

# THE ART + SCIENCE OF HUMAN WELLBEING

Imagine a future where physical, mental, and social wellbeing are virtually guaranteed.

This future requires more than the next big leap in biomedicine and medical technology. We must also gain a more complete understanding of the environmental and socioeconomic factors that contribute significantly to human health.

At USC Dornsife, art and science complement one another, sparking new ways to solve problems and navigate complexity. Together with collaborators across the University of Southern California, our experts explore everything from the fundamental molecular mechanisms underpinning biology to the ways that culture and traditions influence therapeutics.

Here, researchers aim to stop the progression of debilitating conditions, send them into remission, and prevent them from happening to begin with. We do this not just to create a world free of disease and infirmity but to unlock the entirety of human potential.

We invite you to join us in realizing this vision.

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USC DORNSIFE HEALTH EDUCATION



### **THE SoCAL TREATMENT**

Located in the heart of Los Angeles — where the urban society of tomorrow emerges in the present — USC Dornsife grapples with pressing human health challenges while getting ahead of complex issues on the global horizon.

Research moving from bench to bedside is informed by the city's unmatched cultural and socioeconomic diversity, ensuring that everyone stands to benefit from our discoveries. Robust collaboration between institution and industry accelerates the development of novel therapeutics. And innovation, infused with SoCal's entrepreneurial spirit, is guided by a long tradition of integrating cutting-edge technology with the arts and humanities.

## UNRAVELING THE BUILDING BLOCKS OF LIFE

Think of a cell as a tremendously complicated little machine made up of many different biomolecules such as proteins, DNA, RNA, and metabolites. Until we can explore exactly what is happening deep inside the cell and from many angles, it is difficult to fix these machines when they break. But it's no longer impossible. Today, USC Dornsife scientists provide unprecedented access to the building blocks of life — their structures, how they interact, and how they influence our health.





#### Cross-Disciplinary Biosciences

By combining methods and tools from different scientific fields, USC Dornsife researchers uncover new knowledge about the body's most basic biological structures. Teams are investigating the structural dynamics of DNA, the mechanism of DNA damage, and new ways to manipulate cells. Others are taking synthetic chemistry approaches to drug discovery or physics-based approaches to understanding the structure of cellular membranes that allow drugs into a cell. By encouraging collaboration, USC Dornsife is leading the way in chemical biology, a field that explores how biological systems that make up the human body react to chemicals on the molecular level; as well as biophysics, a specialization focused on understanding what physical forces cause certain reactions and processes in living organisms.





#### Applying Algorithms to Biological Data

How likely am I to develop a heart defect? How severely will my body respond to a viral infection? Do my genes make me predisposed to addiction? Researchers in the new **Department of Quantitative** and Computational Biology pioneer advanced computational techniques — including artificial intelligence — to understand how human genes express themselves. From mapping missing sections of DNA to revealing the genetics shared among population groups — and ensuring underrepresented groups are included in data sets — USC Dornsife researchers build on a tradition of leadership in the field that goes back more than 40 years.



#### Synthesizing Biological Structures

Imagine a world in which chemical drug therapies — therapies that can bring detrimental side effects — are a thing of the past. Instead, people take medication made of living cells to treat their unique medical needs. At USC Dornsife, experts in the emerging field of synthetic biology are developing technologies that could make this possible. For example, research teams led by Professors Ian Ehrenreich and James Boedicker explore potential methods for engineering cells to work with our own biological systems — essentially teaching these cells to take on new tasks. Looking ahead, innovations built on their discoveries might include new biological structures that target diseases like cancer and diabetes.

#### The Healing Power of Microbes

We often think of bacteria as organisms that make us sick. However, many actually protect our bodies, while others have the potential to underpin technological innovations. For example, a research team led by Professor Moh El-Naggar studies a peculiar kind of bacteria that survives by moving electrons outside of the cell wall onto rocks and minerals. They explore how we might harness the power of these "electric bacteria" to revolutionize health treatments among other applications. Could the electrical properties of bacteria in our bodies lead to new therapeutic strategies more effective than antibiotics? Could living electronics be developed that interface physical technologies to human tissue? While more research is needed, there is hope that these microbes could underpin new bio-electronics and offer solutions to health challenges like Alzheimer's, dementia, and paralysis.





Moh El-Naggar
Dean's Professor of Physics
and Astronomy and Professor
of Physics and Chemistry



### **MENTAL HEALTH**

Physical and mental health are inextricably connected. Yet, the public dialogue frequently casts mental health in the background, and those who suffer from disorders are often stigmatized. Experts at USC Dornsife are taking on mental health challenges with creativity and empathy. Some develop novel treatments and interventions. Others illuminate the critical ways in which mental health affects how we handle stress, relate to others, and make healthy choices. By integrating ideas across a variety of fields, our researchers are helping to shape a future in which individuals and communities can live life to the fullest.



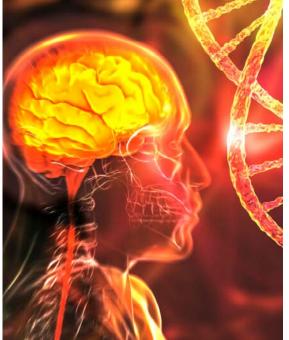
#### Accelerating Treatments for Alzheimer's Disease

Developing therapeutics for Alzheimer's is particularly difficult. Because both genetic and environmental factors affect the development of the disease — and because of the heavy risk in testing novel therapeutics on human subjects — progress toward finding a cure has been incremental at best. However, research led by biophysicist Peter Chung at USC Dornsife could help. By synthesizing one of the biomarkers frequently found in Alzheimer's patients, his lab works to effectively mimic the way these structures appear and function in the human brain. Their research may soon enable scientists to screen potential Alzheimer's treatments more thoroughly before moving to human trials.

#### Giving Heart and Soul to A.I.

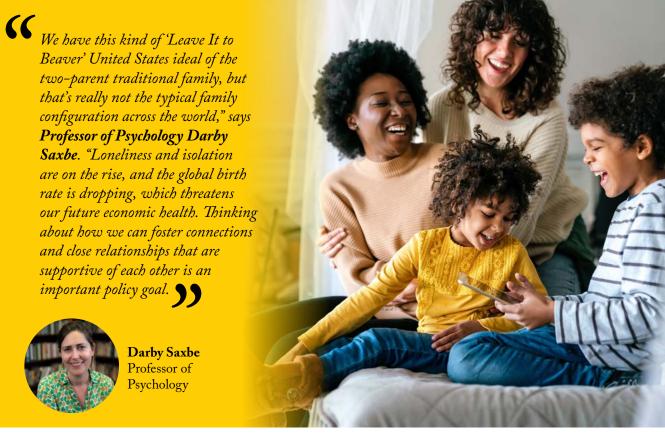
"Danger, Will Robinson, danger!" You might know these famous words from the science fiction series Lost in Space, in which an artificially intelligent robot works to protect his human friends. But will A.I. actually be capable of caring for us, worrying about us, or expressing empathy? Hanna and Antonio Damasio, world-renowned neuroscientists at the USC Brain and Creativity Institute, explore what it might take to create A.I. with the ability to identify and express "feelings" that promote deep interaction with humans, as well as ways to prevent A.I. from crossing an individual's moral and emotional boundaries. Picture, for example, a future where robots serve as therapeutic companions to the elderly or lonely when a family member cannot be by their side.





"Your Brain Doesn't Look a Day Over 40!"

The human brain holds many clues about a person's long-term health — in fact, research shows that a person's "brain age" is a more useful and accurate predictor of health risks and future disease than their birthdate. Using artificial intelligence to analyze more than 4,000 MRIs, USC cross-school research teams developed a new model that estimates brain age more accurately than any prior method. Not only is this great news for assessing the risk of diseases, but experts believe it may also help in designing patient-specific treatment plans and lifestyle interventions that help people have healthier, better-functioning brains.



#### Relationships Matter

Social connection is a public health priority and a buffer against stress and disease. And there is no social connection more enduring or powerful than family. However, the very notion of family is evolving, and we need new approaches to explore the way these relationships affect mental health. Led by psychologist Darby Saxbe, scholars and clinicians at the **Center for the Changing Family** respond to these changes by conducting research that informs health interventions and policy reflecting the oversized impact that the modern family — in all its forms — can have on our wellbeing.

# HEALTHCARE ACCESS AND EQUITY

A person's background, geographic location, or income level often factors heavily into the quality of healthcare and healthy food options available. USC Dornsife experts are exploring ways to overcome the barriers that prevent underserved populations from taking advantage of the very best treatments and interventions. With creativity and compassion, we can transform healthcare systems to support a more robust, productive, and equitable future for people of all backgrounds.





#### Research-Driven Advocacy for Healthier Communities

Far too often, a sense of powerlessness running through disadvantaged communities prevents those most affected by structural inequities from identifying and taking part in efforts to effect change. The Equity Research Institute, led by Distinguished Professor Manuel Pastor, explores new strategies for empowering leaders to organize direct participation by impacted community members in the processes that shape their lives. By taking power back, these communities will define what must happen to truly address the unequal distribution of social, economic, and environmental burdens creating health disparities.

#### The Alarming Cost of Pollution

Environmental economist Paulina Oliva studied what exposure to air pollution does to the mind and the economy — and the results are troubling. Using data from urban Chinese populations, she found that pollution spikes correspond to higher rates of mental illness and cost China \$23 billion in unnecessary health expenditures. Oliva's research, which focuses primarily on economic policy in the developing world, has also provided insights into the connection between rising temperatures and infant mortality, the reduction in labor output caused by health impacts of air pollution, and the inequitable distribution of environmental damages affecting underserved populations.



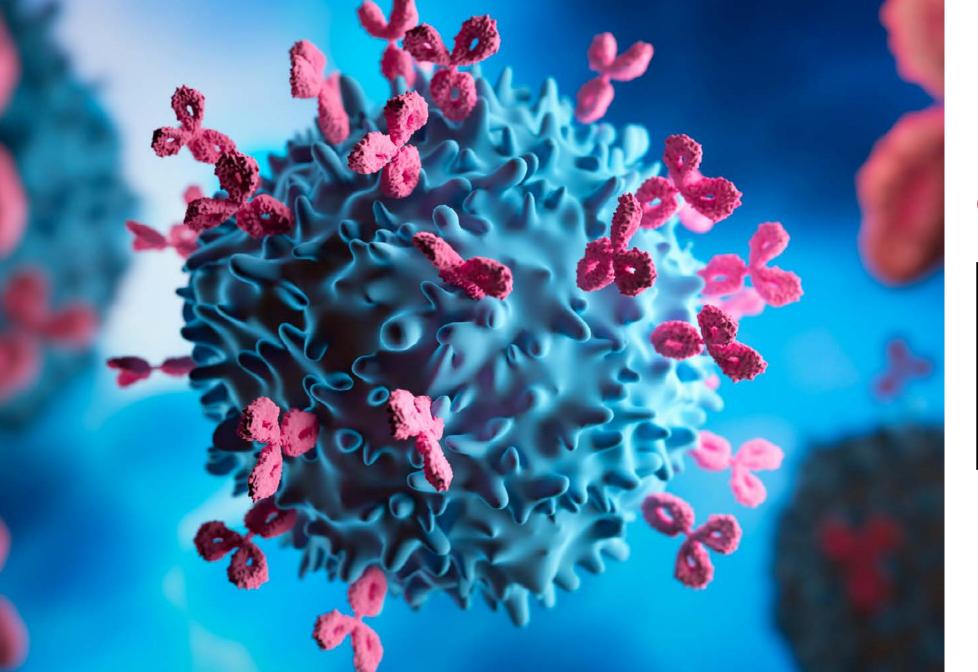
#### Public Exchange<sup>™</sup>: USC Urban Trees Initiative

Trees are among the most effective resources for cleaning the air and reducing the health impact of extreme heat. In collaboration with the City of Los Angeles, a team of USC researchers and project managers coordinated by **USC Dornsife Public Exchange**<sup>™</sup> is working to add 90,000 trees to the city's urban forest. But the project involves much more than digging holes in the ground. Leveraging advanced mapping technology, air quality measurements, and expertise in landscape architecture, the USC Urban Trees Initiative provides data-driven recommendations on where, how many, and what kinds of new trees to plant in disadvantaged neighborhoods.

#### Understanding Health in America

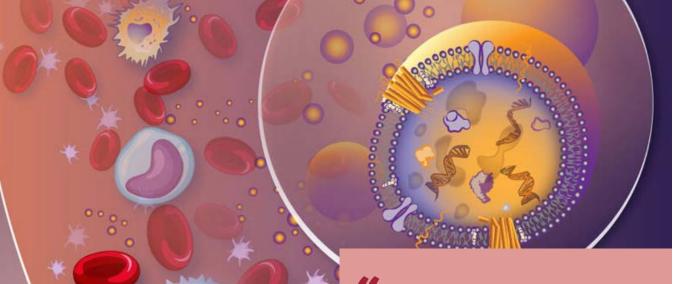
From surprising predictors of "long COVID" to the ways that sleep trends shed light on social inequities, the Center for Economic and Social Research **(CESR)** helps us understand how geographic location, minority status, gender, age, and other demographic measures contribute to a person's health. Led by economist Arie Kapteyn, CESR uses a unique methodology that leverages data from a panel of approximately 10,000 American households to take the nation's temperature on current issues like health insurance and Medicare, drug use, and the ways that retirement savings influence health choices.





### **CANCER**

While cancer "moonshots" offer tremendous hope for the future, a revolution in treatment and prevention is already improving the outlook for millions of cancer patients worldwide. From the development of personalized therapies and targeted drugs to noninvasive screening tools and early-detection methods that rely on prediction science, scientists at USC Dornsife are expanding the arsenal in the fight against cancer.



#### Predicting the Spread of Cancer

Breast cancer affects 1 in 8 women over their lifetime. Detecting it early is critical, but screening typically involves mammography X-rays or tissue biopsy — methods that can be unreliable and painful. However, researchers at the USC Michelson Convergent Science Institute in Cancer recently developed a special blood test called a liquid biopsy that can determine with tremendous accuracy whether a patient has early-stage breast cancer. Using a simple, in-office blood draw, doctors in the future could detect multiple cancer biomarkers before the disease has spread and design a personalized plan to treat it.

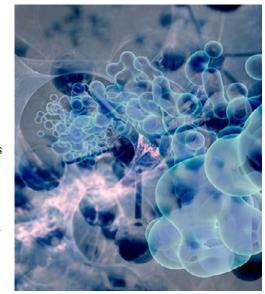
Typically, I'm the bearer of bad news — 'You have cancer in your blood," said **Dean's Professor Peter Kuhn**. "A test like this could give hope that if there is a sign of cancer, we can find it very early and improve treatment and survival.



Peter Kuhn
Dean's Professor of Biological
Sciences and Professor of Medicine,
Biomedical Engineering,
Aerospace & Mechanical
Engineering, and Urology

#### Targeting Single Cancer Cells

Traditional cancer treatments use a blunt-force approach — interventions like radiation or chemotherapy — that can damage biological structures beyond their cancer target. But improved techniques under development could greatly reduce collateral damage. At USC Dornsife, a research team led by Fabien Pinaud builds tiny nanoprobes to target cancer with tremendous precision. These probes attach to biomarkers of cancer in a cell — such as mutated proteins — before a specialized laser-imaging technique is used to "light up" the malignant cells, distinguishing them from healthy ones. The next step is to explore how this technology might be used to not just locate, but destroy cancerous cells in a noninvasive way.



#### A Novel Starter

When you think of yeast, you probably think of baking bread. But this tiny micro-organism is also helping celebrated biologist Susan Forsburg unravel big questions about cancer. Her research team uses a strain of "fission yeast" — the same kind used in brewing — to understand how, when, and why mutations occur within cells. Because this yeast has genetic building blocks similar to our own, understanding the processes that result in mutation (the underlying cause of cancer) can help us make sense of why this happens in the human body. Results have yielded significant insights about the systems that protect against mutated cell replication and why they fail — an important piece to solving the cancer puzzle.



## EXPRESSIONS AND EXPERIENCES OF HUMAN HEALTH

When it comes to successful visits with a doctor, communication is key. But in a world of 15-minute appointment windows and an overloaded healthcare system, so much can be lost in translation during patient-physician interactions. At USC Dornsife, experts are working to improve health outcomes by helping doctors communicate more efficiently with their patients. Whether it is using culturally appropriate language or addressing the lived experiences that affect health outcomes, researchers uncover ways to help doctors meet patients where they are and better understand their medical needs.



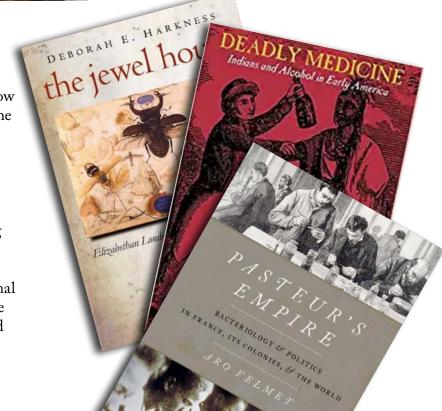


#### Defining the Future of Social Medicine and Planetary Health

What might help doctors better understand how someone's ethnicity or migrant status affects the way they report their symptoms of disease? How do traditional cultures approach and potentially adopt unfamiliar technology that could improve wellbeing? What role does politics play in a nation's preparedness for epidemics? USC Dornsife researchers working in the emerging areas of social medicine and planetary health study how health and illness are experienced in various cultural and relational contexts. They connect the dots that illuminate how issues like poverty, war, food systems, and cultural norms affect illness and disease. With a broader perspective, we may develop more equitable access, care, and outcomes.



We all bring more than a list of symptoms into the doctor's office — we bring our personal experiences, emotions, and relationships with disease. At USC, experts across areas including English, classics, philosophy, and clinical medicine are shaping the growing field of narrative medicine to explore the many ways that an individual's report of their illness can affect diagnoses and medical interventions. By understanding what a "closer reading" of a patient's story might reveal from the characters and cultural traditions they describe to the latent meaning in a moment of silence — clinicians might uncover ways to improve holistic patient care.



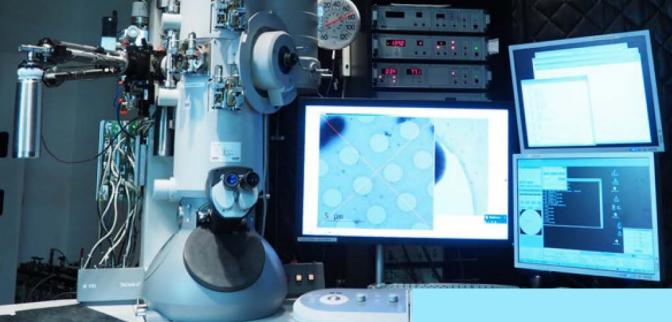
#### The Past Is Prologue

At USC Dornsife, historians and anthropologists uncover valuable knowledge on how diseases have evolved over time and how humans have responded to them. Our scholars explore topics like the long history of distrust in science, addiction in early America, and the ways that bacteriology changed medical ethics. Their research not only helps to nudge society away from repeating mistakes of the past, but it can also help clinicians and policymakers anticipate the impacts of their decisions in an uncertain future.



## **ADVANCED IMAGING AND MEDICAL TECHNOLOGY**

Leveraging some of the most advanced technology in the world, USC Dornsife researchers provide unprecedented ways of seeing molecules and cells, use big data to create medicine, and partner with industry to accelerate the future of human health.



#### Freeze Frame: Snapshots of Biological Molecules

To solve some of humanity's greatest health challenges, scientists need to see small — so small, in fact, that they can see what is happening inside individual molecules. This once impossible feat is happening now at USC, where two of the world's most advanced cryoelectron microscopes are housed on campus — the result of a partnership with biotech giant Amgen and instrument maker Thermo Fisher Scientific. These powerful microscopes allow scientists to take snapshots of biological molecules in three dimensions by freezing them in place. The tool also enables researchers to see how molecules act in the presence of other molecules, which is critical for the development and acceleration of new drug therapies.

#### Magnifying Discovery

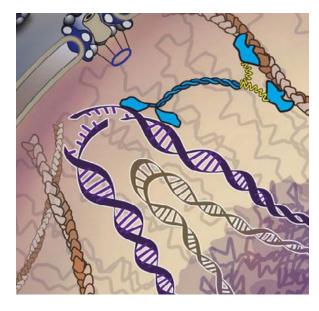
Leveraging cryo-EM technology, Cornelius Gati and his collaborators recently determined the atomic-level structure of a key protein that influences neurons — a discovery that could inform new therapies for debilitating neurological disorders. And a team led by Vsevolod Katritch used cryo-EM to uncover a chemical link that could block the harmful side effects of fentanyl and still reduce pain.

## Designing Virtual Models to Fast-Track Therapies

Researchers working at **The Bridge Institute**, housed in the USC Michelson Center for Convergent Bioscience, build dynamic virtual models that enable experts to see the world within a cell. For example, scientists, engineers, and visual artists are collaborating on a model of the pancreatic beta cell, which helps regulate blood sugar — a key process in preventing diabetes. This convergent research will help support and accelerate new therapies that make the disease more manageable and, hopefully, a thing of the past.

### One Person's Trash Is Another Person's ... Medicine?

Where some see waste, USC Dornsife experts see an opportunity! In a study coled by Travis Williams, researchers showed that plastics recovered from the Great Pacific Garbage Patch could be turned into common household medicines. By feeding these plastics to an engineered fungus, experts created antibiotics, cholesterol-lowering statins, immunosuppressants, and more. And they did it all within a week. This process has big implications for the production of medicine as well as the health of our oceans — a true one-two punch!







#### Sharpening "Molecular Scissors"

Bioscience has entered an exciting new era in which we can not only diagnose and even predict a person's susceptibility to diseases based on personal genetics but also act on that information. CRISPR/Cas9 technology allows geneticists and medical researchers to "cut and paste" sections of DNA sequences in a genome — potentially leading to cures for a wide range of illnesses and genetic disorders. But significant gaps remain in our understanding of the molecular mechanism that makes the technology work. A USC Dornsife team led by chemist Peter Qin is developing new tools to pinpoint just what is going on inside a CRISPR-edited biomolecule that enables it to recognize the intended target with a high degree of accuracy. Their work could help improve accuracy and precision in new iterations of this revolutionary technology.

## Clicking Together New Drug Therapies

Searching for molecules that could act as effective therapies for diseases requires extensive time, money, and resources — and it often ends in failure. But researchers at the **USC** Center for New Technologies in Drug Development and **Discovery** use big data to accelerate the process. They recently created a computer-assisted process called "V-SYNTHES" that uncovers effective drug candidates by drawing from a virtual library of chemical building blocks. The algorithm suggests which blocks might be "clicked" together like puzzle pieces to quickly build and test the most promising virtual molecules. V-SYNTHES technology has already proven to be 5,000 times faster than traditional methods in identifying drug-like molecules that could selectively target cannabinoid receptors key targets for pain relief and diseases such as cancer, multiple sclerosis, and Parkinson's disease.



## USC DORNSIFE HEALTH EDUCATION

Technologies and therapies borne out of cutting-edge research are revolutionizing the world of healthcare. But as the demand for healthcare services continues to grow, so too does the demand for compassionate professionals and creative thinkers.

At USC Dornsife, we train the next generation of leaders to not only use the resources available today, but to anticipate and lead solutions to human health challenges in the years ahead. While many of our students may end up working in fields outside of healthcare, they will all develop core skills built into a modern liberal arts education — skills that empower them to use their talent toward improving the wellbeing of society.





The liberal arts education at USC Dornsife is so instrumental in finding passions that not only work with your future goals, but supplement and help to enhance them. Being able to interact in different spheres of academics allows me to have a broader approach to problem-solving and critical learning related to my goal of being a doctor.

> Joshua Senior, Biological Sciences '25



#### PhD Specializations

Chemical Biology (Chemistry)

Computational Biology and Bioinformatics (Quantitative & Computational Biology)

Molecular Biology (Biological Sciences)

Neurobiology (Biological Sciences)

Physical Biology (Physics)

Population, Health, and Place (Spatial Sciences Institute)

Social Medicine (Anthropology)

#### Undergraduate Degree Programs

Health and Human Sciences B.A.

Human Biology B.A. & B.S.

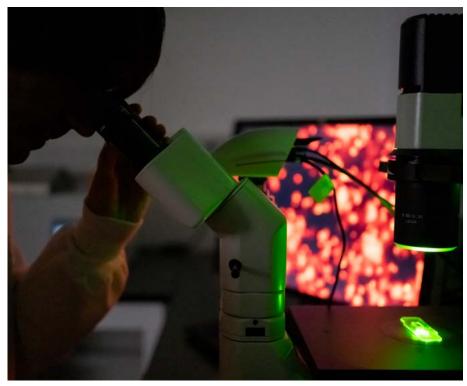
International Health, Development, and Social Justice (Minor)

#### Co-Curricular Programs

Joint Educational Program (Health-related mini teams; Medical STEM Program; Trojan Health Volunteers)

Physical Education and Mind Body Health

Pre-Health Advising and Student Shadowing Program













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