Learning at the Interfaces at the MIT Koch Institute

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Origin Story: MIT Center for Cancer Research

- Founded at MIT in 1974
- Consisted of Cancer Biologists
- Accelerated fundamental science and understanding of cancer
  - Isolation of the first human cancer genes
  - Discovery of split genes and RNA splicing in eukaryotic organisms
  - Description of extracellular matrix components and their critical role in metastasis
  - Identification of the molecules that led to two of the first FDA-approved molecularly targeted cancer drugs, Herceptin® approved in 1998 and Gleevec® approved in 2001

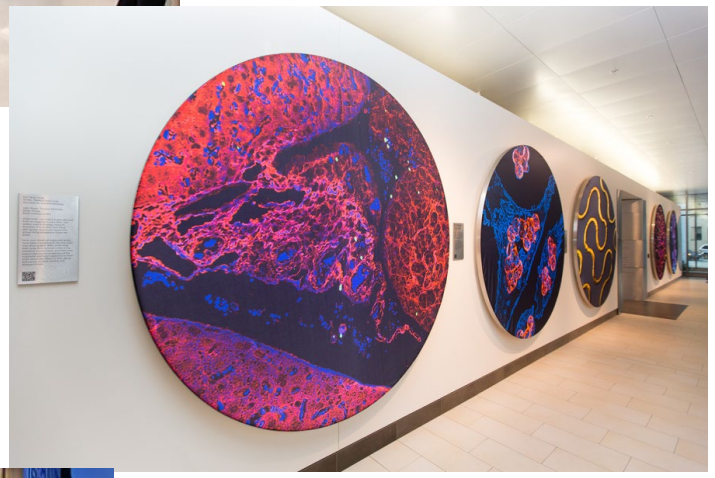
Salvador Luria, Nancy Hopkins, David Baltimore, ca. 1974

The Next Level - MIT Koch Institute:

- 2007: A new collaborative research model introduced in the re-imagination of the center
- the first to bring cancer biologists together with **biological**, **chemical**, **mechanical**, and **materials science engineers**, computer scientists, clinicians, and others to develop new insights into cancer, as well as new tools and technologies
- With a new vision came a new building to house us all together:
- 14 scientists and 13 engineers from across fields **engineers paired integratively across floors**

Koch Institute Model

- **Shared Building Spaces** – No divisions
- Intramural members ‘moved’ from their disciplinary buildings into the Koch with entirety
- Extramural members expected to actively engage in community life
- **Social connections** enabled by shared commons, the Koch Café, elevators, shared hallways and core facilities



50 laboratories and more than 1,000 researchers – all connected via KI community

Koch Institute Model

Shared Infrastructure – Swanson Biotechnology Core

- 12 Core Facilities with top staff that provide a range of essential and unique services and connect people across the Institute.
- Core provides platforms but also trains researchers and **enables them to expand on the use and adaptation of tools for new discovery – this is key for interdisciplinary work!**

Examples:

PMIT: Preclinical Modeling, Imaging & Testing

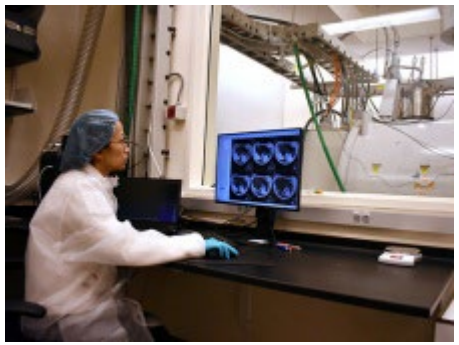
- **Navigate and streamline the path** from the development to the evaluation of technologies within a valid biological system. Helps with development and implementation of models.

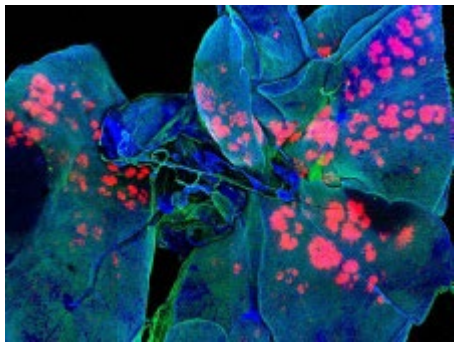
Microscopy

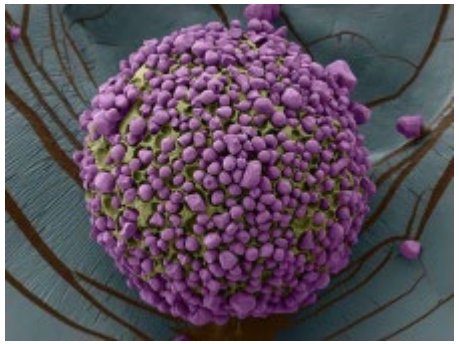
- The Microscopy Core Facility provides experimental consultation, fee-for-service **imaging assistance, and training in and access to several imaging platforms**.

Nanotechnology Materials

- The Peterson (1957) Nanotechnology Materials Core Facility **assists investigators in research relating to nanomaterials.** The Core offers **top level equipment and expertise** to work with nanomaterials for the purposes of both characterization and imaging.







Koch Institute Model

Unique Shared Funding Opportunities

- **Special seed grants** within the KI enable PI's to launch a collaboration rapidly with a neighbor colleague
- **KI postdoctoral fellowships and grad student fellowships** that enable expansion of study in a variety of core areas
- **The Bridge Program** – funds MIT and Harvard Cancer Center/Dana Farber Cancer Center PI's in work on cancer together. Requires 50/50 split in funding and undergoes competitive review with external panel
- Special focused centers are also interdisciplinary and provide funding such as:
  - The Marble Center for Cancer Nanomedicine
  - Center for Precision Medicine

Koch Community =
Science + Engineering + Medicine Together:

Angie Belcher and Sangeeta Bhatia

Michael Yaffe

Early and Constant Contact….

… among many talented undergrad, grad students and postdocs sharing and exchanging

Scientific retreats that enable true exchange:

Koch Retreat for all KI members – faculty, student and staff
Arranged for 1.5 days off-campus (often out of town)
A short talk given by a trainee in every lab with ample time for Q&A
Heavily attended poster sessions
Shared meals

And Many Opportunities for Teaching and Learning from Each Other (e.g.):

- Focus Fridays
- The Doctor is In
- Genius Bar
- Biology 101
- Science W/In/Sight
- Koch Institute Symposium
- Immune Engineering Symposium

A big tradition – the KI Halloween party – the night of the retreat:

Opportunities to gain clinical insights

The KI has allowed more accessible pathways for clinicians to reach engineers and vice versa.

Intentional programs such as the Bridge and collaborations with industry such as J&J help, as well as funding such as OCRP, NIH, foundations

Visibility and platforms for discussing cancer and its challenges help to bring researchers together with clinicians and patients or patient advocates in unique ways.

Important to be able to leverage the platform to gain clinical perspectives

Ovarian Cancer Symposium Educates Patients About Early Scientific Innovations

September 24, 2014 by Marci Landsmann

Last week, more than 100 patients, survivors, family members, advocates, and researchers came together for a symposium at the Koch Institute for Integrative Cancer Research at the Massachusetts Institute of Technology (MIT) in Cambridge. The Koch Institute invited the public to the Sept. 16 event, titled "Bridging the Gap in Ovarian Cancer," so people affected by the disease could learn about novel scientific approaches that may one day improve ovarian cancer detection and treatment.

New initiative takes aim at women's cancers

Koch Institute professors Paula Hammond, Sangeeta Bhatia and Angela Belcher, and MIT alumna Parul Somani at the Koch Institute's "Intercepting Ovarian Cancer" event in November 2023. Hammond, Bhatia, and Belcher presented on their multi-dimensional approaches to the early detection of cancer, while Somani discussed her experiences as a BRCA1 carrier, breast cancer survivor, ovarian cancer previvor, and cancer care-giver.

Outreach is also an opportunity - Science connects people…

Koch Institute Nanoparticle “Flash” dance, Cambridge Science Fair 2012

Innovations grow from interactions – some examples of outcomes

- Design of an onco-fluorescent agent and hand-held imaging tool to improve surgical outcomes in breast cancer, now approved by the FDA
- Pioneering the use of gene editing and organoids for tumor modeling
- Design of delivery systems for RNA interference therapies to treat cancer and other diseases, and approved for vaccines against COVID-19 and other conditions
- Helped characterize a metabolic target unique to cancer cells, with a new drug, AG-221 (enasidenib), approved by FDA in 2017 for acute myeloid leukemia
- Tools for single cell analysis that improve accessibility of sequencing technologies, accelerate understanding of cellular networks, and help clinicians choose the most effective therapies for patients
- Maps of cell signaling pathways to identify interventions and drug combinations that improve outcomes for patients with prostate, triple negative breast, and other cancers
- Development of nanoparticle “hitchhiking” vaccines, currently in clinical testing, that stimulate T cells to attack tumors
- Creation of machine learning tools to accurately assess risk of breast and other cancers

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The Third Revolution:

The Convergence of the Life Sciences, Physical Sciences, and Engineering

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

January 2011

Letter to our Colleagues:

This report is presented to the health science research community to help delineate an important new research model—convergence—which draws on an ongoing merger of life, physical and engineering sciences.

This new model is being adopted at many institutions in different forms. The past decade has seen the evolution of new interdisciplinary research areas—bioinfomatics, synthetic biology, nanobiology, computational biology, tissue engineering, biomaterials, and systems biology are examples. These new fields share a comparable, underlying research model, convergence, and there is a need to see them as a unity in order to ensure their continued progress. The successful application of this model will require not simply collaboration between disciplines, but true disciplinary integration.

Convergence will be the emerging paradigm for how medical research will be conducted in the future. However, convergence faces a series of policy challenges that must be resolved to allow it to emerge at a scale that could be truly transformative.

The report that follows attempts to define this new research model, offers a series of cases to indicate its promise, reviews the role of the new model in improving the economics of health delivery, and offers a series of policy recommendations to better implement it. We thank staff at MIT's Washington Office for assisting in this effort, including Amanda Arnold, Alison Fox, Kari McCarron, Bill Bonvillian, and Tracy Kambara. We, as faculty at MIT, offer this report to both encourage dialogue with our colleagues at many different institutions who are likewise adopting this new model as well as introduce convergence as a blueprint for innovation to others. We look forward to your questions and ideas.

Sincerely,

Phillip A. Sharp
Institute Professor and Professor of Biology

Charles L. Cooney
Robert T. Haslam Professor of Chemical Engineering

Marc A. Kastner
Dean, School of Science, Donner Professor of Science

Jacqueline Lees
Professor of Biology and Ludwig Scholar,
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Ram Sasisekharan
E. H. Taplin Professor of Health Sciences and Technology,
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Paul E. Newton Professor of Neuroscience, Head,
Department of Brain and Cognitive Sciences

Key to developing the interdisciplinary field of Cancer Engineering

- Learning to speak to each other – and to hear each other across fields
- Connections to **clinicians** *and* **patients**
- **Resources geared toward accelerating cross-pollination**
- Exchanging ideas together **in an iterative fashion**
- ***Constant interactions –*** *structured and unstructured*
- ***Moving towards a shared goal***

END