# PRECISION HEALTH

&

# Integrated Diagnostics

Stanford
M E D I C I N E

http://med.stanford.edu/phind.html

# Center Overview and Vision

**The Precision Health and Integrated Diagnostics (PHIND) Center is the <u>first center</u> in the world focused on precision health and integrated diagnostics.** The PHIND Center plays a critical role in mobilizing the components needed to advance this new vision of healthcare. It is developing, testing, and disseminating the next generation of healthcare mechanisms for precision health. Whereas precision medicine is focused on the treatment after the manifestation of disease, precision health is focused on early prediction and prevention of disease onset. The PHIND Center integrates diagnostic information collected from multiple sources both on the body, and in one's home. It also studies the fundamental biology underlying early transitions from health to disease and the associated biomarkers (molecules) of health and early disease.

## Center Research Areas

The Center aims to fundamentally revolutionize healthcare leading to better and more productive lives for individuals by integrating several key areas including:

- Risk analytics to predict risk of specific disease(s) for a given individual
- Fundamental studies of the biology of disease initiation/progression to understand the earliest transitions from healthy humans, organs and cells to the disease state
- Biomarker research to study the molecules that indicate healthy states and early signs of disease
- Diagnostic technology and information to accurately monitor and detect health changes early, such as collecting and analyzing information from multiple sources on the body and in the home, office or wider community
- Health economic analyses for precision health strategies to show savings to the health care system for pursuing various precision health efforts

### Director, PHIND Center at Stanford

**Sanjiv Sam Gambhir, MD, PhD**
Chair, Department of Radiology
Virginia and D. K. Ludwig Professor of Cancer Research
Professor by courtesy, Departments of Bioengineering and
    Materials Science & Engineering
Division Chief, Canary Center at Stanford for Cancer Early
    Detection
Division Chief, Molecular Imaging Program at Stanford
    (MIPS)

### Deputy Director, PHIND Center at Stanford

**Ryan Spitler, PhD**
Department of Radiology
Stanford University

# Advisory Boards

## Internal Advisory Board

**Oliver O. Aalami, MD**
Clinical Associate Professor, Vascular Surgery

**Zhenan Bao, PhD**
Professor, Chemical Engineering

**Garry Gold, MD**
Professor, Radiology

**Ian H. Gotlib, PhD**
Professor, Psychology

**Michael Snyder, PhD**
Professor, Genetics

## External Advisory Board

**Brook Byers**
Founding Member, Kleiner Perkins Caufield & Byers

**Rati N. Godrej, MD**
Physician, Godrej Industries Limited

**Joseph M. Hogan**
President, CEO, Align Technology

**Jeff Huber**
Vice Chairman & Founding CEO, GRAIL

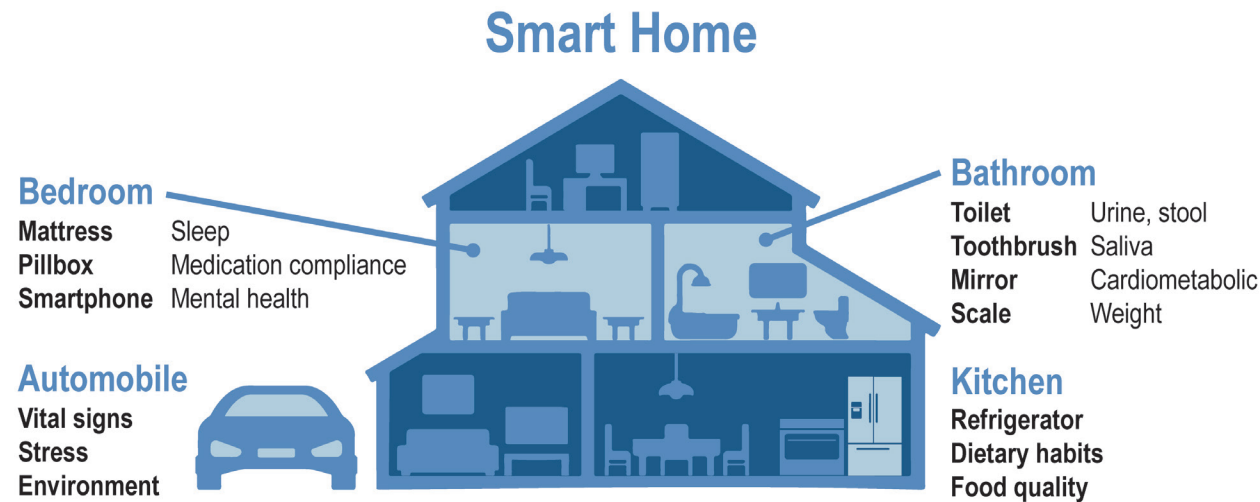**Richard M. Leavy, PhD**
Former CEO, Varian Medical Systems

**Bethany Mayer**
Executive Partner, Siris Capital Group LLC

**Amir Dan Rubin**
President & CEO, One Medical Group

# What is the difference between Precision Health and Precision Medicine?

*Precision **Health*** leverages the numerous assessments including omics, immune status, medical imaging, family history, physical condition and standard doctor visits to predict and prevent disease from occurring. *Precision **Medicine*** uses similar tools, but is primarily focused on patient treatment after the onset of disease. Both health areas have overlap and are complementary in improving patient care. *Precision **Health*** is a way of improving overall lifelong health (proactive), while *Precision **Medicine*** is generally not implemented until after an individual becomes ill (reactive).



## Smart Home

**Bedroom**
| | |
|---|---|
| Mattress | Sleep |
| Pillbox | Medication compliance |
| Smartphone | Mental health |

**Bathroom**
| | |
|---|---|
| Toilet | Urine, stool |
| Toothbrush | Saliva |
| Mirror | Cardiometabolic |
| Scale | Weight |

**Automobile**
- Vital signs
- Stress
- Environment

**Kitchen**
- Refrigerator
- Dietary habits
- Food quality

Devices in the home or automobile are capable of passively monitoring biological fluids, human behavior, and physiological signs. Passive monitoring approaches permit high-frequency monitoring without requiring a change in user behavior.
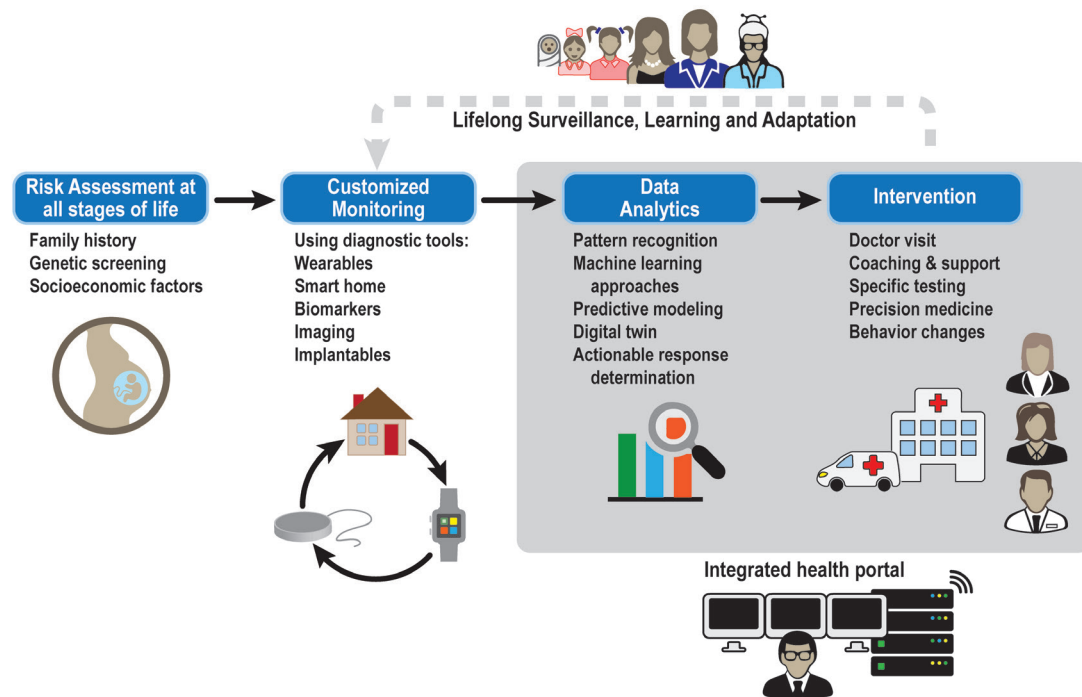


Many different components of health care can contribute to precision health.

Oliver O. Aalami, MD

Russ B. Altman, MD, PhD

Amin Arbabian, PhD

Zhenan Bao, PhD

Joseph Cheung, MD, MS

Frederick T. Chin, PhD

Christina Curtis, PhD, MSc

Utkan Demirci, PhD

Manisha Desai, PhD

Alfredo Dubra, PhD

Joshua Eric Elias-Merriman, PhD

Stephen Felt, DVM, MPH

Carolyn Fredericks, MD

Sanjiv Sam Gambhir, MD, PhD

Christopher Gardner, PhD

Brice Gaudilliere, MD, PhD

Andrew Gentles, PhD

Paul George, MD, PhD

Ian H. Gotlib, PhD

Francois Haddad, MD

Trevor Hastie, PhD

Siddhartha Jaiswal, MD, PhD

Thomas Kenny, PhD

Mykel John Kochenderfer, PhD

Anshul Kundaje, PhD

Allison W. Kurian, MD, MSc

James Landay, PhD

Laura C. Lazzeroni, PhD

Jan Liphardt, PhD

Holden Maecker, PhD

Ravi Majeti, MD, PhD

Sanjay V. Malhotra, PhD, FRSC

Rachel Manber, PhD, CBSM

Tracey McLaughlin, MD, MS

Jennifer A. McNab, PhD

Elizabeth Mormino, PhD

Mindie H. Nguyen, MD, MAS

Pablo Paredes, PhD

Stephen Quake, PhD

Byron Reeves, PhD

Thomas Robinson, MD, MPH

Brian Rutt, PhD

George W. Sledge Jr., MD

Michael Snyder, PhD

H. Tom Soh, PhD

Justin L. Sonnenburg, PhD

Ryan Spitler, PhD

Avnesh S. Thakor, MD, PhD

Anthony D. Wagner, PhD

Dennis Wall, PhD

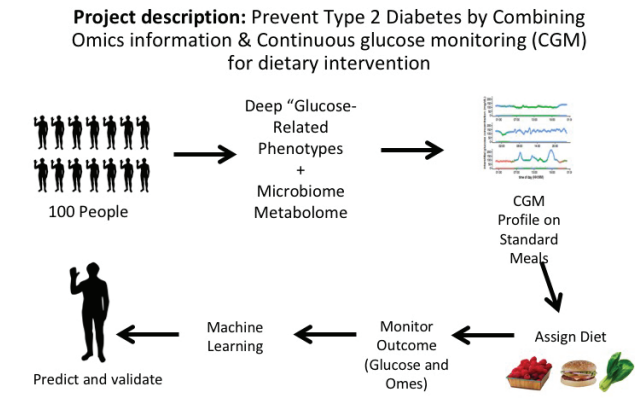Irene Wapnir, MD

Robert West, MD, PhD

Leanne Williams, PhD

Joseph C. Wu, MD, PhD

Jamie Zeitzer, PhD

Xiaolin Zheng, PhD

# Research

## Sponsored Dream Team Projects

### Precision Diets for Diabetes Prevention



**Project description:** Prevent Type 2 Diabetes by Combining Omics information & Continuous glucose monitoring (CGM) for dietary intervention
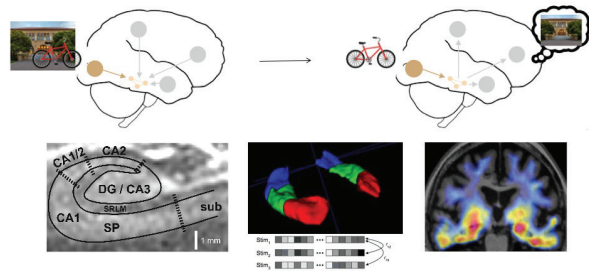
Prevent Type 2 Diabetes by combining omics information and continuous glucose monitoring (CGM) for dietary intervention.

**Project Leaders:**

Michael Snyder, PhD, Professor, Genetics
Tracey McLaughlin, MD, MS, Associate Professor, Medicine
Justin Sonnenberg, PhD, Associate Professor, Microbiology
Manisha Desai, PhD, Professor, Medicine
Christopher Gardner, PhD, Professor, Medicine

### Enabling Early Cancer Detection with Lower Costs and Improved Sensitivity from Non-Invasive Genome-wide Liquid Biopsy Tests through Novel Deep Learning Analytics and Improved Chemistry
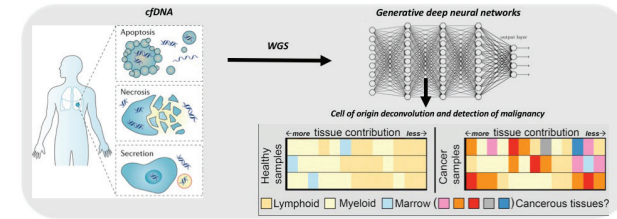


Developing a novel cfDNA sequencing technology and deep learning analytical framework that achieves state-of-the-art accuracy in distinguishing normal versus pathological states and tissue-of-origin from clinical samples.

**Project Leaders:**

Christina Curtis, PhD, MSc, MS, Assistant Professor, Oncology & Genetics
Anshul Kundaje, PhD, Assistant Professor, Computer Science & Genetics
Allison Kurian, MD, Associate Professor, Oncology & Health Research and Policy
George Sledge, MD, Professor, Oncology
Irene Wapnir, MD, Professor, Surgery
Robert West, MD, PhD, Professor, Pathology

### Predicting Healthy vs. Pathological Aging: Multimodal Biomarkers of Age-Related Memory Change and Risk for Alzheimer's Disease



The Predicting Health in Aging (PHIA) project is addressing two major health goals, leveraging a deeply characterized cohort of 200 healthy older individuals from whom baseline measures of brain structure, brain function, genetics, and cerebral spinal fluid (CSF) biomarkers of risk for Alzheimer's disease (AD) are collected.

**Project Leaders:**

Anthony Wagner, PhD, Professor, Psychology
Elizabeth Mormino, PhD, Assistant Professor, Neurology & Neurological Science
Brian Rutt, PhD, Professor, Radiology
Carolyn Fredericks, MD, Clinical Assistant Professor, Neurology & Neurological Science
Jennifer McNab, PhD, Assistant Professor, Radiology
Frederick T. Chin, PhD, Assistant Professor, Radiology

### Multidimensional Predictors of Major Depressive Disorder and Suicidal Behaviors in High-Risk Adolescents
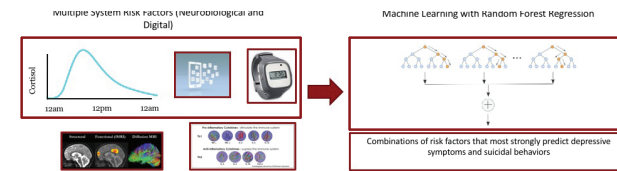


The goal of this longitudinal study is to leverage a well-characterized sample of healthy adolescents who experienced early life stress to integrate multi-system neurobiological and digital phenotypes with machine learning algorithms to identify risk factors and mechanistic targets involved in the onset of depression and engagement in suicidal behaviors. This project will facilitate the development of more timely and precise approaches to the prevention of these debilitating conditions and their devasting consequences.

**Project Leaders:**

Ian H. Gotlib, PhD, Professor, Psychology
Holden Maecker, PhD, Professor, Microbiology & Immunology
Rachel Manber, PhD, Professor, Psychiatry & Behavioral Sciences
Trevor Hastie, PhD, Professor, Statistics
Dennis Wall, PhD, Associate Professor, Pediatrics

# Research

## Sponsored Dream Team Projects (continued)

### Assessment of Early Knee Osteoarthritis Using a Low Cost, Rapid, and Multimodal Imaging and Biomechanics Approach

**Project Leaders:**

Brian Hargreaves, PhD, Professor, Radiology

Scott Delp, PhD, Professor, Bioengineering, and Mechanical Engineering, and, by courtesy, Orthopaedic Surgery

Garry Gold, MD, Professor, Radiology

Akshay Chaudhari, PhD, Postdoctoral Research Fellow, Radiology

### Precision Diagnostics and Prediction of Food Allergy

**Project Leaders:**

Sindy Tang, PhD, Associate Professor, Mechanical Engineering

Kari Nadeau, MD, PhD, Professor, Medicine, and Pediatrics, and, by courtesy, Otolaryngology

Pablo Paredes, PhD, Instructor, Radiology

### Detection and Prevention of Autism through Wearable Artificial Intelligence and Multimodal Data Integration

**Project Leaders:**

Dennis Wall, PhD, Associate Professor, Biomedical Data Science, and Pediatrics

James Landay, PhD, Professor, Computer Science

Trevor Hastie, PhD, Professor, Statistics

Thomas Robinson, MD, MPH, Professor, Pediatrics

Pablo Paredes, PhD, Instructor, Radiology

Michael Snyder, PhD, Professor, Genetics

### Wearable Wireless Sleep Monitoring System for Precision Health

**Project Leaders:**

Ada Poon, PhD, Associate Professor, Electrical Engineering

Zhenan Bao, PhD, Professor, Chemical Engineering

Emmanuel Mignot, MD, PhD, Professor, Psychiatry and Behavioral Sciences

## Sponsored Individual Seed Projects

### Improving Abdominal Aortic Aneurysms Detection and Screening

**Project Leaders:**

Oliver O. Aalami, MD, Clinical Associate Professor, Surgery

Ronald L. Dalman, MD, Professor, Surgery

Nathan Itoga, MD, Resident, Surgery

Todd H. Wagner, PhD, Associate Professor, Surgery

### Utilizing the Immune Profile of Blood as a Biomarker for Transient Ischemic Attacks

**Project Leaders:**

Paul George, MD, PhD, Assistant Professor, Neurology & Neurological Sciences

Brice Gaudilliere, MD, PhD, Assistant Professor, Anesthesiology

## Sponsored Individual Seed Projects (continued)

### Biomarkers and Biological Processes Associated with Future Cancer Development and Exposure to Food-based Carcinogens

**Project Leader:**

Andrew Gentles, PhD, Assistant Professor, Medicine, and, by courtesy, Biomedical Data Science

### A Non-invasive Proteomics Platform for Non-invasively Monitoring Diet and Microbiome Influences on Human Immune Systems

**Project Leader:**

Joshua Elias-Merriman, PhD, Chemical and Systems Biology

### A Real-time Continuous Biochemical Sensing Platform

**Project Leaders:**

Zhenan Bao, PhD, Professor, Chemical Engineering

Jan Liphardt, PhD, Associate Professor, Bioengineering

### Platform for At-home Urine Microscopy

**Project Leader:**

Audrey Bowden, PhD, Assistant Professor, Electrical Engineering

### Noninvasive Impedance Spectroscopy of Blood using Advective Heat Transport

**Project Leader:**

Thomas Kenny, PhD, Professor, Mechanical Engineering

### Progression of Clonal Hematopoiesis of Indeterminate Potential to Acute Myeloid Leukemia

**Project Leader:**

Ravi Majeti, MD, PhD, Professor, Medicine

### Novel EEG Biomarkers of Sleep Health: A Machine Learning Study

**Project Leaders:**

Jamie Zeitzer, PhD, Associate Professor, Psychiatry and Behavioral Sciences

Mykel Kochenderfer, PhD, Assistant Professor, Aeronautics and Astronautics

### VascTrac: Passive Mobile Screening for Peripheral Artery Disease as Biomarker and Risk Assessment Tool for Cardiovascular Disease

**Project Leader:**

Oliver O. Aalami, MD, Clinical Associate Professor, Surgery

### Breath Acetone Sensor towards Non-invasive Diabetic Monitoring

**Project Leader:**

Xiaolin Zheng, PhD, Associate Professor, Mechanical Engineering

### In vivo Real-time Biosensing using Aptamers on mm-sized Implants

**Project Leaders:**

Amin Arbabian, PhD, Assistant Professor, Electrical Engineering

H. Tom Soh, PhD, Professor, Radiology, and Electrical Engineering

Stephen Felt, DVM, MPH, Associate Professor, Comparative Medicine

## Sponsored Individual Seed Projects (continued)

### Elucidating the Mechanisms of Metabolic Cardiomyopathy through Personalized Exosome Profiling, the ExoHeart Collaborative Initiative

**Project Leaders:**

Utkan Demirci, PhD, Professor, Radiology, and, by courtesy, Electrical Engineering

Michael Snyder, PhD, Professor, Genetics

Francois Haddad, MD, Clinical Associate Professor, Cardiovascular Medicine

Joseph Wu, MD, PhD, Professor, Cardiovascular Medicine, and Radiology

### The Smart Menstrual Pad for Precision Health Screening in Women

**Project Leaders:**

Avnesh Thakor, MD, PhD, Assistant Professor, Radiology

Utkan Demirci, PhD, Professor, Radiology, and, by courtesy, Electrical Engineering

### A Decision-analytic Framework for Economic Evaluation of Current Precision Health Approaches and Prioritization of Their Future Research and Development

**Project Leaders:**

Jeremy Goldhaber-Fiebert, PhD, Associate Professor, Medicine

Joshua Salomon, PhD, Professor, Medicine

Grace Lee, MD, Professor, Pediatrics

Kathryn Phillips, PhD, Professor, Clinical Pharmacy

Douglas K. Owens, MD, MS, Professor, Medicine

Laurence Baker, PhD, Professor, Health Research & Policy

Sanjay Basu, MD, PhD, Assistant Professor, Medicine

Jay Bhattacharya, MD, PhD, Professor, Medicine

### Identifying Microbiome Markers of Progression of Alzheimer's Disease

**Project Leaders:**

Ami S. Bhatt, MD, PhD, Assistant Professor, Medicine

Gavin Sherlock, PhD, Associate Professor, Genetics

### Finding Novel Biomarkers in Human Sweat to Non-invasively Assess Risk and Progression of Metabolic Diseases

**Project Leaders:**

Richard N. Zare, PhD, Professor, Chemistry

Robert J. Tibshirani, PhD, Professor, Biomedical Data Science, and Statistics

Michael Snyder, PhD, Professor, Genetics

### Determination of Sepsis Marker Levels in Pregnant Women During the Peripartum Period

**Project Leaders:**

Natali Aziz, MD, MS, Clinical Associate Professor, Obstetrics & Gynecology

Samantha Do, MD, Fellow, Medicine

Ronald S. Gibbs, MD, Clinical Professor, Obstetrics & Gynecology

Shanthi Kappagoda, MD, MS, Clinical Assistant Professor, Medicine

### Identifying Fibroblast Subtypes Contributing to the Progression of Preinvasive to Invasive Lung Adenocarcinoma

**Project Leaders:**

Sylvia K. Plevritis, PhD, Professor, Radiology, and Biomedical Data Science

Gerlinde Wernig, MD, Assistant Professor, Pathology

Matt van de Rijn, MD, PhD, Professor, Pathology

Joseph Shrager, MD, Professor, Cardiothoracic Surgery

Ann Leung, MD, Professor, Radiology

### IgG Glycosylation as a Scalable Biomarker of Insulin Resistance and Metabolic Health

**Project Leaders:**

Michael Snyder, PhD, Professor, Genetics

Andrew Lipchik, PhD, Postdoctoral Fellow, Genetics

Fahim Abbasi, MD, Clinical Assistant Professor, Medicine

Joshua W. Knowles, MD, PhD, Assistant Professor, Medicine

### Molecularly Selective Membranes for Electronic Sensing of Hormones

**Project Leaders:**

Alberto Salleo, PhD, Associate Professor, Materials Science and Engineering

### Automated Detection of Cerebral Ischemia to Reduce Disability and Mortality

**Project Leaders:**

Paul Yock, MD, Professor, Bioengineering, and Medicine

Jaime Lopez, MD, Associate Professor, Neurology & Neurological Sciences

Ross Venook, PhD, Lecturer, Bioengineering

### Infant Epigenetic Markers of Maternal Attachment Style

**Project Leaders:**

Thalia K. Robakis, MD, PhD, Clinical Assistant Professor, Psychiatry and Behavioral Sciences

Alex E. Urban, PhD, Assistant Professor, Psychiatry and Behavioral Sciences

Ian H. Gotlib, PhD, Professor, Psychology

### Male infertility and the Future Risk of Metabolic and Vascular Diseases

**Project Leaders:**

Michael L. Eisenberg, MD, Associate Professor, Urology

Gary M. Shaw, DrPH, Professor, Pediatrics, and, by courtesy, Health Research & Policy

## PHIND Events

**PHIND Monthly Seminar Series**
Covering a range of Precision Health Research topics

**Annual PHIND Symposium**
A collection of world-renowned scientists sharing their latest Precision Health discoveries.



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## Related Press

**New Center Sets out to Stop Disease Before it Starts**
http://med.stanford.edu/news/all-news/2018/05/new-center-sets-out-to-stop-disease-before-it-starts.html

**5 Questions: Sam Gambhir on Progress in Precision Health**
https://med.stanford.edu/news/all-news/2018/02/5-questions-sam-gambhir-on-progress-in-precision-health.html

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## PRECISION HEALTH
### *&*
## *Integrated Diagnostics*

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