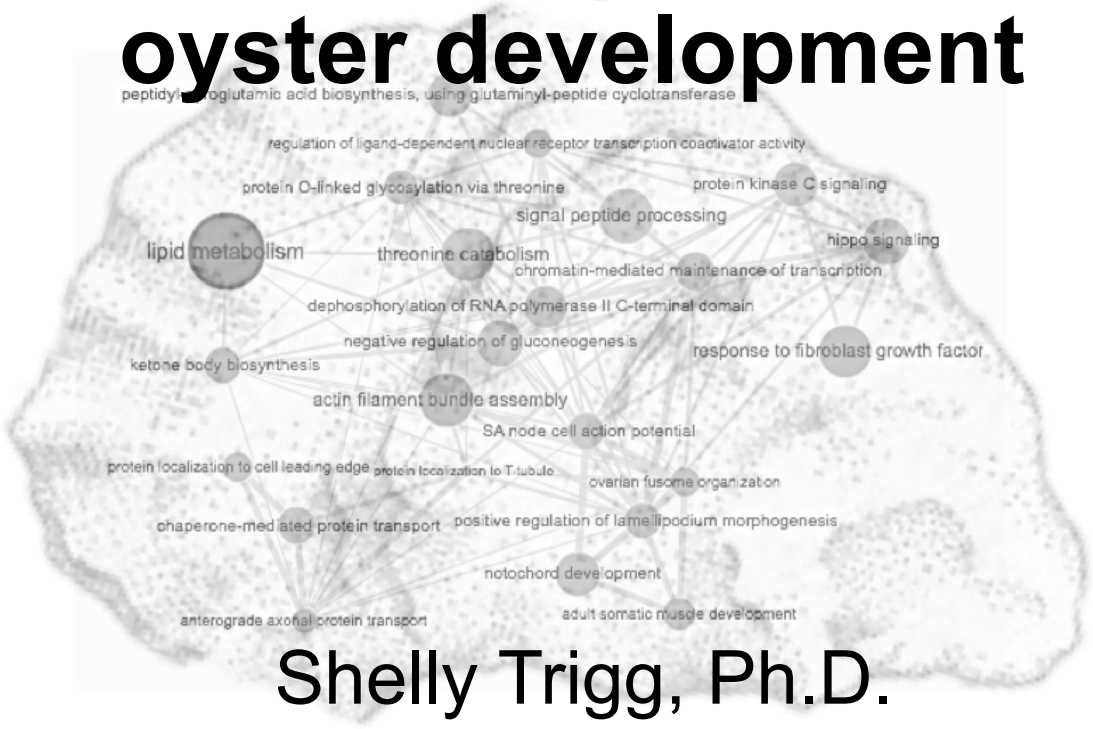
A protein inventory reveals mechanisms of temperature impact on oyster development



Shelly Trigg, Ph.D.
strigg@uw.edu
Steven Roberts Lab, School of Aquatic and Fishery Sciences
University of Washington, Seattle, WA

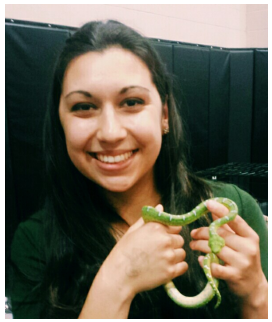
UNIVERSITY of WASHINGTON

SCHOOL OF AQUATIC and FISHERY SCIENCES

Roberts Lab
School of Aquatic and Fishery Sciences
University of Washington

Acknowledgements

Roberts Lab
School of Aquatic and Fishery Sciences
University of Washington



Kaitlyn Mitchell Rhonda Elliot

Steven Roberts
Emma Timmins-Schiffman
Brent Valdopalas
Grace Crandall
Yaamini Venkataramen
Laura Spencer
Sam White

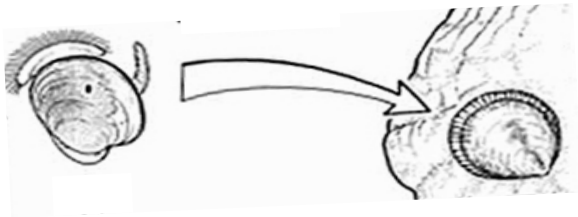
SINCE TAYLOR SHELLFISH 1890 Farms

Benoit Eudeline

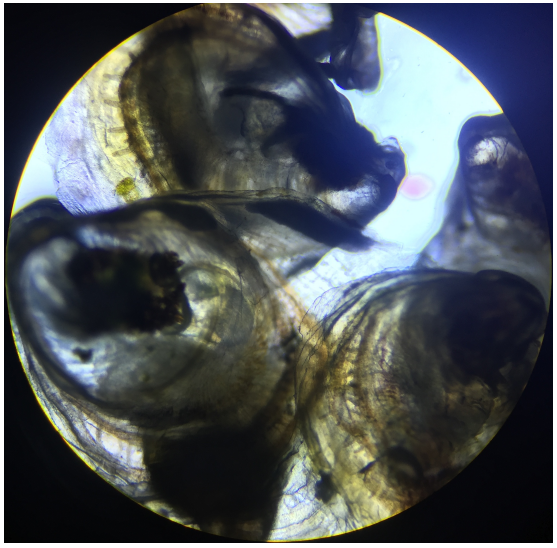
Sea Grant Washington

Award NA140AR4170078
Project R/SFA-8

Oyster (*C.gigas*) seed are delicate



Oyster seed



Oyster seed

- Pacific oyster are **sensitive** to environmental conditions from larval transition → early stage juveniles
- High mortality typically happens 10-14 days post-set @23C
- Increased rearing temperature (27-29°C) has lead to increased growth rates and survival
- We don't fully understand oyster physiology, why high mortality occurs, or why increased rearing temperature helps
- A thorough molecular baseline of oyster development during this life stage could help:
    1. identify candidate biomarkers for monitoring seed health
    2. mitigate current challenges

Questions

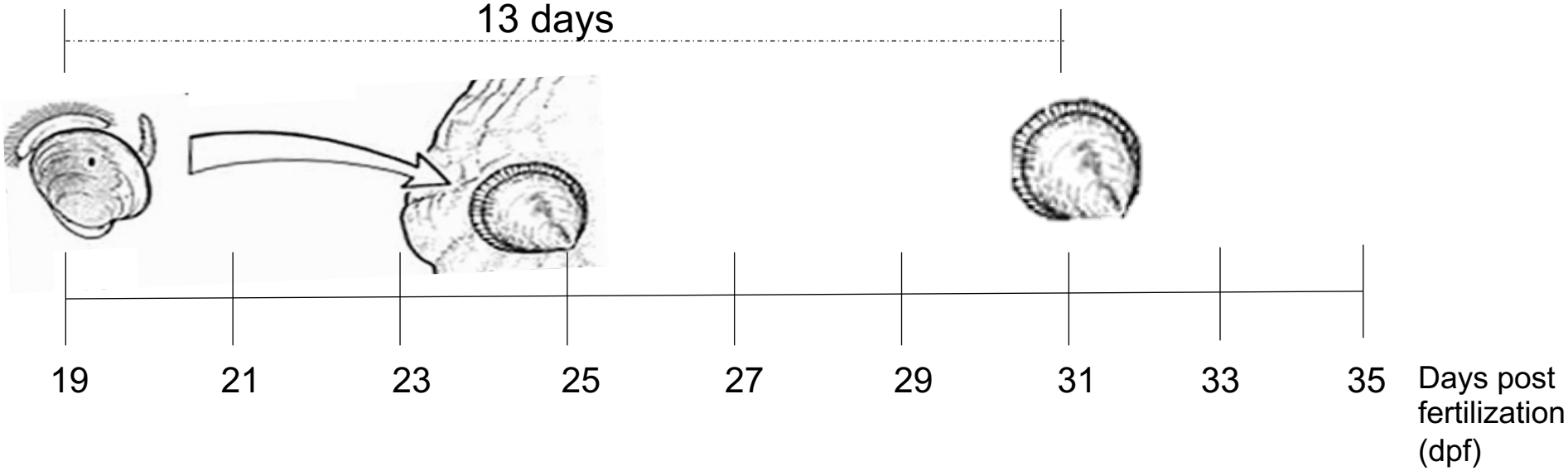
- What fundamental physiology occurs during oyster development?

- How do warmer temperatures affect juvenile development on a global molecular level?

Experimental Design

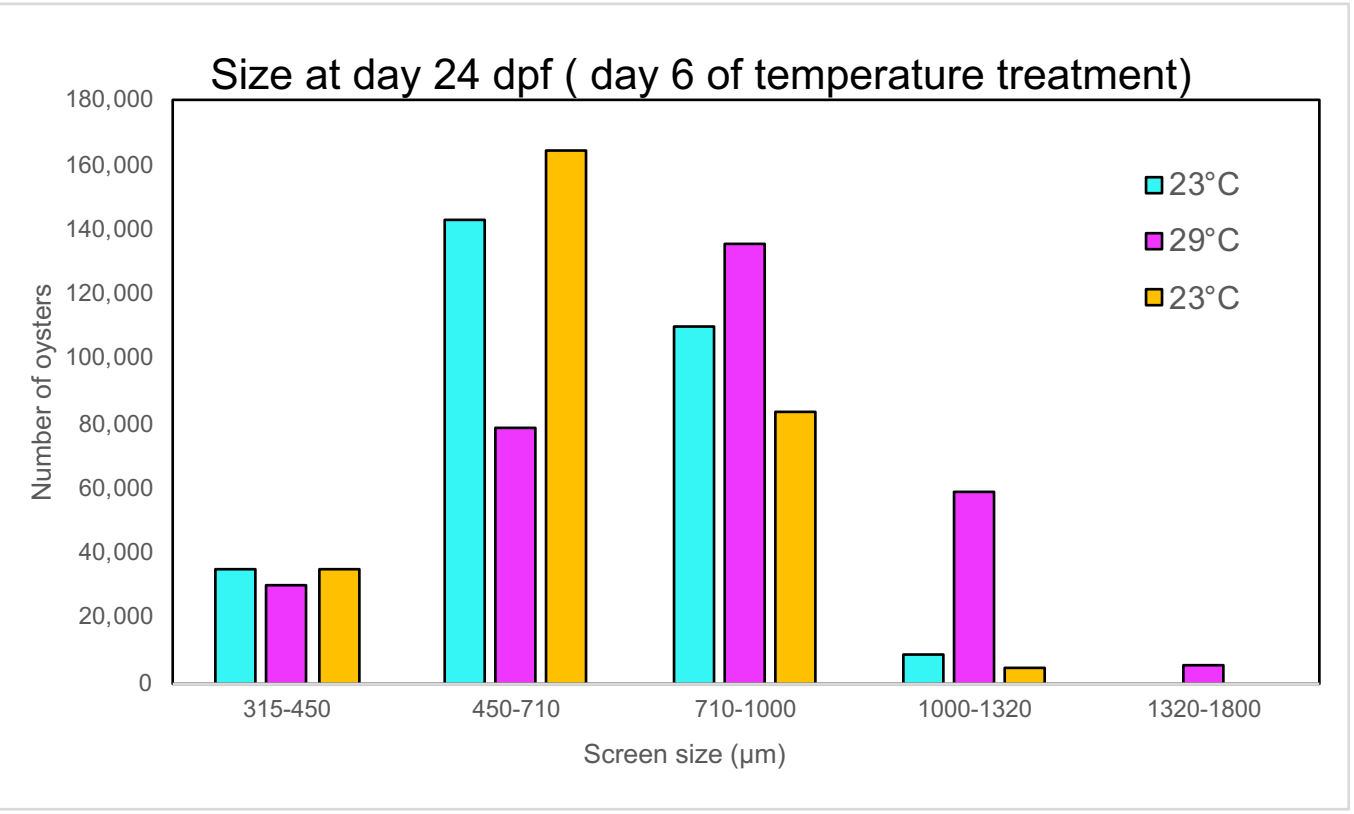
temperature treatment:

23°C **29°C**

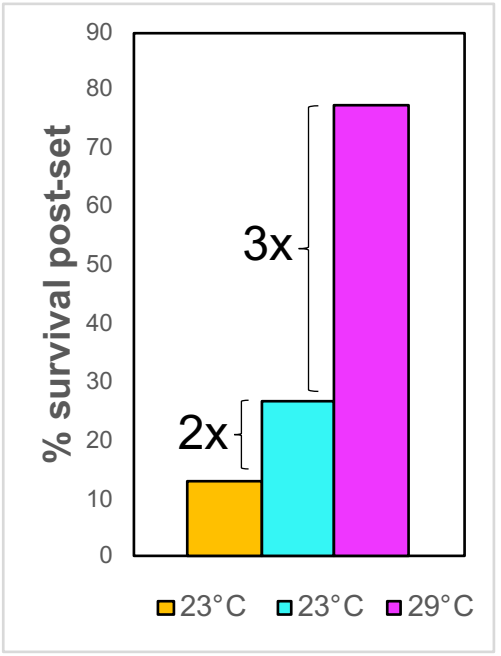


Size and survival differences between temperature groups

Difference in size distribution but not survival at 24 dpf



Difference in survival at 35 dpf

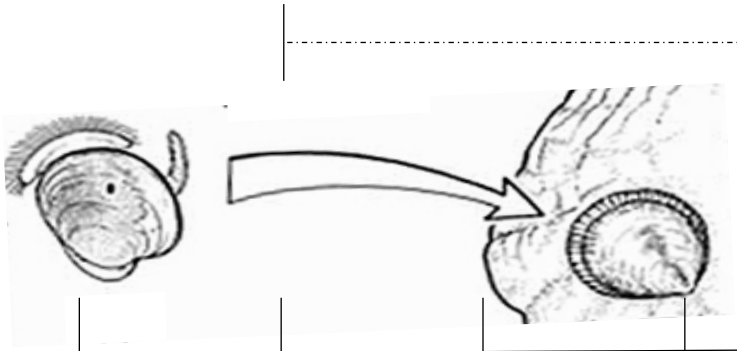


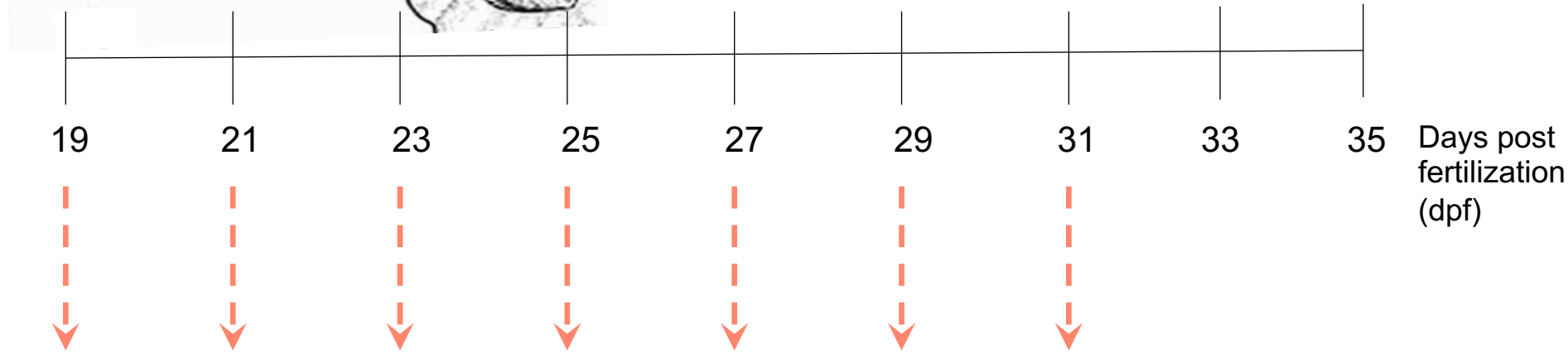
- 29°C has more animals of larger size

Experimental Design

temperature treatment:

23°C **29°C**

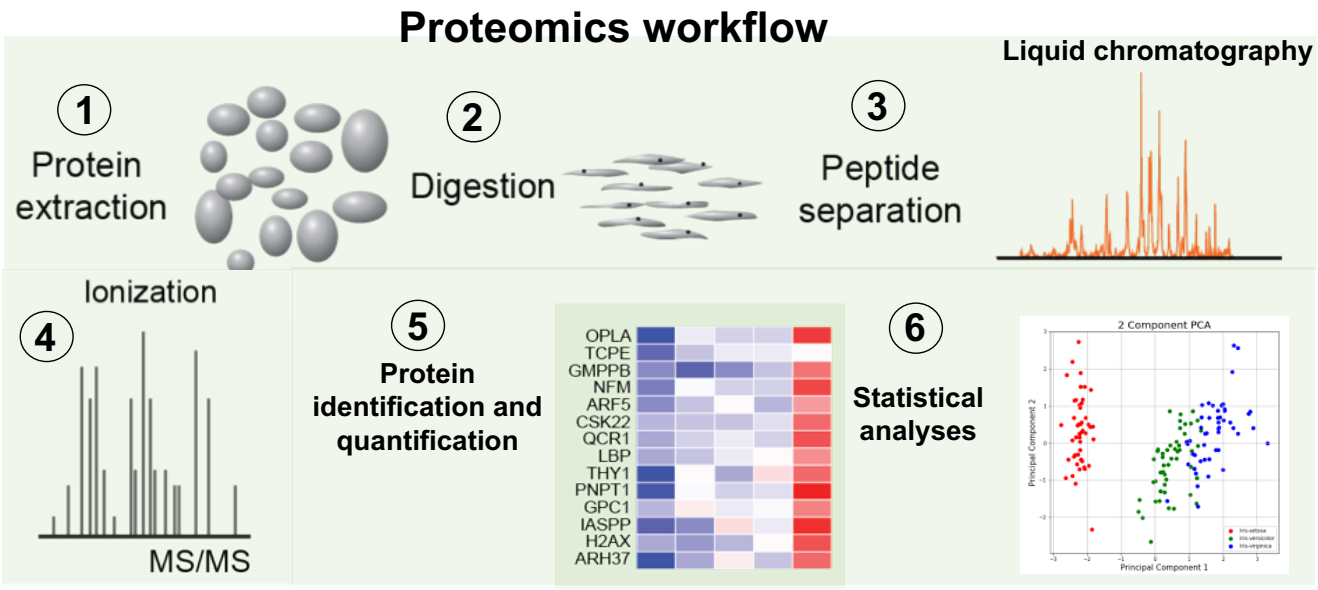




PROTEOMICS

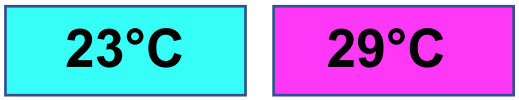
Proteomics = global protein inventory

- Proteins are the active players in the cell that carry out biological processes
- Non-biased birds eye view of all proteins present and their abundances
  - We can infer what processes are going on
- We can make comparisons between individuals and see what processes may underlie different outcomes

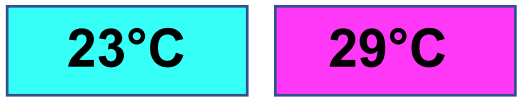


Proteomics comparisons

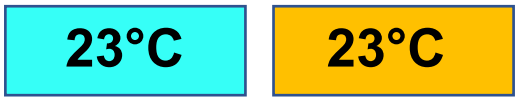
1. Fundamental development:
Proteins abundances that commonly change over time



2. Temperature effect:
Proteins abundance differences driven by temperature



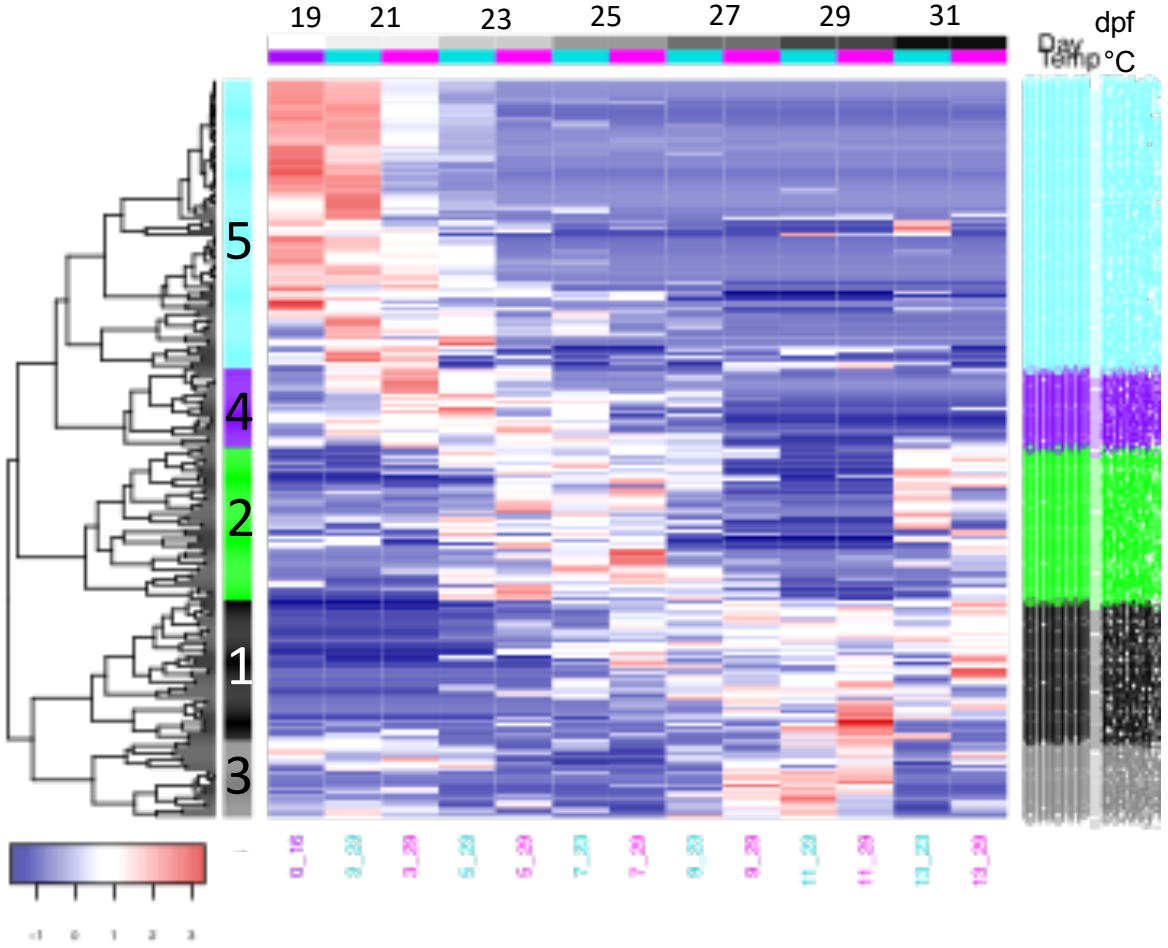
3. Silo effect:
Protein abundance differences driven by silo

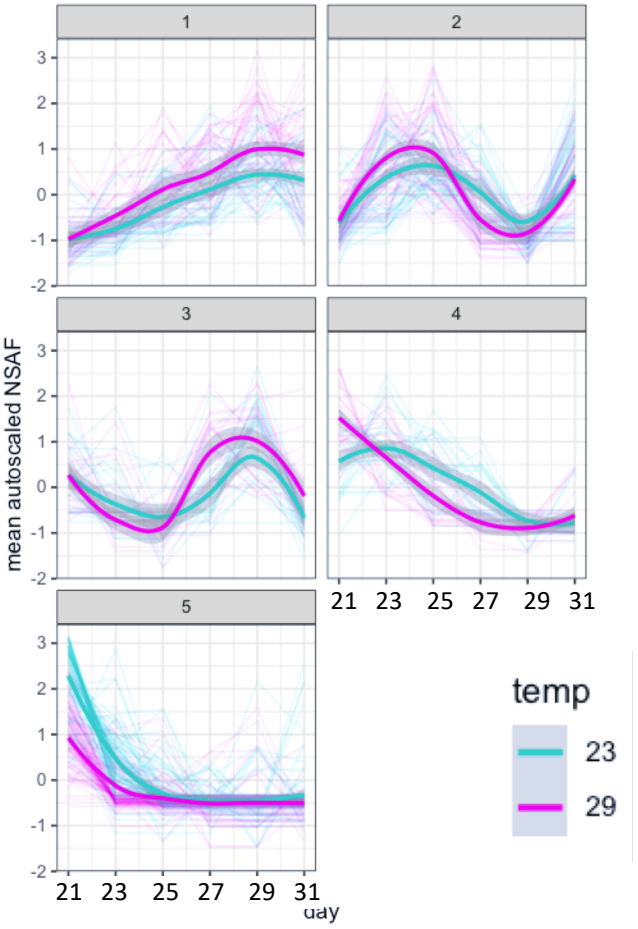


Clustering differentially abundant proteins reveals 5 distinct patterns over time

1. Fundamental development:
Proteins abundances that commonly change over time

23°C **29°C**

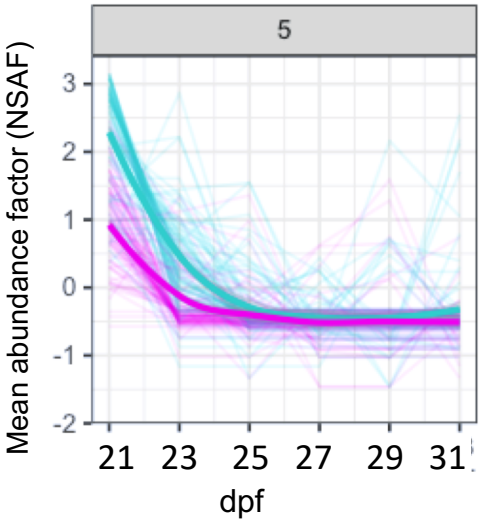




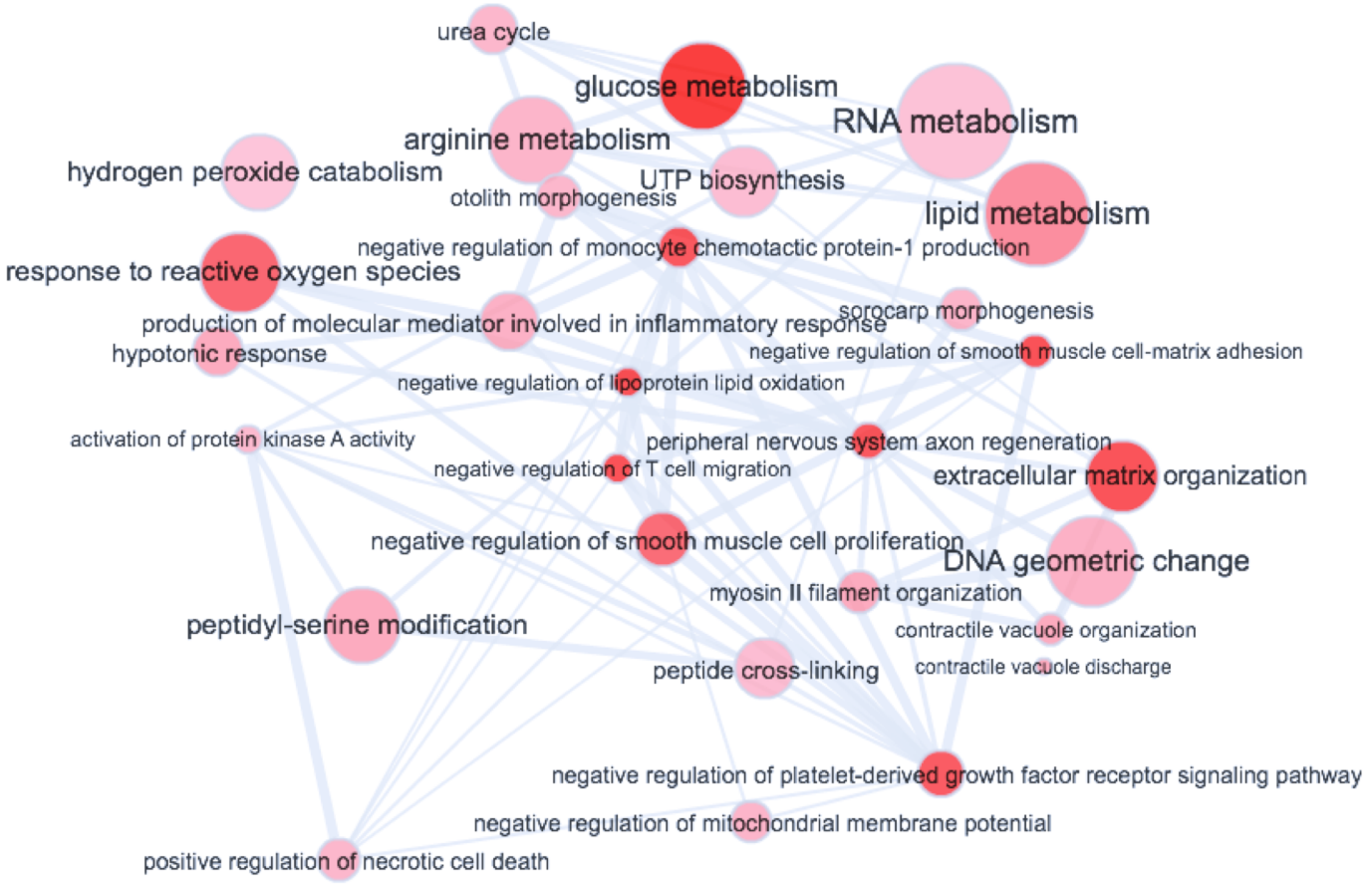
Early developmental processes that sharply decrease over two days

1. Fundamental development:
Proteins abundances that commonly change over time

23°C **29°C**



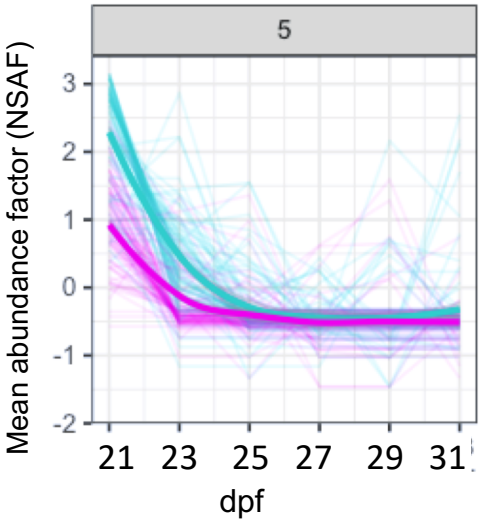
Clade 5

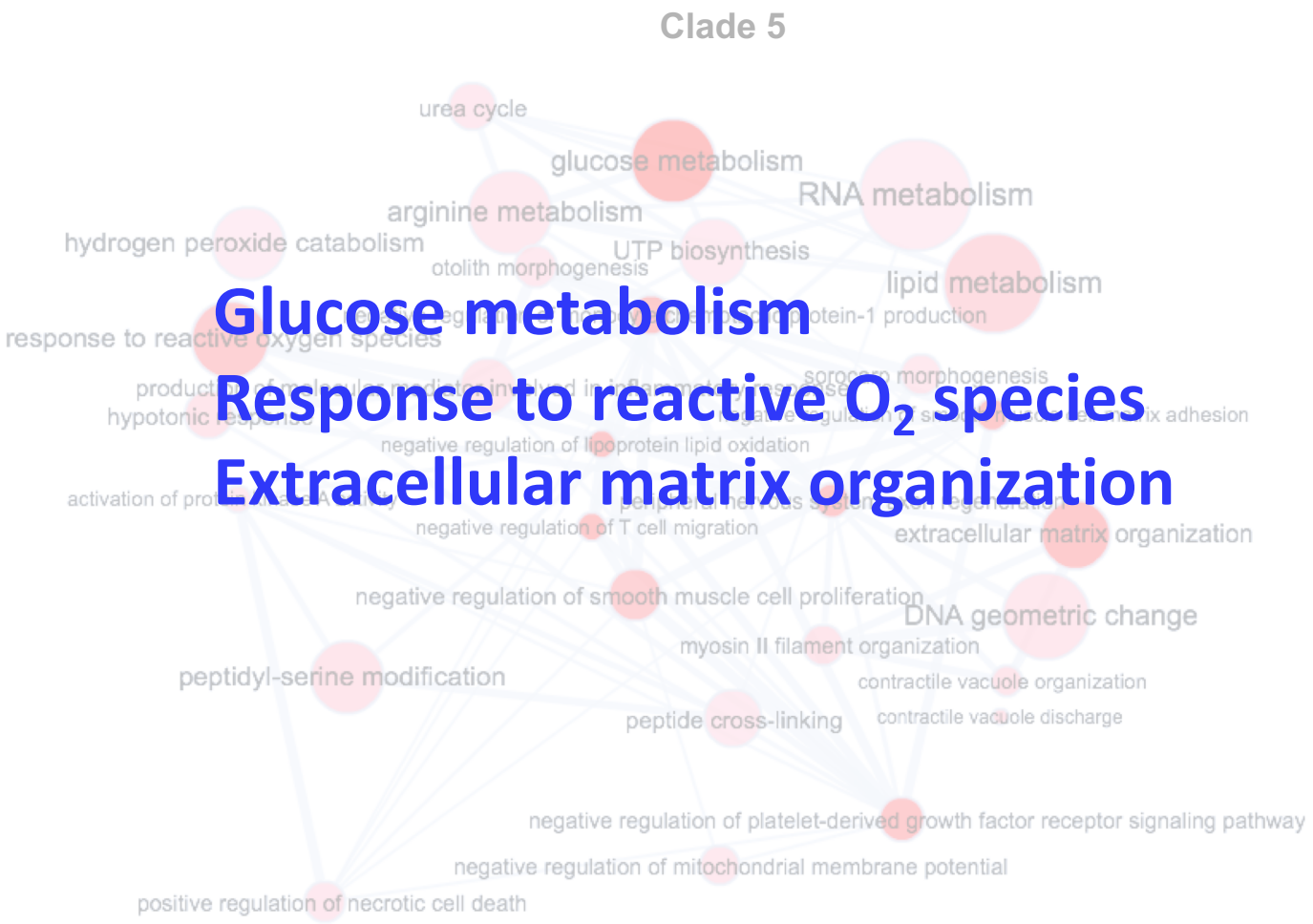


Early developmental processes that sharply decrease over two days

1. Fundamental development:
Proteins abundances that commonly change over time

23°C **29°C**





Glucose metabolism

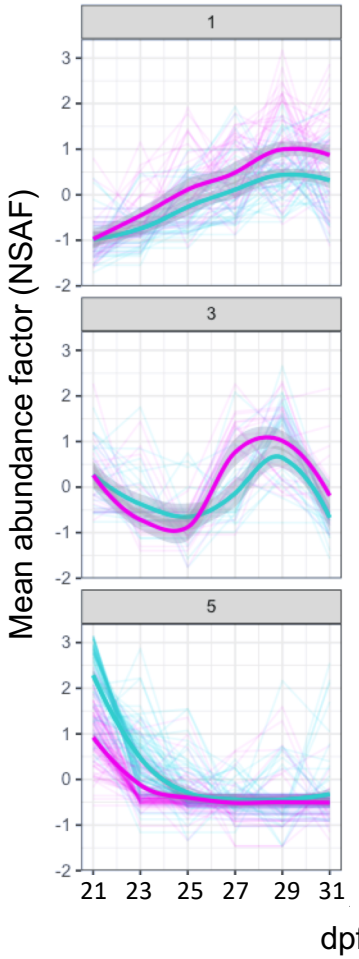
Response to reactive O_2 species

Extracellular matrix organization

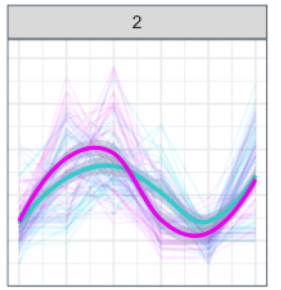
Protein patterns and processes we could expect to see in normal development

1. Fundamental development:
Proteins abundances that commonly change over time

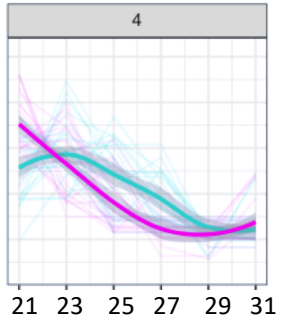
23°C **29°C**



- **Glycolytic process and glucose homeostasis**
- **Cortical cytoskeleton organization**



- **Regulation of cilium assembly**
- **Extracellular matrix organization**



- **Stress signaling**
- **Apoptotic process**
- **Amino and nucleic acid metabolism**

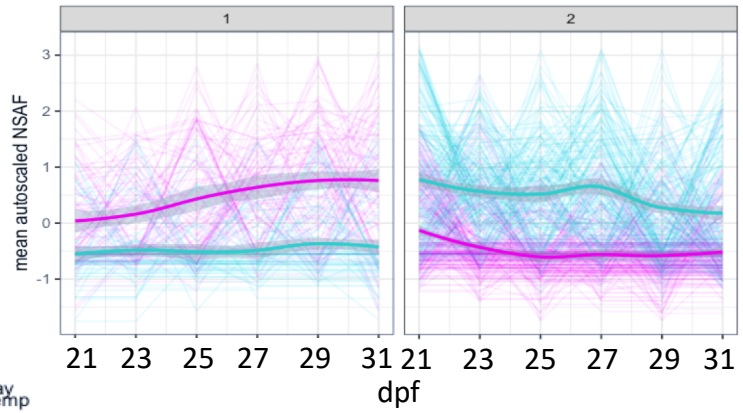
- **Actin cytoskeleton organization**
- **Synaptic vesicle exocytosis**

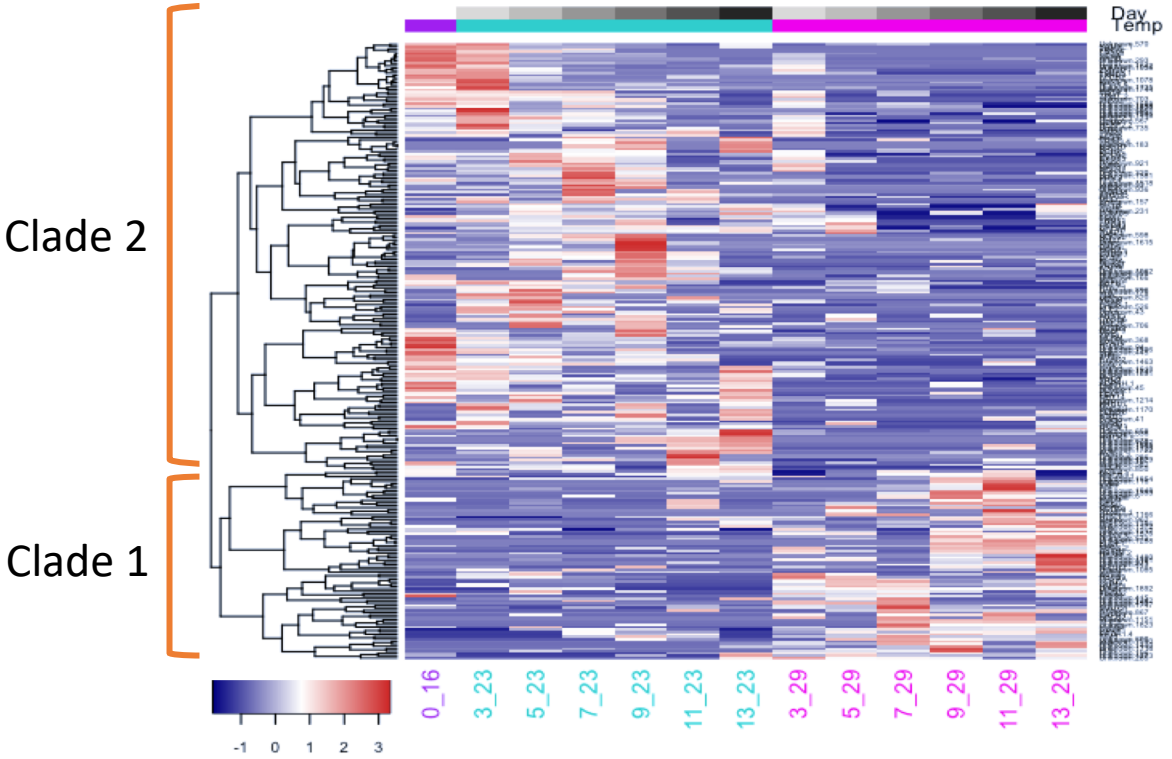
- **Glucose metabolism**
- **Response to reactive O_2 species**
- **Extracellular matrix organization**

Proteins and processes underlying increased growth and survival at 29°C

2. Temperature effect:
Proteins abundance differences driven by temperature

23°C **29°C**





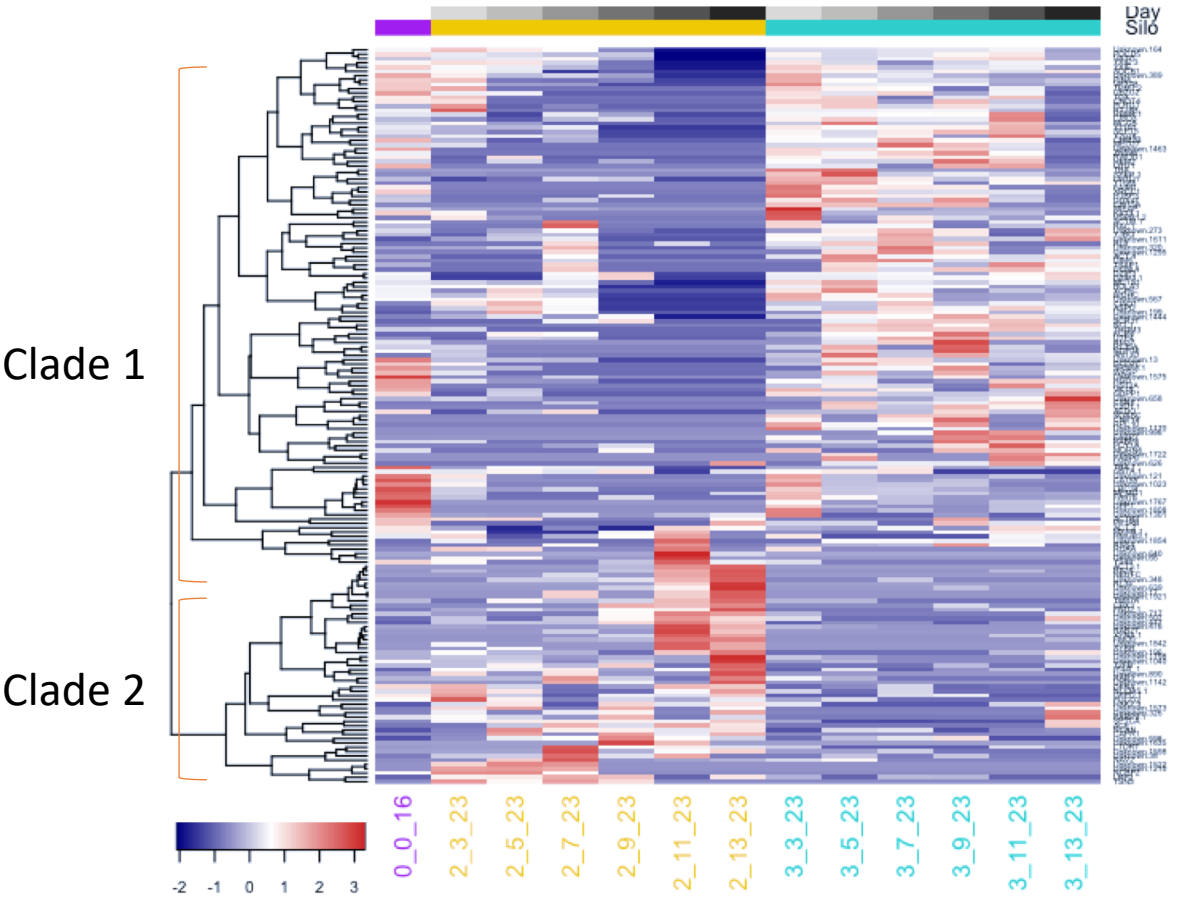
- **Lipid metabolism**
- **Response to fibroblast growth factor**
- **Actin filament bundle**

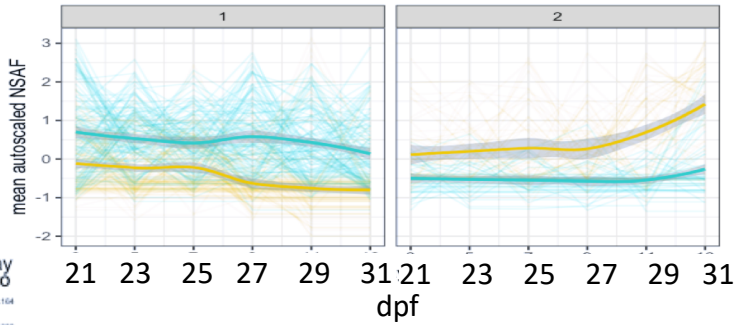
- **Microtubule-based process**
- **Positive regulation of cell death**
- **Protein homotetramerization**

Proteins and processes underlying decreased survival at 23°C

3. Silo effect:
Protein abundance differences driven by silo

23°C **23°C**





- **Pyrimidine nucleoside salvage**
- **Cellular amino acid metabolism**
- **Endosome transport via multivesicular body sorting pathway**

- **Regulation of exocytosis**
- **Regulation of cholesterol import and esterification**
- **Rab protein signal transduction**

Conclusions

- 29°C rearing led to increased size and survival
- Proteomics data show clear physiological differences between animals reared at 29°C and 23°C
- Established a baseline protein and biological process inventory for fundamental oyster development
- Identified set of proteins and potential processes underlying decreased survival
- Identified set of proteins and potential processes underlying increased growth and survival

Significance and the future

- Proteins in these sets have potential to be biomarkers for determining the health status of seed and predicting outcome before mass mortality events happen
- Need to measure top ranked proteins and/or cell processes on a larger scale

Shelly Trigg (strigg@uw.edu)