the immune system to fight cancer cells; explore immune transplantation in conjunction with solid organ transplantation to reduce rejection and reliance on immunosuppressive medicines; and examine how immunotherapy can combat conditions like cardiovascular disease, obesity, and sickle cell anemia.

Neuroscience

In addition to imaging tools, faculty associated with Pitt's Brain Institute use clinical and basic science expertise to unlock the mysteries of normal and abnormal brain function. Concentrated primarily in the Departments of Neurobiology, Neurology, Neurological Surgery, Ophthalmology, and Psychiatry in the School of Medicine and the Departments of Neuroscience and Psychology in the Dietrich School of Arts and Sciences, these investigators are working to develop novel treatments and cures for brain disorders, including neurodegenerative diseases, spinal cord injuries, tumors, psychiatric illnesses, and traumatic brain injury.

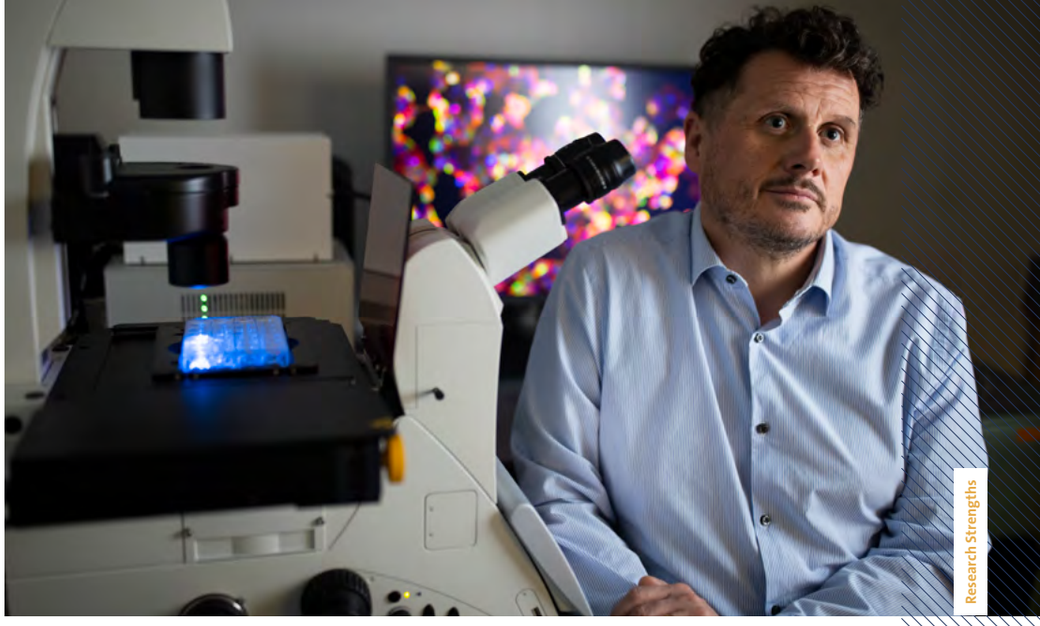
Precision Medicine and Big Data

The programmatic focus of the Institute for Precision Medicine is to apply new knowledge in genetics, genomics, and other disciplines toward the advancement of evidence-based medicine, with the goal of improving disease prevention and treatment models. Current goals focus on research and clinical implementation of pharmacogenomics and development of computational infrastructure for analysis and sharing of large-scale phenotype (clinical) and genotype data. The School of Medicine has recently received federal and state grants, in collaboration with the Pittsburgh Supercomputing Center and Carnegie Mellon University, to handle and analyze biomedical big data.

Clinical and Translational Science

The Clinical and Translational Science Institute (CTSI) at the University of Pittsburgh was established in 2006 as part of a nationwide consortium of 12 institutions sponsored by the National Institutes of Health (NIH) to speed the translation of biomedical research findings into clinical practice and evidence-based health policy. Funding for CTSI's efforts to date tops $318 million.

In addition to cataloguing and linking COVID-19 research studies to available resources, CTSI has awarded $900,000 to 17 research projects out of more than 150 submissions to address different aspects of the COVID-19 pandemic. CTSI also assisted the National Institute of Allergy and Infectious Diseases (NIAID) with contacting more than 400,000 potential U.S. study participants and coordinating logistics for a study to determine the spread of COVID-19 across the country.

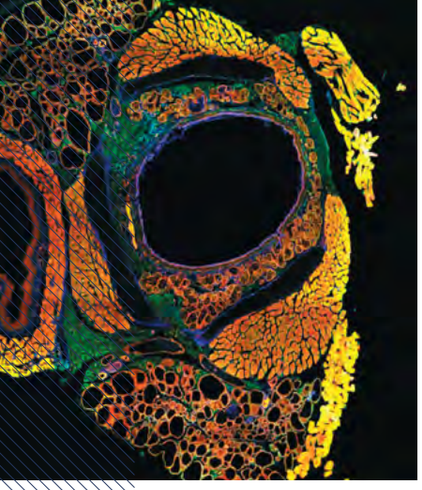


W. Paul Duprex, PhD, Director of the Center for Vaccine Research

In 2016, the National Institutes of Health chose CTSI to help build the foundational partnerships and infrastructure needed to launch NIH's *All of Us* Research Program, which aims to engage 1 million or more research participants to revolutionize how disease is prevented and treated based on individual differences in lifestyle, environment, and genetics. Pitt was awarded $4.2 million in the first year, with the potential of up to $69 million over six years. Pitt's project, called *All of Us Pennsylvania*, began enrolling the first of an anticipated 100,000 to 200,000 patients in the region in mid-2017 and plans to fund pilot studies using accrued data to advance precision medicine.

Vision Restoration

The School of Medicine is working alongside renowned partner institutions in France (see page 9), to develop treatments for currently untreatable retinal diseases, such as retinitis pigmentosa, age-related macular degeneration, and vascular eye disease using pharmacologic approaches, gene therapy, stem cell implantation and the artificial retina. More recently, School of Medicine and French researchers have begun to collaborate on fundamental research, development of novel therapeutics, and clinical trials, with an initial focus on ophthalmology, vision, and neuroscience. These partnerships also emphasize exchange of academic personnel, joint academic conferences, and exchange of scientific, educational, and scholarly materials.



José-Alain Sahel, MD, Distinguished Professor and chair, Department of Ophthalmology

$577
MILLION IN NIH FUNDING IN 2018

$582
MILLION FOR RESEARCH IN 2019

Research Funding

Funding from the National Institutes of Health (NIH) is considered the benchmark of overall stature among research-intensive academic health centers. Since 1998, the University of Pittsburgh has annually ranked among the top 10 recipients of NIH funding. In an analysis of NIH funding for fiscal year 2019, the University of Pittsburgh received more than $582 million in funding—approximately 80% of which went to the School of Medicine.

Overall, the University of Pittsburgh has budgeted approximately $874 million for research of all kinds in fiscal year 2020; nearly 70% of this amount is for research in the School of Medicine. As a result of its success, the School of Medicine has invested significantly in new research infrastructure in disciplines like developmental, cellular, structural, and computational and systems biology and in faculty recruitment.

Achievements

Following are some of the medical school's notable achievements over the course of its 134-year history.

[1913] Maud L. Menten, MD, PhD, and Leonor Michaelis, MD, develop the Michaelis-Menten Equation. One of the first concepts taught in biochemistry, the equation is crucial to understanding how enzymes function and underlies the development of most drugs over the past century. Menten also investigated the mobility of proteins in the presence of electric fields, called electrophoresis. This work provided important information on differences in the size and mobility of hemoglobin molecules and predated Nobel Laureate Linus Pauling's work on sickle cell disease by several years.

[1950] Philip S. Hench, MD, a 1920 graduate of the School of Medicine, and two other scientists win the Nobel Prize in Physiology or Medicine for discoveries relating to the hormones of the adrenal cortex.

[1952] A killed-virus polio vaccine is developed by Jonas Salk, MD, and a team of researchers. The introduction of the vaccine to the public in 1955 led to a rapid and dramatic drop in the incidence of this previously unpreventable disease.

[1958] Peter J. Safar, MD, demonstrates the efficacy of mouth-to-mouth ventilation and combines his discoveries with other scientists' work on chest compression to develop the ABCs of cardiopulmonary resuscitation (airway, breathing, and circulation).

[1961] Klaus Hofmann, PhD, leads a team that develops a synthetic form of adrenocorticotropic hormone (ACTH) that performs all of the biological functions of the naturally occurring hormone.

Canadian-born physician and biochemist Maud Leonora Menten (1879-1960) made important contributions to enzyme kinetics and histochemistry.

Dr. Jonas Salk's polio vaccine research team at work; organ transplantation pioneer Dr. Thomas Starzl

[1962] Niels K. Jerne, MD, undertakes landmark research on antigen-antibody interactions. Two articles produced during his time at the School of Medicine were among those later cited by the Nobel Committee as providing the basis for his prize-winning work.

[1964] Panayotis G. Katsoyannis, PhD, performs the first chemical synthesis of a polypeptide hormone, insulin, and combines it with biologically active material, providing the means to explore and validate previous assumptions about the active amino acids in the insulin molecule.

[1964] Julius S. Youngner, ScD, sheds new light on the cause of immune and inflammatory responses by discovering that nonviral agents, as well as viral ones, can trigger interferon induction. Within the next decade, Youngner and others discover that certain viruses have mechanisms that can actually inhibit the action of interferons. He also identified a second type of interferon, now called gamma-interferon, which displays typical antiviral capabilities plus a host of distinctive properties.

[1967] Dr. Safar is instrumental in founding the Freedom House Ambulance Service, which was based in Pittsburgh's predominantly African American Hill District neighborhood. Over its eight years in operation, Freedom House set a new standard for ambulance service and helped establish national guidelines for community-wide emergency medical services.

[1979] In the first of several landmark papers on lead exposure in children, Herbert Needleman, MD, reports in the New England Journal of Medicine that subclinical exposure to lead is associated with lower IQ.

[1980] Investigators isolate and cultivate *Legionella micdadei* (Pittsburgh pneumonia agent) from human lung tissue. A team led by A. William Pasculle, ScD, goes on to delineate the microbiology, epidemiology, clinical syndrome, and environmental ecology of this organism, which is the second leading cause of legionella-based pneumonia.

[1984] Thomas E. Starzl, MD, PhD, performs the world's first double transplant operation (simultaneous heart and liver) on a 6½-year-old girl from Texas.

[1985] Bernard Fisher, MD, and team are the first to recognize the systemic pattern of breast cancer development, leading to the conclusion that lumpectomy combined with radiation therapy is as effective as mastectomy in treating breast cancer. Fisher's group went on to show the effectiveness of chemotherapy and hormonal therapy (tamoxifen) in preventing recurrence.

[1991] Following his earlier work in establishing the clinical utility of the immunosuppressants cyclosporine and tacrolimus (FK506), Dr. Starzl explores the theory of chimerism as a means of boosting transplant organ tolerance and reducing dependence on immunosuppressive drugs by proving that cells from donor organs intermingle with a transplant patient's own tissues.

[1996] Investigators led by John W. Mellors, MD, discover that plasma HIV load plays the critical role in determining the prognosis of AIDS patients.

[2000] Researchers led by Bora E. Baysal, MD, PhD, and Bernard Devlin, PhD, discover that a mutation in a gene encoding a mitochondrial protein is the cause of hereditary paraganglioma. This study is the first to link the structure of mitochondrial DNA to tumor development.

[2004] In collaboration with colleagues in Sweden, researchers complete the first human study of a radioactive dye called Pittsburgh Compound B (PiB) developed by William E. Klunk, MD, PhD, and Chester A. Mathis, PhD, to detect, using PET scanning, the beta-amyloid deposits that are associated with Alzheimer's disease. Subsequent research correlates detection results in living patients with their later autopsy results to confirm the effectiveness of PiB in signaling the presence of beta-amyloid deposits.

[2007] Gary A. Silverman, MD, PhD, and Clifford J. Luke, PhD, overturn the long-held view of necrosis as a chaotic, irreversible process by showing it to be part of a regulated response to stress by SRP-6, a powerful protein known as a serpin that they believe might be harnessed to either target or spare cells as a way to better manage cancer, heart disease, stroke, or neurological conditions.

[2008] Researchers led by Yuan Chang, MD, and Patrick S. Moore, MD, MPH, the husband-and-wife team who previously identified the Kaposi's sarcoma-associated herpesvirus, use novel sequencing technology to identify a previously unknown polyomavirus that is strongly linked with a rare but deadly skin cancer called Merkel cell carcinoma.

[2011] A team including Michael Boninger, MD, Andrew B. Schwartz, PhD, and Elizabeth Tyler-Kabara, MD, PhD, demonstrates successful use of a brain-computer interface that allows a man who had been paralyzed seven years earlier in a motorcycle accident to tenderly give his girlfriend a "high-five" using a robotic arm maneuvered by his thoughts.

[2013] A team led by Angela Gronenborn, PhD, and Peijun Zhang, PhD, describes for the first time the 4-million-atom structure of HIV's capsid, or protein shell. The findings, highlighted on the cover of Nature, could bolster efforts to defeat an often-changing virus that has been a challenge to conquer.

[2013] For the first time, a mouse heart was able to contract and beat again after its own cells were stripped from the extracellular matrix and replaced with human heart precursor cells, Lei Yang, PhD, reports in Nature Communications. The result suggests that a functional organ could be regenerated by placing human induced pluripotent stem cells into a three-dimensional scaffold.

[2013] A first-of-its-kind vaccine developed by Olivera Finn, PhD, and colleagues successfully prompts the immune system to respond to early indications of colon cancer in people at high risk for the disease.

[2014] Robert Friedlander, MD, MA, and colleagues identify for the first time a key molecular mechanism by which the abnormal protein found in Huntington's disease can cause brain cell death. The findings could one day lead to ways to prevent the progressive neurological deterioration that characterizes the condition.

[2015] A team led by Cecilia Lo, PhD, identifies mutations associated with congenital heart disease in 61 genes, many not previously known to cause the disease. The study indicates that the antenna-like cellular structures called cilia play a critical role in the development of these heart defects.

[2016] A team led by Mark T. Gladwin, MD, engineers a protein that reverses carbon monoxide (CO) poisoning in mice, a discovery that could potentially lead to the creation of the first antidote in humans to the often deadly poisoning.

[2018] José-Alain Sahel, MD, and colleagues develop a wireless photovoltaic retinal prosthesis. A clinical trial for advanced macular degeneration is approved by the FDA and, following implementation in France, five patients will be enrolled in the Pittsburgh area for the first U.S. trial.

[2019] Kyle Orwig, PhD, and colleagues report success in achieving a live nonhuman primate birth resulting in part from sperm produced after immature testicular tissue had been cryopreserved and later used to restore fertility to the same animal. The study, the last step in a proof-of-concept model of cancer survivorship, offers hope that boys treated for cancer prior to puberty may someday father biological children of their own.

[2019] An international team of researchers and clinicians led by Graham Hatfull, PhD, reported that they successfully treated a seriously ill teenager with cystic fibrosis who had disseminated infection by *Mycobacterium abscessus* using a cocktail of genetically engineered phages. This accomplishment represents a number of firsts: the first genetically engineered phage treatment—in this case, to convert a lysogenic phage to a lytic variety—and the first treatment of a mycobacterium. Dr. Hatfull has a primary appointment in the Department of Biological Sciences, Dietrich School of Arts and Sciences, and a secondary appointment in the School of Medicine's Department of Computational and Systems Biology.

[2020] Using a genetically modified mouse organ transplant model, a research team led by Fadi Lakkis, MD, demonstrates that innate immune cells exposed to a foreign tissue can remember and initiate an immune response if exposed to that foreign tissue in the future. The findings could pave the way to drugs that lengthen long-term survival of transplanted organs.

[2020] Kacey Marra, PhD, and colleagues create a biodegradable nerve guide using a polymer tube filled with growth-promoting protein that can regenerate long sections of damaged nerves, without the need for transplanting stem cells or a donor nerve.

UPMC (University of Pittsburgh Medical Center)

Through its affiliation with UPMC, the School of Medicine offers students opportunities for clinical training, educational experiences, and research in virtually any medical specialty. Although legally separate and distinct entities, the School of Medicine and UPMC share mutual interdependence and a synergy that is reflected in a common commitment to excellence in education, research, and clinical care.

As an integrated global health enterprise and one of the nation's leading academic health care systems, with $21 billion in revenues, UPMC integrates more than 90,000 employees; more than 6,000 affiliated physicians, including 4,900 employed by the health system and 1,438 who are also full-time faculty of the School of Medicine; 40 tertiary care, specialty, and community hospitals; as well as specialized outpatient facilities, cancer centers, rehabilitation facilities, retirement and long-term care facilities, imaging services, doctors' offices, and a health insurance plan covering 3.8 million members.

As of August 1, 2020, the UPMC Medical Education Program has 1,293 medical residents and 418 clinical fellows in programs approved by the Accreditation Council for Graduate Medical Education, plus four clinical fellows in other programs.

U.S. News & World Report consistently ranks UPMC Presbyterian Shadyside among the nation's best hospitals in many specialties and ranks UPMC Children's Hospital of Pittsburgh on its Honor Roll of America's Best Children's Hospitals.

The core of the health system is located in the Oakland, Shadyside, and Lawrenceville neighborhoods of Pittsburgh, where the following health

UPMC

care facilities are interwoven with University of Pittsburgh facilities: UPMC Presbyterian, UPMC Montefiore, Eye and Ear Institute, UPMC Magee-Womens Hospital, UPMC Western Psychiatric Hospital, UPMC Hillman Cancer Center, UPMC Shadyside, and UPMC Children's Hospital of Pittsburgh.

UPMC Hillman Cancer Center is one of the largest integrated community networks of cancer physicians and health care specialists in the United States and the only National Cancer Institute-designated Comprehensive Cancer Center in Western Pennsylvania, providing patients the latest advances in cancer research, prevention, detection, diagnosis, and treatment.

UPMC's clinical programs have earned international recognition, drawing patients from around the world. In addition, the medical center is now transporting its expertise to other countries, including Italy (where it manages the Mediterranean Institute for Transplantation and Advanced Specialized Therapies in Palermo) and Ireland, as well as ventures in China and Kazakhstan.

The mission of UPMC Transplant Services is to foster a multidisciplinary approach to the advancement of the clinical, scientific, and social aspects of transplant to improve the lives of patients with end-stage organ failure and their families. The UPMC Liver Transplant Program leads the nation in overall number of liver transplants performed from living donors. Two-thirds of all living-donor transplant procedures in Pennsylvania are performed at UPMC.

In recognition of its leadership in using information technology to improve clinical outcomes and efficiency, UPMC was named one of the country's "Most Wired" health systems for the 21st consecutive year—the only health care organization to be consistently recognized with that distinction during that time frame—according to the College of Healthcare Information Management Executives (CHIME).

For more information: www.upmc.com

City of Bridges

Pittsburgh is home to three rivers (the Allegheny and Monongahela converge here to form the Ohio), more bridges than any other city in the world (by some estimates), 26 colleges and universities, seven Fortune 500 companies, and the remnants of Fort Duquesne, which was built in the 1750s and later replaced by Fort Pitt.

The population of the seven-county region is nearly 2.3 million, with some 300,000 living within the city. Pittsburgh is vibrant, safe, and affordable; it features the amenities and liveliness of a large city with small-town civility and neighborhood feel.

While Pittsburghers know well of all the city has to offer, in recent years it's been ranked one of the best American cities to live in, dine in, and visit by multiple outlets and ranking lists. Pittsburgh was recently named a best U.S. city to visit by Condé Nast Traveler, the seventh best U.S. city in which to start a career by LinkedIn, and the third best American city for coffee lovers by Apartmentguide.

Three major professional sports teams—the six-time Super Bowl champion Pittsburgh Steelers; the 2016 and 2017 Stanley Cup champion Pittsburgh Penguins; and the Pittsburgh Pirates, a franchise that, in the past decade, reached the postseason multiple times after a long absence—provide plenty of reasons to cheer, or jeer, depending on the season. In addition, the University is home to a full range of sports teams. The Pitt Panthers typically offer some of the finest performances in college athletics and joined the esteemed Atlantic Coast Conference in 2013. For athletes and spectators alike, there is the Pittsburgh Marathon, usually in early May, when more than 30,000 elite and amateur athletes run up to 26.2 miles through the city of bridges.

Oakland, the neighborhood in which Pitt is located, is unquestionably the intellectual center of the community. In the heart of Pitt's campus is the 42-story Cathedral of Learning, the second tallest university building in the world and home to more than two dozen Nationality Rooms styled to reflect the culture of the faraway places to which many Pittsburghers can trace their roots.

Pittsburgh's hills and valleys give way to breathtaking views and are home to 90 neighborhoods, many of them embracing distinct ethnic and cultural flavor plus traces of Old World attitudes and culture. Possibly the most famous, Mister Rogers' Neighborhood, a children's television show broadcast from here for 33 years, reflected in its own simple and charming way a neighborly place to be—which is, perhaps, the best way to describe Pittsburgh.

All photos courtesy of the University of Pittsburgh except those listed below.

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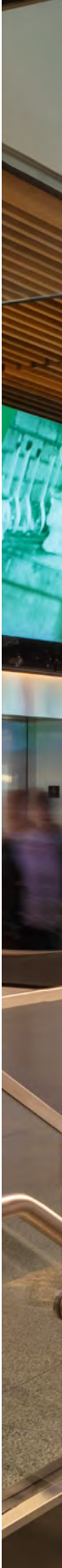

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