



Memorial Sloan Kettering  
Cancer Center

# Cancer Engineering Program

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**Center for Molecular Imaging &  
Bioengineering**



Gerstner Sloan Kettering  
Graduate School of Biomedical Sciences  
PhD Program in Cancer Engineering

NASEM Cancer Engineering - 05/21/2025

# Metabolic flux is perturbed in Cancer and new tools are needed to help us understand and leverage this change in biology

Cell

Leading Edge

Review

## Metabolic analysis as a driver for discovery, diagnosis, and therapy

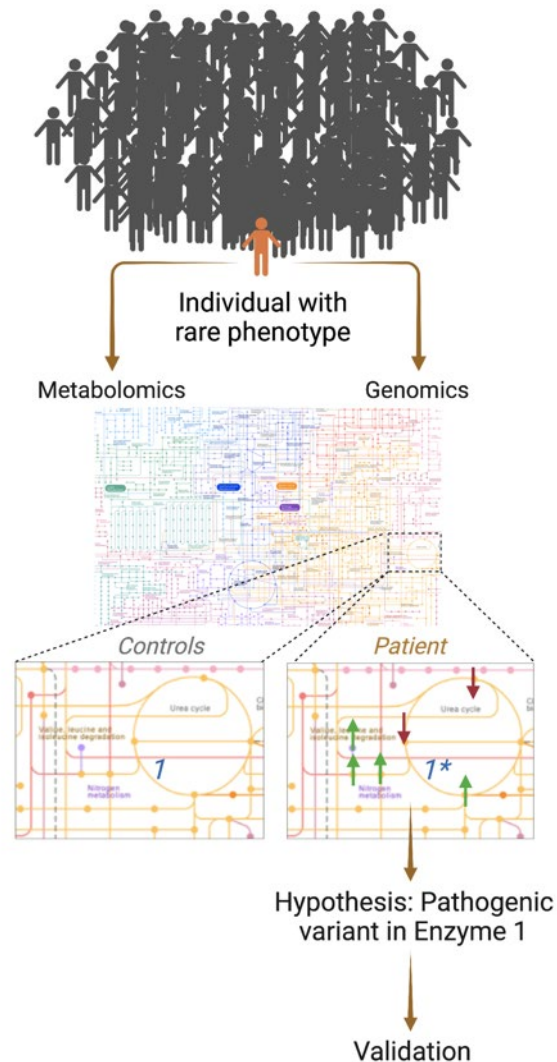
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<sup>2</sup>Department of Radiology and Molecular Pharmacology Program, Memorial Sloan Kettering Cancer Center, New York, NY 10065, USA

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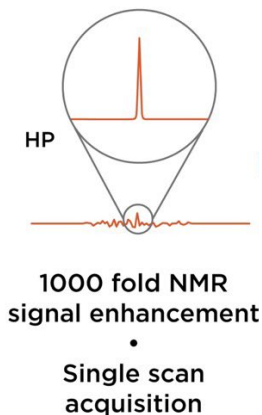
<https://doi.org/10.1016/j.cell.2022.06.029>



# How can we measure “metabolic health” of a target tissue?

Molecular Imaging provides a means of assessing not just the target organ but holistically multiple organs simultaneously

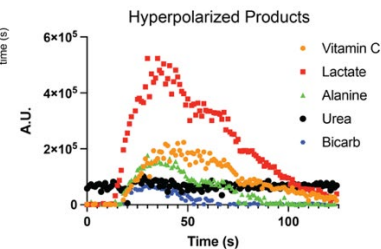
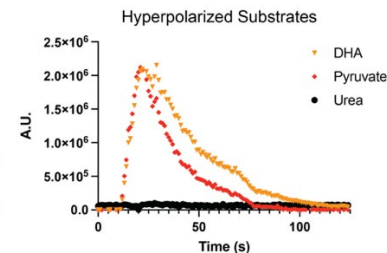
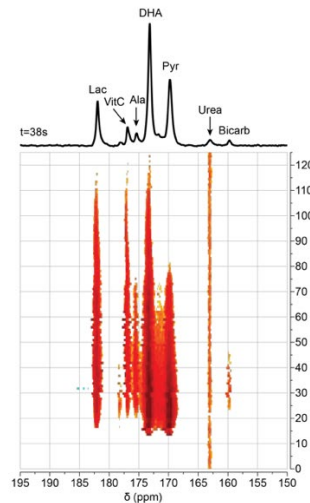
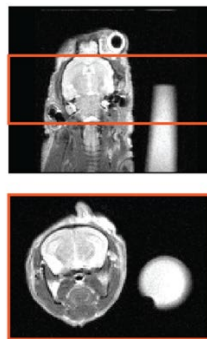
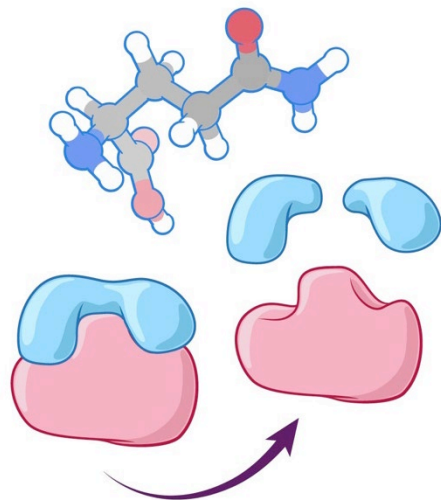
To do this we needed a new approach to allow us to visualize the conversion of a substrate to its products – Hyperpolarized MRI



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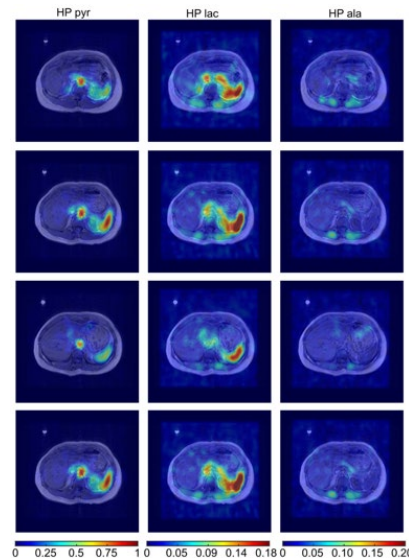
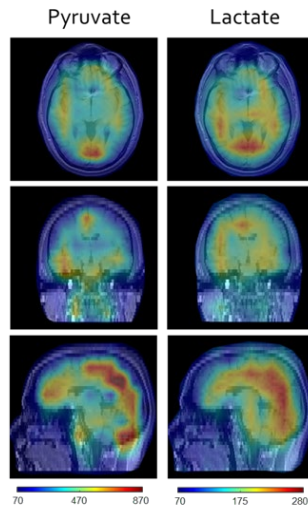
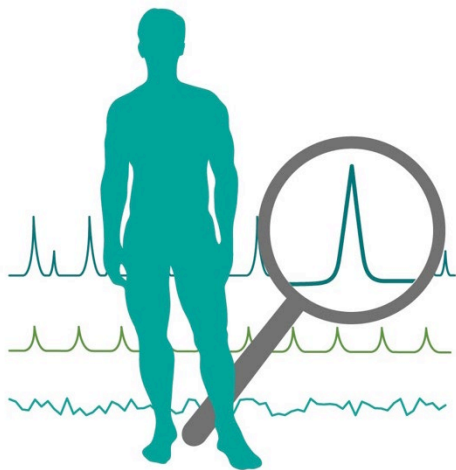
With HP MRI in hand, we needed new materials (probes) to illuminate *in vivo* biochemistry:



# How can we measure “metabolic health” of a target tissue?

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But even with probes, we needed to develop the physics and engineering to encode it *in vivo*



Granlund et al. *Cell Metabolism* 2020  
Miloushev et al. *Cancer Res* 2018  
Deh et al. *MRM* 2024  
Zhang et al. *JMRI* 2024

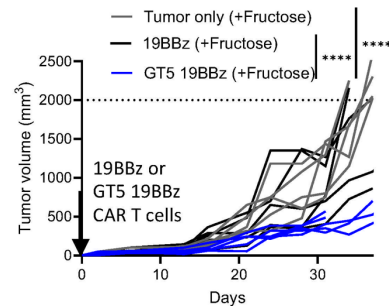
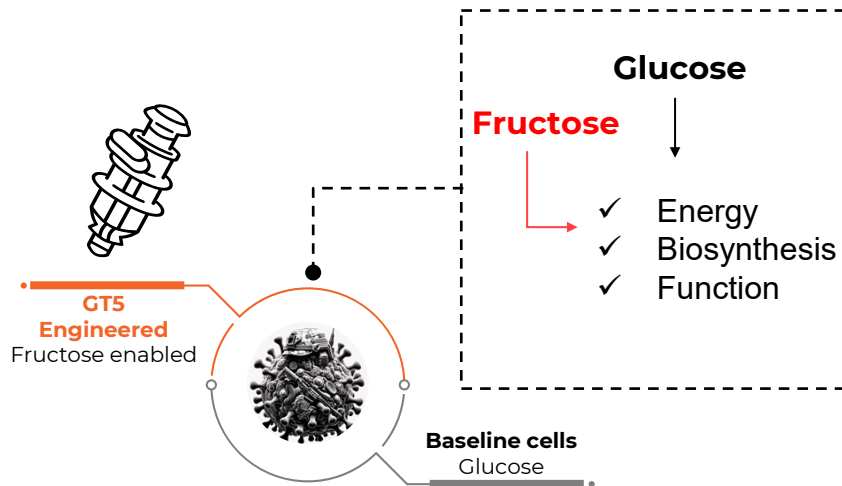
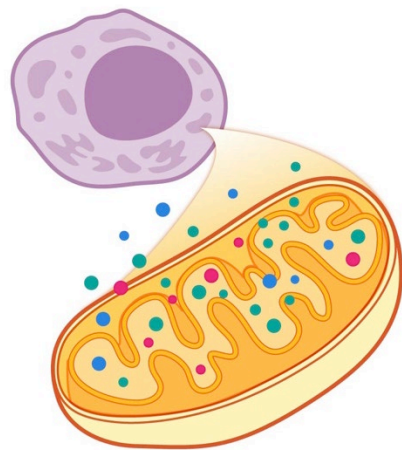


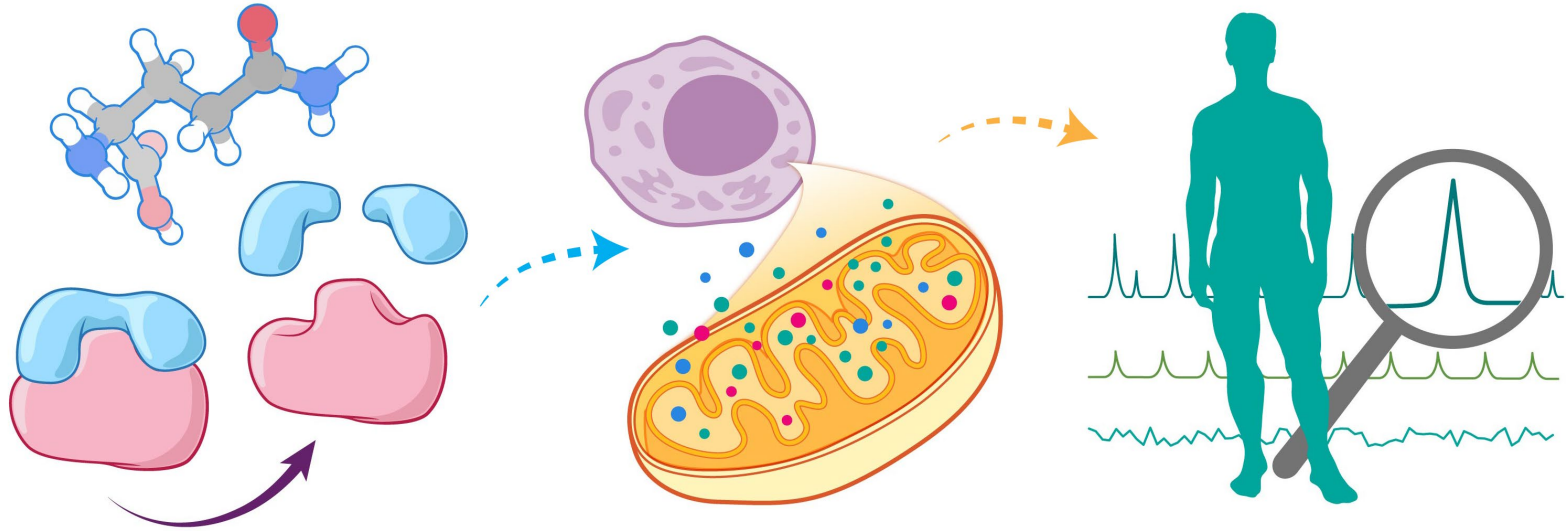
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# How can we measure “metabolic health” of a target tissue?

Molecular Imaging provides a means of assessing not just the target organ but holistically multiple organs simultaneously

Once we had it, we could learn about *in vivo* cancer metabolism and develop ways to leverage it for metabolic engineering

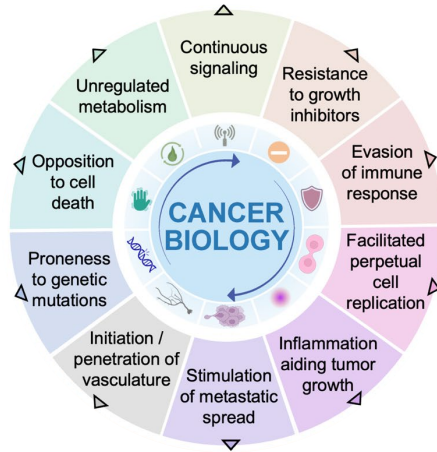




To address the next generation of impactful questions, we learned that what was truly needed was a new kind of engineer...

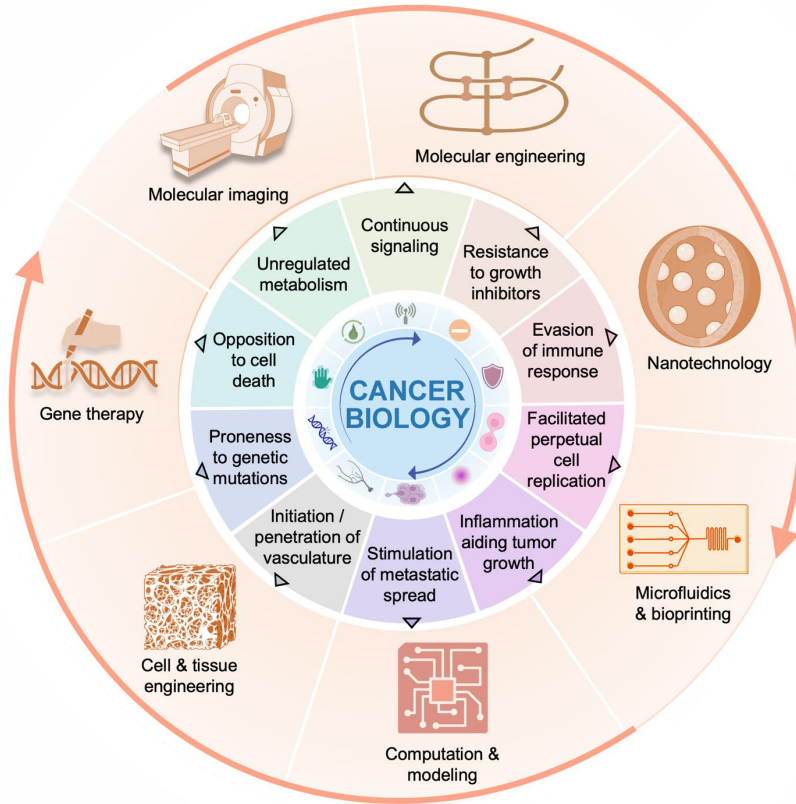


# How do we view Cancer Engineering?

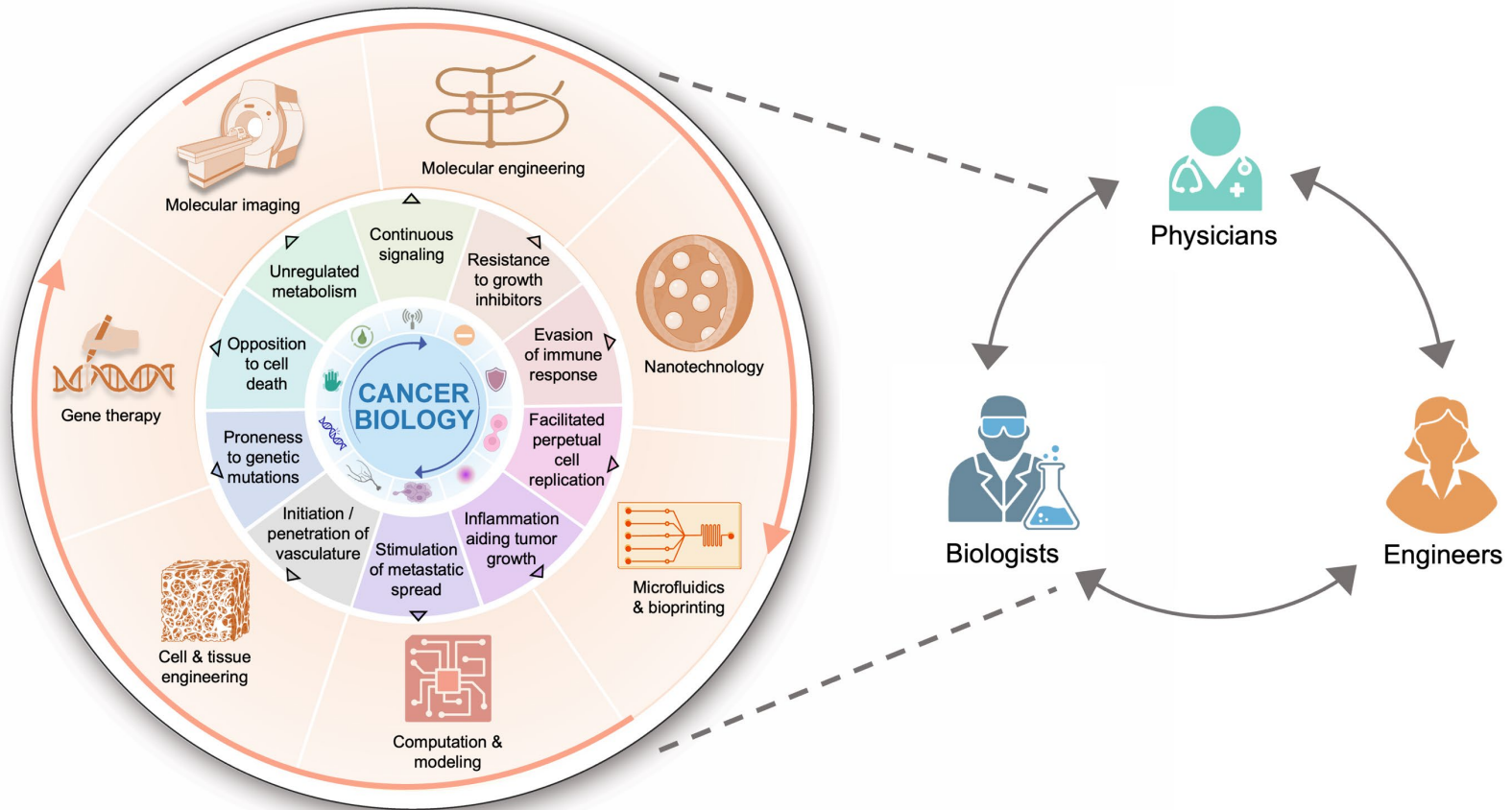




# How do we view Cancer Engineering?



# How do we view Cancer Engineering?



# Center for Molecular Imaging and Bioengineering (CMIB)

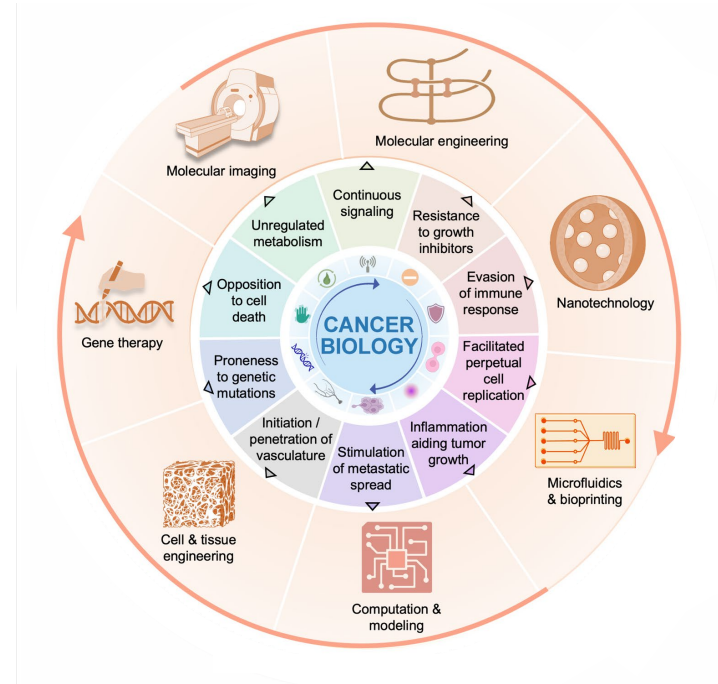
## Building a community around Cancer Engineering at MSK

### Top Down and Bottom Up simultaneously

- Faculty recruitment in Key Areas
- Pilot Grants
- SKI Cancer Engineering Seminar Series to bring international faculty speakers to MSK
- Cancer Engineering Research in Prog (CERIP)

### Develop a pipeline

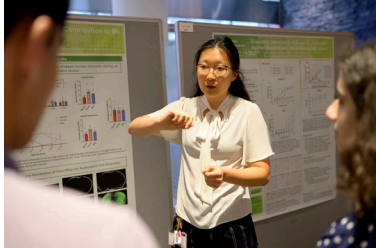
- Educational programs (EISP Summer program)
- NIH T32CA254875 - Molecular Imaging in Cancer Biology and the first PhD Program...



# Building community requires mobilizing trainees at all levels

## Engineering and Imaging Summer Program (EISP)

Highly competitive, 10-week summer intern program to bring students across the US to MSK



## Cancer Engineering Research in Progress (CERIP)

Showcasing the work of grad students and postdocs (2x/month)



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# Why Build the First Cancer Engineering PhD Program?

Cancer research is becoming increasingly technology-focused – creating demand for innovators and engineering-minded trainees.



New innovations by GSK CE students have the potential to accelerate cancer research in our labs and enter clinical trials in our hospital.

# Innovative Structure and Curriculum



**Small  
Class Sizes**

**134**  
(55)

**Number of  
Thesis Mentors**



**80+ Faculty  
Teach in  
Courses**



**All courses  
completed in  
1<sup>st</sup> year**



**Rotations  
separate from  
classes**



# First Year Schedule

## FALL SEMESTER

		Python Basics 10 Sessions		Advanced Stats 9 Sessions	
Rotation 1 Lab 5 weeks		Experimental Biology and LCA 4 weeks	Cancer Engineering + Entrepreneurship 10 weeks		Winter Break
JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER

## SPRING SEMESTER

Rotation 2 Lab 5 weeks	Immunology 4 weeks	Spring Break	Cancer Biology 8 weeks	Rotation 3 Lab (optional) 5 to 8 weeks	
JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE



# Cancer Engineering Research Areas

It is important to match research areas with our current footprint and the goals of the expansion of the program



Molecular  
Imaging &  
Theranostics



Integrative  
Computational  
Biology



Nanotechnology &  
Biomaterials



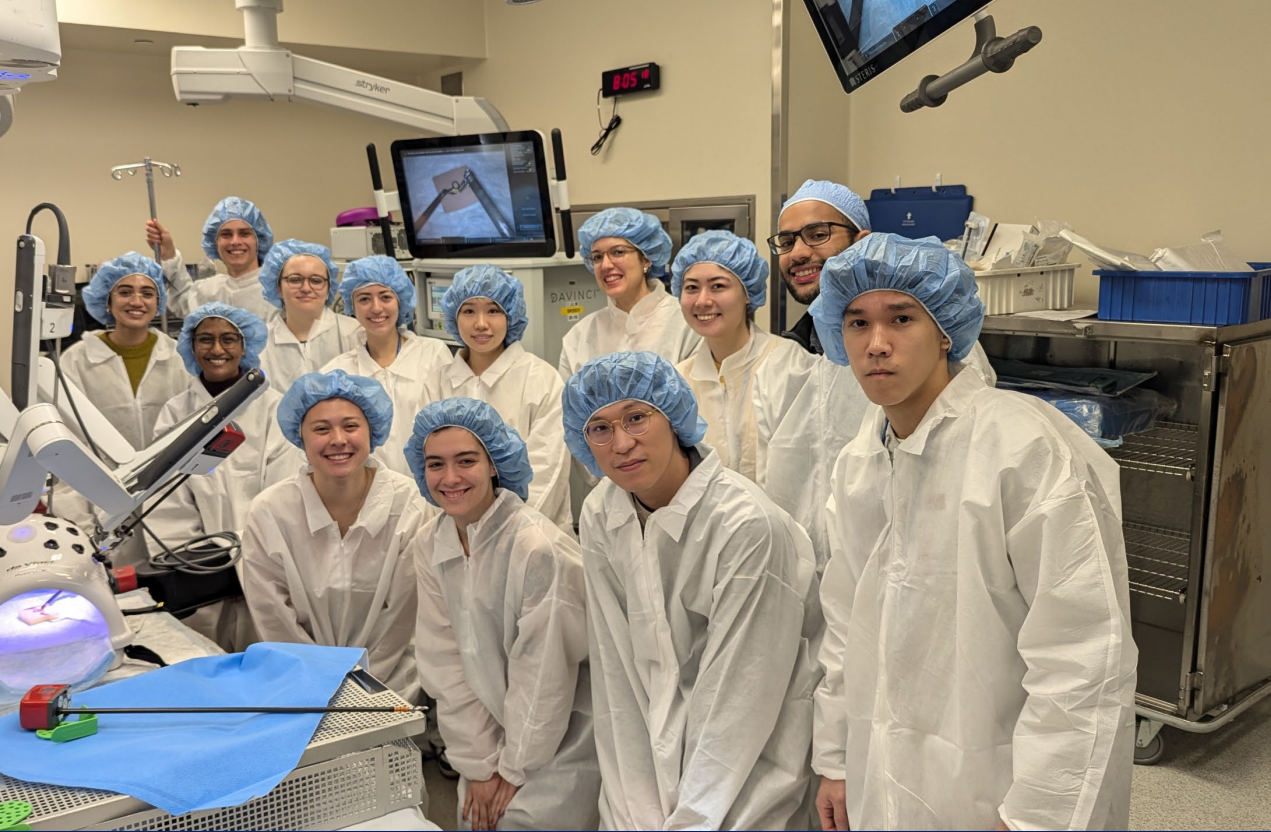
Genetic &  
Tissue  
Engineering



Immuno-  
Engineering







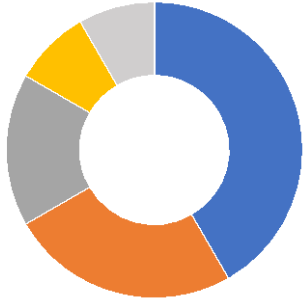
**Bringing the Clinic to the Curriculum**





# Hands-on Learning

# How has our first class of CE students done?



- Cell and Genetic Engineering
- Immuno-Engineering
- Nanotechnology
- Imaging
- Diagnostics



Graduate Research Fellowship Program



Ana Rosu, BS JHU  
Cancer Engineering



Gianfranco Yee, BS MIT  
Cancer Engineering



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# By building the CE program, MSK has become competitive in recruiting and building in this space



**Xinbo Yang, PhD**  
Protein Engineering  
Molecular Pharm Program



**Junhong Choi, PhD**  
Syn Bio and Gene Editing  
Developmental Bio Program



**Joo-Hyeon Lee, PhD**  
Tissue Engineering  
Developmental Bio Program



**Maria Akhmanova, PhD**  
Computational Modeling  
Cell Bio Program

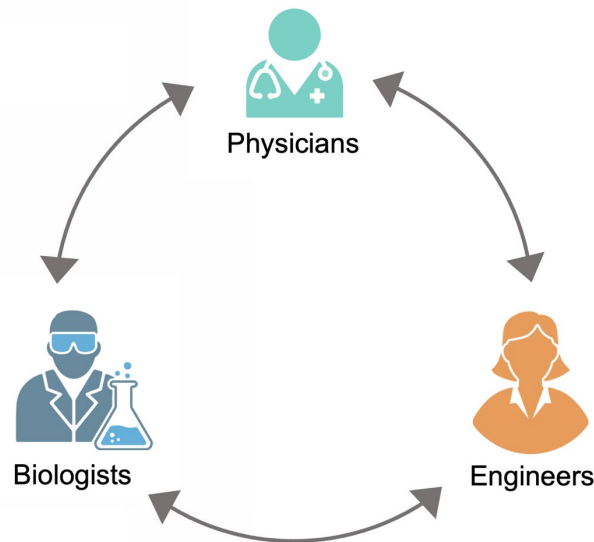
# Where do we want the CE field to go?

Cancer engineers will develop crucial innovations that will transform cancer research, diagnosis, and treatment

Targeted RFAs that help train these students and facilitate their future independent careers

Departments and Centers/Institutes across the US that will facilitate faculty positions at the interface of cancer centers and basic science/engineering departments

Multi-institution partnerships to push this field forward





# Acknowledgements

## Keshari Lab

Vesselin Miloushev  
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Briana Turner  
Celia Martinez De La Torre  
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Grace Figlioli  
Nancy Santiappillai  
Skye Zhao  
Aisha Pintor  
Tanya Schild

## Center for Molecular Imaging & Bioengineering

Ross Boltyanskiy  
John Consiglio  
Colleen Maher  
Kimberly Hubbard



Gerstner Sloan Kettering  
Graduate School of Biomedical Sciences  
PhD Program in Cancer Engineering

Michael Overholtzer  
Tom Magaldi  
Dan Heller  
Julie Nadel  
Julie Masen  
Pat and Ian Cook

*"We are grateful for the opportunity to partner with MSK to establish this farsighted doctoral program that will train the next generation of cancer engineers. MSK graduates will go on to develop technologies that we can't even imagine today and develop new cures and diagnostics that will save lives," says Ian.*



STARR CANCER  
CONSORTIUM



NATIONAL CANCER INSTITUTE



National Institute of Biomedical Imaging  
and Bioengineering



THOMPSON  
FAMILY  
FOUNDATION



The Mark Foundation  
for Cancer Research



Emerson  
Collective

THE  
DANA  
FOUNDATION



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[@KeshariLab](http://ski.edu/keshari)

<https://www.sloankettering.edu/gerstner/cancer-engineering>

<https://www.mskcc.org/research-programs/molecular-imaging-bioengineering>