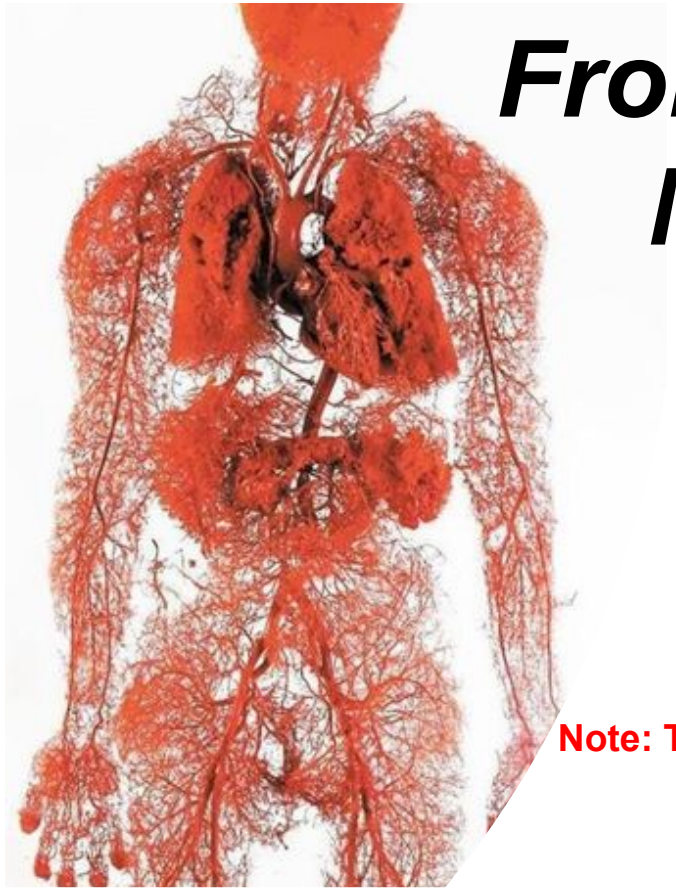
NAVBO Webinar

Mapping Knowledge about Human Vasculature Across Body Scales

Aug 31, 2021



From Mapping the Vasculome to Mapping the Human Body. And Back!

Zorina Galis, PhD
Chief, Vascular and Hypertension Branch
NIH / NHLBI

Note: The opinions presented do not necessarily represent the NIH/NHLBI opinions.

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Main Points

From the Vasculome to HuBMAP

- September 2014: NIH Workshop "Small Blood Vessels, Big Health Problems" (NHLBI, NINDS)
- July 2015: New NIH Common Fund Proposal Competition: "*Vasculome-ZIP*" (NHLBI &NINDS w/NCI, NICHD, NIAID, NIDA, NEI, NIAAA, ORWH, NCATS)
- December 2015: Finalist NIH Common Fund, Presentation to NIH Directors Table:
  - *"Vasculome-ZIP," a Google Map" of the Human Vasculature*

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

The NIH Common Fund Human BioMolecular Atlas Program (HuBMAP)

https://commonfund.nih.gov/HuBMAP

Vision:

Catalyze development of an open, global framework for comprehensively mapping the human body at a cellular resolution

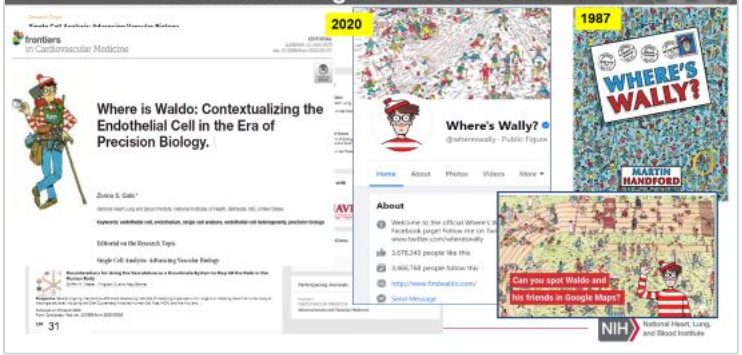
NIH National Institutes of Health

From HuBMAP back to the Vasculome

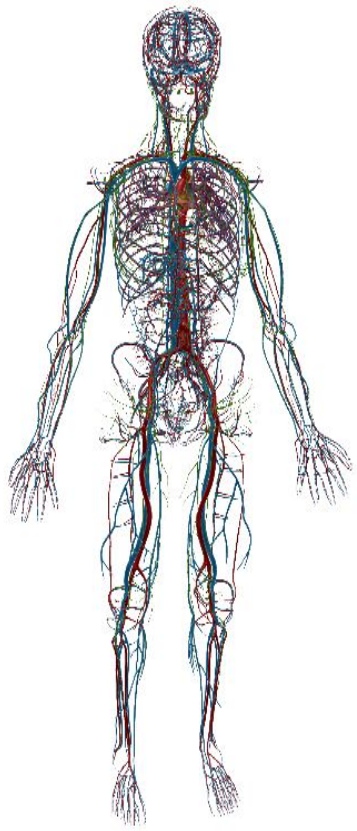
- December 2017 >>> Proposal to use the Vasculature as a Common Coordinate Frame (VCCF) for the Human Body. Joint NIH-Chan Zuckerberg Initiative Meeting
- December 2017: New HuBMAP RFAs published
- August 2018: First HuBMAP Awards were made
- May 2019: >>> Presented "Evaluating the Vasculature as CCF. Road Map for the Human Body "Google Map". HuBMAP Anatomical Mapping Workshop, IU/Virtual

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

"Endothelium as the Organizing Principle of the Vasculome" >>> Allows for Single Cell Resolution VCCF



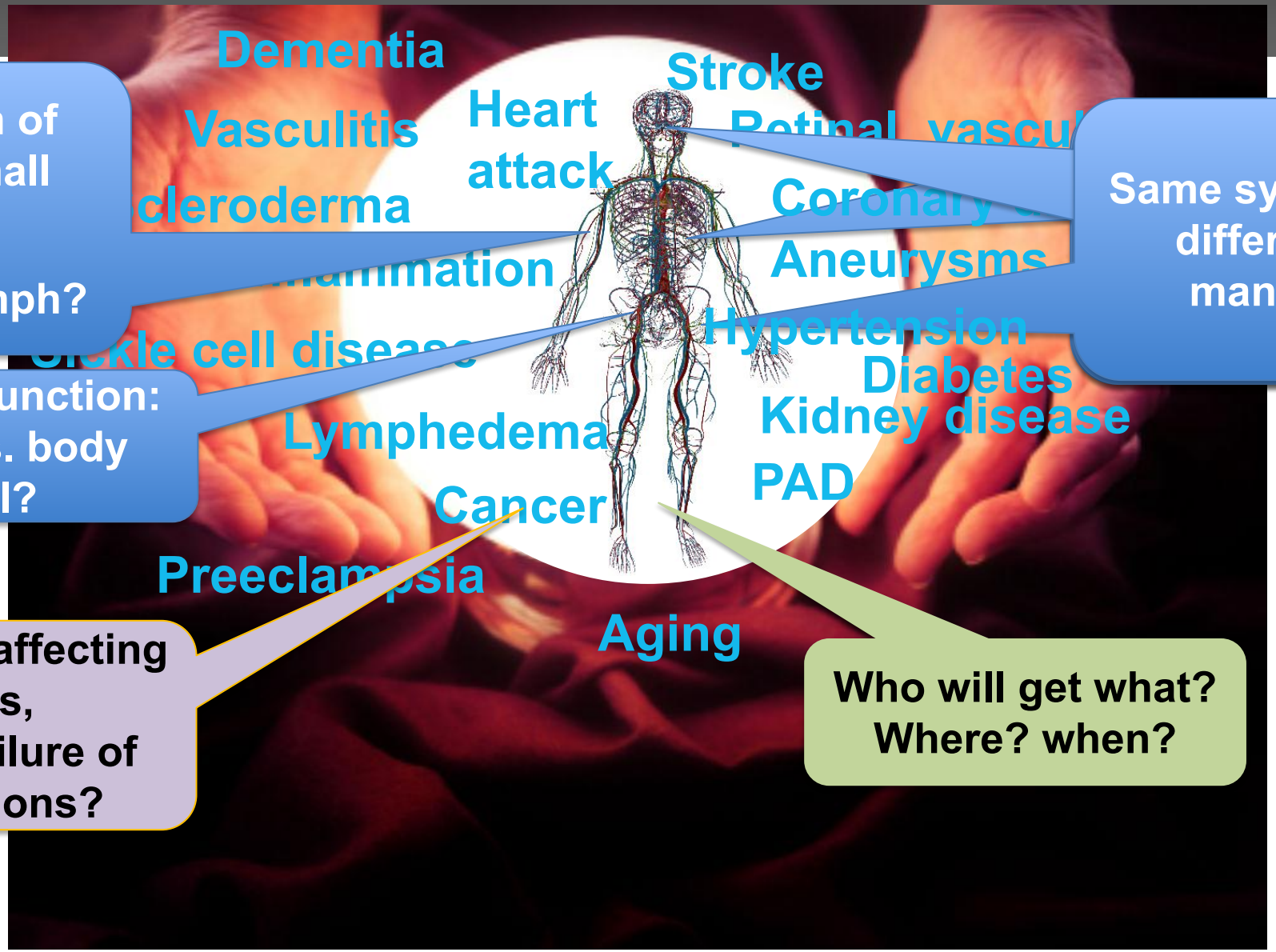
From the Vasculome to HuBMAP



- **September 2014: NIH Workshop "Small Blood Vessels, Big Health Problems" (NHLBI, NINDS)**
- **July 2015: New NIH Common Fund Proposal Competition: "*Vasculome-ZIP*" (NHLBI &NINDS w/NCI, NICHD, NIAID, NIDA, NEI, NIAAA, ORWH, NCATS)**
- **December 2015: Finalist NIH Common Fund, Presentation to NIH Directors Table:**
  - ***"Vasculome-ZIP," a Google Map" of the Human Vasculature***

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Enduring Mysteries…



Contribution of large vs. small vessels?

Blood vs. Lymph?

Same systemic disease, different vascular manifestations?

Vascular function: organ vs. body level?

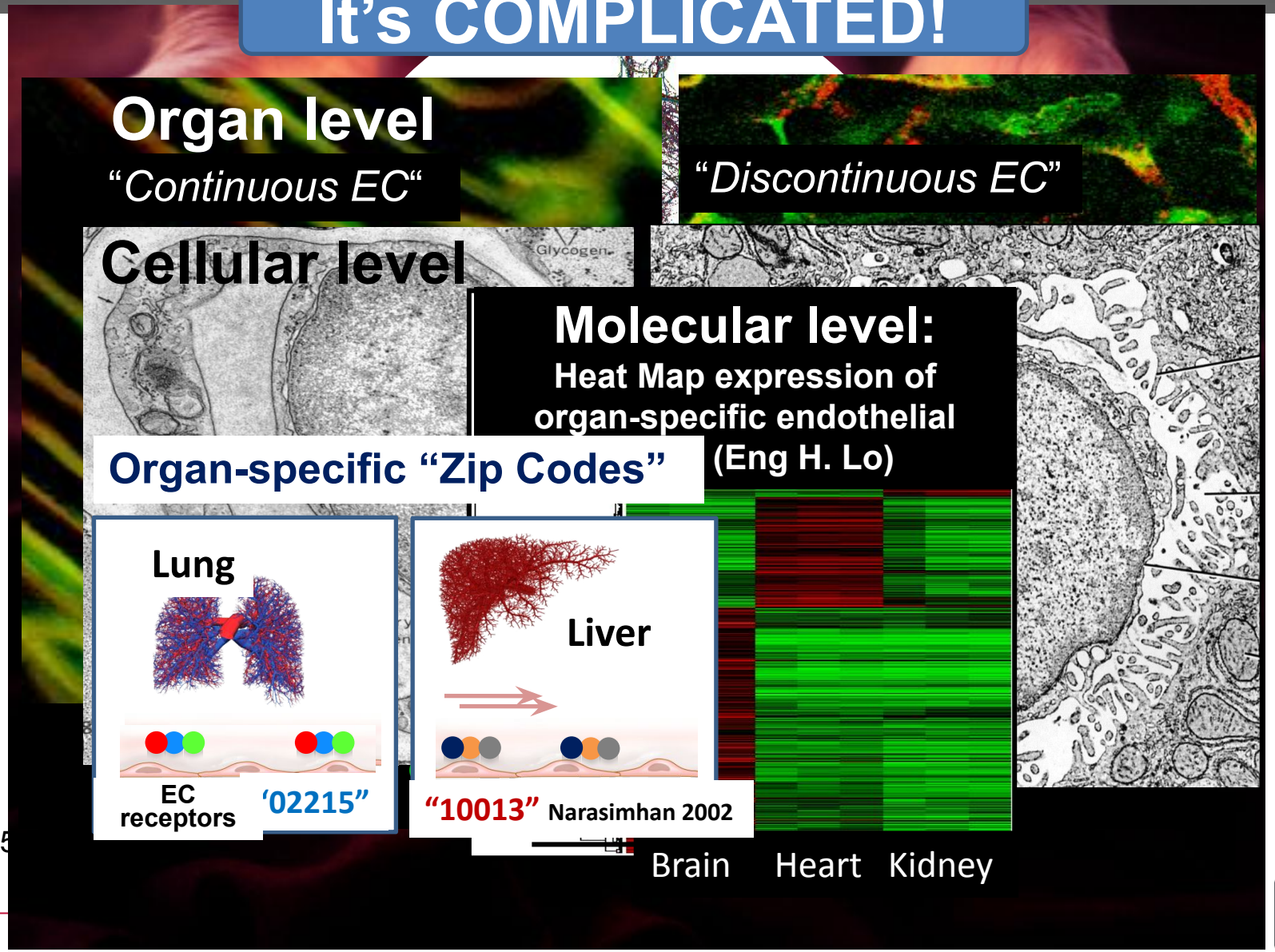
Parameters affecting access, success/failure of interventions?

Who will get what? Where? when?

Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

Why are these persisting?

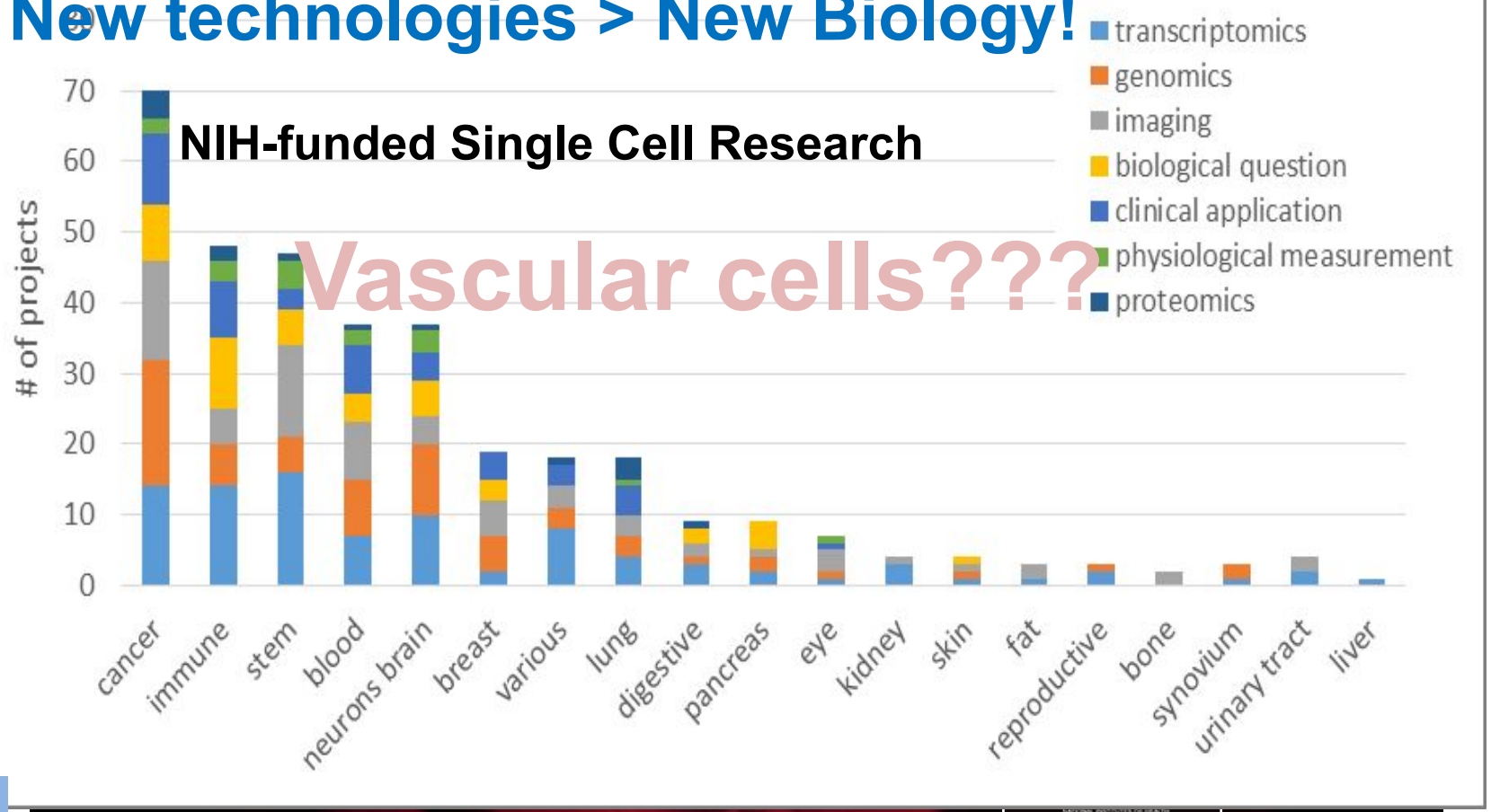
It's COMPLICATED!



Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

Current Solution For Understanding Vascular Complexity?

New technologies > New Biology!



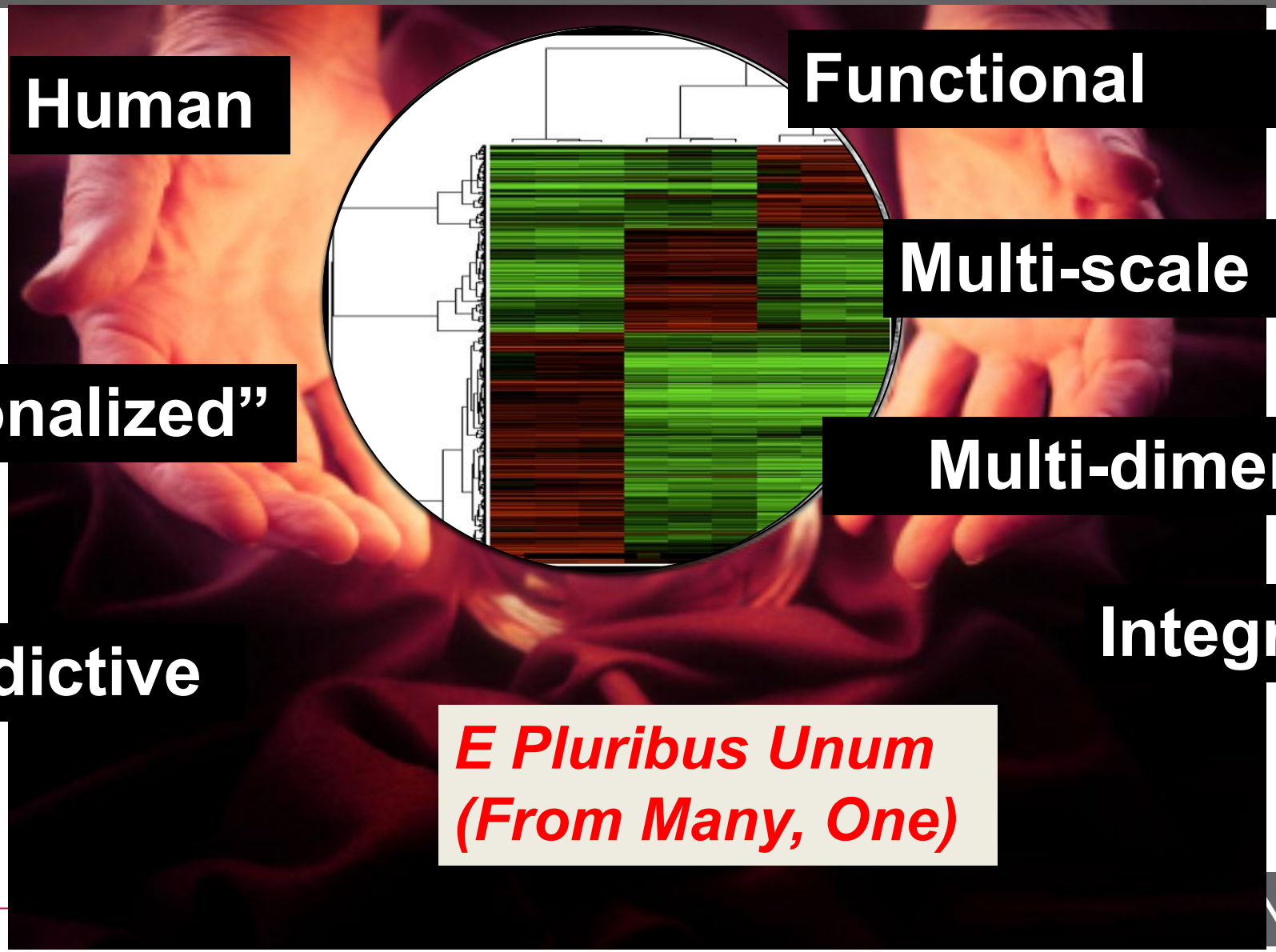
IVBM 2016
NHLBI Session
E Pluribus Unum:
"The Vasculome?"

Time for *"The Vasculome?"*

The Endothelium: *Organizing Principle*?

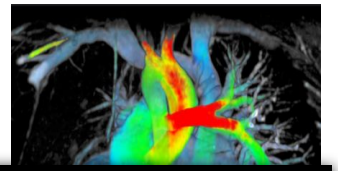
Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

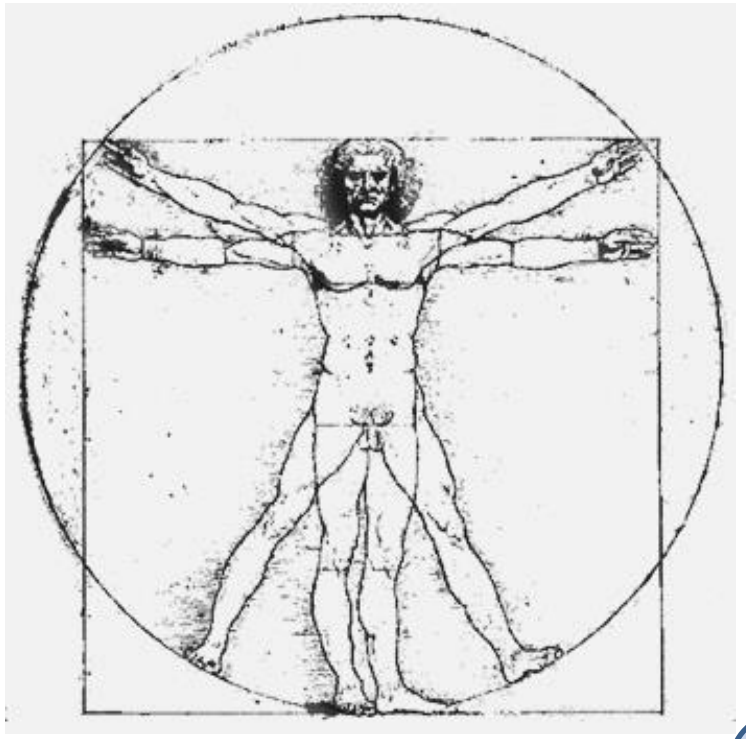
"The Vasculome"…



Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

Whole body/organ analysis



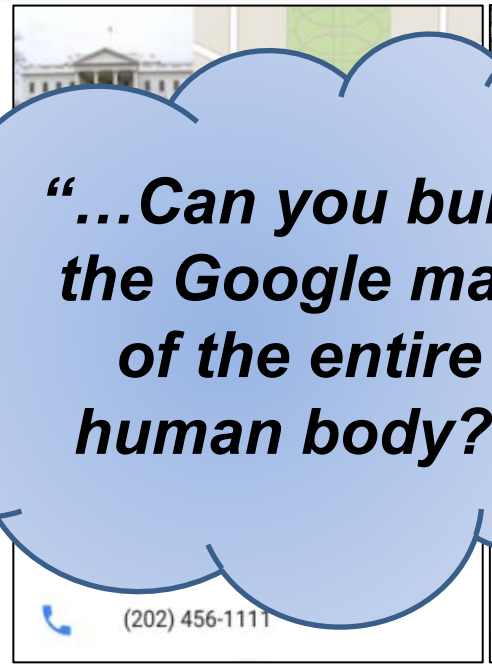


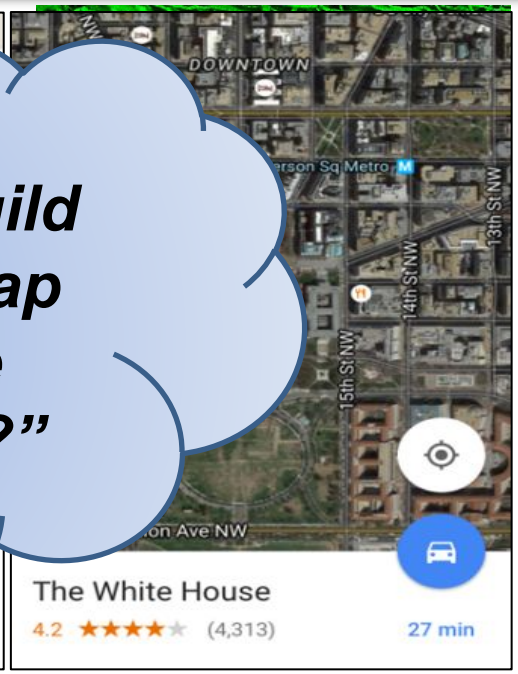
OBSERVED SCALE

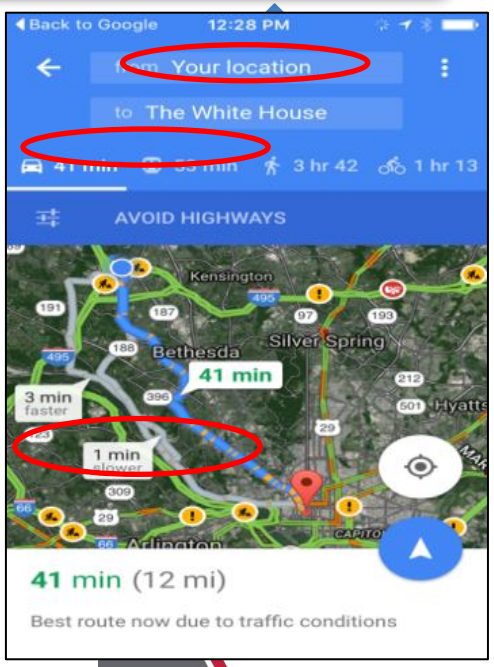
INVESTIGATION RE

"We Need a "Google Map" of the Human Vasculature!"

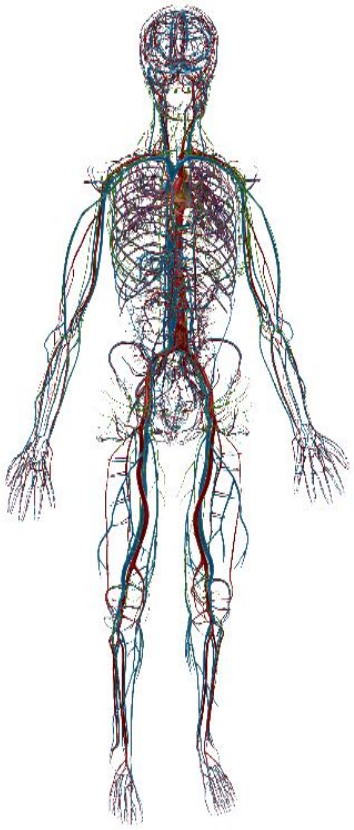
"…Can you build the Google map of the entire human body?"







From the Vasculome to HuBMAP



>>> **Approved December 2015**… as Google map for the entire Human Body!

- Single Cell Analysis Program (SCAP) 2.0 (NIBIB&NIMH w/NIAID, NCI, NIGMS, NIDDK)

- **January 2016: New Common Fund "Concept" Presented at the NIH Council of Councils** (NHLBI, NIBIB, NIDDK): ***The Human Biomolecular Atlas Program (HuBMAP)***
- **September 2016: NIH Council of Councils Approves New "HuBMAP" Common Fund**
- **October 2106: IVBM 2016: E Pluribus Unum: "The Vasculome?"**
- **December 2017: New HuBMAP RFAs published**
- **August 2018: First HuBMAP Awards**
- **August 2020: First Data Release!**
- **To be continued…**

https://commonfund.nih.gov/hubmap

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

The NIH Common Fund Human BioMolecular Atlas Program (HuBMAP)

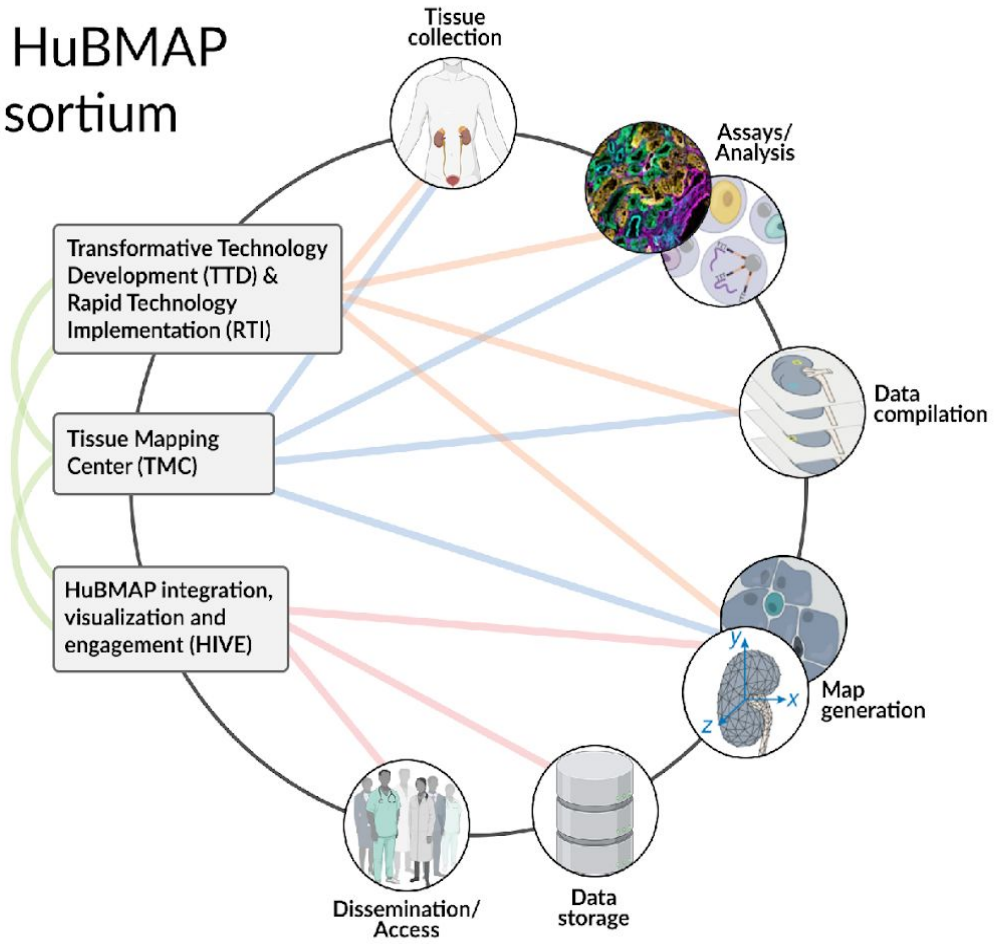
https://commonfund.nih.gov/HuBMAP

Vision:

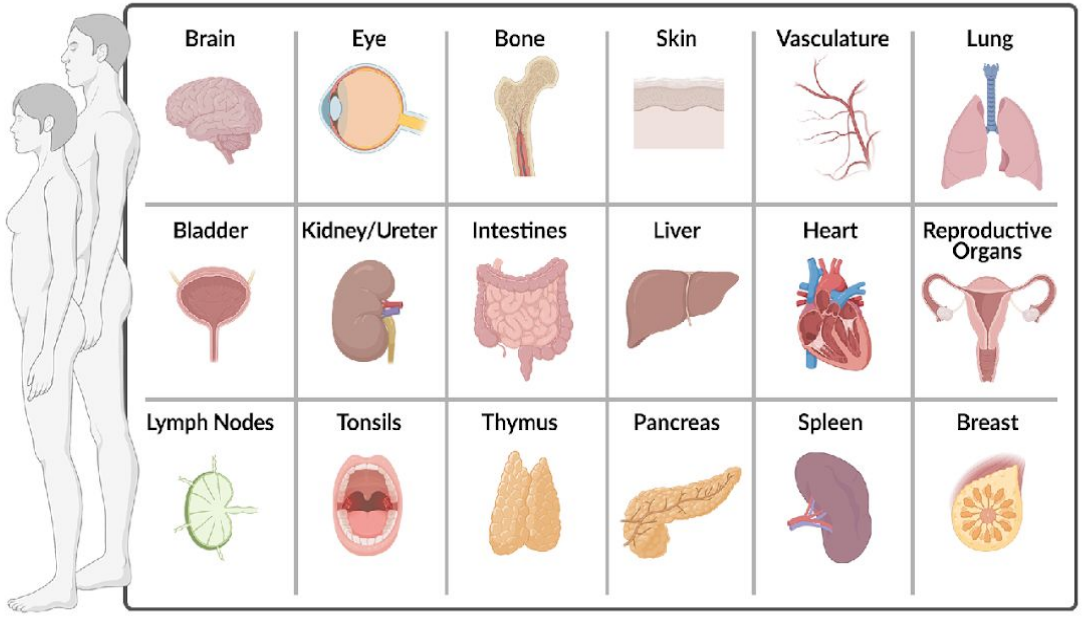
Catalyze development of an open, global framework for comprehensively mapping the human body at a cellular resolution

NIH National Institutes of Health
Office of Strategic Coordination - The Common Fund

The HuBMAP Consortium



Organ Specific Projects

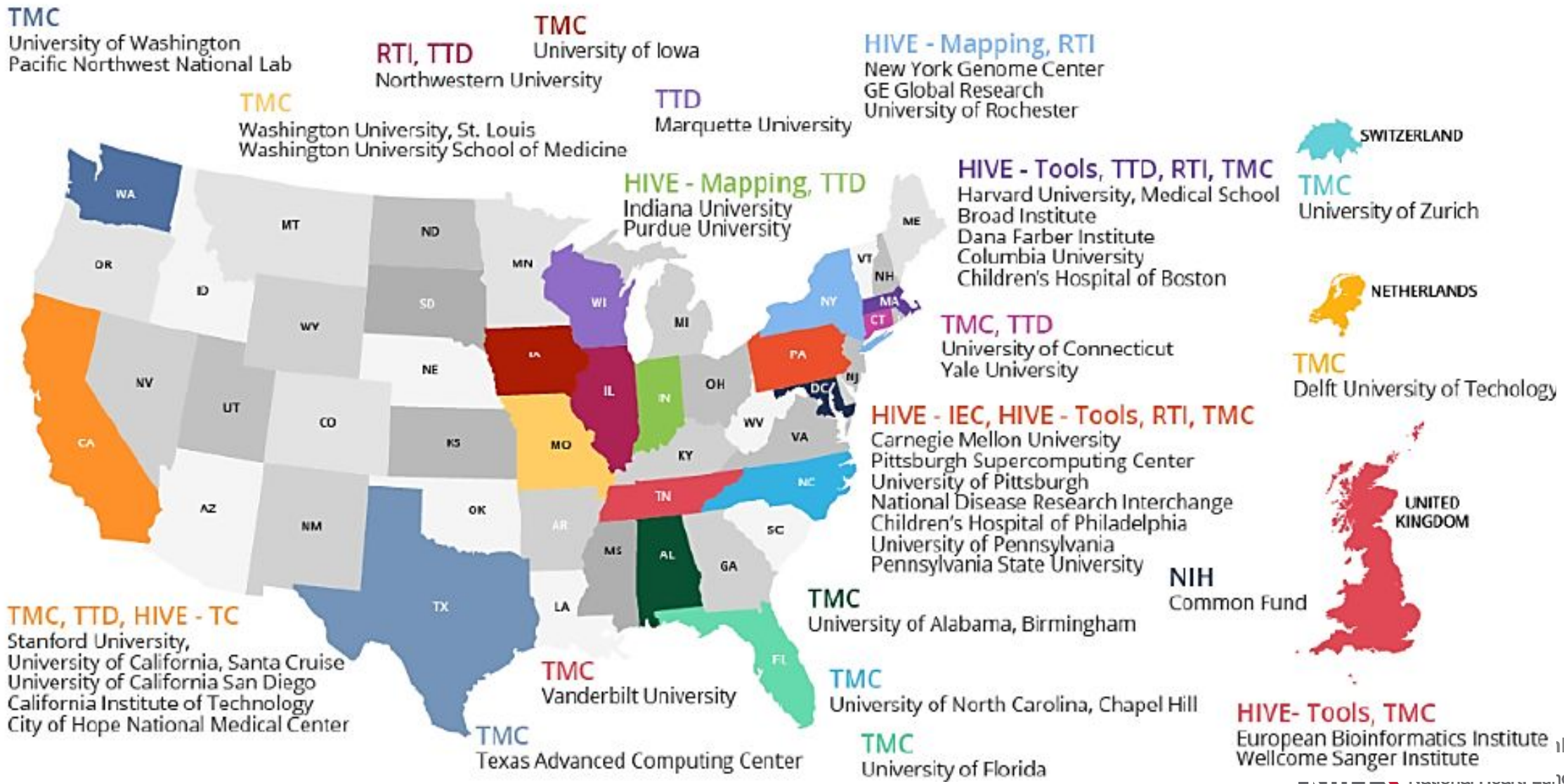


The Human Body at Cellular Resolution: *The NIH Human Biomolecular Atlas Program*.
Snyder et al. 2019, *Nature* 574, 187-192.

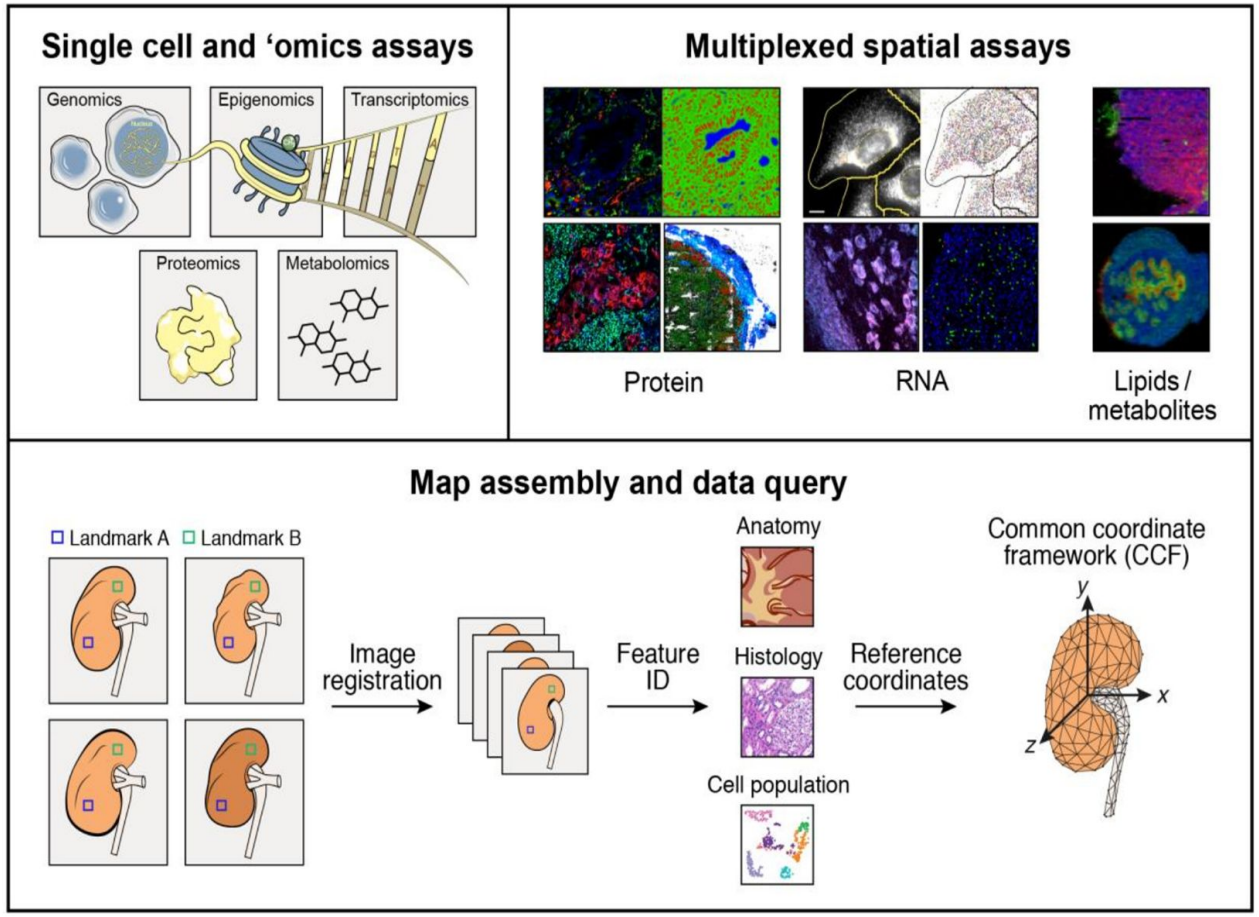
https://hubmapconsortium.org/

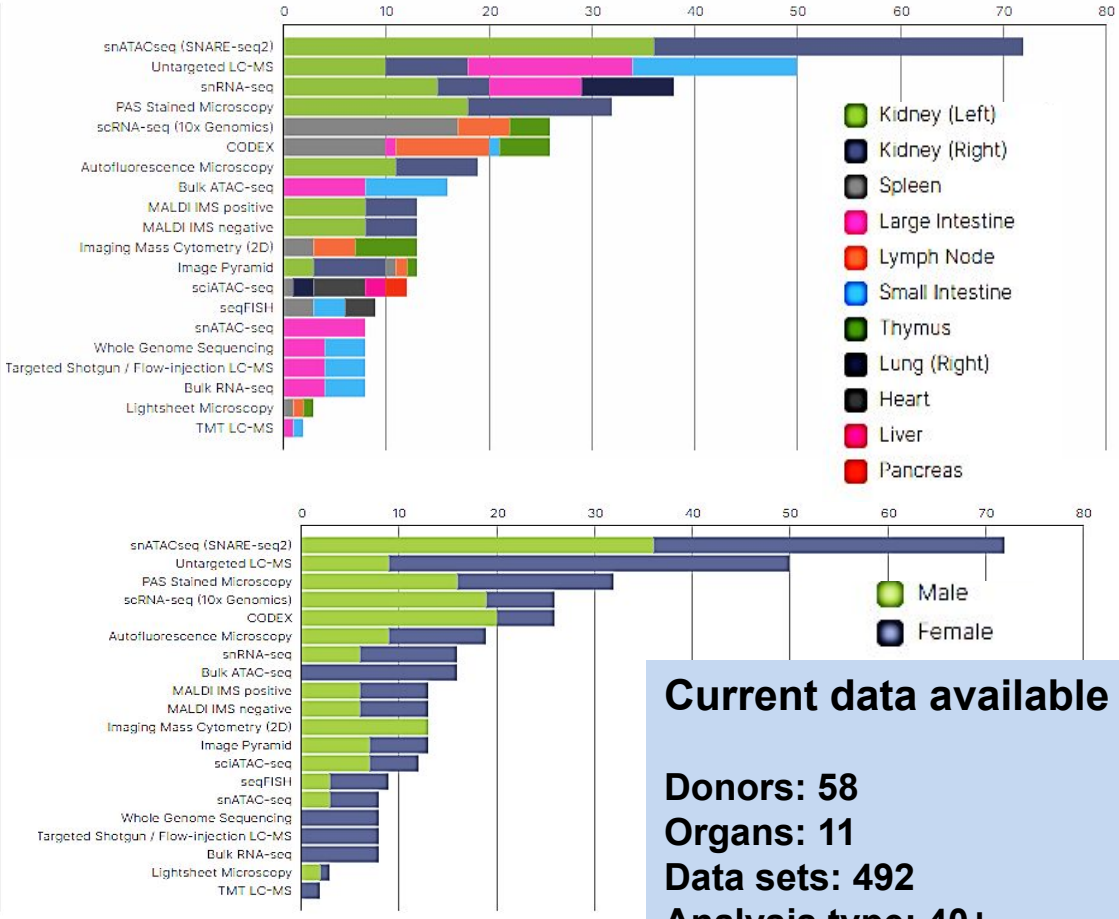
Zorina Galis, PhD
National Heart, Lung, and Blood Institute

HuBMAP Consortium Contributing Sites
https://hubmapconsortium.org/



HuBMAP: Richness of open-access data sets and analysis tools



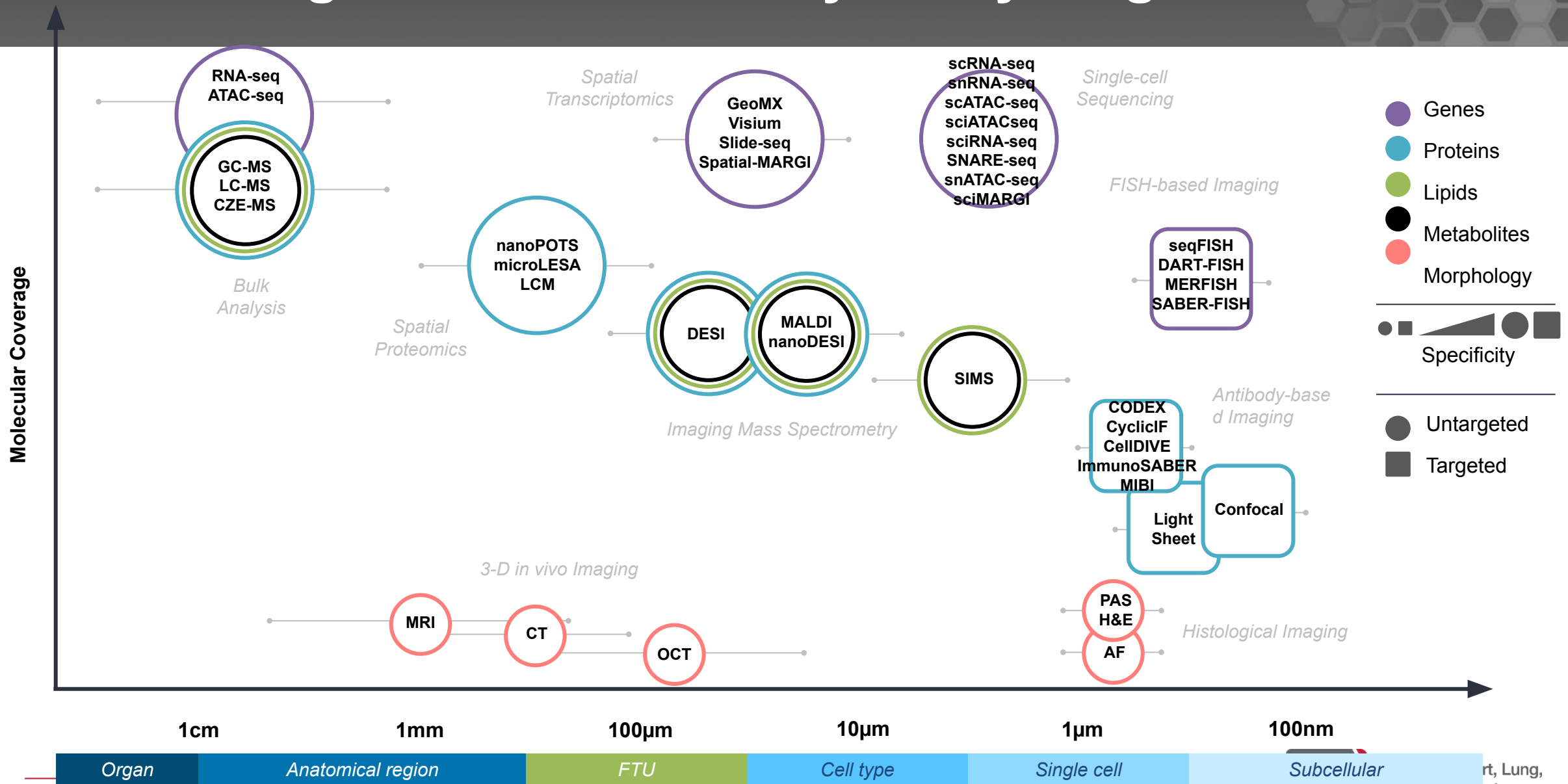


Current data available

Donors: 58
Organs: 11
Data sets: 492
Analysis type: 40+

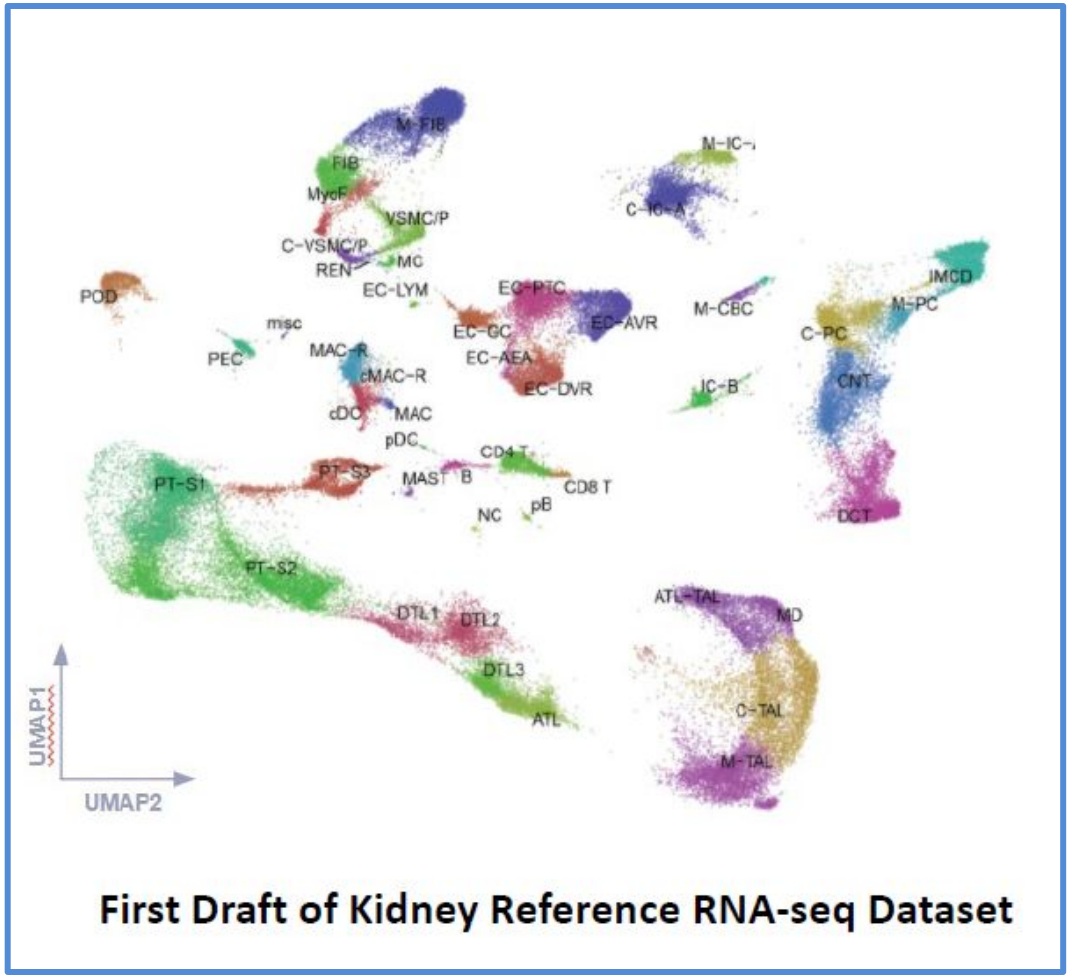
Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Coverage of HuBMAP Analyses by Target and Scale

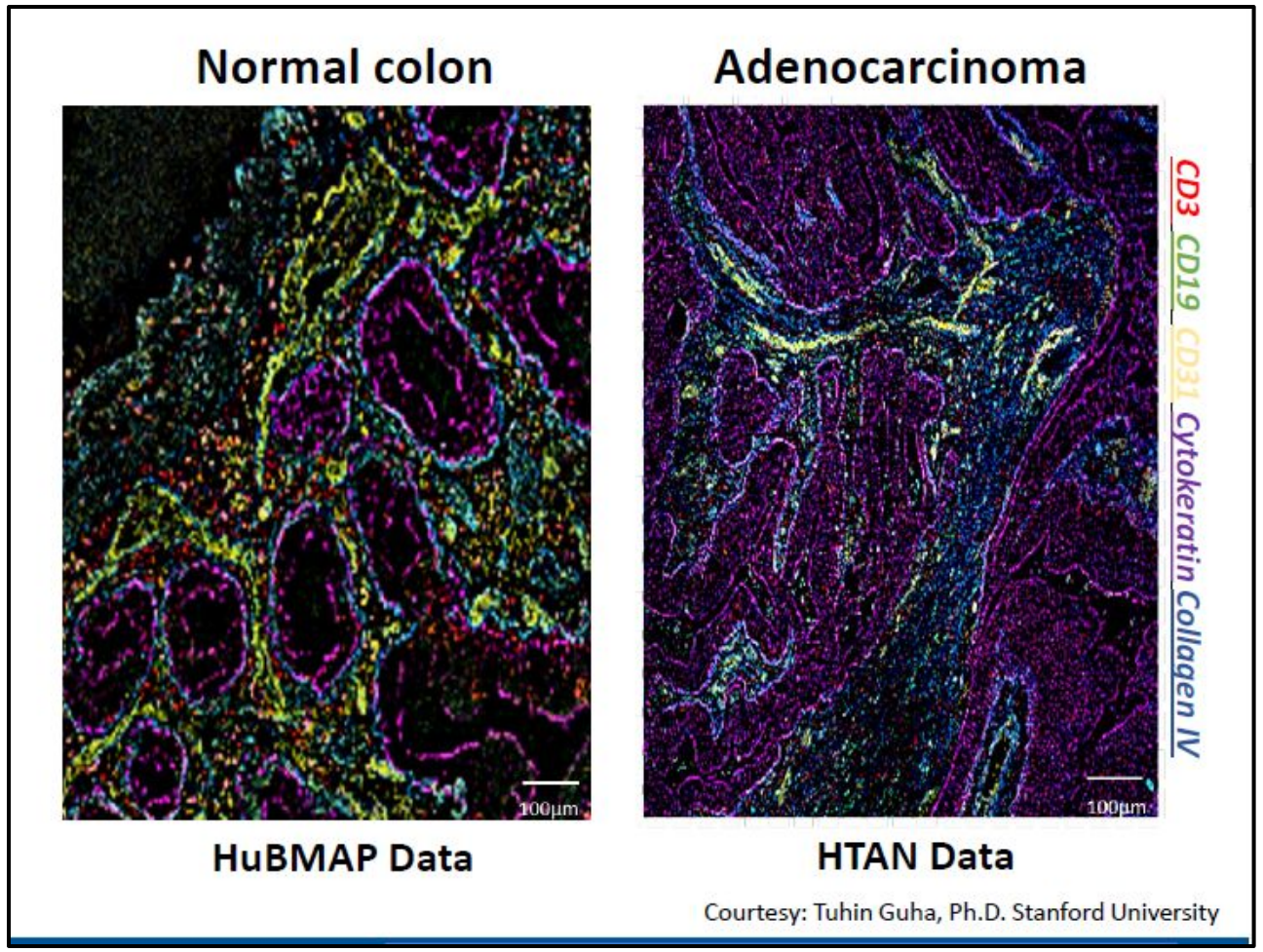


c/o Dr. Katy Börner, IU/MC HuBMAP

HuBMAP
Provides a normal reference for human tissues



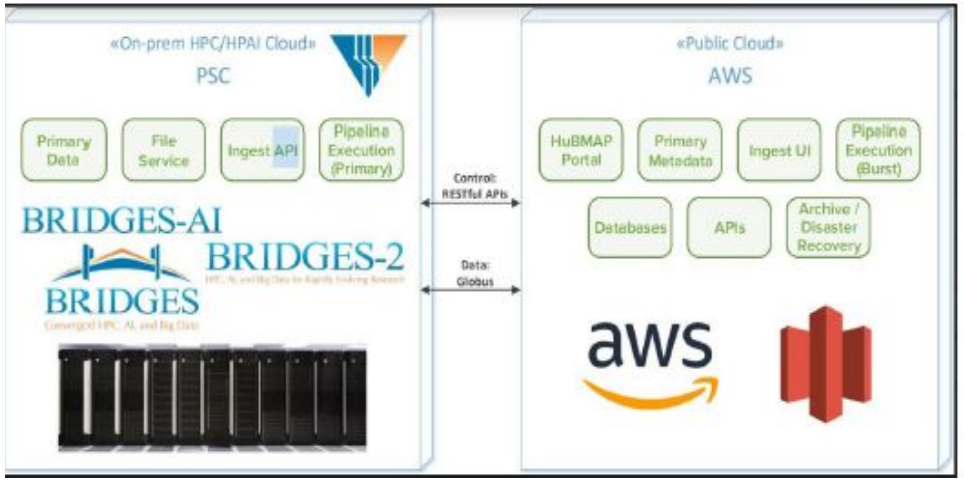
First Draft of Kidney Reference RNA-seq Dataset



Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

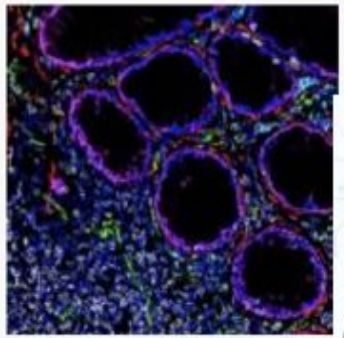
HuBMAP also provides a platform for management of internal and external data

PLATFORM FOR DATA MANAGEMENT



First data release (2020): over 23 TB data, 450 data sets, over 90 coders, etc.

Internal and External Coordination



This image uses CODEX imaging to map proteins in a section of colon tissue. Courtesy of John Hickey of the Stanford Tissue Mapping Center.

Lenna Galis, PhD
National Heart, Lung, and Blood Institute

HuBMAP Provides Tools

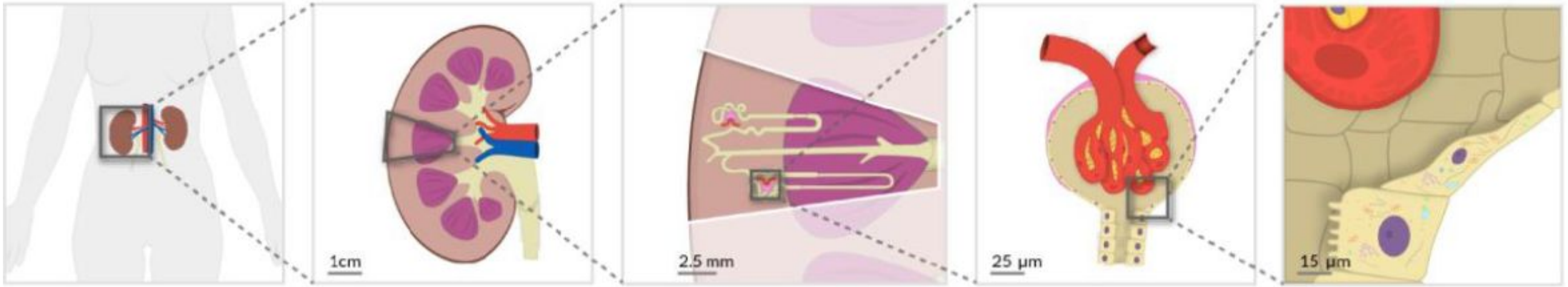
- **Visualization, Search, Modeling**
- **Tissue Atlassing >>> Knowledge Management**
  - **Registration and Exploration User interface**
  - **Semantic Ontology: Common Coordinate Frame (CCF), Anatomical Structure Cell Type +Biomarker (ASCT+B) Tables**
  - **Reference tools**

Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

Semantic Representation of a Kidney

Börner et al https://arxiv.org/ftp/arxiv/papers/2007/2007.14474.pdf

The Semantic Ontology divides the body into a set of nested named anatomical structures and cell types, from larger (left) to smaller (right) objects.



Body	Organ	Functional Tissue Unit	FTU Sub-structure(s)	Cellular
• Body	• Renal capsule	• Nephron	• Bowman's capsule	• Parietal epithelial cell
• Kidney (Left, Right)	• Renal pyramid	• Renal corpuscle	• Glomerulus	• Capillary endothelial cell
• Aorta	• Renal cortex	• Proximal convoluted tubule	• Efferent arteriole	• Mesangial cell
• Renal artery	• Renal medulla	• Loop of Henle	• Afferent arteriole	• Podocyte
• Renal vein	• Renal calyx	• Distal convoluted tubule		
• Ureter	• Renal pelvis	• Connecting tubule		
		• Collecting duct		

ı Galis, PhD
National Heart, Lung, and Blood Institute

ASCT+B Tables

Construction begins with domain experts manually developing ASCT+B tables, which indicate the most important anatomical structures (AS) and cell types (CT), organize them into a hierarchy, and map them to the 3D Reference Object Library.

ASCT Table

Structure/Region	Sub structure/Sub region	Cell Type
Renal Corpuscle	Bowman's (glomular) Capsule/parietal layer	Parietal epithelial Cell
	Bowman's (glomular) Capsule/visceral layer	Podocyte
	Glomerular Tuft	Capillary Endothelial Cell
		Mesangial Cell
Tubules	Proximal Tubule	Proximal Tubule Epithelial Cell (general)
		Proximal Convoluted Tubule Epithelial Cell Segment 1
		Proximal Tubule Epithelial Cell Segment 2
		Proximal Tubule Epithelial Cell Segment 2
	Loop of Henle, Thin Limb	Descending Thin Limb Cell (general)
		Ascending Thin Limb Cell (general)
	Loop of Henle, Thick Limb	Thick Ascending Limb Cell (general)
		Cortex-TAL Cell
		Medulla-TAL Cell
		TAL-Macula Densa Cell
	Distal Convolution	Distal Convoluted Tubule Cell (general)
		DCT Type 1 Cell
		DCT Type 2 Cell
	Connecting Tubule	Connecting Tubule Cell (general)
		CNT-Principal Cell

Ontology

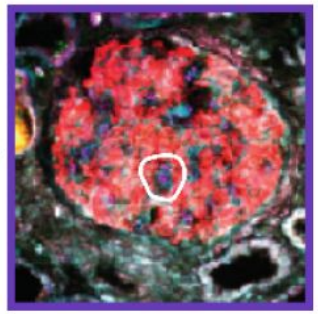
Anatomical Structures Partonomy

kidney
- kidney capsule
- cortex of kidney
  - outer cortex of kidney
- renal medulla

Cell Types Ontology

connective tissue cell
- pericyte cell
  - mesangial cell
    - extraglomerular mesangial cell
    - glomerular mesangial cell

3D Reference Object Library



c/o Dr. Katy Börner, IU/MC HuBMAP

Human Anatomical Structures, Cell Types, and Biomarkers (ASCT+B) Tables

Cold Spring Harbor Laboratory

bioRxiv

THE PREPRINT SERVER FOR BIOLOGY

Work of 16 international consortia to construct human ASCT+B tables and three-dimensional reference organs in support of a Human Reference Atlas

bioRxiv posts many COVID19-related papers. A reminder: they have not been formally peer-reviewed and should not guide health-related behavior or be reported in the press as conclusive.

New Results

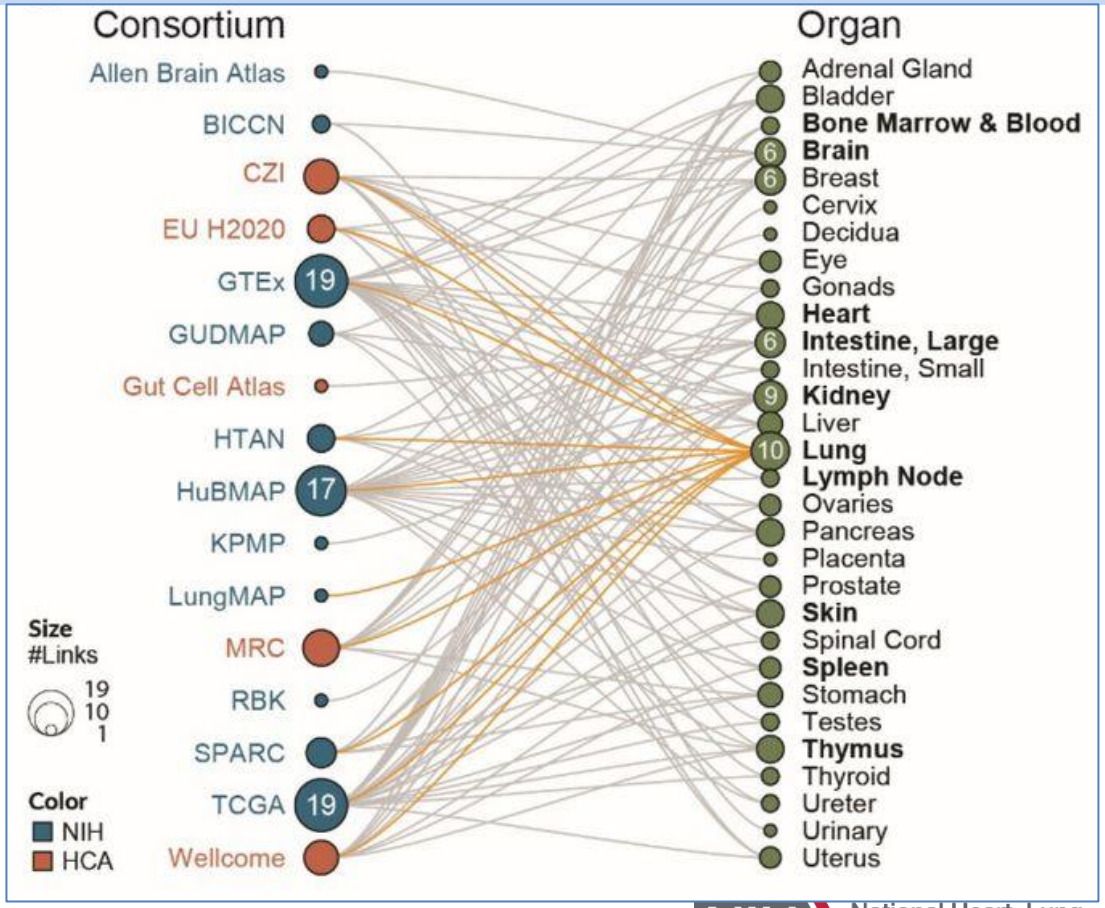
Anatomical Structures, Cell Types, and Biomarkers Tables Plus 3D Reference Organs in Support of a Human Reference Atlas

Katy Börner, Sarah A. Teichmann, Ellen M. Quardokus, James Gee, Kristen Browne, David Osumi-Sutherland, Bruce W. Herr II, Andreas Bueckle, Hrishikesh Paul, Muzlifah A. Haniffa, Laura Jardine, Amy Bernard, Song-Lin Ding, Jeremy A. Miller, Shin Lin, Marc Halushka, Avinash Boppana, Teri A. Longacre, John Hickey, Yiing Lin, M. Todd Valerius, Yongqun He, Gloria Pryhuber, Xin Sun, Marda Jorgensen, Andrea J. Radtke, Clive Wasserfall, Fiona Ginty, Jonhan Ho, Joel Sunshine, Rebecca T. Beuschel, Maigan Brusko, Sujin Lee, Rajeev Malhotra, Sanjay Jain, Griffin Weber

doi: https://doi.org/10.1101/2021.05.31.446440

https://www.biorxiv.org/content/10.1101/2021.05.31.446440v2.full

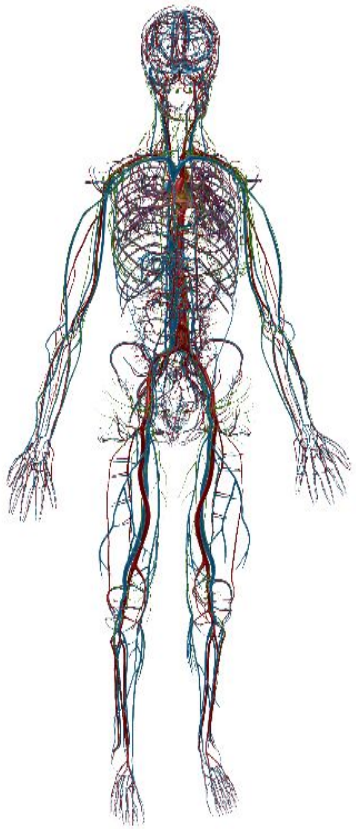
https://hubmapconsortium.github.io/ccf-asct-reporter/



NIH National Heart, Lung, and Blood Institute

From HuBMAP back to the Vasculome

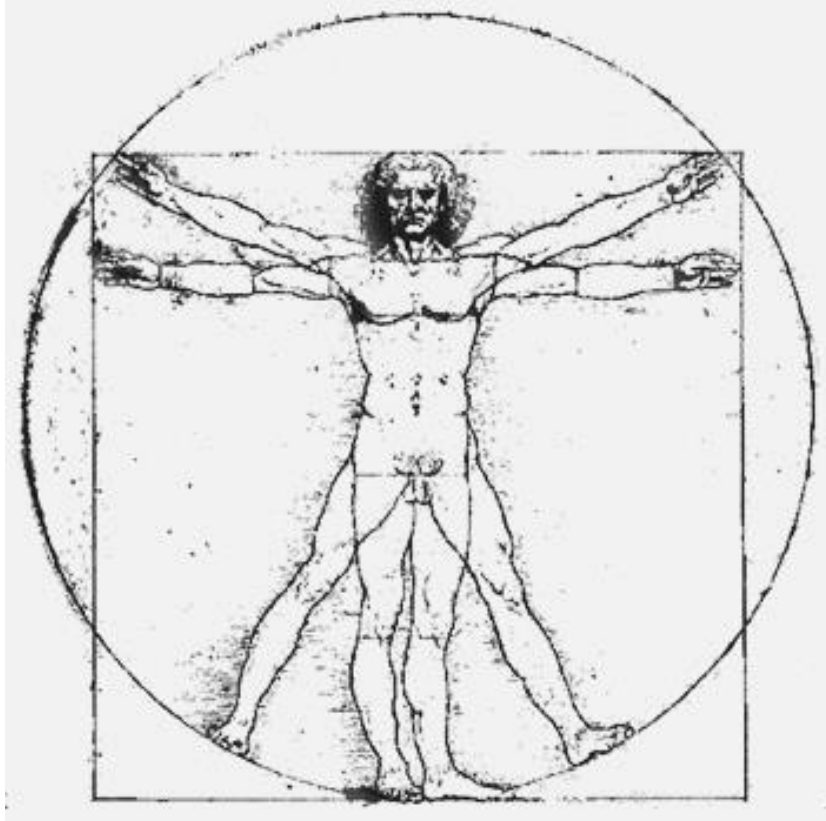
- **December 2017** >>> Proposal to use the Vasculature as a Common Coordinate Frame (VCCF) for the Human Body. Joint NIH-Chan Zuckerberg Initiative Meeting
- **December 2017:** New HuBMAP RFAs published
- **August 2018:** First HuBMAP Awards were made
- **May 2019:** >>> Presented "Evaluating the Vasculature as CCF. Road Map for the Human Body "Google Map". HuBMAP Anatomical Mapping Workshop, IU/Virtual



Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Major challenge for mapping the human body: Finding a Common Coordinates Frame (CCF)

Joint NIH-Chan Zuckerberg Initiative Meeting (Dec 2017)



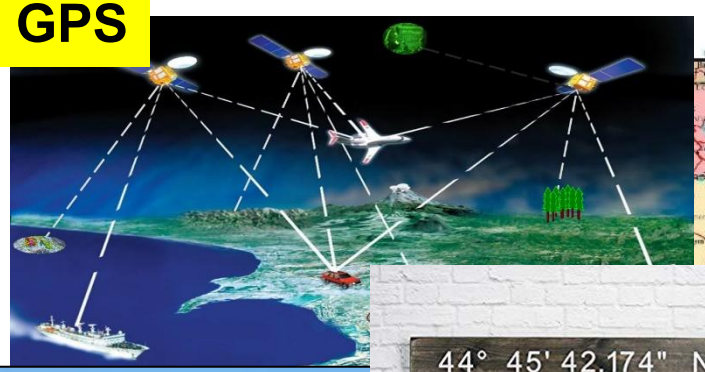
Desirable Features for a Body CCF ? (The "needs assessment")

1. *Works across several scales: cell <> tissue/organ <> whole body*
2. *Applicable to all (most) body tissues*
3. *Accounts for donor differences (e.g., size, shape, sex)*
4. *Useful/Acceptable across various specialty domains*

Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

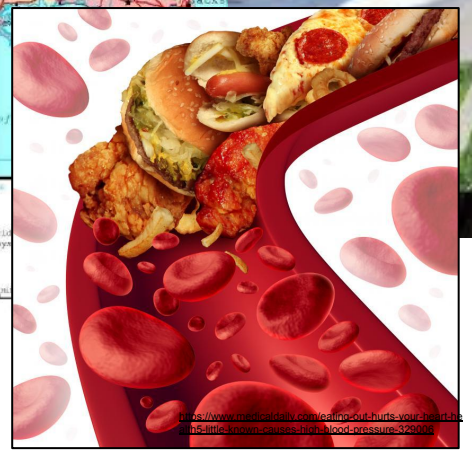
Many Ways to Identify and Reach a Specific Location….

GPS



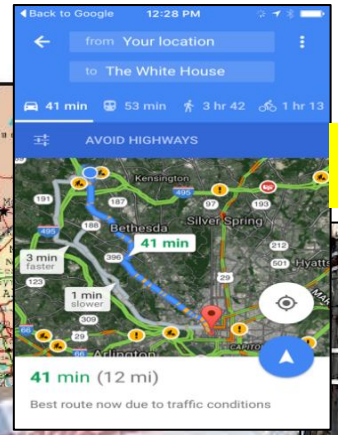
https://www.pymnts.com/intelligence-of-things/2018/drone-delivery-mobile-orders-flytrex-ncdot-holly-springs/

The human body already uses a precise delivery system…

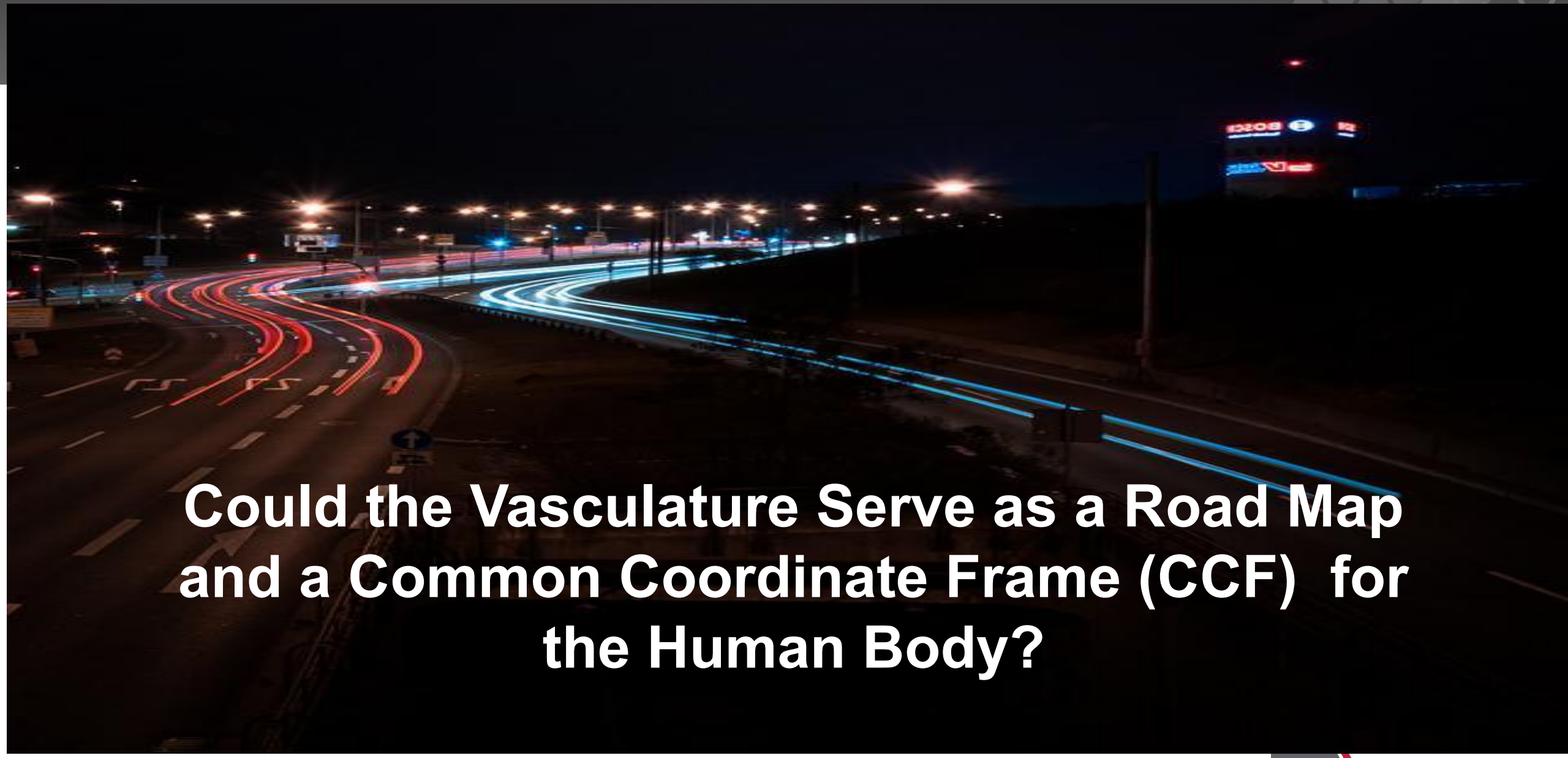


https://www.medicaldaily.com/eating-out-hurts-your-heart-here-s-little-known-reason-high-blood-pressure-429005

Road Map

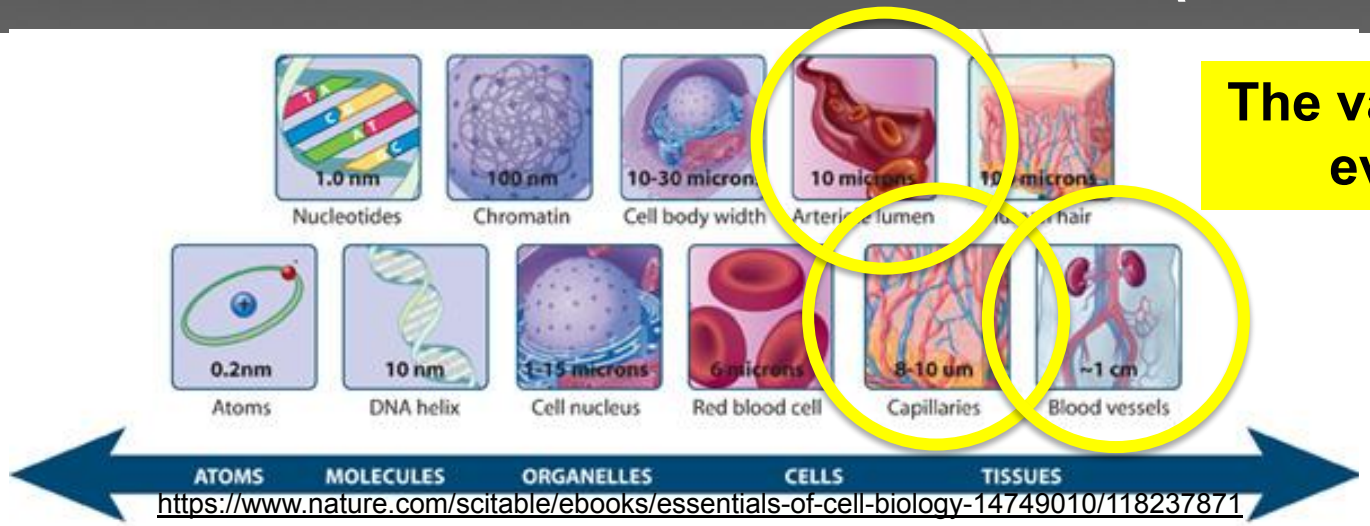


Zorina Galis, PhD
National Heart, Lung, and Blood Institute



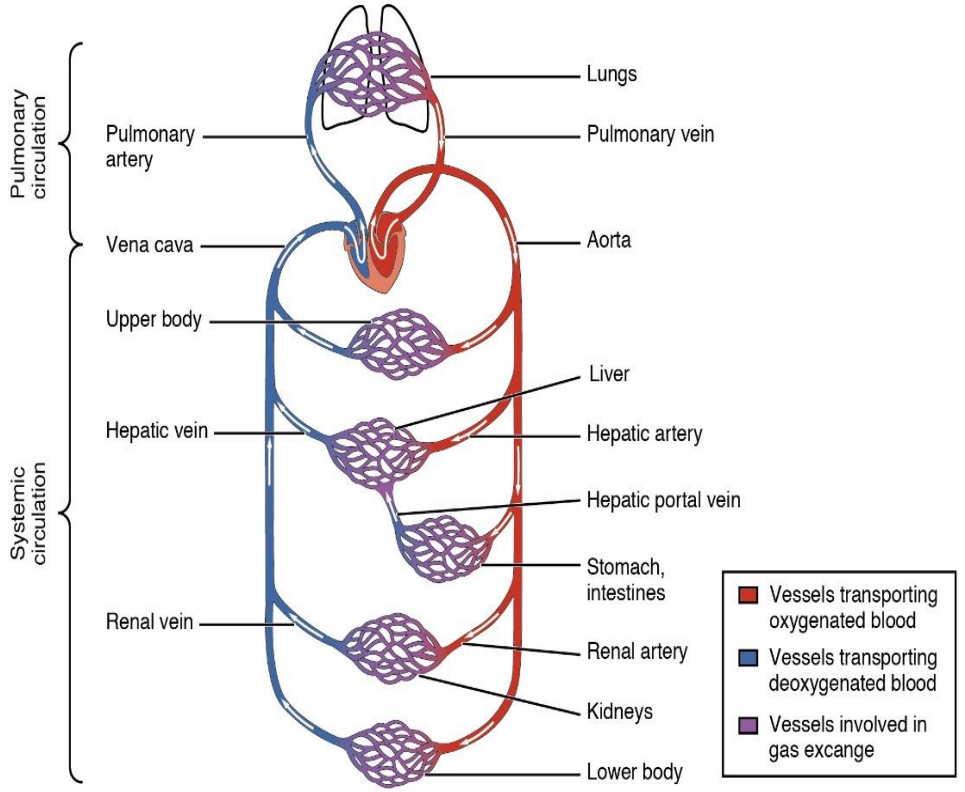
Could the Vasculature Serve as a Road Map and a Common Coordinate Frame (CCF) for the Human Body?

CCF Desirable # 1:
"*Works across several scales (cell <> tissue <> whole body)*"



https://www.nature.com/scitable/ebooks/essentials-of-cell-biology-14749010/118237871

The vasculature reaches within and integrates every and all body tissues and organs



https://en.wikipedia.org/wiki/Circulatory_system#/media/File:2101_Blood_Flow_Through_th

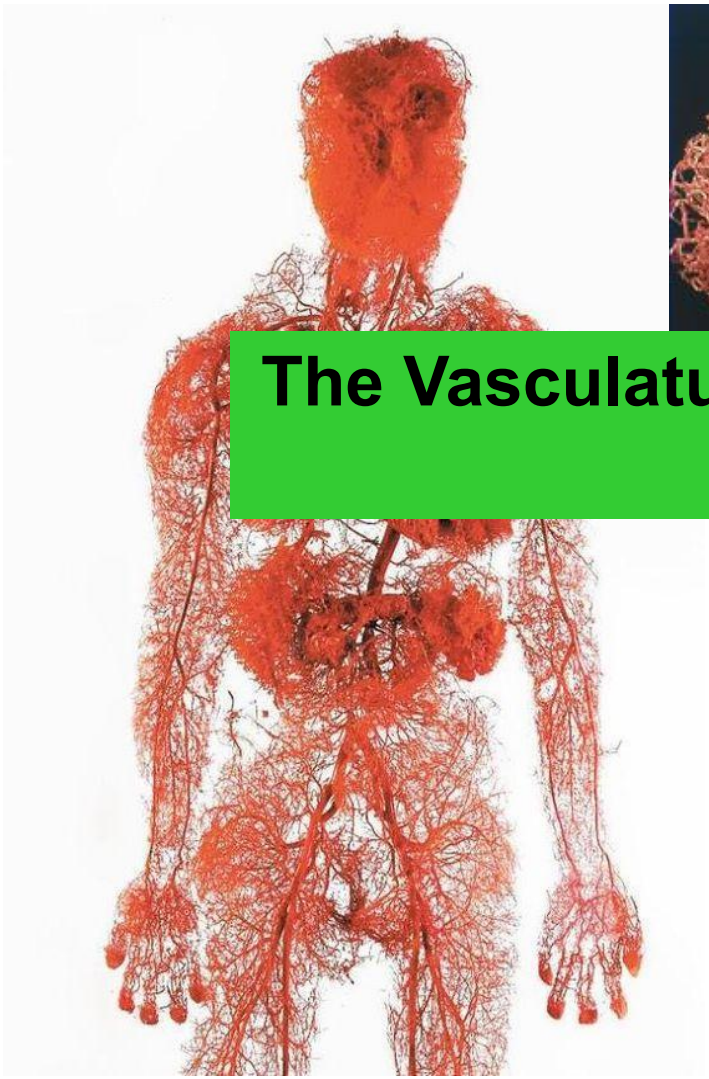
TABLE I
VESSEL SIZES AND FLOW VELOCITIES IN HUMANS[1]

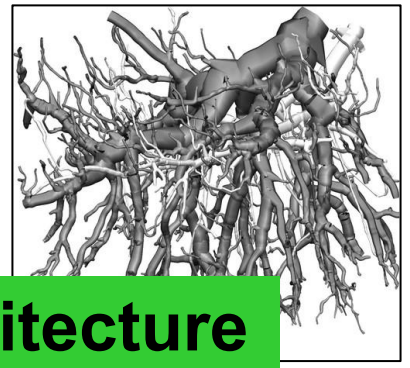
Vessel type	Diameter (mm)	Average velocity (mm/s)
Aorta	25	330
Small arteries	0.2 - 1.0	300
Arterioles	0.01 - 0.20	150
Capillaries	0.006 - 0.010	0.3
Venules	0.01 - 0.20	5
Small veins	0.2 - 5.0	20
Vena cava	35	200

Blood Vessels Go (Seamlessly!) Across Scales Macro<>Meso<>Micro

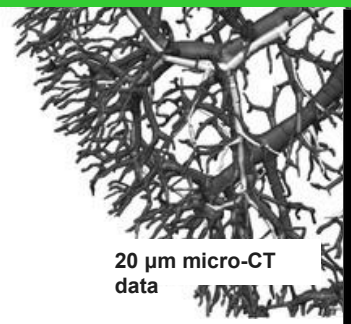
Zorina Galis, PhD
Lung,
tute

CCF Desirable #2:
"Applicable to all (most) body tissues"



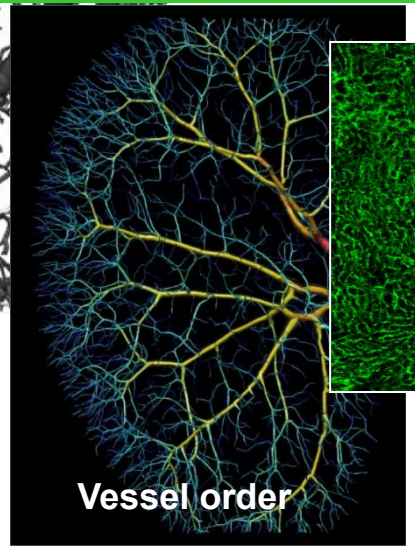


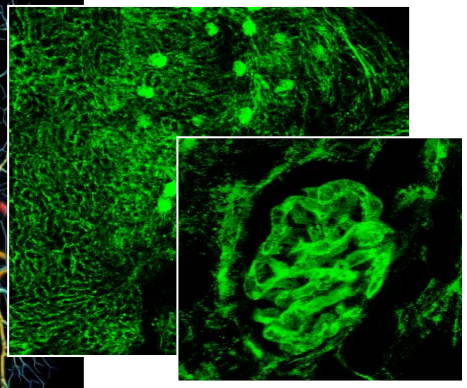
The Vasculature is "Framing" the Organ/Tissue Architecture Across Scales



20 µm micro-CT data

Nordsletten et al, 2006 Am J Physiol





Galis et al, JAHA 2016

https://www.pinterest.jp/pin/522699100479032485/

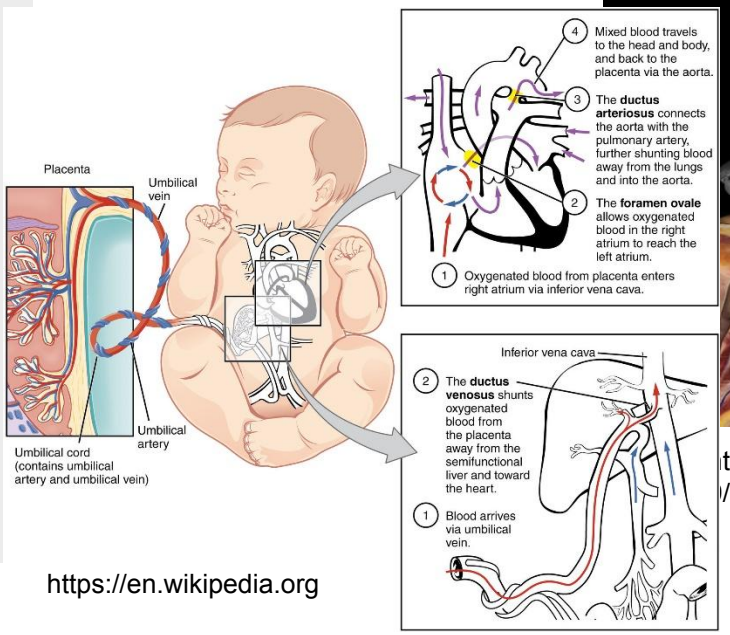
Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

CCF Desirable # 3:
"Accounts for donor differences (e.g., size, shape, sex)"

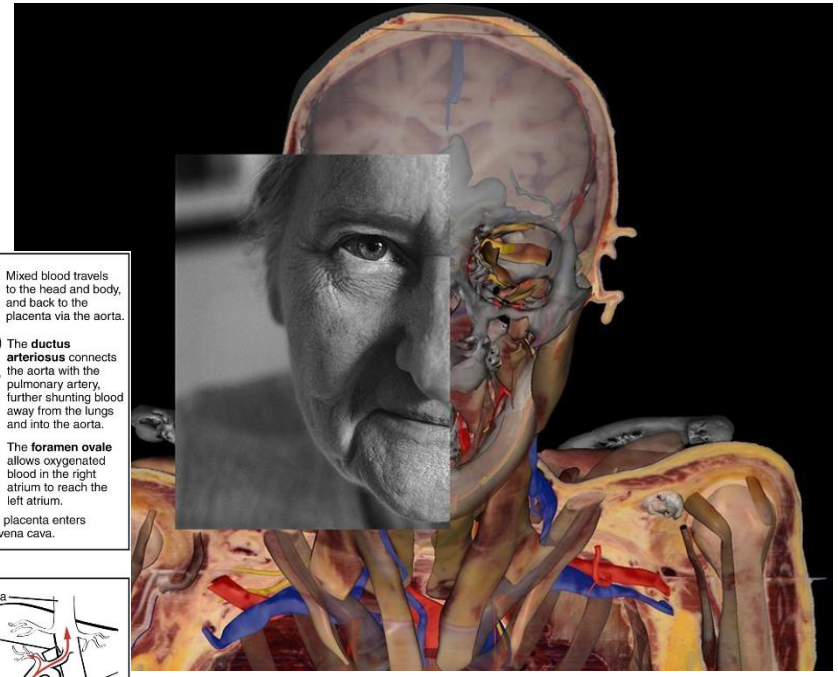
Vasculature Keeps Up With Individual Body Characteristics (Size, Shape, Sex etc.) and with Changes (Development, Aging, etc.)

https://www.womenshealthmag.com/

https://www.cafepress.com



https://en.wikipedia.org



ttps://www.nationalgeographic.com/magazine/201
/01/visible-human-susan-potter-cadaver/

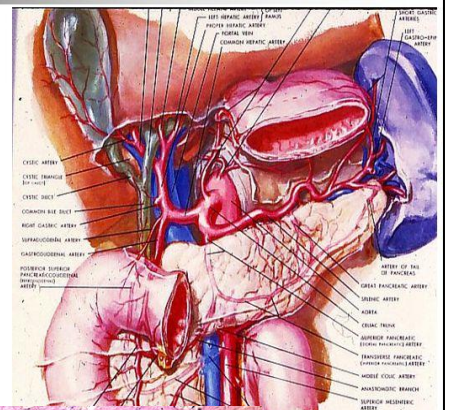
Zorina Galis, PhD
National Heart, Lung, and Blood Institute

CCF Desirable #4:
"Useful/Acceptable across specialty domains"

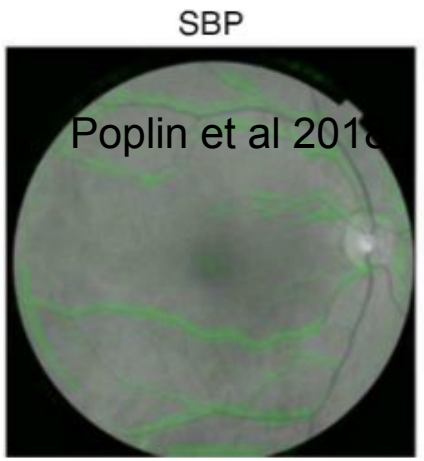
- **Scientists, clinicians, modelers know many vessels by their own names!**
- **Vessels are used as body landmarks and conduits for clinical interventions (e.g. surgery planning, drug delivery) and diagnostic (biopsy, predictions, etc.)**

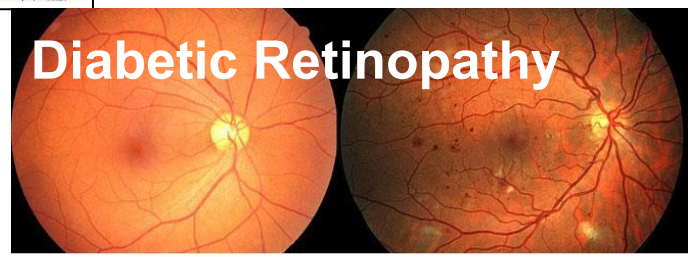
Vascular Landmarks of the Pancreas

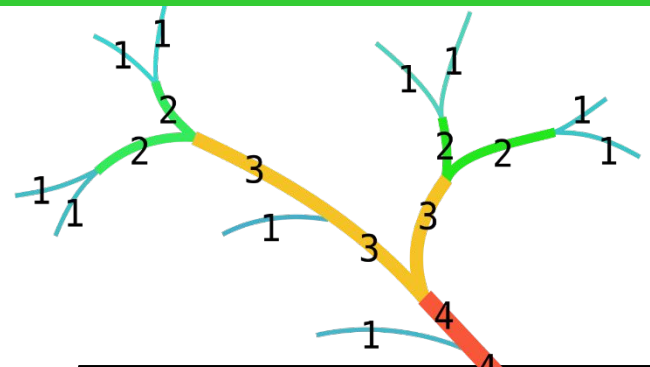
- Pancreatic sonography depends largely on identifying surrounding landmark vessels

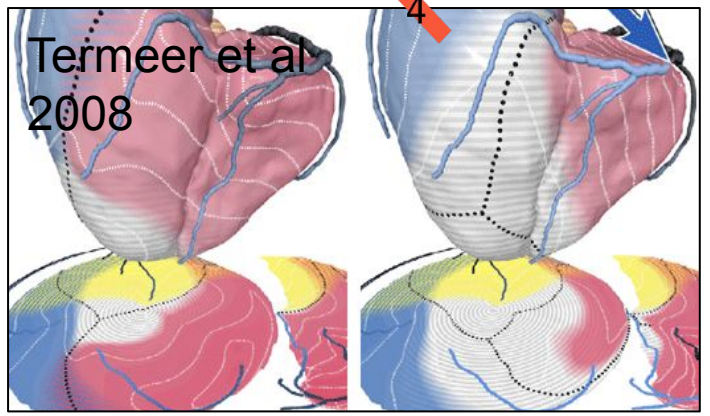


https://path.upmc.edu/cases/case172/micro.html







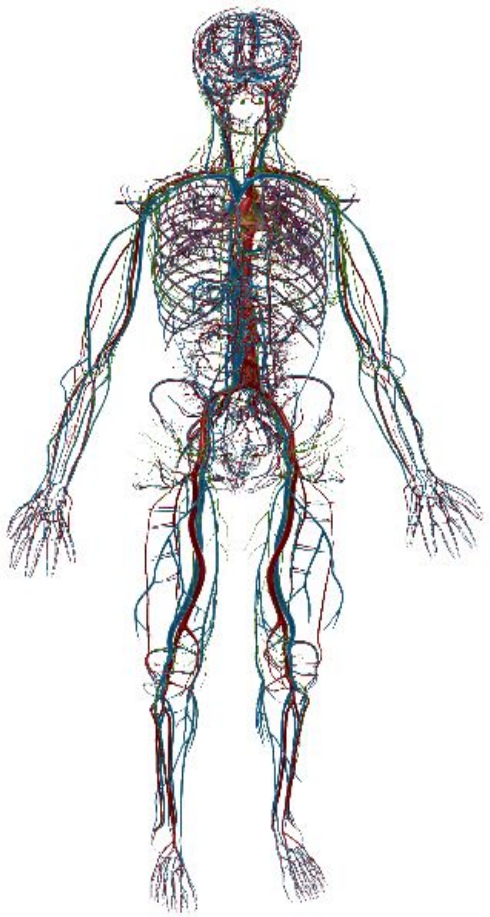


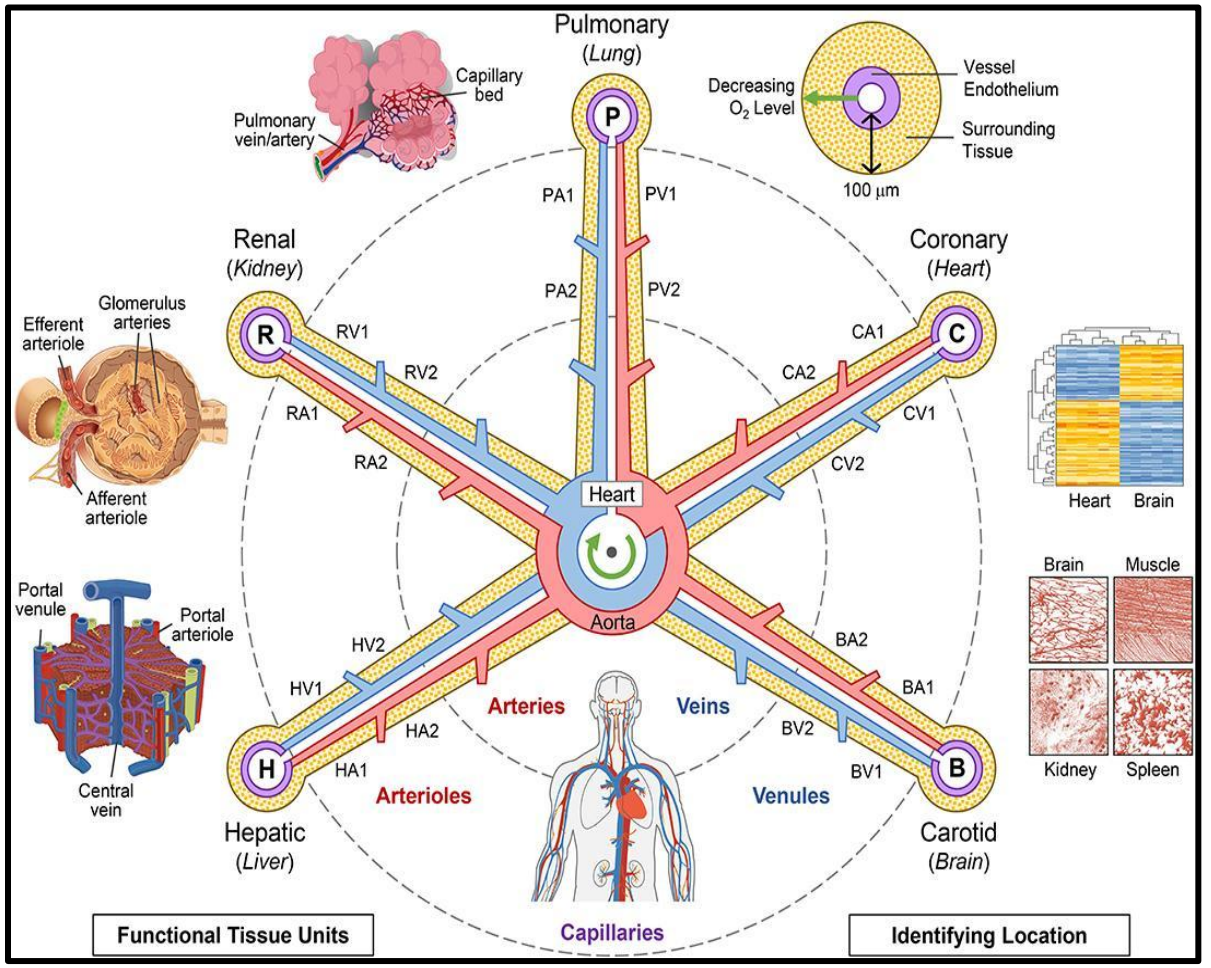
Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

2019 HuBMAP Anatomical Mapping Workshop (IU/virtual): "Evaluating the Vasculature as Common Coordinate Frame (CCF) Road Map for the Human Body "Google Map"?

Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

The Hub-and-Spoke Model of a Vascular Coordinate System





Weber, Griffin M, Yingnan Ju, and Katy Börner. 2020. "Considerations for Using the Vasculature as a Coordinate System to Map All the Cells in the Human Body". *Frontiers in Cardiovascular Medicine* 7 (29): doi: 10.3389/fcvm.2020.00029.

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

“Endothelium as the Organizing Principle of the Vasculome” >>> Allows for Single Cell Resolution VCCF

Research Topic

Single Cell Analysis: Advancing Vascular Biology

frontiers in Cardiovascular Medicine

EDITORIAL
published: xx June 2020
doi: 10.3389/fcvm.2020.00127

Where is Waldo: Contextualizing the Endothelial Cell in the Era of Precision Biology.

*Zorina S. Galis**

National Heart Lung and Blood Institute, National Institutes of Health, Bethesda, MD, United States

Keywords: endothelial cell, endothelium, single cell analysis, endothelial cell heterogeneity, precision biology

Editorial on the Research Topic

Single Cell Analysis: Advancing Vascular Biology

Considerations for Using the Vasculature as a Coordinate System to Map All the Cells in the Human Body

Griffin M. Weber, Yingnan Ju and Katy Börner

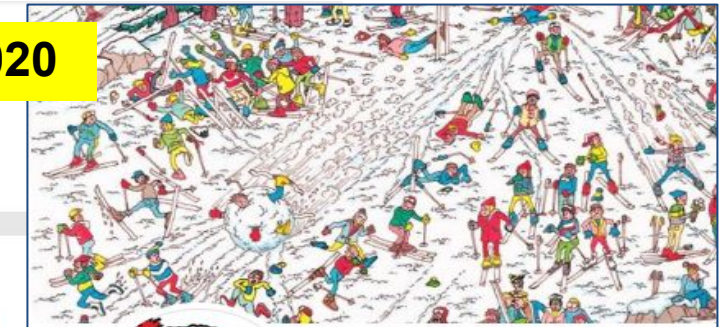
Perspective Several ongoing international efforts are developing methods of localizing single cells within organs or mapping the entire human body at the single cell level, including the Chan Zuckerberg Initiative's Human Cell Atlas (HCA), and the Knut and ...

Published on 13 March 2020
Front. Cardiovasc. Med. doi: 10.3389/fcvm.2020.00029

Participating Journals

Cardiovascular Medicine
Atherosclerosis and Vascular Medicine

2020



Where's Wally?
@whereswally · Public Figure

Home About Photos Videos More

About

Welcome to the official Where's W
Facebook page! Follow me on Twi
www.twitter.com/whereswally

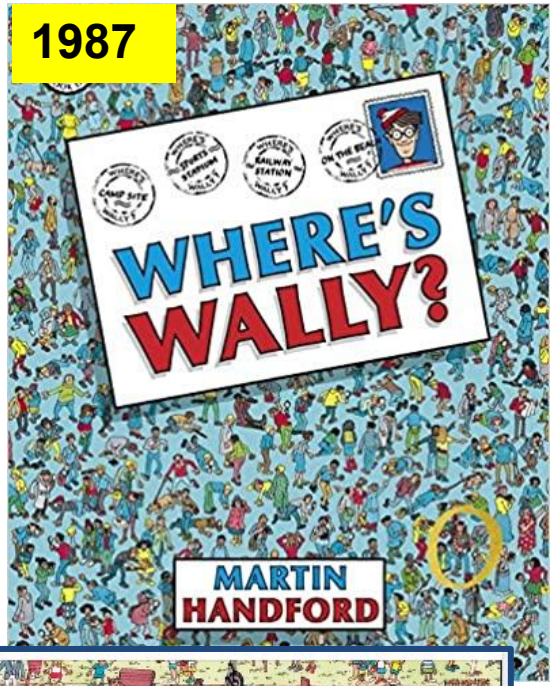
3,678,343 people like this

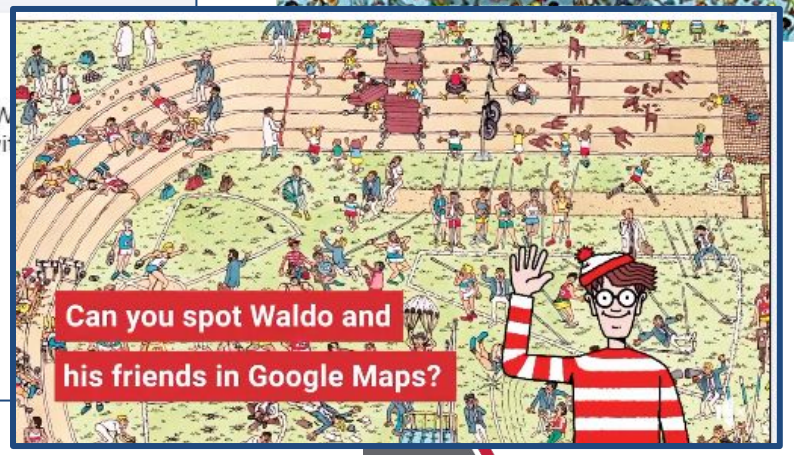
3,466,768 people follow this

http://www.findwaldo.com/

Send Message

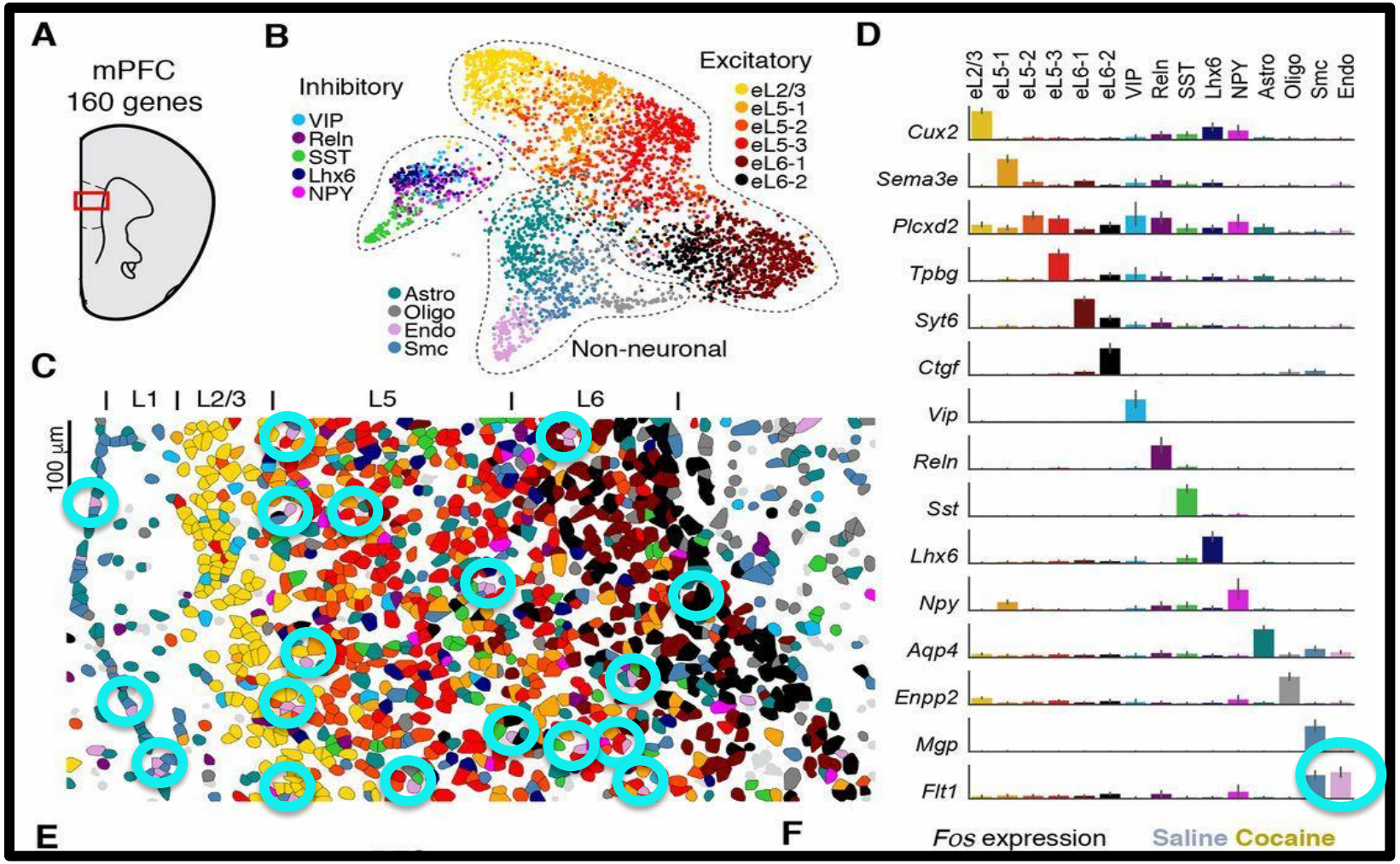
1987





NIH National Heart, Lung, and Blood Institute

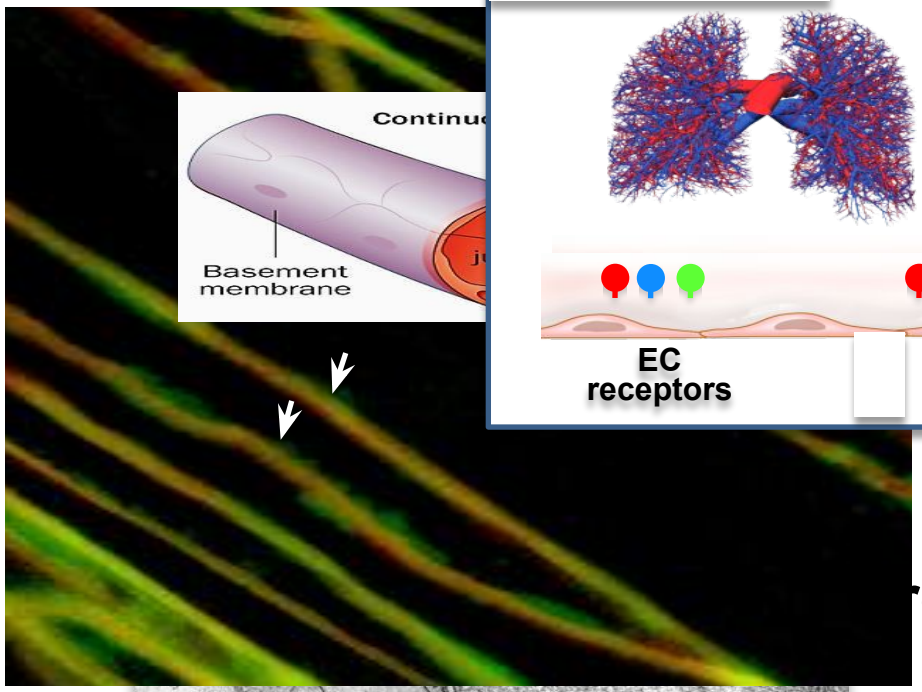
Like Waldo, The Endothelial Cell (EC) Is Hiding In Plain Sight Everywhere!



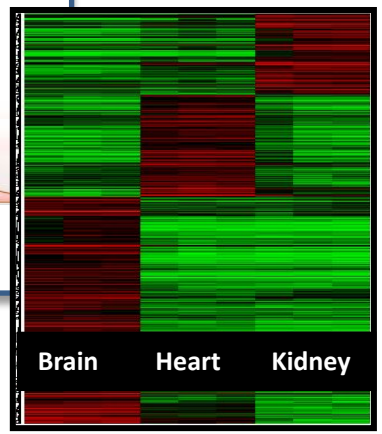
Brain Mapping by Cell Type (STARmapping)
Wang et al, *Science* 21 Jun 2018

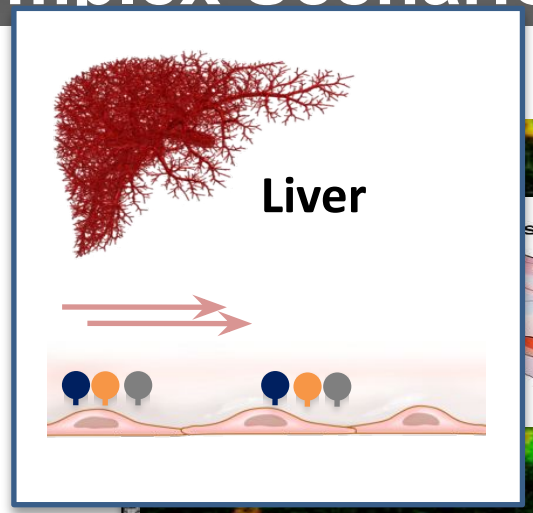
Zorina Galis, PhD
National Heart, Lung, and Blood Institute

As Observers Have Grown Astute, Just Like Waldo, ECs Become Recognizable in Ever More Complex Scenarios

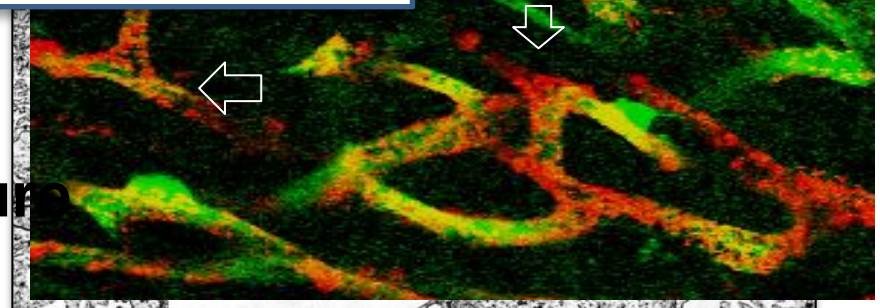


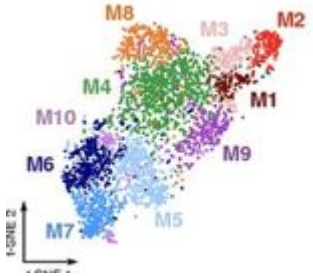
Organ level

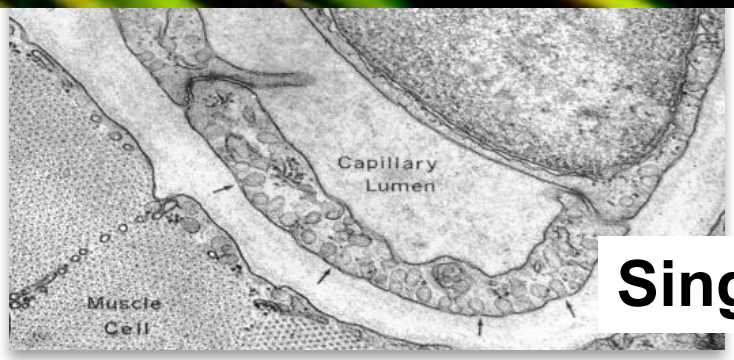


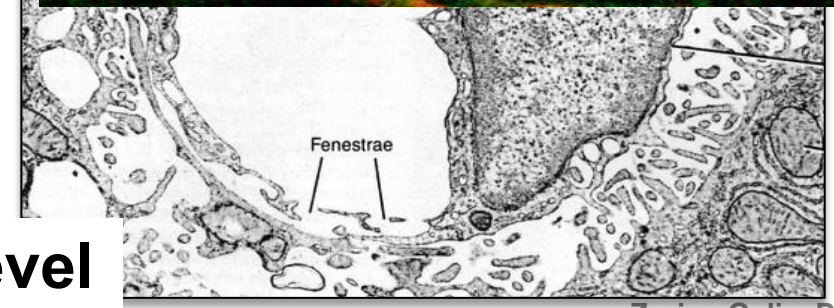


rganotypic Vasculatur







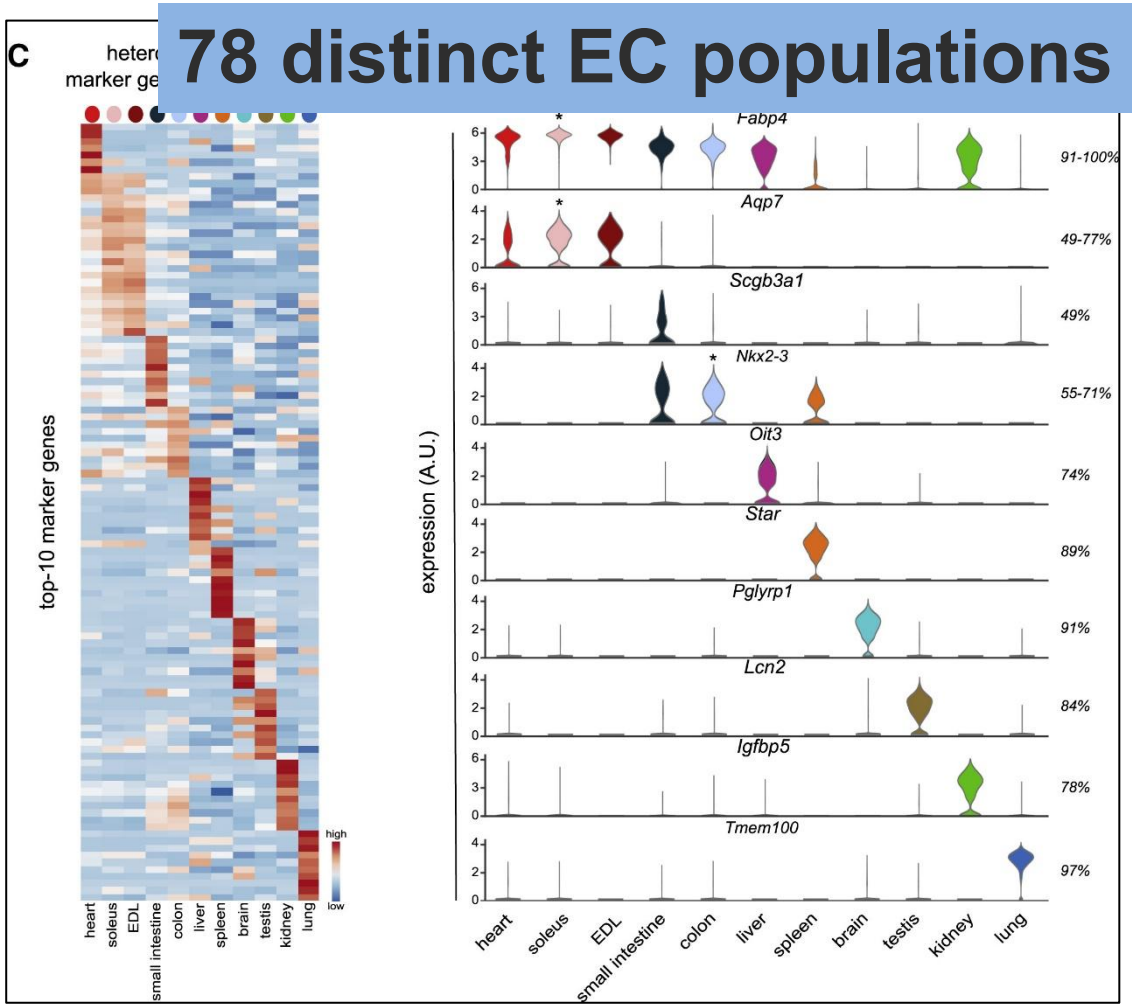


Single Endothelial Cell Level

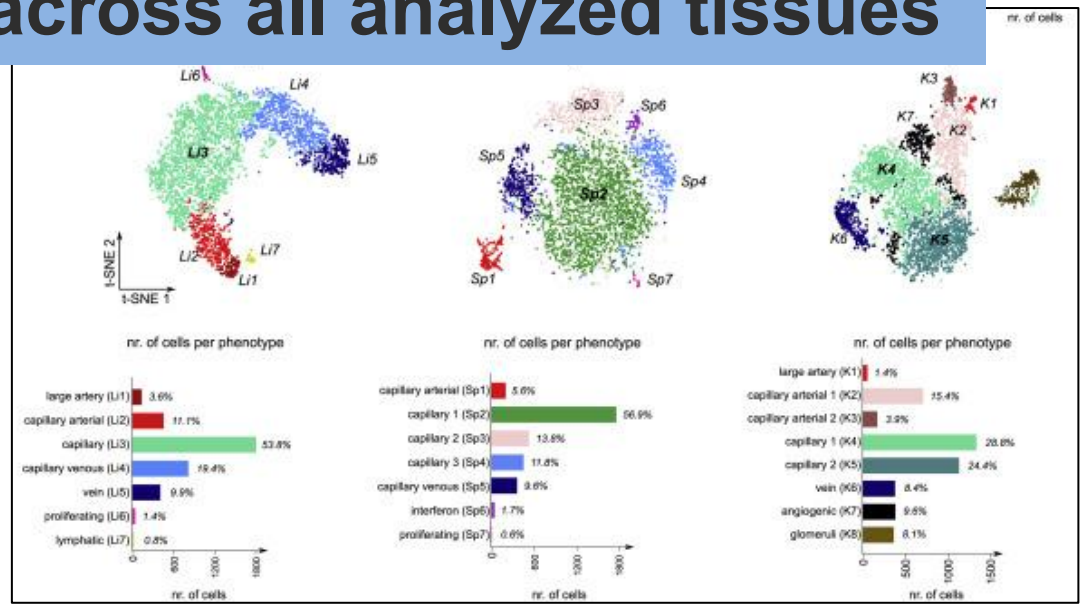
Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

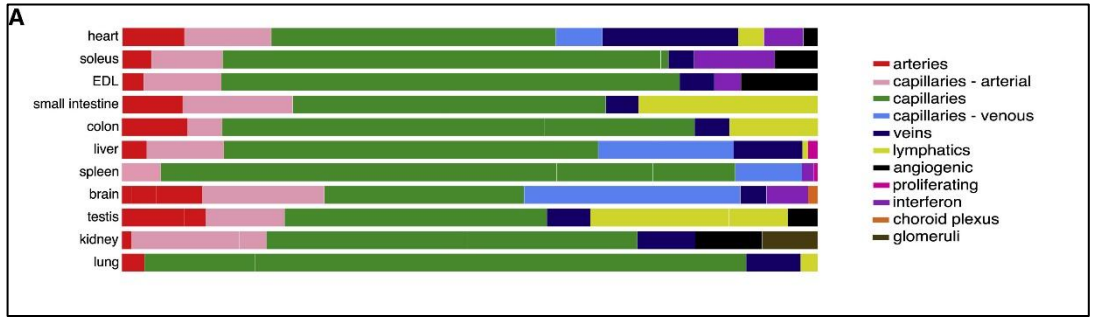
EC Heterogeneity Across Tissues >> Vascular Bed Heterogeneity within the Organ

78 distinct EC populations across all analyzed tissues



EC markers





EC Phenotypes

Kalucka et al, Cell 2020

Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

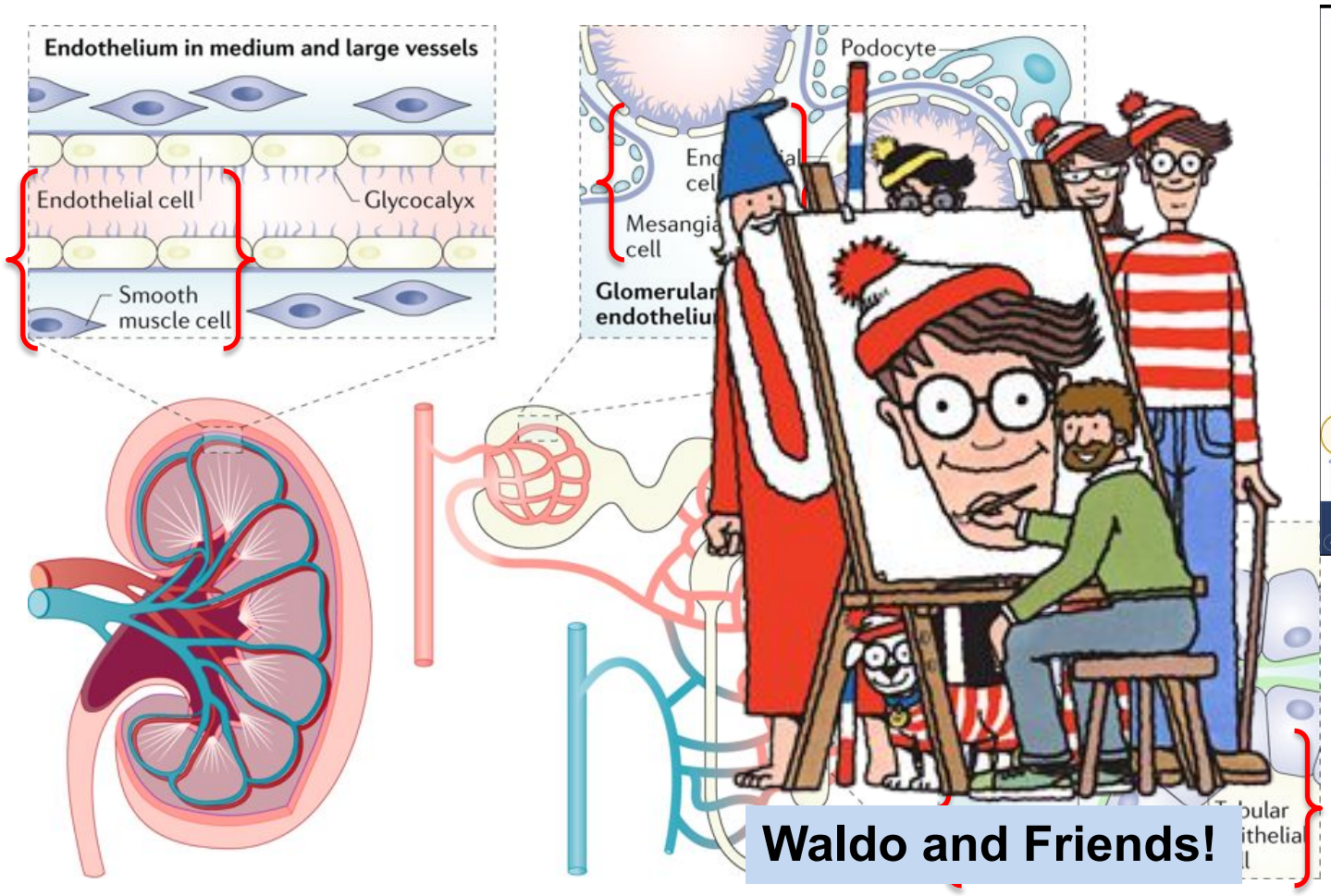
EC Holds Important Contextual Information, Revealing Its Precise Context : Understanding Brain Vasculature Zonation

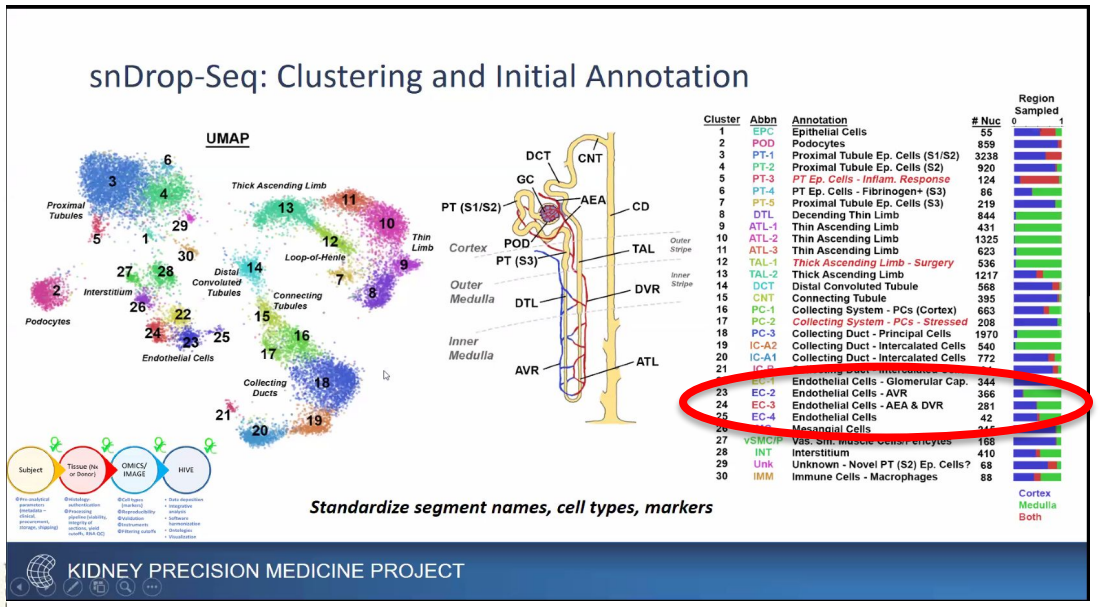
EC can be precisely positioned along the blood vessel while walking from the arterial to venous side

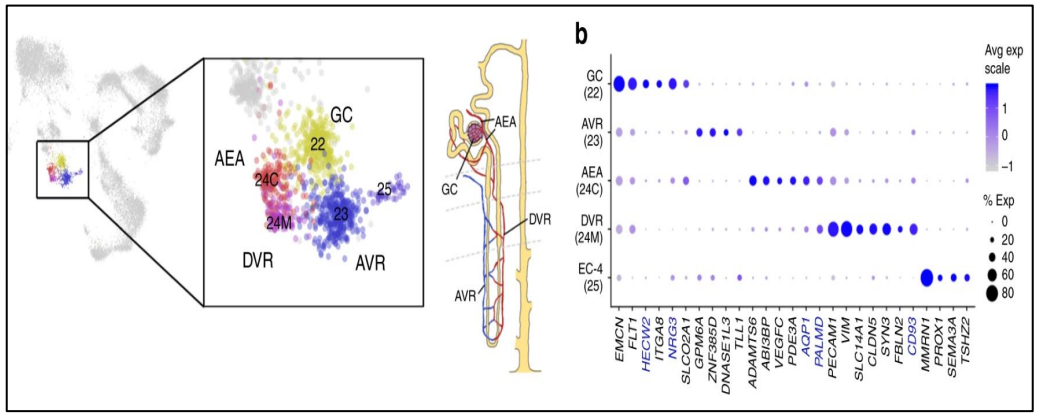
(Vanlandewijck et al, Nature 2018)

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Diverse Endothelial Cell Populations Associate With Different Cells of The Kidney







Endothelium structure and function in kidney health and disease, Jourde-Chiche et al., *Nature Reviews Nephrology* (**15**), 87–108 (2019)
https://www.nature.com/articles/s41581-018-0098-z/figures/3

Lake et al, 2019 Nature Communications

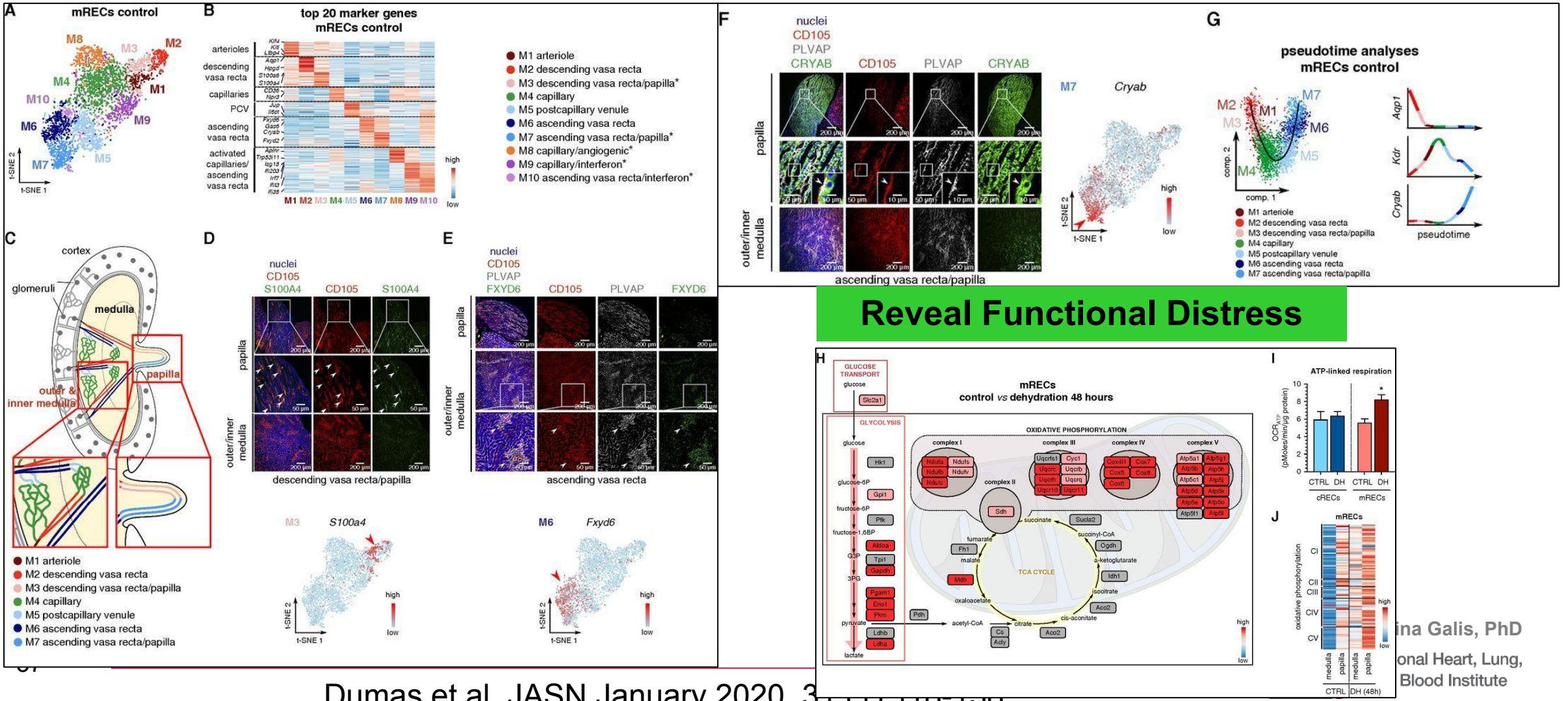
Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Renal ECs Indicate Kidney Compartment-specific Gene Signatures

Precise Spatial Information

Predict Temporal Information

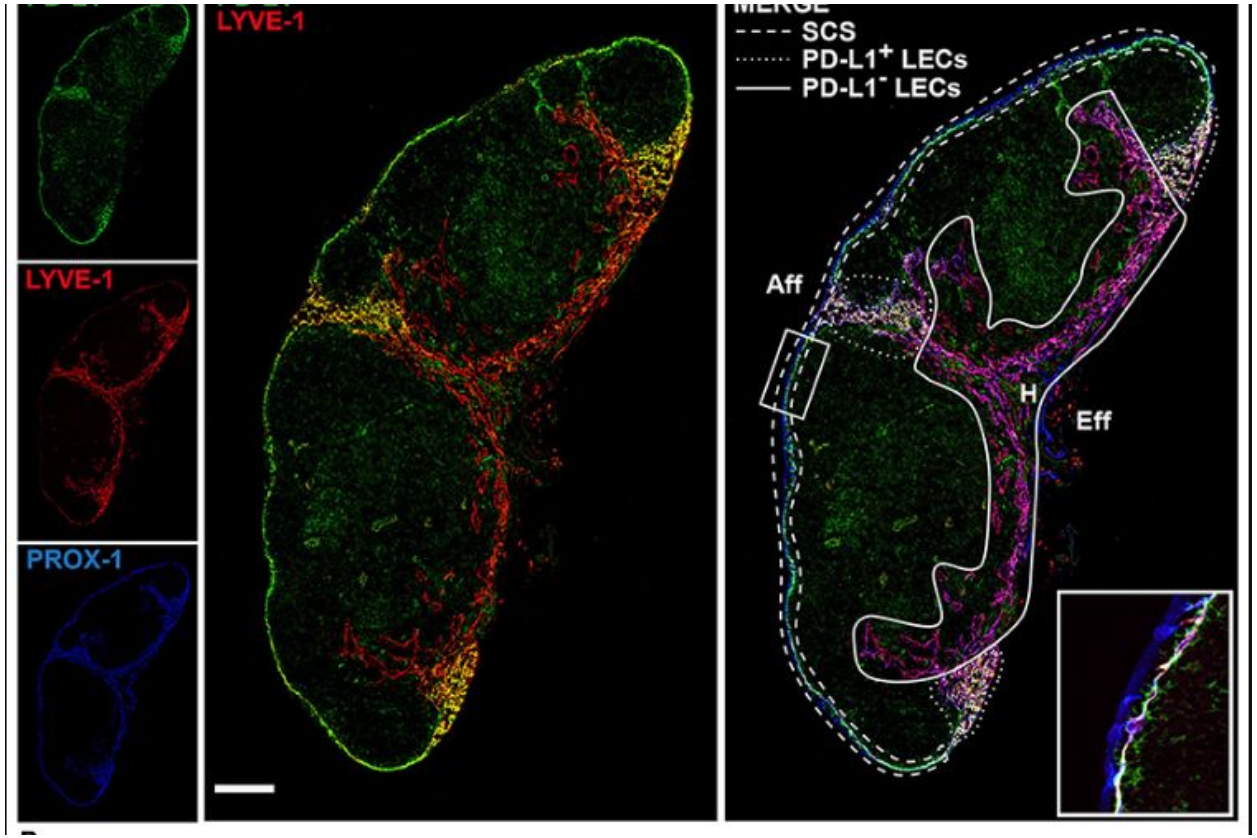
Reveal Functional Distress

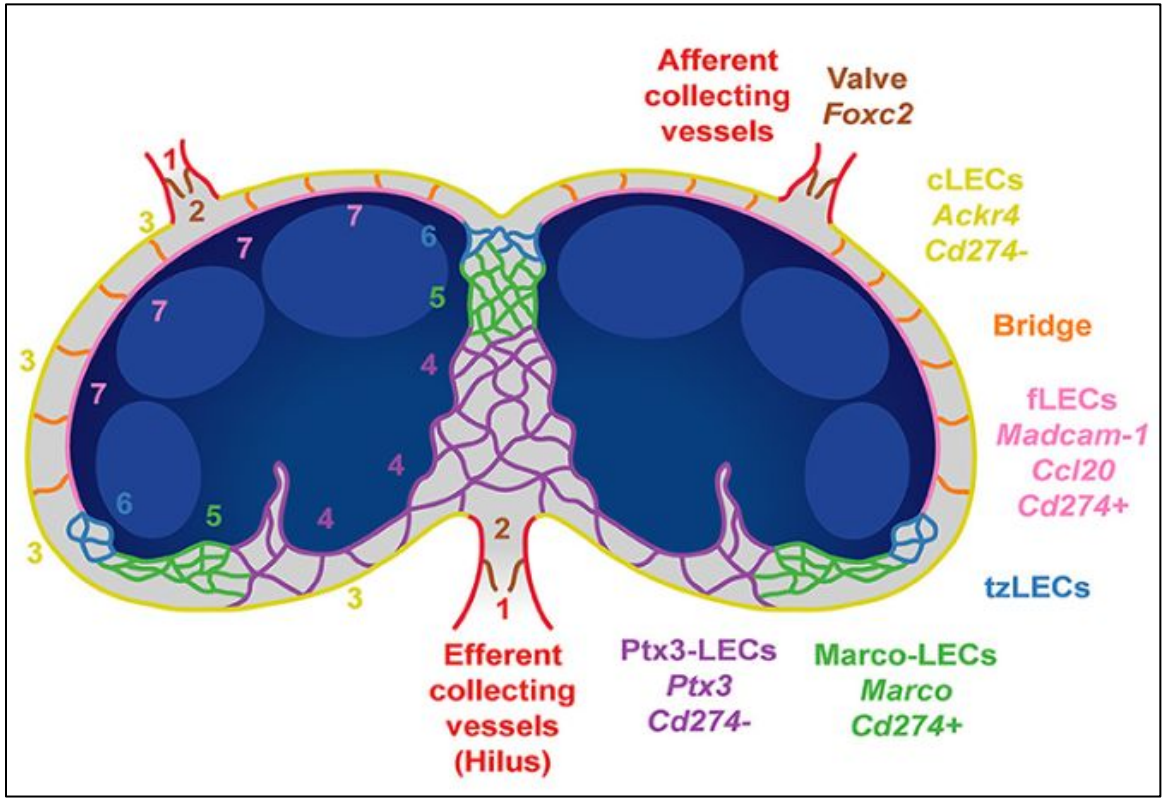


Dumas et al, JASN January 2020, 31 (1) 118-138

ina Galis, PhD
onal Heart, Lung,
Blood Institute

Lymphatic ECs Help Map Lymph Nodes Architecture





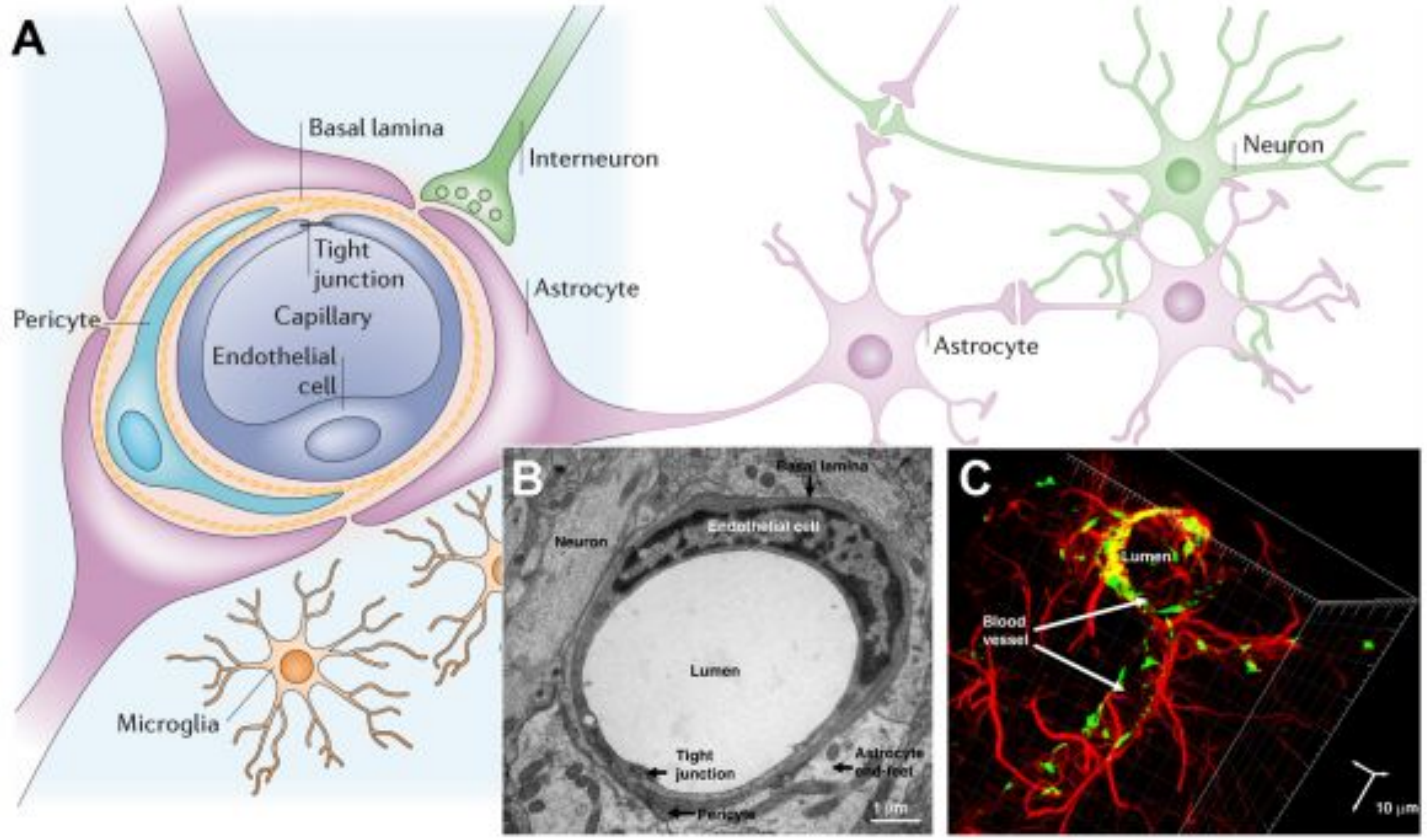
Xiang et al, Frontiers in Cardiovascualr Medicine 2020

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Endothelial Cells Are Central To *Functional Tissue Units*

The Brain Neurovascular Unit

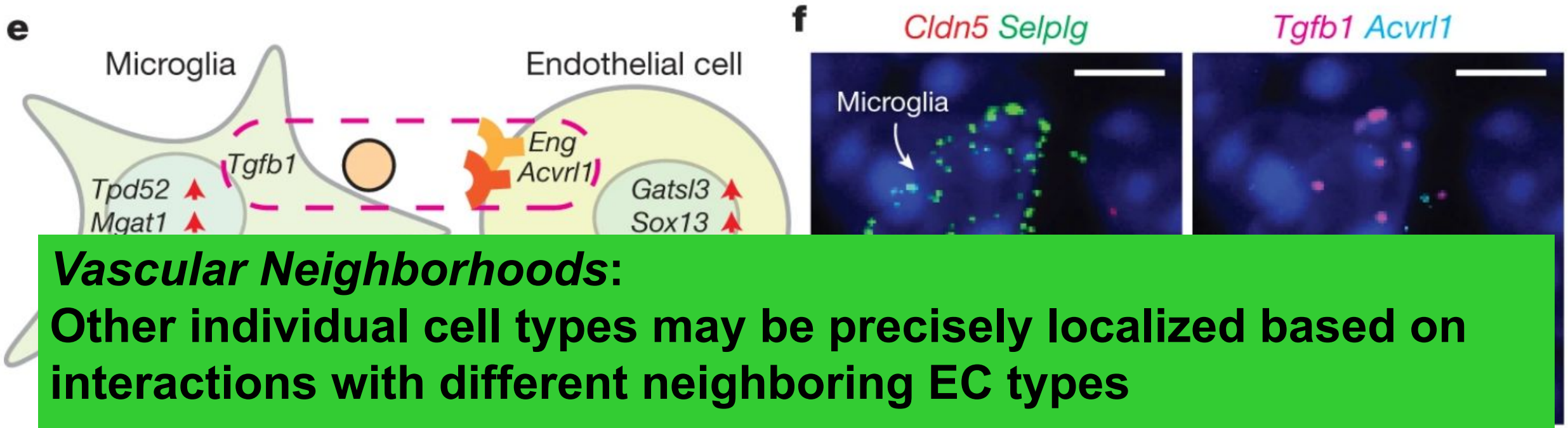
The Translational Significance of the Neurovascular Unit: A Mini-Review, McConnell et al, 2016 JCI



A single endothelial cell = blood vessel (capillary) is at the center of the neurovascular unit

Lolita Cains, PhD
NIH National Heart, Lung, and Blood Institute

Ears dropping on EC “intimate conversations”



***Vascular Neighborhoods*:**
Other individual cell types may be precisely localized based on interactions with different neighboring EC types

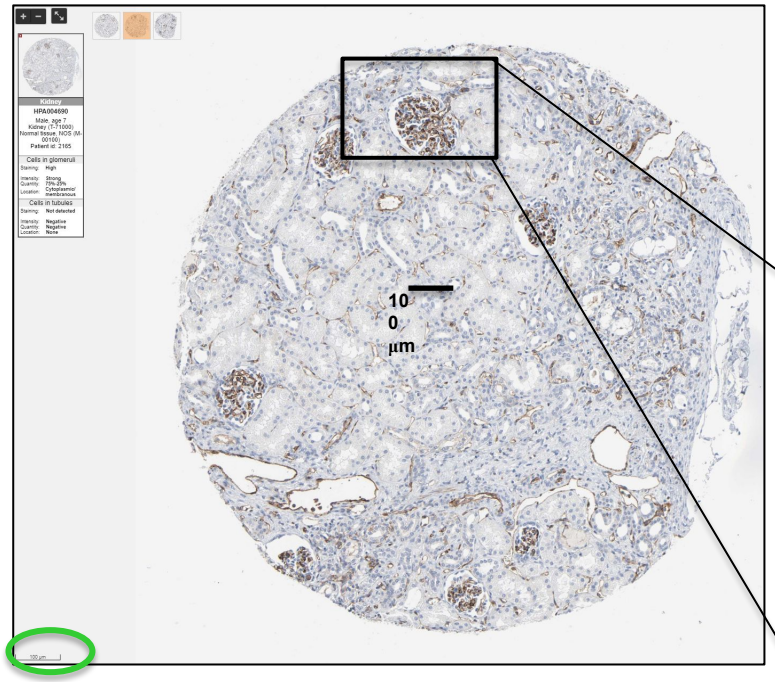
>>> A GPS-Like Localization Approach Using Endothelial Cells?

http
/s4

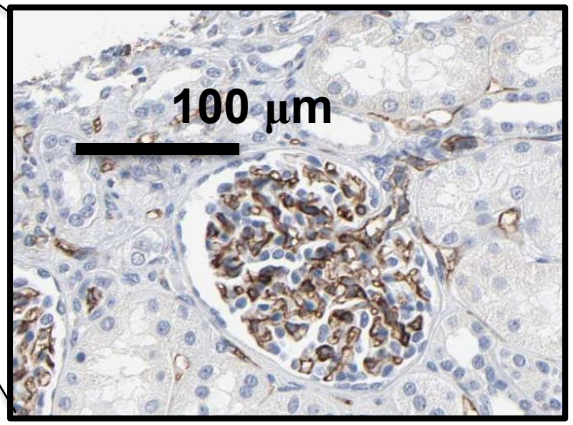
seqFISH+ reveals ligand–receptor repertoires in neighboring cells

Tissue Organization/Pattern and Vasculature (Utility of a 100 μmeter "tissue-stick"?)

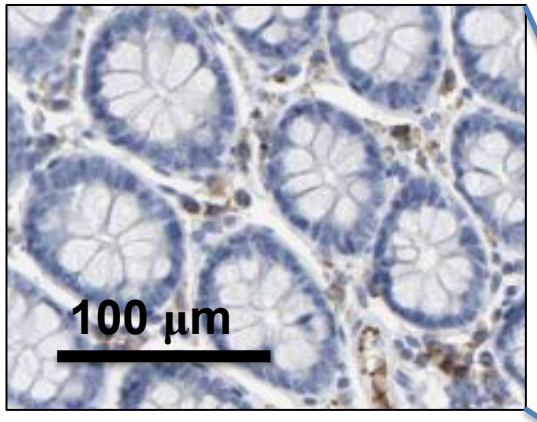
Kidney Histology PECAM-1 Staining
(EC, endothelial cells)



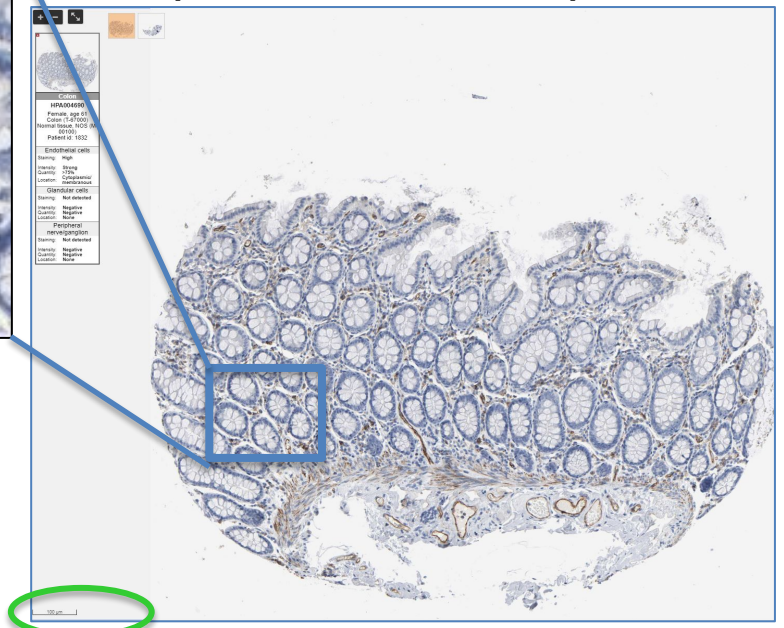
Protein Atlas
https://www.proteinatlas.org/ENSG00000261371-PECAM1/tissue/kidney#img



Close-up:
Kidney Corpuscule (glomerulus)



Colon Histology
PECAM1 (CD31) staining
(Endothelial Cells)



Protein Atlas
https://www.proteinatlas.org/ENSG00000261371-PECAM1/tissue/colon#img

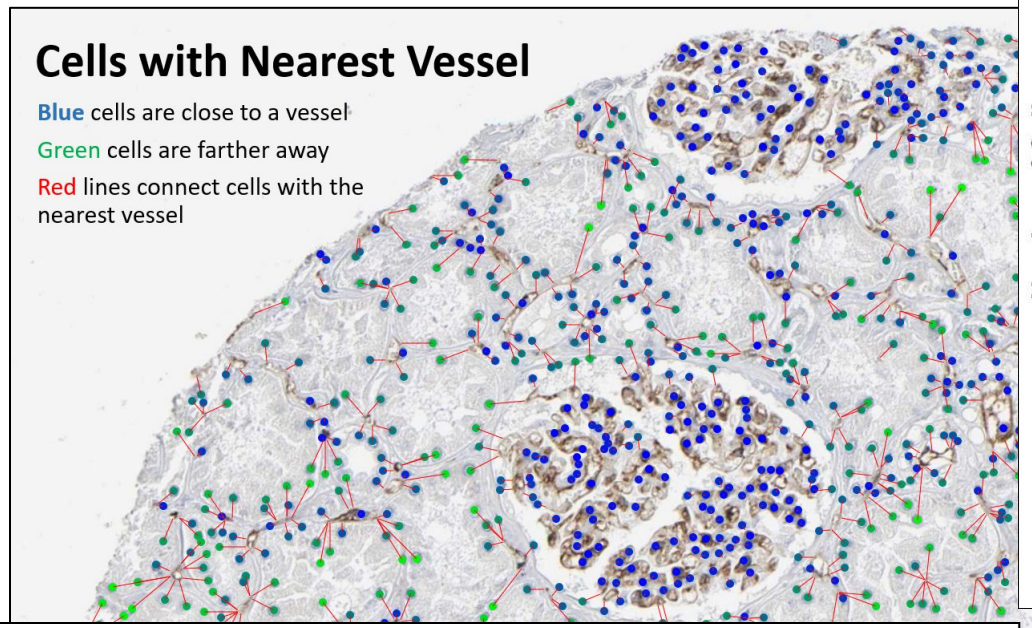
41

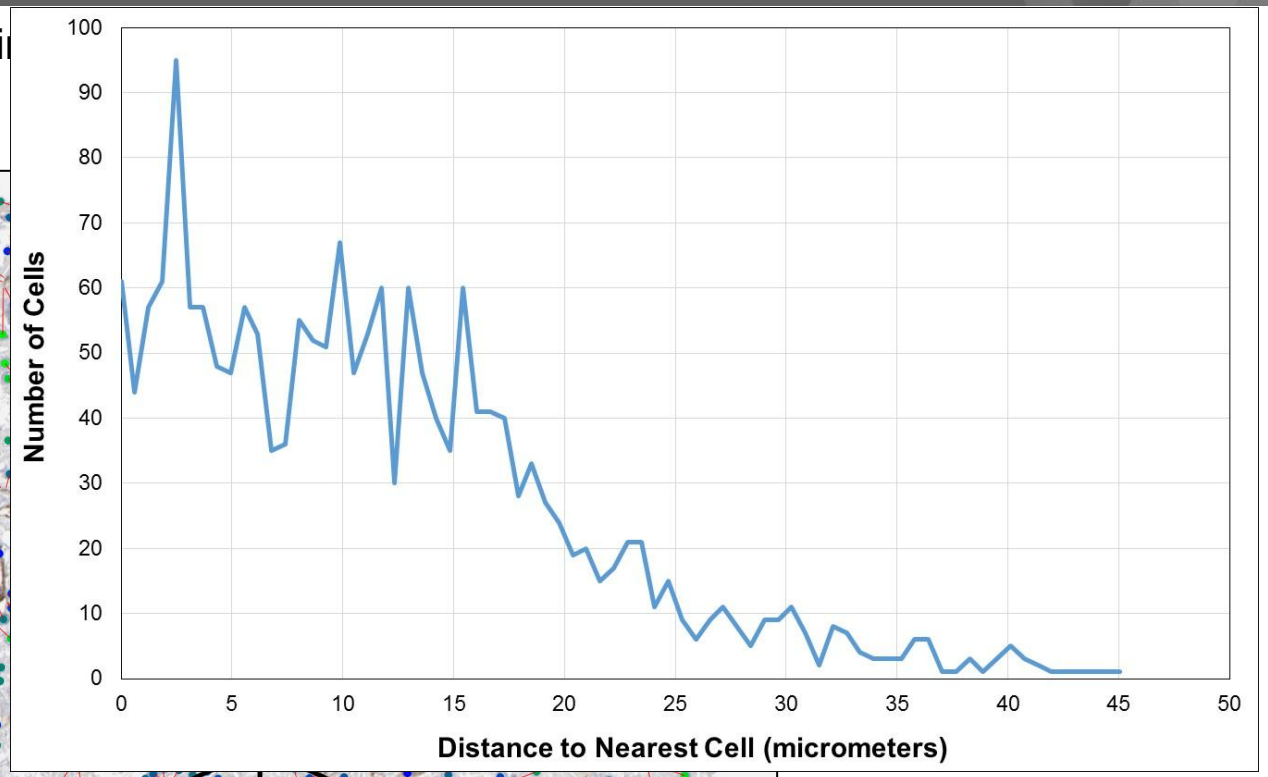
Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

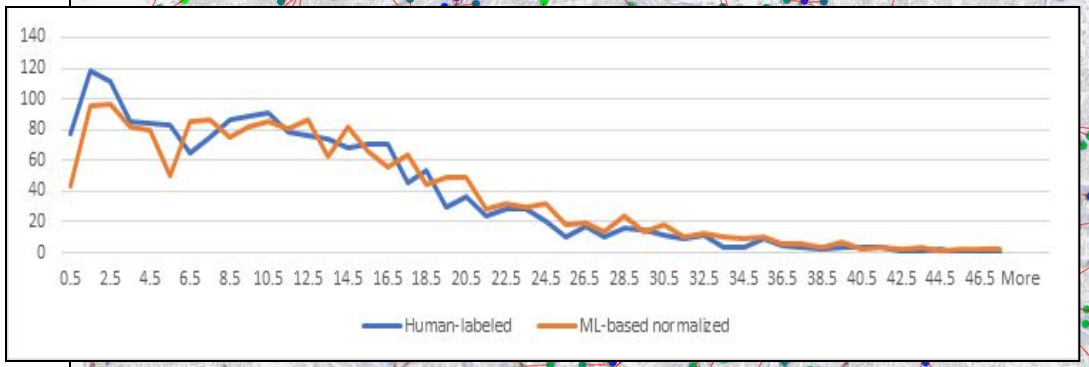
Distance from Closest Endothelial Cell (EC) - Kidney

Using data from the Human Protein Atlas (EC/CD31 Stai

Weber, Galis, Ju



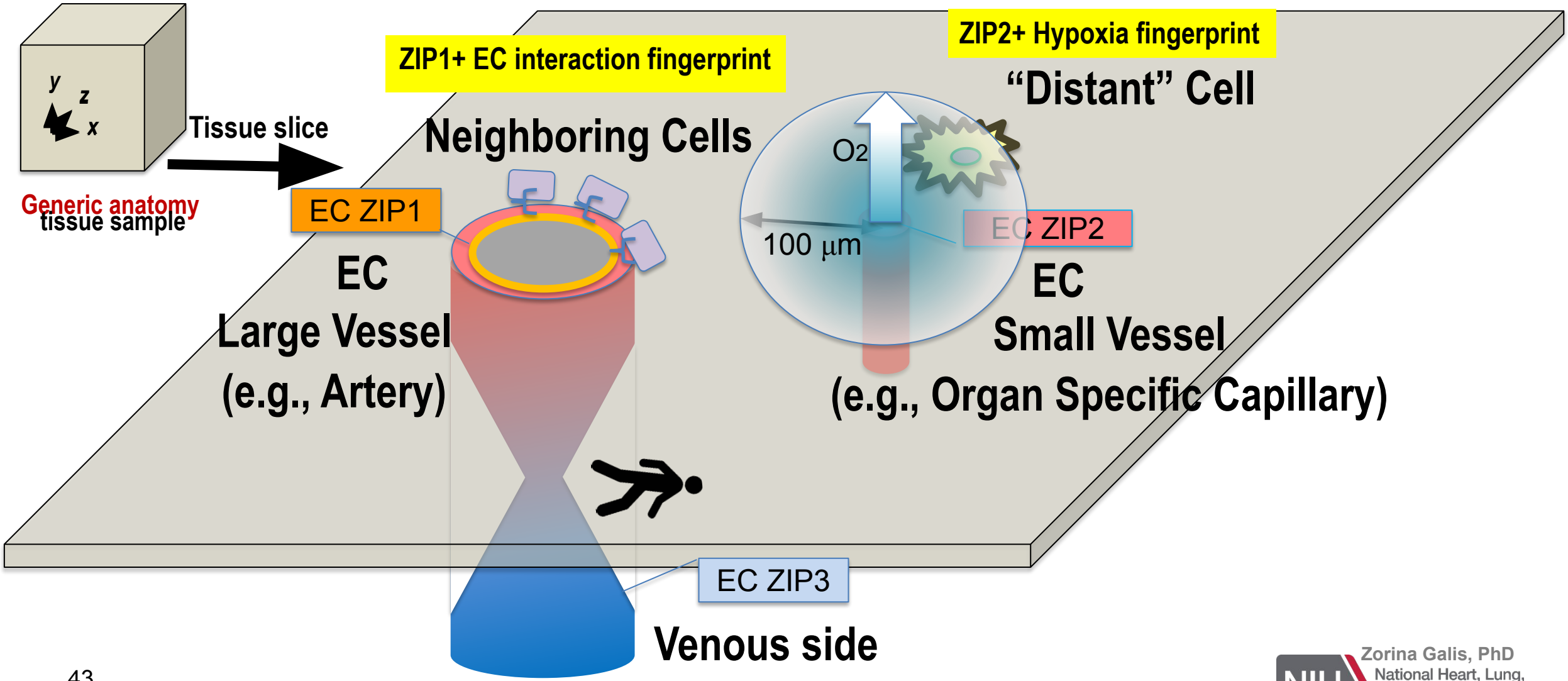




WANTED: High Quality Histology Data

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Endothelial Cell Gene Expression Can Be Used To Establish the Precise Location and Functional State of Other Cells



Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

HuBMAP CCF PORTAL

Menu

The Human Body Atlas: High-Resolution, Functional Mapping of Voxel, Vector, and Meta Datasets

MC-IU team within the HuBMAP HIVE

The ultimate goal of the HIVE Mapping effort is to develop a common coordinate framework (CCF) for the healthy human body. This framework will support cataloging different types of individual cells, understanding the functions of and relationships between those cell types, and modeling their individual and collective function. During the initial three years of HuBMAP, the MC-IU team has built many elements of the CCF. We co-organized the construction of ASCT+B Tables and implemented a CCF Ontology. We collaborated with NIAID at NIH on the design of a 3D Reference Object Library. Lastly, we developed three interactive user interfaces. The CCF ASCT+B Reporter supports the authoring and interactive review of ASCT+B Tables. The CCF Registration User Interface (RUI) supports uniform tissue data registration across organs and labs. The CCF Exploration User Interface (EUI) supports exploration of semantically and spatially explicit data —from the whole body to the single cell level. For an introduction to HuBMAP goals, data, and code visit the Visible Human MOOC (VHMOOC).

- CCF Anatomical Structures, Cell Types and Biomarkers (ASCT+B) Tables
- CCF Ontology
- CCF 3D Reference Object Library
- CCF ASCT+B Reporter
- CCF Registration User Interface (RUI)
- CCF Exploration User Interface (EUI)
- Visible Human MOOC (VHMOOC)
- Kaggle Competition and Awards

Anatomical Structures, Cell Types, plus Biomarkers (ASCT+B) table for Vasculature v1.0

Description

Anatomical Structures, Cell Types, plus Biomarkers (ASCT+B) tables aim to capture the nested *part_of* structure of anatomical human body parts, the typology of cells, and biomarkers used to identify cell types. The tables are authored and reviewed by an international team of experts.

LABEL	VALUE
Creator(s):	Griffin Weber; Sujin Lee; Rajeev Malhotra; Marc Halushka; Avinash Boppana
Creator ORCID:	0000-0002-2597-881X; 0000-0002-6692-6880; 0000-0003-0120-4630; 0000-0002-7112-7389; 0000-0003-0834-8274
Project Lead:	Katy Börner
Project Lead ORCID:	0000-0002-3321-6137
Creation Date:	2021-03-12
License:	Creative Commons Attribution 4.0 International (CC BY 4.0)
Publisher:	HuBMAP
Funder:	National Institutes of Health

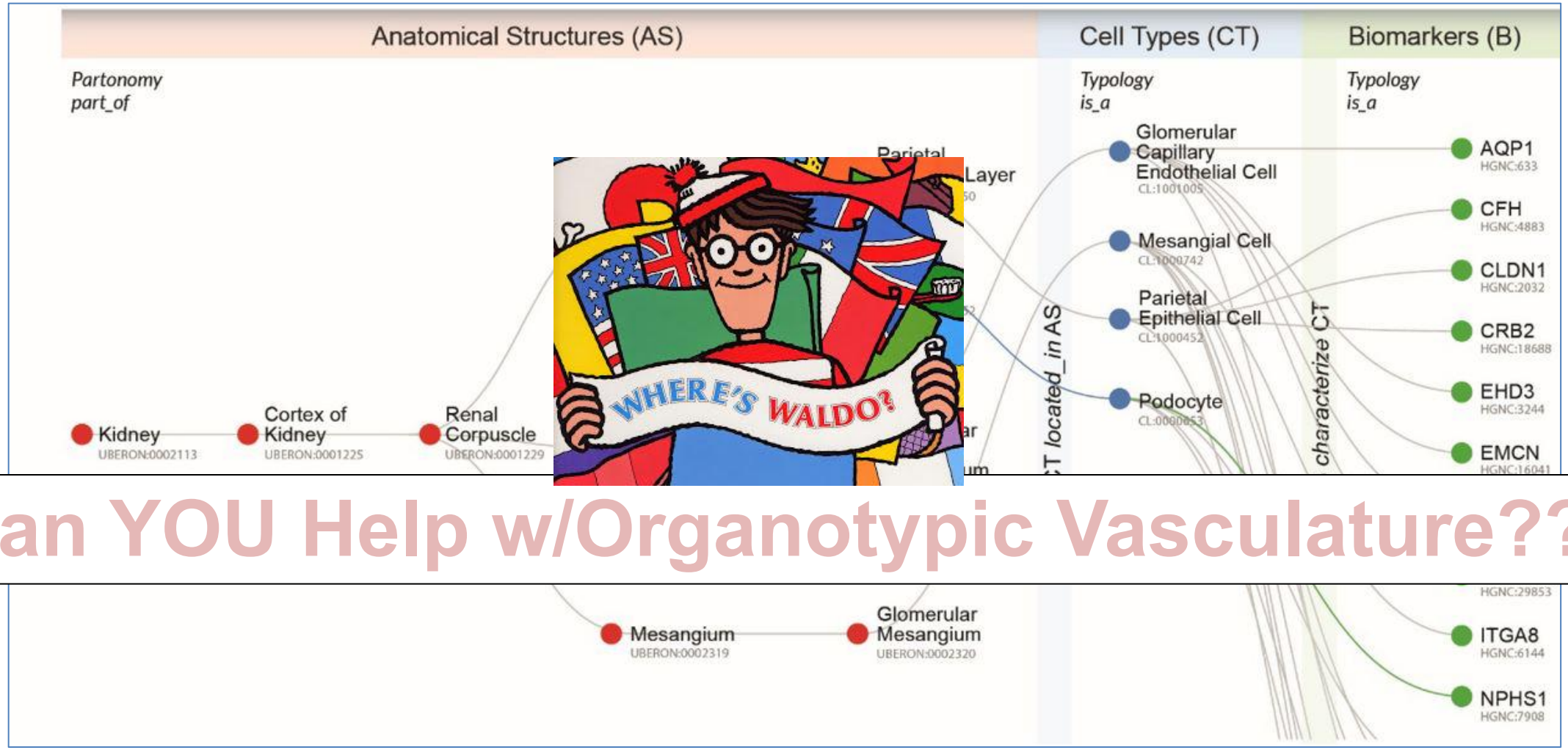
Exis

The be
numbe
and AS

Organ								
Bone								
Brain								
Heart								
Intest								
Kidne								
Lung								
Lymp								
Skin	16	42	70	0	70	17	19	105
Spleen	46	66	255	80	145	68	172	414
Thymus	25	41	511	388	123	38	180	657
Vasculature	870	2	1	1	0	869	606	2
Totals:	**1,534**	**622**	**2,154**	**1,492**	**632**	**3,393**	**14,987**	**3,580**

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Case Study: Kidney ASCT+B

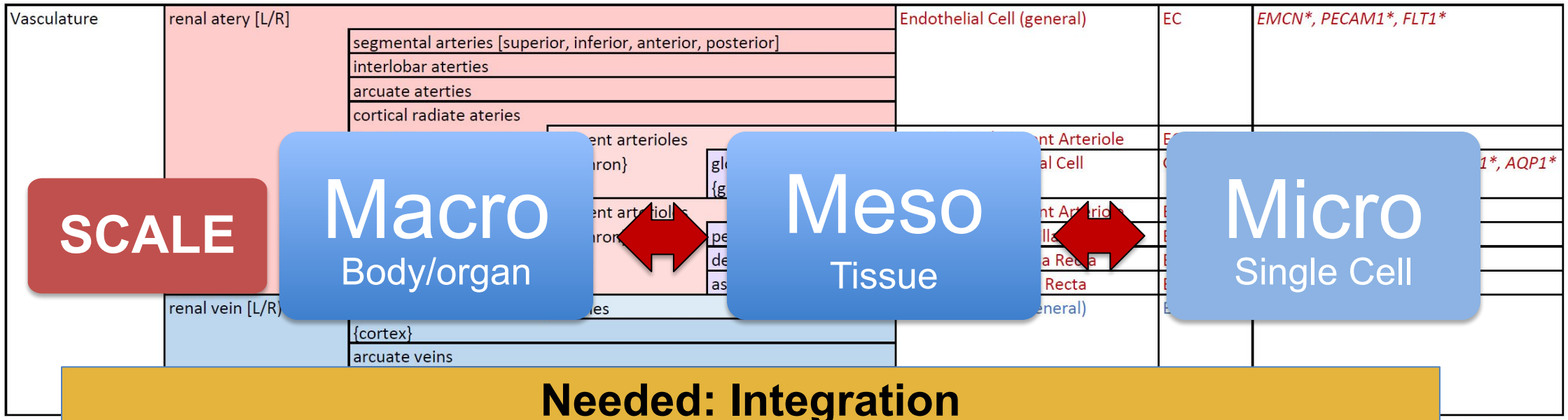


Can YOU Help w/Organotypic Vasculature???

https://www.biorxiv.org/content/10.1101/2021.05.31.446440v2.full

Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

Wanted: Seamless Integration of VASCULAR Anatomical Structures and Cell Types (ASCT) in ALL Organ Tables



Needed: Integration

Vasculature	renal artery [L/R]	segmental arteries [superior, inferior, anterior, posterior]	Endothelial Cell (general)	EC	EMCN*, PECAM1*, FLT1*
Vasculature	renal artery [L/R]	interlobar arterties	Endothelial Cell (general)	EC	EMCN*, PECAM1*, FLT1*
Vasculature	renal vein [L/R]	cortical radiate veins {cortex}	Endothelial Cell (general)	EC	EMCN*, PECAM1*, FLT1*
Vasculature	renal vein [L/R]	cortical radiate veins {cortex}	Endothelial Cell (general)	EC	EMCN*, PECAM1*, FLT1*
Vasculature	renal vein [L/R]	arcuate veins	Endothelial Cell (general)	EC	EMCN*, PECAM1*, FLT1*
Vasculature	renal vein [L/R]	interlobar veins	Endothelial Cell (general)	EC	EMCN*, PECAM1*, FLT1*

SIGN UP as an domain expert !

For more information and to join the ASCT+B open working group please email infoccf@indiana.edu

Dr. Griffin Weber

NIH National Heart, Lung, and Blood Institute

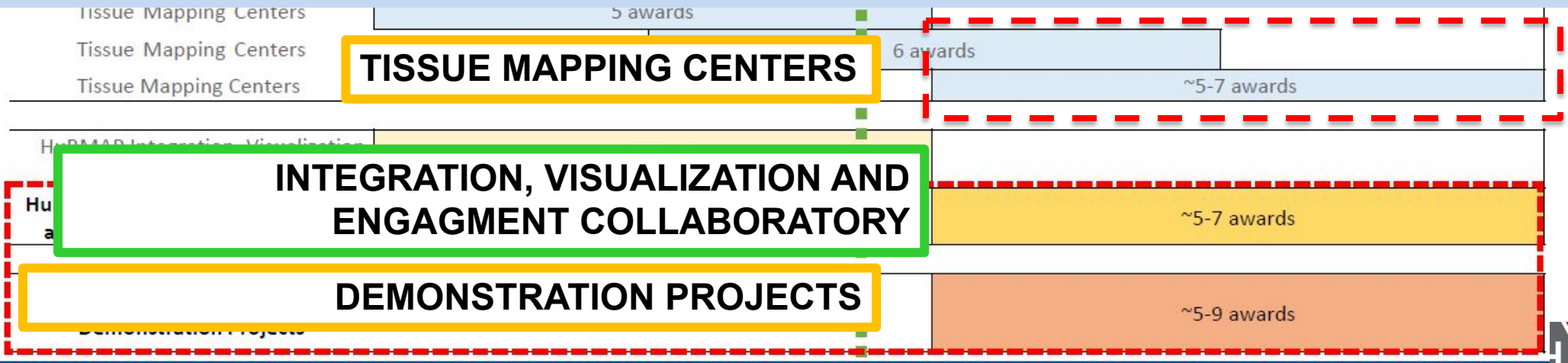
New HuBMAP Initiatives Approved by the NIH Council of Councils May 2019/2021

Program Timeline

https://dpcpsi.nih.gov/sites/default/files/Day-1-215PM-CF-Concept-HuBMAP-Conroy_508.pdf

NIH The Common Fund

- **Check for latest updates at NIH Common Fund HuBMAP https://commonfund.nih.gov/hubmap**
- **Sign up for HuBMAP mailing list for updates https://hubmapconsortium.org/hubmap-mailing-list/**
- **Follow HuBMAP on Twitter _HuBMAP**



Zorina Galis, PhD
National Heart, Lung, and Blood Institute

BOSTON LYMPHATIC SYMPOSIUM

NIH Clinical Pre-Conference | Patient Home | Clinical Home | Prior Symposia

Hosted by the Boston Lymphatic Center In Partnership with Lymphatic Education & Research Network

"Yet to Be Charted: Mapping the Lymphatic System Across Body Scales and Expertise Domains"

UPCOMING event for the lymphatic community

Virtual Workshop Sponsored by the NIH/NHLBI
Boston Lymphatic Symposium Pre-Conference

NIH National Heart, Lung, and Blood Institute

Streaming Live | November 4, 2021 | 9:30am-4:00pm ET

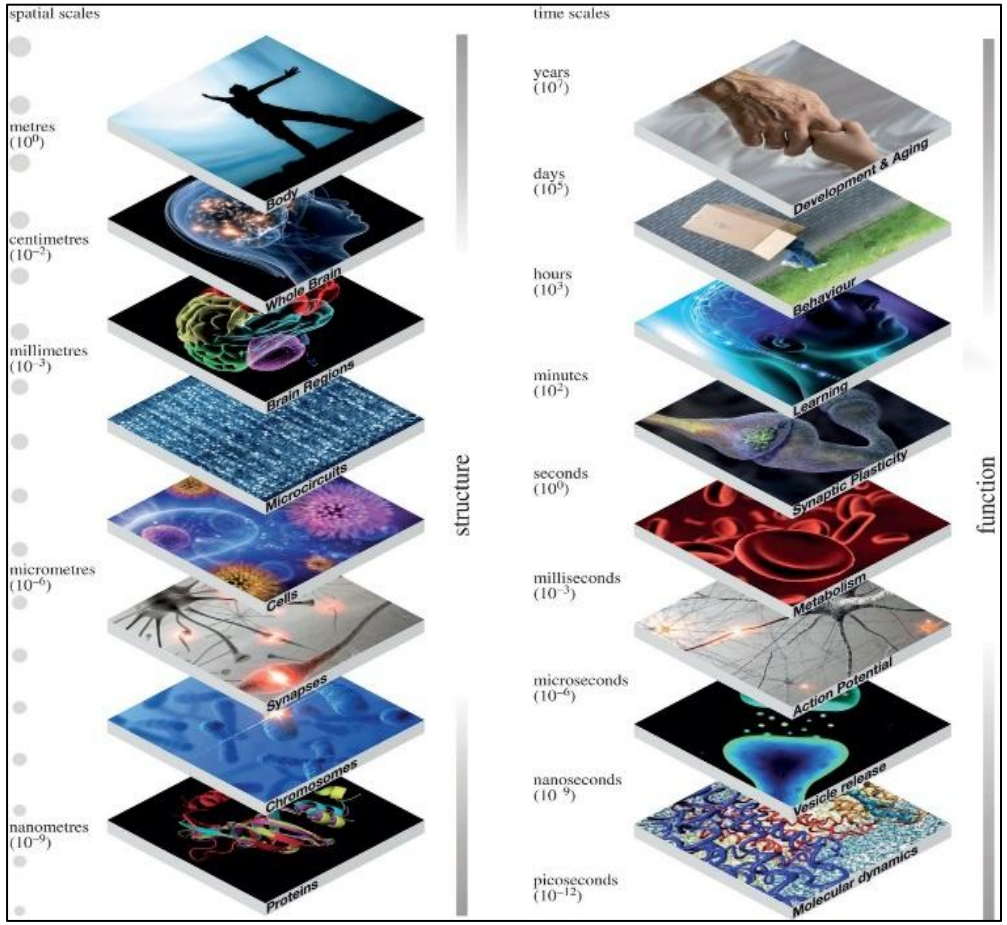
Come join us!

The content of this event is primarily geared toward clinicians, basic scientists, and other experts in the field of lymphatics, however, **all** are welcome to attend. Registration is free.

NIH Pre-Event Registration

https://bostonlymphaticsymposium.org/pre-symposium/

From Precision Vascular Biology to Precision Medicine



Frackowiak et al., The future of human cerebral cartography: a novel approach. Phil Trans R Soc B (2015)

- **WHAT: Assembling and analyzing high content spatial/temporal and functional biological information**
- **HOW: new investigative and computational technologies, including ML**
- **WHY: Identifying the molecular/cellular bases of local and individual variations, signaling transitions from health to disease, targeted interventions**
- **>>basis for "*Precision Medicine*!"**

Zorina Galis, PhD
National Heart, Lung, and Blood Institute

Seeking to Enable Solutions for Important Biomedical Challenges …is a (Fun) Team Sport!

HuBMAP NIH Core Group, NIH Director Award 2019 for "*building exceptional collaborations inside and outside the NIH to create a transformative paradigm that enables cooperative worldwide efforts to map the human body*"

The Human BioMolecular Atlas Program (HuBMAP) Team

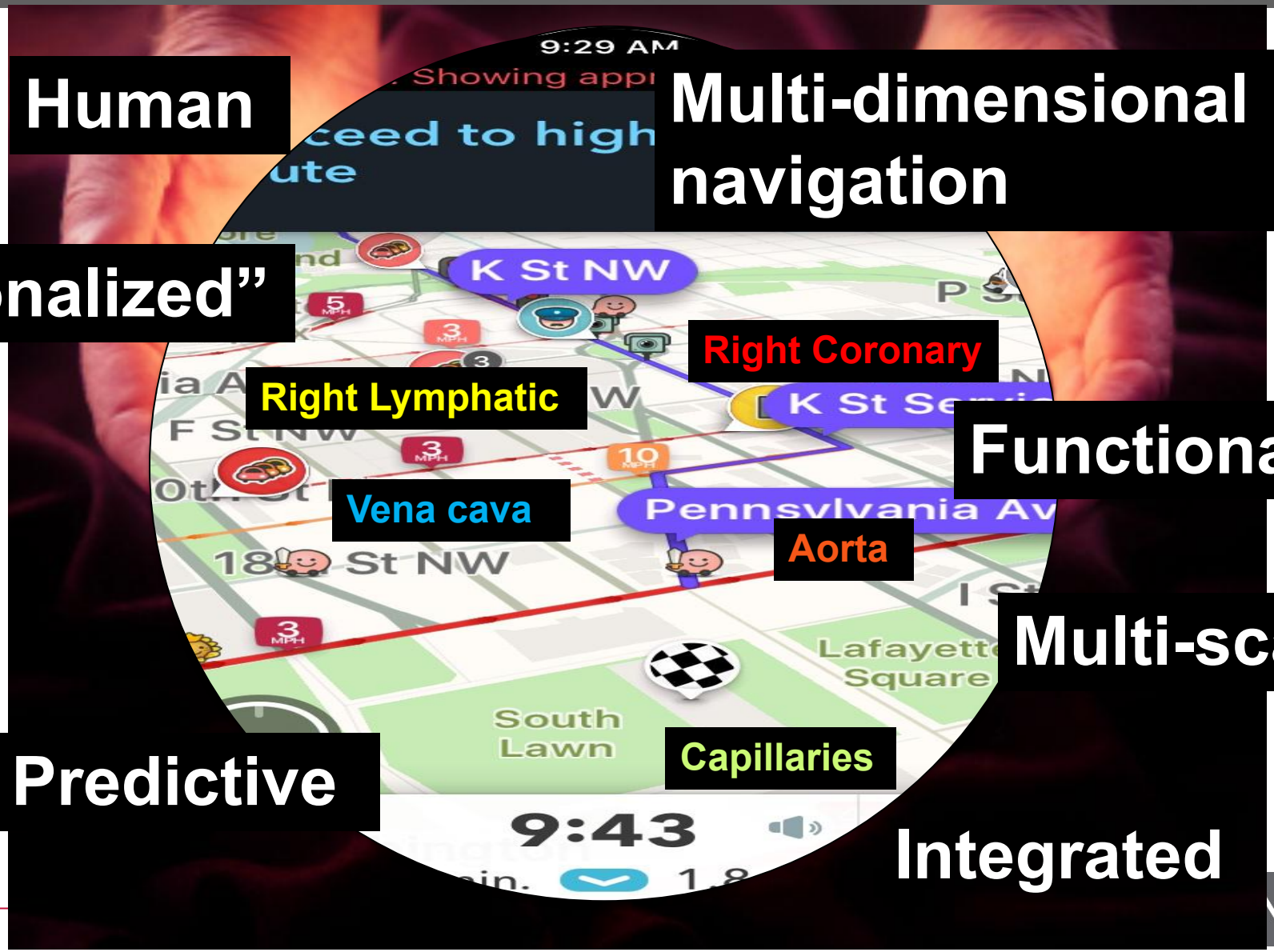
https://commonfund.nih.gov/hubmap

NAVBO !!!
North American Vascular Biology Organization

Zorina Galis, PhD
NIH National Heart, Lung, and Blood Institute

National Heart, Lung,
and Blood Institute

“The Vasculome”…



Zorina Galis, PhD
National Heart, Lung, and Blood Institute
NIH

HuBMAP Types of Analyses

IMAGING

DNA/RNA
DART-FISH
seqFISH
smFISH
MERFISH
Slide-seq
SABER-FISH
GeoMx

Lipids/Metabolites
MALDI Imaging MS
SIMS Imaging
DESI Imaging MS
NanoDESI Imaging MS

Proteins
Multiplexed IF
IHC
Lightsheet
CODEX
Cell DIVE
DART-FISH
CyTOF Imaging
MALDI Imaging MS
nanoPOTS
MIBI
Immuno-SABER

Other
MR Imaging
CT Imaging
Autofluorescence
Stained Microscopy

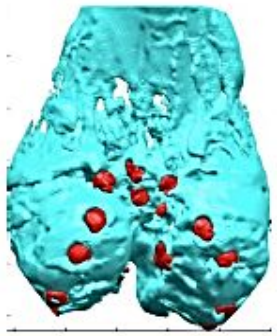
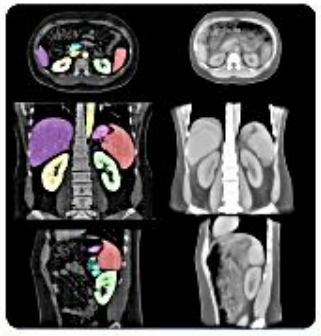
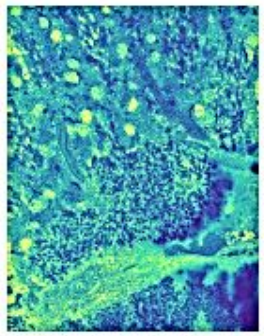
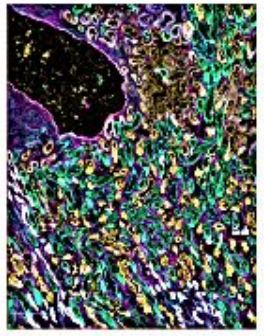
SEQUENCING

snDropseq
scRNAseq
snRNA-seq
snATAC-seq
sciRNAseq
sciATACseq
scTHSseq
SNAREseq
scATACseq

BULK OMICS

Lipids/Metabolites
LC-MS/MS

Proteins
Bottom-up LC-MS/MS
Top-down LC-MS/MS
TMT LC-MS/MS


Zorina Galis, PhD
National Heart, Lung, and Blood Institute