Community Stressed
Homelessness, mental illness and other health crises tear at the weakest parts of the social fabric; these doctors mend mind and body for the common good.

BY YADIRA GALINDO

With Data This Big
The next medical breakthrough may come from a mathematician or a video game aficionado. Or it may come from you.

BY HEATHER BUSCHMAN, PHD

Bodies of Knowledge
For first-year medical students, anatomy lab offers immediate, tangible lessons in what it means to be human — from many perspectives.

BY JACQUELINE CARR

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On the Covers
Inside and out, this year’s magazine reflects UC San Diego Health Sciences’ tripartite mission to conduct translational and transformational medical research, educate medical leaders of the future and provide unsurpassed compassionate, personalized patient care.
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UC San Diego Health Sciences comprises the region’s only academic health system, one of the nation’s top research-intensive schools of medicine, the Herbert Wertheim School of Public Health and Longevity Science and the Skaggs School of Pharmacy and Pharmaceutical Sciences.

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The Empiricism of Empathy

As always, we remain committed to advancing and fulfilling our tripartite mission as quickly and as fully as possible. We seek to improve health through innovative research, education and patient care. And, as you’ll see in our three feature pieces, that commitment takes many forms, from a desire and ability to envision the unseen to old-fashioned, hands-on learning and caring.

In this issue’s research feature, for example, you’ll meet two faculty members from unexpected backgrounds whose work brings them together to analyze and better manage Big Data capable of improving heart disease diagnoses and our understanding of the health ramifications associated with sedentary behavior. Many aspects of research and medical education change quickly and often, spurred by breathless innovation, but we remain grounded in some traditional methodologies.

Throughout this issue, you’ll discover a variety of engaging topics, from unprecedented efforts to prevent physician burnout at the new T. Denny Sanford Institute for Empathy and Compassion at UC San Diego and a writer’s deep dive into personal genetic sequencing results to a visit with a nurse in our Senior Emergency Care Unit, part of the Gary and Mary West Emergency Department at Jacobs Medical Center — the first of its kind west of the Mississippi River.

I hope this publication will give you a sense of our expansive and far-reaching innovations and aspirations, from the investigation of elusive cells to caring for whole populations of people. Throughout, the double helices of passion and compassion thread, stitching together our striving to improve human health in San Diego and beyond.

We welcome your feedback at somnews@ucsd.edu.

Sincerely,

David A. Brenner
Vice Chancellor, UC San Diego Health Sciences

A LETTER FROM DAVID A. BRENNER

THE PAST DECADE at UC San Diego Health Sciences has been one of tremendous growth. We’ve built innovative basic and translational research buildings; opened a spectacular hospital, a new outpatient pavilion and multiple clinics; hired superstar faculty and staff; and launched and expanded programs ranging from digestive diseases to phage therapy and the latest in microscopy.

(And documented it all in Discoveries, which is celebrating its 10th year with this issue!) This is no time to rest on our laurels. As always, we remain committed to advancing and fulfilling our tripartite mission as quickly and as fully as possible. We seek to improve health through innovative research, education and patient care.

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Ten Eventful Years

UC SAN DIEGO HEALTH SCIENCES

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In cadaver lab, the students confront death and all its moral weight. This lab is one of the first and most enduring lessons in professionalism for medical students. With each cut, there is an invaluable lesson. Initially what may feel like a violent act transforms into something revelatory — on both sides of the scalpel.

— MARK WHITEHEAD, PHD

NERVOUSLY, I APPROACHED THE anatomy lab. My assignment was to observe the dissection of human cadavers and, simultaneously, the nascent learning of more than 130 first-year medical students. While I was permitted to take notes, photography was strictly forbidden.

I wandered the building's basement, a maze of fluorescently lit hallways, some punctuated with empty steel gurneys. Eventually, I found the lab entrance, marked by a massive pile of colorful backpacks.

I hesitated. As a high school student, I had dissected rats in biology class. I recalled the distinctive smell of formaldehyde and the animals’ small but complex skeletons and minuscule organs. But now, I paused. On the other side of the lab’s double doors were 30 human bodies. That’s more mortality than I’m accustomed to dealing with on a Friday morning.

Pushing the doors open, I expected to see a macabre scene, something from a Stephen King novel perhaps or a “Grey’s Anatomy” episode. Instead, I was greeted by a buzz of excited voices. Groups of students hovered over tables, each occupied by an individually assigned cadaver. The learning sounded loud and joyful.

I looked for Mark Whitehead, PhD, chief of anatomy. I didn’t see him, and so I quickly retreated to the back of the room where I might blend in, unobserved yet able to observe. I scanned the room, eyes half-closed, hoping I could manage the views, worried about things I wouldn’t be able to unsee.

Images came in fragments: Stainless steel tables beneath bright, surgery-style lights. Buckets filled with mallets, saws and other tools of pathology. An instructor’s hands pointing, gesticulating, a blur of motion. Curious eyes following those hands, minds presumably in tow. The last belong to students intent on becoming doctors.

Whitehead appeared at my side. He explained as I watched that “during Introduction to Anatomy, we review the history of using human bodies for medical education and the importance of respecting the donor as ‘the medical student’s first patient,’” Whitehead said. “Like living patients, the donor teaches human biology and how things can go awry. The donor also teaches humanity and humaneness.”

Whitehead trains medical students to view their anatomical experience with the donor as an ethical compact: The donor gives his or her body to medical science so that the student can learn and, in time, do good as a physician.

“In cadaver lab, the students confront death and all its moral weight,” he said. “This lab is one of the first and most enduring lessons in professionalism for medical students...With each cut, there is an invaluable lesson. Initially what may feel like a violent act transforms into something revelatory — on both sides of the scalpel.”

— MARK WHITEHEAD, PHD

For first-year medical students, anatomy lab offers immediate, tangible lessons in what it means to be human — from many perspectives.

BY JACQUELINE CARR

“BODIES KNOWLEDGE”
For both Jordan and Matthew, the lab is infinitely more effective than just book-learning. It draws upon all of their senses. They can feel how joints bend and move in coordination. They can see how the right lung is wider but shorter to make room for the liver beneath it, while the left lung is narrower to accommodate the adjacent heart. Human anatomy varies from person to person. There is no completely accurate textbook example.

“Books do a good job, but they can’t account for all of the individual human variations that exist. Books also don’t offer the tangible aspect of learning,” said Jordan. “For things as complex as human anatomy, the hands-on aspect is huge. We had a beautiful brachial plexus (a network of nerves extending from the spinal cord through the neck and into the armpit) in our donor. Tracing the nerves through the arm was a daunting task, but also rewarding and amazing to behold.”

“You can’t tell depth perception from a book and can’t appreciate how convoluted and complicated the body is,” added Matthew. “You can’t appreciate how many nerves and peripheral blood vessels surround the body. Any mobile app or book will have the body down to its basics, its main structures. That’s helpful, but you can’t really know what that looks like in 3D. I was surprised how every donor’s vasculature was different. Some arteries or nerves were definitely not where I expected them, or were even missing.”

Whitcomb confirmed their observations. While the gender of the donors is evenly split, each body tells its own story. Beneath telltale scars, some donors once carried implanted medical devices, such as cardiac stents or hip or knee replacements. Others showed evidence of untreated disease, such as diabetes or lung cancer.

“I want to show the donor and their family that their sacrifice, their donation did not go to waste and that they had an indelible effect on my life and my future career as a physician.”

— MATTHEW, MEDICAL STUDENT

The average adult human body contains 78 organs divided into 11 systems (these numbers are debated). There are 206 bones and approximately 640 skeletal muscles. The small intestine stretches 20 feet; the large extends five feet. The heart weighs 11 ounces; the brain three pounds. Laid end-to-end, the blood vessels stretch more than 60,000 miles, and there are 46 miles of central nervous system fibers; all contained within 17 to 20 square feet of skin, weighing 30 pounds, give or take.
Why do the medications we take by mouth look the way they do?

BY SCOTT LAFEE

FOR GOOD AND ALL, Americans consume a lot of medications. More than half of the population takes at least one prescription medication — four, on average — according to a nationally representative survey published a few years ago. Some of these medications are injected or inhaled, but the vast majority are consumed orally, a mode that dates back thousands of years to when practitioners combined therapeutic ingredients with substances like clay, grease, honey or bread to create measured, easier-to-swallow doses. Beyond bread, the multitudinous numbers of over-the-counter remedies. Flavored medications for people who have difficulty swallowing tablets and capsules. Lozenges are medications that dissolve in the mouth. "There are many reasons why some medications can’t be used in solid dosage form," said Christian Mnatzaganian, PharmD, assistant clinical professor in the Skaggs School of Pharmacy and Pharmaceutical Sciences at UC San Diego. "Some pharmacologically active ingredients need to reach the site of action quickly, and in a tablet or capsule, it would take too long. Some medications are unstable in pill form, such as insulin, which can be rendered ineffective by stomach acids. Others can be rendered ineffective by the liver." Medications in oral form are stable enough to withstand the body's effect upon them, Mnatzaganian said. "They’re also easier and often safer to use; they’re usually cheaper, too." Between 1997 and 2016, according to the most recent data available, the number of prescriptions filled by American adults and children rose 85 percent, from 2.4 billion to 4.5 billion a year. That equates to untold numbers of pills, tablets, capsules, chewables and lozenges in all manner of shapes, sizes, colors and markings, not to mention the multitudinous numbers of over-the-counter remedies. Hereewith, our oral history in three easy-to-swallow doses.

1. Shape

Oral solid dosage forms come in myriad shapes: triangles, squares, polygons, bow ties, hearts, kidneys, apples, eggs and tears, but practically dictates that most are round, oval or capsule (the last shape having been around for a surprisingly long time, dating back to 1833). These forms are easier to swallow, require simpler manufacturing technologies and are less likely to chip or break in their containers. Shape can also help distinguish a specific medication. Or more precisely, a specific maker of that medication, since generic versions of the same pharmaceutical can assume other forms. For example, the over-the-counter heartburn reliever PEPCID AC is a four-sided, diamond-shaped tablet, while NORSACA, a medication for treating high blood pressure, is an elongated octagon. A distinctive shape can help both patients and health-care practitioners more quickly and accurately recognize the appropriate brand-name medication.

2. Color

Like shape, color may help identify the medication. This is especially important for medications like WARFARIN, a prescription blood thinner (branded as COUMADIN) whose tablet strength is fixed to a specific color (pink, lavender, green, tan, blue, peach, teal, yellow and white). “Slight dose changes in these medications can result in major changes in efficacy and for side effects,” said Mnatzaganian, “so it’s crucial for the pharmacist and patient to make sure that the exact tablet dispensed and taken is the one that is prescribed for them.”

There are no rules about what a drug must look like, only that generic versions must contain the same active ingredient as the original and deliver it in the same way. Until the mid-20th century, pills were almost invariably round and white, with a few pastel variations. Coloration took off in the 1960s and 1970s with new manufacturing technologies and mass marketing. Today, it’s estimated that pills, tablets and capsules can be tinted in more than 80,000 color variations.

Color is typically the first thing consumers notice and remember about a drug, a fact marketers exploit: “Ask your doctor about the purple pill,” goes the ad for NEXUM. Colors also influence patient perception, a sort of placebo-by-pigment effect. Red and orange are considered to be bold and strong, and often used for stimulants or pain relievers, such as acetaminophen (TYLENOL) or ibuprofen (MOTRIN). Yellow suggests happy-go-lucky: Many allergy medications come in shades of lemon, saffron and gold. VIAGRA originally debuted as the little blue pill, quite pale in color and more reminiscent of the soothing blue hues used by some sedatives. These days, it’s a darker, more vibrant blue — like a sky looking forward to night. DIPHENHYDRAMINE, an antihistamine also used as a multi-branded sleep aid, is a middle-of-the-night, slumber-inducing purple.

“Since patients come to recognize the shapes and colors of their tablets,” said Mnatzaganian, “it may improve adherence to their medications, especially if their sight is poor but they can identify colors.”

“On the other hand,” she said, “patients who only know their medications by shape and color may have issues refilling prescriptions or sticking to their prescribed schedule. Researchers have found that when patients switch from a brand name drug to a generic that looks different in color or shape, they are more likely to stop taking the medicine.”

Most medications remain beyond the realm of tasty gummies — jelly beans disguised as doctors. Their active ingredients defy sugar-coating, and so they are mass-marketed. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint can be a single letter, number or a combination. It can be a company name, logo, symbol, monogram or National Drug Code (a longer numerical series that is the universal product identifier for human drugs in the United States).

Despite all of these identifiers — or sometimes because of them — it can be confusing to know exactly what pill you have in hand. For example, one generic brand of acetaminophen gelbals describes the recommended adult dose as 650 milligrams — one gelbal. But individual gelbals are marked “350,” suggesting one needs to take two. In fact, the 350 is the maker’s imprint code, not the milligram dosage. When in doubt, read product labels for more information or consult a pharmacist.

3. Markings

All approved prescription and over-the-counter solid oral medications have a unique marking, which can be printed, debossed, engraved or embossed. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor. The imprint works in conjunction with the medication’s size, shape and color to better identify it and indicate the active ingredient, strength, manufacturer or distributor.

Most medications remain beyond the realm of tasty gummies — jelly beans disguised as doctors. Their active ingredients are not designed to be swallowed whole. Color here can play a subtle role, suggesting a flavor irrespective of actual ingredients. In a 2011 study, for example, patients said they thought pink tablets tasted sweeter than red. Yellow tablets were salty. Blue and white were bitter. Orange was sour.
FOR MORE THAN 30 YEARS, Tom Crisman has been a registered emergency room nurse at UC San Diego Health. He’s seen it all, from routine cuts and scrapes to the terrible traumas of car crashes, fires and violence.

When word went out for nurses to staff the new Senior Emergency Care Unit (SECU), Crisman, 66, was first in line. “My mom has Alzheimer’s, so the motivation is very personal.”

But the need is not. The country is aging: 10,000 Baby Boomers turn 65 every day; by 2030, they will all be older than 65, and by 2035, the U.S. Census projects there will be as many seniors in the United States as people under the age of 18.

Age brings more, new and different health challenges, from diet to managing aches and pains to disease, both chronic and acute. It requires a different kind of emergency care.

In 2019, UC San Diego Health opened a state-of-the-developing-art unit specialized in treating seniors requiring emergency care. It was the first of its kind in California to treat qualifying patients over the age of 65 in a dedicated, customized space.

“My job is to provide senior patients with the highest quality of care, and this environment makes that possible,” said Crisman, who works with a multidisciplinary team that includes specially trained pharmacists, social workers and gerontologists. In the SECU, Crisman is known as a GENIE, or Geriatric Emergency Nurse Initiative Expert. There are four GENIEs in the SECU. “I don’t grant wishes,” he says with a laugh, “but I assist seniors with all of their needs, from identifying a symptom to a gentle touch to take away some anxiety.”

The unit is part of the Gary and Mary West Emergency Department at Jacobs Medical Center in La Jolla. It’s the first emergency department west of the Mississippi River to receive a Level 1 Gold accreditation from the American College of Emergency Physicians for its efforts to improve the quality and standards of emergency care to elderly patients.

The most common reasons patients come to the SECU include chest pain, abdominal pain, back pain, stroke, pneumonia or broken bones or fractures. “Many patients are brought to the senior emergency care unit because they can no longer perform daily activities due to a decline in bodily functions, or their caretakers can no longer provide the adequate amount of care needed at home,” said Crisman. “We sometimes have to have hard and emotional conversations with families about the reality of their loved one’s health condition.”
AFTER BEING TRIAGED in the main emergency department, the patient enters the SECU through a hallway. There is a stark difference in how the SECU looks and sounds compared to the traditional emergency department, which can be a harshly lit, crowded and sometimes chaotic place. The hallways and 19 patient rooms in the SECU are wrapped in sound-absorbing walls and ceilings to reduce ambient noise. A variable lighting system mimics the time of day to reduce visitor disorientation. Contrasting colors between walls and floors improve mobility and reduce fall risk.

Everything is designed to reduce hospital admissions and readmissions in the aging population.

“Almost 35 percent of the patients who come through our emergency room doors are over the age of 65,” said Vaishal Tolia, MD, MPH, medical director of the Department of Emergency Medicine at UC San Diego Health.

“Seniors can present with symptoms like weakness, dizziness and confusion. Oftentimes, these vague symptoms don’t really require an admission to the hospital, but rather, upfront specialized care. Our goal is to give these patients what they desire, which is usually to be treated and go home.”

From January 2019 through August 2019, there were more than 7,000 patients determined eligible for the SECU, with 1,915 admitted to the hospital and 304 readmitted 30 days after discharge.

“Recent data has also shown that when a GENIE is part of the patient’s care in the SECU, there is a 9 to 15 percent increase in the patient being referred to specialty care, and that decreases the patient’s risk of coming back to the SECU,” said Crisman.

These preliminary numbers continue to be compiled and compared so staff can determine the effectiveness of the SECU and identify areas of improvement. “Our goal is for hospital systems across the nation, including all University of California systems, to adopt our SECU model,” said Crisman, who frequently travels around the nation to teach other medical staff about the SECU.

The SECU was made possible by an $11.8 million grant from philanthropists Gary and Mary West. The grant enables research initiatives between UC San Diego Health and the West Health Institute to identify, evaluate and disseminate best practices in geriatric emergency care.
11:00 am

WEARING CRISP BLUE SCRUBS and a pair of running shoes, Crisman greets his first SECU patient of the day — 76-year-old Virginia Dayandante — with a wide smile. He places a warm blanket over her legs and pulls a chair up to her bedside.

Dayandante immediately reaches for Crisman's hand as if to look for a source of comfort and connection. Dayandante speaks Tagalog and needs an interpreter, but the gentle touch and eye contact between patient and nurse require no translation.

Crisman rolls in a computer monitor on a stand. The interactive video interpreter system, called MARTTI, provides patients like Dayandante with a professional on the other side of the screen, much like Skype, to communicate with their medical team in their native language. With Dayandante's interpreter ready, Crisman starts the screening process.

Dayandante is suffering from abdominal pain that is radiating to her back.

“I have a heartiness in my stomach,” she says.

Crisman wants to assess how well Dayandante can walk. He carefully helps her rise from the exam room bed and walks with her a few feet down the hall with a firm grip. “She has a wide stance and a short gait. She could really benefit from physical therapy to reduce the risk of falling.”

After gently placing Dayandante back in bed and replacing the warm blanket, Crisman asks a list of questions, some obvious, some not. It's part of the ISAAR test, or Identification of Seniors At Risk. “The answers help determine if patients are likely to have a poor outcome if we discharge them from the emergency department,” said Crisman. “We are working to implement the same screening practices in other departments within UC San Diego Health, like senior behavioral health.”

CRISMAN: “Have you fallen in the last three months?”

DAYANDANTE: “No.”

CRISMAN: “Do you or your family have enough money for groceries and medication?”

DAYANDANTE: “Yes, my daughter helps me.”

CRISMAN: “Oh good, you have a caregiver. Can you bathe or shower on your own?”

DAYANDANTE: “I can if my stomach isn’t in pain.”

CRISMAN: “When is the last time you had a bowel movement?”

DAYANDANTE: “About three days ago.”

CRISMAN: “Okay, very interesting.”

“We are assessing a variety of things, like their mental health, nutrition, mobility, any financial issues that would prevent them from taking medication, if they have any confusion and we’re also trying to understand their caregiver situation,” Crisman said. “I am also scanning the patient for bruises, confusions or lacerations to rule out elder abuse or identify if there may be a serious problem.”

Three simple words also determine if patients in the SECU are experiencing any concerning, age-related memory problems. Dayandante's words are: Apple. Table. Penny.

Patients are told the words and then asked to perform a task on a paper clock to distract their minds. After a few minutes, they are asked to repeat the three words. “We also ask patients to spell the word ‘world’ backwards,” said Crisman. Due to the language barrier, it is decided that Dayandante will not have to perform those memory tasks.

Instead, Crisman asks Dayandante her age, date of birth and what year it is. “2019,” Dayandante answers slowly and thoughtfully. “I feel like toasting to her because she got them all right,” said Crisman chuckling, which makes Dayandante smile for the first time since he entered the room.

2:20 pm

AFTER REPORTING DAYANDANTE’s health condition to the attending physician, Crisman retreats to a staff lounge for a brief break. He pores over notes describing newly arrived patients.

The lounge boasts the usual amenities: coffee, snacks and bottled waters. But there are also stacks of pamphlets outlining how patients can find necessary transportation, community services and legal advice. “These patients have more needs than just physical,” Crisman said, “and it takes a lot of people working together to help them.”

CRISMAN ENTERS THE ROOM of 88-year-old Walter Becker, who was transported by ambulance from a nursing facility. Becker has congestive heart failure and needs oxygen and fluids.

Becker is, quite literally, a retired rocket scientist.

“My patients are reminders that aging doesn’t discriminate,” said Crisman. “You can’t outthink it.”

Due to his deteriorating health, Becker — a father of eight — does not speak much while lying in the hospital bed. He answers Crisman's questions with either a nod or simple “yes” or “no.”

When he has a hard time remembering the word “river” during his memory exercise, he offers the substitute “ocean.” “I didn’t realize I was going to be doing this much caregiving at this point in my life,” said Carol. “I've had to change many plans in my life, including today. I was supposed to be getting physical therapy but had to cancel my appointment because I am now in the emergency room with him.”

Becker subtly reaches for his wife's hand and gives her a reassuring wink and smile.

With an oxygen mask on and assistance from Crisman, Becker then tries to get up from his bed. His blood pressure drops suddenly and precipitously, prompting a decision to admit Becker for additional tests and monitoring. Approximately 15 to 20 patients visit the SECU daily. Each receives the same tireless compassion, energy and attention to detail that Dayandante and Becker did.

“Patients like Virginia and Walter want to know that you understand how they feel. They want to be heard,” said Crisman, his eyes slightly tearing. “This job shows me every day that my patients are reminders that aging doesn’t discriminate.”

“It’s a life lesson that never gets old.”

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“It’s a life lesson that never gets old.”
THIS PROCESS IS STILL the lifeblood of biomedical research and discovery, but a complementary approach has emerged in the past decade: the harnessing of what’s become known as Big Data.

More than just a lot of numbers, Big Data in medicine refers to the many sources of information that can be generated about a cell, a person or a population, all potentially contributing to better health care. These data sources may be related to an individual’s health, environment, lifestyle or diet. Data can be derived from a person’s genes, proteins and resident microbes. Or from wearable devices. All of it is increasingly captured within repositories, such as government databanks or patients’ electronic medical records, and accessible to biomedical researchers.

Faster, cheaper computing power and new technologies that can collect large-scale data and store it have accelerated the use of Big Data in medicine, but progress has not come without growing pains.

“People think more data is better,” said Karen Messer, PhD, chief of the Division of Biostatistics at UC San Diego School of Medicine. “But that’s not always true.”

Messer said thoughtful vigilance is vital to ensuring that data are carefully collected and well-documented, and that the analysis is devoid of biases, false positives and the human impulse to equate an association between two data points as cause and effect.

“To put it all together, we need a variety of expertise, including statisticians, other data scientists, computer scientists, even designers,” said Messer, who helped launch a new UC San Diego School of Medicine doctoral program in biostatistics in 2016.

Meet Albert Hsiao and Loki Natarajan, two UC San Diego School of Medicine researchers who are making these tools, applying them to research and patient care, and training the next generation of biomedical data scientists.

UC San Diego Health has partnered with the National Institutes of Health’s All of Us Research Program to accelerate medical discoveries by gathering data on health, habits, family history, genetics and environment from one million or more participants. All of Us is led by Lucila Ohno-Machado, MD, PhD, professor and chair of the Department of Biomedical Informatics. To enroll, visit AllOfUs.ucsd.edu or contact our team at allofus@ucsd.edu or (858) 265-1711.

Contribute Your Own Big Data to Science
Albert Hsiao, MD, PhD

Radiologist and Video Game Aficionado

GROWING UP IN THE 1980S, Albert Hsiao loved video games — first-person shooter games like “Doom” and real-time or turn-based strategy games like “Dune II” and “Civilizations.” So it’s not surprising that Hsiao majored in computer science at Caltech. But he also wanted to apply his interests and skills to helping people, and so after graduation, he enrolled in UC San Diego School of Medicine. It wasn’t long into the process of becoming a doctor that Hsiao realized he missed physics, computers and engineering. As a result, Hsiao added a bioengineering PhD from Jacobs School of Engineering at UC San Diego to his medical degree, participating in the School of Medicine’s Medical Scientist Training Program. When it came time to choose a specialty, Hsiao picked diagnostic radiology, which combines math, computer science, engineering, anatomy and sophisticated imaging to peer within the human body and detect disease.

He quickly encountered a frustration, however: It was cumbersome to perform magnetic resonance imaging (MRI) on patients with complex heart disease. The patient would show up for his or her scan. Hsiao would sit with the technologist to get the right images, then take those images to a workstation, where he would spend more hours drawing contours around regions of interest, taking measurements, assessing them and finally arriving at a diagnosis.

“And that would be just one patient,” he said. “Meanwhile, there’s a long list of patients behind me. So I would be up until midnight every day, and yet I’d only be able to get through two or three patients. It was pretty terrible.”

During his post-medical school training as a resident at Stanford University, Hsiao learned about a new type of MRI, called 4D Flow. With a standard MRI, physicians can see the basic structure of a person’s heart and blood vessels. With 4D Flow, they can see and measure how blood flows — how much, how fast, in what direction — in three dimensions over time (the fourth dimension), all in one exam. Physicians now use 4D Flow to more accurately detect abnormalities, diagnose valve defects, pre-plan surgery and track treatment response.

“It was an awesome MRI technique,” Hsiao said. “It was clear from the beginning that it had the potential to be very visual and interactive, like a video game. So I thought, okay, I’m really going to like this.”

But like many technologies, 4D Flow and other advancing imaging methods meant vasty more data to crunch, assess and store — perhaps 10 to 20 times more than a standard MRI.

So Hsiao wondered, “How do we take that large amount of data we’re generating and make it simpler?” Drawing inspiration from video games, he created new software to improve the way physicians view and analyze 4D Flow MRIs.

“The user interfaces that I grew up with playing a variety of video games seem to have become embedded in my subconscious. They provided intuition for working with three- and four-dimensional imaging data.”

Hsiao said the user’s ability to “fly through” anatomy in the software he built for 4D Flow MRI is a lot like those first-person shooter games. Improved disease detection and follow-up is akin to strategy games.

“Suddenly, with his own, customized 4D Flow software, Hsiao could diagnose each patient in just ten minutes instead of six hours. Others took note, including imaging technology giant GE Healthcare, which recommended Hsiao start a company.

Now called Arterys, Inc., Hsiao’s company is considered a leader in intelligent, cloud-based medical imaging software used to improve the diagnoses of cardiovascular disease and cancer. In collaboration with GE Healthcare, Arterys is developing and marketing Hsiao’s 4D Flow MRI analysis platform. Meanwhile, Hsiao finished his Stanford training and moved back to UC San Diego Health to practice as a cardiovascular radiologist, where he uses his 4D Flow analysis platform and oversees a research team.

“We’ve been able to grow a pretty substantial congenital heart imaging program and take care of many patients in need,” said Hsiao, now an associate professor of radiology and associate director of the Center for Translational Imaging and Precision Health at UC San Diego Health.

“This approach works best for patients with congenital heart disease because their anatomy is complex. With older imaging methods, you’d have to try again and again to capture just the right angles. With 4D Flow, we’re capturing everything in one go.”

Hsiao’s team is addressing new clinical problems through a combination of coding, technology development and data analysis. They recently pitched GE Healthcare on the idea of using different parts of heart MRIs “Imagine being able to simply put a patient on the MRI, run our system, and have it automatically scan and return a diagnosis on the spot.”

The ultimate goal, perhaps no one like Hsiao in the room at all. Artificial intelligence and machine learning systems would be able to plan the scan and provide it to the technologist, who could make adjustments if necessary. There would be no radiologist guiding the process.

As his research advances, Hsiao says his medical training proves ever crucial. Engineers, he said, are good at solving problems presented to them, but those might not be the real problem, and they may not be relevant to patient care. For example, an engineer might develop an artificial intelligence system that’s better than a human radiologist at diagnosing one of 15 conditions, but Hsiao said that’s not really the issue.

“I’m not trying to diagnose one of 15 conditions on a film, I’m trying to do what’s best for each patient,” he said. “For one patient, the goal may be to determine the diagnosis, but for another, it might be to determine whether a treatment is helping or hurting.”

Despite his efforts at making radiology easier and more automated, Hsiao doesn’t worry about putting himself out of work.

“It’s going to take a long time before we replace radiologists with robots. I’m still reading something like 460 traditional x-rays and CT scans over a weekend. It’s brutal, and we need all the tools we can get. We’re building some of those right now at UC San Diego, because we are realizing that if you’re not developing new technology now, you’re going to be buying it later.”

“With 4D Flow, clinicians can simultaneously see and measure how blood flows — how much, how fast, in what direction — in three dimensions over time, and use that information to detect abnormalities, pre-plan surgery and track treatment response.

“The user interfaces that I grew up with playing a variety of video games seem to have become embedded in my subconscious. They provided intuition for working with three- and four-dimensional imaging data.”

— ALBERT HSIAO, MD, PHD
Loki Natarajan, PhD
Mathematician and Biostatistician

Loki Natarajan might have been a medical doctor, but she couldn’t handle dissecting frogs in high school. She might have been a research scientist, yet vision problems made it difficult to use a microscope. But she was good at numbers and theoretical thinking, so “pure math” became her thing.

“What I was doing was pristine. It was fun,” Natarajan said, “but only my thesis advisor and maybe one other person in the world could understand the kinds of things I was doing.”

One day, while Natarajan was a faculty member at Tufts University, where she taught math, a friend invited her to a seminar on computational biology. It was the early 1990s. “I went, and I was totally hooked,” Natarajan said.

There, she found biologists, mathematicians and computer scientists discussing research questions like how the sense of smell works. When her family decided to relocate to San Diego, Natarajan took that as a sign and opportunity to change the direction of her career.

“A lot of people just think math is math, whether it’s theoretical, statistics or anything involving numbers,” Natarajan said. “But it’s not—they’re all different.”

The first thing Natarajan did when she got to UC San Diego was take a statistics class. Then a new friend invited her to another seminar, this one on public health and tobacco. Afterward, she met the speaker, John Pierce, PhD, now Professor Emeritus of Cancer Prevention at UC San Diego. Natarajan was prescient. Natarajan mastered statistics. “I was totally hooked,” Natarajan said.

“Measure diet and physical activity can be tricky,” she said. “Many studies rely on participants to self-report what they do or eat each day.”

“But who remembers every little thing they ate? I can barely remember what I ate today, so I can’t ask what I ate over the last month. I wouldn’t even think to report things like the tiny amount of milk I put in my tea.”

In the WHEL study, participants provided dietary reports every 24 hours, with the help of a trained nutritionist who asked questions to help prompt more accurate accounts. The researchers also collected diet-related biomarkers — molecules in the blood that provide clues as to what a person ate. For example, one group in the study was supposed to be increasing their fruit and vegetable intake. To determine whether they did, the team measured levels of carotenoids (red and orange vegetables), cryptoxanthin (citrus) and lycopene (tomatoes) in their blood.

Between the questionnaires and biomarker measurements, Natarajan had data to create a more complete picture of what participants were actually eating. She developed a way to correlate truth and error in the way people reported what they ate, making the diet study more accurate than most.

Natarajan’s work with WHEL data led to involvement in another study, this time on physical activity.

Most activity studies rely on participants self-reporting how many minutes per day they spend in moderate or vigorous physical activity. Instead, the UC San Diego study gave each participant a Fitbit, a device similar to a Fitbit. The researchers gathered movement data minute by minute, giving Natarajan a huge amount of information with which to map out activity patterns for each participant.

With Natarajan’s mathematical expertise, the research team found an interesting trend: Participants who were more active in the morning had better short-term outcomes, such as lower insulin and glucose levels and inflammation, but counterintuitively, those who were more active in the morning experienced worse overall health in the long term. “The current hypothesis,” Natarajan said, “is that perhaps women who are more active in the morning aren’t actually feeling that well and are simply trying to get all of their chores done before they need to rest for the remainder of the day.”

While the researchers continue to work that out, Natarajan is on her latest study, an effort to predict which patients with diabetes are most likely to suffer kidney failure, which affects approximately 25 percent of people with diabetes.

The research team collaborated with 100 different metabolites — molecules involved in the metabolic process — from 100 patients with diabetes. They plotted what those metabolites look like in patient samples and used a visualization tool for interactive exploration of genomic data sets for both research and clinical applications.

Natarajan enjoys the challenge of looking in patient samples and a visualization tool for interactive exploration of genomic data sets for both research and clinical applications.

For Natarajan, it’s the data that matters. "It's the data that matters." said Natarajan. "It's the data that matters. It's the data that matters. It's the data that matters. It's the data that matters. It's the data that matters. It's the data that matters. It's the data that matters."
They sequence tumor DNA, Schoenberger and LJI’s epidemiologist, 1991. This work was dismissed by contemporaries and forgotten with advances in chemotherapy and radiation therapy, but it was a memorable early example of immunotherapy, an attempt to harness the human body’s immune system to treat or prevent cancer.

In general, vaccines work by training the human body’s immune system to recognize and fight off infectious microbes, such as the viruses that cause measles and mumps or the bacteria that cause tuberculosis and typhoid. A vaccine either to treat or prevent cancer has long been a dream, but also fraught with complications. It was a memorable early example of immunotherapy, but one that did not catch on.

The “modern” idea of immunotherapy, an attempt to harness the immune system to treat or prevent cancer, began in 1891, when an American surgeon named William B. Coley purposefully injected a cancer patient with streptococcal bacteria, the kind that cause strep throat. Coley thought the resulting infection might have the side effect of shrinking the man’s malignant neck tumor — and it did.

With very few linked to infectious agents. Among them are Ezra Cohen, MD, associate director for translational science at UC San Diego Moores Cancer Center; Aaron Miller, MD, PhD, UC San Diego Health physician-scientist; and their colleagues, who have forged their own path to a potential cancer vaccine. This is their journey so far.

BY YADIRA GAILINDO

IN GENERAL, vaccines work by training the human body’s immune system to recognize and fight off infectious microbes, such as the viruses that cause measles and mumps or the bacteria that cause tuberculosis and typhoid. A vaccine either to treat or prevent cancer has long been a dream, but also fraught with complications.

It was a memorable early example of immunotherapy, but Coley’s work was dismissed by contemporaries and forgotten with advances in radiation therapy and chemotherapy. More than a century later, others have taken up the cause, this time better equipped with a deeper understanding of human and cancer pathologies and a more powerful armamentarium of pharmaceutical tools.

The Whitworths form the Immunotherapy Foundation and fund Cohen’s research

Cohen partners with Stephen Schoenberger, PhD, professor of immunology at the La Jolla Institute for Immunology (LJI), to develop a technology that reliably defines neoantigens — foreign protein fragments recognized by the immune system — in a patient’s cancer

Cohen and Schoenberger deconstruct delivery options including cell therapy, engineered cells and a vaccine before settling on a personalized cancer vaccine for quickest delivery to a patient

With the neoantigen technology in hand, the team collects tumor samples from patients with head and neck cancer to test the immune system’s response:

- They sequence tumor DNA
- Schoenberger and LJI’s Bjorn Peters, PhD, develop a novel algorithm to select mutations that are recognized by the immune system
- Schoenberger develops an assay to interrogate the immune system to determine which neoantigens responded

Finding a mouse model that mimics the human body’s immune system: an in vivo and ex vivo assay to interrogate the immune system that are recognized by the vaccine platforms that would produce the immune response they were looking for — cancer cell-destroying CD8 T cells

Once the team proves that it can use smaller, nonfresh samples, it expands research to other cancers

For one year the team evaluates vaccine platforms that would produce the immune response they were looking for — cancer cell-destroying CD8 T cells

For one year the team evaluates vaccine platforms that would produce the immune response they were looking for — cancer cell-destroying CD8 T cells

In addition to the vaccine, patients will receive pembrolizumab (Keytruda), an immune checkpoint inhibitor that blocks interaction between the molecule PD-1 on immune cells and the molecule PD-L1 on cancer cells. Combined with the vaccine, the drug should unleash the full potential of T cells — critical players in the body’s immune response

FDA approves the personalized cancer vaccine protocol

Finding a mouse model that mimics the human body’s immune system: an in vivo and ex vivo assay to interrogate the immune system that are recognized by the vaccine platforms that would produce the immune response they were looking for — cancer cell-destroying CD8 T cells

Tamara Strauss, who has been living with high-grade, stage IV pancreatic neuroendocrine cancer for more than three years, is enrolled as the first patient in the pilot study to test a personalized vaccine using her unique cancer mutations to boost an anti-tumor immune response

Tamara Strauss, who has been living with high-grade, stage IV pancreatic neuroendocrine cancer for more than three years, is enrolled as the first patient in the pilot study to test a personalized vaccine using her unique cancer mutations to boost an anti-tumor immune response

The U.S. Food and Drug Administration approves the personalized cancer vaccine protocol

DISCOVERIES.UCSD.EDU
ON ANY GIVEN NIGHT, more than half a million people in the United States find themselves without a home. The greatest number of homeless live but do not reside in California: almost 130,000 at last count, of which more than 10,000 were military veterans and more than 12,000 were unaccompanied young adults, ages 18 to 24. Most of these homeless — 69 percent — live on the street, in parks or other places not intended for human habitation.

Homelessness is a public health crisis. So too is mental illness. They are often interconnected, but one does not necessarily lead to the other. Homelessness has many causal factors. Christine Varnadore became a teenage runaway to escape a home corrupted by drugs, alcohol, prostitution and abuse, only to find herself in a decade-long abusive relationship before stumbling into Father Joe’s Villages, a comprehensive campus in downtown San Diego that serves to end and prevent homelessness by providing housing, health care and other resources.

When she became a mother at the age of 16, Christine vowed to change the course of her family’s life by sheltering them from the lifestyle in which she had grown up. But there was a price. Focused on the well-being of others, Christine’s health suffered, resulting in multiple hospitalizations and lost jobs.

“This place is irreplaceable,” Christine says, smiling, her eyes now filled with happy tears. “I avoided it to stay strong, to take care of others. But I have to accept it now and focus on me.”

Christine pauses, momentarily dropping her guard, and begins to sob. She has been telling her story to Sarah Carreira, MD, director of the UC San Diego Combined Family Medicine and Psychiatry Residency Program, which provides health care to patients at Father Joe’s Villages.

“With a gentle touch, Carreira responds. ‘It’s okay to grieve. You have done everything right. I know you’re preparing for the worst, but see this instead as an opportunity to find out what’s wrong with your health and change course so that you can begin to heal.’”

Certified in both family medicine and psychiatry, Carreira blends physical and behavioral health care into one 30-minute visit. After talking to Christine and walking her through her emotional struggles, Carreira switches to advising Christine on pain medication for her recent kidney infection.

“They discussed an upcoming appointment with a gastrointestinal specialist to determine the cause of her pain, along with weight loss and bleeding.”

“I wasn’t just another person with an illness and druggy parents. Dr. Carreira looked at me for who I am and helped me start living in reality.”

BY YADIRA GALINDO
Pressing Problems

IN 1966, the then-six-year-old UC San Diego elected to make public health a part of its mission to better address the needs of individuals within a community. Patients like Christine require a specialized, personalized therapeutic approach to help them get back on their feet. Public health issues like homelessness, mental illness, obesity and other chronic diseases are preventable, but only if community health is emphasized, said Cheryl Anderson, PhD, professor and interim chair in the Department of Family Medicine and Public Health at UC San Diego School of Medicine.

“There’s a lens that a community health department looks through which allows us to think not just about that patient, but also about the factors around that patient that led to them being at the doctor’s office on that day,” said Anderson, who also directs the UC San Diego Center of Excellence in Health Behavior and Equity.

“Public health is thinking about saving thousands to millions of lives at a time. Our strategies look beyond what we can do in the medical office on a single day.”

School of Medicine researchers and clinicians often collaborate with nonprofits and government organizations. Peter Davidson, PhD, assistant professor in the Department of Medicine, is leading a study examining the effectiveness of San Diego County Sheriff’s deputies administering the nasal spray drug naloxone to opioid overdose victims prior to the arrival of paramedics. The goal is not to end drug use, but to simply save lives.

“When the war on drugs was declared, it made opioid use more dangerous by making it hazardous for people to call 9-1-1 for help,” said Davidson. “My work is focused on people who are in the midst of using drugs to try to reduce the number of accidental deaths from overdose. More than 70,000 people die each year while we are searching for better treatment options or more effective drug prevention programs.”

As an academic health system and a public institution, UC San Diego has a long history of caring for the region’s most vulnerable patients. Since 1997, its medical students and faculty have maintained several not-for-profit, nationally recognized Student-Run Free Clinic Projects to provide quality health care at no cost to underserved communities.

In 2011, this effort expanded when the School of Medicine and the Autonomous University of Baja California School of Medicine launched Health Frontiers in Tijuana, another student-run free clinic serving substance users, sex workers, the homeless and U.S. deportees to Mexico’s border town with San Diego. More recently, UC San Diego Health was contracted by the County of San Diego Health & Human Services Agency to provide health screenings for asylum-seekers entering the United States.

The Combined Family Medicine and Psychiatry Residency Program provides comprehensive service that Father Joe’s Villages could not afford on its own, said Jeff Norris, MD, the Villages’ medical director.

“There are people who don’t know they have a mental illness. If I tell them they need to see a psychiatrist, I might lose them,” Norris said. “The doctors practicing in the combination program can meet them where they are and can crack into psychiatry needs in a gentler way, in a way that neither a family medicine doctor nor psychiatrist can do alone.”

In 2018, Father Joe’s Villages served 2,424 unique patients with an average of seven visits per patient, covering medical, dental, psychiatry and behavioral health services. Based on internal reports, Norris estimates they prevented more than 2,100 emergency room visits, resulting in savings to the community and better care for patients.

“Some think people experiencing homelessness must have been involved in substance abuse or were incarcerated,” said Margaret McCahill, MD, clinical professor in the Department of Family Medicine and Public Health. “But there are many people who become homeless because they are ill and have no access to health care, especially those over 50 years of age.”

One couple in particular stands out for McCahill. They were married for 40 years and both worked in low-paying jobs. When the wife became ill, she lost her job and her husband began missing work to serve as her caregiver. They could not afford health insurance on his diminishing income, but he made too much money to receive government assistance. When the couple sought help at Father Joe’s Villages, the wife was in end-stage kidney failure. She would die two weeks later.

“It’s infuriating. Her diabetes and hypertension were treatable had she received care much earlier,” said McCahill, who founded the UC San Diego Combined Family Medicine and Psychiatry Residency Program in 1997. “She wouldn’t have suffered or died years prematurely.”
A Future Shared

ON A SUNNY FRIDAY MORNING, Sher Sandvik walks into Father Joe’s Villages holding her dog, a Papillon-Chihuahua mix, clutched tightly in her arms. She is visibly upset and tells Allison Ellsworth, MD, one of 10 UC San Diego Combined Family Medicine and Psychiatry residents, that it is becoming increasingly difficult for her to control her emotions and care for herself and her beloved pet, Snickers.

This is not Ellsworth’s first meeting with Sher, who shelters at Father Joe’s Villages. “Sometimes I feel like we make very slow progress with patients,” said Ellsworth. “We don’t move as quickly as a medical doctor or during a traditional psychiatry appointment, but it’s because we are taking time to build relationships. If there is no trust, patients don’t return.”

Sher trusts Ellsworth, describing in great detail the roller coaster of emotions she is feeling when her anxiety and obsessive-compulsive disorder flare up. “I’m scared I’m going to do something to get myself kicked out of here.” Ellsworth listens intently, occasionally asking probing but gentle questions to better understand Sher’s situation and needs.

“We don’t move as quickly as a medical doctor or during a traditional psychiatry appointment, but it’s because we are taking time to build relationships. If there is no trust, patients don’t return.”

—ALLISON ELLSWORTH, MD

In late 2019, the UC Board of Regents approved the new Herbert Wertheim School of Public Health and Human Longevity Science at UC San Diego, combining and leveraging diverse, interdisciplinary resources across campus and health sciences. The school was jump-started by a 2018 pledge of $25 million from the Dr. Herbert and Nicole Wertheim Family Foundation. It has become the third school of public health in the UC system.
Every achievement rests upon earlier work and insight. “If I have seen further it is by standing on the shoulders of giants,” Isaac Newton famously wrote in 1675—a sentiment since echoed many times by many others.

Nor is science conducted alone. Research demands collaboration, minds meeting and diverging, interacting in often unexpected ways that create surprising combinations and results, not unlike individual neurons linking in circuits that crisscross the brain.

Examples abound; here’s one. Fred H. “Rusty” Gage, PhD, is president and professor at Salk Institute for Biological Studies. He’s also a longtime adjunct professor of neurosciences at UC San Diego, with multiple appointments, relationships and projects involving everything from investigations of human brain plasticity to the use of induced pluripotent stem cells (iPSC) to create models of neurodegenerative diseases for study and potential therapies.

In the following graphic, we asked Gage to highlight six collaborators representing the span of his interests. We asked those six to cite three collaborators of their own, and those collaborators to each name three more.

The result is a cascading network of 79 connected scientists who span academia and industry, the world and a universe of passions, from treating cancer, repairing spinal cord injuries (SCI) and preventing diseases like Alzheimer’s and muscular dystrophy to the hidden lives of bacteria and how humans relate to architecture and health care.

Science is a singular endeavor never singularly done.

By Scott LaFee
THE
EMPIRICISM
of
EMPATHY

A new institute seeks to pinpoint the neurobiology of compassion, transform medical education and improve the well-being of future doctors and current clinicians.

BY DEBRA KAMIN

Both empathy and compassion are fundamental to human nature, but not universally so nor in equal measure. In their absence, we see inevitable consequences, from individual dysfunction to epidemics of loneliness, indifference and suicide.

Speculation about compassion and empathy has been the province of philosophy and poetry for millennia. The new T. Denny Sanford Institute for Empathy and Compassion at UC San Diego brings an empirical eye to the subject. Established in 2019 with a $100 million gift from South Dakota businessman and philanthropist T. Denny Sanford, the new institute seeks to determine the neurological basis of empathy and compassion, then use that data and knowledge to design a compassion-focused curriculum for new generations of medical professionals and to create new methods to protect and promote the well-being of current clinicians and their patients.

“I have had the opportunity to see how grace, humanity and kindness can change people and the world,” said Sanford, who has given millions to promote improved health care, basic research and teacher training throughout the country and who cites the Dalai Lama as a personal inspiration. “This gift extends that vision. Doctors work in a world where compassion is essential, but often lost in the harsh realities of modern medicine. If we can help medical professionals preserve and promote their compassion based on the findings of hard science, the world can be a happier, healthier place.”

It begins with hard science, said David Brenner, MD, vice chancellor for health sciences at UC San Diego. “We really believe that we have state-of-the-art tools that will let us do serious, in-depth research on the neurobiology of compassion. We didn’t have that before. We didn’t have the advanced imaging, the genomics, the metabolomics, the biomarkers. We really think we can approach this like we can any other clinical problem.”

If You’re a Nurse, It’s Worse

A national study published last year by the Archives of Psychiatric Nursing found that both male and female nurses are at higher risk of suicide than the general population.

Specifically, female nurse suicides were significantly higher: 11.97 suicides per 100,000 female nurses compared to 7.58 suicides per 100,000 females in the general population. Among male nurses, the findings were similar: 39.8 male nurse suicides per 100,000 male nurses compared to the male population ratio of 28.2 per 100,000.

“Nurses have traditionally been much better at caring for others than caring for themselves,” said Judy Davidson, DNP, RN, at UC San Diego Health and a co-author of the study. “Nurses are exposed to things that everyday people don’t see. Many are up close and personal with death. But when a police officer is involved with a death, they get time off from work. Nurses do not have this option. They may experience the death of a patient and then see their next patient shortly thereafter.”

The Healer Education Assessment and Referral program assists nurses by helping identify those at high risk of suicide and providing treatment through an anonymous and encrypted screening program. Learn more about HEAR on page 35.

Among scientists who study the human psyche, empathy is defined as the ability to see and feel the emotions of others. Compassion is what happens when these perceptions trigger a desire to help, to proffer assistance, comfort or relief.
UC SAN DIEGO HEALTH SCIENCES

The Toughest Diagnosis

CHRISTINE MOUTIER, MD, was a student at UC San Diego School of Medicine when the cloud descended. She became anxious, stressed, nervous—not herself. But Moutier, who would become a psychiatrist, professor, and dean, figured what she was feeling was normal. Medical school is a notorious pressure cooker.

“It was my first-ever experience of having my own mental health distress, and it led to me taking time off from school and thinking I wasn’t cut out for medicine,” Moutier said. “Because when your experience with mental health distress is new, you think it’s situational. You think that it’s entirely linked to the circumstances going on in your life.”

“It isn’t. Nor is it unique.

In a 2019 national survey by Medscape, roughly half of U.S. physicians reported experiencing burnout, often culminating in depression and, occasionally, suicide. In fact, doctors have the highest suicide rate of any profession: about 28 to 40 suicides per 100,000, according to the American Psychiatry Association. Psychiatrists have the highest suicide rate among medical specialties.

For Moutier, that early brush with burnout and depression was mild and passing, she returned to medical school and thrived. But she also sought therapy, and in the process, realized she wanted to more deeply explore the world of mental health.

One year into her psychiatry residency at UC San Diego Health, a fourth-year medical student killed himself. Moutier had worked closely with him just a few months previously; she was shaken.

“I was training in psychiatry. I thought I should have been able to see the warning signs,” Moutier said. “I actually went through what I would call a mild, but nevertheless significant, experience of suicide-loss trauma.”

Moutier realized that the culture of the medical profession, with its nose-to-the-grindstone, work-to-the-bone, never-complain ethos, was part of the problem. Moutier joined the UC San Diego medical school faculty and became dean of student affairs and medical education, serving from 2004 to 2013. Throughout, she searched for ways to start conversations about physician burnout and encourage medical students and doctors to seek help before depression or anxiety reached a dangerous point.

Physicians Healing Selves

MOUTIER WAS NOT ALONE in looking for answers. So too was colleague Sidney Ziskin, MD, a widely respected professor of surgery and director of the UC San Diego Regional Burn Center, unexpectedly committed suicide. In the decade that followed, roughly one local physician or medical student would take his or her life each year, a number that matched what Moutier and Ziskin were hearing from other medical schools and hospitals. They realized they were looking at an epidemic. “Suicide among physicians has always been shrouded in this veil of silence,” said Ziskin. “It was clear that we were not alone. This was a national or even a global phenomenon.”

Hansbrough’s death prompted a reckoning among health leaders at UC San Diego. Burnout, depression and suicide were already topics covered — at UC San Diego, a multi-pronged program that includes education for medical and pharmacy students, a confidential online assessment survey for burnout and depression symptoms and personalized referrals to mental health clinicians. The program has produced significant results, including more than 500 confidential referrals for physicians, nurses and medical students seeking help.

“We can’t take full credit. You can’t say it’s cause and effect,” said Ziskin. “But our take is that if we’ve prevented even one person’s suicide by getting them into treatment, then the program is a massive success.”

A Long Way to Go

MOUTIER, who joined the American Foundation for Suicide Prevention as its chief medical officer in 2013, said the overall situation is improving, too; there is more awareness and more resources dedicated to prevention and treatment.

“The just the idea that medical professionals are fully human, with their own human vulnerabilities related to physical and mental health, was not even close to what it is now,” she said. “It’s still going to be an imperfect situation, because medical students come into medical school when they are young in their life, and without experience in having to ask for help. But there’s a way to manage that for 99.9 percent of people.”

HEAR was the first program of its kind in the UC system. UC Davis has since launched a similar initiative, and others are in the works. Progress remains slow, said William Noreccors, MD, a UC San Diego Health geriatrician who has long been deeply involved in the Physician Assessment and Clinical Education Program, an older UC San Diego initiative to assist, train and treat older doctors.

“It takes a while for the light bulb to go on,” Noreccors said about the need to fight proactively to protect physicians’ mental health. “The medical community is still a lot like the military. There’s a hierarchy. There’s a power structure, and you don’t want to show yourself to be weak or unable to do your work, especially from a mental illness.”

The potential of the new Sanford Institute to accelerate change—and change minds—is huge, said Smith at the Student-Run Free Clinic, both in terms of advocating compassion and self-compassion among physicians and medical students and in creating the happier, healthier world envisioned by Sanford.

“We could create a culture of wellness and caring for each other and a culture in which your mental health does not decline over the course of your training, but stabilizes or improves,” said Smith. “I think you can map any mental state, agreed William Mobley, PhD, associate dean of neuroscience initiatives and interim director of the new institute. “The question is: Can you separate that mental state from other mental states? Can you really know that you’re looking at compassion versus attention versus memory versus fear? You have to create tasks that allow you to really separate what you would say is a compassionate perception of the world or a compassion-ate willingness to reach out to care for someone else. You have to separate that from other brain states, from other activities, but yeah, you can do that.

“So we’ll build on the literature. We’ll build on past work. And we’ll build new studies that allow us not just to do that, but to do it in the context of real-world situations. How does a student who’s just entering medical school respond to a patient in need? What do their brain networks really look like? And then, what will those networks look like after we’ve engaged in training programs that sensitize them to properly pay attention to the signals a patient is sending about their own distress, their worry, their fear? How do they change? Can we then modify those training programs using brain imaging to teach us how to make those training programs even more effective?”

While the institute’s ultimate mission is to develop evidence-based compassion cultivation training programs applicable to many uses, it is beginning with the training of new doctors and improvement of well-being among current clinicians—two areas where compassion and empathy are critical, but sometimes lacking or lost.

“People and medicine because they are driven by compassion. They have desire to serve, desire to help others, desire to decrease suffering,” said Sunny Smith, MD, co-medical director of the Student-Run Free Clinic, which provides free health care to some of San Diego’s neediest communities and which will be a partner and training ground for the institute.

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THE NEONATAL INTENSIVE CARE UNIT (NICU) is one of the most vulnerable environments in a hospital. It is where the tiniest and most fragile patients — infants born prematurely or critically ill — fight to survive, aided by highly specialized doctors and nurses working around the clock. More than 1,000 such babies are treated each year at UC San Diego Health. Augustin (photo illustration right) was born at 25 weeks gestation, a little over half the average term. He was 12.2 inches in length and weighed 1.7 pounds, just a bit longer and heavier than an iPad Pro. Babies born at Augustin’s gestational age can face multiple life-threatening health issues, including underdeveloped lungs, bleeding in the brain and necrotizing enterocolitis, a serious intestinal disease. It requires advanced technologies to save these children, often by providing life functions mechanically while their bodies develop the ability to do them naturally.

Technological advancements have dramatically improved the survival rates and prospects for infants like Augustin. “Even a decade ago, a baby born 25 weeks gestation would have had more difficulty surviving,” said Erika Fernandez, MD, director of the NICU at UC San Diego Health. “Today, with next-generation technology, more babies born less than a pound are stabilizing after birth sooner and surviving. They are overcoming extreme health issues and going home with their families.”

Progress never stops in the NICU. Currently, there is an emphasis upon wireless and miniaturized technologies, which can mean noninvasive mechanical ventilation, smaller devices and improved monitoring capabilities. Parents are able to hold their infants sooner. “They have opportunities to do skin-to-skin contact earlier, which promotes bonding and many health benefits that set these babies up for success,” said Fernandez.

In this photo illustration, you can see the multiple pieces of equipment required, each playing a crucial role, to keep Augustin alive.

1. Mechanical ventilation. Most premature babies have underdeveloped lungs. Babies born severely premature may need a tube placed in their airway and a ventilator to oxygenate their lungs through scheduled breaths. These ventilators sense the infant’s breathing effort and adjust introduced breaths based on the calculated need of the infant. New, noninvasive mechanical ventilation allows the baby to be supported by the machine without the airway tube.

2. Continuous Positive Airway Pressure. CPAP delivers constant air pressure into the infant’s nose, keeping air sacs in the lungs inflated and helping prevent apnea, a common issue in premature babies.

3. Central intravenous lines. These thin, soft tubes are used to deliver long-term intravenous medications, such as antibiotics, nutrition (for infants not yet able to nurse or digest food) and to draw blood. They are typically inserted into umbilical vessels or a vein in an extremity, known as peripherally inserted central catheter, or PICC Line. The catheter tip is usually positioned in a large vein that carries blood into the heart.

4. Feeding tube.

5. Transcutaneous CO2 monitor. A sensor applied to the body that provides real-time monitoring of the infant’s often fluctuating oxygenation and ventilation.

6. Oxygen monitor. Oxygen supplementation using noninvasive tools is an important component, minimizing risk of pulmonary toxicity from hyperoxia (an abnormally high concentration of oxygen in the blood) to hypoxemia (an abnormally low concentration of oxygen in the blood).

7. Electrocardiogram leads. These wires monitor the infant’s heart rate and respirations. The average heart rate for a premature baby is greater than 120 beats per minute, which may be twice that of a full-term baby.

8. Intravenous therapy (IV). A catheter that delivers liquid substances directly into a vein. For babies in the NICU, an IV typically is used to deliver medications, blood products, nutrients and more.

After five months in the NICU, Augustin had made up for lost time, and was discharged weighing 10 pounds, 11 ounces.
AT 37 YEARS OLD, TANIA MARTINEZ had a blossoming career as a lawyer and often traveled with her bright and bubbly 7-year-old daughter, who enchanted friends and strangers alike with her dimpled smile and kindness.

But then a diagnosis threatened to end their adventures. Tania was diagnosed with stage IV inflammatory breast cancer, a rare and aggressive disease in which cancer cells block lymph vessels in the skin of the breast. The median survival rate for patients with stage IV inflammatory breast cancer is less than two years.

Tania’s health care team quickly created a treatment plan. Surgery was followed by chemotherapy and radiation, which reduced the ability of Tania’s immune system to fend off infections—a common side effect among patients undergoing cancer treatment. When a severe case of pneumonia struck, Tania was placed in a medically induced coma for five weeks, with hope that her body might recover if completely at rest.

Doctors advised her family—to my family—to get Tania’s legal affairs in order. The instruction was unnerving. No one expects to hear such things, especially about an otherwise healthy younger sibling. With nothing more to do but wait for encouraging news, I pored over photographs of Tania and me taken during a recent outing. In Tania’s dimples, I saw my own smile, and suddenly the similarities we share paralyzed me with a singular thought: Was a BRCA gene mutation the cause of her cancer? A breast cancer diagnosis in one’s thirties is rare. For a woman aged 30, the probability of developing invasive breast cancer in the next decade is just 0.44 percent, or one in 228, according to breastcancer.org. But if Tania carried the BRCA gene mutation, my two other sisters and I might carry it too—and be at higher risk of breast and ovarian cancers. And so might Tania’s daughter.

Tania’s doctors ordered genomic sequencing of her tumor. Her cancer was negative for BRCA mutations, but still my thoughts and fears lingered. I reached out to Lisa Madlensky, PhD, director of the Family Cancer Genetics Program with Moores Cancer Center at UC San Diego Health: Should I consider genetic testing?

“If genomic sequencing reveals that a young person with breast cancer has an inherited genetic mutation that causes cancer, then we know what the mutation is and blood relatives may want to be tested for it,” said Madlensky. “If she didn’t have a BRCA mutation, then testing other family members for it is unnecessary.”

“Familial diseases, like some forms of heart and neurological disorders, have been linked to specific, identified genetic mutations passed generation to generation. For breast cancer, the mutation lies in the BRCA1 and BRCA2 human tumor suppressor genes. These mutations increase a person’s risk for disease, but having the mutation does not mean the person is destined to be afflicted,” said Madlensky.

Since Tania is not a carrier of the mutation, it is unlikely that other family members have it. The logical side of my brain understood this, but my inquisitive side continued to prowl for more information and, perhaps, comfort. Could I lay to rest my questions and concerns by sending my DNA sample to a genetic testing company?
Direct-to-Consumer Genetic Tests

**THE CHOICES FOR DIRECT-TO-CONSUMER genetic testing products are myriad. I selected one of the largest and best known, 23andMe, which uses genetic variations to make predictions about health and provide information about physical traits and ancestry. It is also federally approved to provide a test for cancer risk based on BRCA mutations.**

The testing process is simple. After purchasing the test kit online, I received a mailed package containing a tiny test tube for collecting saliva. Sample collection was the most challenging part. My mouth was dry; nerves, I suppose. It took 15 minutes to reach the fill line. The average person produces roughly five teaspoons of saliva per hour. One-quarter of an hour produced a single teaspoon, which I sent the lab.

A couple of weeks later, an email from 23andMe advised that I could review my test results on its secure website. After logging in, I was prompted to read and sign off on a series of legal statements. Read carefully, I was told. Users are cautioned that test information is not medical advice, nor is it a diagnosis. If you have questions, you are advised to consult with a physician or geneticist.

Notably, 23andMe does not immedi-
ately reveal your risk for diseases such as cancer, Alzheimer’s disease or Parkinson’s disease. You must specifically consent to reveal this information.

“You cannot unsee your personal-
ed risk assessment once you open it,” explained Madlensky. “For maladies like Alzheimer’s disease, there’s no evidence-based intervention that can be offered if we find out you have a very high risk. This information can cause distress and anxiety.”

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“If it turns out that you do have a BRCA mutation, said Madlensky, you and your physician should discuss options. Your health care strategy might involve more frequent mammograms or, on the more aggressive end, a preventative mastecto-
my or oophorectomy (surgical removal of the ovaries). But these are decisions that should be made with your health care team after you are fully informed of what your risk assessment truly means — and the full range of options available.

“Consumers who are accessing these types of findings may not understand the implications or limitations of what you get from consumer genetic tests,” said Cinnamon Bloss, PhD, associate pro-
fessor in the departments of Psychiatry and Family Medicine and Public Health. “It is good that people’s access to their own health information has evolved over the last decade, but it does create some challenges. There is a degree of health literacy needed to interpret the mass amount of genetic data that you receive from these reports.”

**GENETICISTS CAN WALK PEOPLE through the pros and cons of undergoing genetic testing and, should a person decide to fol-
low through, they can help explain what the results mean. If results come from a direct-to-consumer test, a physician will likely want to order a medical-grade genomic test to verify the accuracy of the assessment before offering next steps.**

Some items regarding traits in my personal report missed the mark. For example, I had a variant that gave me “slightly higher odds of disliking cilantro.” I eat cilantro almost every day. The report also said I am unlikely to have dimples; my nickname growing up was “Dimples.” So, before taking the report at face value, a follow-up with your doctor should be in order.

“For most people,” said Madlensky, “direct-to-consumer genetic tests will not call for medical intervention because most of the risk assessments are based on a polygenic risk score — a number that takes into account variation in multiple genetic loci. Yes, it is estimating your risk based on your genetic makeup rather than finding a genetic mutation directly responsible for a disease.”

“The majority of adults are not going to have a major finding because you’ve already made it to adulthood and you don’t yet have a diagnosis of a genetic disease,” said Madlensky. “These tests shouldn’t be taken too seriously, but if you do undergo one, you should be on the lookout for little nuggets of truth that are potentially important for your health.”

For example, learning of a genetic variant for hereditary hemochromatosis is a meaningful and actionable discovery. This condition results in the absorption of too much dietary iron, which can cause life-threatening damage to various organs.

Menstruating women rid their bodies of excess iron through their monthly cycles. For men and post-menopausal women, it is necessary to manually expel an overaccumulation of iron. That can be as simple as donating blood, said Madlensky. Knowing you have this condition before it negatively affects the body can be lifesaving.

23andMe also provides information about carrier status, which can inform couples during family planning. A carrier is a person who has a recessive allele for a genetic trait that is not expressed. But a genetic trait that is not expressed. But the carrier can pass along the allele to their children. If both parents pass along the same recessive gene, a child may express the recessive gene in the form of conditions like cystic fibrosis or sickle cell anemia.

“But the idea that you have had defini-
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What I Learned From 23andMe

MY PERSONAL DNA REPORT said, “You do not have the three genetic variants we tested. However, more than 1,000 variants in the BRCA1 and BRCA2 genes are known to increase cancer risk, so you can still have a variant not included in this test.”

I am not likely to be a carrier, but it cannot be ruled out completely. Will I request or pay for a more thorough genetic test of all 1,000 variants? No. I think I’ve learned enough about genetic variants. I want to sleep peacefully at night without worrying about it and when a disease might strike.

“Most common diseases are a combination of genetics, lifestyle and chance,” said Madlensky. “Some of this we can control and some we cannot.”

Genetics and lifestyle are key players in one of the only areas in which the 23andMe report indicated that I have an increased risk of disease — diabetes.

“Your genetics are associated with an increased likelihood based on data from people of European descent. Much like the three BRCA variants tested for by 23andMe, many of the studies used to determine risk of disease do not apply directly to me. Last, my personal DNA report provides only a glimpse into how variants in my genome may or may not affect my health.

I wondered, can I use this new-found personal genetic information to benefit me in other ways, such as sports performance? 23andMe confirmed something I already knew. I am not a sprinter. My muscle composition is “uncommon among elite power athletes.” In other words, sprinters, throwers and jumpers have abundant fast-twitch muscle fibers. Could I compensate and train my way to a more competitive level? “Fast fibers generate more power than slow fibers because they’re larger in diameter and contract more quickly. If you weren’t born with these, you can’t become powerful enough to become elite in those sports,” said Michael Hogan, PhD, professor of medicine in the Department of Medicine. “The slow fibers that elite distance runners or cyclists have contain a lot of mitochondria, which provides long-term energy and enhances an athlete’s ability to keep the force high for longer periods of time. These are mostly genetic traits.”

As much as 80 percent of a person’s athletic ability is genetics, said Hogan. The rest is training. Good thing my genes have slow-twitch muscles. I am going to need those for the marathon.

Could nutrigenomics — the discipline that integrates genomic science with nutrition and behavior — help me build a personalized food plan to boost sports performance? Or can it help people who have unsuccessfully tried to lose weight on trendy diets drop a few pounds? The science is not there yet, said Amir Zarrinpar, MD, PhD, assistant professor in the Division of Gastroenterology, who co-authored a study that compared weight loss among participants on a genetically guided diet versus a standard balanced diet. Participants did not lose more weight on a genetically personalized plan.

“We can use genetics to personalize cancer treatment, but not to make meaningful nutritional recommendations at this time,” said Zarrinpar. “Still, as we transition to a personalized medicine phase, we are supposing that a lot of things that we had previously ruled out because on a population level, it wasn’t showing a benefit may now identify individuals who will benefit. If you take a computer and teach it how to analyze your genetics and that of thousands of other individuals, we can find relationships and predict who will respond to what. The future will be very exciting.”

For my family, the future is certainly more rousing. Tania awoke from her medically induced coma and has been in remission for the past few years. She has gone on to have more adventures, alongside her daughter and with all of us.

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When you run your DNA through 23andMe, the company only reports back on a fraction of your genome, but it produces a lot of raw data. This information is yours to download. I ran my raw genetic data through another website that provides additional analysis on disease risk. It showed variants in other parts of my genome that would put me at normal risk of type 2 diabetes. “Consumer genetic tests give a lot of weight to the idea that your genes are your destiny,” said Madlensky. “For a lot of common diseases that we know have behavioral and environmental risk factors, like diabetes, it may disproportionally plant the seed of genetic destiny when it’s not that way at all.”

THREE KEY POINTS stuck with me. First, having a variant that increases risk for a disease is not predictive like some genetic mutations might be. Second, polygenic scores are often based on studies of people with European descent. Much like the three BRCA variants tested for by 23andMe, the many of the studies used to determine risk of disease do not apply directly to me. Last, my personal DNA report provides only a glimpse into how variants in my genome may or may not affect my health.

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As much as 80 percent of a person’s athletic ability is genetics, said Hogan. The rest is training. Good thing my genes have slow-twitch muscles. I am going to need those for the marathon.

Could nutrigenomics — the discipline that integrates genomic science with nutrition and behavior — help me build a personalized food plan to boost sports performance? Or can it help people who have unsuccessfully tried to lose weight on trendy diets drop a few pounds? The science is not there yet, said Amir Zarrinpar, MD, PhD, assistant professor in the Division of Gastroenterology, who co-authored a study that compared weight loss among participants on a genetically guided diet versus a standard balanced diet. Participants did not lose more weight on a genetically personalized plan.

“We can use genetics to personalize cancer treatment, but not to make meaningful nutritional recommendations at this time,” said Zarrinpar. “Still, as we transition to a personalized medicine phase, we are supposing that a lot of things that we had previously ruled out because on a population level, it wasn’t showing a benefit may now identify individuals who will benefit. If you take a computer and teach it how to analyze your genetics and that of thousands of other individuals, we can find relationships and predict who will respond to what. The future will be very exciting.”

For my family, the future is certainly more rousing. Tania awoke from her medically induced coma and has been in remission for the past few years. She has gone on to have more adventures, alongside her daughter and with all of us.
UC San Diego Health Expands Primary Care Throughout County

With new primary, urgent and express care locations in Rancho Bernardo, Encinitas and Eastlake, UC San Diego Health is now more convenient than ever. Additional new clinics are planned over the next few years for Carmel Valley, Carlsbad and Poway.

“Primary care is the start of a patient’s health journey and offers prevention measures and management of chronic to complex conditions, as well as being the bridge to specialty care,” said Christopher Kane, MD, CEO, UC San Diego Health Physician Group. “Your family doctor’s office can become your medical home, where all aspects of care can be coordinated in a warm, welcoming and familiar environment.”

Cure for Ventricular Fibrillation?

A common cause of cardiac arrest is a condition called ventricular fibrillation, or VF, in which the heart beats erratically, preventing a steady, healthy pumping of blood. Patients who suffer from VF lose in constant fear of triggering a cardiac event, which can only be treated with an automated external defibrillator and which can become fatal in a matter of seconds. But a new procedure developed at UC San Diego Health is now presenting an alternative: a curative procedure.

David Krummen, MD, cardiac electrophysiologist at UC San Diego Health, first developed the procedure, called Targeted Ventricular Fibrillation Ablation. The process, which combines computerized mapping of the heart muscle with precise ablation of trouble spots, immediately showed promise. The procedure has since been performed on a handful of patients, all of whom report dramatically fewer or no VF symptoms.

New Resources to Combat the Opioid Epidemic

To help combat the opioid epidemic, UC San Diego Health was named one of 31 health facilities across the state to participate in the California Bridge Program, an accelerated, 18-month training program for health care providers to enhance access to around-the-clock treatment for patients with opioid use disorder. The program provides chosen sites with funding, training and technical assistance to improve and increase access to treatment of acute symptoms, initiation of long-term medication and referrals to outpatient clinics.

“There are many barriers preventing patients with substance use disorders from following through on making the connection to substance use treatment programs, but starting them on medication that has such a big impact on their symptoms in such a short time dramatically improves their likelihood of continuing care with this lifesaving medication,” said Carla Marenfeld, MD, psychiatrist and director of the Addiction Recovery and Treatment Program at UC San Diego Health.

Excellence in Microscopy

UC San Diego, in a collaborative agreement with Leica Microsystems, Inc., opened a new Leica Microsystems Center of Excellence on the School of Medicine campus to further the application of and accessibility to advanced microscopy technologies in support of the life science and health research communities. The center supports a combined mission to educate the next generation of scientists and drive new scientific discoveries.

“The science and practice of medicine are relentlessly more complicated and nuanced, requiring physicians and scientists to understand the workings of the human body in ever-increasing detail,” said Steven Garfin, MD, interim dean of the UC San Diego School of Medicine. “The new Leica center offers another, powerful tool, one that can be used by students and faculty alike.”

The center will include ongoing collaboration between working researchers and Leica Microsystems engineers, creating valuable dialogue in how to improve and innovate software, systems and workflow.

Nature what works and how we can use that information to develop new therapeutics for diseases like cancer, diabetes or cardiovascular disease,” said Lars Bode, PhD, associate professor and director of MOMI CORE. “We’ve been looking for new therapeutics all around the world, in the deepest oceans and in chemical labs, but maybe the answer has been in front of us the entire time. Maybe the answer to some diseases, like inflammatory bowel disease, is in breast milk.”

Microbes Meet Mother’s Milk

Two renowned UC San Diego research centers have joined forces to take a deeper look at how components of human breast milk and microbiomes (microbial communities in the body) can change the course of therapeutics for infant and adult diseases. The new “MOD Biome” comprises the Larsson-Rosenquist Foundation Mother-Milk Infant Center of Research Excellence (MOMI CORE) in the UC San Diego School of Medicine and the Center for Microbiome Innovation in the Jacobs School of Engineering. Previous studies have shown the first 1,000 days of life is a key phase for the development of a healthy microbiome and that breast milk is a primary influencing factor.

“We want to understand from Mother’s Milk what works and how we can use that information to develop new therapeutics for diseases like cancer, diabetes or cardiovascular disease,” said Lars Bode, PhD, associate professor and director of MOMI CORE. “We’ve been looking for new therapeutics all around the world, in the deepest oceans and in chemical labs, but maybe the answer has been in front of us the entire time. Maybe the answer to some diseases, like inflammatory bowel disease, is in breast milk.”

UC San Diego Health Sciences Academic and Clinical Enterprises

UC San Diego Health Sciences Academic and Clinical Enterprises

**Professional Schools**

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<td>Faculty Members</td>
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**School of Medicine**

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**Skaggs School of Pharmaceutical Sciences**

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<td>National Medal of Science Recipients</td>
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**Pharmacology and Pharmaceutical Sciences**

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**Nursing Students, Annually**

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<td>Total</td>
<td>808</td>
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<td>RNs</td>
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**Percentage of RNs with Specialty Certification**

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**Annual Operating Budget**

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**Fact and Figures**

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**UC San Diego Health Clinical Enterprise**

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**UC San Diego Health Sciences**

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<td>Total</td>
<td>UC SAN DIEGO HEALTH SCIENCES</td>
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UC San Diego Research Awards by Campus Area — $1.35B in FY19

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<tr>
<th>Health Sciences</th>
<th>General Campus</th>
<th>Scripps Institution of Oceanography</th>
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<tbody>
<tr>
<td>$761M</td>
<td>$357M</td>
<td>$180M</td>
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UC San Diego Health Academic Enterprise

- **Total Clinical Trials**: 2,400 (Approx)
- **Patients in Active Treatment**: 7,000 (Approx)
- **Actively Enrolling Trials**: 1,000 (Approx)
- **New Trials Annually**: 250 (Approx)

Nature Index 2019

- **4th among public research universities in the U.S. based upon high-quality scientific research papers**
- **6th among academic U.S. institutions in biomedical sciences**
- **9th among top 200 institutions in the world in biomedical sciences based upon published research**
- **7th among the top 200 health care institutions worldwide**

U.S. News & World Report 2020

- **6th among research-intensive public medical schools in the U.S.**
- **2nd among public schools in neuroscience/neurobiology**
- **3rd among public schools in biological sciences**
- **21st among public medical schools in primary care**

UC San Diego Industry and Economic Impact

- **One Thousand Economic Impact**: $16.5B
- **Jobs Supported in California**: 100,492
- **Annual statewide Economic Impact**: $940.6M
- **Low or no-cost Health Care and Other Community Health Benefits in FY18**: $423.7M

UC San Diego Innovations and Technology Transfer

- **Active Inventions**: 118
- **New Licenses Inventions in FY18**: 3,000+
- **Invention Disclosure**: 47

UC SAN DIEGO HEALTH SCIENCES

DISCOVERIES.UCSD.EDU
NEW MEDICATIONS AND DIAGNOSTICS BASED ON UC SAN DIEGO RESEARCH

Achievements, Charity Care and Other Benefits to the Community

SAN DIEGO STARTUPS BASED ON UC SAN DIEGO DISCOVERIES

RESEARCH DISCOVERY  |  BIOMEDICAL STARTUP (year founded)  |  ACQUIRED BY (year founded)  |  AMOUNT
--- | --- | --- | ---

Cumulative Royalties, FY 2019  |  >$200M

1. Led by UC San Diego Jacobs School of Engineering

COMMITTEE BENEFIT  |  PROGRAMS AND SERVICES PROVIDED
--- | ---
Government-sponsored care shortfalls  |  $289.2M
Uncompensated care  |  $77.3M
Education of health professionals  |  $52.5M
Community health services  |  $2.9M
Subsidized health services  |  $1.8M
Charity care and other community benefits include:  |  $423.7M FY2018