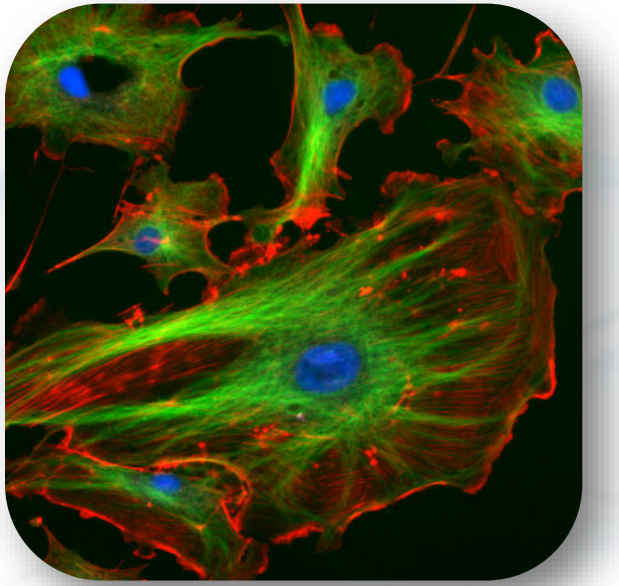
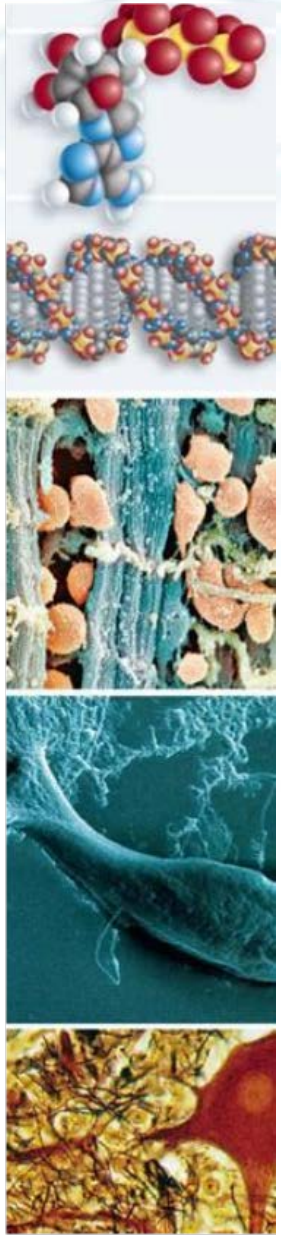


NIST and the Biosciences

Kelley C. Rogers, Ph.D.
Technical Program Director for Biosciences,
Material Measurement Laboratory

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce



'In 10 years we have developed strong core capabilities in target areas of molecular and cellular analysis.

To have impact in the next wave of the building bioeconomy requires a great deal of additional sophistication to examine system-level complexity.'

MML Director, Laurie Locascio, 2015 VCAT

2015 VCAT RECOMMENDATIONS FOR NIST BIOSCIENCES PROGRAMS

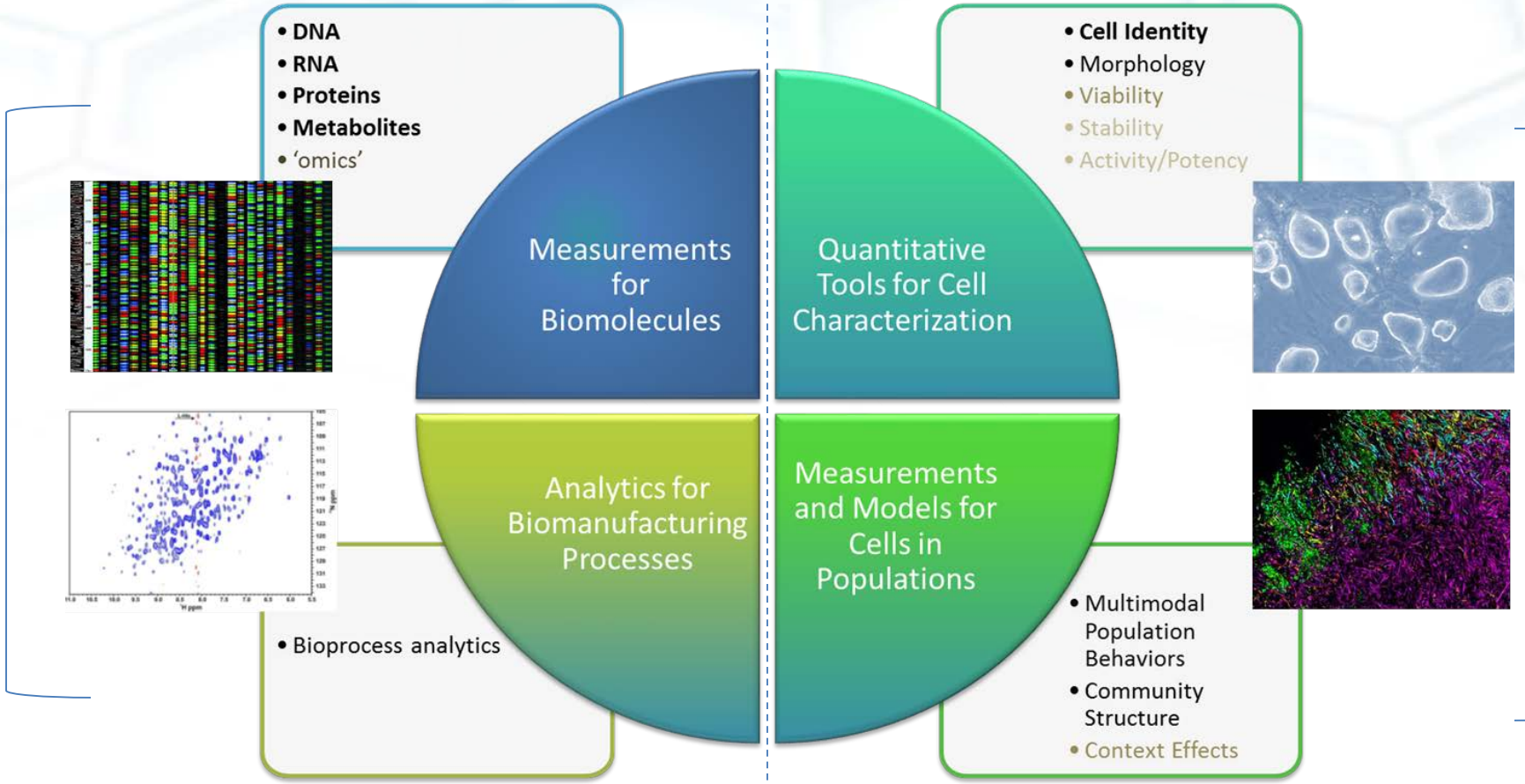
1. *Increase visibility in bio expertise to better recruit world-class talent.*
2. *Leverage existing partnerships to expand technological capacity.*
3. *Complement existing protein analytical tools with higher throughput, lower cost screening technologies.*
4. *Continued investment in the biosciences portfolio.*

NIST CORE STRENGTH IN BIOLOGICAL MEASUREMENTS

MML: Biomolecular Measurements Division and Chemical Sciences Division

MML: Biosystems and Biomaterials Division

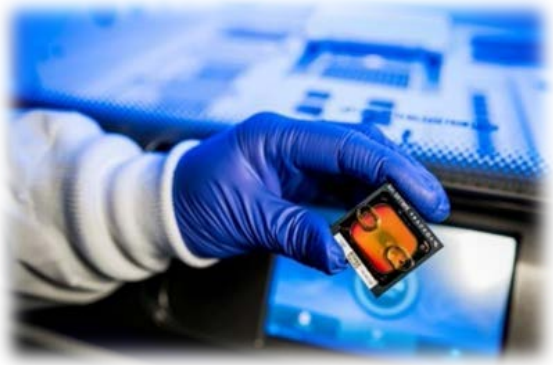
Collaborations with CNST, NCNR



Collaborations with ITL, PML, CNST

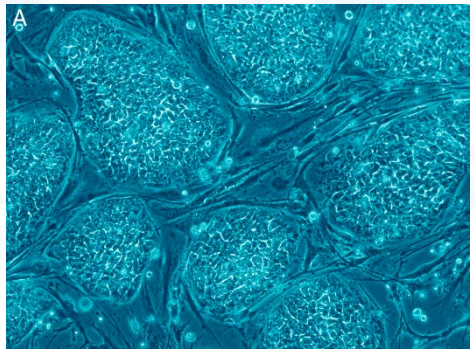
CUSTOMERS FOR NIST BIO PROGRAMS

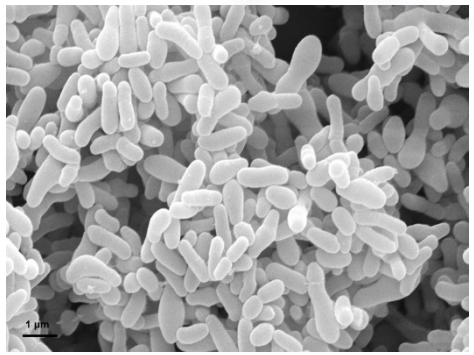
- Clinical Medicine Community
- Biopharmaceutical Industry
- Regulatory Agencies
- DNA Forensics Community
- Mass Spectrometry Community
- Synthetic Biology Industry
- Equipment Manufacturers

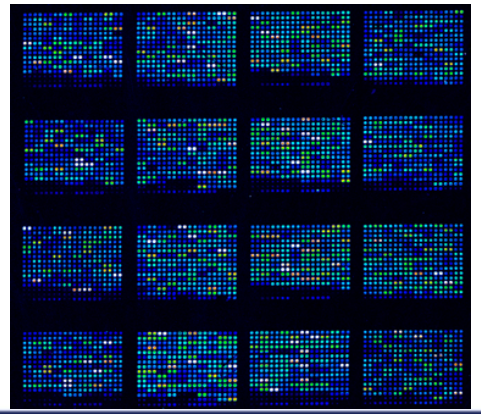


Our customers span the entire Bioeconomy.

NIST Biological Sciences Strategic Priorities







❑ Complex Biotherapeutics

Develop measurement science, standards and tools to support the quantitative definition of complex biologic therapeutics and correlation of their structural differences with clinical outcomes.

❑ Engineering Biology

Develop the measurements and models for engineering biology to map the fundamental principles that drive the development of the next generation of bio-based products.

❑ Microbial Metrology

Develop measurement infrastructure for microbial measurements in health and environmental applications.

❑ Precision Medicine

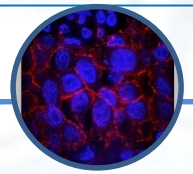
Develop measurement science and standards to ensure confidence in clinical decision-making, and ultimately enable adoption of precision medicine.

❑ Reproducibility of Biomedical Research

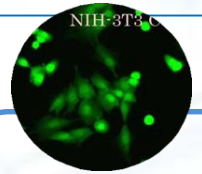
Establish NIST as the agency for measurement assurance to enable reproducibility of biomedical research results.

https://mmlstrategy.nist.gov/

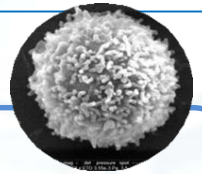
NIST Products for Biosciences



Reference Materials for Cancer Biomarkers

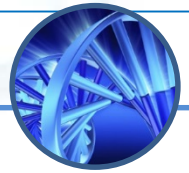


Documentary Standards for Cell Line Authentication

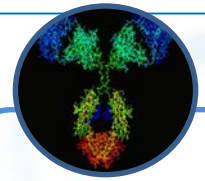


Reference Cell Standard for HIV Monitoring (CD4+ cell count)

MRI Phantom Imaging Standards



Genomic DNA Reference Material



NISTmAb Reference Material

Mass Spectral Database

Complex Biotherapeutics

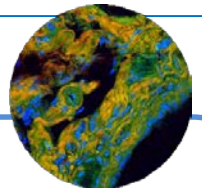
Precision Medicine

Engineering Biology

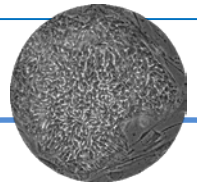
Microbial Metrology

Confidence in Biomedical Research

NIST Basic Research in 'BioMetrology'

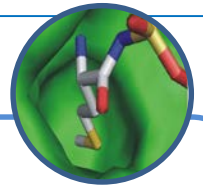


Label-less 3D Chemical Imaging for Cells/Tissues

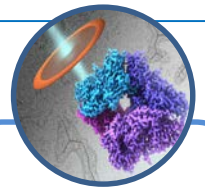


Imaging Tools & Algorithms for Qualification of Stem Cells

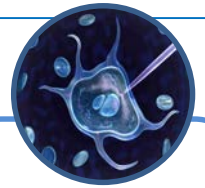
Microfluidic Control of Anti-biotic Resistance Potential



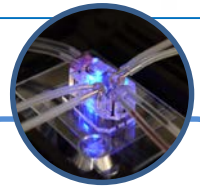
Next-Gen Protein Sequencing



*Precision CryoEM



*Living Genetic Sensor Foundry



'Body on a Chip' sensor integration

NIST PROGRAM IN BIOMANUFACTURING

Objectives:

Develop measurement science, standards, data & technology to support development, manufacturing, & regulatory approval of innovative, high-quality biologics

Vision:

Be a global leader in providing high impact measurement solutions for the biopharmaceutical industry

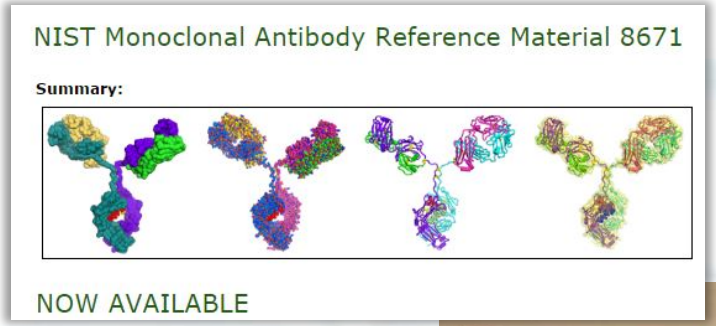
NIST:

- Focus is on measurements and standards for protein therapeutics
- $9M program (4 MML Divs., NCNR)
- Works closely with biopharma industry, FDA, equipment vendors to identify key ***infrastructural measurement problems***
- Scientifically trusted, impartial 3rd party that promotes cross-industry collaboration & open data sharing

Genentech
A Member of the Roche Group
Janssen
Pharmaceutical Companies of Johnson & Johnson
Lilly
AMGEN
FDA
Bristol-Myers Squibb
Pfizer
SANDOZ
Biopharmaceuticals
Biogen
gsk
MERCK
MedImmune

HIGHLIGHTS IN BIOSCIENCES: 2015-2017

- Release of first Monoclonal Antibody Reference Material
- Human and Microbial Genomic Reference Materials released building on pilot
- HER2 Genomic DNA Standard (Tumor profiling) Released
- NIST 'Engineering Biology Standards Development Foundry' for 2018
- Cryo-EM capability for biopharmaceuticals for 2018
- Two new advanced manufacturing institutes awarded in the 'Manufacturing USA' network
    - NIST: The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL)
    - DoD: Advanced Tissue Biofabrication (rebranded 'BioFabUSA')



biofabusa
Manufacturing the Future of Biofabrication

NIIMBL
The National Institute for Innovation in Manufacturing Biopharmaceuticals

‘BioManufacturingUSA’ – synergy with NIST Biosciences

NIMBL

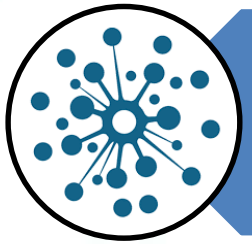
$70 M DoC, + min $129 M non-fed

- Process innovation for existing biopharmaceuticals (mAbs, vaccines)
- Scalable manufacturing processes for emerging classes of biologics (cell/gene, microbial, chimeric products)
- Standards development

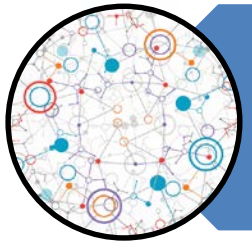
biofabusa
Manufacturing the Future of Biofabrication

$80 M DoD, + $214 M non-fed

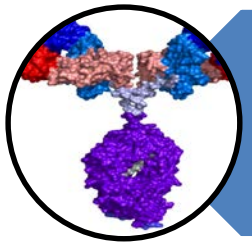
- Building blocks for tissues and scaffolds
- Bioprinting technology and other fabrication innovation
- ‘Tissue on a chip’ technology for drug screening
- Standards development for tissue-based products



Extensive Stakeholder Ecosystems



Opportunity to Leverage Resources



Recognized NIST Expertise

2015 VCAT RECOMMENDATIONS FOR NIST BIOSCIENCES PROGRAMS

1. *Increase visibility in bio expertise to better recruit world-class talent.*
2. *Leverage existing partnerships to expand technological capacity.*
3. *Complement existing protein analytical tools with higher throughput, lower cost screening technologies.*
4. *Continued investment in the biosciences portfolio.*

2015 VCAT RECOMMENDATIONS FOR NIST BIOSCIENCES PROGRAMS

Increase visibility in bio expertise to better recruit world-class talent.

1

- Staffing for critical programs: *a three-pronged approach to attract, retain & unfetter talent*
  - Aggressive participation in the NRC Postdoctoral Associateships Program
  - Invest in Ph.D. staff with the resources to do high-level measurement science and service development
  - Leverage existing partnerships as a talent pipeline for recruiting

Justin Zook (Leader - Genome-in-a-Bottle Consortium) – 2017 Presidential Early Career Award for Scientist and Engineers

2015 VCAT Recommendations for NIST Biosciences Programs

Increase visibility in bio expertise to better recruit world-class talent.

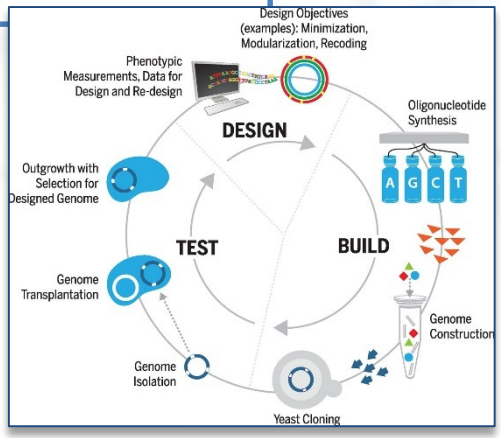
1

NIST Visibility – highlights 2015-2017:

- High-Impact publications in Engineering Biology
- Biomanufacturing Leadership: NIIMBL and BioFabUSA
- New consortia:
  - Regenerative Medicine SCB
  - Gene-editing Standards Consortium (forming)
- NIST Workshops:
  - Biomanufacturing for CAR-T
  - Cell Counting (with FDA)
  - Pathogen Detection (with FDA)
  - Microbiome Measurements (with NIH)
  - Advanced Imaging for Precision Medicine
- New NIST website to facilitate external access to NIST expertise

BioManufacturingUSA™
Federal Stakeholders Council

MATES
THE MULTI-AGENCY TISSUE ENGINEERING SCIENCES WORKING GROUP



CRISPR standards

NATURE METHODS | VOL.14 NO.6 | JUNE 2017 | **541**

With the ever-expanding use of CRISPR technology, the development of standards to quantitatively benchmark on- and off-target activity needs to keep pace.

Sec. 3036 of 21st Century Cures Act: *Requires HHS (FDA) in consulation with NIST and stakeholders to "facilitate an effort to coordinate and prioritize the development of standards…"*

2015 VCAT RECOMMENDATIONS FOR NIST BIOSCIENCES PROGRAMS

Leverage existing partnerships to expand technological capacity.

2

UNIVERSITY OF MARYLAND | NIST
INSTITUTE FOR BIOSCIENCE
& BIOTECHNOLOGY RESEARCH

insight | innovation | application

- Expanded collaboration in CryoEM capabilities.
- UMD membership in NIIMBL will strengthen alignment in biomanufacturing focus areas.

JMB
The Joint Initiative for Metrology in Biology

- Refinement of tech scope for JIMB partnership with Stanford to 'DNA Read and Write' (Genomics and Synthetic Biology)
- Shared research facility being established-
  - NIST SRM development
  - Collaborative 'Platform Labs'
  - Commercial Partnering Space

Goal is to maximally leverage these partnerships (technical complementarity, facilities, pipeline for talent). NIIMBL and BioFabUSA 'constellation' further expand our partnership reach.

2015 VCAT RECOMMENDATIONS FOR NIST BIOSCIENCES PROGRAMS

Complement existing protein analytical tools with higher throughput, lower cost screening technologies.

3

- NIST products enable development of technology agnostic platforms
  - NISTmAb use by innovator stakeholders
- NIST basic research offers disruptive potential
  - IMS for next-gen protein sequencing
- NIIMBL consortium focus will provide industry-prioritized needs, and partnering opportunities

2015 VCAT RECOMMENDATIONS FOR NIST BIOSCIENCES PROGRAMS

Continued investment in the biosciences portfolio.

4

- Calls for NIST efforts in biosciences exceed available funding
  - Cell measurements/Regenerative Medicine
  - Gene-editing standards
  - Engineering Biology
  - Biomanufacturing process technology
- Non-base funding opportunities are fully leveraged
  - IMS awards
  - Director's Reserve funds
  - Strategic and Emerging Research Initiative (SERI) Program
  - Other agency funding (FDA, DHS, DARPA, NIH)
- Opportunity and challenge within NIIMBL

EXPLOSIVE GROWTH AREAS FOR BIOTECHNOLOGIES

- Wearable Health Technology
- Complex Biologics
- Gene Editing Tools
- Meta ‘omics’ and context effects in biological systems
- Precision Imaging
- Process Analytical Technology for Biomanufacturing
- Data and Informatics –

Biology is inherently complex – as will be the ‘biometrology’ tool kit needed to measure it.