3PM

8PM in London (GMT), 5AM in Tokyo (GMT+9)

Funders

Moderator: Katy Börner, *Indiana University*

Presenters:

- Chris Kinsinger, *NIH/CFDE*
- Amy Cook, *CIFAR, Canada*
- Takei Kenta & Yusuke Date, *Japan Science and Technology Agency, Japan*
- Reed Shabman, *Interagency Modeling and Analysis Group, NIH*

Chris Kinsinger, *NIH/CFDE*

Cell Characterization toward Biomedical Knowledge

Chris Kinsinger, Ph.D.
Assistant Director for Catalytic Data Resources
Office of Strategic Coordination

Multiscale Human Event, Dec 14, 2024

National Institutes of Health
Office of Strategic Coordination–The Common Fund

The NIH Common Fund
Bold Science, catalyzing discoveries

Mission: To support **bold scientific programs that catalyze discovery** across all biomedical and behavioral research. Investigators and **multiple NIH Institutes, Centers, and Offices** collaborate on **innovative research** expected to address high priority challenges for the NIH as a whole and make a **broader impact in the scientific community**.

*** Transformative * Catalytic * Goal-driven * Synergistic * Novel ***

Accelerate emerging science

Remove research roadblocks

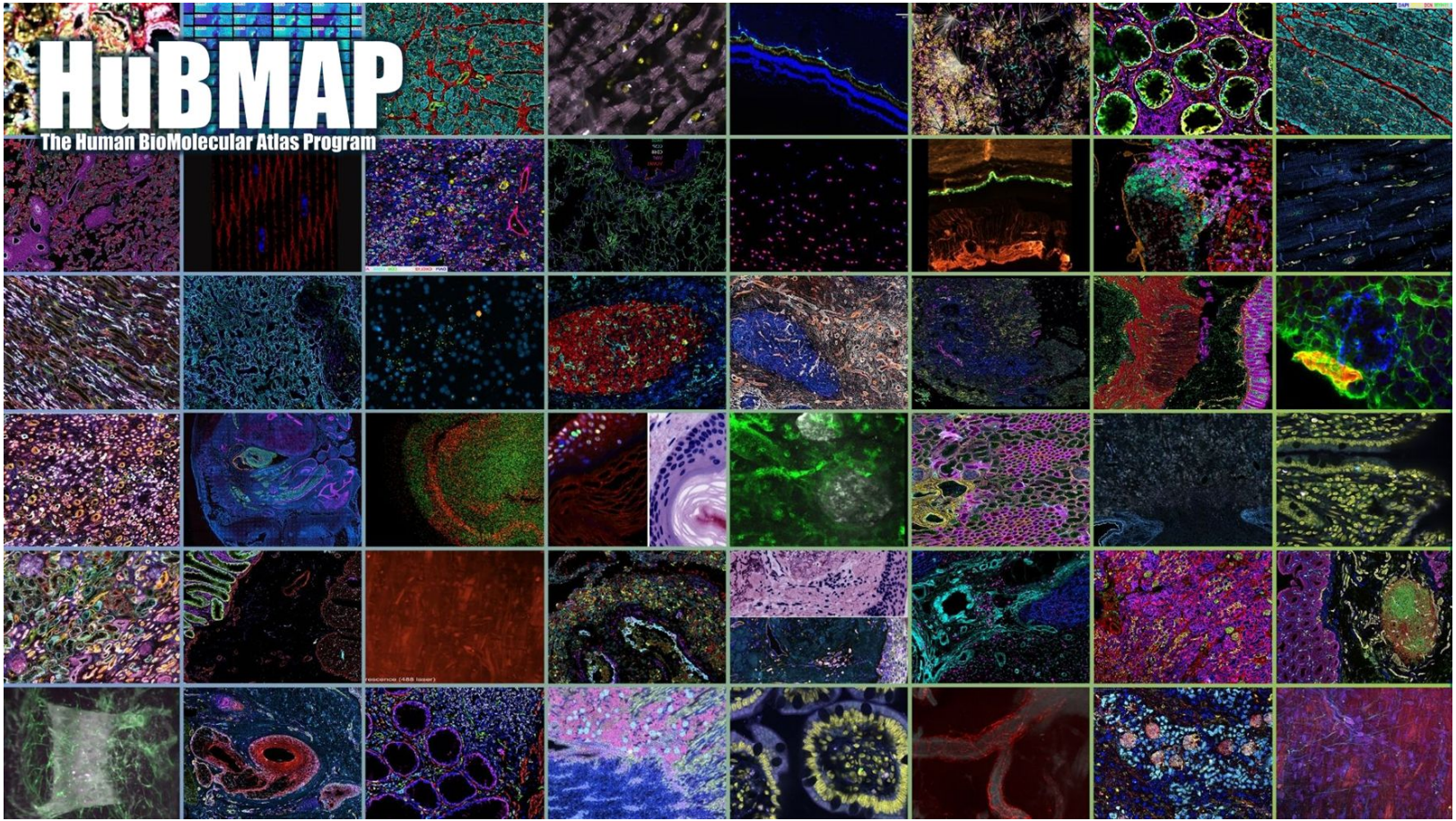
Enhance the research workforce

Support high-risk, high-reward science

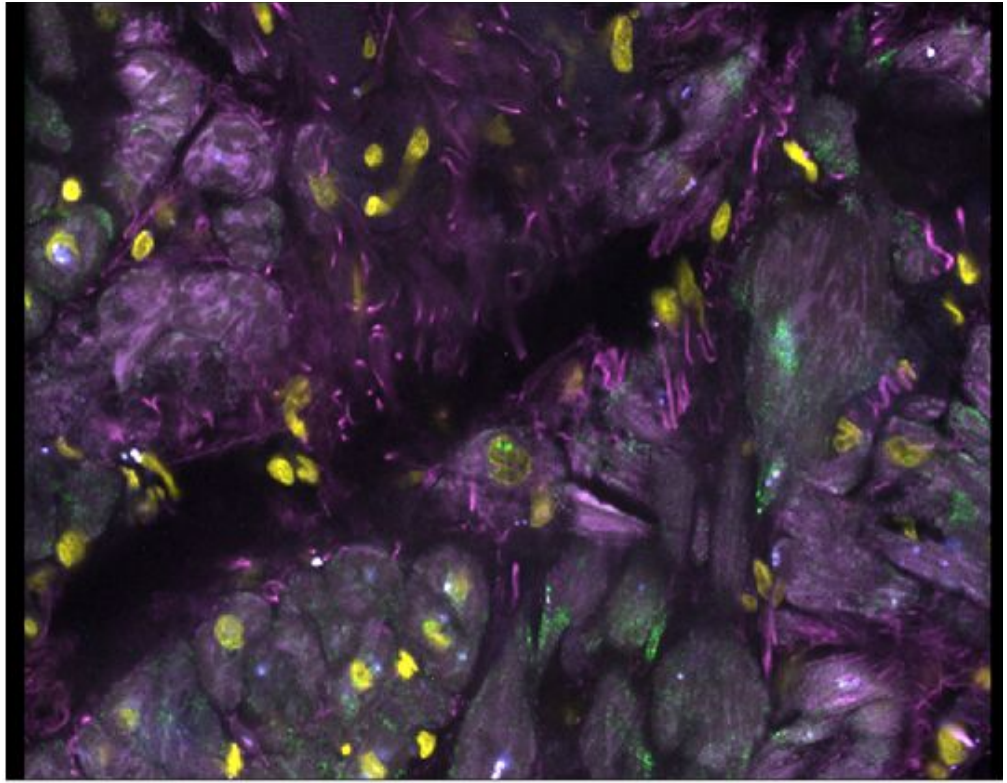
Each according to its kind

You may have heard of Elf on a Shelf but…
Nothing can prepare you for
An axolotl on Aristotle

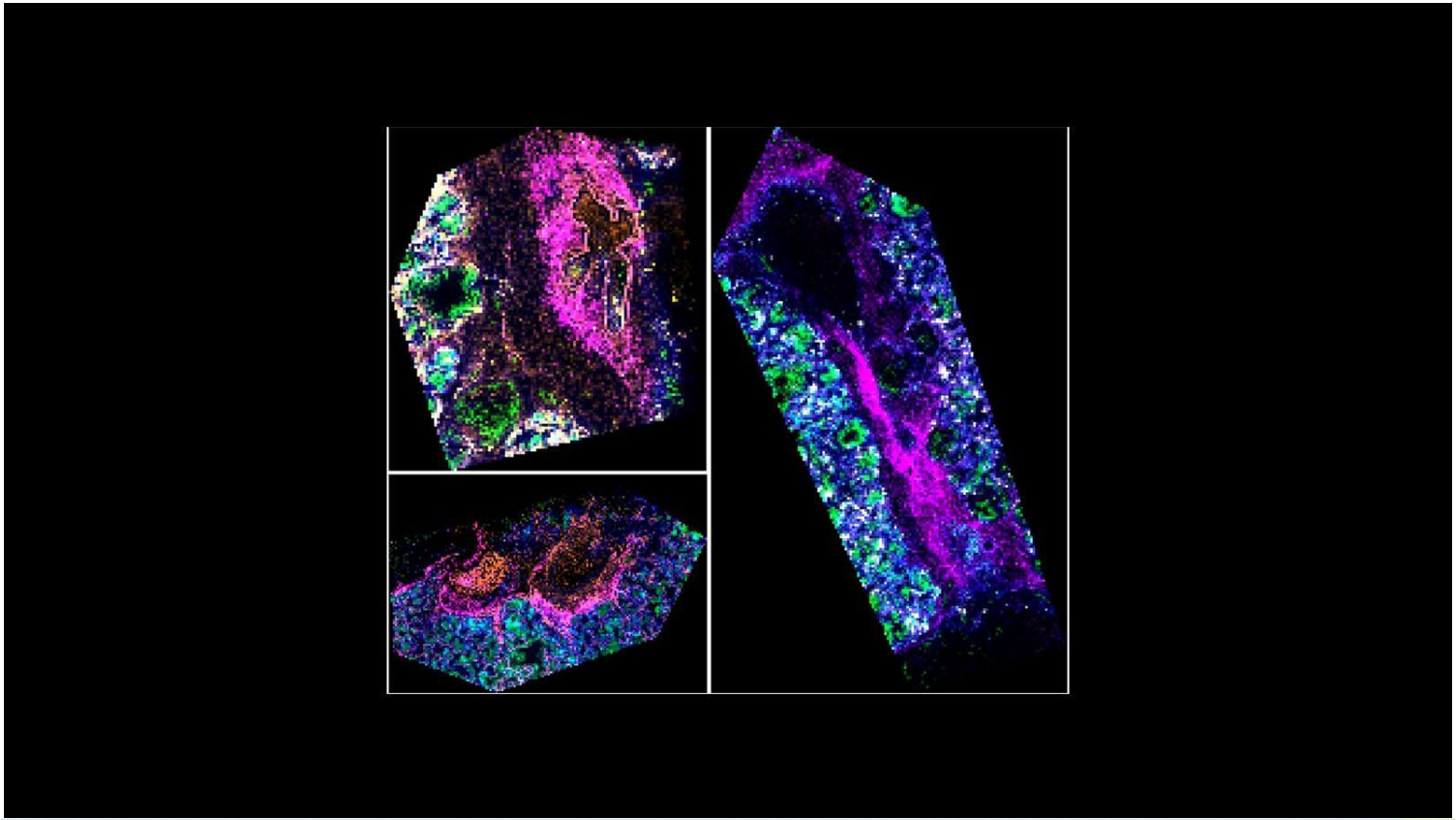
The Cell


HuBMAP
The Human BioMolecular Atlas Program

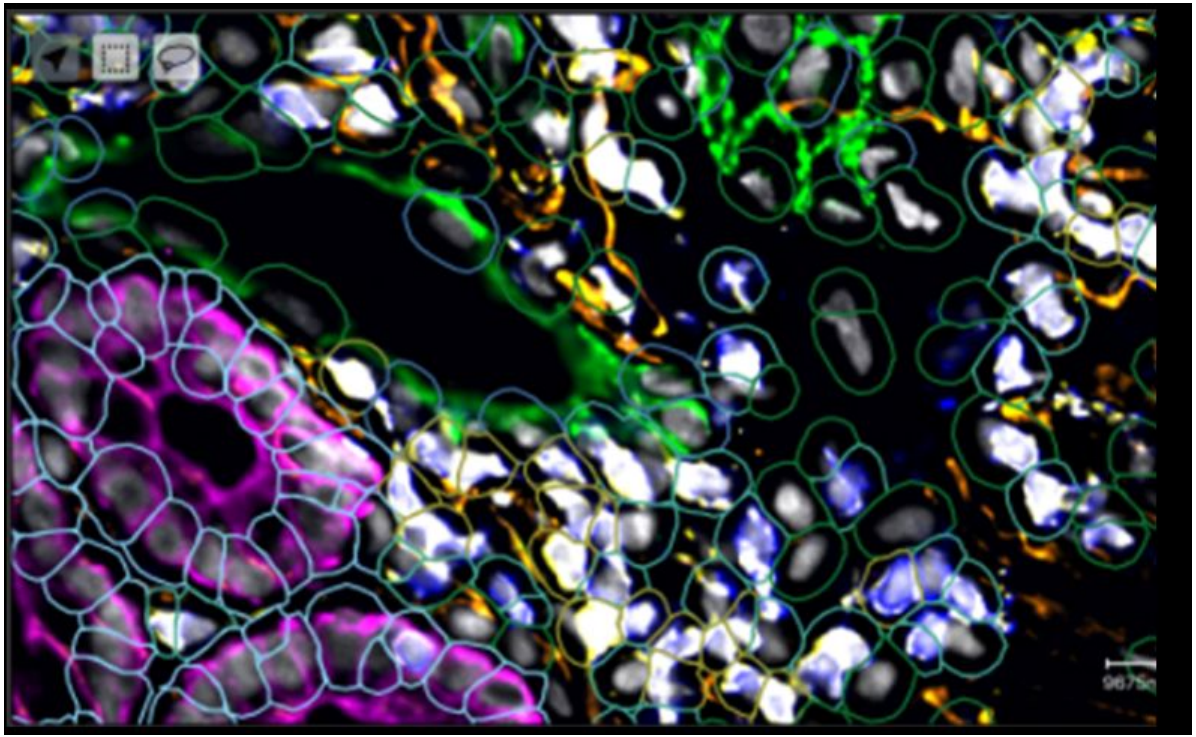
by gene



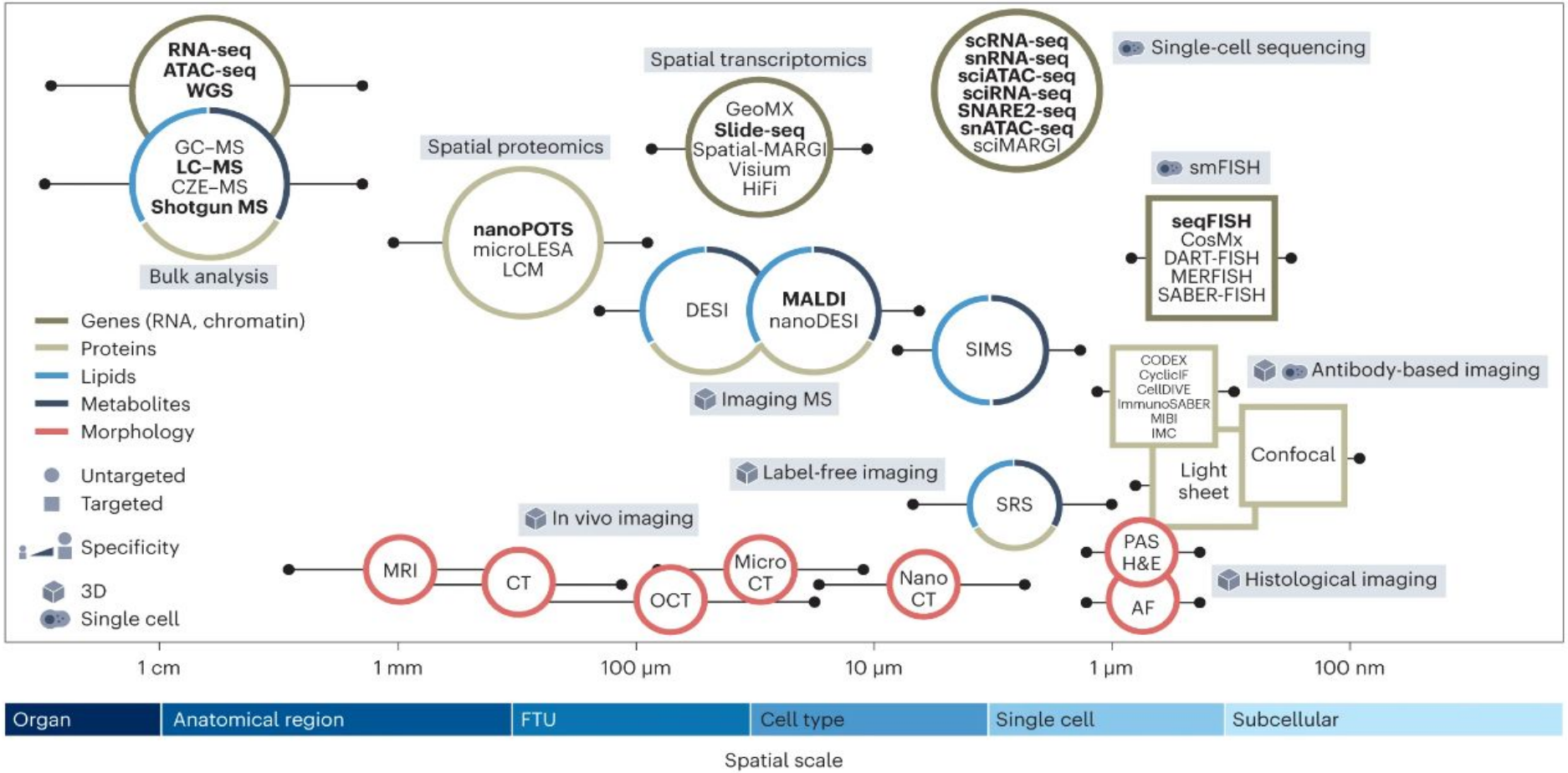
by protein



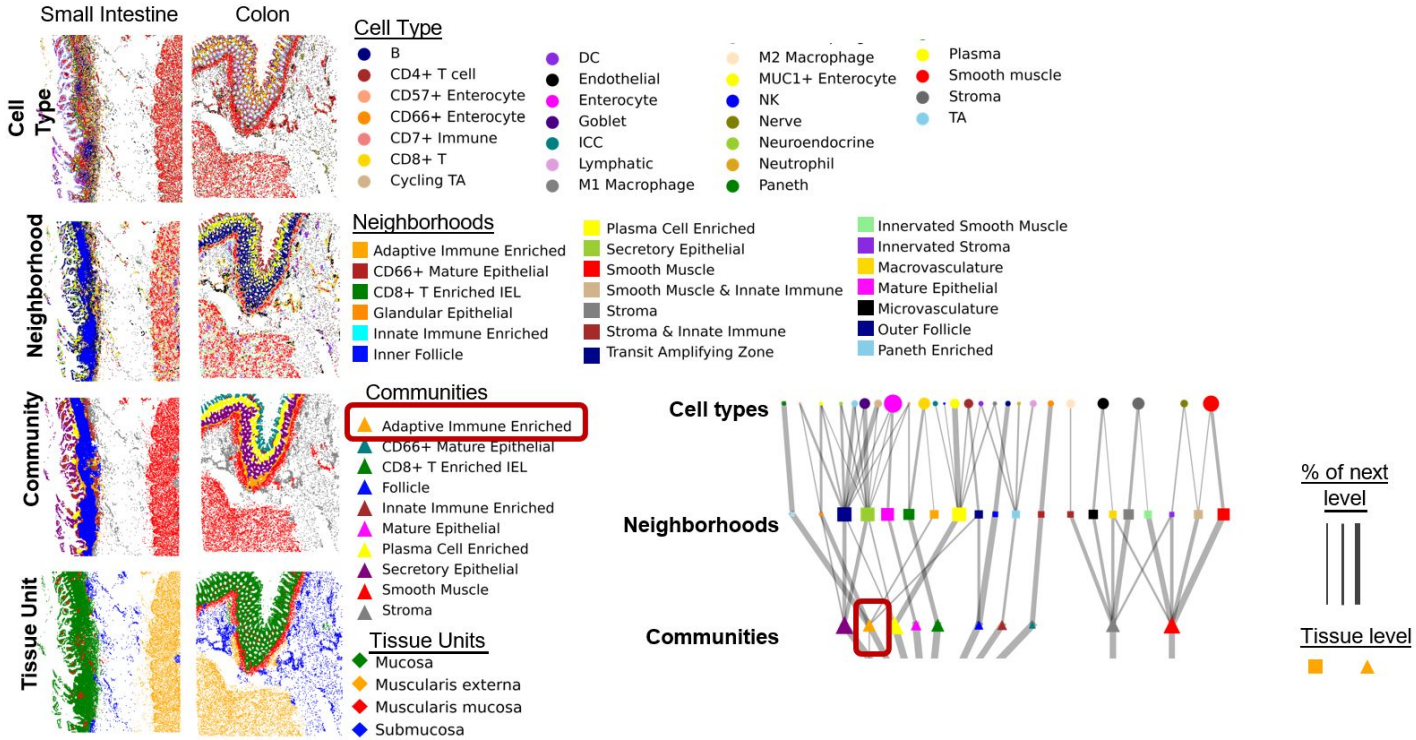
Cell size/shape



Ways to characterize the cell



Overall Structure of Intestine by Multi-Level Analysis of Functional Units



Single Cell Consortia

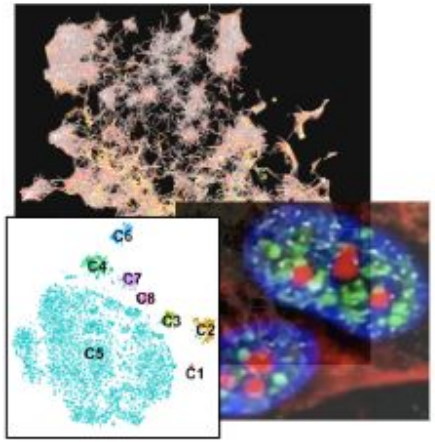
Attributed to Lord Ernest Rutherford, 1939

Cui bono?

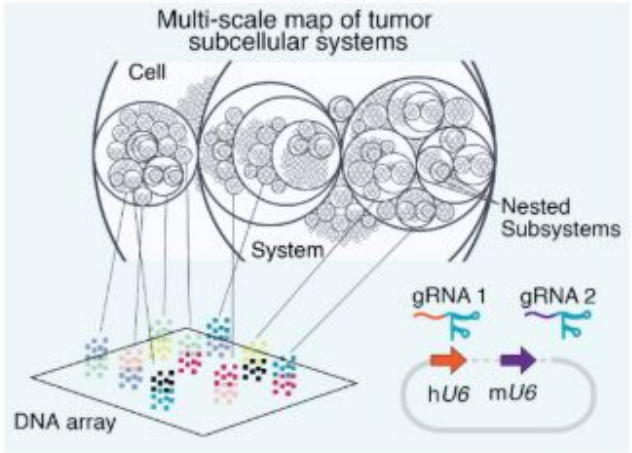
- How do we integrate these data?
- How do we tie these efforts together?
- How to relate cell maps to disease?
- How do we turn these data into knowledge?

Data integration: one way

Cell Maps for AI



AI/ML & Viz



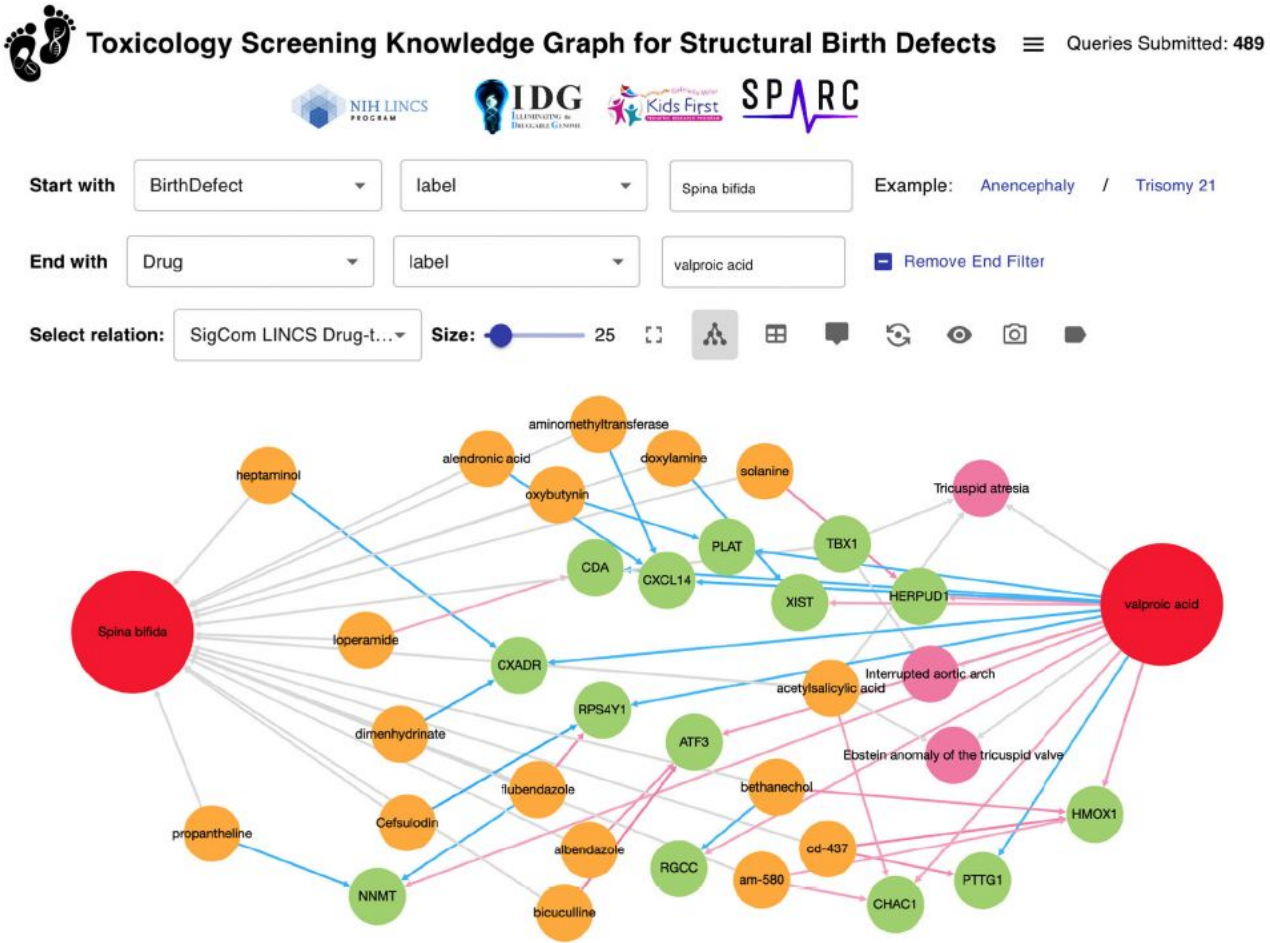
AI/ML & Viz

AI-ready datasets informing the structure & function of human cells
Spatial proteomics, CRISPR

Integrated maps of human cell architecture
Spanning 10^{-9} to 10^{-5} m

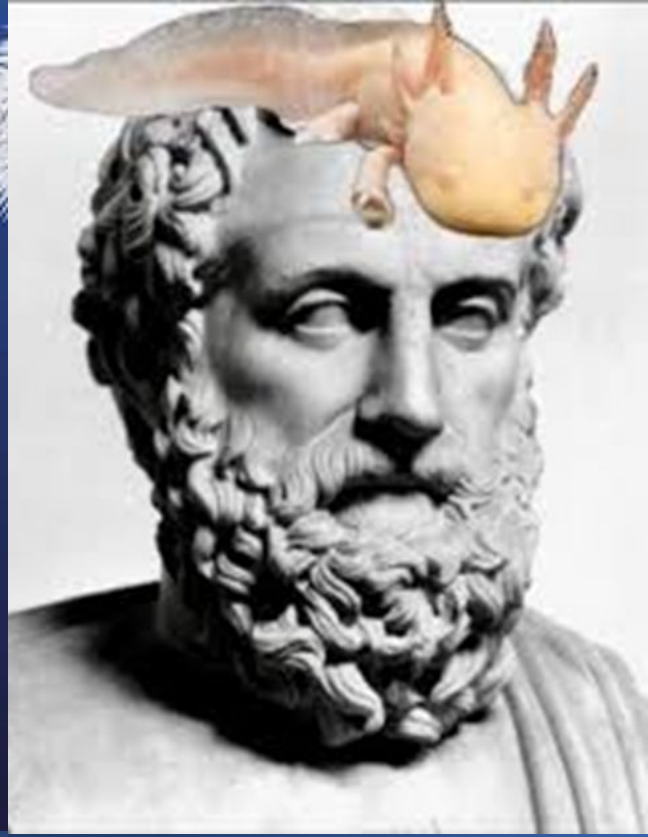
AI/ML human genome translation
Promoting trustworthy AI

Courtesy of Trey Ideker
University of California – San Diego


Toxicology Screening Knowledge Graph for Structural Birth Defects
Queries Submitted: 489
NIH LINCS PROGRAM
IDG
Kids First
SPARC
Start with
BirthDefect
label
Spina bifida
Example:
Anencephaly
/
Trisomy 21
End with
Drug
label
valproic acid
Remove End Filter
Select relation:
SigCom LINCS Drug-t...
Size:
25
aminomethyltransferase
alendronic acid
doxylamine
heptaminol
oxybutynin
solanine
Tricuspid atresia
PLAT
TBX1
CDA
CXCL14
XIST
HERPUD1
Spina bifida
valproic acid
loperamide
CXADR
acetylsalicylic acid
Interrupted aortic arch
RPS4Y1
dimenhydrinate
ATF3
Ebstein anomaly of the tricuspid valve
flubendazole
bethanechol
HMOX1
propantheline
Cefsulodin
albendazole
cd-437
RGCC
am-580
PTTG1
NNMT
CHAC1
bicuculline

Acknowledgements

Dena Procaccini
Richard Conroy
Trey Ideker
HuBMAP Consortium
CFDE program



Happy Holidays!

Thank you

commonfund.nih.gov

@NIH_CommonFund

National Institutes of Health
Office of Strategic Coordination–The Common Fund

Amy Cook, *CIFAR*

CIFAR

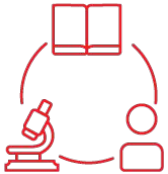
Amy Cook, PhD
Head, Research Operations

WHO WE ARE

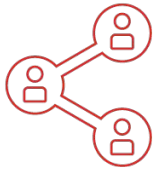
- The Canadian Institute for Advanced Research (CIFAR)
- Globally influential research organization proudly based in Canada
- We mobilize the world's most brilliant people across disciplines and at all career stages to advance transformative knowledge and solve humanity's biggest problems
- We are supported by the governments of Canada, Alberta and Québec, as well as Canadian and international foundations, individuals, corporations and partner organizations

CIFAR

CIFAR'S NEW DIRECTIONS



Affirming pinnacle aspiration



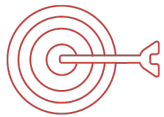
Opportunities for early-career researchers

Portfolio of Impact Clusters

Issues 'on the horizon'

Talent identification

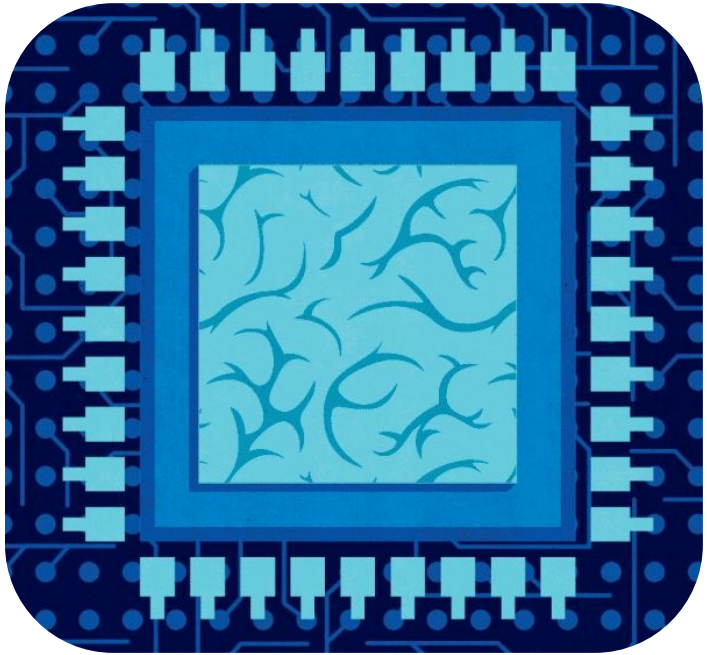
Strategic partnerships



Potential for greatest impact

CIFAR

IMPACT CLUSTERS



- Building Thriving Societies
- Decoding Complex Brains & Data
- Exploring Emerging Technologies
- Nurturing a Resilient Earth
- Shaping the Future of Human Health

Research Programs

CIFAR

2014, 2020

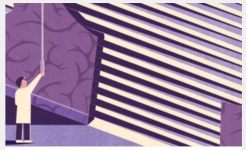
Accelerated Decarbonization

How can we learn from nature to harvest energy from the sun?

2019

Boundaries, Membership & Belonging

Is it possible to have a world without “us” and “them”?



2014, 2020

Brain, Mind & Consciousness

What are the origins and mechanisms of consciousness?

2003, 2007, 2012, 2019

Child & Brain Development

How do childhood experiences affect lifelong health?

2019

Innovation, Equity & The Future of Prosperity

How can innovation be beneficial to all?

2023

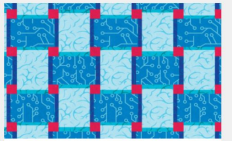
Humanity’s Urban Future

What makes a good city of the future?

2014, 2020

Humans & the Microbiome

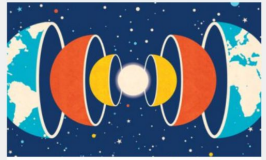
How do microbes that live in and on us affect our health, development and even behaviour?



2004, 2008, 2014, 2019

Learning in Machines & Brains

How do we understand intelligence and build intelligent machines?



2019

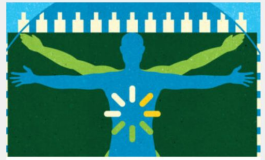
Earth 4D: Subsurface Science & Exploration

How do we understand the life, groundwater and environment deep below the surface of a planet?

2019

Fungal Kingdom: Threats & Opportunities

What might we uncover in an unknown biosphere?



2023

Future Flourishing

What does it mean to live (well) without human exceptionalism?

1986, 1991, 1996, 2001, 2006, 2011, 2016

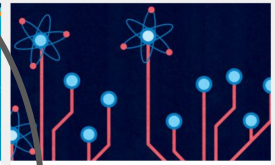
Gravity & the Extreme Universe

What is extreme gravity, and how can it help us understand the origin of the universe?

2023

CIFAR MacMillan Multiscale Human

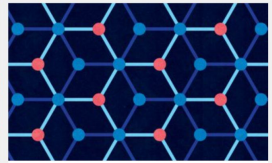
Is it possible to create a multiscale map of the human body?



2002, 2007, 2012, 2019

Quantum Information Science

How do we harness the power of quantum mechanics to improve information processing?



1987, 1992, 1997, 2002, 2007, 2012, 2019

Quantum Materials

How could quantum materials transform our society?

Leadership

Gary Bader

Program Co-Director

CIFAR MacMillan Multiscale Human

University of Toronto

Canada

Katy Börner

Program Co-Director

CIFAR MacMillan Multiscale Human

Indiana University

United States

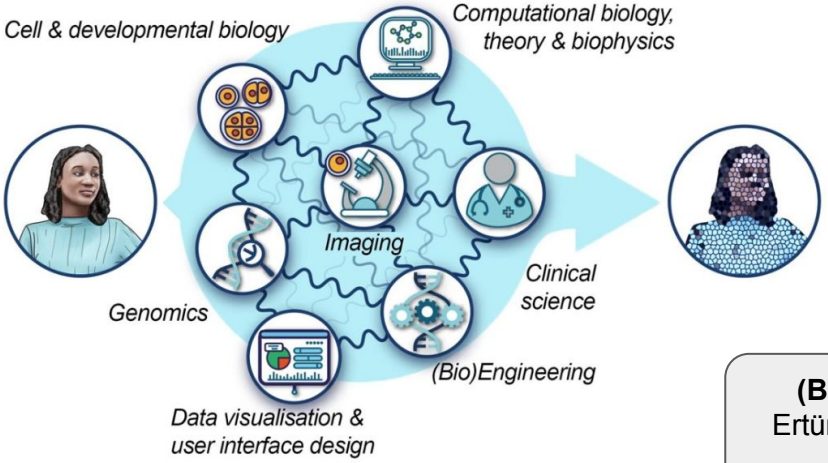
Sarah Teichmann

Program Co-Director

CIFAR MacMillan Multiscale Human

Wellcome Sanger Institute

United Kingdom



Clinicians
Gallgher, Haniffa

(Bio)engineers
Ertürk, Lee, Yachie, Zandstra

Cell and developmental biologists
Chedotal, Haniffa, Lein, Yachie, Zandstra, Zhen

Computational biologists, theoreticians and biophysicists
Bader, Goyal, Englehardt, Teichmann, Regev, Pe'er

Data visualisation and user interface design experts
Börner, Bader

Imaging experts
Ertürk, Chedotal, Gallagher, Lee, Zhen

Genome scientists
Bader, Lein, Pe'er, Regev, Teichmann

CIFAR's Research Program Model

CIFAR Research Programs are interdisciplinary, sustained networks focused on generating **transformative knowledge.**

- Comprised of 15-25 fellows from around the world (mix of career stages)
- 2-3 meetings per year: deeply collaborative networks funded for 5-year terms (renewable), with a 10-year+ horizon
- Catalyst funds to encourage collaboration

CIFAR Azrieli Global Scholars Program

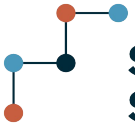
The Program develops highly talented early career researchers into influential research leaders who shape the direction of boundary-pushing research.

The program has three core components:

1. Participating in a CIFAR Research Program
2. Strengthening leadership & communication skills
3. Increasing impact within and outside of academia

CIFAR

Global Research Partners include.....



Swiss National
Science Foundation

TEMPLETON WORLD
CHARITY FOUNDATION

JACOBS
FOUNDATION

RESEARCH CORPORATION
for SCIENCE ADVANCEMENT

GORDON AND BETTY
MOORE
FOUNDATION

ALFRED P. SLOAN
FOUNDATION

Takei Kenta & Yusuke Date, *Japan*

Science and Technology Agency


Kenta Takei

Japan Science and Technology Agency (JST)

24 Hour Multiscale Human Event

Kenta TAKEI, Department of International Affairs

Yusuke DATE, Department of Strategic Basic Research

Japan Science and Technology Agency

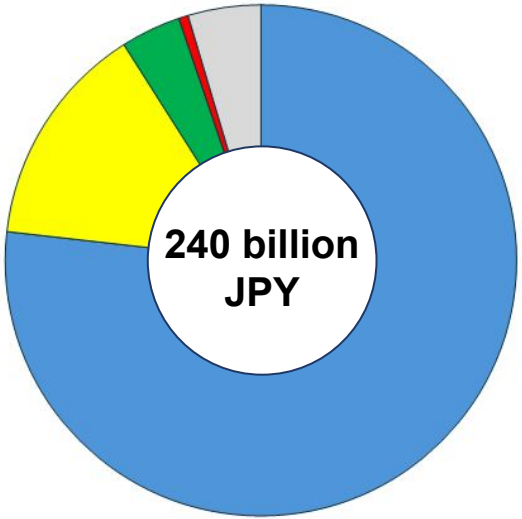
About JST

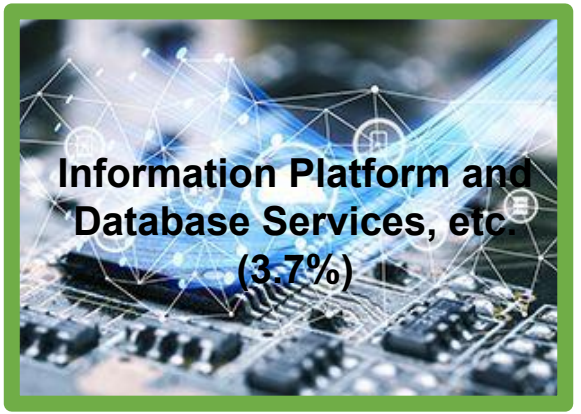
JST is a **national research and development (R&D) funding agency,**
which connects a wide range of stakeholders and drive new values for the global society

Founded in 1996
Budget: 240 billion JPY (2.18 billion CAD *)
Number of full-time employees: 1,477

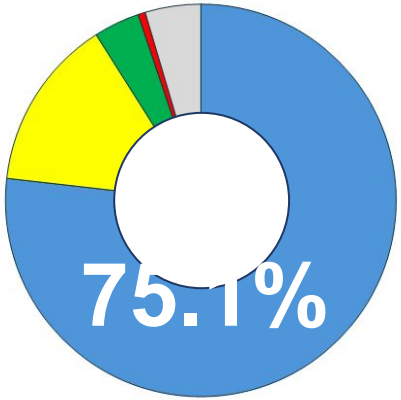
JST's Main Activities

Budget allocation





Close-up of “Research Funding”



240 billion JPY

Research funding (75.1%)

✓ Strategic Basic Research

- Create innovative technology seeds that achieve strategic goals

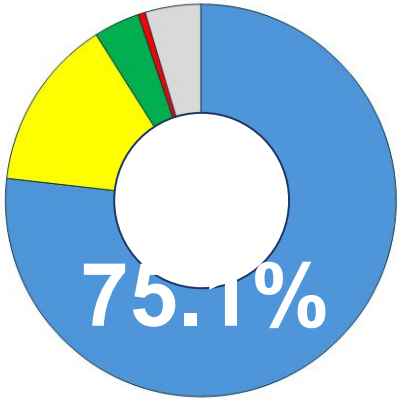
✓ International Collaboration

- Ensure continuous joint innovation and contribution to global challenges

✓ Industry-Academia Collaboration

- Create an environment for universities, research institutes, and industry to continuously generate innovation and promote commercialization

Close-up of “Research Funding”



240 billion JPY

Research funding (75.1%)

✓ Strategic Basic Research

CREST PRESTO sakigake ERATO ACT-X JST MIRAI ALCA-Next Advanced Technologies for Carbon-Neutral

RISTEX MOONSHOT RESEARCH & DEVELOPMENT PROGRAM 創発

✓ International Collaboration

ASPIRE SICORP Strategic International Collaborative Research Program SATREPS Science and Technology Research Partnership for Sustainable Development Program NEXUS 日 ASEAN 科学技術・イノベーション協働連携事業 Networked Exchange, United Strength for Stronger Partnerships between Japan and ASEAN

✓ Industry-Academia Collaboration

A-STEP START 研究成果展開事業 大学発新産業創出プログラム 出資型新事業創出支援プログラム SUCCESS

Introduction of the yuCell Research Area

Department of Strategic Basic Research

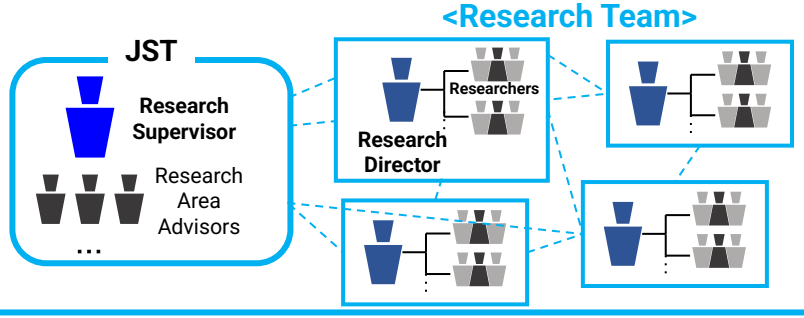
Network-Based Research programs “CREST”,”PRESTO”

- **Funding programs for basic research to overcome the problems facing Japan and to produce creative and innovative technology seeds.**
- JST specifies Research Areas **to fulfil the “Strategic Objectives” set by Japanese Government and appoints Research Supervisors (Program Officers) to lead the area.**
- The Research Supervisors creates a virtual **Network-Based Research Institute** that goes beyond industry-academia-government frameworks and selects projects most suited to accomplish the **Strategic Objectives.**

Japanese Government ⋯⋯► **“Strategic Objectives”**

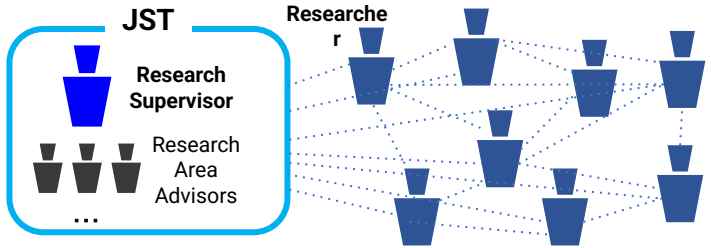
CREST Program Organization (for teams)

Research Period : 5.5 years or less
Research Cost : Total of 1.4M – 4.7M CAD / team



PRESTO Program Organization (for individuals)

Research Period : 3.5 years or less
Research Cost : Total of 28-37K CAD / individual



About yuCell:

Key words
- Bioimaging
- Fluorescent protein
- Chromophore

Research Supervisor
Miyawaki Atsushi
Laboratory Head, Center for Brain Science
Laboratory Head Center for Advanced Photonics
RIKEN

Key words
- Genome editing
- Developmental biology
- Systems genomics
- Genomics

Deputy Research Supervisor, PRESTO:
Takashi Yamamoto
Professor, Graduate School of Integrated Sciences for Life
Director, Genome Editing Innovation Center
Hiroshima University

Strategic Objective

Development of innovative cell manipulation technologies and elucidation of cellular regulatory mechanisms

Research Area (started 2023)

Yū

遊

Yu = Japanese Kanji for “Play”

yuCell

You

To approach the research “playfully”
- **Embrace and enjoy research with childlike curiosity**
- Pursue the unknown with an adventurous spirit.

About yuCell:

Key words
- Bioimaging
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Miyawaki Atsushi
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- Genomics

Deputy Research Supervisor, PRESTO:
Takashi Yamamoto
Professor, Graduate School of Integrated Sciences for Life
Director, Genome Editing Innovation Center
Hiroshima University

Research Area (started in 2023)

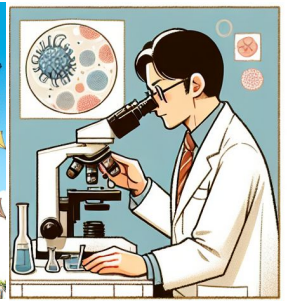
Yū "Playful Science"

遊 x You x Cell: yuCell

Yū = Japanese Kanji for "Play"

To approach the research "playfully"

- **Be able to embrace and enjoy confronting the mysteries of science.**
- Be full of adventurous spirit when pursuing the unknown.



Research Area of yuCell

Examples of research themes covered by yuCell:

(1) Development of advanced technology for controlling cells in a multicellular society (organisms, organoids, etc.)

(2) Development of advanced technology for controlling subcellular components

(3) Development of truly innovative technology for cell control

(4) Quantification of classic cell control

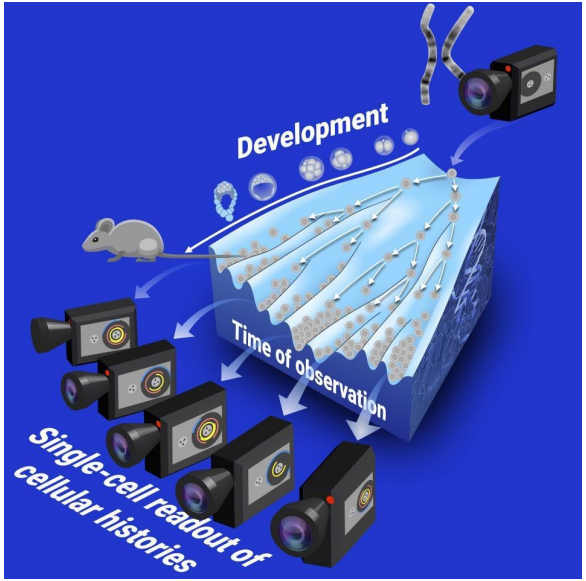
(5) Research on social demands for cell control technology

Covers all living organisms

Research projects of yuCell

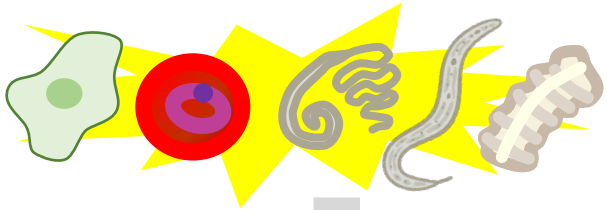
“DNA Event Recorder Cell”
Research Director: Nozomu Yachie

Research Director:
Nozomu Yachie
(Osaka University /
University of British Columbia)



“Manipulating parasites”
Research Director: Kumiko Tsukui

Research Director:
Kumiko Tsukui
(The University of Tokyo)



Discovered and developed a manipulation technique to render five types of parasites non-pathogenic.

Develop and manipulate non-pathogenic parasites

Applications for improving disease treatment, vaccines, and drug delivery

Initiatives to Foster Human Connections

yuCell's networking event: Meet the Humans, Science Optional!

<u>Aim</u>

Create serendipitous encounters for researchers that go beyond their affiliated groups and/or research themes

<u>Event Program</u>

Participants talk at pre-designated tables and freely discuss topics together (1 hr. session)

BUT

- They cannot talk about science topics* for the first 10-15 minutes!
- Once the moderator gives the signal, they are free to incorporate science topics into their discussions.

* If they talk about science topics the secret agents (JST Staff) will swoop in to investigate.

Research project of yuCell (CREST)

	Research Director	Research Projects
Since, 2023	Hideaki Kato	Development of magnetogenetics technologies
	Kotaro Kimura	Session with the worm's brain through ultra-fast optical call & response
	Hirohide Saito	Construction of Functional RNA/RNP Evolution Platform and Development of Cell Regulation Technology
	Moritoshi Sato	Opto-microorganism development for optogenetic intervention and application in vivo
	Kumiko Tsukui	Manipulating parasites
	Hiroshi Nishimasu	Genome eingineering using novel DNA recombinases
	Nozomu Yachie	DNA Event Recorder Cell
	Toshia Ando	Constructive understanding of the evolutionary origins of nanocrystal formation in vivo
Since, 2024	Satoshi Okuda	Development of organ craft technology and elucidation of morphogenesis and evolution mechanisms
	Shiro Suetsugu	Morphing cell membranes at will for a universal delivery of biomaterials of choice
	Asako Sugimoto	Development of novel chromosome manipulation techniques based on nematode-specific chromosome rearrangement mechanisms
	Rei Narikawa	Playing bacteria with light
	Yoshie Harada	Quantum Smart Tool: Manipulation of neural/glial functions via thermal signaling control

Research project of yuCell (PRESTO)

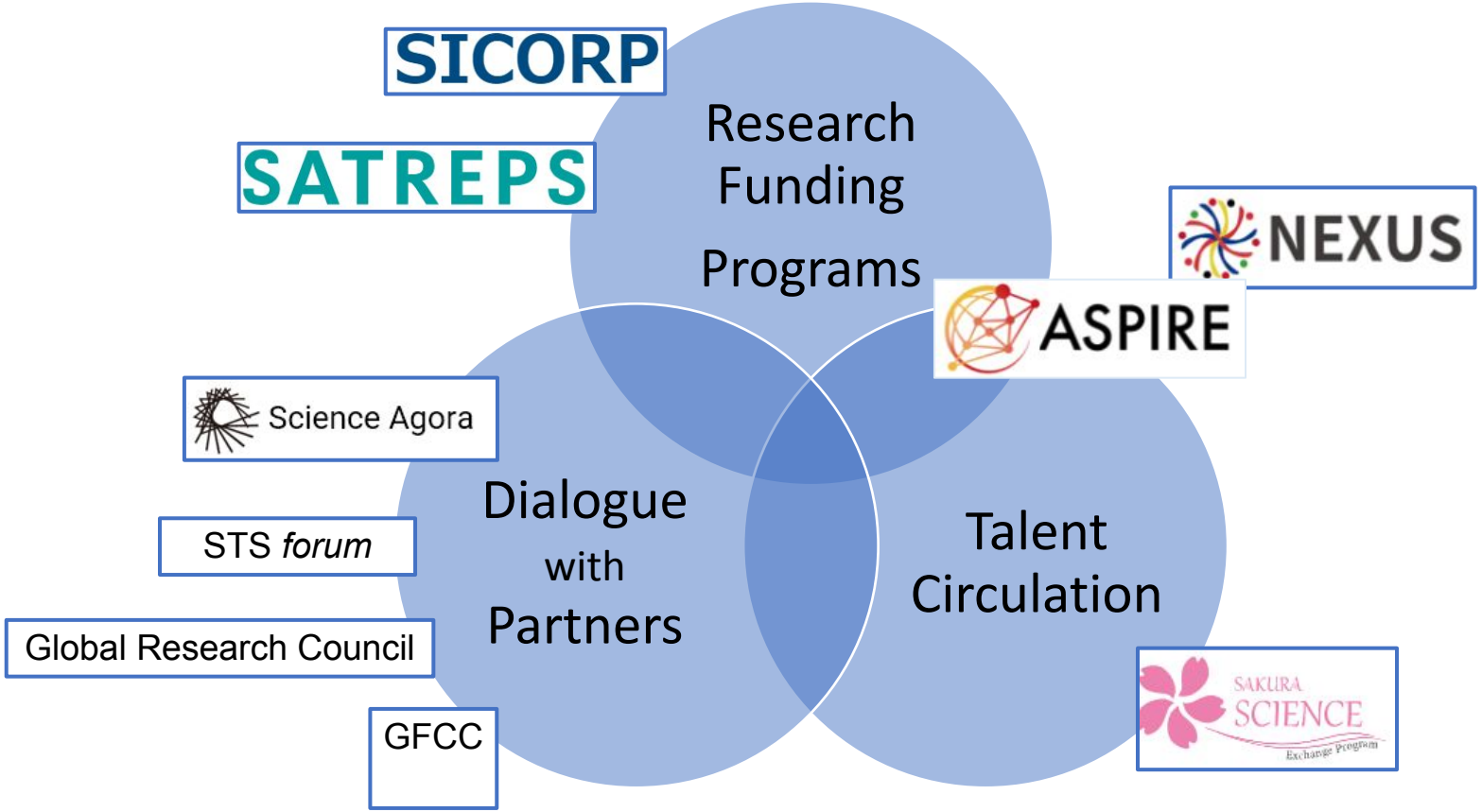
Since, 2024

Researchers	Research Projects
Tomoyoshi Inoue	Optical technologies for controlling deep brain region in mouse
Naoko Irie	Metabolic Manipulation: Harnessing Metabolic Switch Mechanisms in Early Human Embryos
Hiroaki Ohishi	Transcriptional manipulation through spatial crosstalk between epigenomes
Takeshi Onuma	House construction with animal fibers on epidermal cells
Naoyoshi Kumakura	Playing with appressoria: Development of turgor pressure and adhesion control, among the highest generated by cells
Masahiro Kumeta	Cell manipulation by an audible range of acoustic stimulation
Keiichi Kojima	Creation of Opto-GPCRome
Takahiro Kosugi	Development of cell manipulation technology by restoring and extending lost protein functions
Makoto Saito	Investigation of OMEGA-associated systems for the development of molecular tools
Keiichiro Shiraga	Cell control through visualization of water: Manipulating intracellular water
Masaharu Somiya	Construction of designer cells by synthetic membrane fusion machinery
Yuhei Chadani	Manipulating genetic information hidden within the amino acid sequences.
Hideki Nakamura	Developing synthetic cytoskeletons for arbitrary manipulation of cellular movements
Takeshi Higa	Development of opto-manipulation techniques for localization of organelles or membrane proteins
Masahiro Fukuda	A challenge for light-controllable membrane transport
Natsuko Miura	Development of tools for manipulation of cell metabolism via control of enzyme condensates

JST's International Cooperation and ASPIRE Program

Department of International Affairs

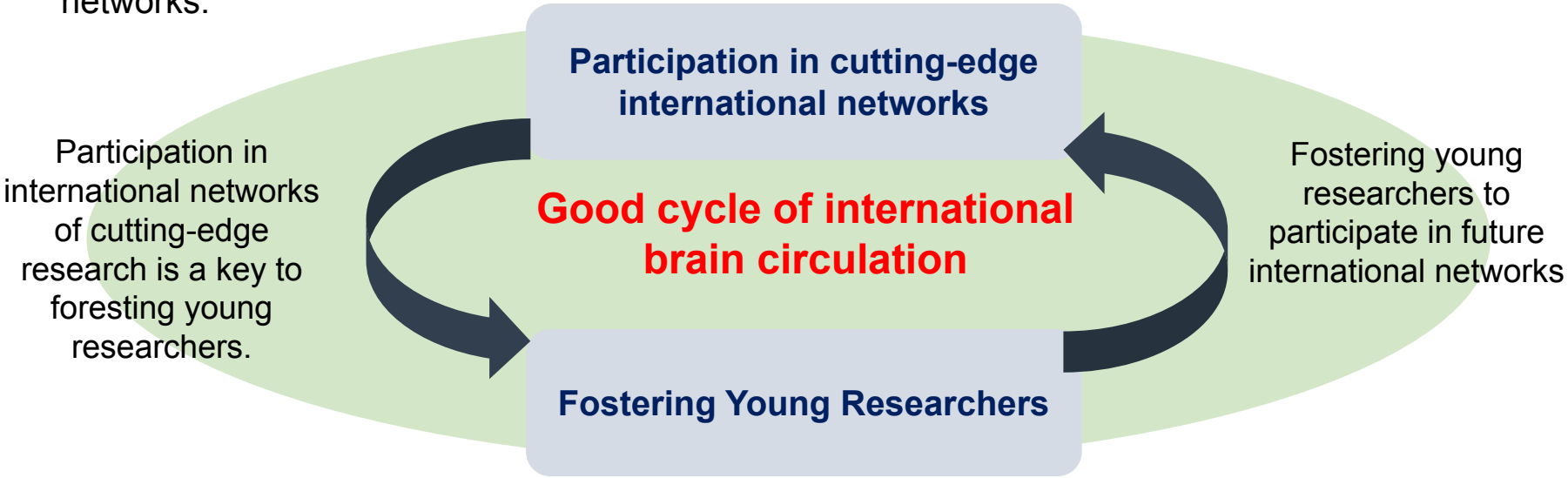
JST's International Cooperations



ASPIRE aims:

Stimulating "international talent mobility" and "joint research"

- Encourage researchers to participate in international networks of cutting-edge research.
- Fostering young researchers and encourage their participation in sustainable international networks.

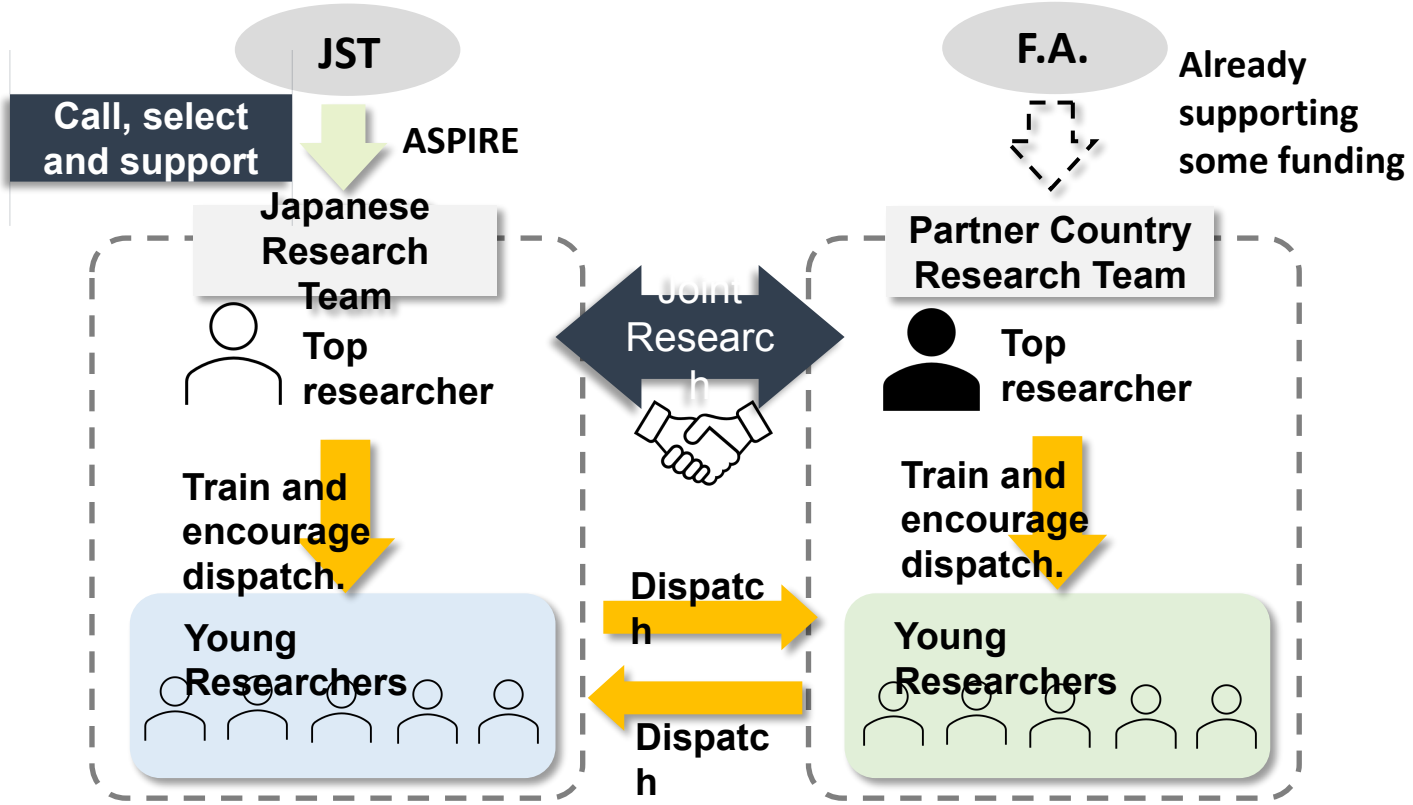


ASPIRE Outline (Alignment call – Japan side call)

ASPIRE supports top researchers joint research project mainly focus on **mobility actions** for nurturing early career researchers.

	ASPIRE for Top Scientists	ASPIRE for Rising Scientists
Research fields	AI & Information, Biotechnology, Energy, Materials, Quantum, Semiconductors, and Telecommunications.	
Partner countries	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, EU, Finland, France, Germany, Italy, Netherlands, Norway, Poland, Portugal, South Korea, Spain, Sweden, Switzerland, UK, US	
Support scale for Japan-side	Around 500 million JPY (910K CAD) for 5 years	Around 60 million JPY (270K CAD) for 3 years

How ASPIRE works in Alignment Call



For Further Information

yuCell Research Area (within CREST, ESTO)

CREST PRESTO sakigake

https://www.jst.go.jp/kisoken/crest/en/research_area/area2023-4.html

ASPIRE Program

ASPIRE

https://www.jst.go.jp/aspire/en/

Thank you for your kind attention.

Grace Peng, *NIH/NIBIB* &
Reed Shabman *NIH/NIAID, Interagency Modeling and Analysis Group (IMAG)*

Reed Shabman: presenting on behalf of Grace Peng, Liz Ginexi, and IMAG

IMAG

Interagency Modeling and Analysis Group

Co-Chairs: Grace Peng, Liz Ginexi, Reed Shabman

IMAG Interagency Modeling And Analysis Group

MULTISCALE MODELING CONSORTIUM

More mechanistic insight creates a higher value product

- ***less propagation of uncertainty***

Since 2003

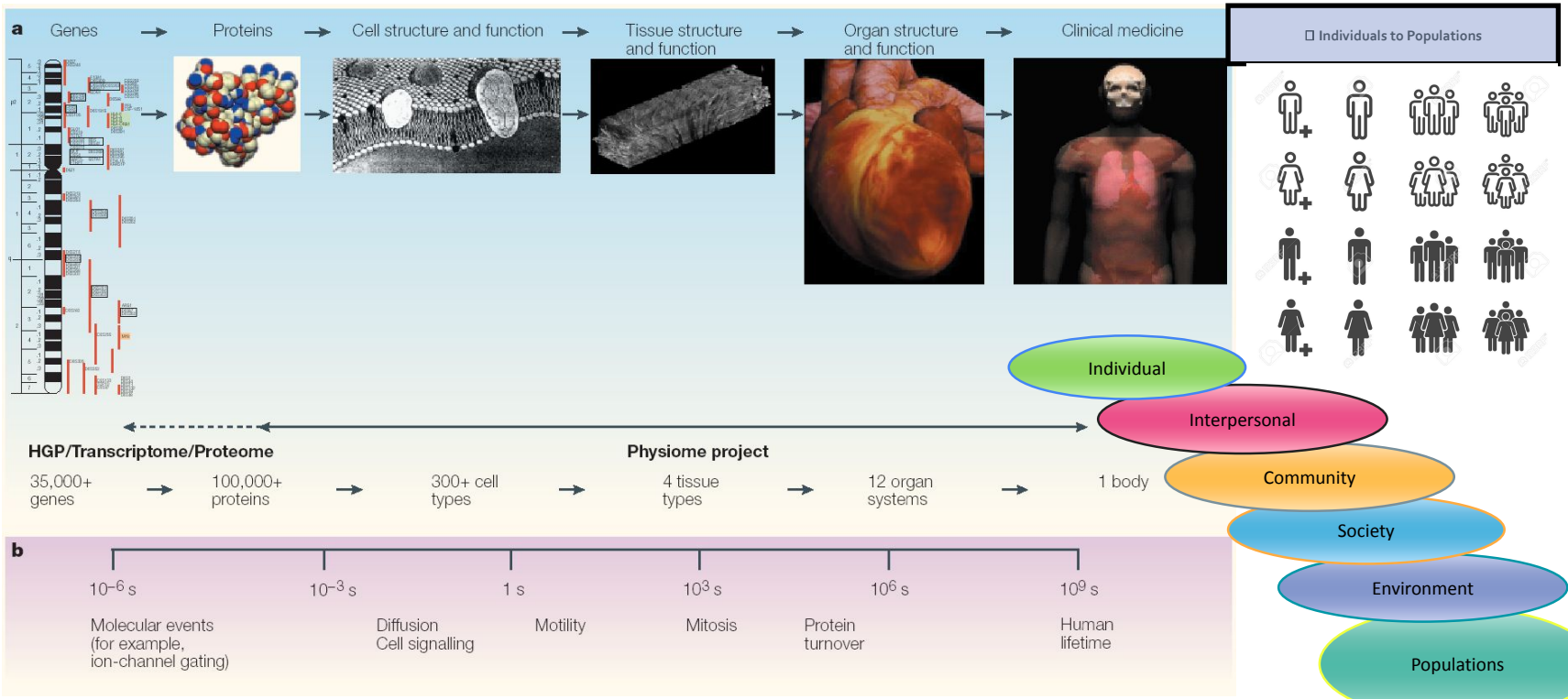
Greater than the sum of its parts

MULTISCALE MODELING CONSORTIUM

Come join us! Form an Interest Group on the wiki!

https://www.imagwiki.nibib.nih.gov/ or search ‘IMAG Wiki’

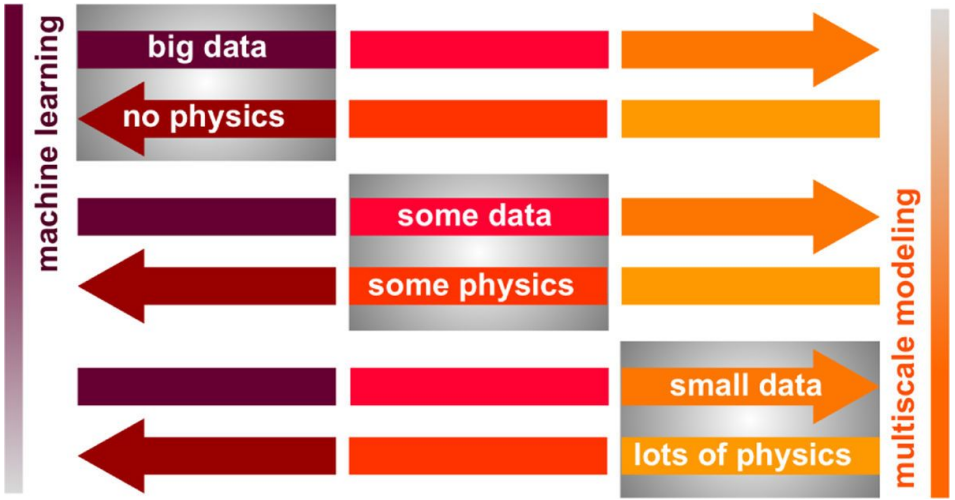
IMAG MULTISCALE MODELING CONSORTIUM



Hunter and Borg, Nature 2003

Social-Ecological Systems

Alber, M., Buganza Tepole, A., Cannon, W.R. *et al.** **Integrating machine learning and multiscale modeling—perspectives, challenges, and opportunities in the biological, biomedical, and behavioral sciences**. *npj Digit. Med.* **2,** 115 (2019). https://doi.org/10.1038/s41746-019-0193-y *Ellen Kuhl



Peng, G.C.Y., Alber, M., Buganza Tepole, A. *et al.** **Multiscale Modeling Meets Machine Learning: What Can We Learn?**. *Arch Computat Methods Eng* (2020). https://doi.org/10.1007/s11831-020-09405-5 *Ellen Kuhl

IMAG

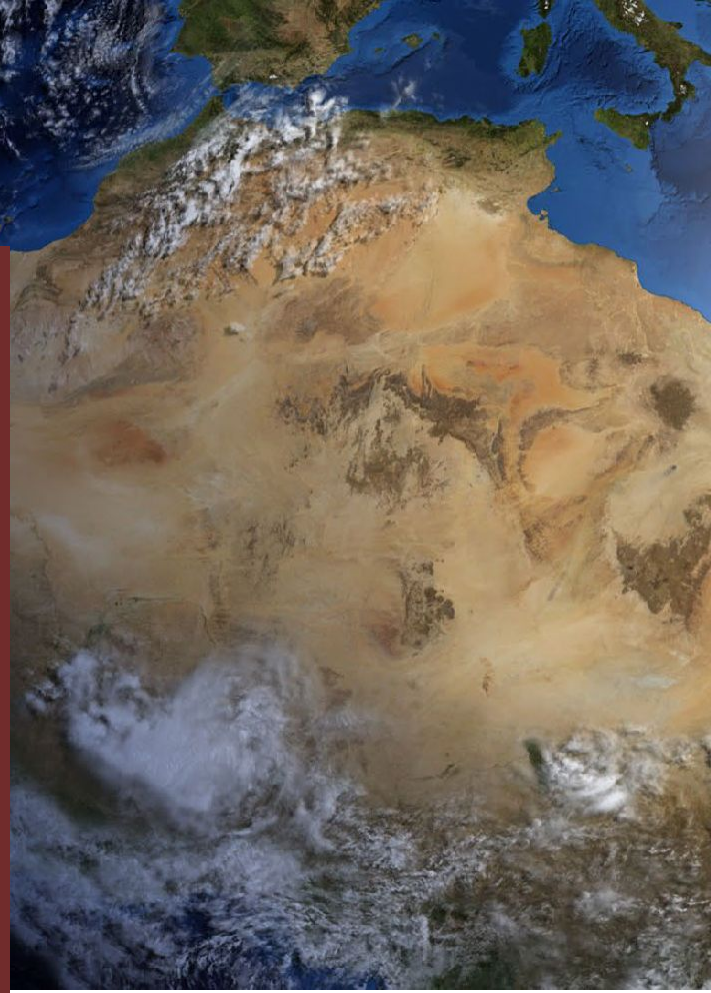
NATIONAL ACADEMIES Sciences Engineering Medicine

Foundational Research Gaps and Future Directions for Digital Twins

Karen Willcox (chair), Caroline Chung, Jim Kinter, Irene Qualters, Brittany Segundo

December 15, 2023

https://www.nationalacademies.org/ digital-twins



REPORT BRIEFING

Definition of a Digital **Twin**

> *A digital twin is a set of virtual information constructs that mimics the structure, context, and behavior of a natural, engineered, or social system (or system-of-systems), is dynamically updated with data from its physical twin, has a predictive capability, and informs decisions that realize value. The bidirectional interaction between the virtual and the physical is central to the digital twin.*

Committee's definition builds on a definition from an AIAA and AIA Position Paper (2020)

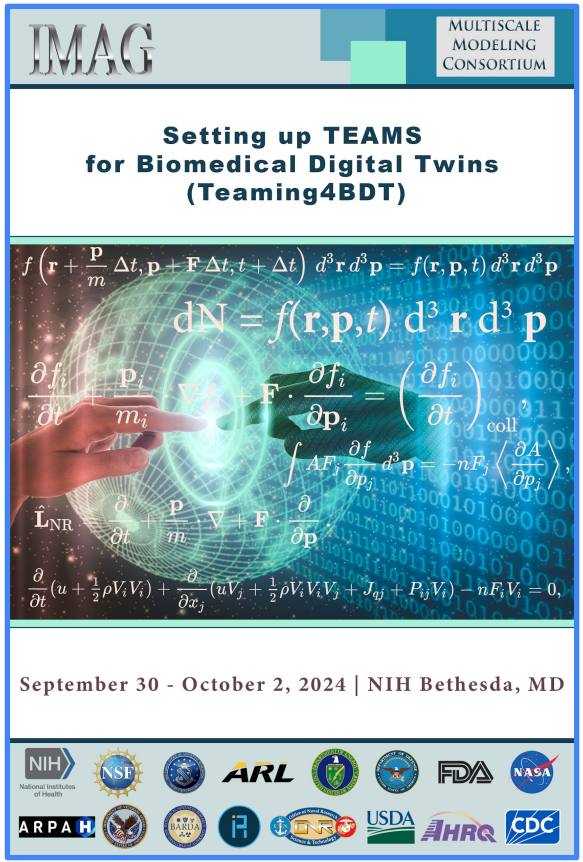
2024 IMAG MSM Consortium Meeting

Setting up TEAMS for Biomedical Digital Twins (Teaming4BDT)

- **September 30 - October 2, 2024**
- All presentations, notes, recordings posted on the IMAG WIKI

Special thanks to NSF for providing Travel Awards

Special thanks to the Society for Mathematical Biology for providing refreshments



Day 1 - Defining Biomedical Digital Twins (BDT)

- Goal 1: To understand the NASEM Digital Twin components
- Goal 2: To identify unique features for digital twins in the biomedical domain (BDT)

Create requirements template for BDT

Day 2 - Approaches to address BDT challenges

- Goal 1: To understand the challenges unique to developing BDT
- Goal 2: To discuss needs with experts and compile BDT component resources

Create assessment template for BDT

Day 3 - Operationalizing Team Science for BDT

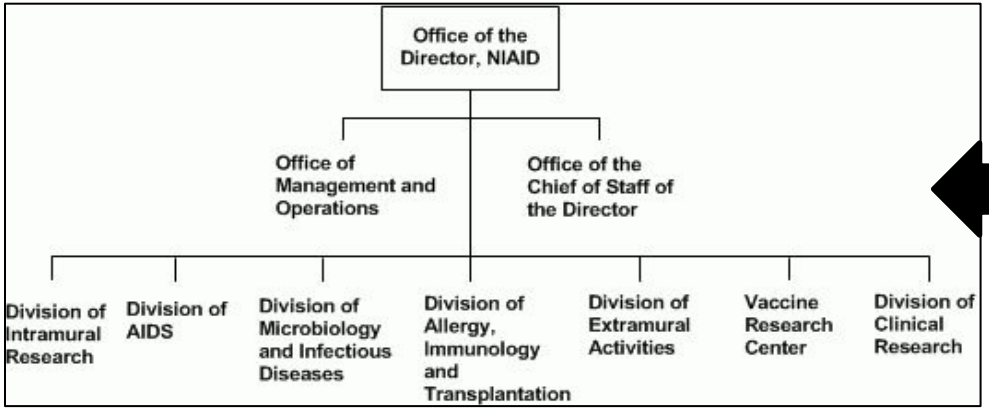
- Goal 1: To form BDT idea teams guided by team science approaches
- Goal 2: To present and review realizable, fit for purpose BDT ideas

Utilize consensus requirements and assessment templates developed in Day 1 and Day 2

Organized and hosted by the Interagency Modeling and Analysis Group (IMAG) and the Multiscale Modeling (MSM) Consortium

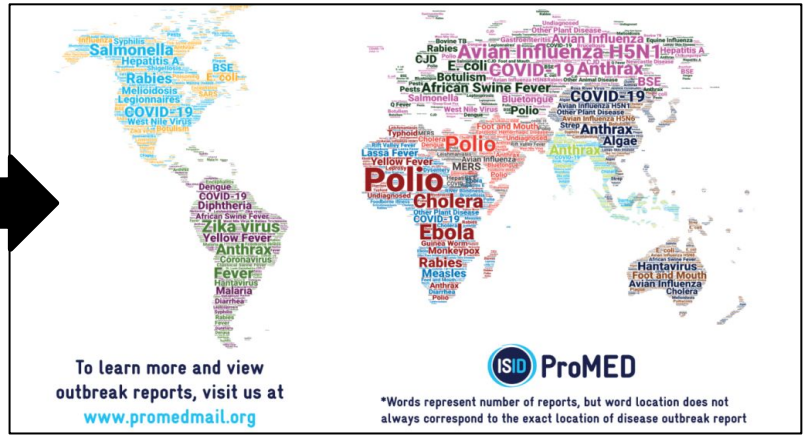
My Day Job....
Data Science & the NIAID Mission

Expand the breadth and depth of knowledge in all areas of infectious, immunologic, and allergic diseases



Facilitate data use and computational methods in research mission areas

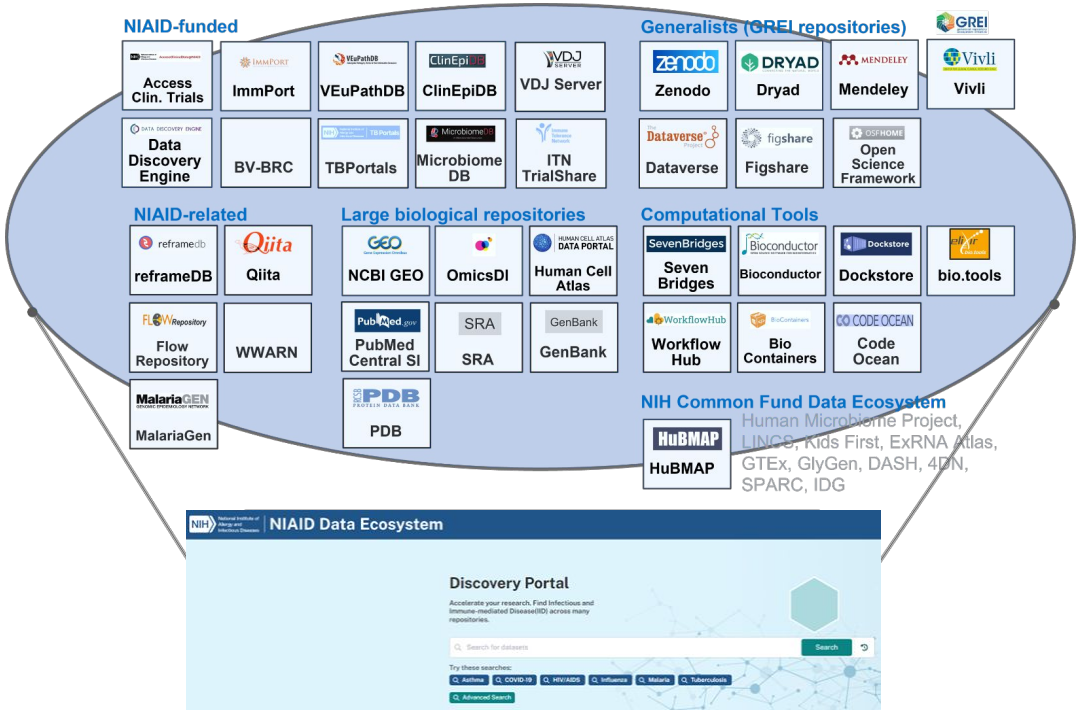
Respond rapidly to new and emerging threats



Coordinate NIAID's data science strategy across its global portfolio of research and training initiatives

NIAID Data Ecosystem Discovery Portal Returns Results from Different Repos at Once

Finding data is a critical first step

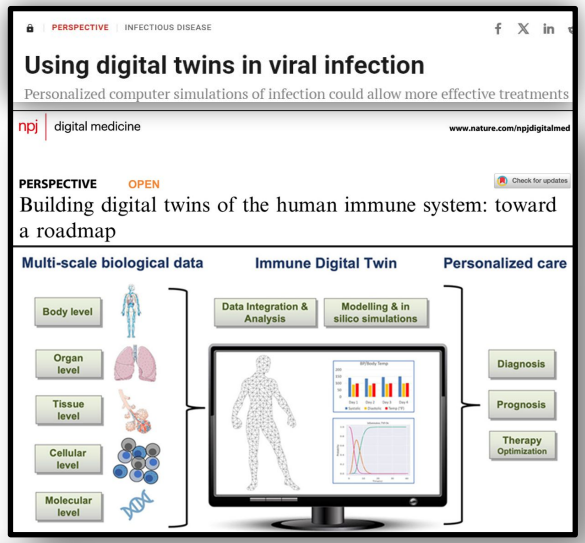


https://data.niaid.nih.gov/

2024 Portal Highlights

- 35 ‘dataset repositories’
- 20 ‘resource catalogues’
- Addition of “NIAID Program Collections”
- Search enabled for “Computational tools”

Example: Artificial intelligence can support real time data capture for applications in immunology



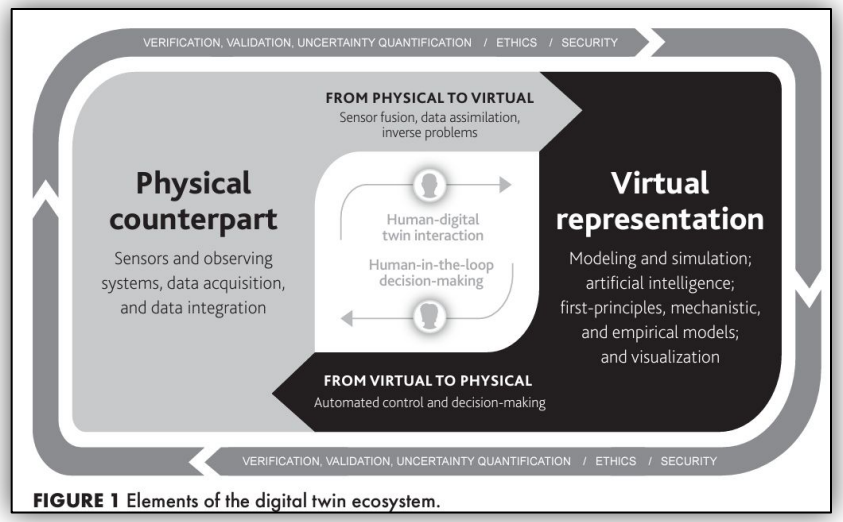


FIGURE 1 Elements of the digital twin ecosystem.

"AI/ML can continuously collect and analyze data from individuals…allowing for constantly updated personalization of patient care." NASEM Report, 2023

Questions or Comments?

Email us!

Office of Data Science and Emerging Technologies (ODSET)

datascience@niaid.nih.gov

Learn more about NIAID Data Science
(datascience.niaid.nih.gov)

Explore the NIAID Data Ecosystem Discovery Portal
(https://data.niaid.nih.gov/)

https://www.imagwiki.nibib.nih.gov/ or search 'IMAG Wiki'

Q&A

https://humanatlas.io/events/2024-24h

Questions

How do we best fund R&D toward a Multiscale Human Atlas?

How do we measure the coverage, quality, utility, and impact of Multiscale Human maps and models?

How can AI be used to advance science (management) and clinical practice?

Thank you