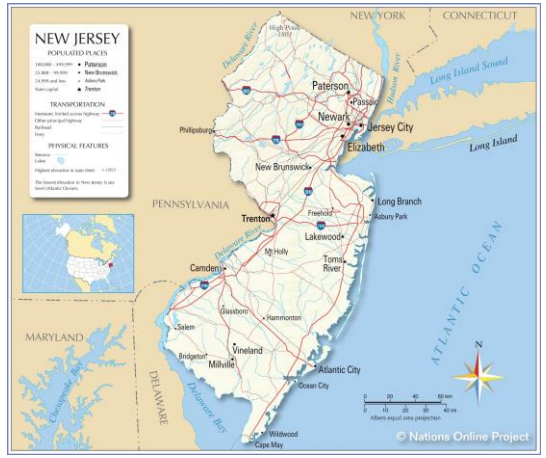
Some Assorted Advice and Anecdotes

Navigating Academia

Building a Skillset



Mouse Embryonic Stem Cells

- Introduced to Machine Vision
- Connections to UPenn

IRACDA Teaching Fellowship

- Modeling of transcription
- Extensive teaching focus

Chemical Engineering

- Mathematical modeling of bacterial metabolism
- Learned to make and solve models
- Connections to Harvard Stem Cell Institute

Developmental Biology

- Modeling of extracellular reaction-diffusion
- Connections to IRACDA/postdoc

The Academic Snowball

Funding leads to more funding

Good talks and posters lead to more talks and posters

Well-done research leads to more research opportunities

How to start your academic snowball:

MARC program

On-campus research

NSF Graduate Fellowship

Summer Internships

Conference Networking

Outreach Programs

Building Networks

Your connections to professors and fellow students are as important as the skills you learn

- Treat every class as an opportunity to make yourself known as someone who is engaged and hardworking
- As mentors for advice, they're usually happy to give it and happy to be asked
- **Every** presentation you make is important
- Make a spreadsheet of names and connections you make

STEM and Disability

Keep your eyes open for disability specific grants or grants that encourage underrepresented minorities:

- NIH F31-D
- NIH diversity supplements
- Foundation for Science and Disability Student Award Program
- NSF GRFP

Don’t be afraid to take things slow

Don’t be afraid to ask for what you need

Work in a team when possible

Use your disability-specific knowledge

Work with your disabilities office

Make sure to visit the disabilities office of every school you consider joining

Get involved in outreach programs

Mycoplasma gallisepticum

Why was it cool?

Has the second smallest free-living bacterial genome

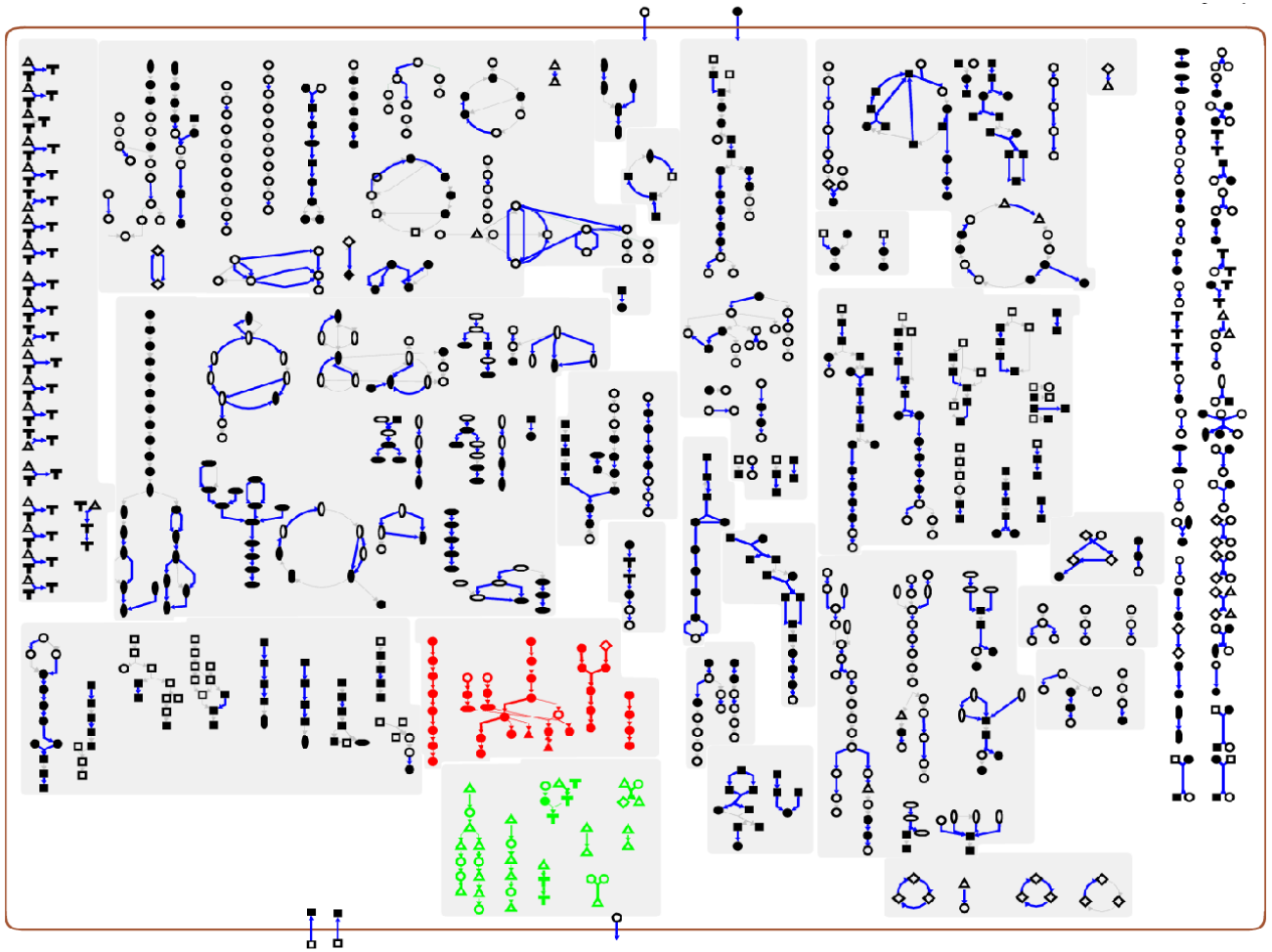
Can study the minimal set of metabolic pathways to sustain a cell

Creating life in a dish… the Venter endeavor

What did we do?

We studied whether high passage lab strains of M. Gal had lost metabolic pathways

We did so by making a system-scale model of the metabolism and measuring metabolite fluxes



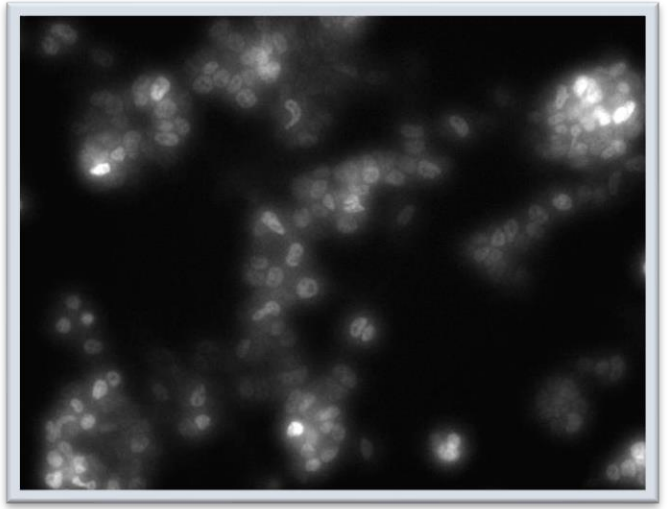
Stem Cell Differentiation

Why was it cool?

Stem cells in a dish show remarkable heterogeneity of factors that control their differentiation

Live imaging could show how changes in those factors controlled the differentiation of individual cells

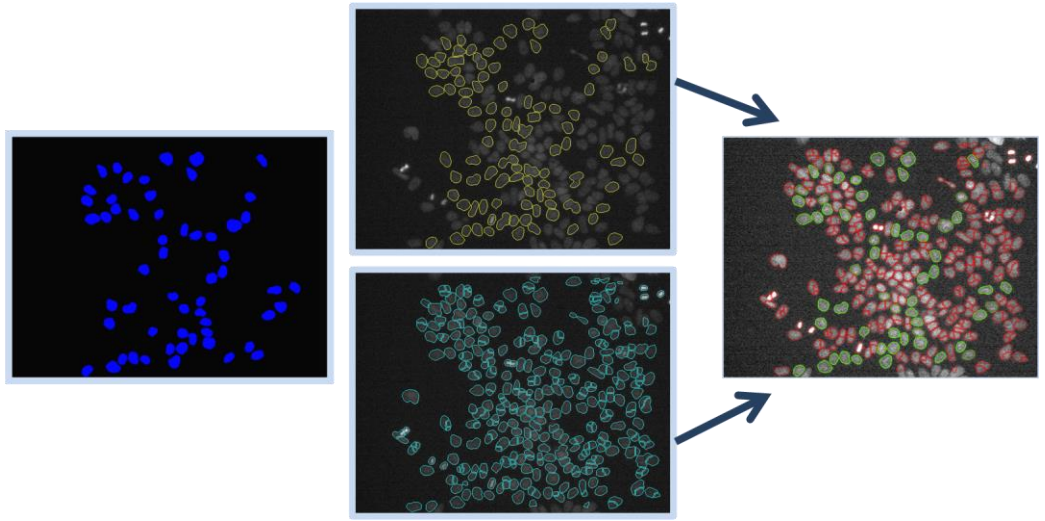
We could control differentiation!



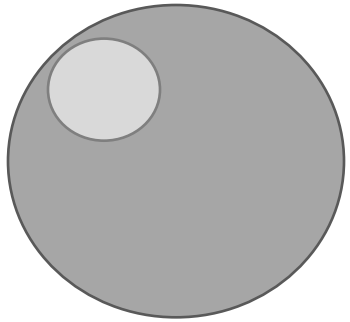
Nanog Protein Levels

What did I do?

Machine vision to identify cells



Axis Patterning in Development



Zygote

Spherical

1 Cell

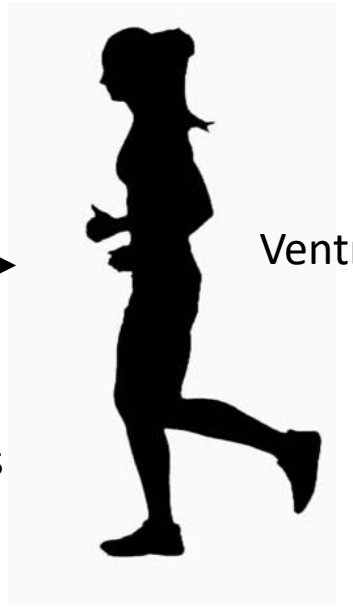
1 cell type

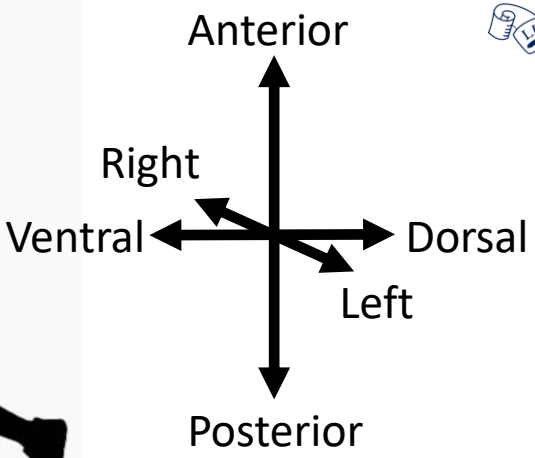
No organs

No axis

Development.

Relaying positional and fate information to over 30 trillion cells





Human

Not Spherical

30+ trillion cells

200+ cell types

11 organ systems

3 axis

Where do you start?

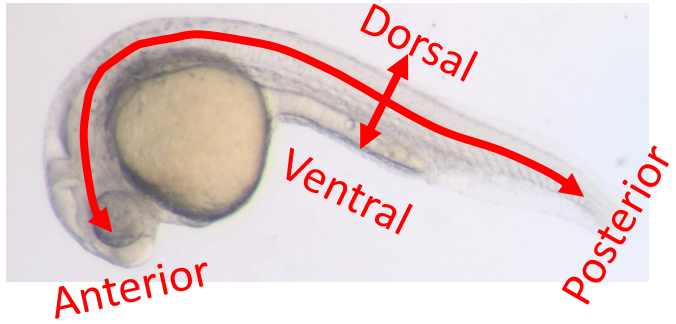
Axis

Axis Patterning in Zebrafish

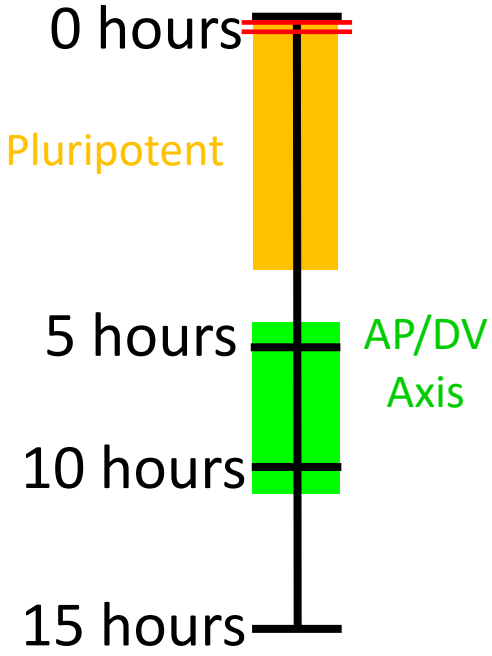
- In zebrafish, a recognizable fish can be seen after just 24 hours

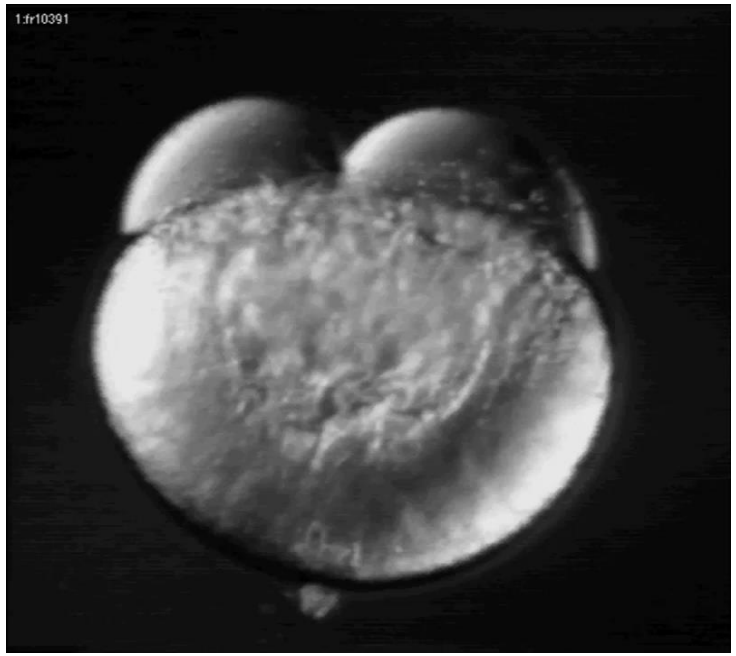
Just Fertilized

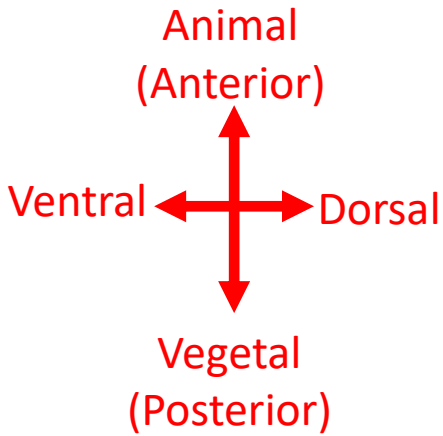
24 Hours After Fertilization



- Axis patterning happens early:





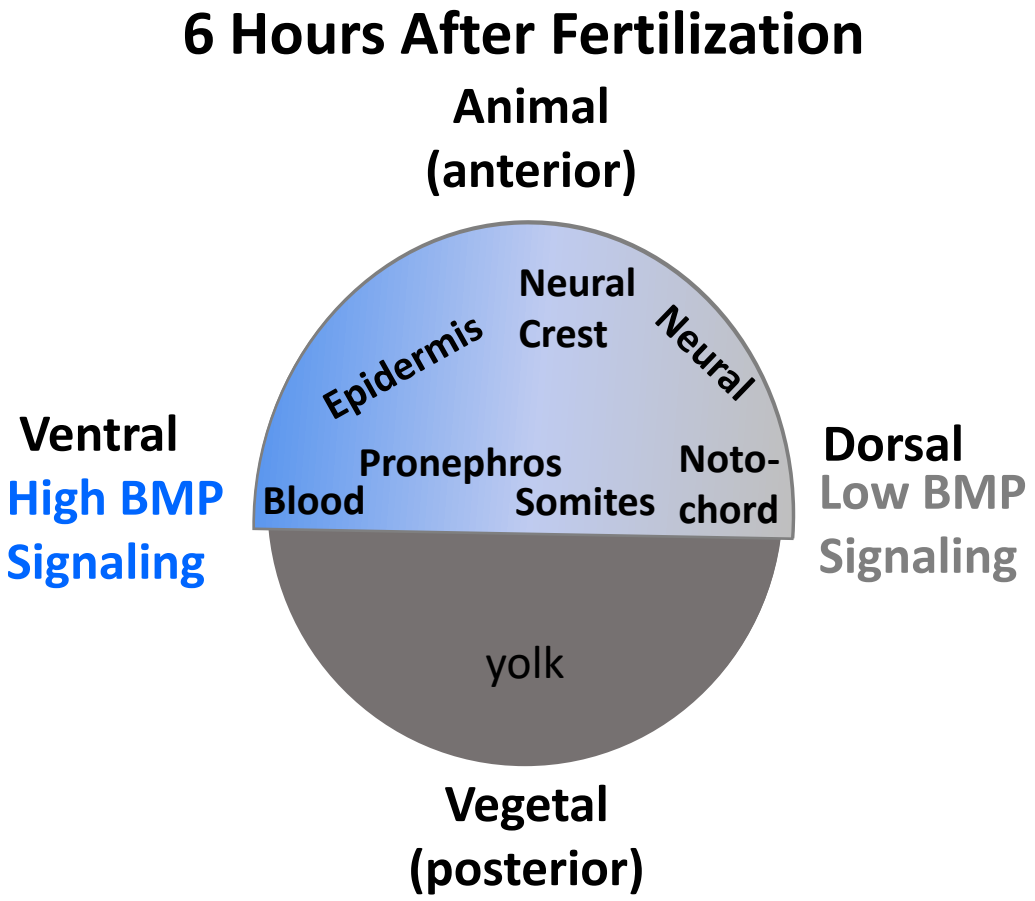


The BMP Signaling Gradient Patterning the D-V Axis

- **BMP (Bone Morphogenetic Protein)** patterns all Dorsal-Ventral cell fates

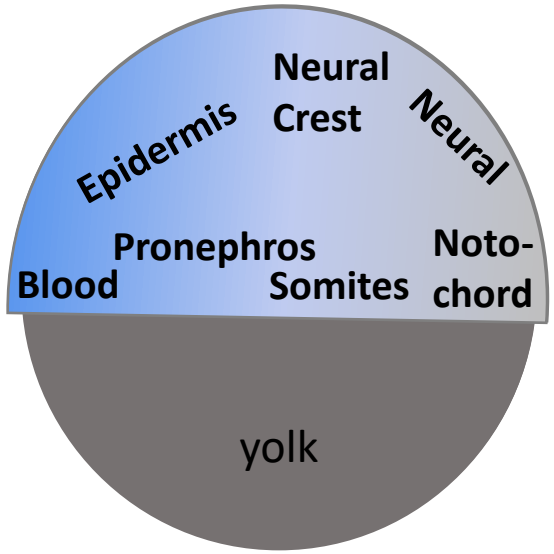
- **How?**

- **BMP** forms a signaling gradient



BMP as a Morphogen

Dorsal-Ventral Patterning
In zebrafish



Dorsal-Ventral patterning of nearly all bilateral organisms

Drosophila

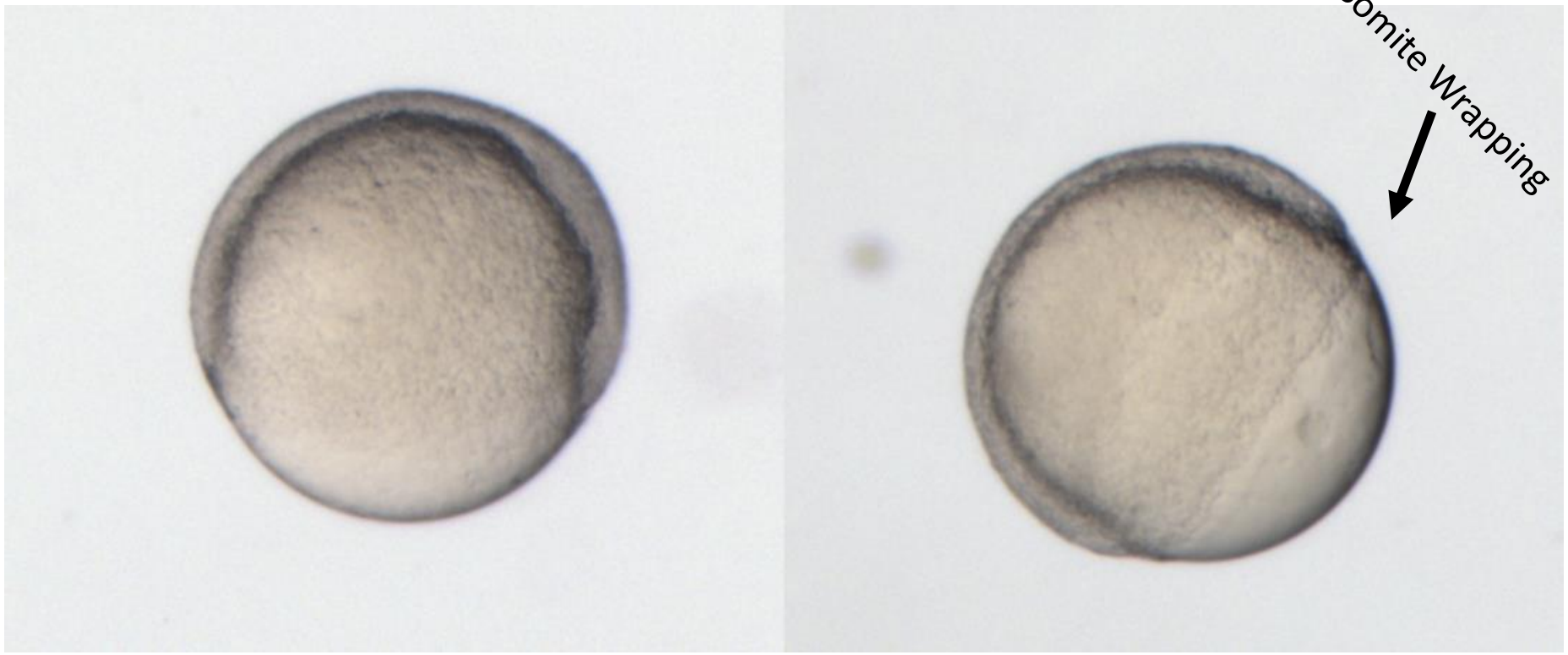
Xenopus

mice

humans

Wild Type

No BMP Signaling

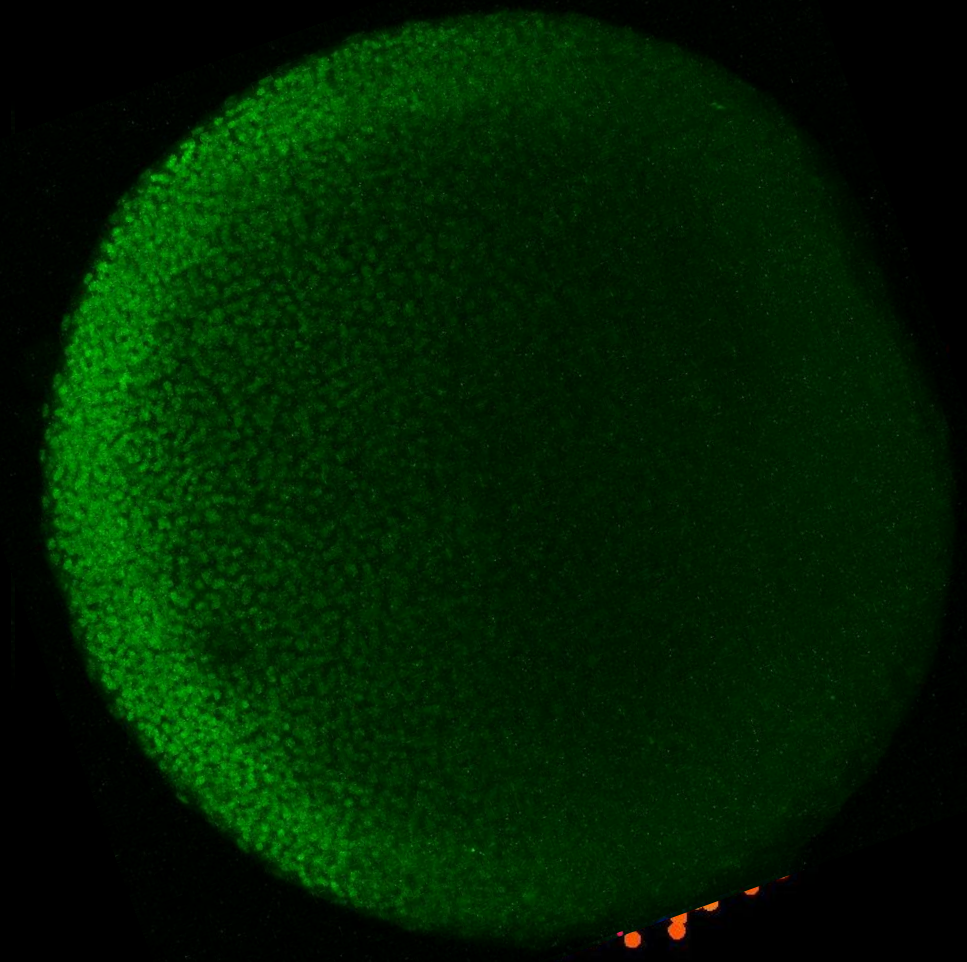


James Dutko

Automated Intensity Measurement

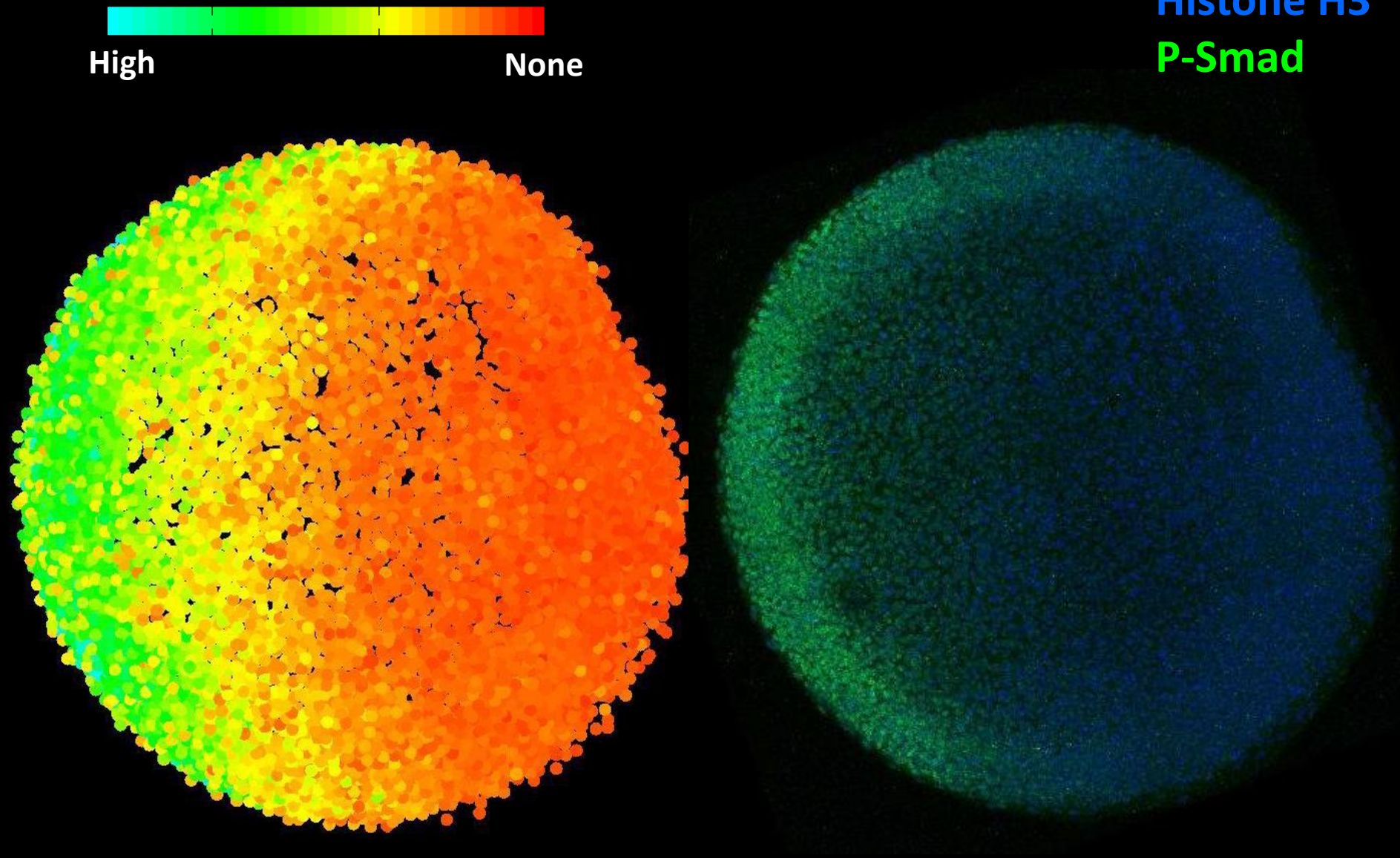
Histone H3
P-Smad
Centroids

Ventral
(High BMP)



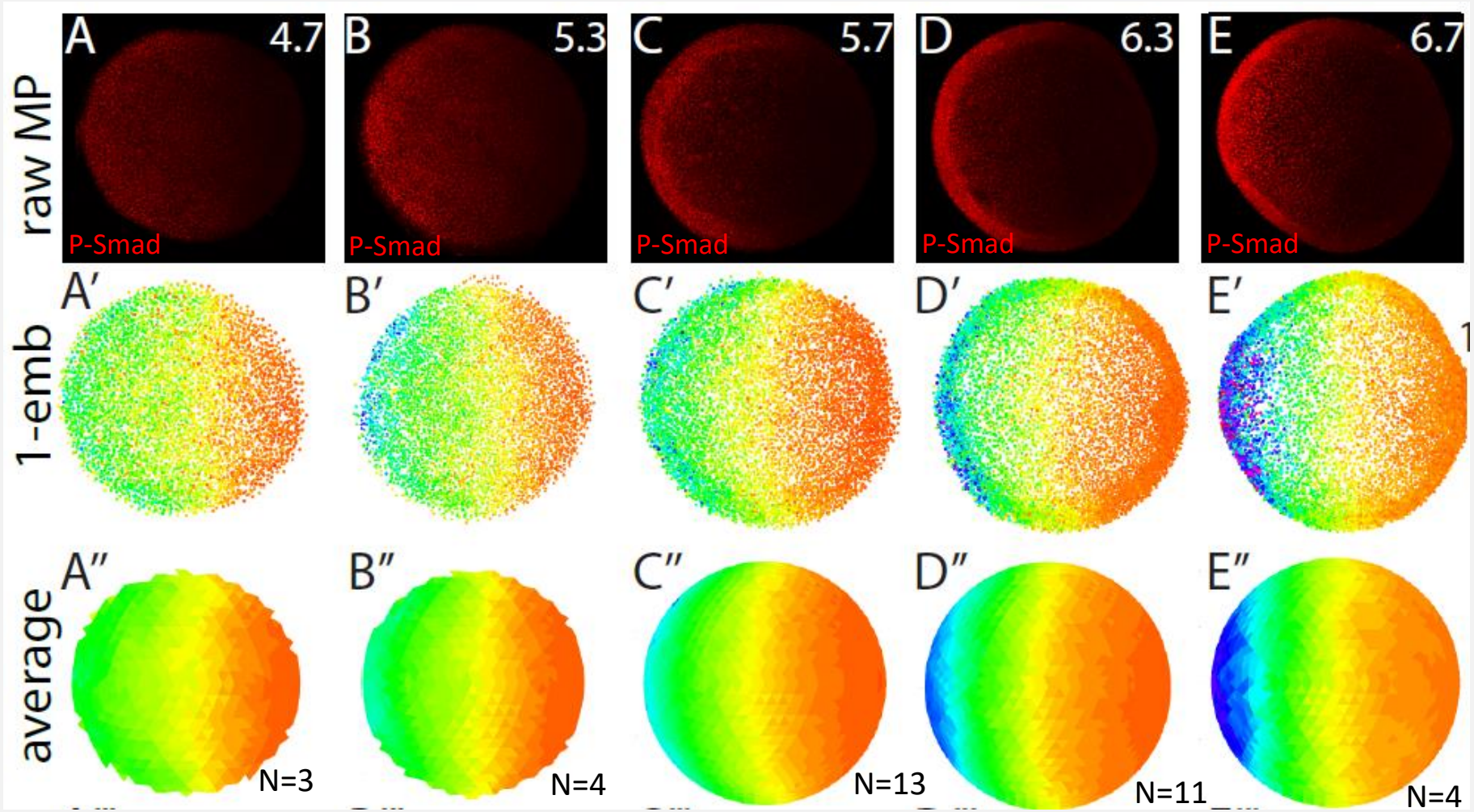
Dorsal
(Low BMP)

Animal (top) View


High
None
Histone H3
P-Smad

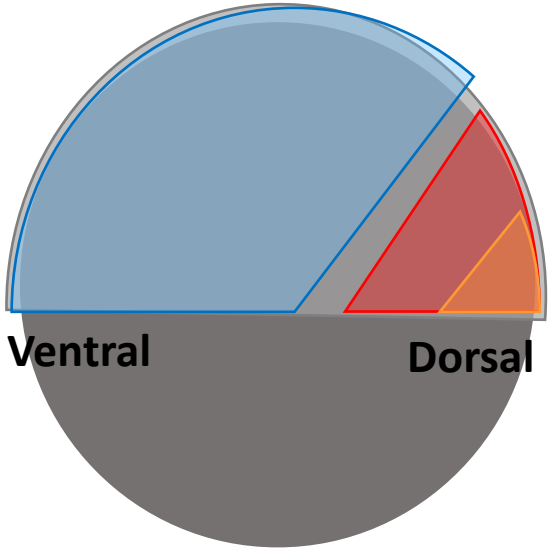
The WT Gradient is Dynamic During DV Patterning

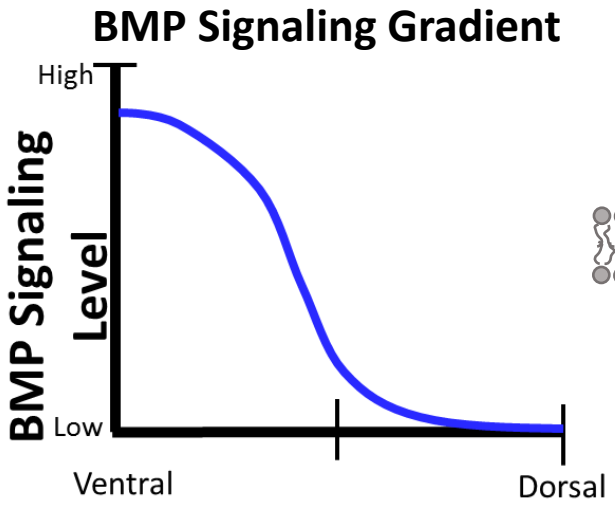
Start of head/trunk patterning (4 hpf) → End of head/trunk patterning (7 hpf)

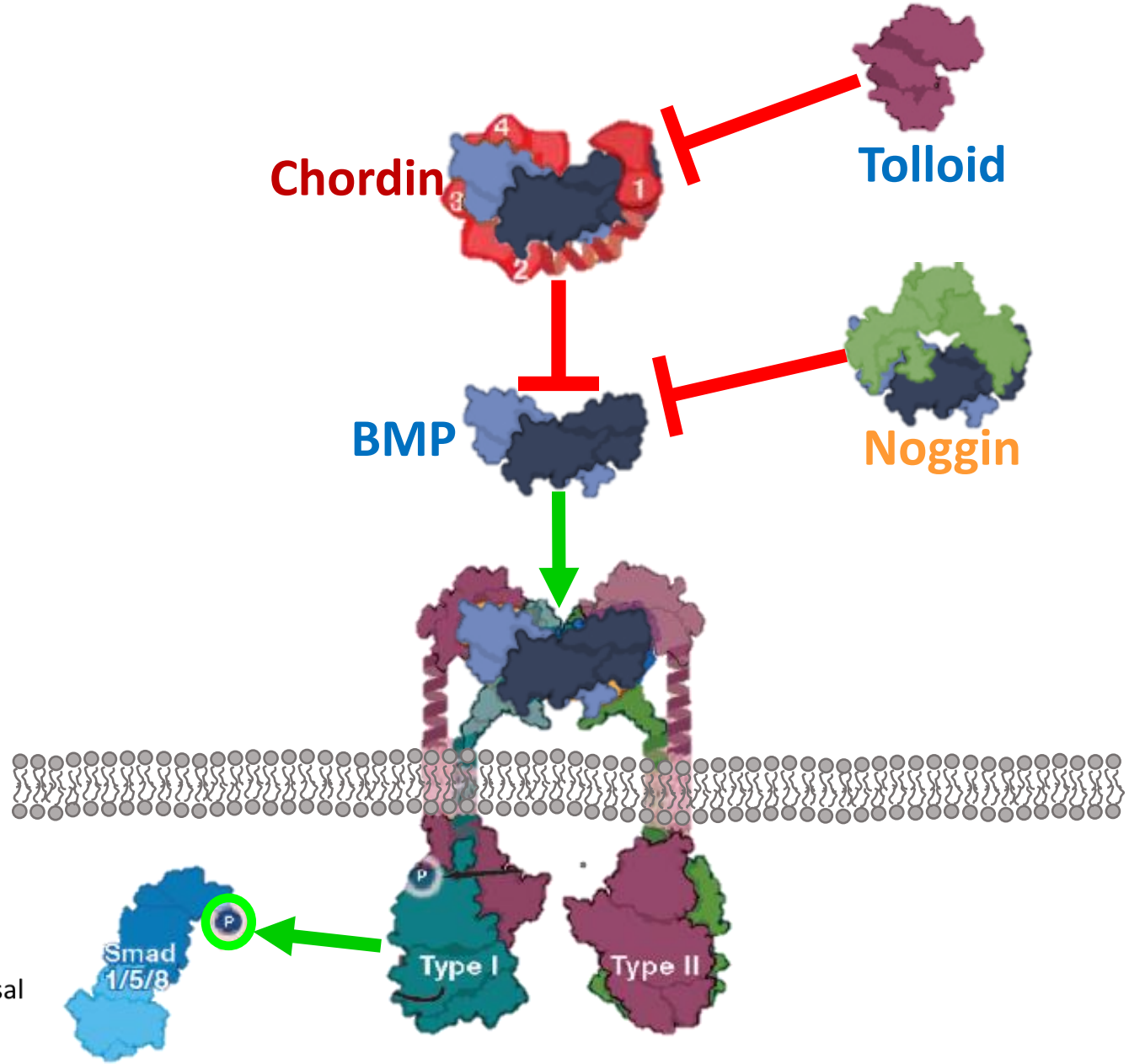


Extracellular regulation of the BMP Ligand

Dutko & Mullins. 2011. Cell.

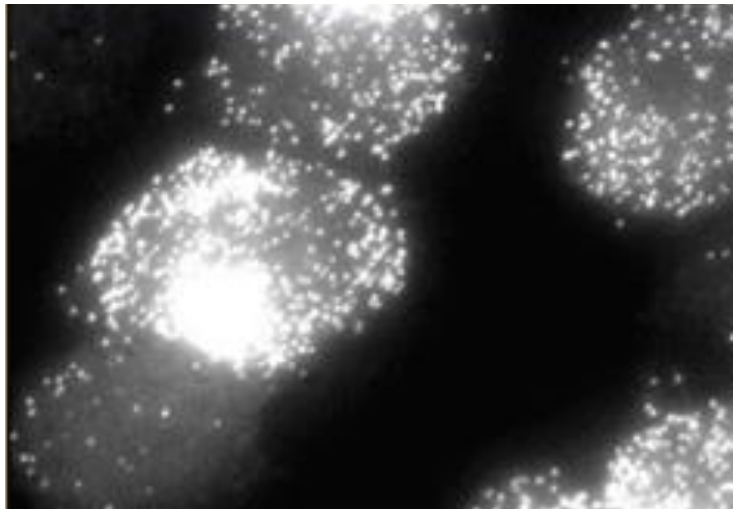




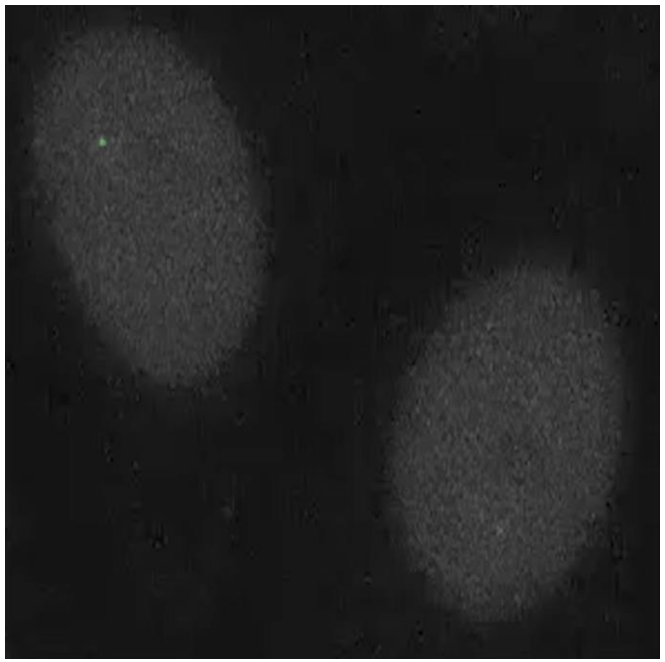


Transcriptional Bursting Contributes to Cell-Cell Variability

Heterogeneity in gene expression has long been observed in cells in the same state



Raj et al. 2008



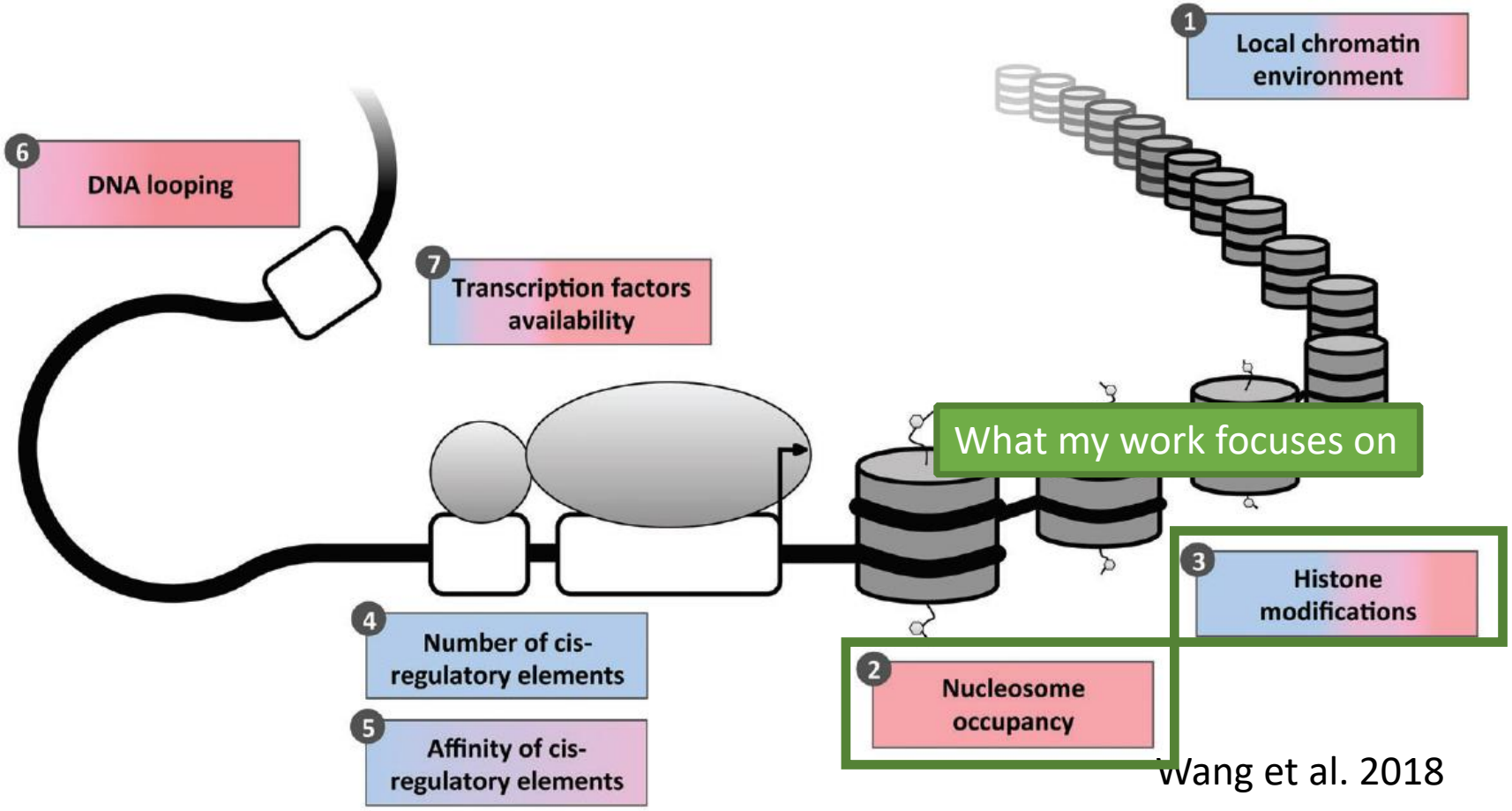
Rodriguez et al. 2019

An important source of heterogeneity is transcriptional busting

tff1 loci bursting in MS2 cells for 10 hours
(15 min per frame)

A Myriad of Factors Impact Transcriptional Bursting

We care how this:

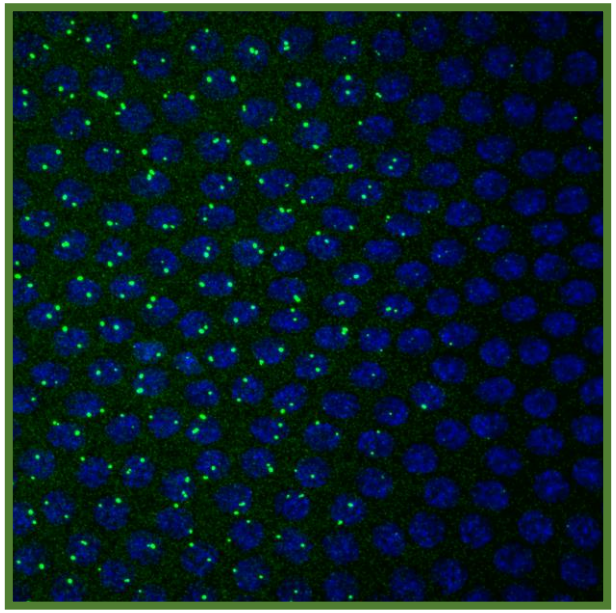


Wang et al. 2018

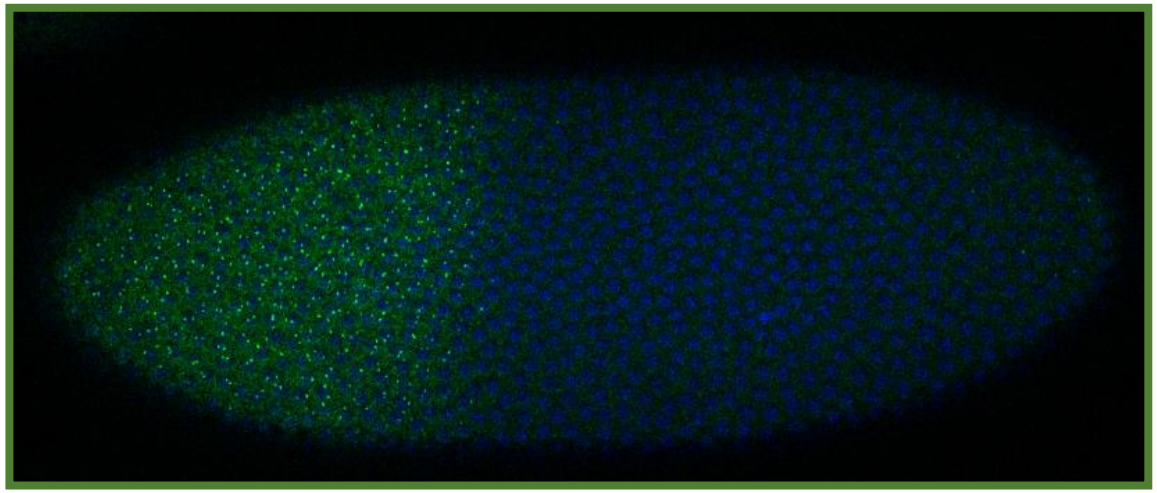
Impacts this:

The Early Drosophila Embryo is Ideal to Study Bursting

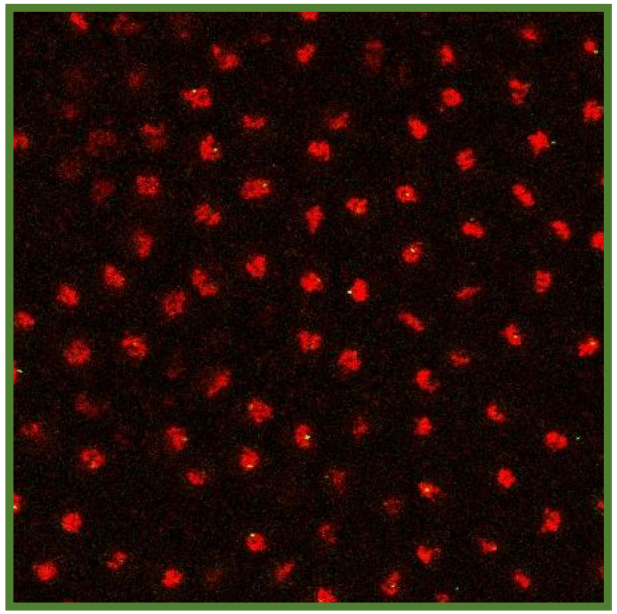
smFISH



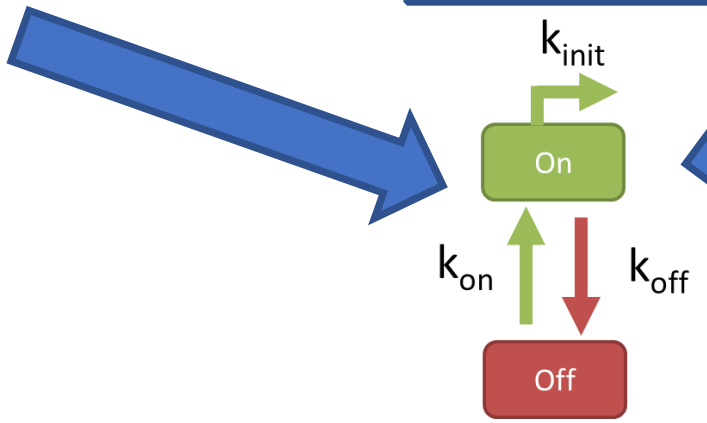
hunchback at Cycle 13

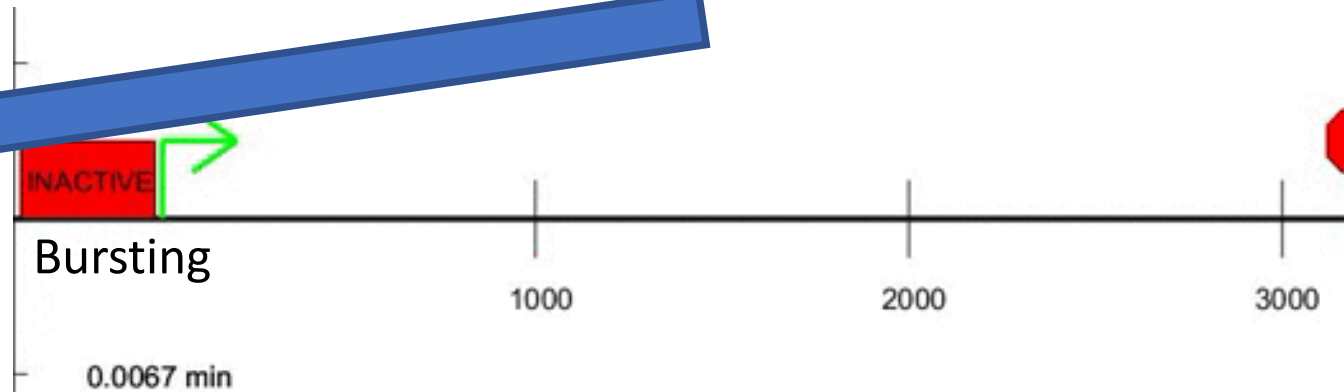


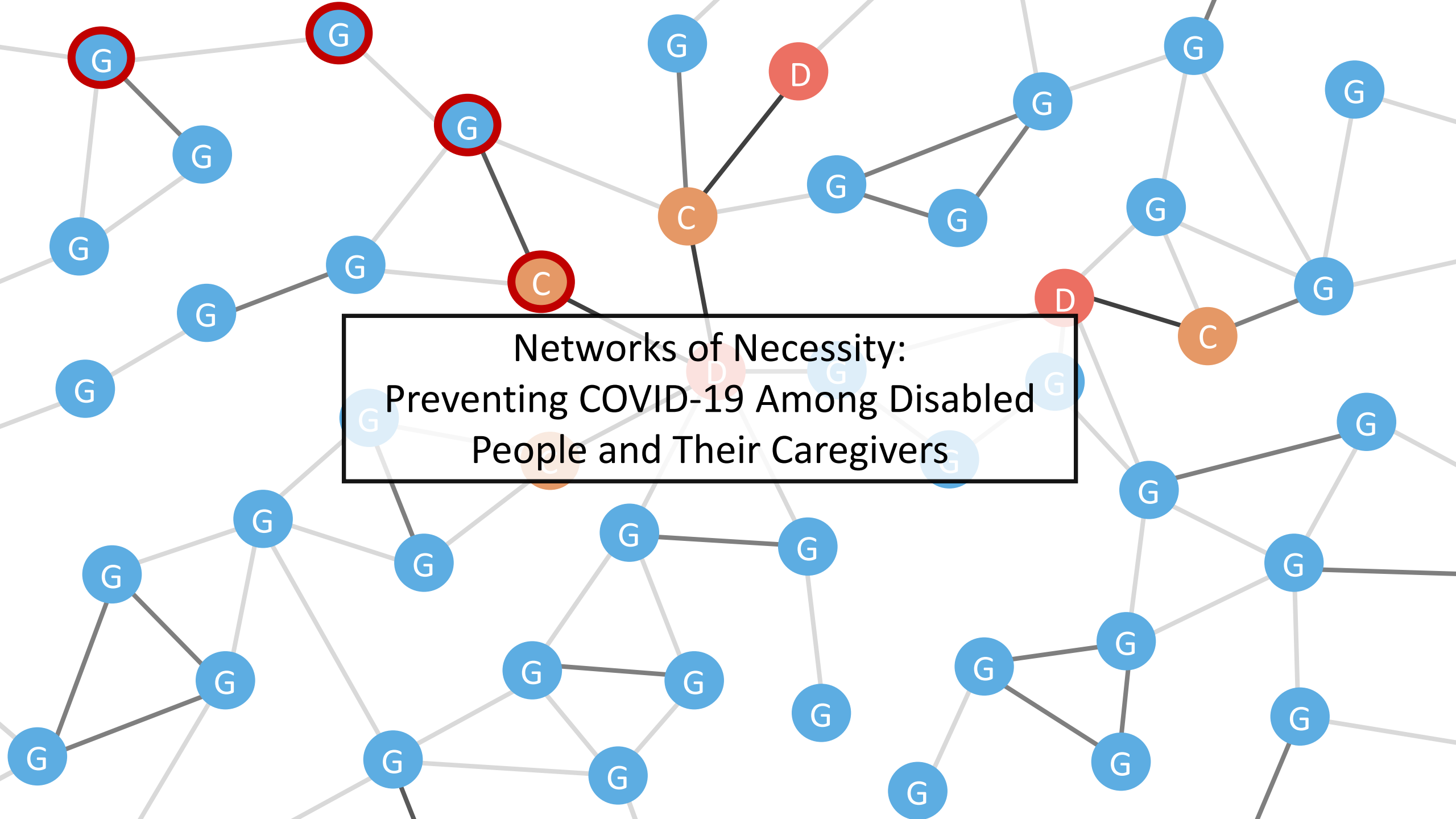
Live-Imaging MS2-Tagged RNAs

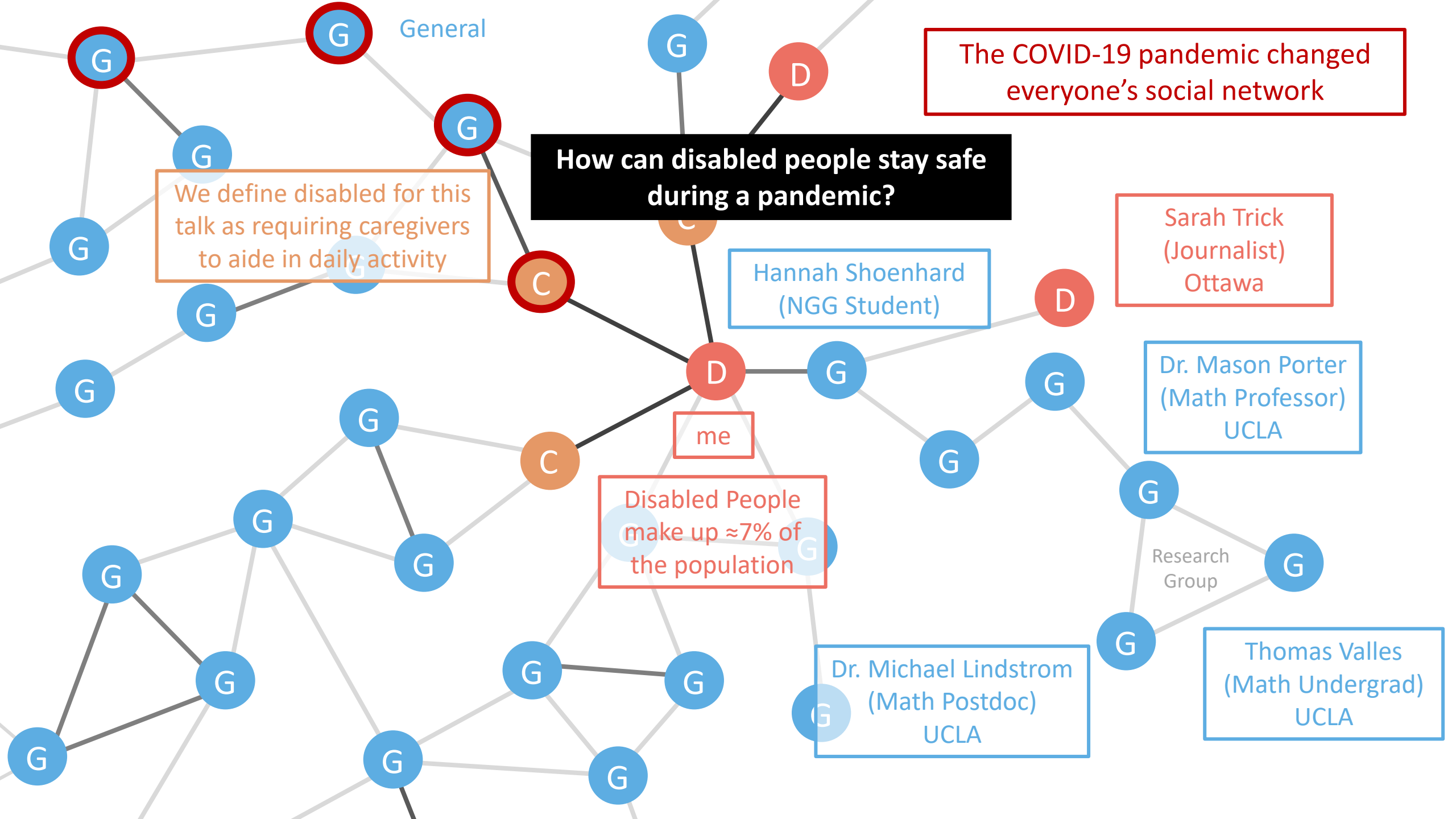


Derive 2-state Model Parameters





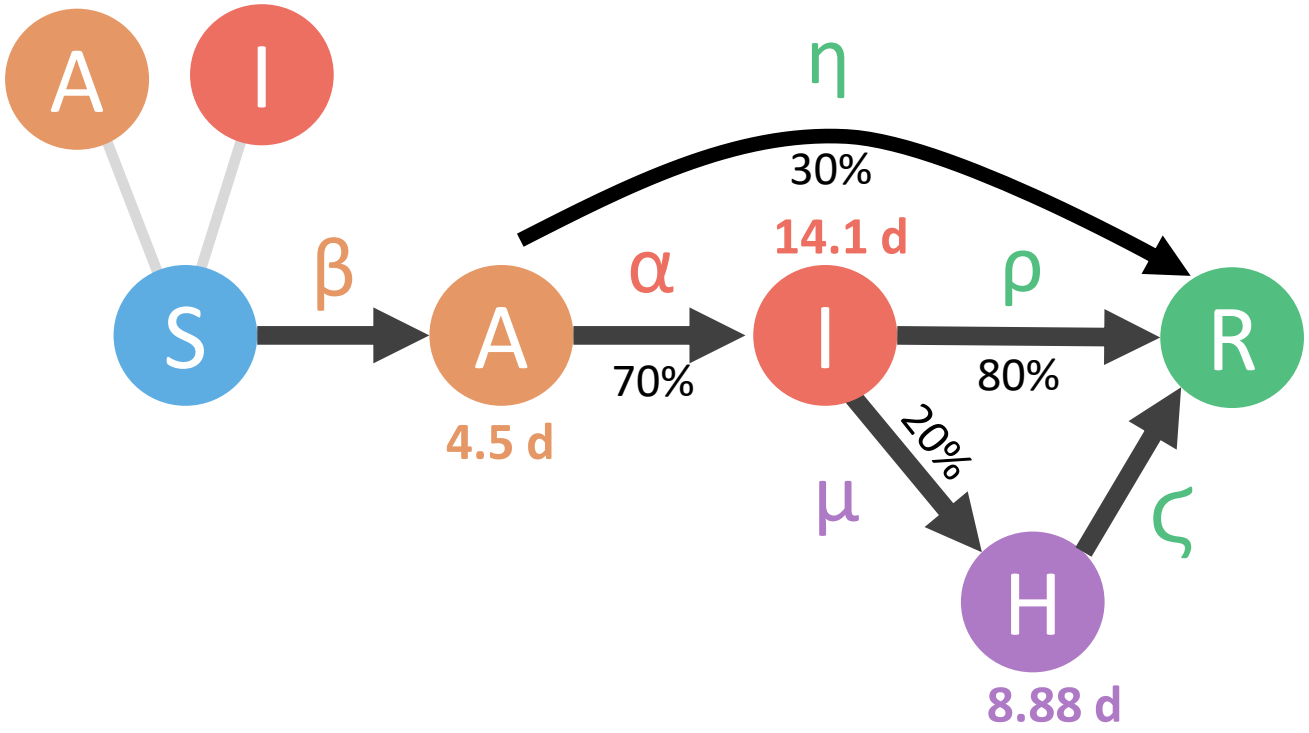

Networks of Necessity:
Preventing COVID-19 Among Disabled People and Their Caregivers


General
The COVID-19 pandemic changed everyone's social network
How can disabled people stay safe during a pandemic?
We define disabled for this talk as requiring caregivers to aide in daily activity
Hannah Shoenhard (NGG Student)
Sarah Trick (Journalist) Ottawa
Dr. Mason Porter (Math Professor) UCLA
me
Disabled People make up ≈7% of the population
Research Group
Dr. Michael Lindstrom (Math Postdoc) UCLA
Thomas Valles (Math Undergrad) UCLA

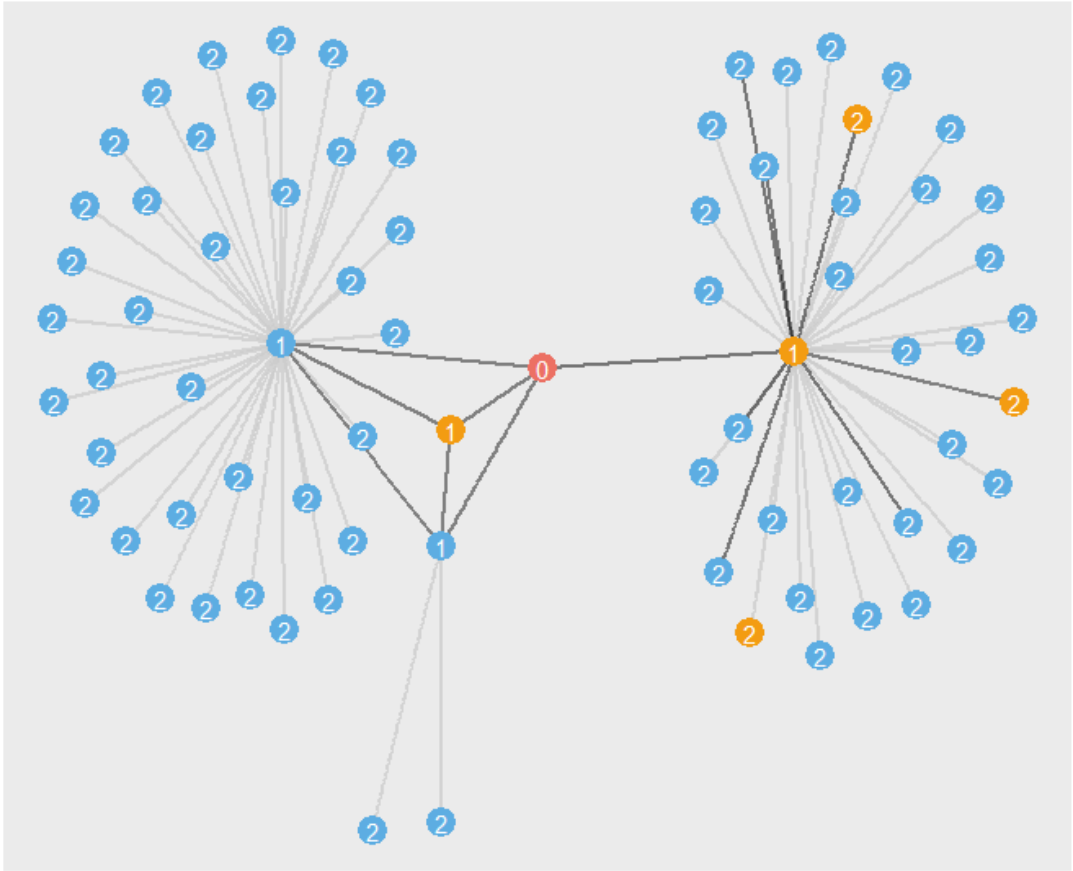
The Questions

Observed Problems	Study Questions
Disabled people and caregivers cannot break their connections	1. How much greater is the risk that disabled people/caregivers will be infected?
Population-wide contact limiting is costly	2. How effective is contact limiting for the disabled population?
PPE has been scarce during the pandemic	3. How effective is mask usage by caregivers and disabled persons at decreasing infections?
Vaccines are limited in their early rollout as infections rage	4. Who do we vaccinate first to protect the disabled population?

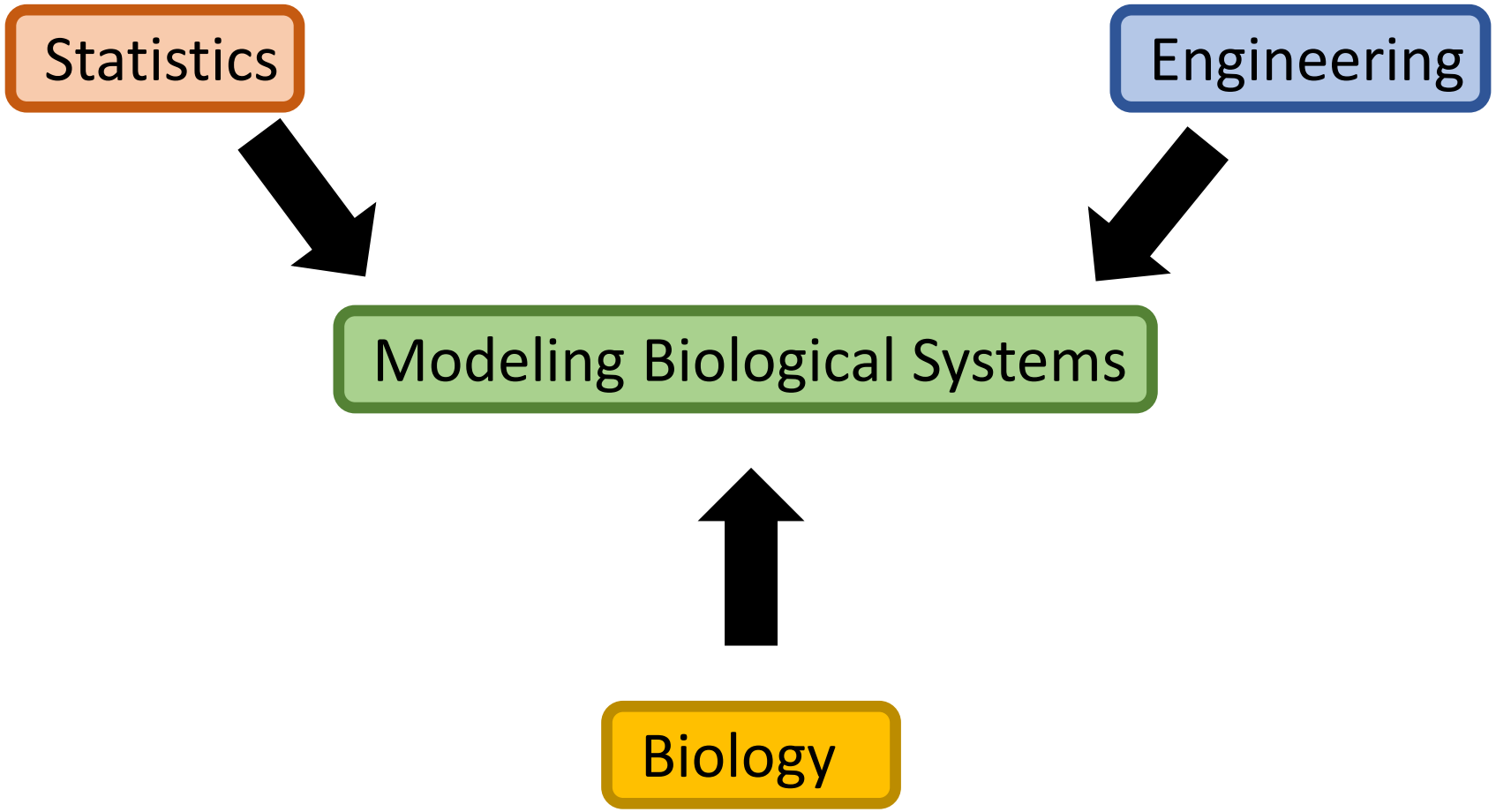
Infected People Break Weak Contacts



Disease Status



S A I H R


Statistics
Engineering
Modeling Biological Systems
Biology