Leveraging a Research & Innovation Powerhouse

Prabhas Moghe
Vice Chancellor for Research & Innovation

Oct 5, 2018
Rutgers Excellence in Alumni Leaders Conference
My journey at Rutgers…

Dream Job!
23 years of research, teaching, and service at Rutgers.

Teaching remains a passion!

Research metrology:
- 25 PhDs;
- >100 Journal Publications
- >4000 citations
- >$20M in research funding

Trained > 70 PhDs in interdisciplinary research (Biointerfaces Stem Cell Science/Engineering)

Research in new therapies and diagnostics for human health
Innovations for human health

U of Minnesota (Chemical Engineering)
Harvard Medical School (Surgery/Bioengineering)
Light, Camera, Action!

“Ink & Image” Infrared Nanoprobes for Precision Cancer Surgery
The Problem / Market Need: Cancer Surgery

- Complete surgical resection of tumors is critical for patient outcomes but challenging for even the expert surgeon

“Did you get it all out?”
Perspective from Julia Tchou, MD, PhD., breast cancer surgeon at U. Penn who led the trials of the NIR dye ICG in breast cancer. J. Surgical Oncology (2016)

→ **10-50%** of breast cancer surgeries fail to remove all tumor tissue at the first attempt

→ Nearly **one in four** women with early-stage breast cancer will need a second surgery within 90 days
“Inking” tumors with infrared emitting nanoparticles that enable high contrast visualization of cancerous tissues.

Visual evaluation: Where is the tumor?

Our Solution

Nanoparticle inked: Real-time highlighting of tumor
• Optical imaging platforms for intra-operative guidance have received FDA clearance:

• BUT: Current platforms using visible / near-infrared light are limited to highlighting superficial structures and lesions:

D’Souza et al., J Biomed Opt 2016
• Optical SWIR-emitting NanoInks provide a unique combination of depth, resolution, and intra-operative imaging capabilities:

<table>
<thead>
<tr>
<th>Technique</th>
<th>Cost</th>
<th>Imaging depth</th>
<th>Imaging resolution</th>
<th>Real-time Intra-Operative</th>
<th>Multiplexed imaging</th>
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</thead>
<tbody>
<tr>
<td>MRI</td>
<td>$$$</td>
<td>10’s cm</td>
<td>100’s μm</td>
<td>N</td>
<td>N</td>
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<tr>
<td>PET</td>
<td>$$$</td>
<td>10’s cm</td>
<td>mm</td>
<td>N</td>
<td>N</td>
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<tr>
<td>SPECT</td>
<td>$$</td>
<td>10’s cm</td>
<td>mm</td>
<td>N</td>
<td>N</td>
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<tr>
<td>CT</td>
<td>$$</td>
<td>10’s cm</td>
<td>mm</td>
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<tr>
<td>US</td>
<td>$$</td>
<td>cm</td>
<td>mm</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Optical: NIR</td>
<td>$</td>
<td>mm</td>
<td>100’s μm</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Optical: SWIR</td>
<td>$</td>
<td>cm</td>
<td>10’s μm</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
NanoInks identify deeper and smaller cancer clusters

Reduced scattering & blood absorption
• SWIR light undergoes less scattering in tissue leading to increased imaging resolution:

Hong et al. Nature Photonics 2014
Surveillance nanotechnology for multi-organ cancer metastases
Future Development

RE Nano-Inks: A Platform Technology for the Future

Applications in surgical guidance
- Glioblastoma debulking
- Sentinel Lymph node mapping
- Breast conservation surgery
- Wedge resection and segmentectomy
- Liver segmentectomy
- Ovarian cancer debulking
- Limb salvage surgery

Applications in veterinary medicine
- Osteosarcoma
- Lung cancer
- Breast cancer

Applications in endoscopy
- Scope
- Stomach
- Infrared light

Immune response prediction
- T-cell burden
- Enhanced T cell burden
- Multi-spectral REANC mediated real time monitoring

PDX applications
- Tumor implantation
- In vivo SWIR imaging of responder population
- Altered treatment regimen
What is the arc of Rutgers’ future?
RUTGERS is one of the original Colonial Colleges ...

Dartmouth—1769
Rutgers—1766
Brown—1764
Pennsylvania—1755
Columbia—1754
Princeton—1746
Yale—1701
William and Mary—1693
Harvard—1636
... and is now in the Big 10 Academic Alliance
We are a somewhat unique institution!

Dartmouth—1769
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Wisconsin
Purdue
Penn State
Ohio State
Northwestern
Nebraska
Minnesota
Michigan State
Michigan
Maryland
Iowa
Indiana
Illinois
Rutgers is a World Research Leader

- #1 Women’s History
- #2 Health Professions
- #3 Philosophy
- Top 25 in English, History, Computer Science, Mathematics, Physics
- Top public business school in the Northeast
- >$700,000,000 annual R&D expenditures
Aspirations for Rutgers..

- A world class magnet/catalyst for innovations
- A highly inclusive institution of new ideas, forward-looking projects, and frontier paradigms
- A place where the humanities research stretches toward new vistas of the environment, medicine, technologies, and the social experience of the coming decades.
- ..If Rutgers opens its research/innovation doors to many of its undergraduates....
- To be the pre-eminent public institution of choice on the East Coast.
Growing Rutgers’ Research

- **Strategic Initiatives:**
  Seek resonance with federal/state/industrial/foundation opportunities
  → Increase # strategic grant submissions

- **Coalescing Teams:**
  Mobilize RU-NB faculty to develop a critical mass around areas of strength
  → Enhance collaborative and competitive edge

- **Research Capacity:**
  Expand training program support for graduate students and postdocs.
  → Invigorate our research ethos and increase # PhDs
Share of All S&E Research Expenditures for Rutgers and Big Ten

Source: NSF R&D Expenditures at Universities and Colleges / Higher Education R&D Survey
Note: Rutgers figures before 2010 reflect university wide reporting. Indiana includes Bloomington & IUPUI for 2016 and is university wide before 2010.
Build 'Noah's ark' for beneficial gut microbes, scientists say

Repository would store ‘friendly’ germs from the intestines of people in remote communities for future medical treatments

*Lactobacillus* bacteria observed in a scanning electron microscope. Photograph: AP

*Dominguez Bello MG et al., Science 05 Oct 2018: Vol. 362, Issue 6410, pp. 33-34*
Build 'Noah's ark' for beneficial gut microbes, scientists say

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Rutgers is in a vibrant corridor of the Northeast...

- New Brunswick to Newark: 28 mi (45 km)
- New Brunswick to New York City: 41 mi (70 km)
- New Brunswick to Camden: 62 mi (100 km)
- New Brunswick to Philadelphia: 66 mi (106 km)
- Newark to Camden: 83 mi (134 km)
- Newark to New York City: 13 mi (21 km)
- Camden to Philadelphia: 4 mi (6.4 km)
... collaborating with regional industry clusters
Research and Innovation are a growing strength at Rutgers

140 NEW PATENTS AND LICENSES

#21 in TOP 100 WORLDWIDE UNIVERSITIES
GRANTED U.S PATENTS WITH
84 PATENTS IN 2016

$29.4M IN LICENSING REVENUE
Research and Innovation are a growing strength at Rutgers

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- $6.70 IN ECONOMIC ACTIVITY FOR EVERY RESEARCH DOLLAR SPENT
- 89 RESEARCH AWARDS AT MORE THAN $1M
- 339 COMPANIES ENGAGED IN RESEARCH
Research and Innovation are a growing strength at Rutgers

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150 NEW INVENTIONS

2,506 & $608.7M IN NEW RESEARCH AWARDS

81 NEW & ACTIVE STARTUPS
Rutgers works with industry...
... Rutgers research innovations on the market

Axion – 100% recycled plastic railroad ties

Scientific Learning – Fast ForWord® reading intervention software

Streptomycin – Nobel Prize-winning antibiotic

Medtronic – absorbable antibacterial envelope for implantable devices

REVA - Fantom® sirolimus eluting bioresorbable scaffold

Estee Lauder - Moringa anti-inflammatory, anti-aging skin cream

Cepheid - GeneXpert® Point of care molecular diagnostic

BioMarin - Brineura™ only known treatment for Batten Disease
• I particularly applaud his announcement of the Innovation Evergreen Fund. It aligns perfectly with our own efforts to provide more investment for brilliant entrepreneurs and innovative startups via Tech Council Ventures, a venture firm now raising its second fund, and JumpStart, our angel network.

• While Murphy’s plan is excellent, we still face great challenges. One is the limited pipeline of strong entrepreneurs graduating from our schools and accelerators. ..

• I know pipelines take time to build — and we must start now

Our great colleges and universities offer many novel programs to promote entrepreneurship; we need to scale them. .. We are eager to bring our 1,000-plus member companies and the investor and entrepreneurial communities to the table to further these goals. In the meantime, we need to attract entrepreneurs from all over to set up shop here.
Innovation Hub in New Brunswick

- One of Governor Murphy’s envisioned signature projects

The State, City, and Rutgers share a vision of New Brunswick as driver of the New Jersey innovation economy

Rutgers working with DEVCO to design collaborative research incubation space in downtown New Brunswick
The New Jersey Innovation and Technology Hub

• “Innovation is at the heart of what we do”

• The Hub can complement Rutgers activities in many new ways
  – Site is adjacent to the flagship Rutgers campus
  – Facilitate new partnerships with the private sector
  – A showcase for student and faculty research
  – Home to new high tech ventures
  – Accelerate university translational research
Rutgers programs amenable to Hub location

Key Activities
Key Partnerships
Key Relationships

- Partner Services for student start ups
- 1 stop shop tech transfer support
- Core High Impact Research Programs
- Entrepreneur Residence Program
- Venture Studio
- Innovations Programs
- Real life test beds/living labs
- External Accelerator Program
- Corporate Engagement Programs
Rutgers Points of Pride..

- More research funding than all NJ schools combined
- Top 20-public research University
- One of the most diverse research-comprehensive Institutions

- A growing network of alumni
  - Develop programs and initiatives that draw in alumni
  - Innovation educational programs for students/alumni mentors
  - With marketing, the Rutgers brand gets ever more strong and alumni engagement is strengthened
  - Research nuggets and breakthroughs can help with “story telling”

- The Innovation Hub could be a signature aspirational project for alumni confluence and engagement.
Thank You

Questions?
Vice Chancellor for Research & Innovation

Rutgers University–New Brunswick

- Recognize high quality research/grants/initiatives
- Develop faculty mentoring mechanisms
- Ideate new research initiatives and centers across RU-NB
- Seed and assist new training programs (predoctoral, postdoctoral)
- Oversee the growth of current research centers
- Develop strategic research partnerships with industry
- Align RU-NB research to federal and state research agency opportunities
- Foster innovations within the institutional academic and research framework
RE-NPs can detect 1 cm deep lung lesions:

RE-NPs can detect micro-lesions $7.8 \text{ mm}^3$ (2.5 mm diameter) in vivo:

Moghe et al., Small 2015

Moghe et al., Nature Biomedical Eng. 2017

RE-NPs can target cancer biomarkers:

RE-NPs can detect small tumors earlier than existing imaging technologies: