



ENGINEERING AT THE SERVICE OF HUMANITY

*Perspectives from an Engineering Dean with an Allied
Medical School*

Dean Rashid Bashir & Team

*Cancer Engineering: The Convergence of Engineering
and Health to Advance Cancer Research and Care*



**The Grainger College
of Engineering**

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

NATIONAL
ACADEMIES

Sciences
Engineering
Medicine

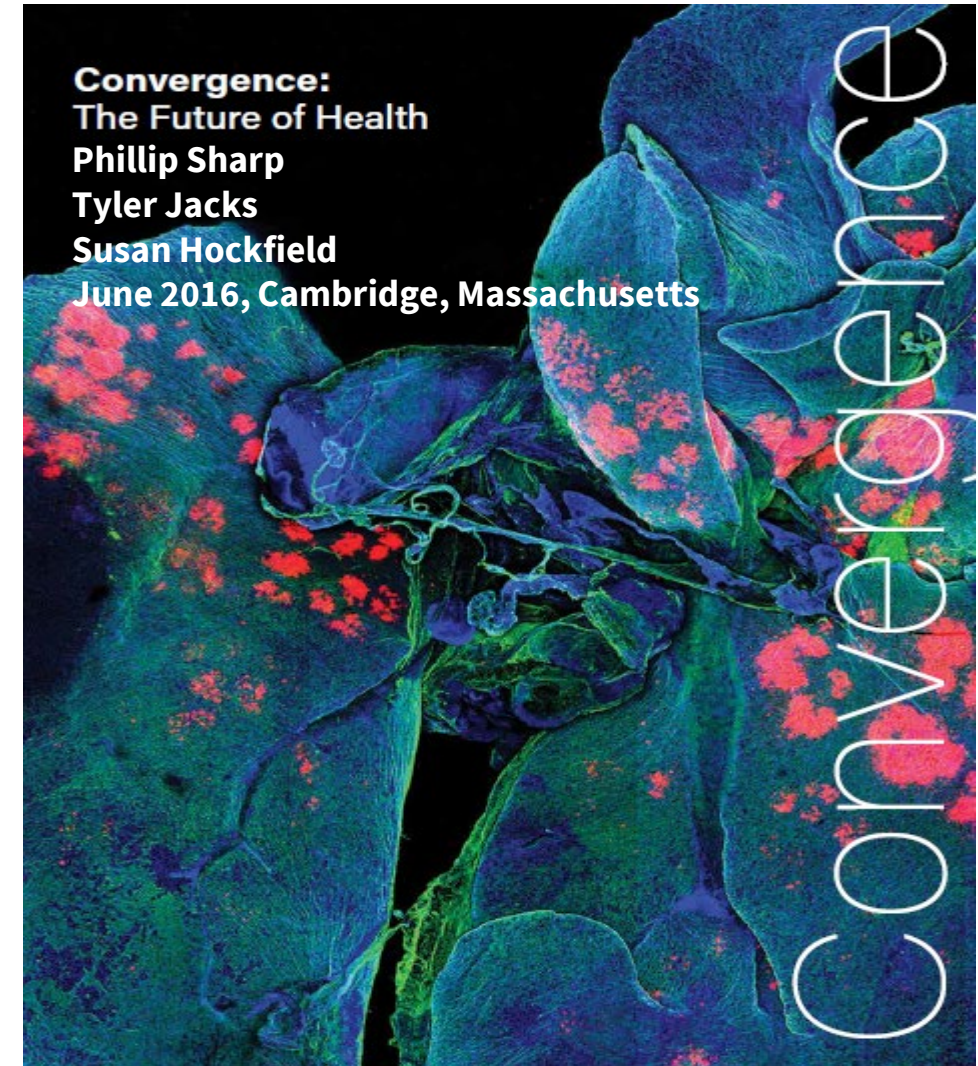
Engineering as a new frontier for translational medicine

Sci. Transl. Med, April 1, 2015

S Chien, R Bashir, RM Nerem, R Pettigrew

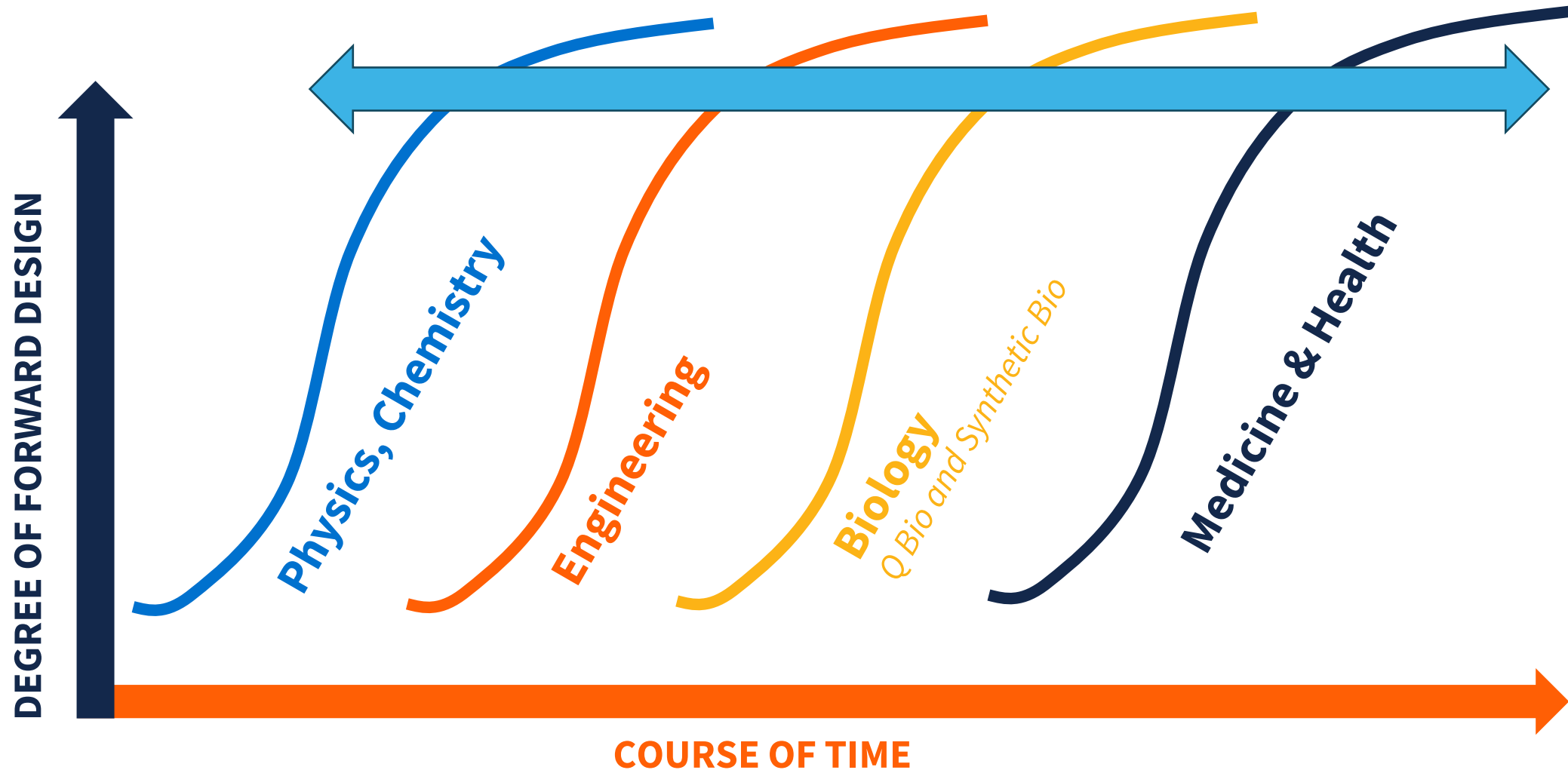
The inclusion of engineering ideas and approaches makes medicine a quantitative discipline that facilitates precision diagnostics and therapeutics improving healthcare delivery for all.....Achieving this vision of **higher-quality healthcare globally while containing or reducing its rising costs** presents conflicting demands and is a challenge for engineering and medicine

We posit that the integration of engineering into medicine, and medicine into engineering—until boundaries vanish—will play a critical role in achieving these broad and specific goals



Phil Sharp and Susan Hockfield, Science, 2017

Forward Design in Biology & Medicine



AT GRAINGER ENGINEERING WE SOLVE PROBLEMS

*to improve
the human
condition.*

*Leadership and partnerships
to develop multidisciplinary
solutions to improve the
human condition*



*to sustain a
healthier planet.*



*to save
people's lives.*



*to help
society thrive.*

Engineering, Health, and Medicine Ecosystem

BIOENGINEERING DEPARTMENT – *Forward Design, Systems & Synthetic Biology*

AERO – *Space Medicine*

AGRICULTURAL AND BIOLOGICAL ENG – *Synthetic Biology*

CHEBE – *Tissue Engineering and Synthetic Biology*

CEE – *Environmental and Synthetic Biology*

ECE – *Imaging and Sensors, Neurotechnology*

ISE – *Applied Health Systems, Human Factors, Ergonomics,*

MATSE – *Biomaterials for Health and Medicine*

MECHSE – *Bio and Cell Mechanics*

NPRE – *Nuclear Medicine and Imaging*

PHYSICS – *Biophysics, Bio-Molecular Dynamics*

SIEBEL SCHOOL COMP. & DATA SCIENCE – *Computational Biology, AI for Biology, Medicine, and Health*

~50/480 TT Fac

DHHS Expenditures

NIH, ARPA-H, CDC, FDA

DHHS Expenditures
increasing and are ~9% of
Grainger's total research
expenditure portfolio (Fed
and non-Fed sources)

BioE and Physics have the
largest DHHS portfolios.

10 other units represented
(7 depts, 2 IRUs, and ARI)

ACCESS TO THE DOMAIN ?

Vision and Resources
Strategic Partnerships
New Structures

Partnerships

Carle Illinois Partnership

Combining Clinical Care, Research, and Academics to advance cancer, neuroscience, imaging, to improving health outcomes.



Jump ARCHES

Utilizing perspectives from engineers, clinicians, and social scientists to improve the future of health care for all.



Mayo Clinic & Illinois Alliance

Working across research, education, and translation for better personalized medicine, more data- and technology-driven healthcare solutions, and novel training programs for healthcare innovators



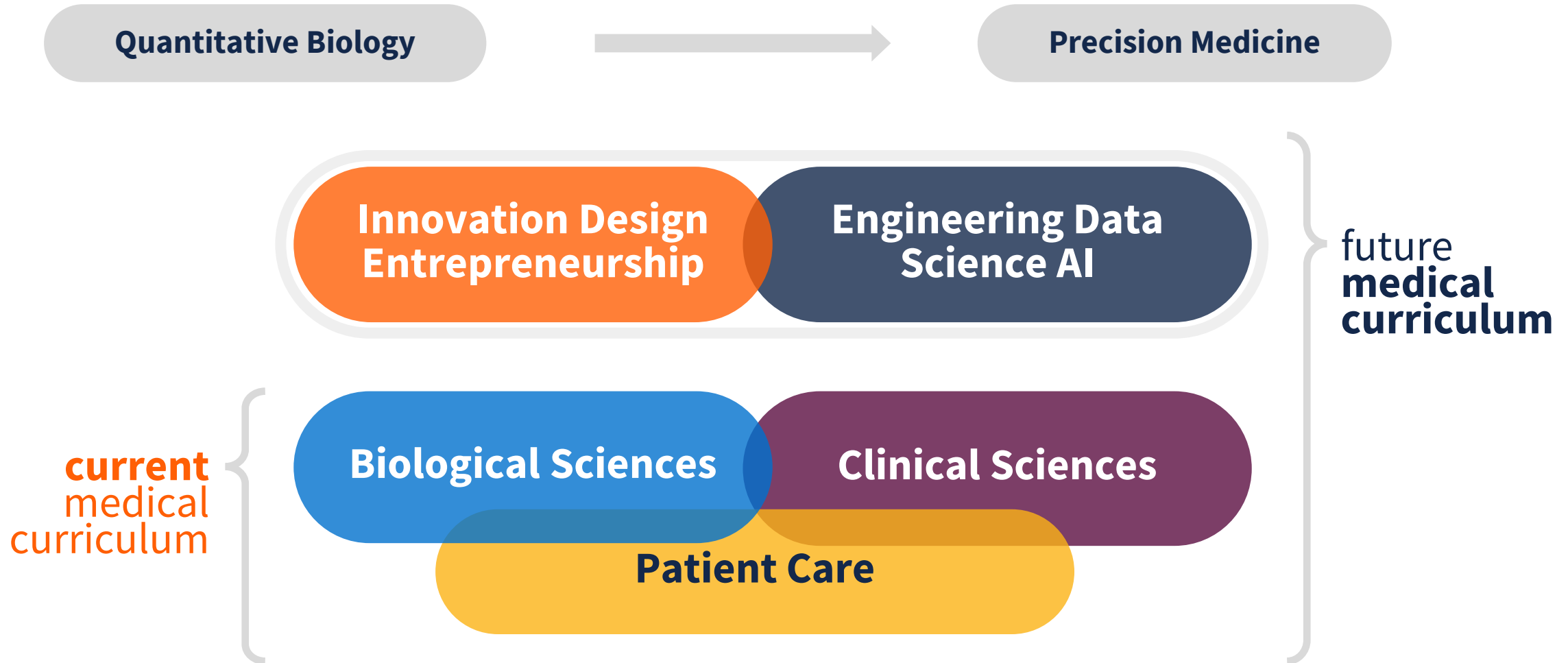
Chan Zuckerberg Biohub Chicago

Engineering technologies to make precise, molecular-level measurements of biological processes within human tissues to ultimately understand and treat the inflammatory states that underlie many diseases.



UChicago, Northwestern, UIUC

Medical Education **Must Change**

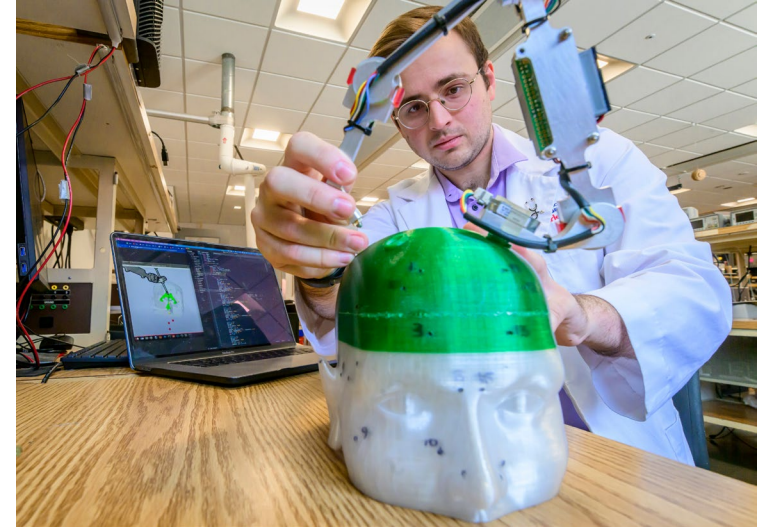


Carle Illinois COLLEGE OF MEDICINE

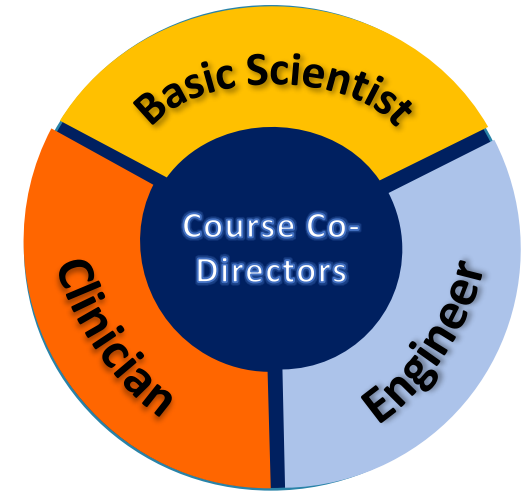


- **Physician Innovators** leading multidisciplinary teams to solve problems and **re-engineer** medicine
- Admitted first class Summer 2018
- 4 classes graduated and placed at **Top National Residency Programs**
- The **world's first accredited** engineering-based college of medicine

Current Dean Mark Cohen



Curriculum designed from the bottoms up at the intersection of **medicine and engineering** – **Forward Design of Human Health**



Engineering Clerkship Rounds

Immersive Clerkship:

Rounds in the hospital



Medical Student + Clinician + Engineering Professor



Identify a problem, Propose an engineering solution

Capstone Innovations

Identify a problem



Propose a solution



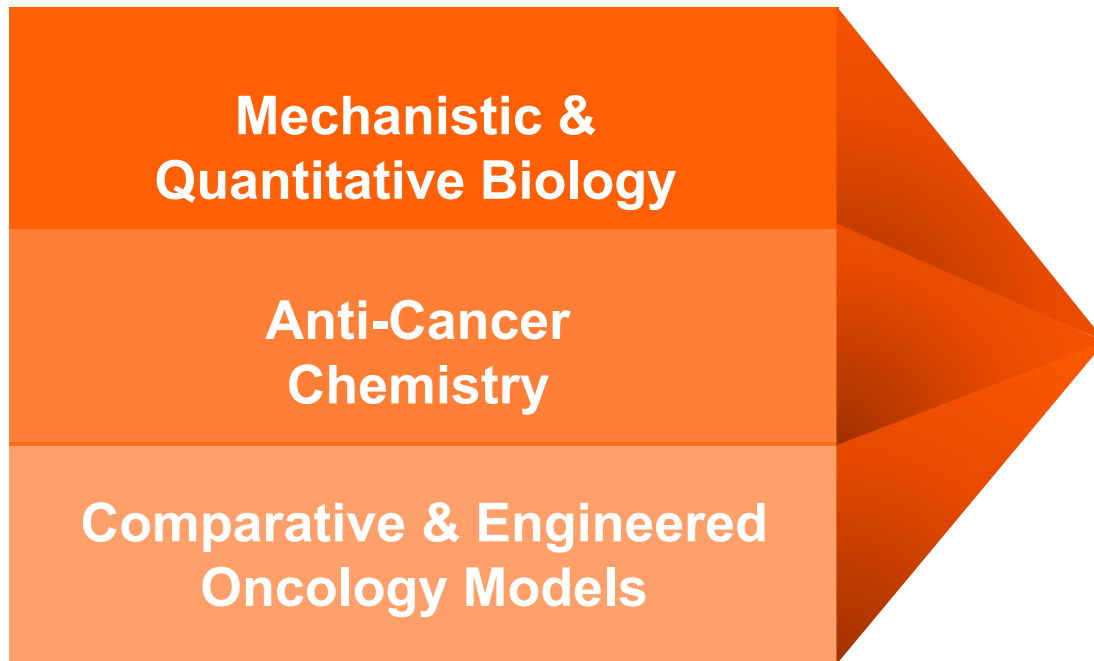
Lead team and develop new prototype or process that will and improve patient outcomes

Data Science

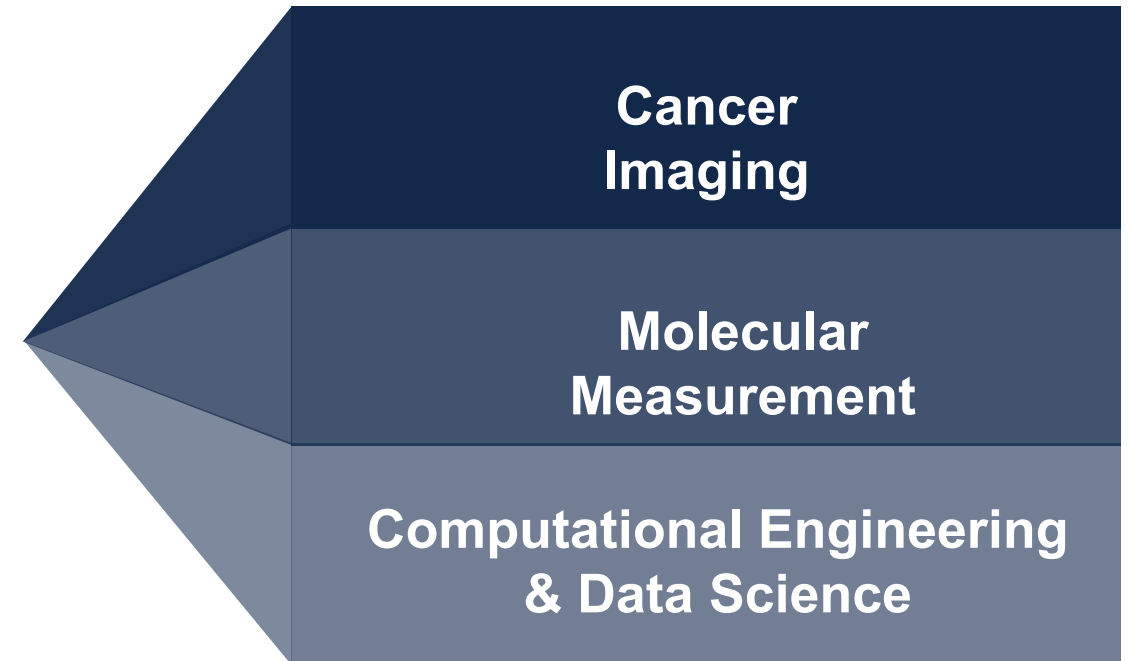
Data to improve clinical care

Mission: Advance fundamental engineering and basic science discoveries to transform cancer research, detection, and treatment.

Cancer Engineering & Biological Systems (CEB)



Cancer Technology & Data Science (CTD)



Cancer center built on the convergence of engineering and oncology to create effective, personalized cancer solutions accessible for all.



The Grainger College of Engineering

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

The background is a collage of various images. On the left, a person in a blue lab coat is working on a white robotic arm with orange and black components. In the center, there's a close-up of a person's arm with a white sensor or electrode array attached. On the right, there's a blue-tinted X-ray of a human skull. At the bottom, there's a colorful, abstract image of what appears to be a medical scan or a complex mechanical structure.

Thank you

EXTRA SLIDES

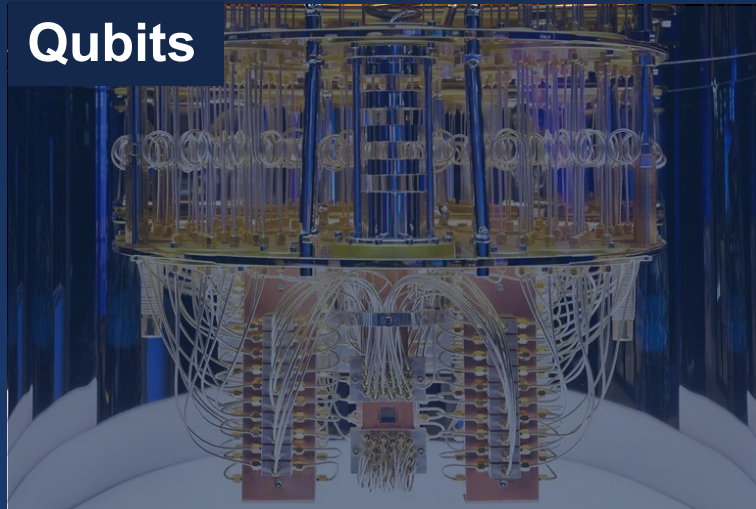
THE FUTURE OF COMPUTING

Bits



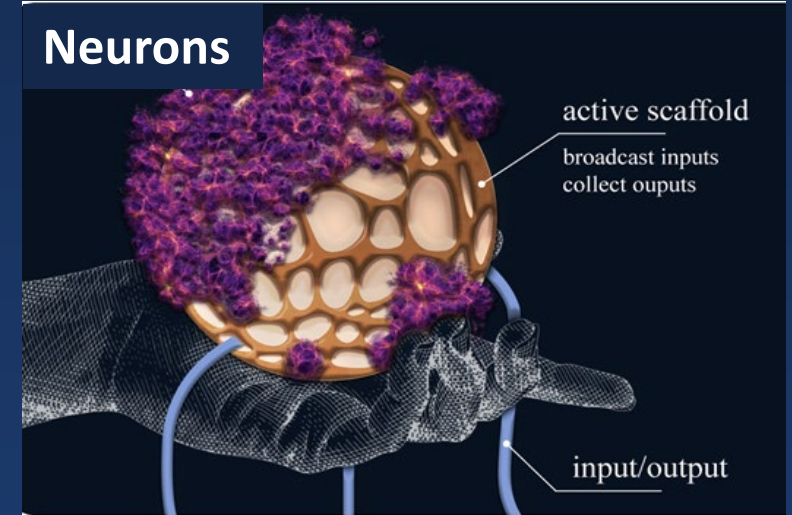
AI

Qubits



Quantum

Neurons



Biology

The First B.S. in Neural Engineering

Welcomed our second cohort Fall 2024

This major provides training at the interface of BioE and neuroscience that includes:

- *Mechanistic understandings of neurobiology and systems neuroscience*
- *Neuroimaging systems*
- *Neuro-data analysis*
- *Neurostimulation devices*
- *Design of electrical & bio-interfacial devices*
- *A specialized capstone course*



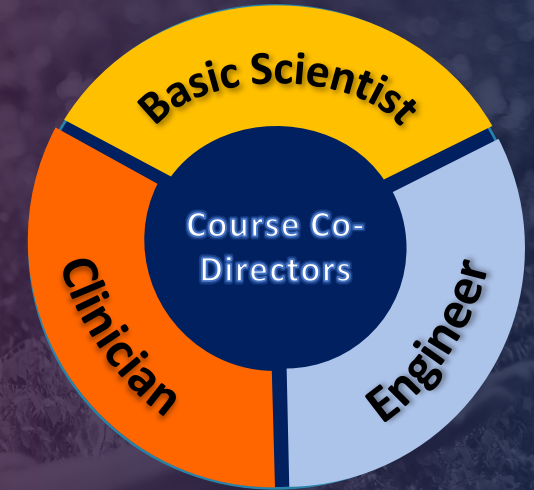
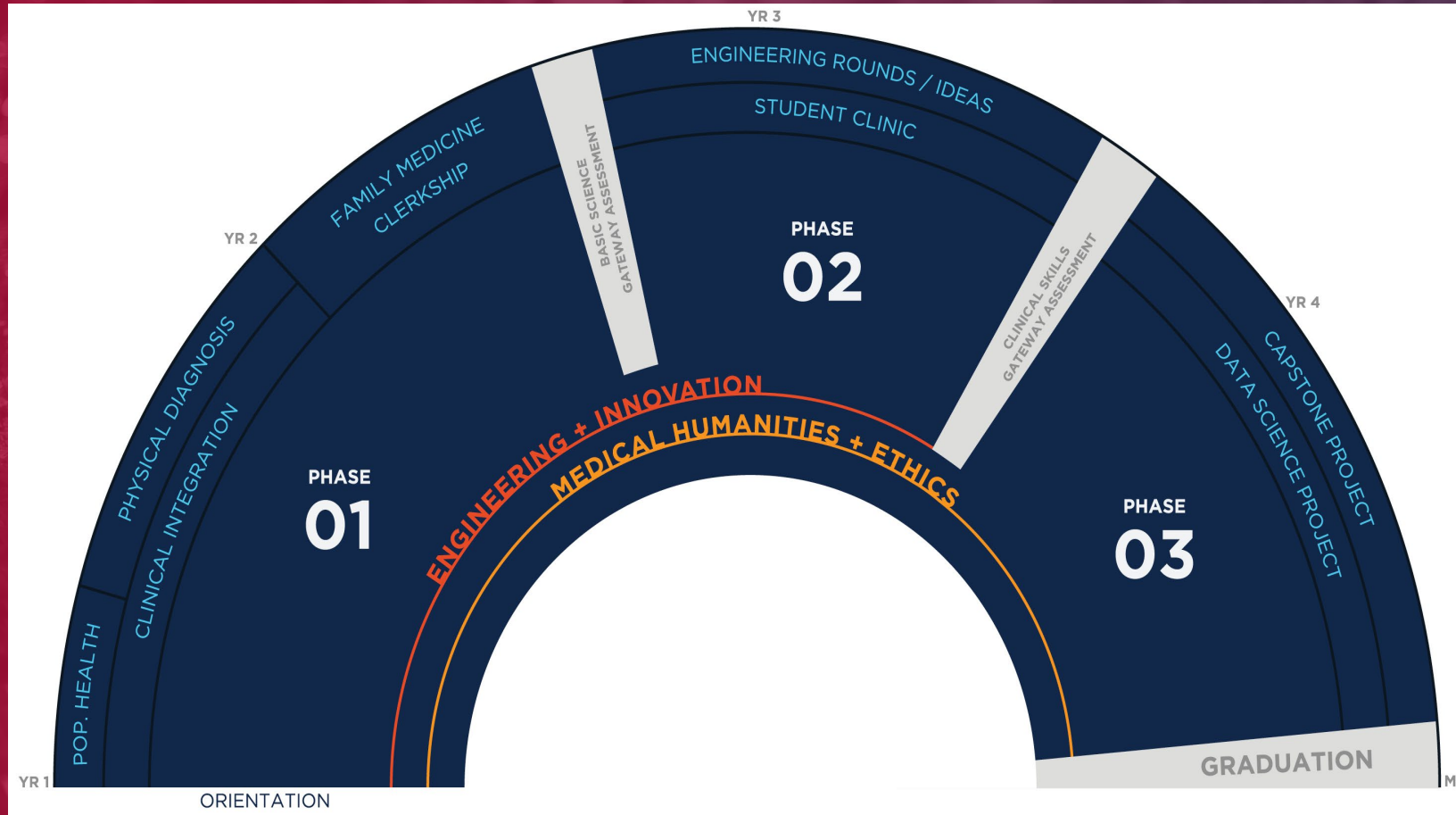
A new hybrid CS+BIOE major (Launched Fall 2024)



- We have partnered with our world class CS department to develop a new CS+BioE major.
- Provides cutting edge training at the interface of bioengineering and computer science.
- Students receive a solid foundation in scientific computing practices as well as training in the application of computation to solve problems in medicine and the life sciences.
- So far, we have received over 500 applications per year for 25 slots



Carle Illinois College of Medicine is the first college of medicine designed from the bottoms up at the intersection of **medicine and engineering** – **Forward Design of Human Health**



- Started Summer 2018,
- Now 4 classes graduated
- Achieved LCME accreditation

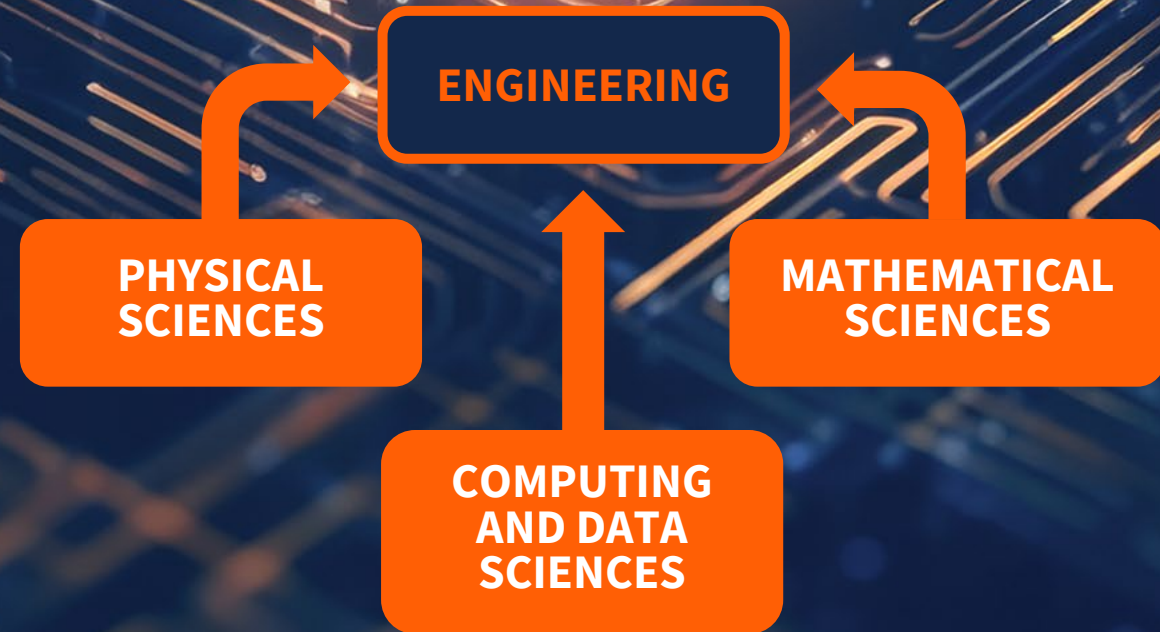
CURRICULAR INNOVATION **ENGINEERING INTEGRATION**

The Grainger College of Engineering and the Carle Illinois College of Medicine are driving a revolutionary approach to health care.

The merging of Grainger engineers with medical students has created problem-solvers and innovators trained to analyze gaps in health care, leverage data-driven research, and lead the development of solutions to improve patient care and outcomes.

Launched the

Siebel School of Computing and Data Science



Siebel School of Computing and Data Science

computing and data science ecosystem

1

Computer Science

Integration of computing across the UIUC campus

2

Data Science

Integration of data science (w. LAS and iSchool) across the UIUC campus

CS, Math, Stat & iSchool

CS+X

- Computer Science + Advertising
- Computer Science + Animal Sciences
- Computer Science + Anthropology
- Computer Science + Astronomy
- Computer Science + Chemistry
- Computer Science + Crop Sciences
- Computer Science + Economics
- Computer Science + Education
- Computer Science + Geography & Geographic IS
- Computer Science + Linguistics
- Computer Science + Mathematics
- Computer Science + Music
- Computer Science + Philosophy
- Computer Science + Statistics

X+DS

- Accountancy + Data Science
- Astronomy + Data Science
- Business + Data Science
- Finance + Data Science
- Information Sciences + Data Science

3

Integration of computing and data science across The Grainger College of Engineering



Aerospace Engineering



Agricultural & Biological Engineering



Bioengineering
CS+Bioengineering



Chemical & Biomolecular Engineering



Civil & Environmental Engineering



Electrical & Computer Engineering



Industrial & Enterprise Systems Engineering



Materials Science & Engineering



Mechanical Science & Engineering



Nuclear, Plasma & Radiological Engineering



Physics
CS+Physics

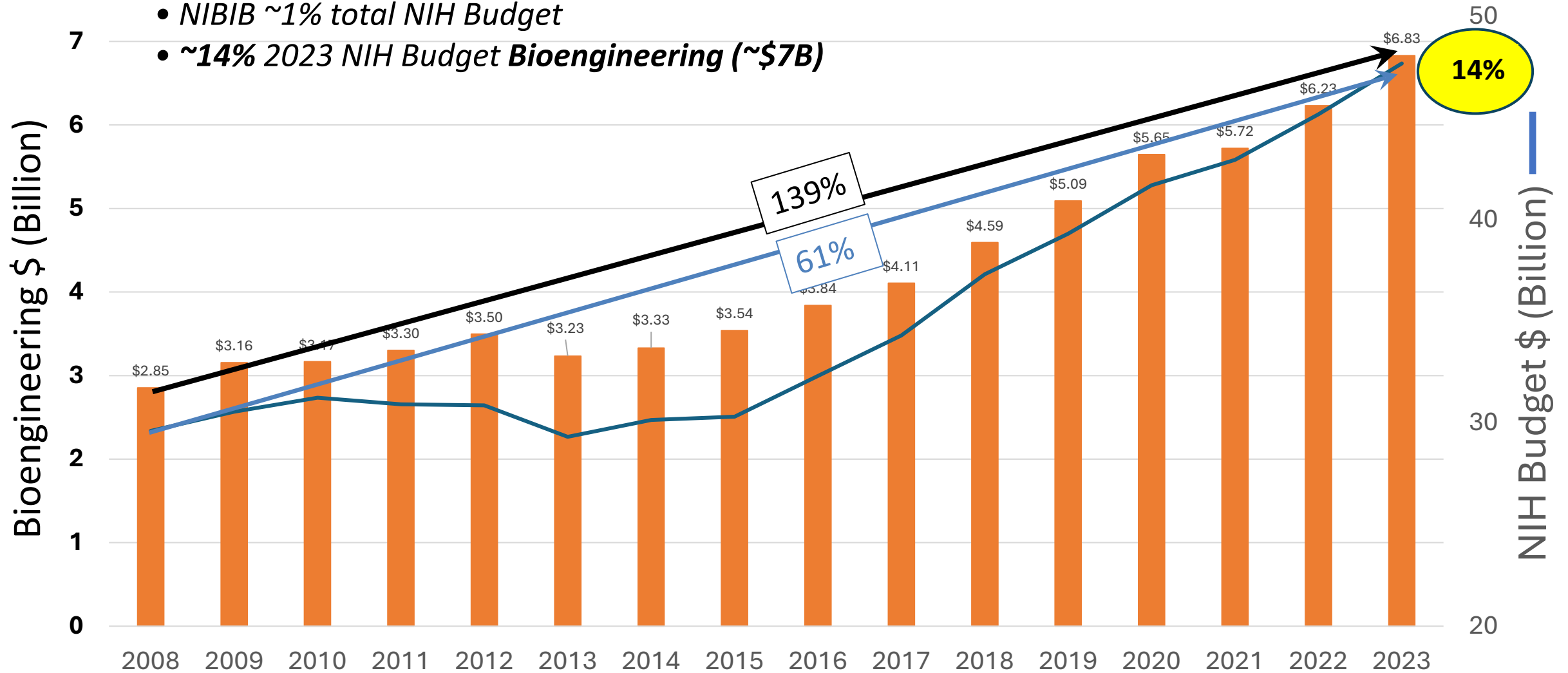
4

UNDER DEVELOPMENT

- NPRES+DS
- MatSE+DS
- ChemE+DS
- PHYS+DS

NIBIB: Bioengineering Impact at NIH

- NIBIB ~1% total NIH Budget
- ~14% 2023 NIH Budget **Bioengineering** (~\$7B)



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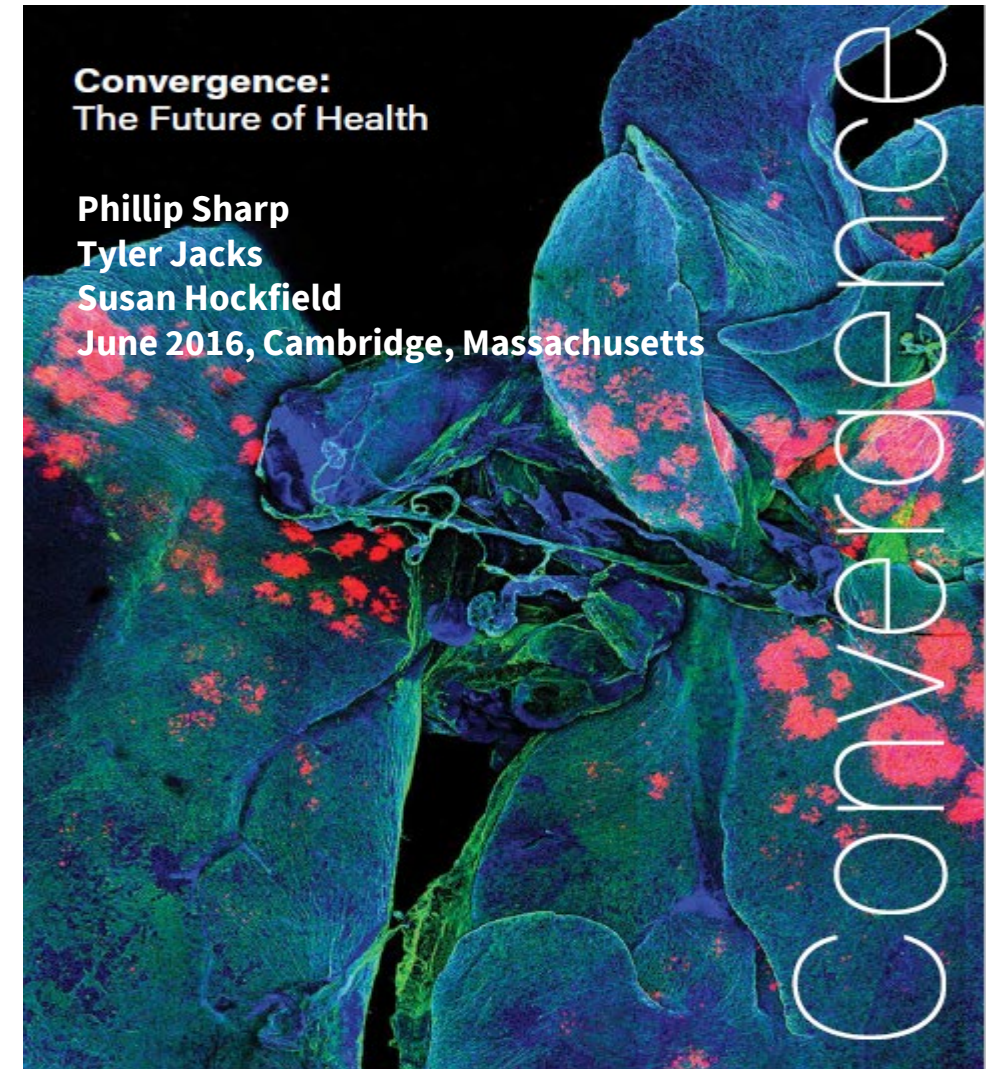
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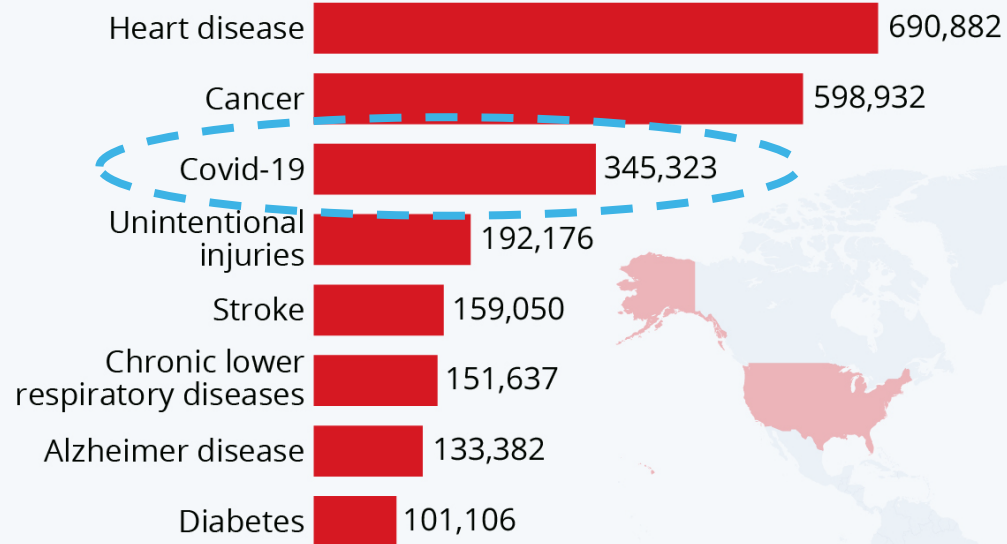
Shu Chien UC, San Diego Robert Nerem Georgia Tech Roderic Pettigrew NIH Rashid Bashir Illinois



Phil Sharp and Susan Hockfield, Science, 2017

Covid-19 Was America's Third Leading Cause Of Death In 2020

Number of deaths for all leading causes of death in the U.S. in 2020



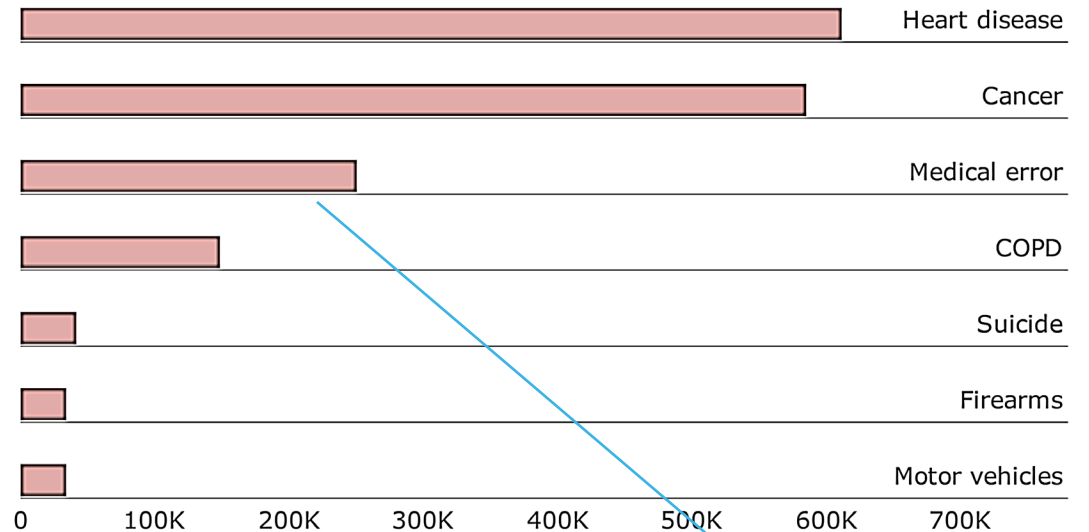
Source: Centers for Disease Control and Prevention



statista

Mistakes cost lives

Medical errors now the third leading cause of death in U.S.



Source: BMJ Publishing Group

Need for healthcare systems engineering, process optimization, modernization

Sepsis in Critical Care and Hospitals



- Leading cause of death in critical care in US and the World
- Estimated **\$26 billion annual** cost to the U.S. healthcare system – most expensive condition and leading cause of readmission

<https://www.cdc.gov/sepsis/datareports/index.html>



1 in 3

One in three patients who die in a hospital have sepsis.

Cases per
100,000 population
(US/*Europe)



Sepsis



Stroke*



Cancer

Lung

Breast

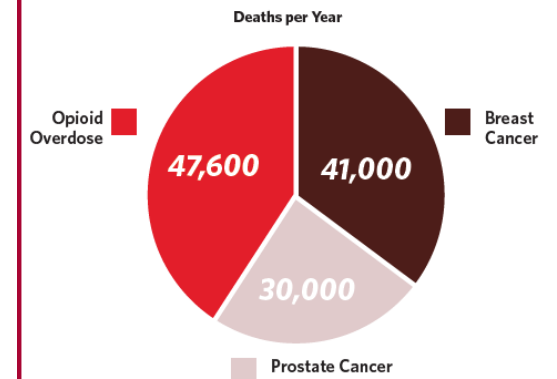
Prostate



Heart

The Leading Cause of Death in the U.S.

Each year in the United States, sepsis causes more deaths than opioids, breast cancer, and prostate cancer combined. Learn the signs and symptoms – it could save a life.



SEPSIS: 270,000 Deaths per Year

(Source: Sepsis Alliance. Numbers are approximate, as of Sept. 2019.)

CLINICAL PARTNERSHIPS

Jump ARCHES

Collaborative interdisciplinary research program between

- The Grainger College of Engineering
- OSF Healthcare, Peoria, IL.
- University of Illinois College of Medicine Peoria

Utilizing perspectives from engineers, clinicians, and social scientists to improve the future of health care for all.

154

**Projects
Received
Funding**

since 2014

110M

**Endowment:
income from
which is used
for seed grants**



CLINICAL PARTNERSHIPS

Mayo Clinic & Illinois Alliance for Technology- Based Healthcare



The Mayo Clinic & Illinois Alliance works across research, education, and translation to:

- Discover and develop ways to make individualized medicine more impactful
- Drive data- and technology-embedded solutions to healthcare challenges
- Create an educational hub of novel training programs for healthcare innovators

Chan Zuckerberg Biohub Chicago

LEADERSHIP



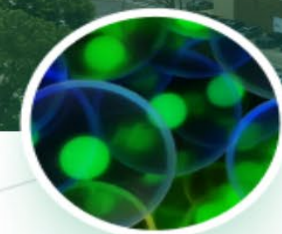
SHANA O. KELLEY, PH.D.
President

CZ Biohub Chicago is engineering technologies to make precise, molecular-level measurements of biological processes within human tissues, with an ultimate goal of understanding and treating the inflammatory states that underlie many diseases.

Northwestern
University

THE UNIVERSITY OF
CHICAGO

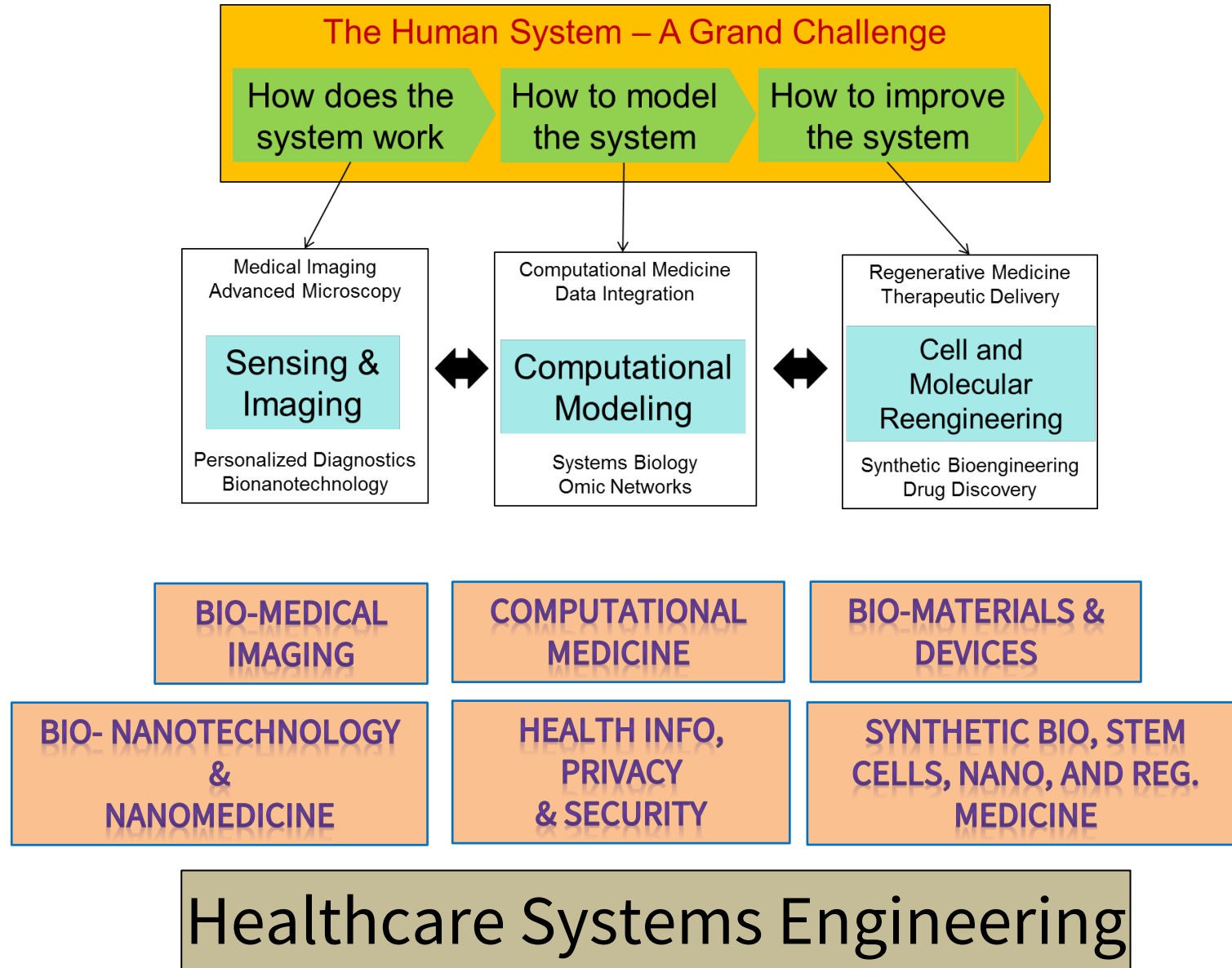
UNIVERSITY OF
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CARLE ILLINOIS COLLEGE OF MEDICINE

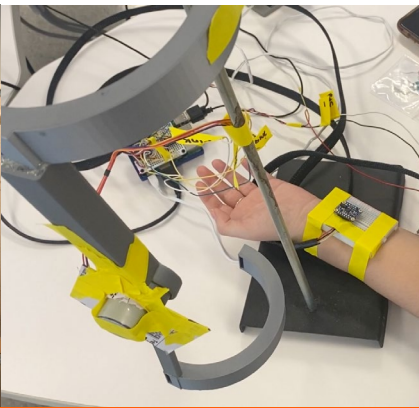
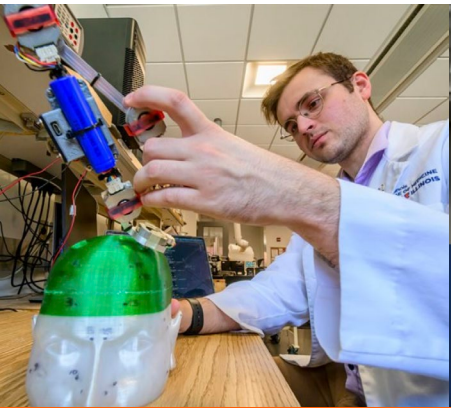
- The **world's first accredited** engineering-based college of medicine
- **Physician Innovators** leading multidisciplinary teams to solve problems and **re-engineer** medicine
- Award winning **medical innovations** to advance medicine with real impact
- **4 Classes graduated** and >95% placement at **Top National Residency Programs**





STUDENT INNOVATIONS

Carle Illinois
**COLLEGE of
MEDICINE**



**Robotic
Neurosurgical**
Navigation device

**Seizure-
Monitoring**
Baseball cap

**Safety
Harness**
To protect first
responders

**Bionic Knee
Brace**
To empower
cerebral palsy
patients

**Brain Cancer
Treatment**
Post-surgical
treatment for
patients with
brain tumors

**Health
in 3D**
New app helps
parents
visualize their
child's heart
disorder