Convergence, Cancer Research and the Koch Institute Experience at MIT

Tyler Jacks
Director

NAS Workshop on Team Dynamics and Effectiveness
July 1, 2013
"I will ask for an appropriation of an $100 million to launch an intensive campaign to find a cure for cancer ... the time has come in America when the same kind of concentrated effort that split the atom and took man to the moon should be turned toward conquering this dread disease."
NCI Cancer Centers

- Comprehensive Cancer Center
- Cancer Center
- Planning Center
Salvador E. Luria, 1969
David Baltimore, 1975
Susumu Tonegawa, 1987
H. Robert Horvitz, 2002
Phillip A. Sharp, 1993
Of an emerging arsenal of precision cancer drugs, two of the most powerful sprang from our work at MIT.
October, 2005: MIT CCR awarded one of seven inter-disciplinary NCI grants to form a Center for Excellence in Cancer and Nanotechnology.

October, 2004: MIT CCR awarded one of nine inter-disciplinary NCI grants to use computational and mathematical ("systems") approaches to understand complex problems in cancer biology.
The Koch Institute: A New Model for Cancer Research

Integration and Collaboration
Discoveries and Solutions
Intramural Koch Institute Biology Faculty

Angelika Amon  Paul Chang  Jianzhu Chen  Herman Eisen  Frank Gertler

Michael Hemann  Nancy Hopkins  David Housman  Richard Hynes  Tyler Jacks

Jacqueline Lees  Phil Sharp  Frank Solomon  Matthew Vander Heiden  Michael Yaffe

Sunday, June 30, 13
The Hub of Cancer Research at MIT
From Renderings to Reality
Local consultants aided Khadafy

Cambridge firm tried to polish his image

Iron hand in Tripoli college of government shows cracks with sudden reverses and signs of deep internal opposition.

In the news

PULLING TOGETHER IN CANCER FIGHT

In new facility, MIT and philanthropist unite diverse specialists in common quest

Vivid art offers a window into intricate science

Doctor indicted in 6 drug fatalities

Prescriptions said to lead to overdoes

Nurse practitioner also faces charges

Mayor plans partnership to revive Dudley Sq.

School Dept. may go to land bank building

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Sunday, June 30, 13
192,000 NASF
~27 Faculty Laboratories
>22,000 NASF of core facilities
The KI Core Facilities have been organized into the Swanson Biotechnology Center

Total area: 22,000 ft\(^2\)
From Convergence to Confluence
Social Hour hosted by the Hammond Lab (5th floor)

Prof Hammond & Jason Deng: Hammond Lab

ATTACK OF THE LAYER-BY-LAYER NANOPARTICLES: Co-delivery of chemodrug and RNAi for cancer treatment

Friday, April 12th, 4:30 PM
Koch Institute Auditorium
Social Hour hosted by the Hammond Lab (5th floor)

Friday Focus Seminar Series
the saga is continuing…

Attack of the layer-by-layer nanoparticles: Co-delivery of chemodrug and RNAi for cancer treatment

Friday, April 12th, 4:30 pm
Koch Institute Auditorium

CANCER Modelining Cancer in the Mouse: The Basics
A new educational series designed to bridge the Biology/Engineering divide
by David Feldser
Jacks Lab

Wednesday, July 25, 3 PM
76-156 (KI auditorium)

The Doctor is IN

THIS MONTH: SMALL CELL LUNG CANCER
Join us to learn more about diagnosis, staging, and treatment in the clinical management of small cell lung cancer.

Wednesday, December 19, 4 PM
Koch Institute Conference Room 76-156
Hosted by KI physician-scientist Anna Farago

CROSSFIRE
A new educational series designed to bridge the Biology/Engineering divide

Modeling Cancer in the Mouse: The Basics

by David Feldser
Jacks Lab

Wednesday, July 25, 3 PM
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Sunday, June 30, 13

Engineering Genius Bar
The 2012 Koch Institute Retreat
Scott Floyd, MD, PhD
Koch Clinical Investigator
Brain Cancer Genetics and Treatment
Instructor, BI Deaconess, Radiation Oncology

Alice Shaw, MD, PhD
Koch Clinical Investigator
Lung cancer genetics and treatment
Assistant Professor, MGH Thoracic Oncology Center
Enhancing Clinical Partnerships
Ortho-McNeil-Janssen Pharmaceuticals, Inc. Announces Oncology Research Collaboration Agreement with the Koch Institute for Integrative Cancer Research at MIT
KI Technology into NewCo's

Fiscal Year: 
- '08
- '09
- '10
- '11
- '12

Cumulative NewCos:
- 14
- 12
- 10
- 8
- 6
- 4
- 2
- 0

(many logos and company names are present)

(Managed by TLO)
Priority Research Areas

1 Nano therapeutics
2 Devices & Monitoring
3 Metastasis
4 Personalized Cancer Medicine
5 Cancer Immunology
Chemotherapeutics

Targeted anti-cancer agents

siRNAs

miRNAs

50 nM
Engineering the Immune System to Fight Cancer

Darrell Irvine

*Unmodified tumor-reactive T-cells*

*Nanoparticle-conjugated tumor-reactive T-cells*

No cytokine

Systemic IL15/21

T cell-bound IL15/21 NPs

Survival (%) vs Days after tumor injection

Sunday, June 30, 13
Novel cancer imaging strategies

M13 phage-stabilized single-walled carbon nanotube imaging probe for NIR II fluorescence imaging

Tumor-targeting ligands

SWNTs Binding Motif

SWNT

M13 Virus

880 nm

6 nm

Post-SWNT-guided cytoreduction

Pre-injection

Pre-surgery

Post-unguided cytoreduction

Inject SBP-M13-SWNT

Unguided surgery

Excitation filter

InGaAs detector

Phantom

SWNT-guided surgery

Sunday, June 30, 13
Engineer implantable devices to monitor and treat cancer

Michael Cima
Systematic analysis of cancer networks

\[
\frac{1}{k_{	ext{off}}} \frac{d\bar{R}}{dt} = \frac{G_1 \bar{P}_a + Da\bar{C}}{1 + Da\bar{R}} + \gamma (1 - \bar{R}) + \bar{C}
\]

\[
\frac{1}{k_{	ext{off}}} \frac{d\bar{C}}{dt} = \frac{G_1 \bar{P}_a + Da\bar{C}}{1 + Da\bar{R}} - \bar{C} - 1 - \delta
\]

\[
d\bar{e}_{1p} = \frac{I_0 + G_2 R_T \bar{C}}{1 + G_4 e_3 + K_{m,1} + (1 - e_1)} - \frac{V_{\max,3} e_1}{K_{m,3} + e_1}
\]

\[
d\bar{e}_{2p} = \frac{k_2 e_1 (1 - e_2)}{K_{m,2} + (1 - e_2)} - \frac{V_{\max,4} e_2}{K_{m,4} + e_2}
\]

\[
d\bar{e}_{3p} = \frac{k_3 e_2 (1 - e_3)}{K_{m,3} + (1 - e_3)} - \frac{V_{\max,6} e_3}{K_{m,6} + e_3}
\]

\[
\frac{1}{k_e} \frac{d\bar{P}}{dt} = \mu (1 - \bar{P}) - (v_0 + G_3 e_3) \bar{P}
\]

\[
\frac{1}{k_e} \frac{d\bar{P}_a}{dt} = (v_0 + G_3 e_3) \bar{P} - \bar{P}_a
\]
science + engineering...conquering cancer together