KOCH INSTITUTE
for Integrative Cancer Research at MIT

A unique approach to cancer research

Matthew Vander Heiden

science + engineering = conquering cancer together

Brief Koch Institute History

1971

The National Cancer Act of 1971

Public Law 92-218
92nd Congress, S. 1828
December 23, 1971

An Act

To amend the Public Health Service Act so as to strengthen the National Cancer Institute and the National Institutes of Health in order more effectively to carry out the national effort against cancer.

1974

MIT Center for Cancer Research

NCI·CC

A Cancer Center Designated by the National Cancer Institute

Former factory dedicated for cancer research

By Stephen Blatt

2011

KOCH INSTITUTE for Integrative Cancer Research at MIT

NCI Cancer Center

A Cancer Center Designated by the National Cancer Institute

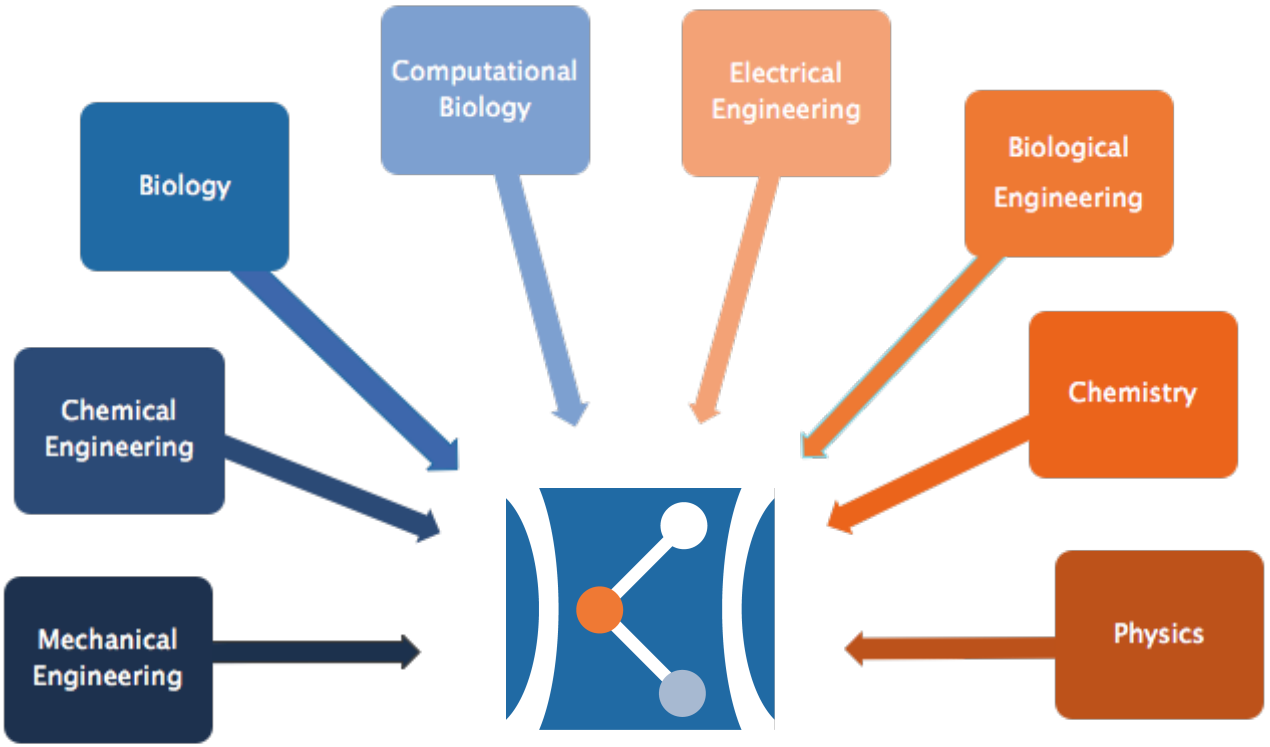
The Koch Institute at MIT

>192,000 NASF
25 members located in the Koch Institute building
32 members located in neighboring buildings
2 clinical investigators
> 700 staff

Kendall Square and the Boston Technology Cluster

Koch Institute Mission

To develop **new insights** into cancer, as well as **new tools** and **technologies** to better detect, monitor, and **treat** the disease.



Dan Anderson

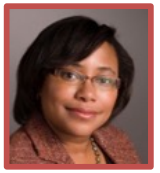
Angela Belcher

Sangeeta Bhatia

Michael Birnbaum

Jianzhu Chen

Michael Cima



Paula Hammond

Michael Hemann

David Housman

Omer Yilmaz

Richard Hynes

Michael Yaffe

Darrell Irvine

Dane Wittrup

Tyler Jacks

Forest White

Angela Koehler

Matthew Vander Heiden

Stefani Spranger

Phillip Sharp

Ram Sasisekharan

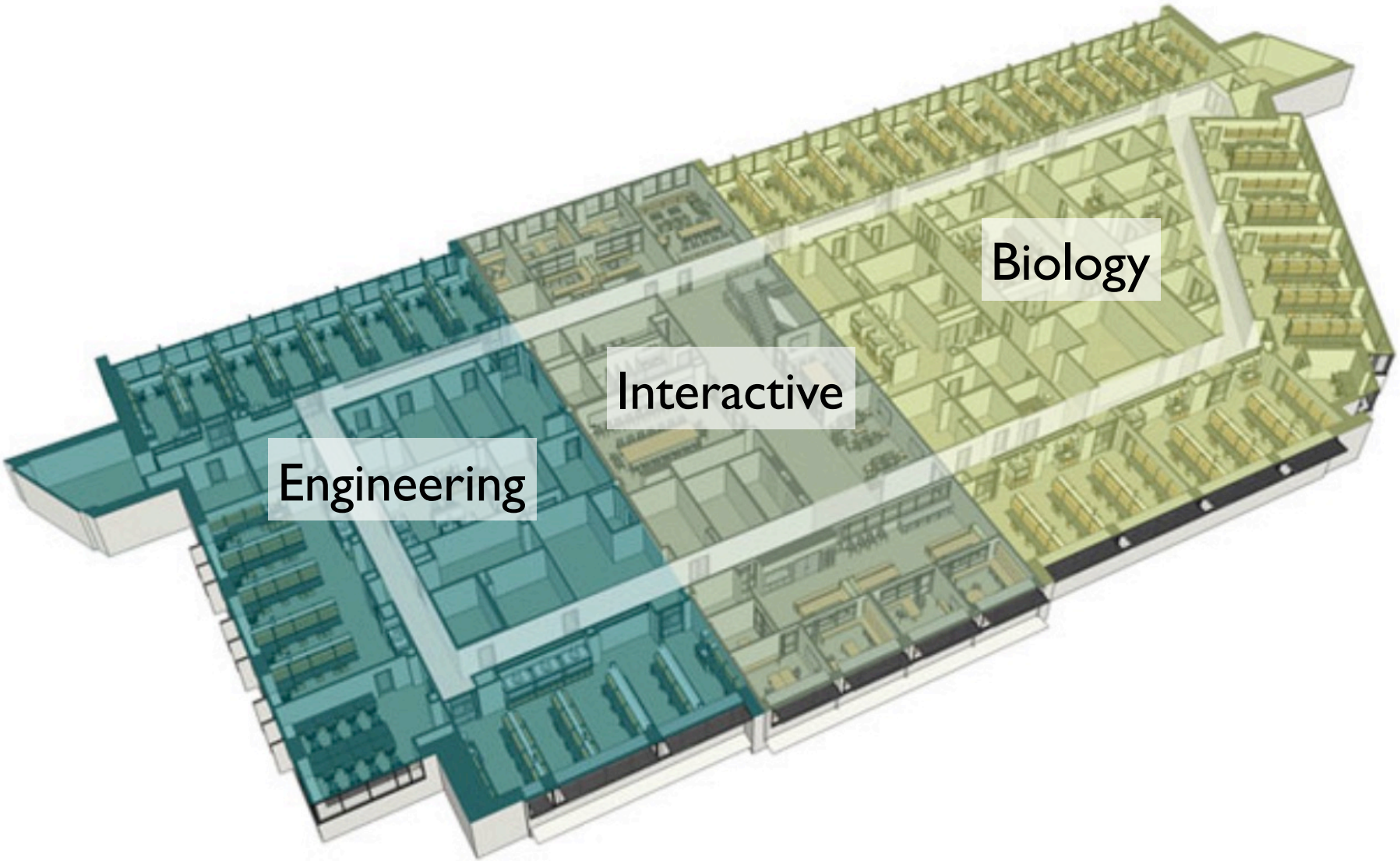
Scott Manalis

Christopher Love

Jackie Lees

Robert Langer

Cross-Disciplinary Research



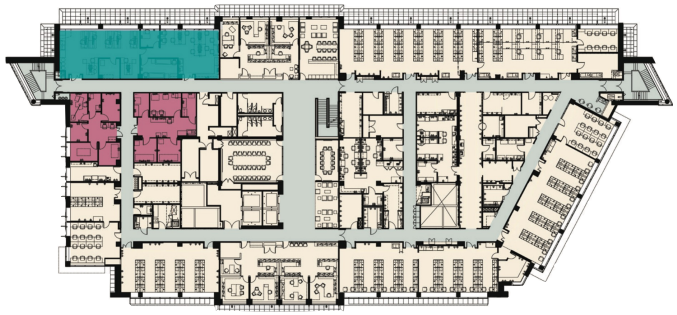
The Core Facilities of the Swanson Biotechnology Center

Basement:

- High Throughput Sciences
- Nanotechnology Materials
- Flow Cytometry
- Integrated Genomics & Bioinformatics (server)
- Zebrafish Facility
- Glassware Preparation
- Media Preparation

Level 1:

- Histology
- Biopolymers & Proteomics
- Integrated Genomics & Bioinformatics
- Preclinical Modeling, Imaging & Testing



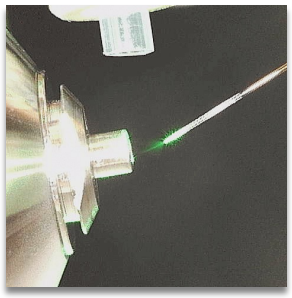
Level 2:

- Flow Cytometry
- Microscopy

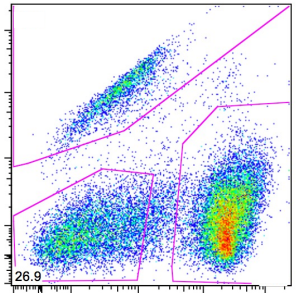
Level 7:

- Preclinical Modeling, Imaging & Testing

The Koch Institute Core Facilities



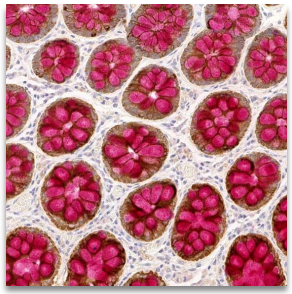
Biopolymers
& Proteomics



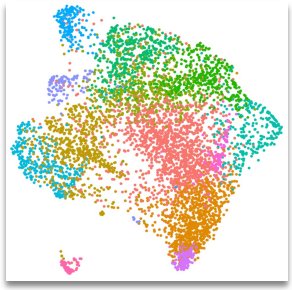
Flow Cytometry

Glassware

High Throughput
Sciences



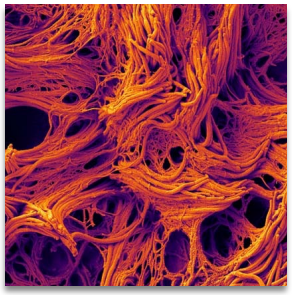
Histology



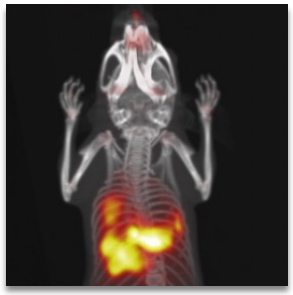
Integrated Genomics
& Bioinformatics

Media Preparation

Microscopy



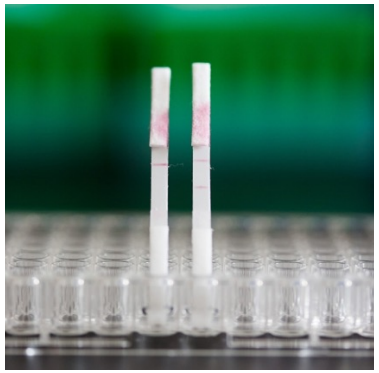
Nanotechnology
Materials



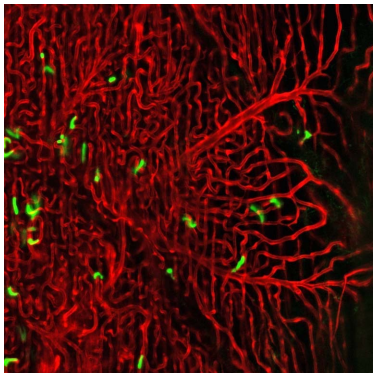
Preclinical Modeling,
Imaging & Testing

Zebrafish

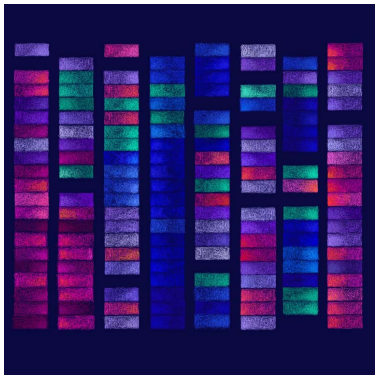
Koch Institute Focus Areas



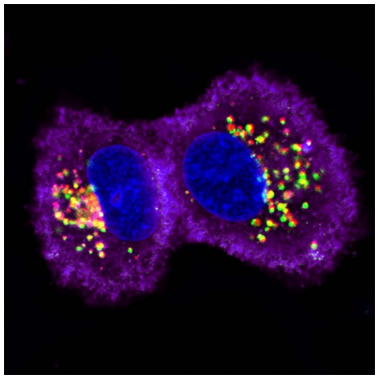
Detection & Monitoring



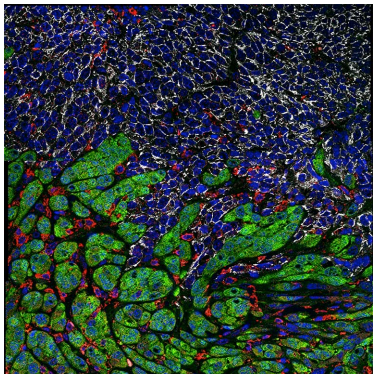
Metastasis



Precision Medicine



Nano-Based Drug Delivery



Immune-oncology

cross-cutting themes traversing multiple cancer types and applied at all stages of the research pipeline

Koch Institute Signature Programs and Centers

FRONTIER RESEARCH PROGRAM

THE BRIDGE PROJECT

MARBLE CENTER FOR CANCER NANOMEDICINE

MIT STEM CELL INITIATIVE

MIT CENTER FOR PRECISION CANCER MEDICINE

LUDWIG CANCER RESEARCH

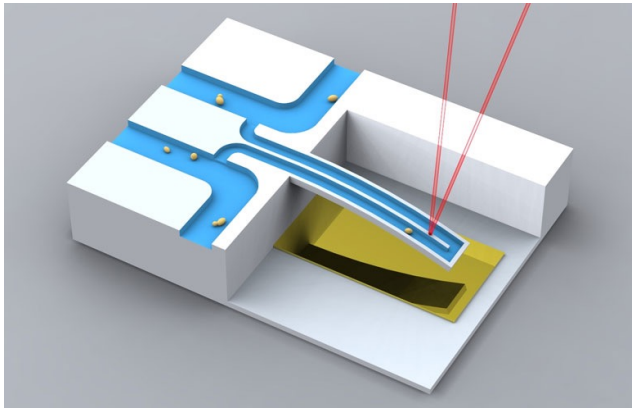
The Bridge Project

- Philanthropically funded
- Collaborative partnership with Dana-Farber/ Harvard Cancer Center

THE BRIDGE PROJECT

Measuring Biophysical Properties of Single Cells

Suspended Microchannel Resonator (SMR)

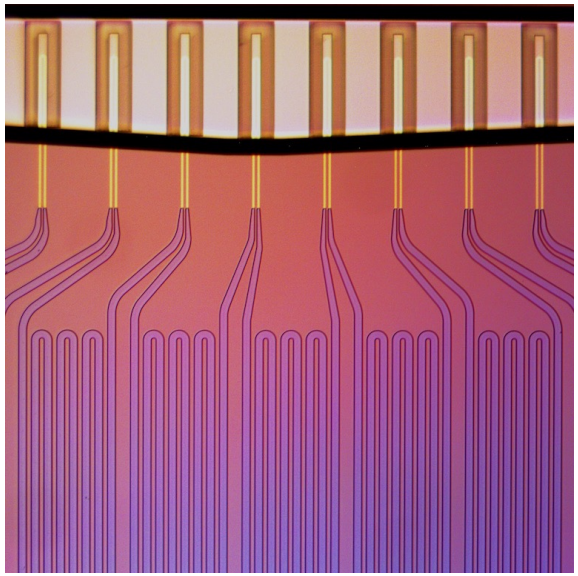


Burg et al. Nature 2007

Resonant frequency shift is directly proportional to single-cell buoyant mass

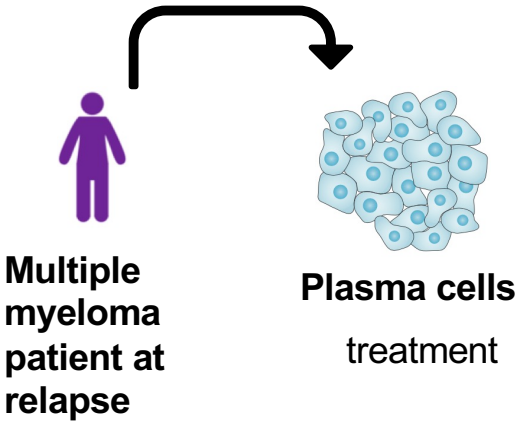
Precision is <0.1% (50 femtograms)

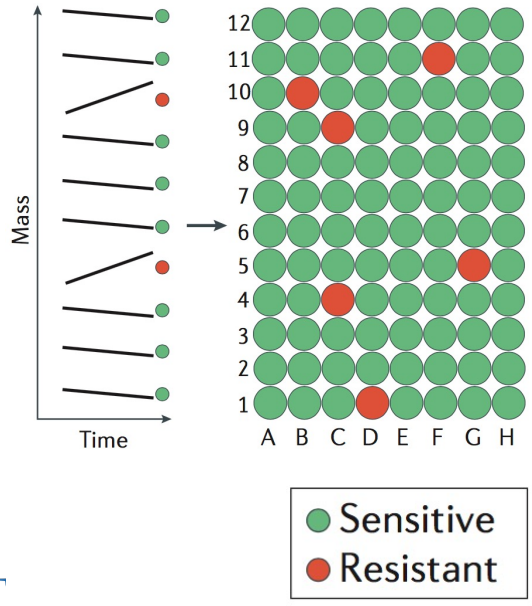
Serial SMR Array



Cermak et al. Nature Biotech. 2016

Mass accumulation rate



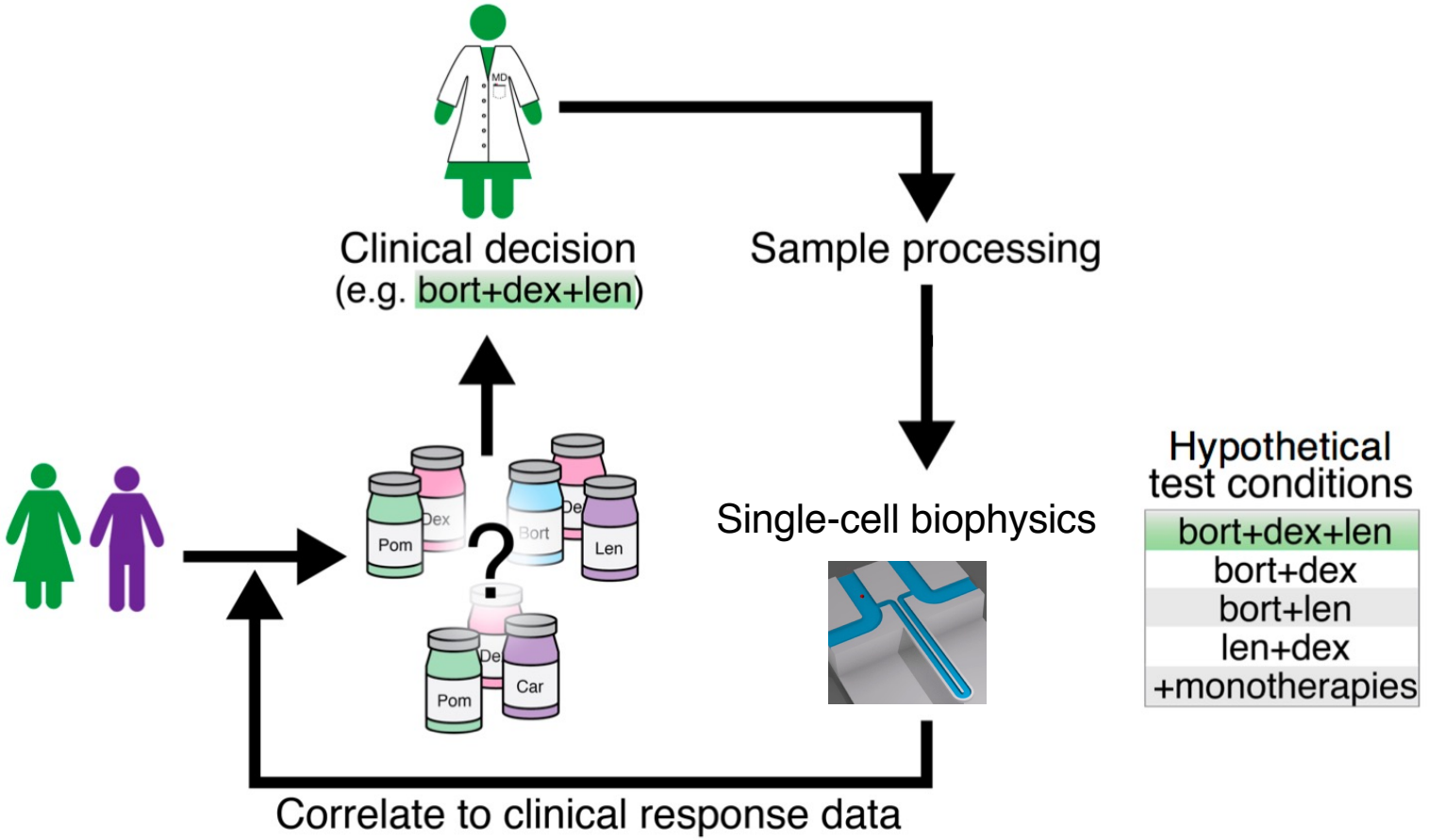


THE BRIDGE PROJECT

Scott Manalis (KI)

Stevens et al. Nature Biotech. 2016
Cetin et al. Nature Comm. 2017

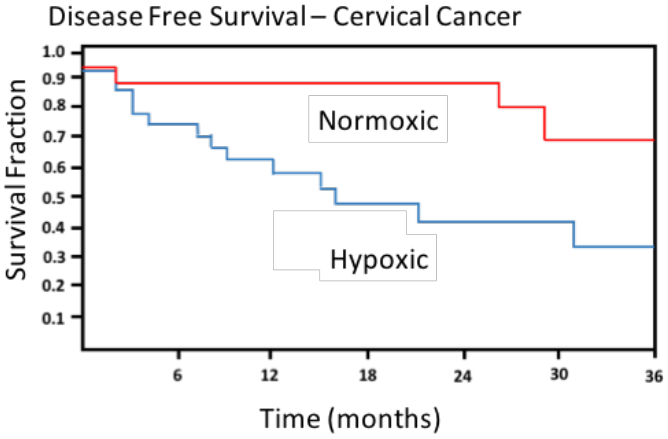
Mass accumulation rate as a predictive biomarker



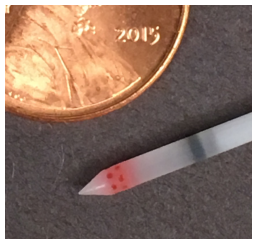
TRAVERA

Scott Manalis (KI)

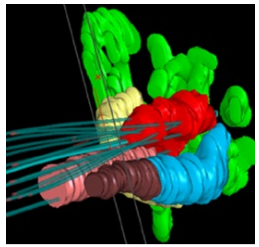
Tumor Oxygen Measurements to Guide Therapy for Cervical Cancer Patients



Clinical Implementation



Clinical Oxygen Sensor Design



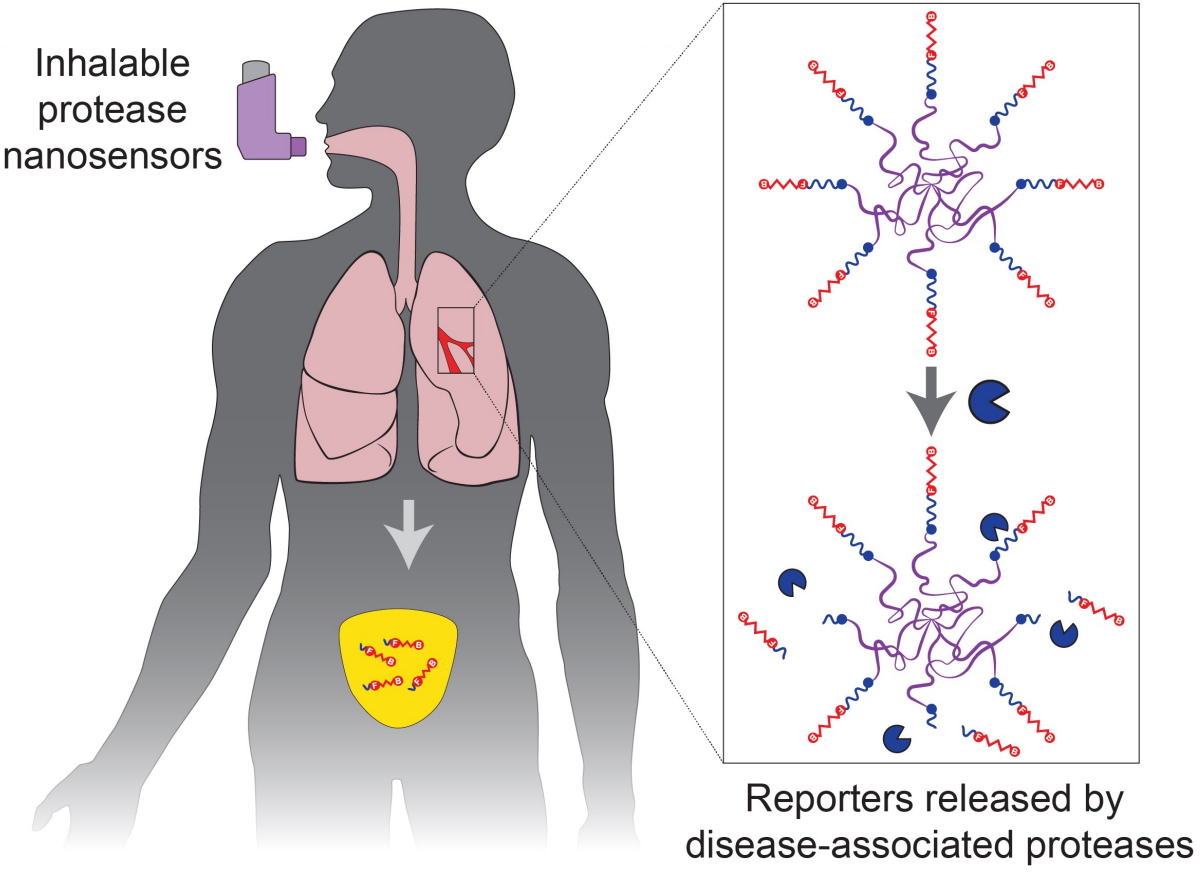
For High Dose Brachytherapy

- Poor clinical outcomes for low oxygen tumors and low oxygen tumors are known to be more resistant to radiation therapy
- New clinical device: oxygen sensor that may guide where to increase brachytherapy radiation dose to tumors with low oxygen levels
- First MR guided HDR brachytherapy with oxygen sensor performed July 2019

Michael Cima (KI)

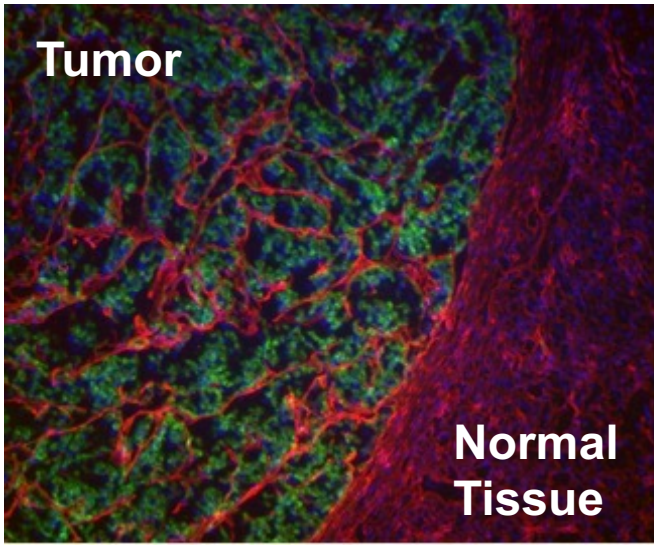
THE BRIDGE PROJECT

Activity-Based Nanosensors for Disease Monitoring and Detection

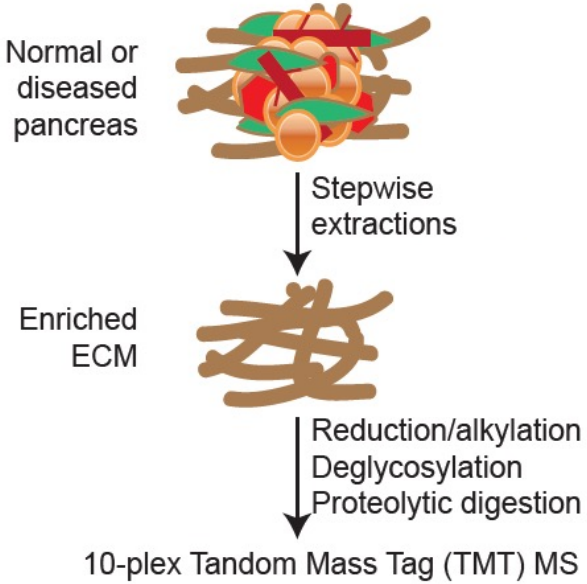


Sangeeta Bhatia (KI)

Imaging extracellular matrix changes to detect cancer



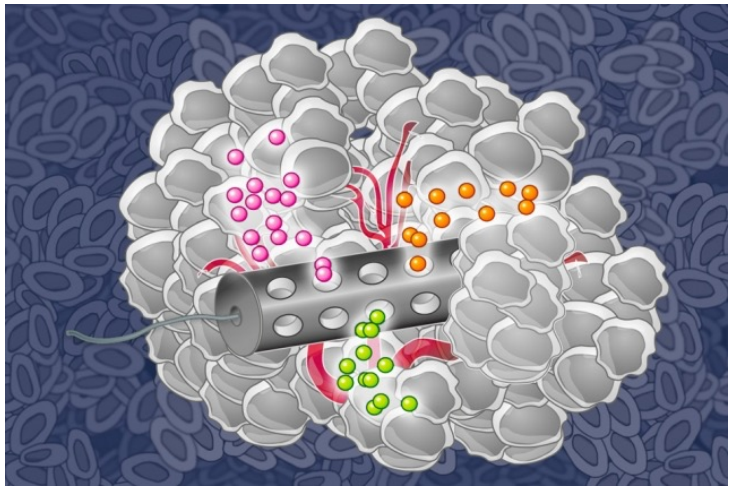
Proteomic analyses of ECM

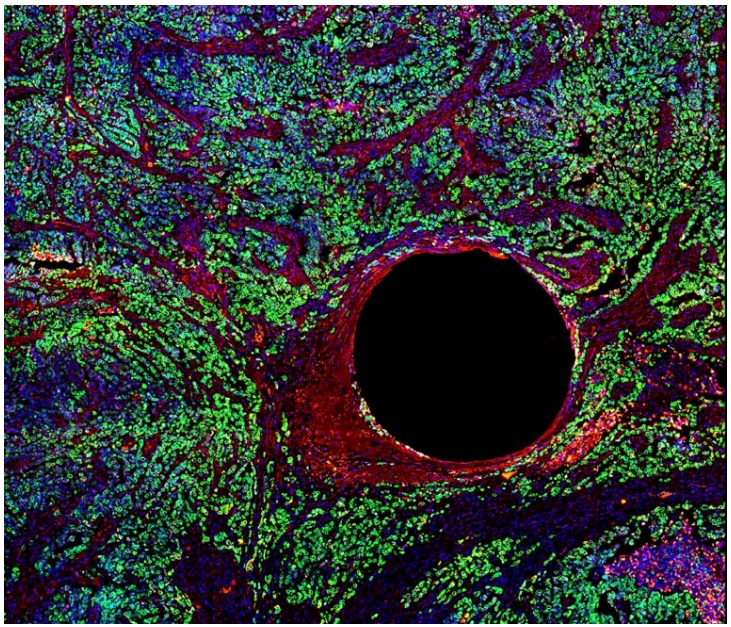


KPC GEMM with PanIN

Richard Hynes (KI)

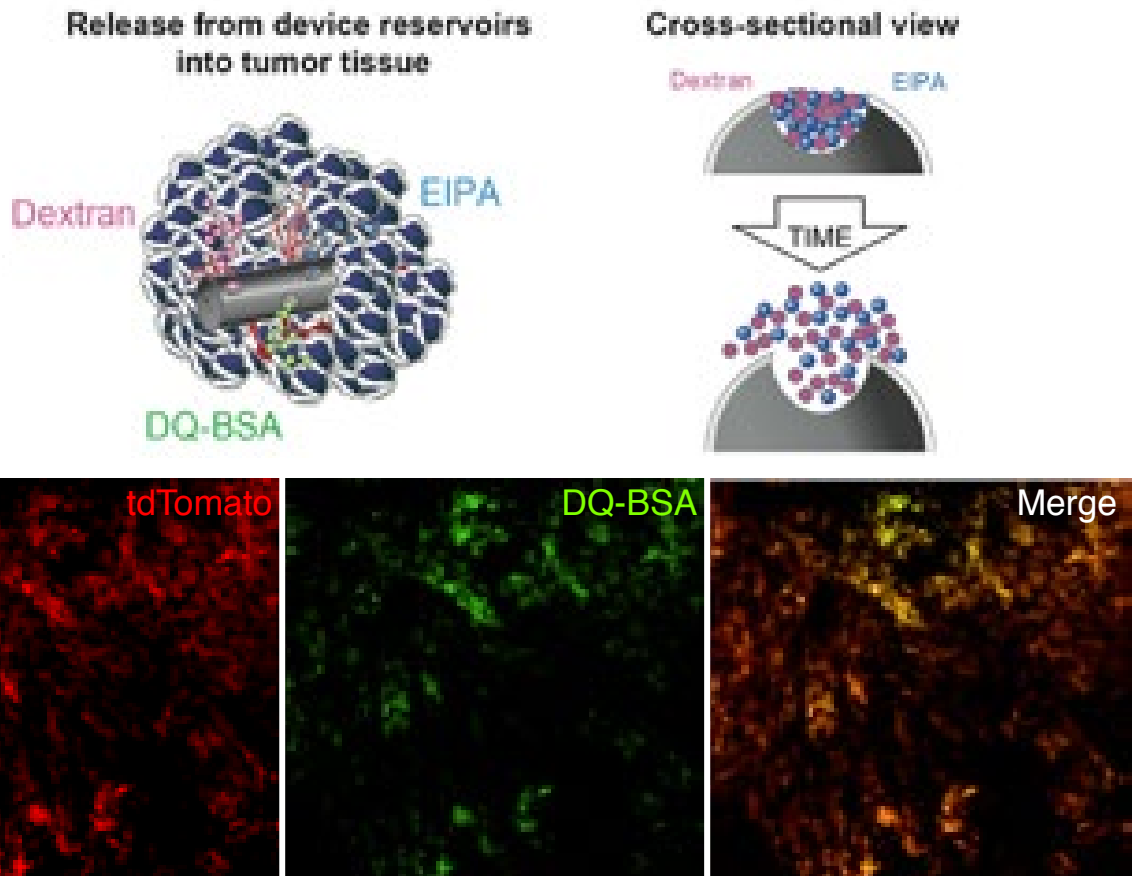
Microdevices to assess drug response





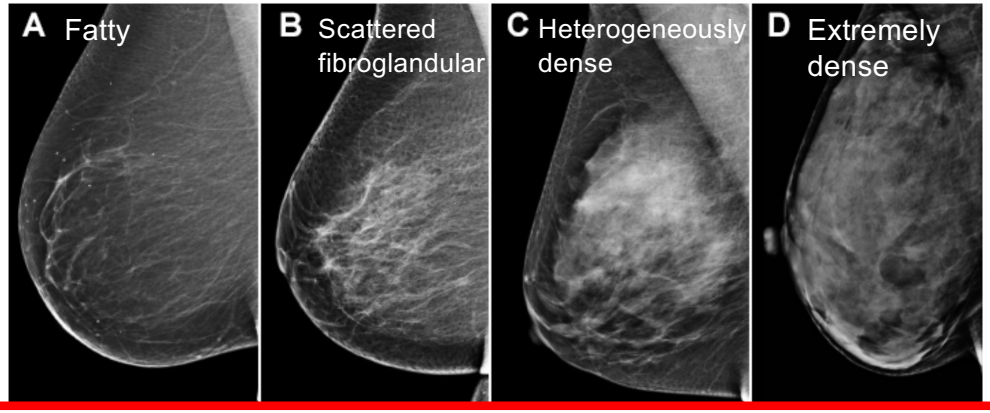
Robert Langer, Michael Cima, Oliver Jonas (KI)

Microdevices to assess drug response



Davidson et al., Nature Med, 2017

Improving Early Detection of Breast Cancer



New federal law requires mammography providers to send breast density notifications

Michael Walter | *February 19, 2019* | *Policy*

When President Donald Trump signed a federal funding bill into law on Feb. 15, it included text that said that all mammography providers must include updated information about breast density in reports sent to both patients and their physicians.

Breast Density Assessments Vary even Among Expert Radiologists

Annals of Internal Medicine ORIGINAL RESEARCH

Variation in Mammographic Breast Density Assessments Among Radiologists in Clinical Practice

A Multicenter Observational Study

Brian L. Sprague, PhD; Emily F. Conant, MD; Tracy Onega, PhD; Michael P. Garcia, MS; Elisabeth F. Beaber, PhD; Sally D. Herschorn, MD; Constance D. Lehman, MD, PhD; Anna N.A. Tosteson, ScD; Ronilda Lacson, MD, PhD; Mitchell D. Schnall, MD, PhD; Despina Kontos, PhD; Jennifer S. Haas, MD, MSc; Donald L. Weaver, MD; and William E. Barlow, PhD; on behalf of the PROSPR Consortium*

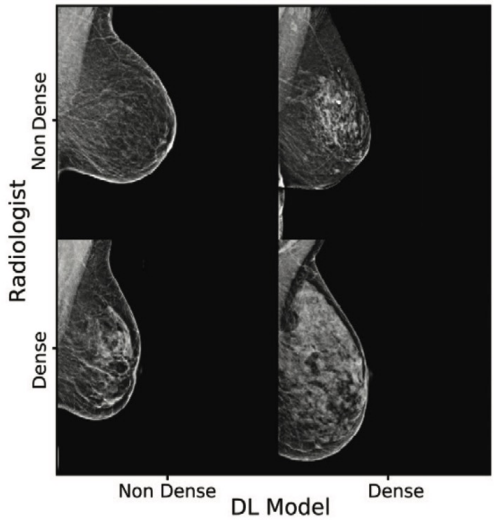
Results: Overall, 36.9% of mammograms were rated as showing dense breasts. Across radiologists, this percentage ranged from 6.3% to 84.5% (median, 38.7% [interquartile range, 28.9% to 50.9%]), with multivariable adjustment for patient characteristics having little effect (interquartile range, 29.9% to 50.8%).

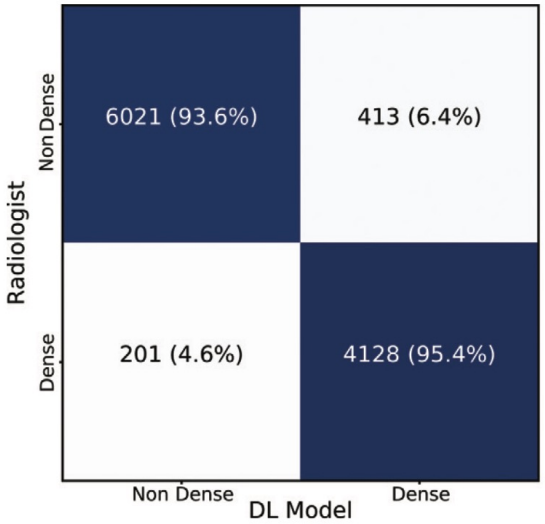
Sprague et al, Annals of Int Med 2016

KI Contribution: Density Assessment Using Deep Learning

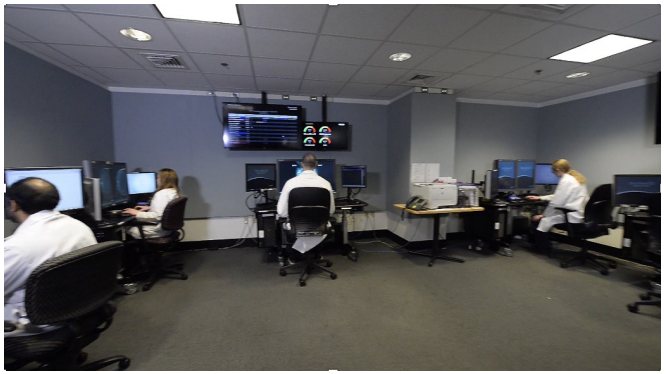
Mammographic Breast Density Assessment Using Deep Learning: Clinical Implementation

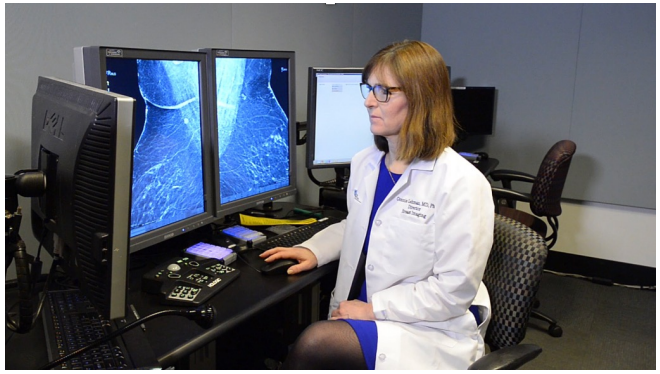
Constance D. Lehman, MD, PhD • Adam Yala, MEng • Tal Schuster, MSc • Brian Dontchos, MD • Manisha Bahl, MD, MPH • Kyle Swanson, BS • Regina Barzilay, PhD





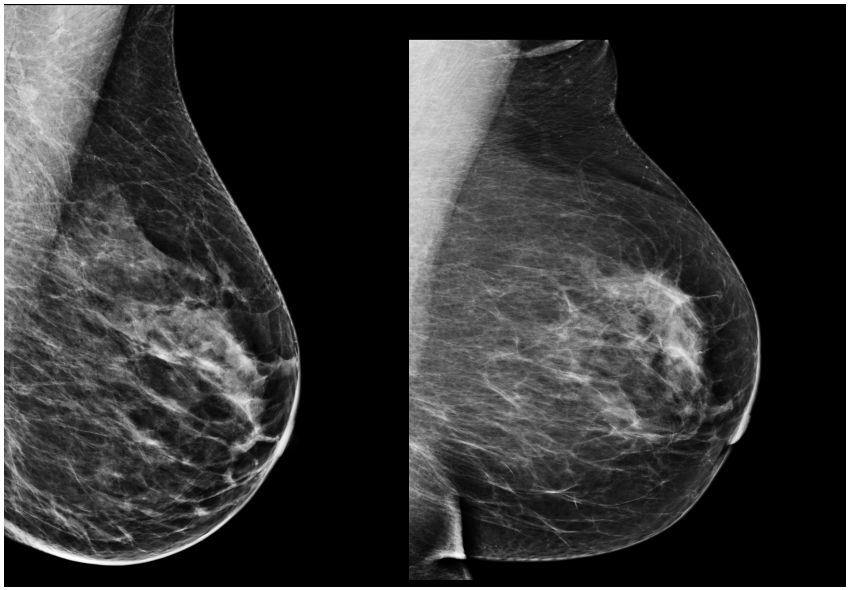
Clinical Implementation



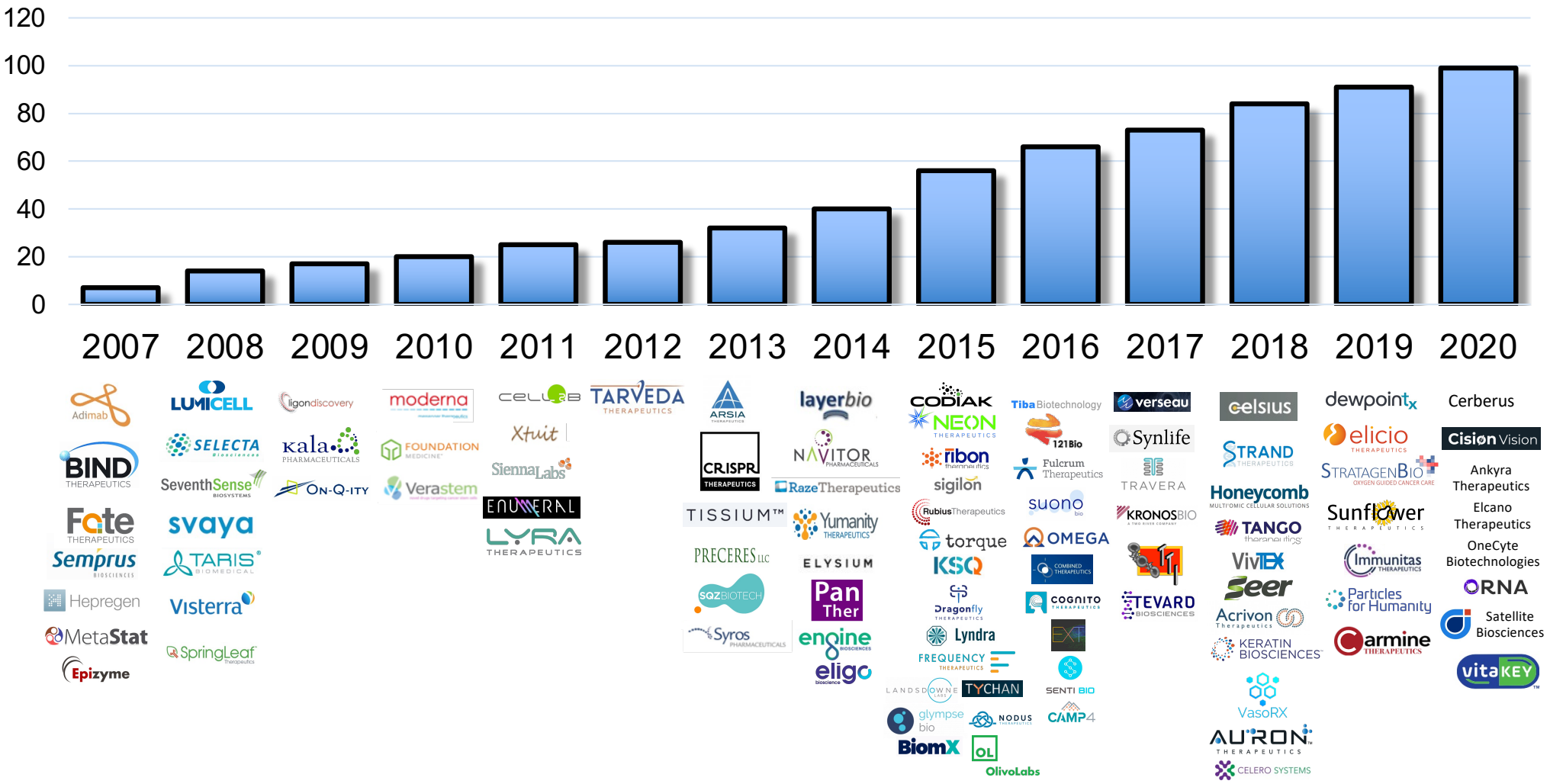


MGH 1811

Can AI Predict Future Breast Cancer?



KI Founded Biotechnology Companies



KOCH INSTITUTE
for Integrative Cancer Research at MIT

science + engineering = conquering cancer together

ki.mit.edu