ALTERNATIVE MODEL SYSTEMS FOR STUDYING NEUROSCIENCE

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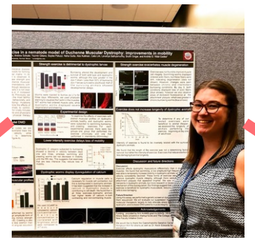
MY JOURNEY TO NEUROSCIENCE RESEARCH

I was born to young parents who did not finish high school

Family members have dealt with mental health, seizures, addiction, and brain cancer

I attended WWU and became the first college graduate in my family



Studied Duchenne muscular dystrophy as a PhD student at ISU

Researching neurodegenerative diseases as a postdoc at Scripps Research

AGENDA

INTRODUCTION

What are model systems? Why do we use them? How are they developed?

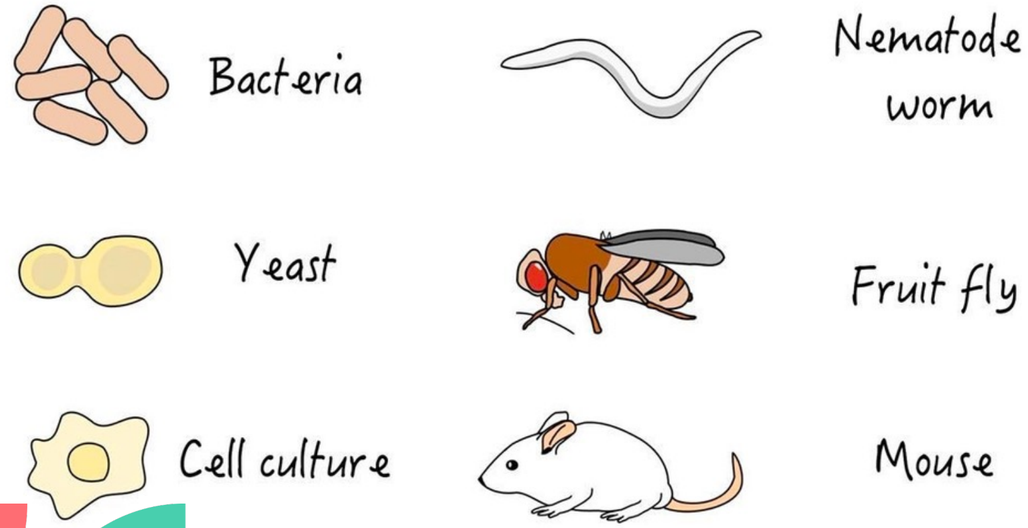
MODEL ORGANISMS

C. elegans, Drosophila melanogaster, zebrafish

OTHER MODELS

Cell culture

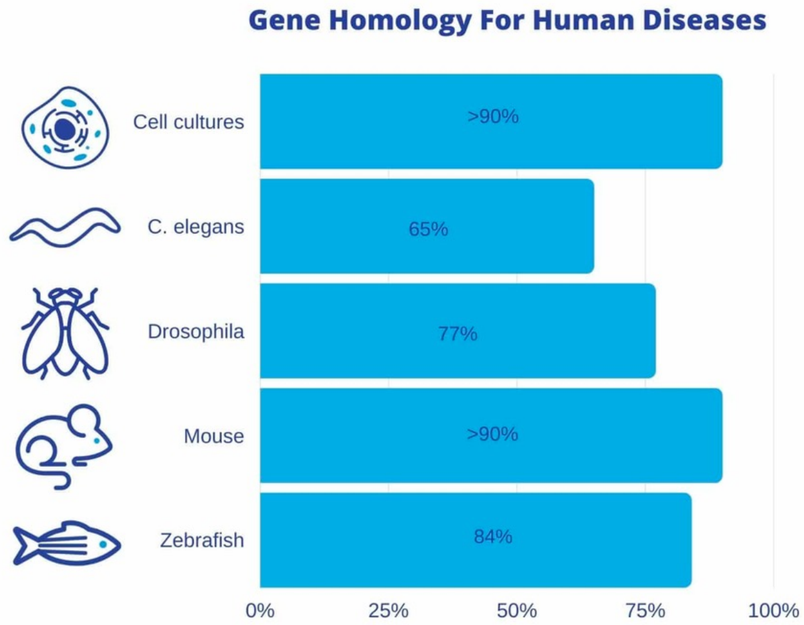
WHAT IS A MODEL SYSTEM?



- A model system is a non-human animal or cells (can be human derived) that are extensively used to study biological questions, including human health and disease
- 'Superheroes' of life sciences
- Model systems have helped us understand the function of genes, proteins and pathways.

WHY ARE MODEL SYSTEMS USED IN SCIENCE?

- Ethics
- Genes and proteins are the same or very similar
- Provide priceless insight at the cell, tissue, organ, and system level



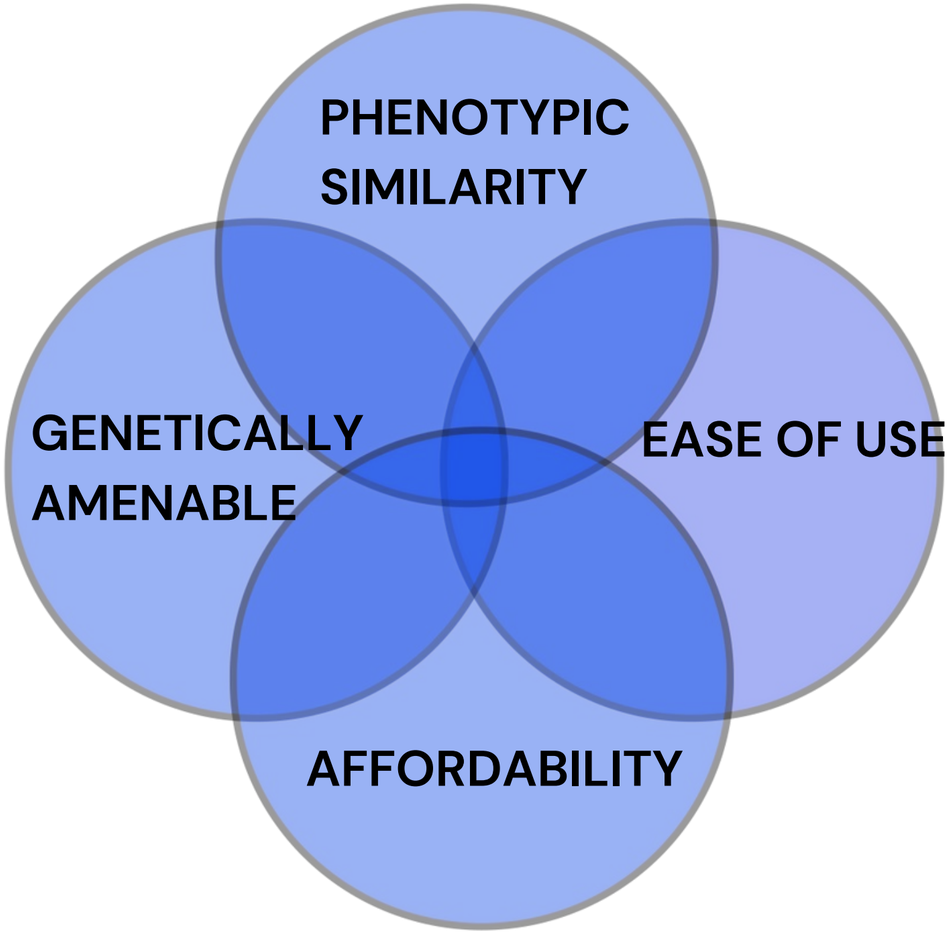
TRAITS OF AN IDEAL MODEL

PHENOTYPIC SIMILARITY

Does the disease or biological process look similar in the animal as it does in humans?

GENETICALLY AMENABLE

How easy is it to alter the animals genetics? Are there tools available that have been validated?



AFFORDABILITY

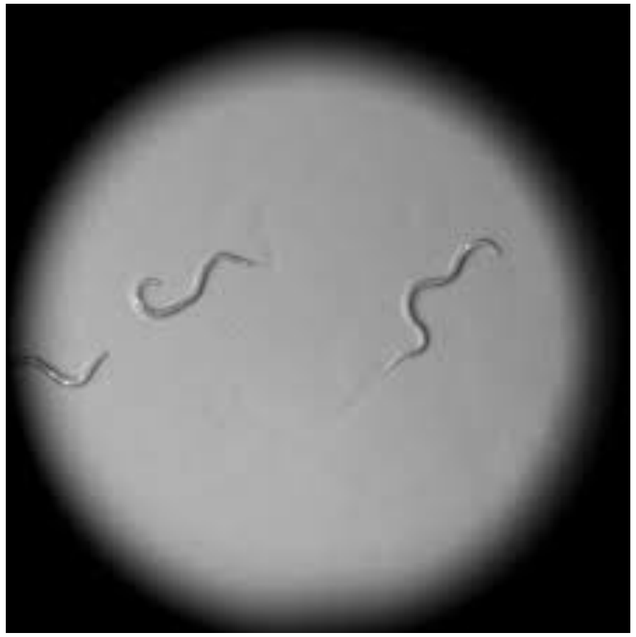
Cost of care and maintenance, as well as specific tools and resources.

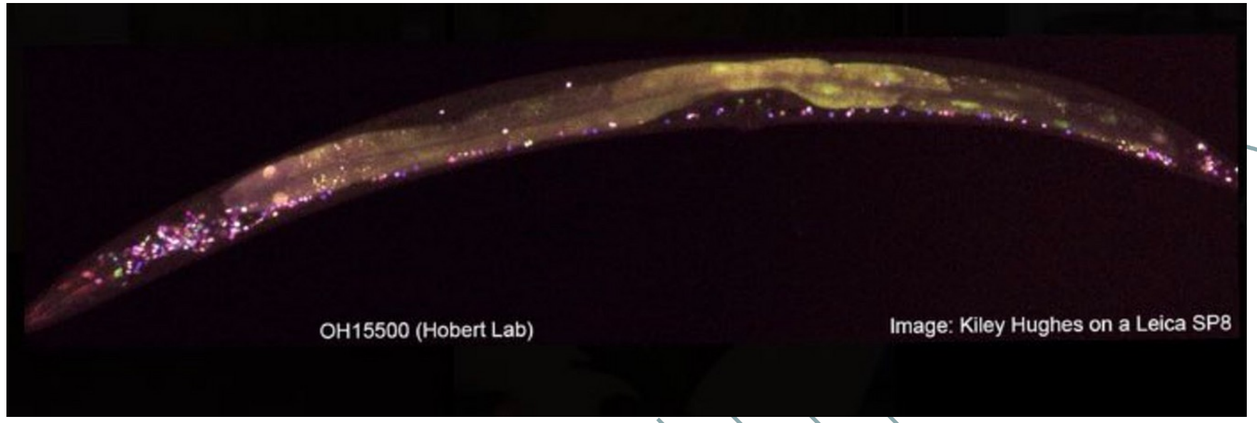
EASE OF USE

How long do they live? How long do they develop? Can learning students pick it up quickly?

CAENORHABDITIS ELEGANS

- Well understood and characterized cell lineage
- Transparent
- Simple, tractable behaviors
- First sequenced genome
- Hermaphroditic with quick development

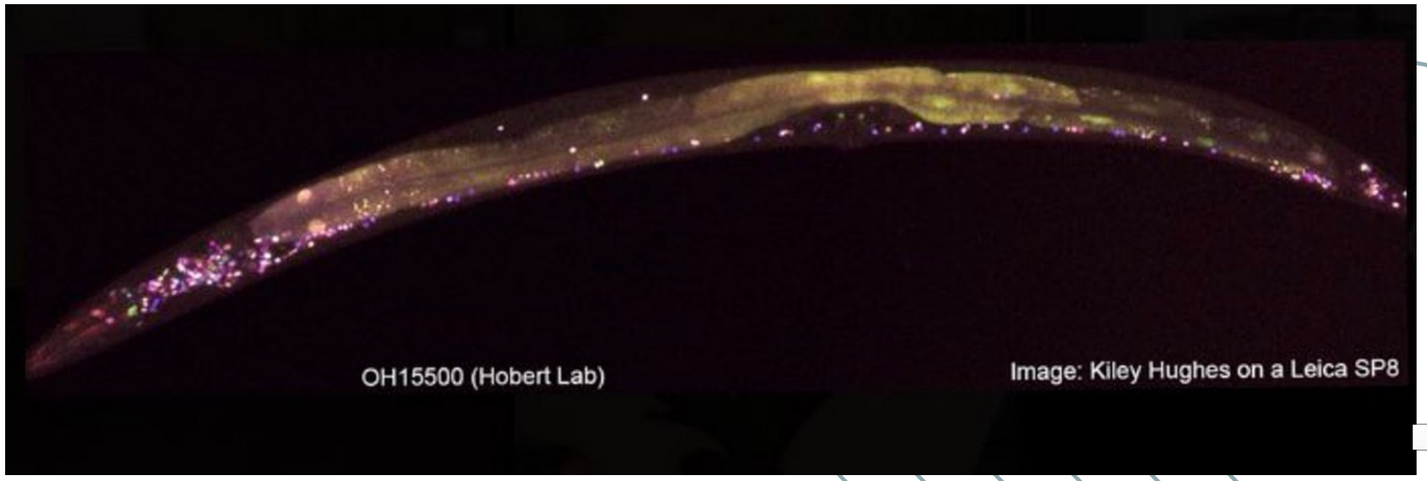




CAENORHABDITIS ELEGANS

What have worms taught us?

GFP as a reporter, RNA interference, optogenetics, and identification of genes that affect lifespan, cell death, and neuron growth.



DROSOPHILA MELANOGASTER

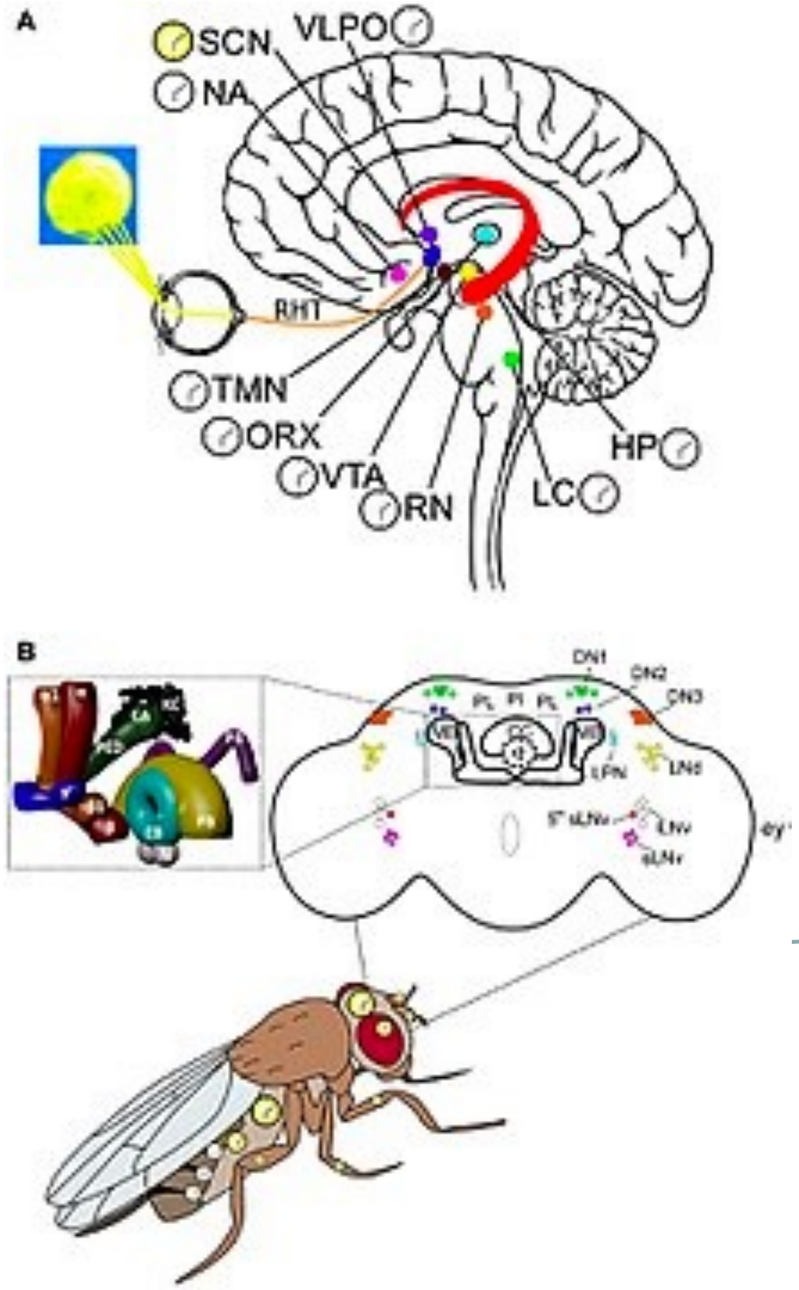
- Inexpensive and easy to use
- Easily manipulated DNA
- Simple but coordinated behaviors
- Quick development and high reproduction
- Clear phenotypes

Fruit Fly Lab: Tiny Flies Make Big Biology Happen in Space | NASA

DROSOPHILA MELANOGASTER

What have flies taught us?

How genes are inherited, cell division, and identification of mutagens. First system used to understand olfaction and molecular basis of circadian rhythm.



Zordan and Sandrelli, Frontiers in Neurology 2015

ZEBRAFISH

- Inexpensive and easy to use
- Produces many offspring
- Mammalian
- Embryos are transparent and develop external
- More complex behaviors
- Genetically amenable
- Self-healing

Image source: Max Planck Institute- laboratory animal day

ZEBRAFISH

What have zebrafish taught us?

Mechanisms of ocular regeneration, understanding of thyroid cancers and brain-gut axis.

Image source: Max Planck Institute- laboratory animal day

CELL CULTURE

- Can be of human orgin
- Reduces need for animals

Cell lines

- Continued supply
- Observation of cell differentiation

Primary culture

- Manipulate physiological conditions
- Separation of individual neurons

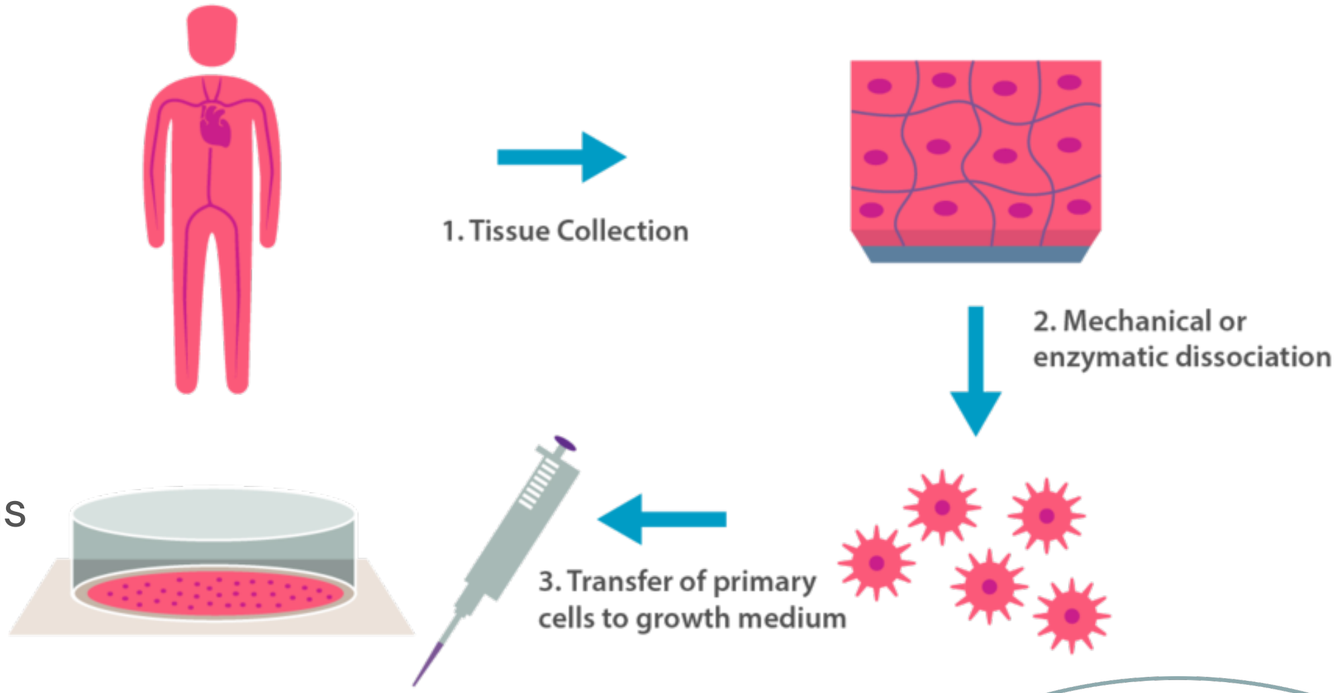


Image source: What are primary cells : advantages and limitat... - faCellitate

CELL CULTURE

Cell lines

Development of HPV vaccine, polio vaccine, understanding of disease development.

Primary culture

Development of biomarkers and cellular biology of diseases, patient specific studies, understanding of single cell development.

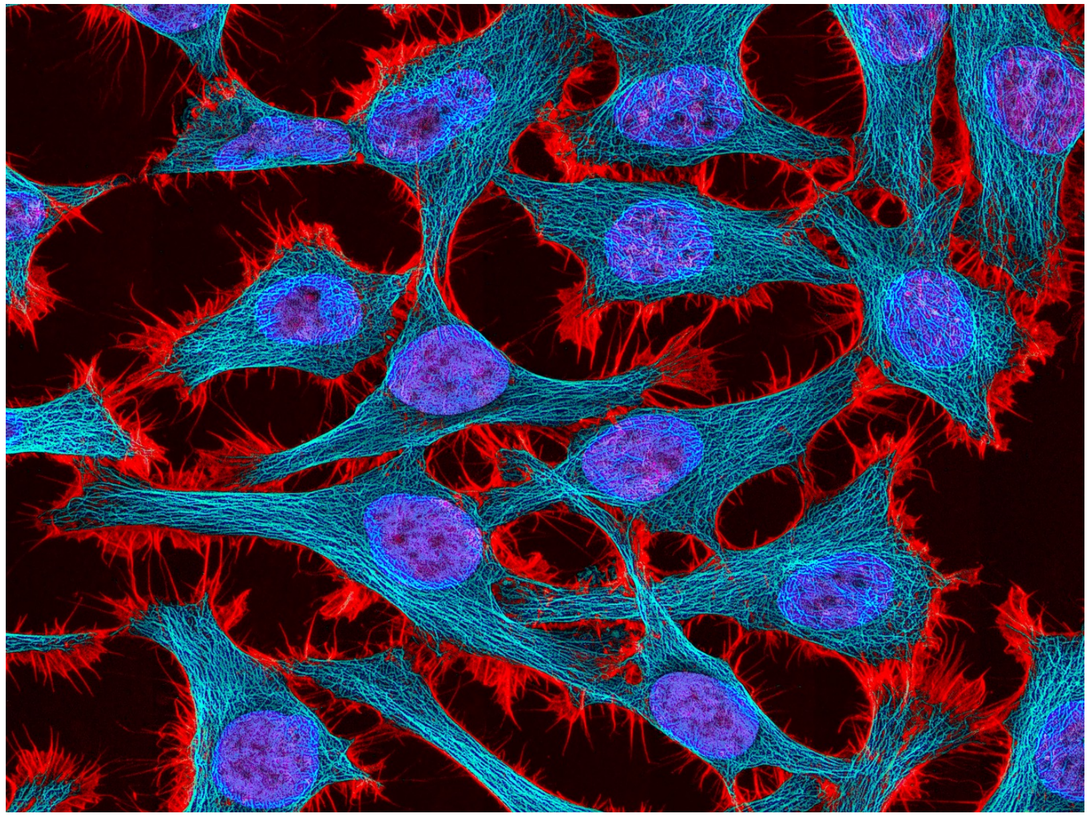


Image source: Scientific American

SUMMARY

Model systems allow us to uncover and test our understanding of biological processes. Which model is chosen depends on the question at hand!

THANK YOU

For any questions reach out to instructors or email me at kihughes@scripps.edu