



# ***Multi-omic approaches to understand reef coral development and symbiosis***

**Ariana S. Huffmyer, PhD**

University of Washington - School of Aquatic and Fisheries Sciences

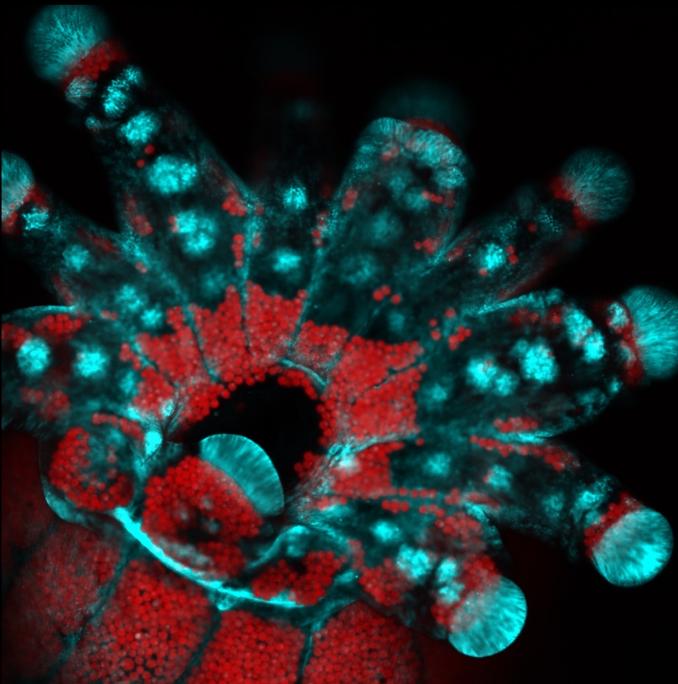
*National Science Foundation Ocean Sciences Postdoctoral Fellow  
University of Washington eScience Data Science Postdoctoral Fellow*

# ARIANA S HUFFMYER, PhD

Postdoctoral Researcher | University of Rhode Island | University of Washington



*Early life history coral reef ecophysiology and symbiosis*



<https://linktr.ee/ashuffmyer>



ashuffmyer@uri.edu



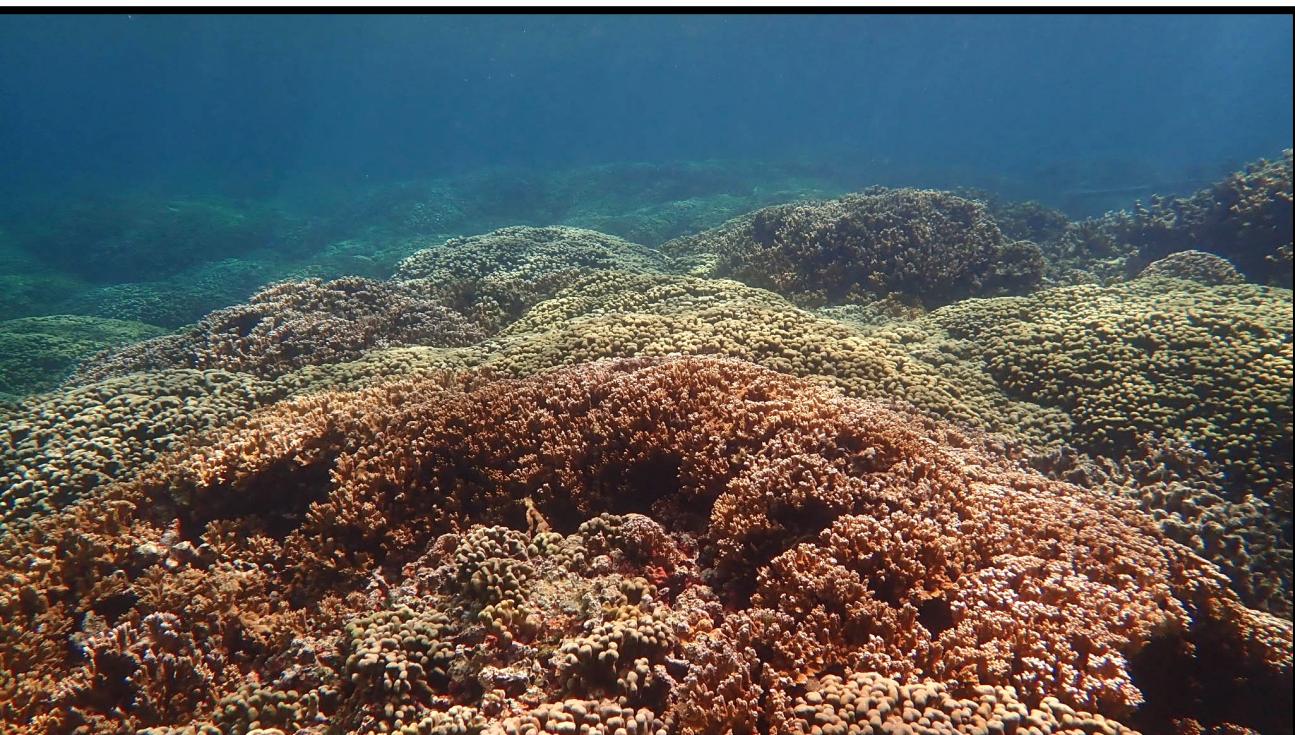
@Dr\_Cnidariana

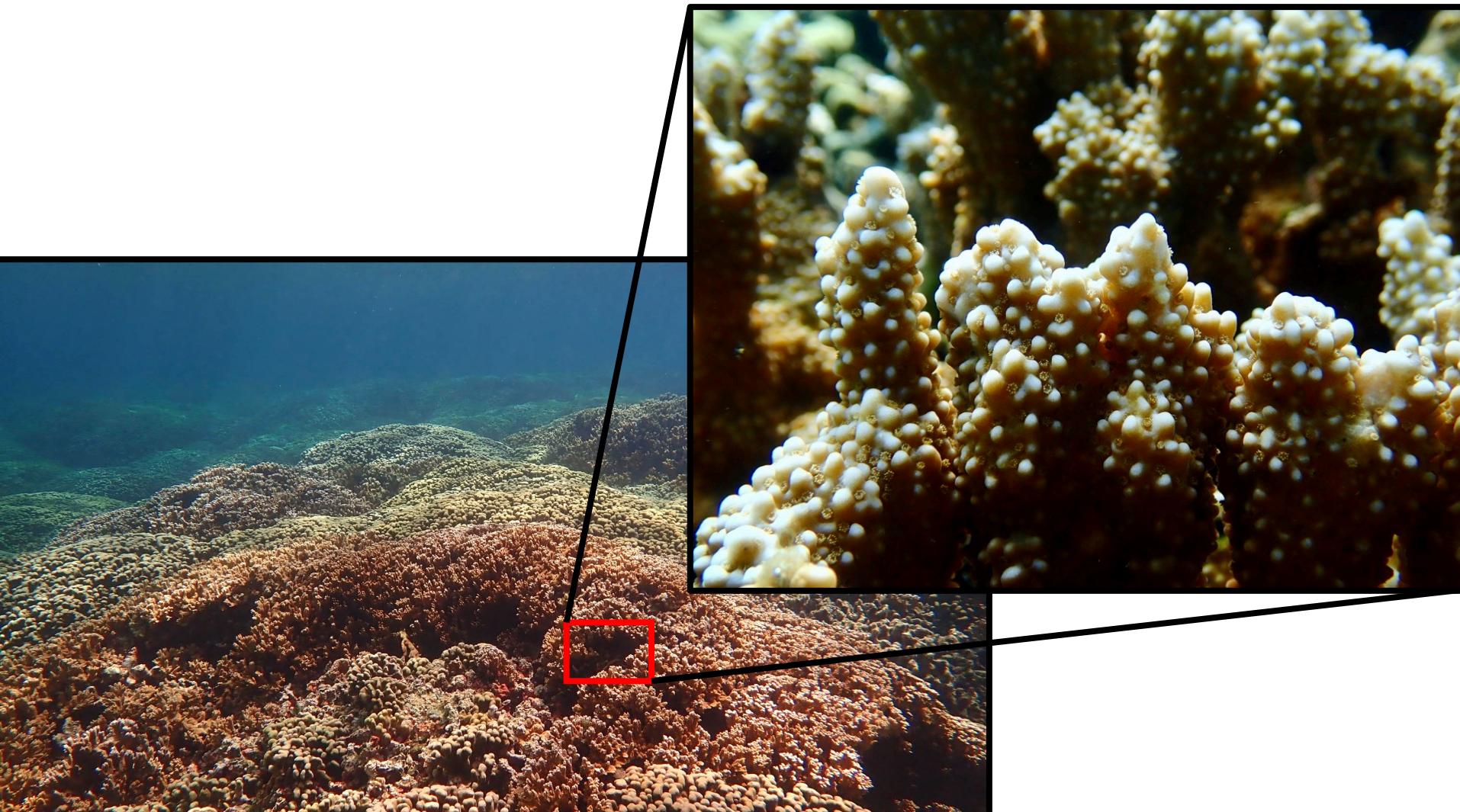


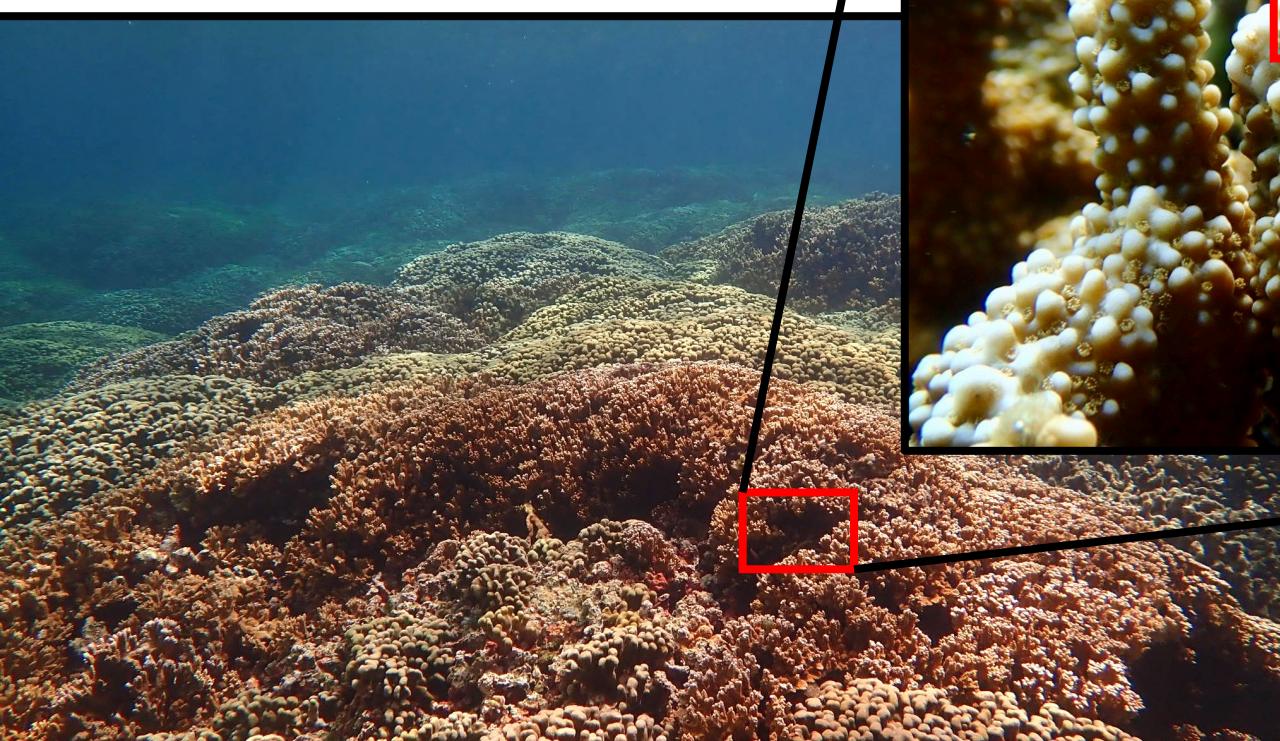
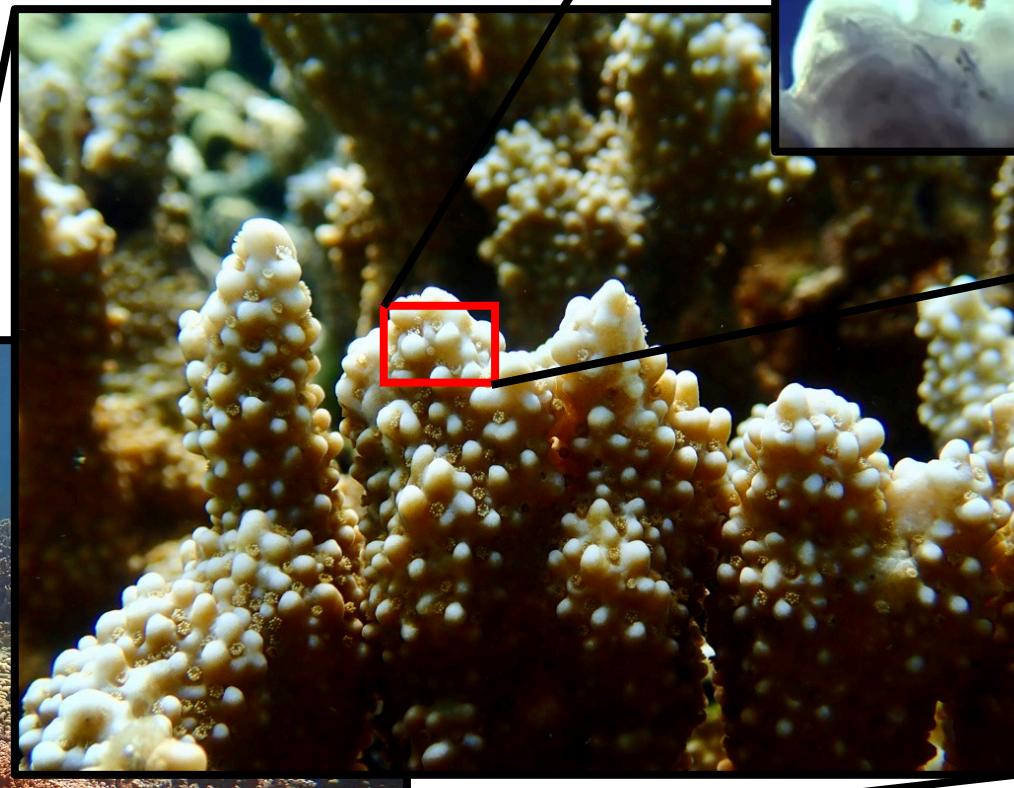
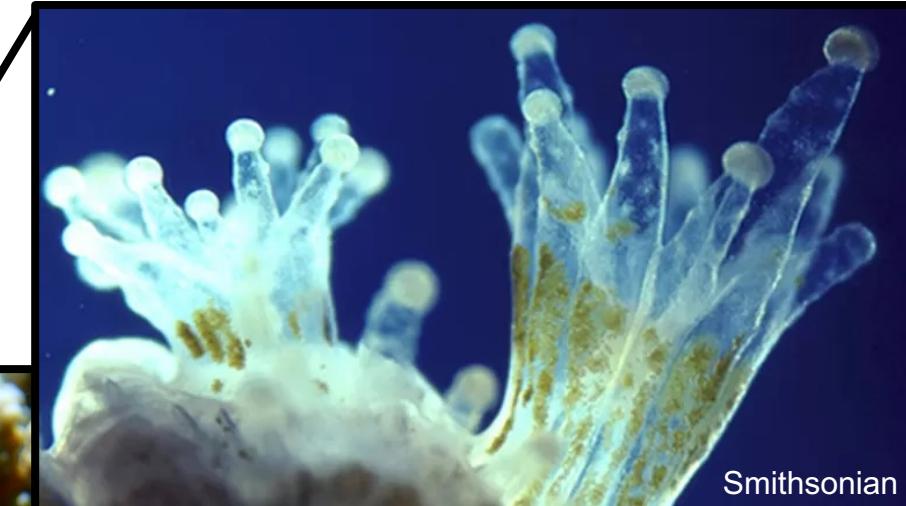
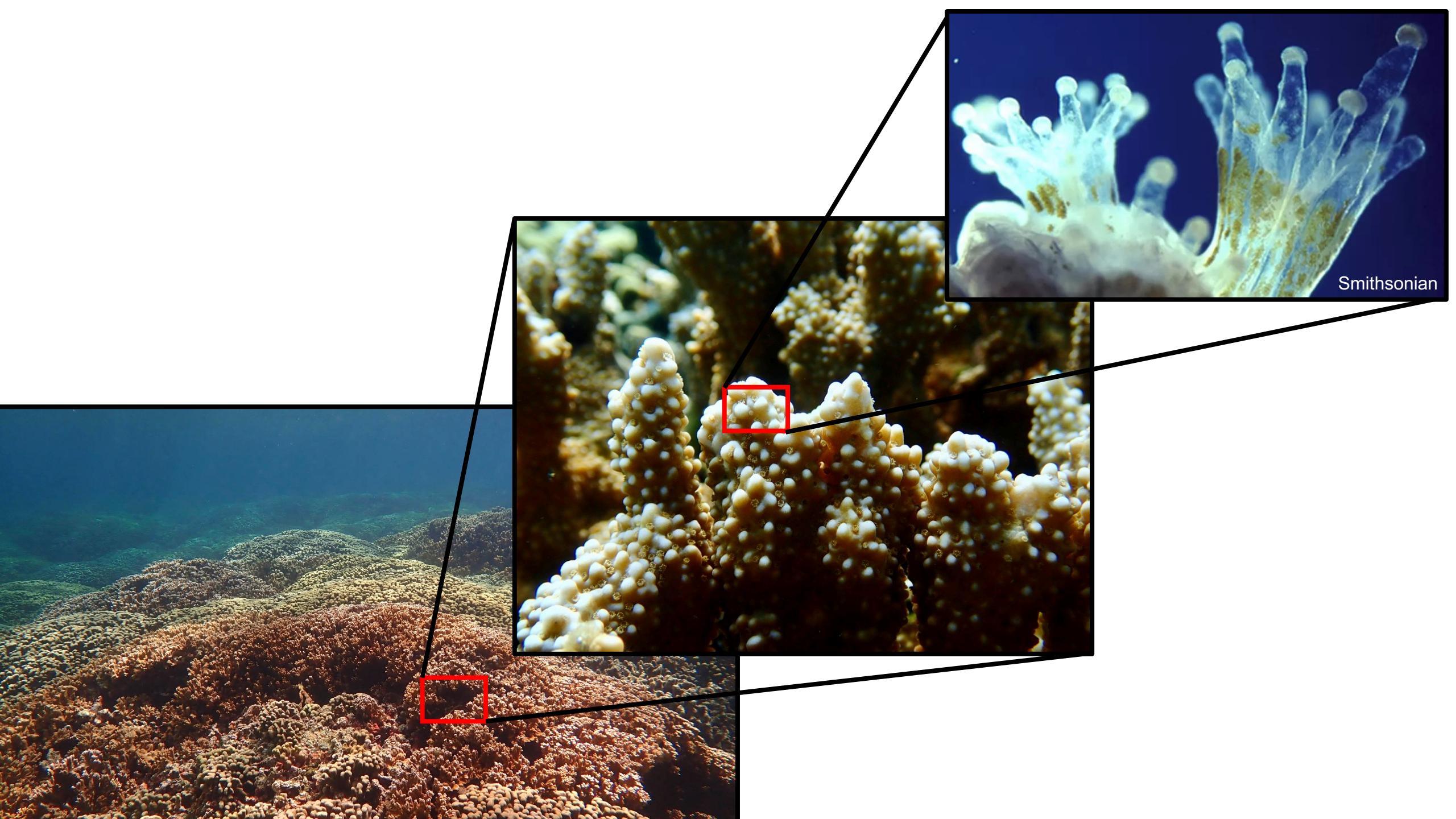
AHuffmyer

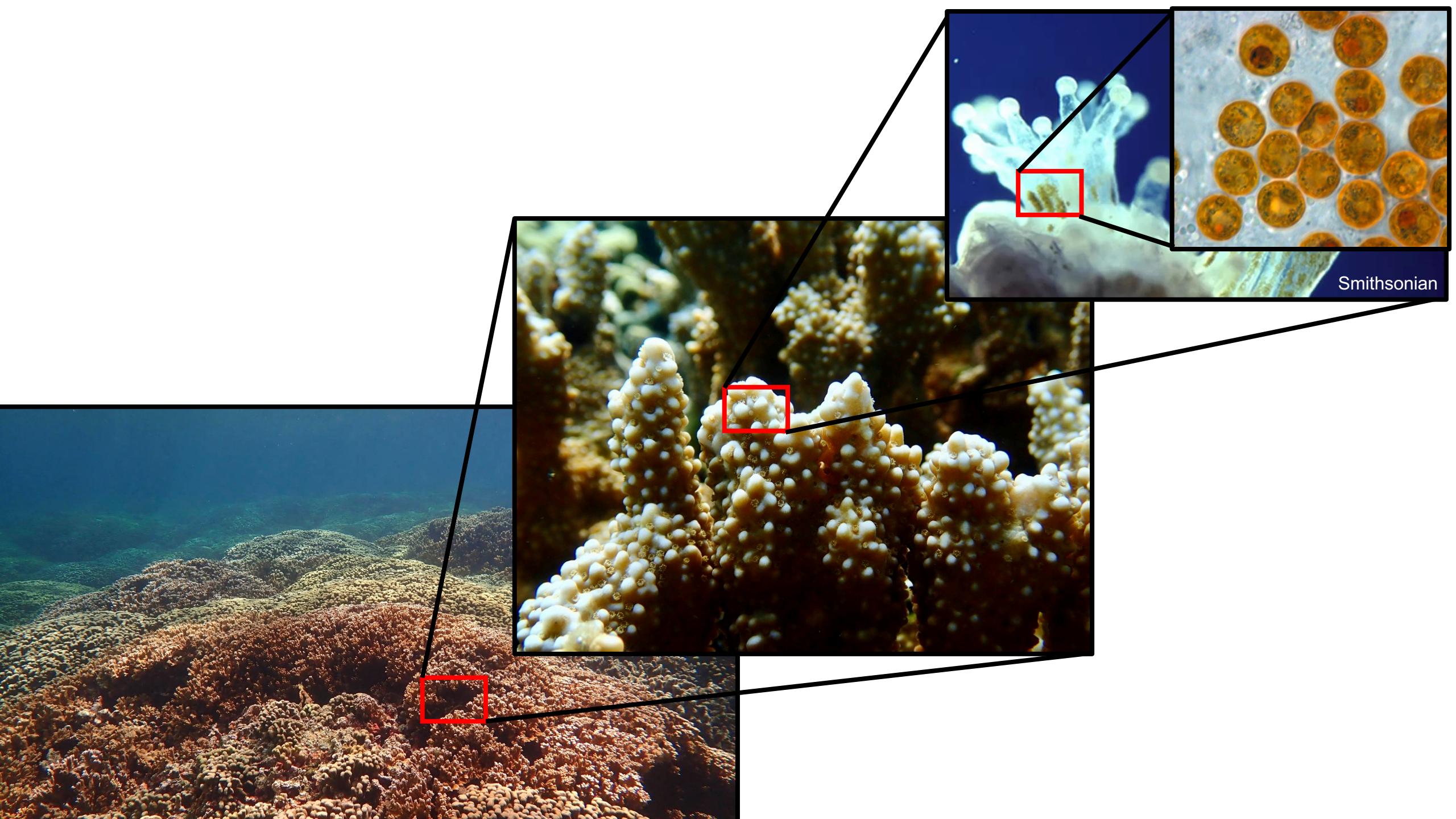
**Postdoctoral Researcher** | University of Washington | University of Rhode Island

**PhD in Marine Biology** | University of Hawai'i at Mānoa | Hawai'i Institute of Marine Biology



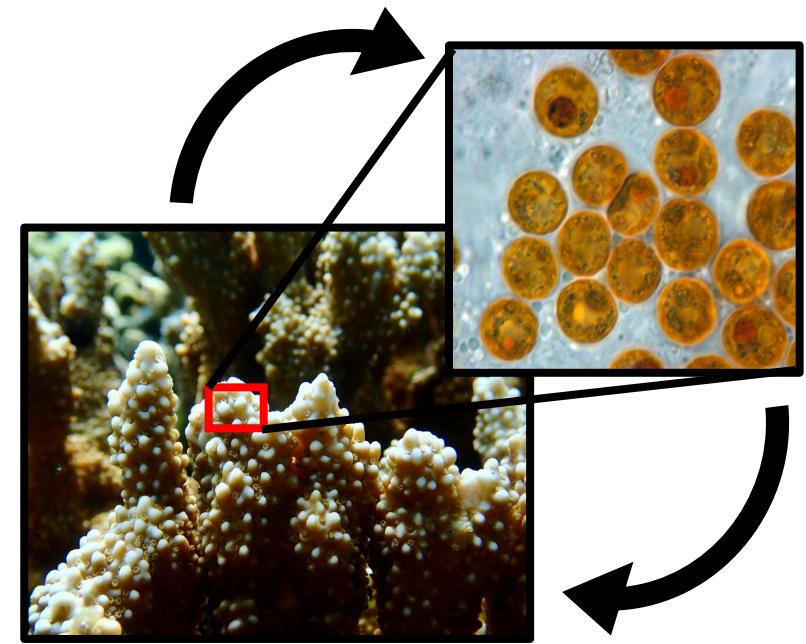
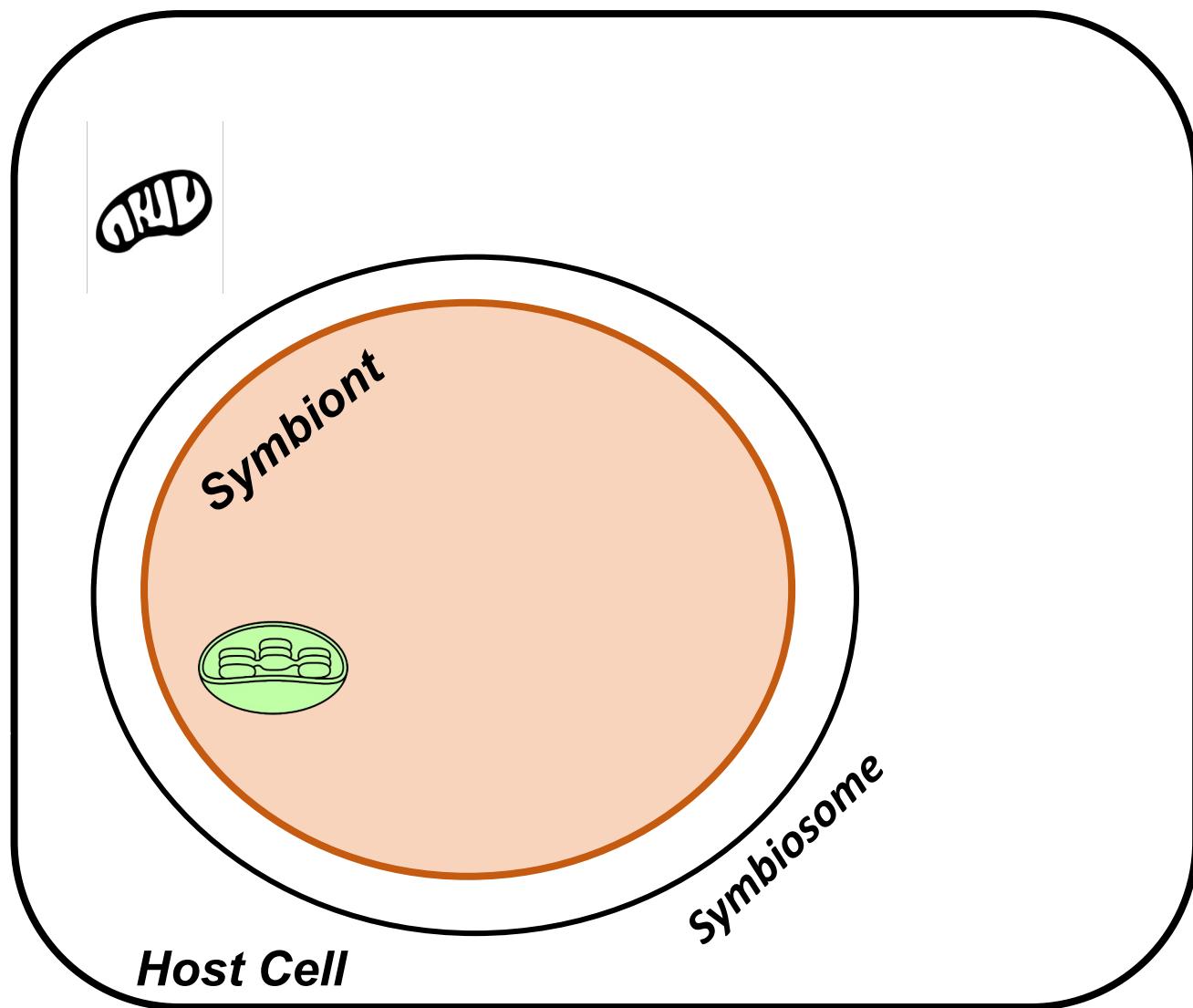




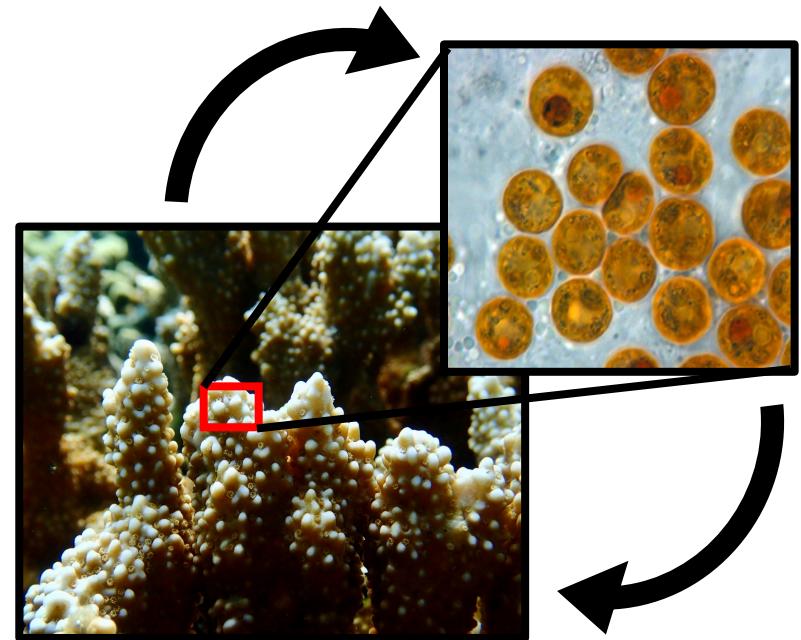
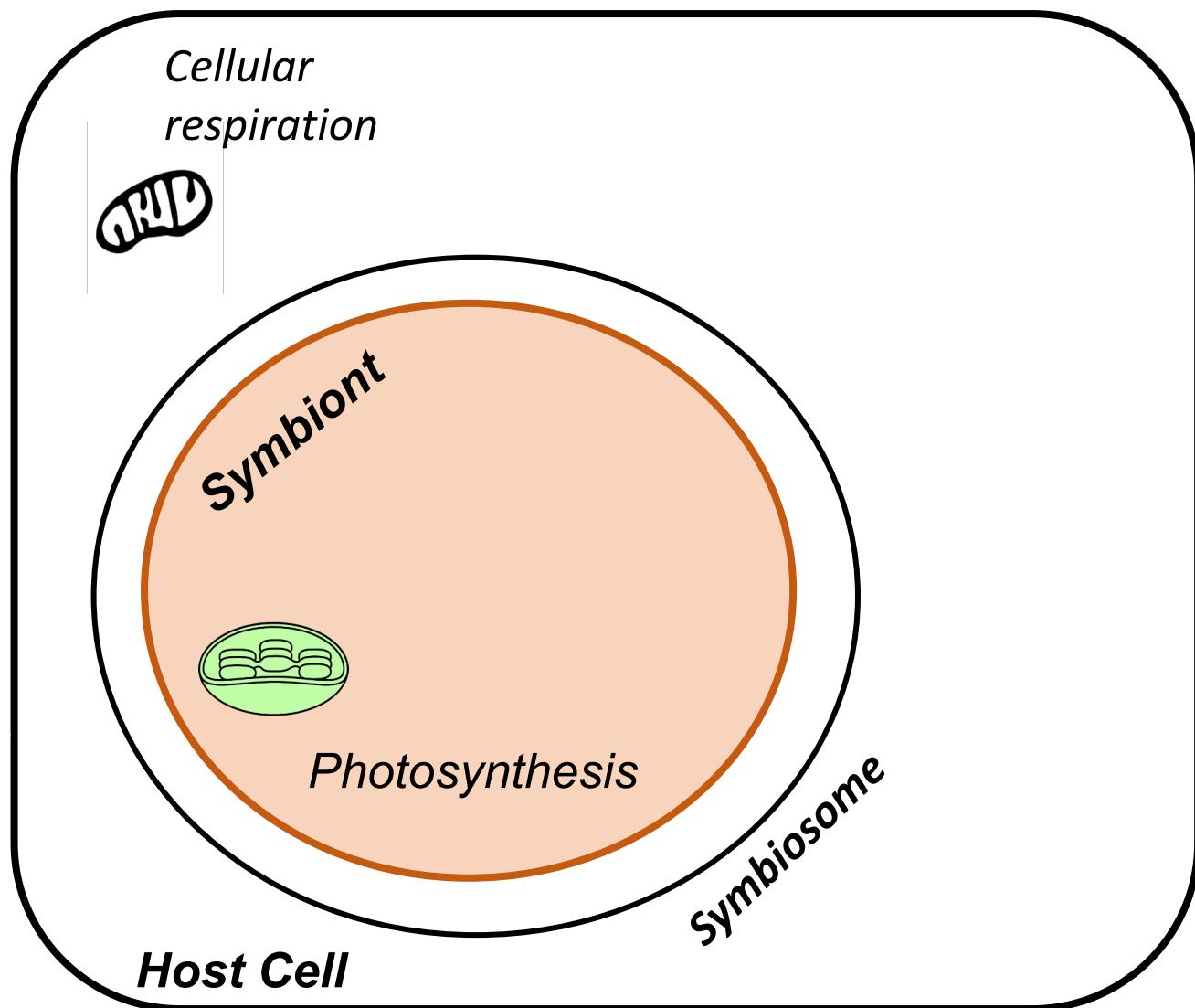


Smithsonian

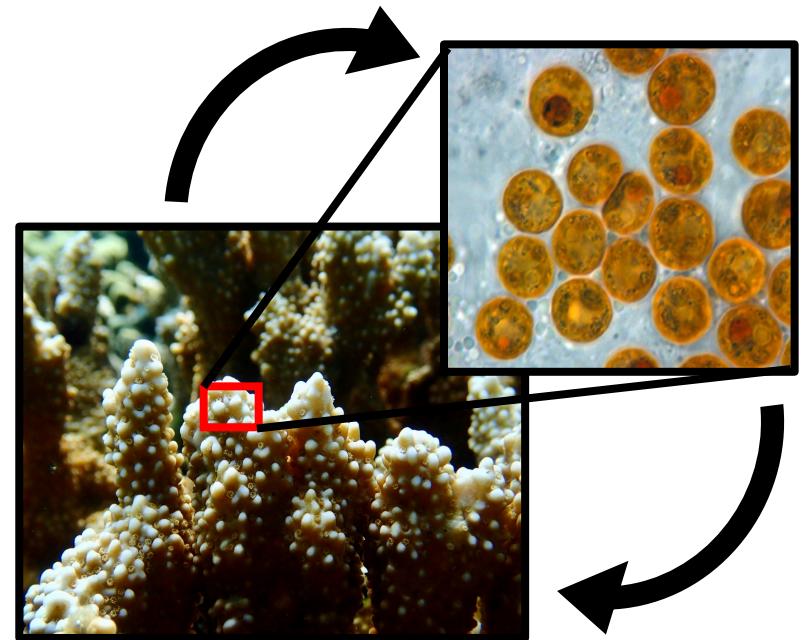
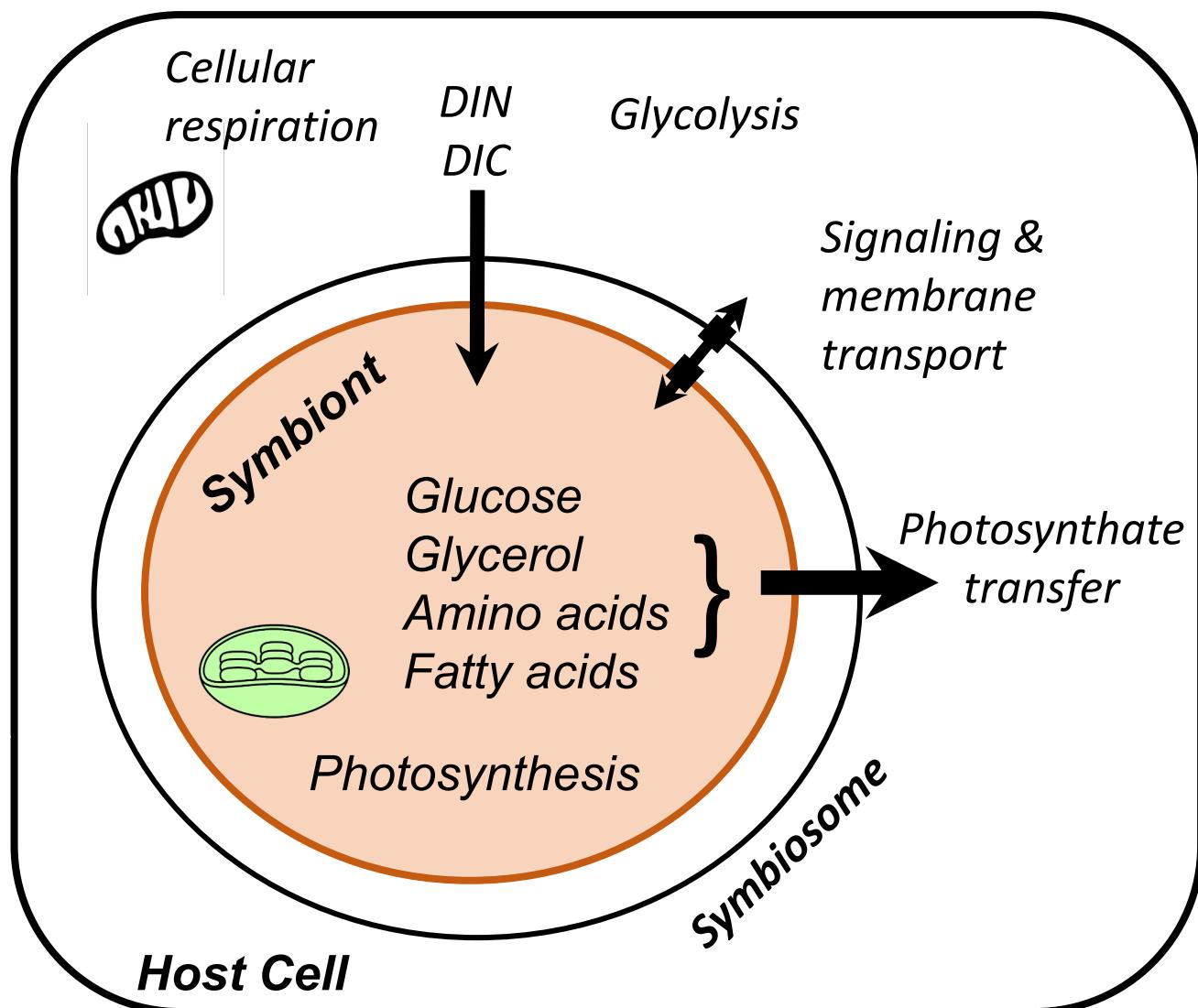
## Coral-Symbiodiniaceae Nutritional Exchange



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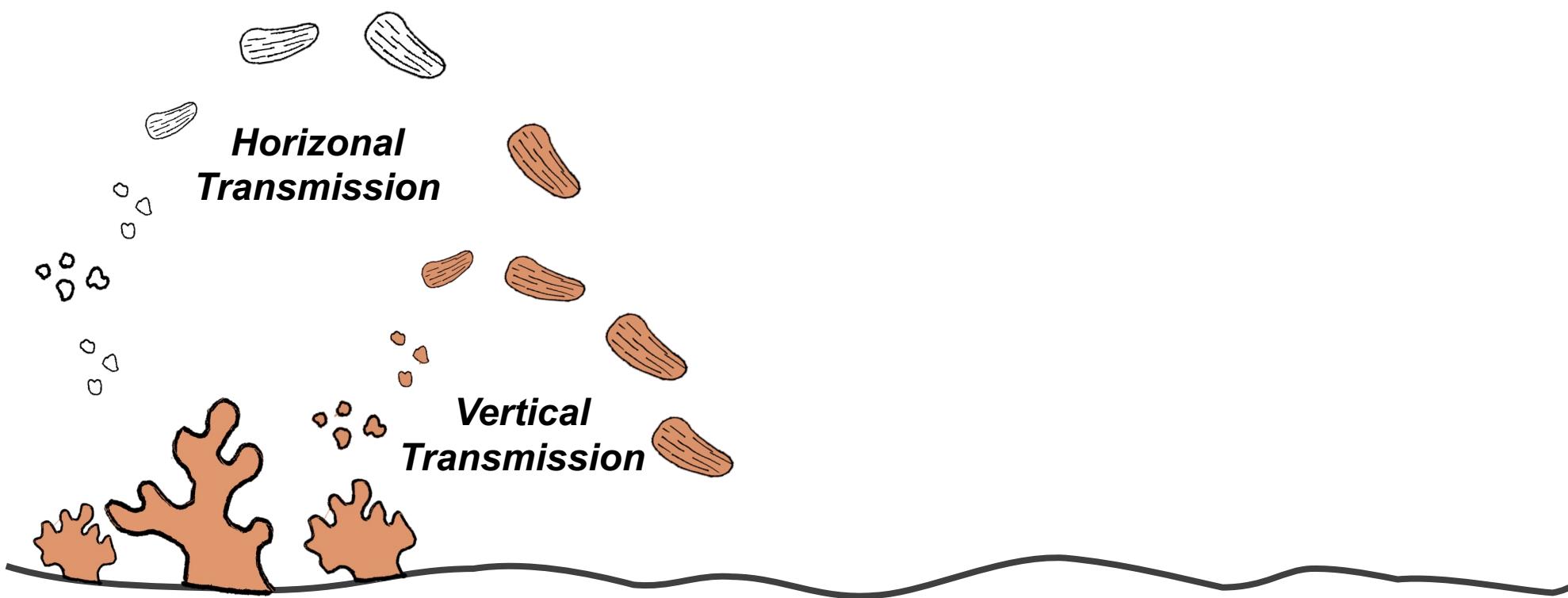


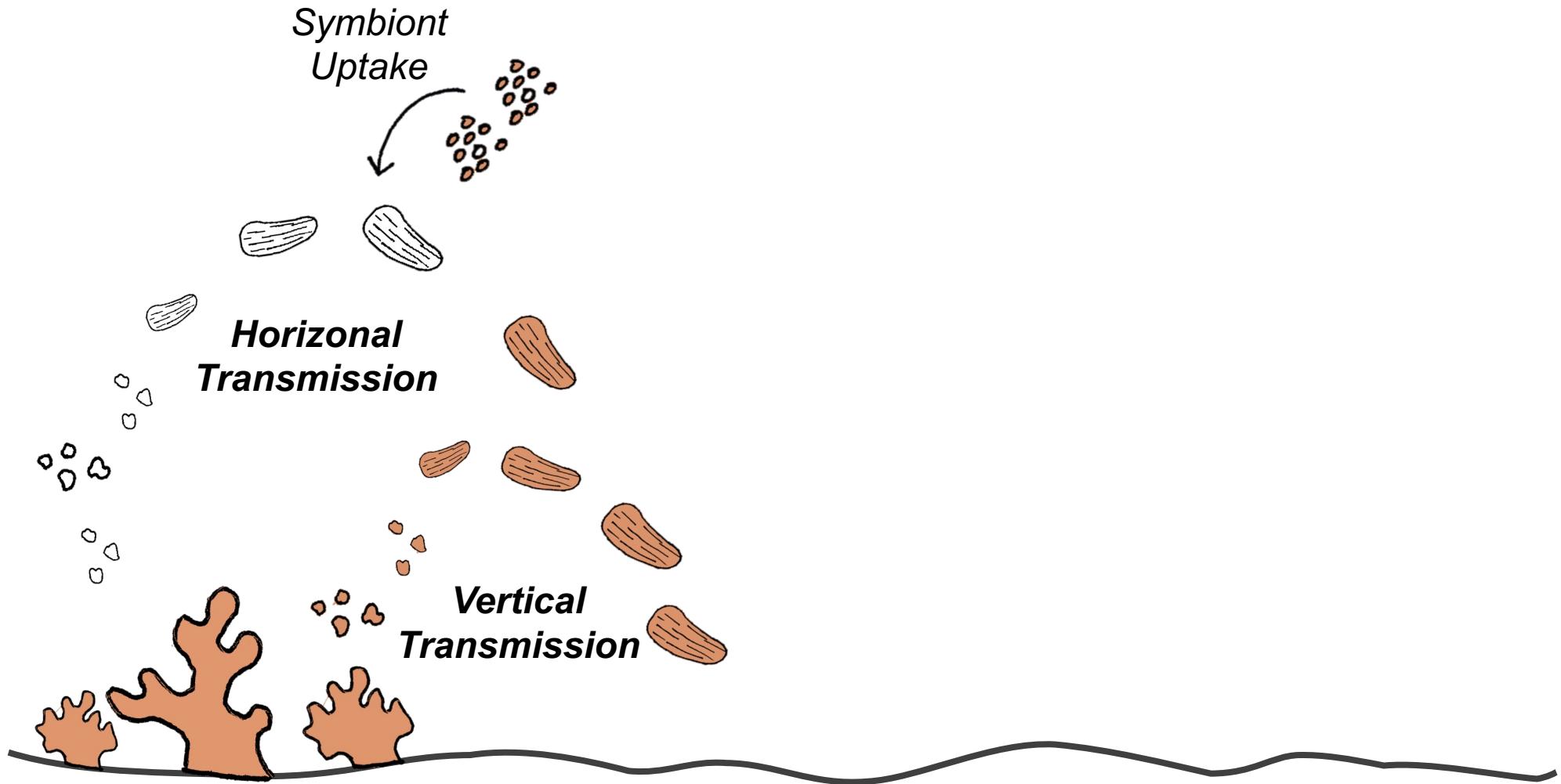
## Coral-Symbiodiniaceae Nutritional Exchange

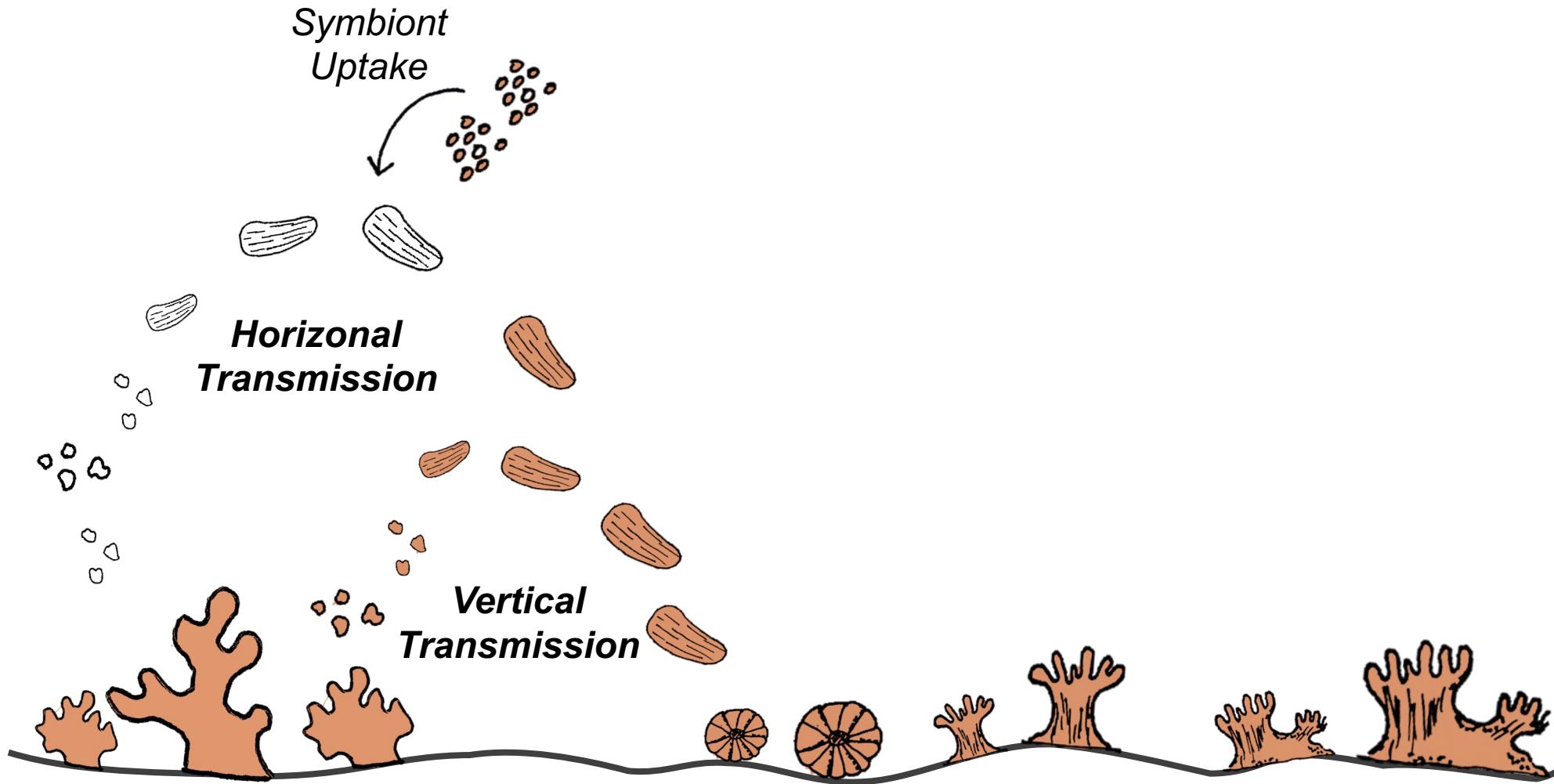




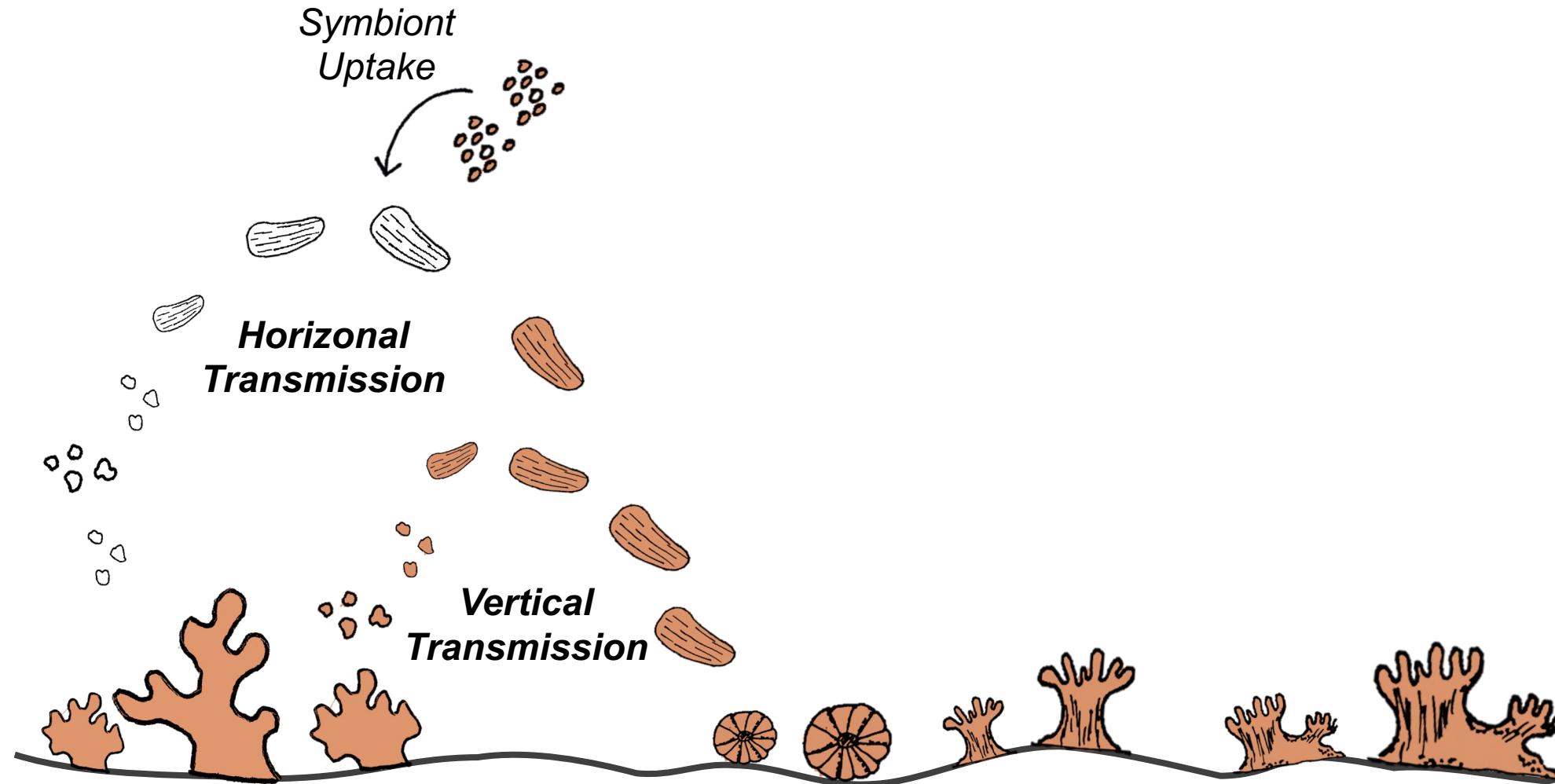




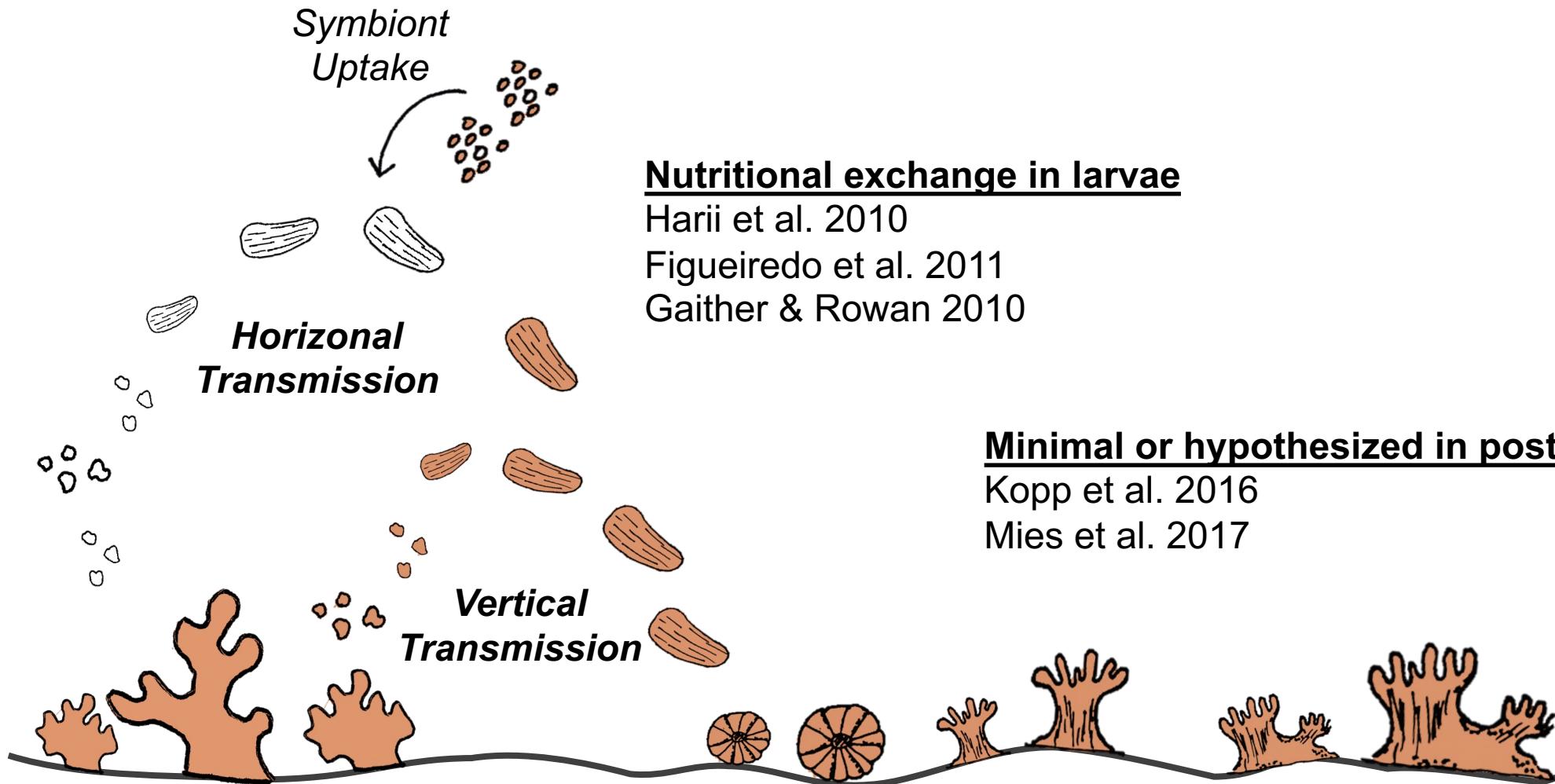




**When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?**

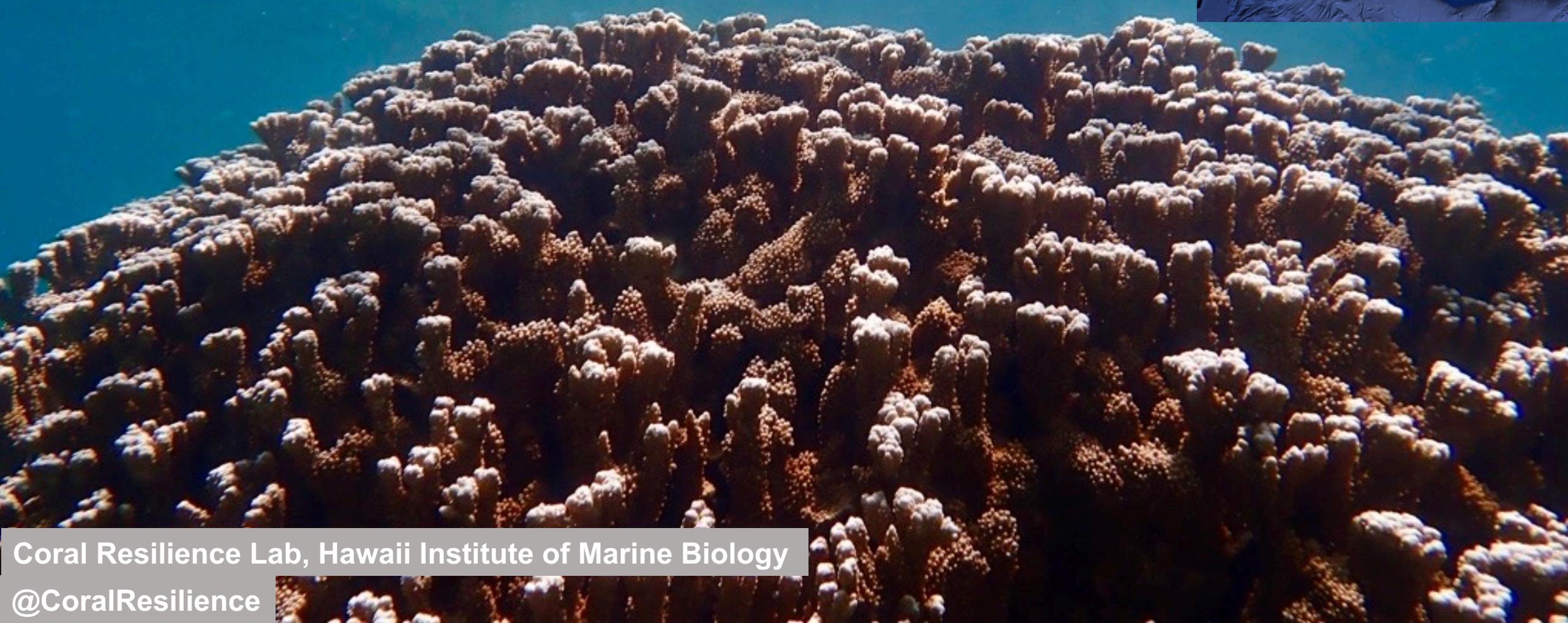


**When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?**



*Montipora capitata*

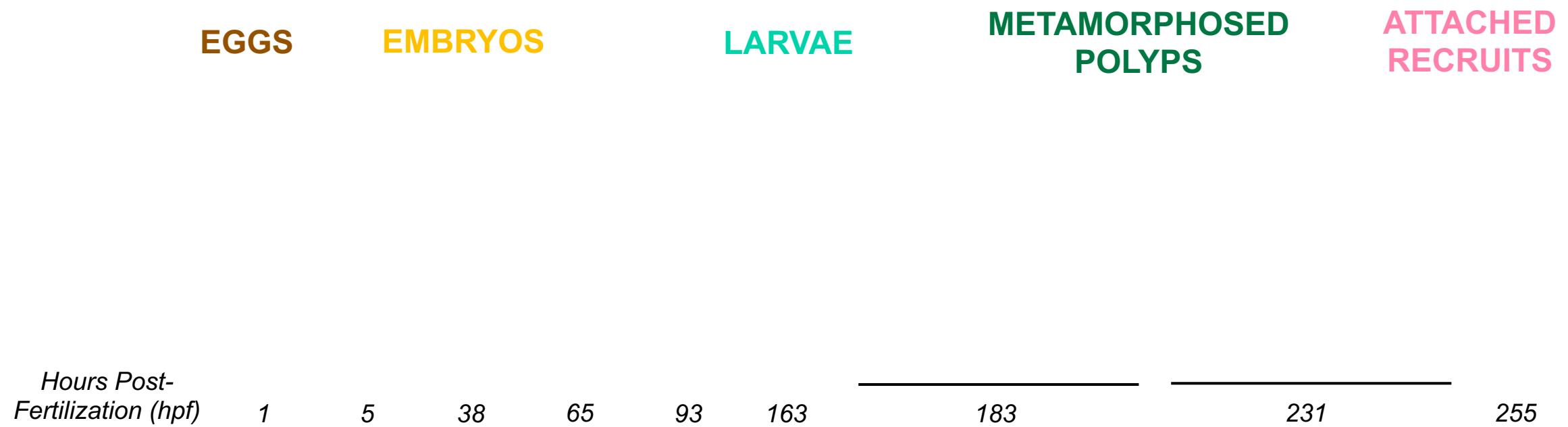
Hermaphroditic broadcast spawner  
Vertical Symbiodiniaceae transmission



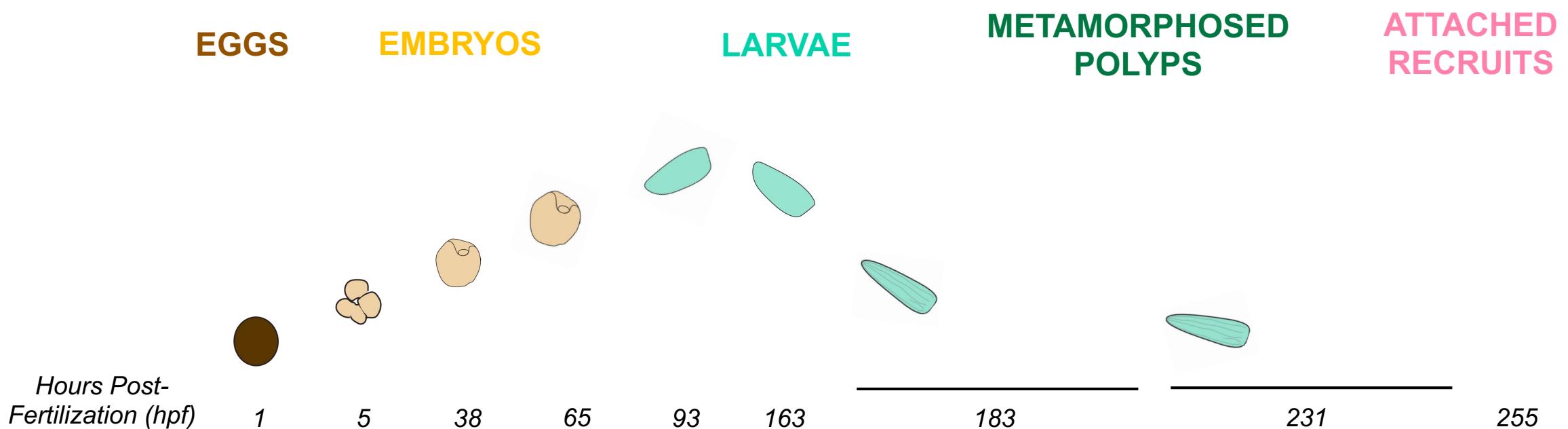
Coral Resilience Lab, Hawaii Institute of Marine Biology

@CoralResilience

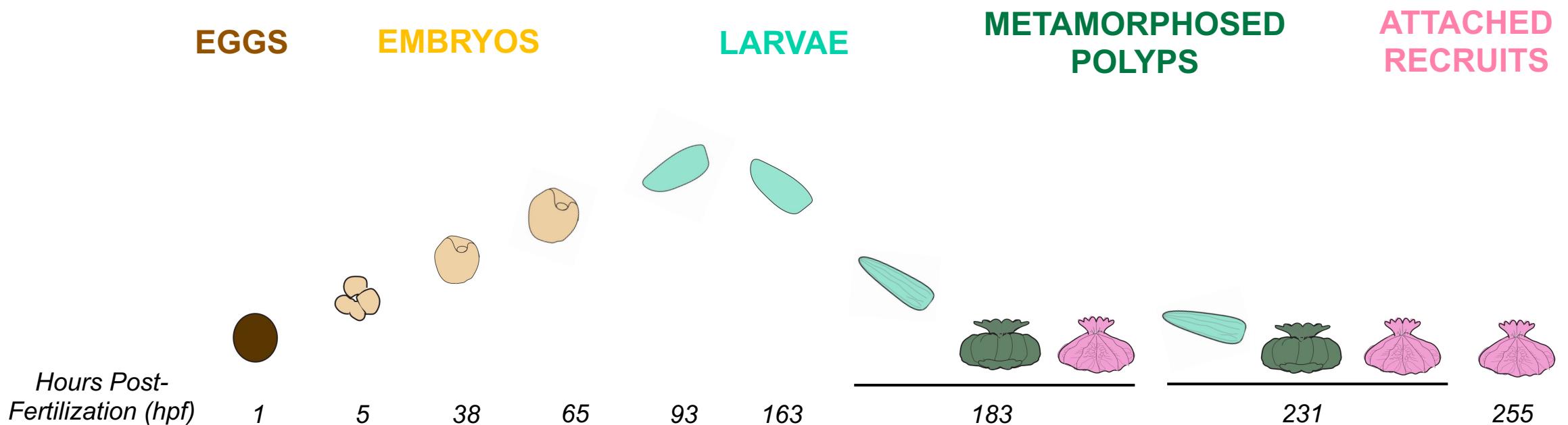
**When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?**



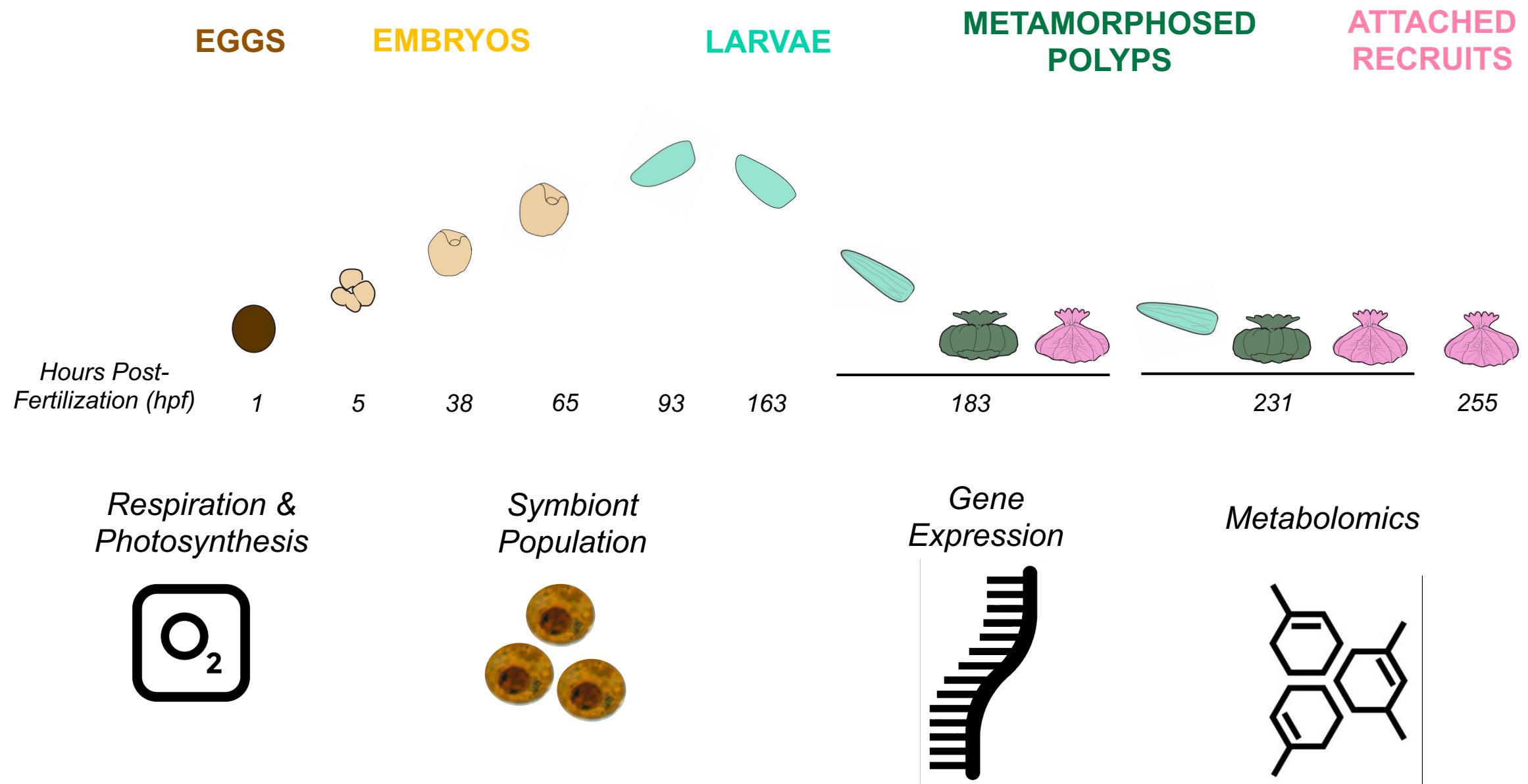
# **When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?**



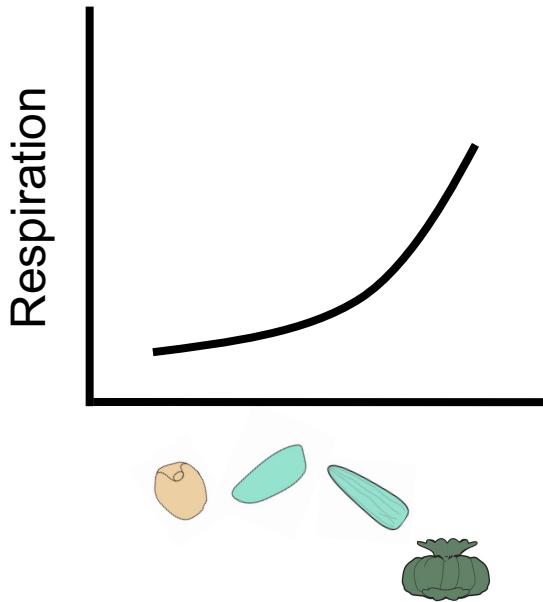
# *When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?*



# **When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?**

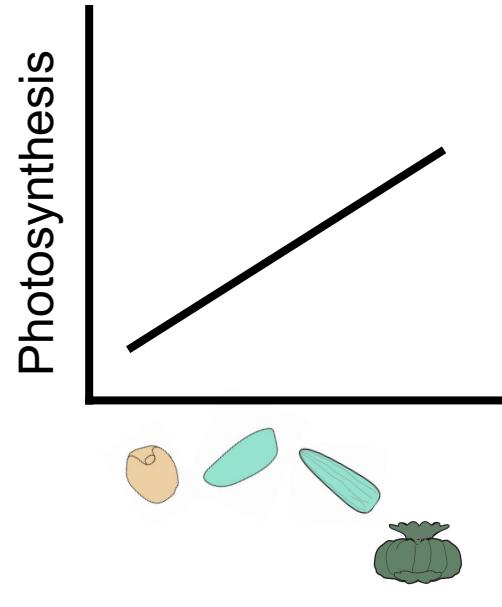
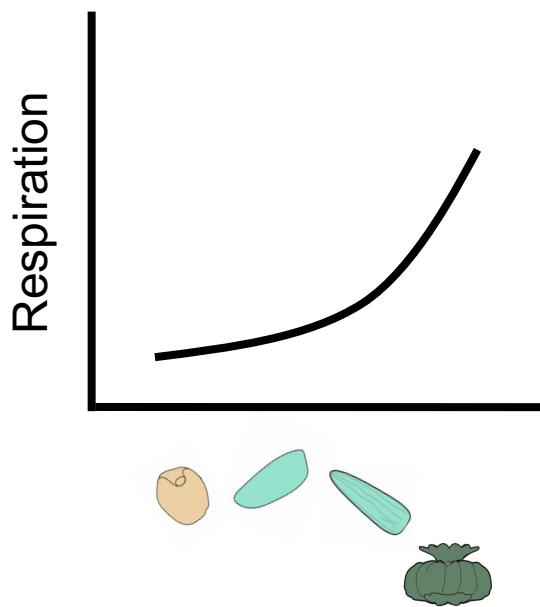


# Metabolism & symbiosis across development

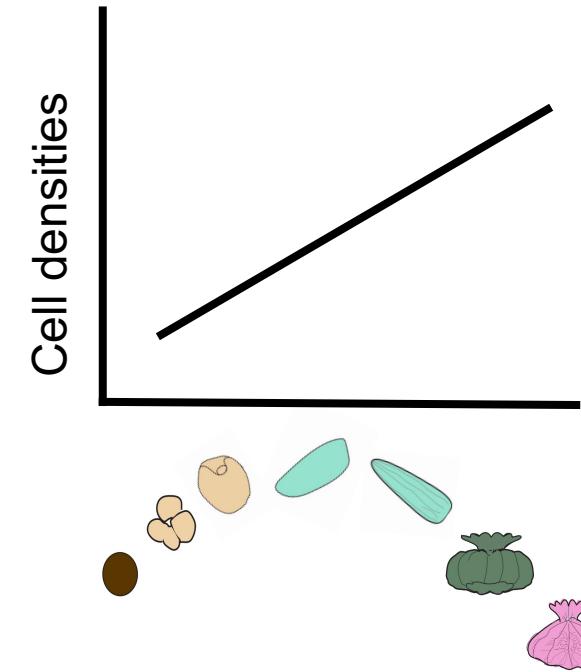
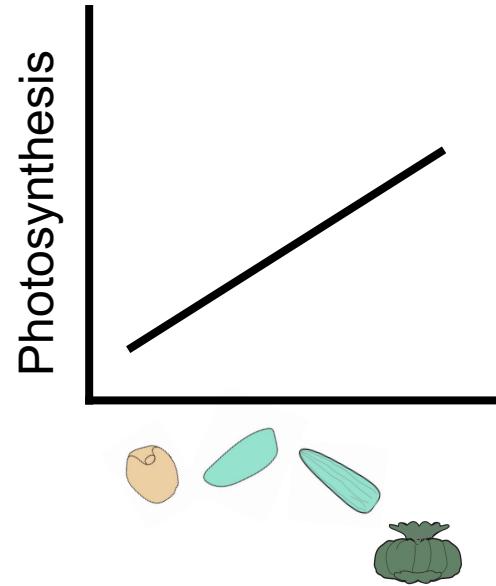
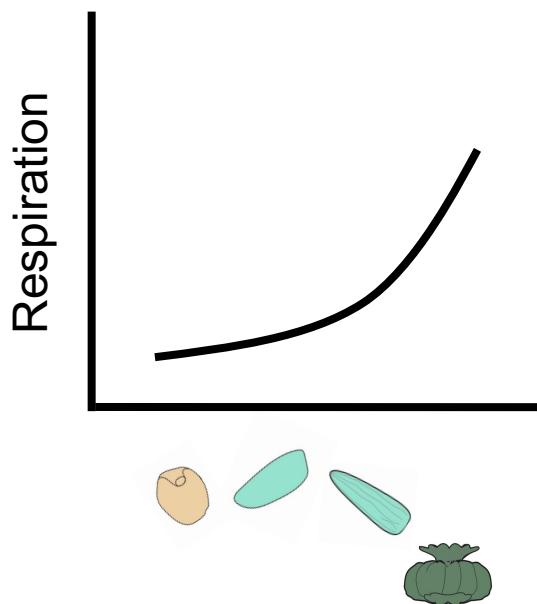


*GLMM p<0.001  
Individual normalized*

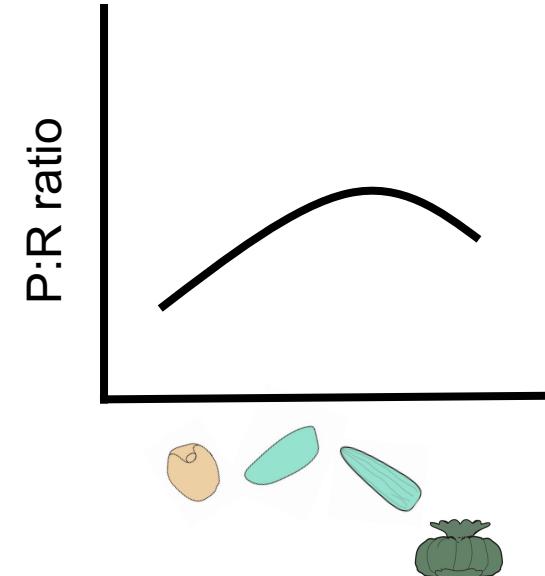
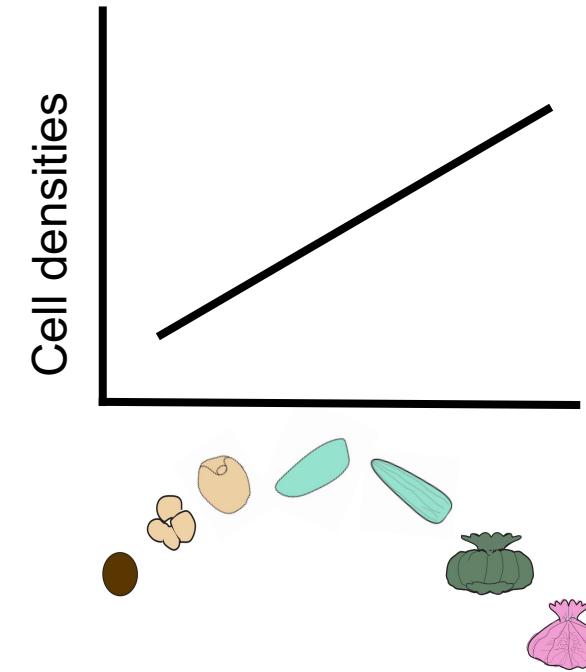
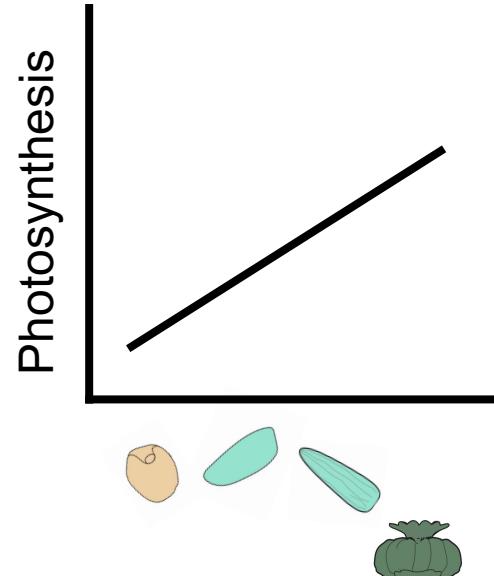
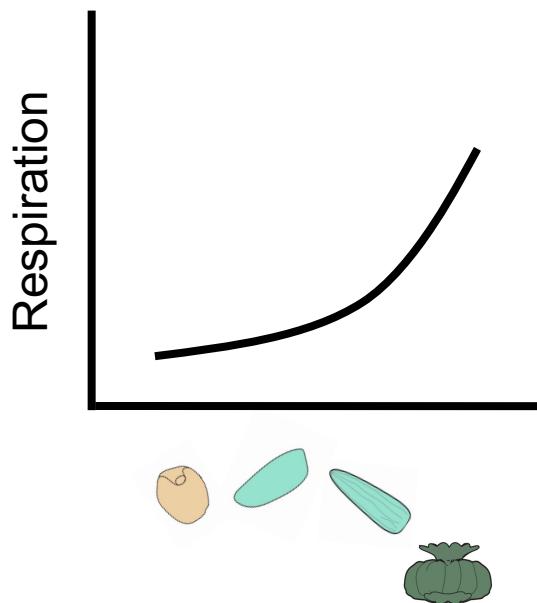
# Metabolism & symbiosis across development



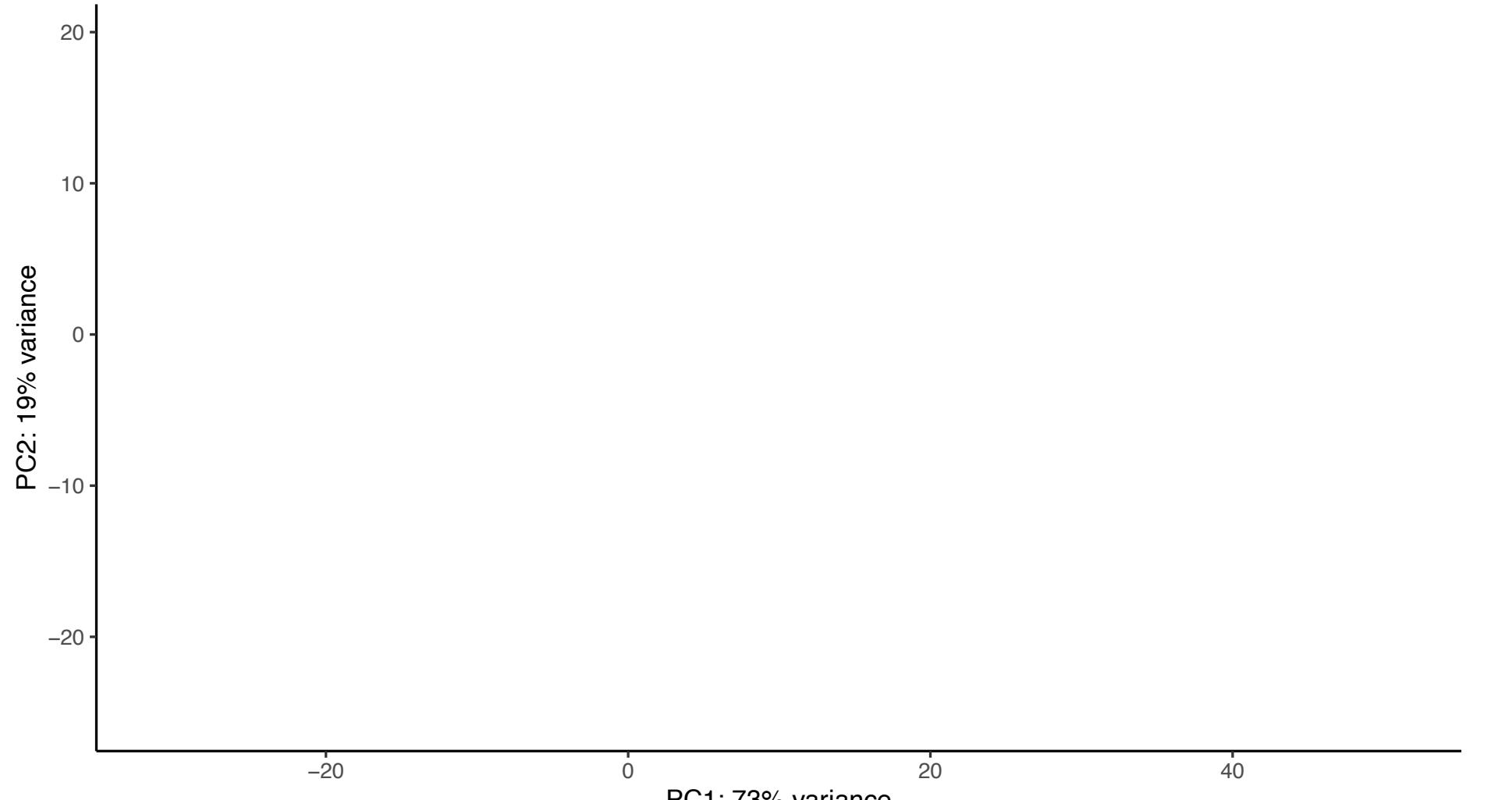
# Metabolism & symbiosis across development



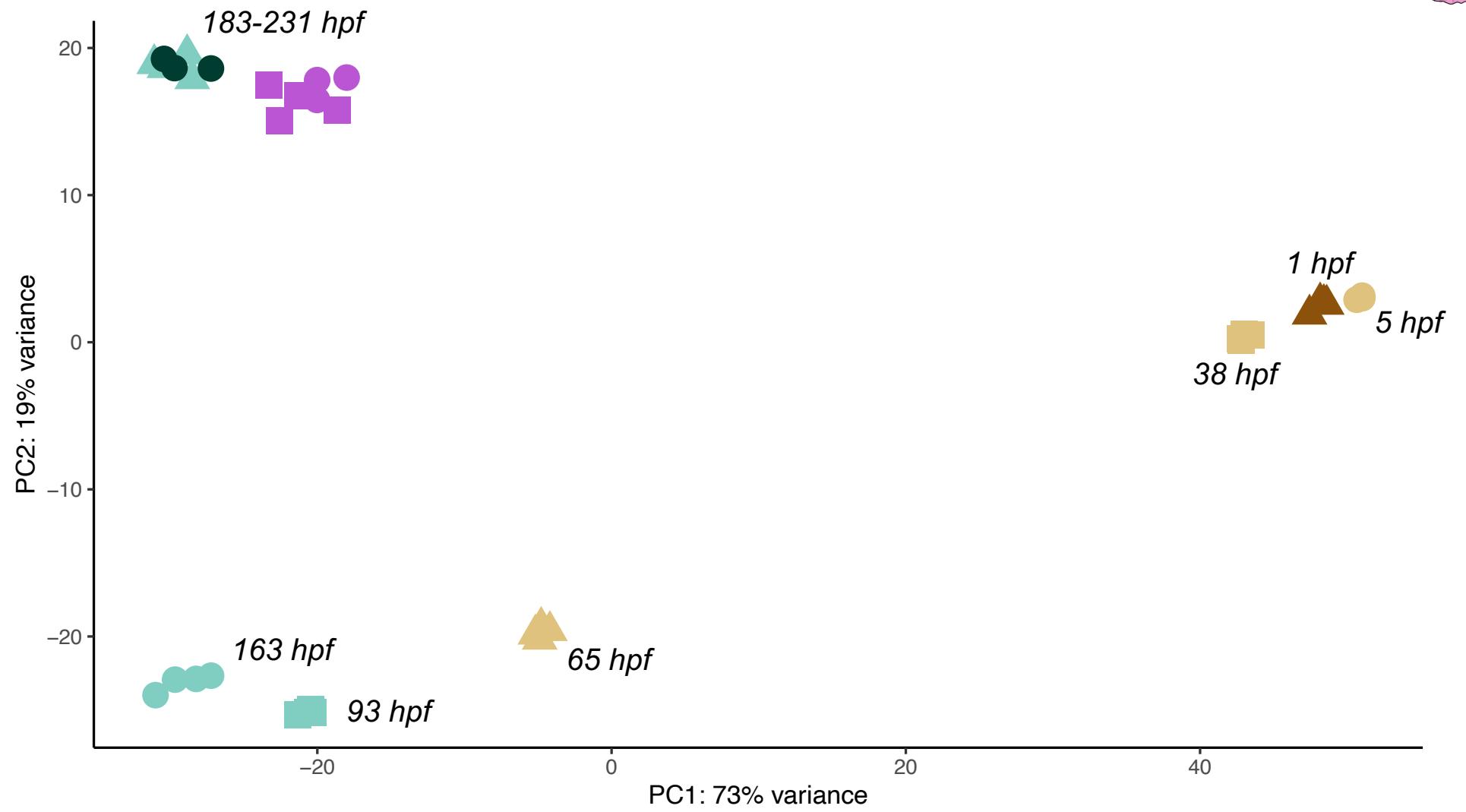
# Metabolism & symbiosis across development



# Distinct gene expression profiles across ontogeny



# Distinct gene expression profiles across ontogeny



TagSeq (Lohman et al. 2016)

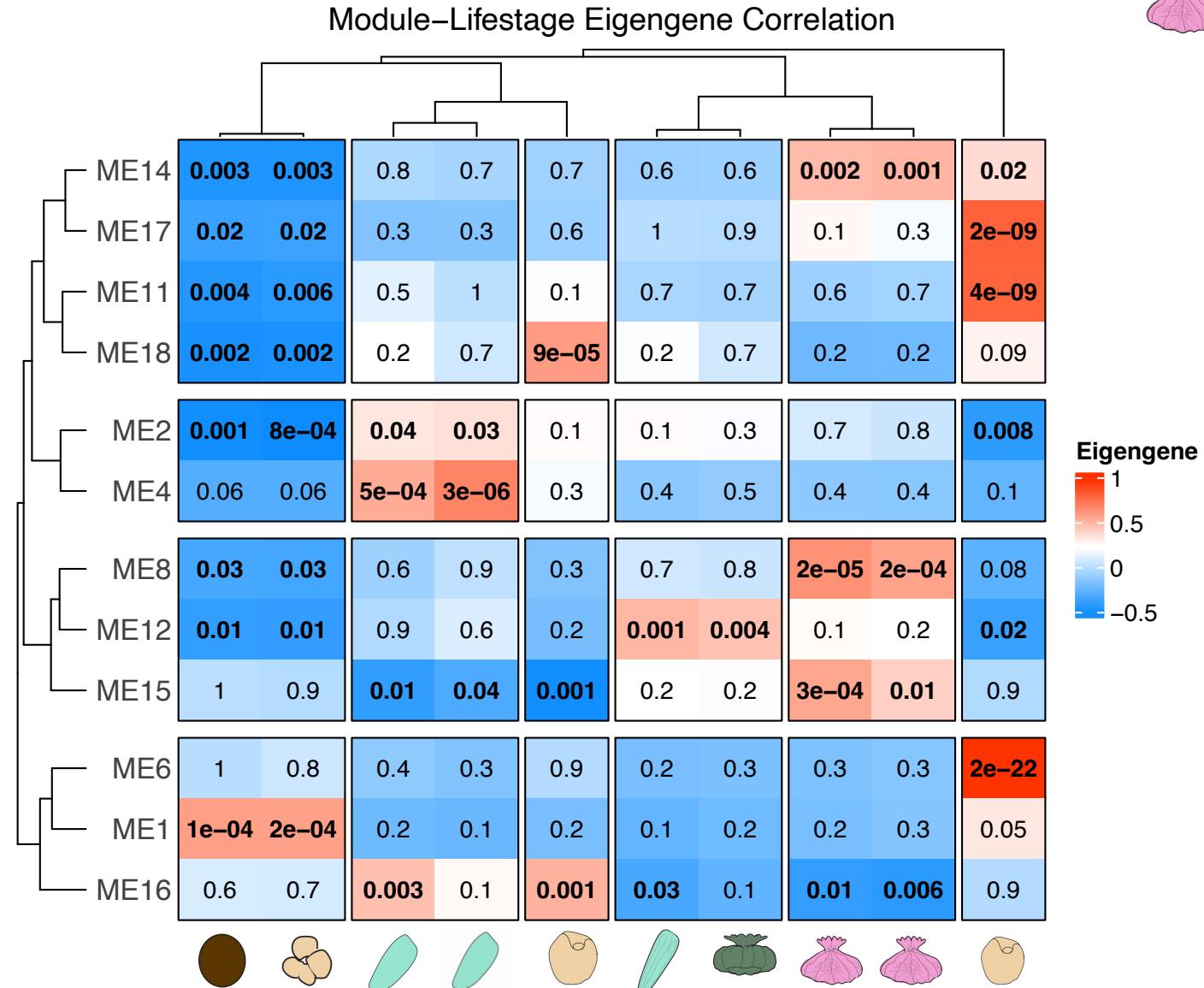
Illumina NovaSeq 100 bp sequencing (UT Austin)

Trimming & QC (FastP); alignment (HISAT2, Stringtie2)

# Distinct gene expression profiles across ontogeny

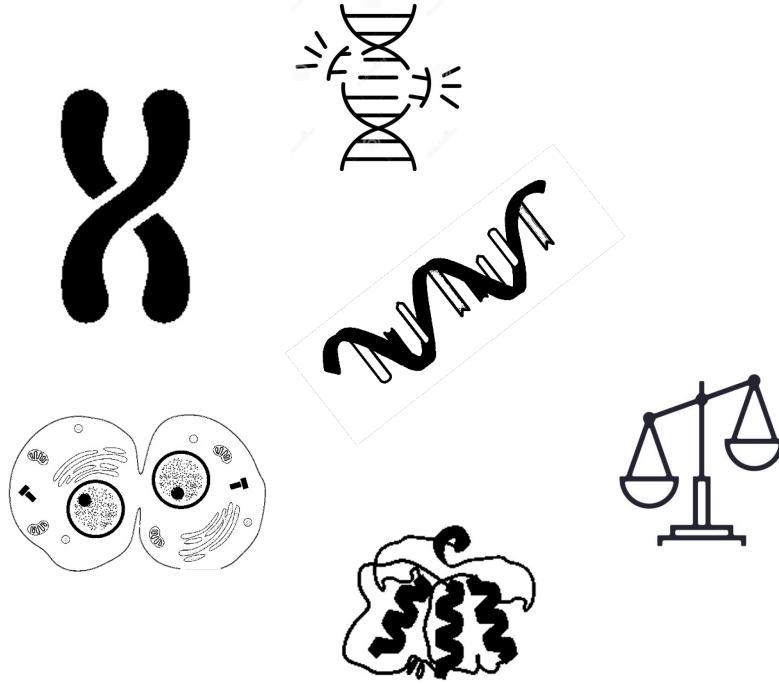
*Weighted gene co-expression network analysis (WGCNA)*

Dynamic tree cut module detection  
GO-Seq functional enrichment  
Filtered FDR<0.05

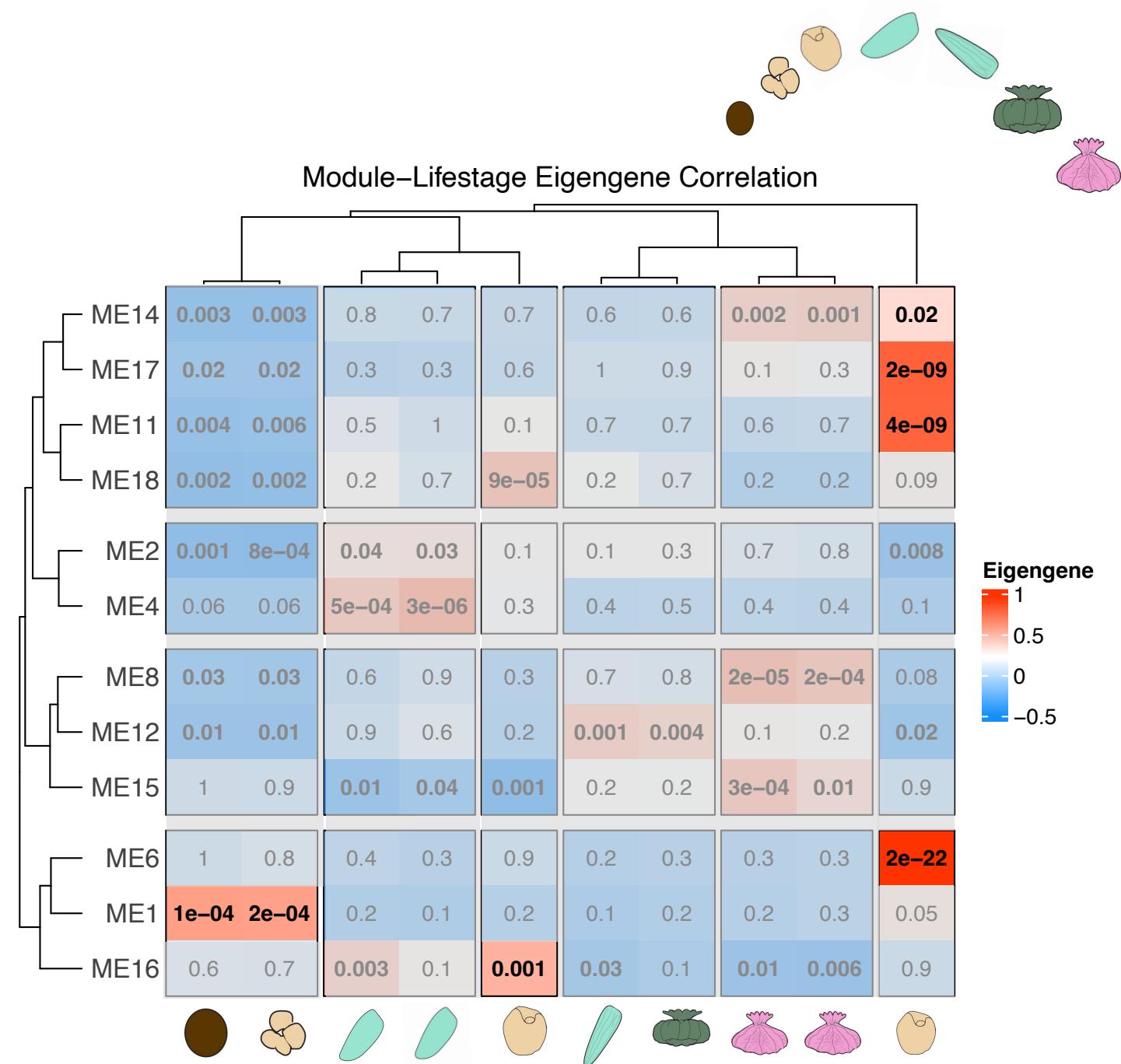


# EGG-EMBRYOS

## 1 hpf - 65 hpf

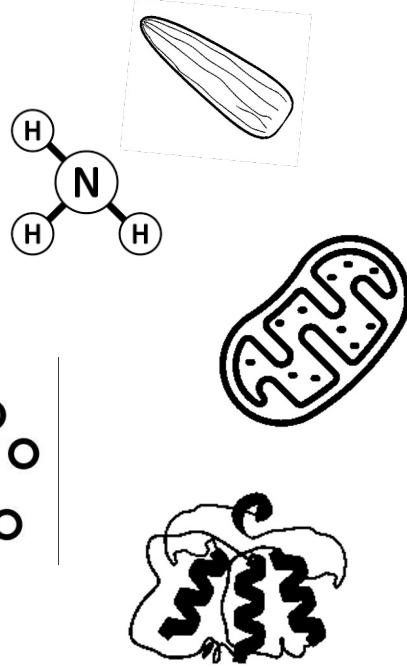
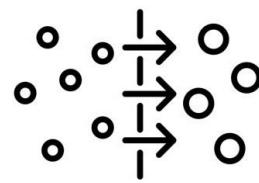


*Cell division, transcription, embryonic development, DNA repair, homeostasis*

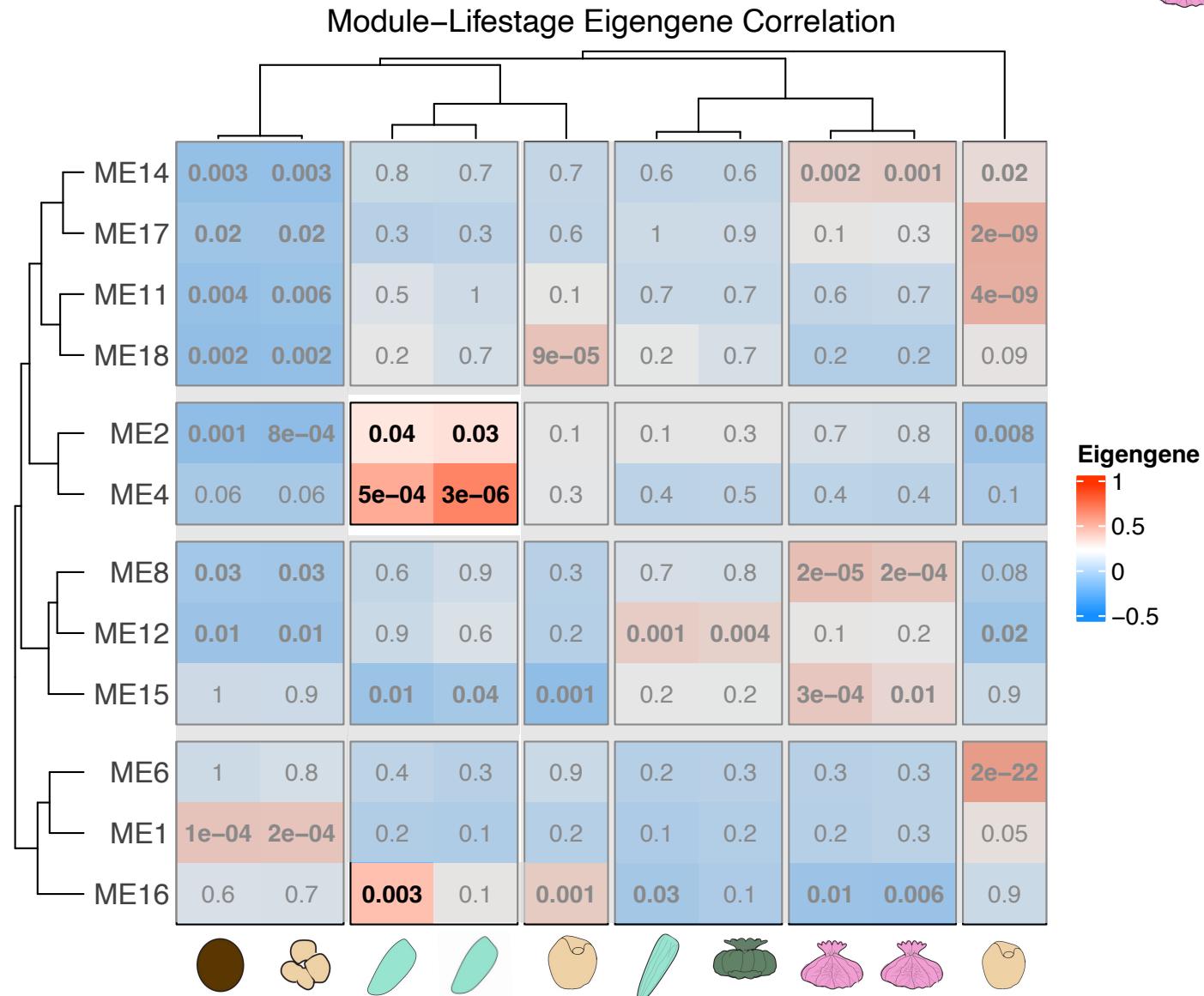


# LARVAE

93 hpf – 163 hpf

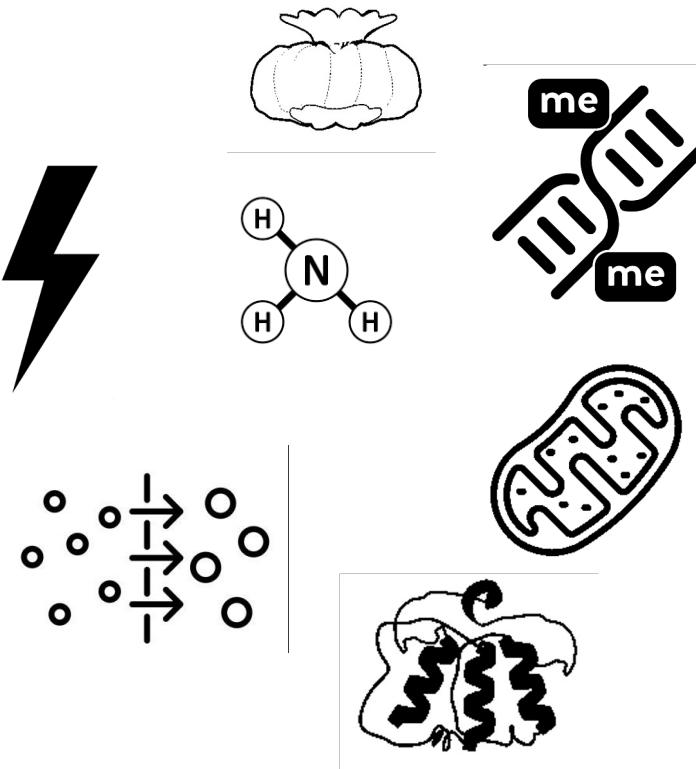


*Nitrogen and carbohydrate metabolism,  
structure development, ion transport*

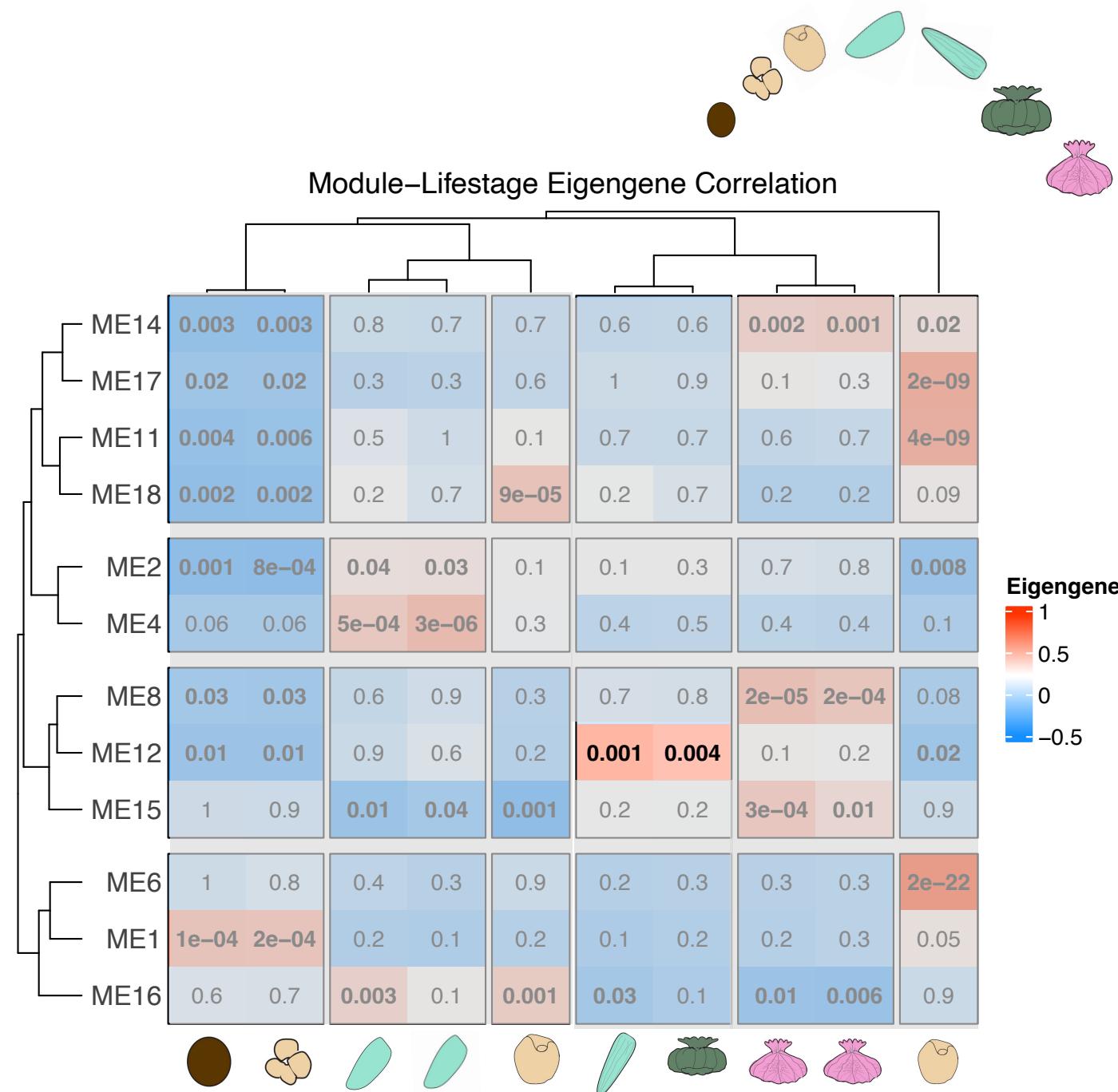


# LARVAE & METAMORPHOSED POLYPS

231 hpf

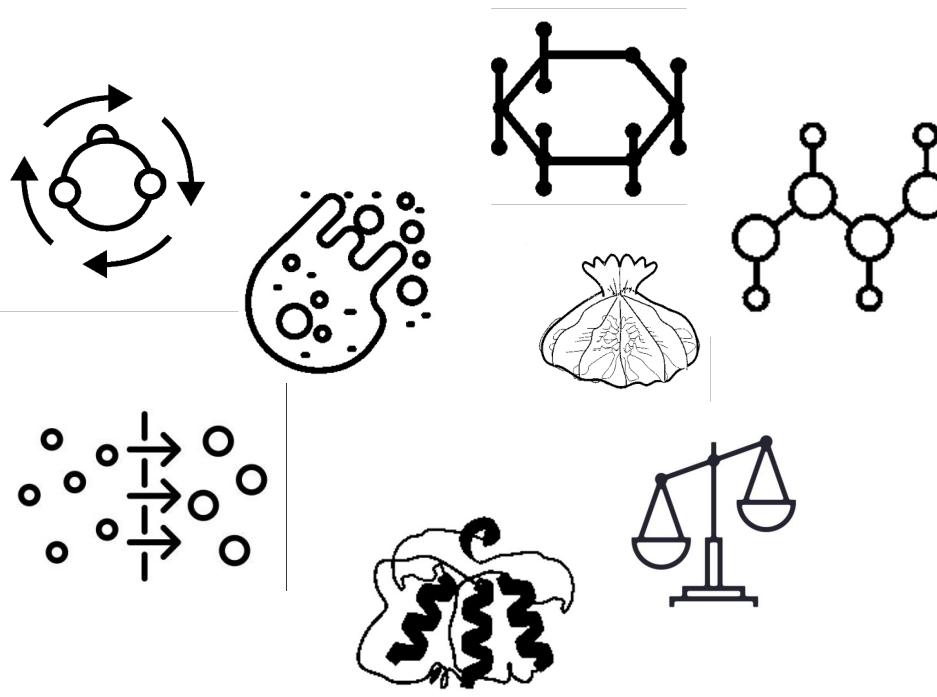


*Nitrogen metabolism, membrane transport, protein transport, metamorphosis, carbohydrate metabolism.*

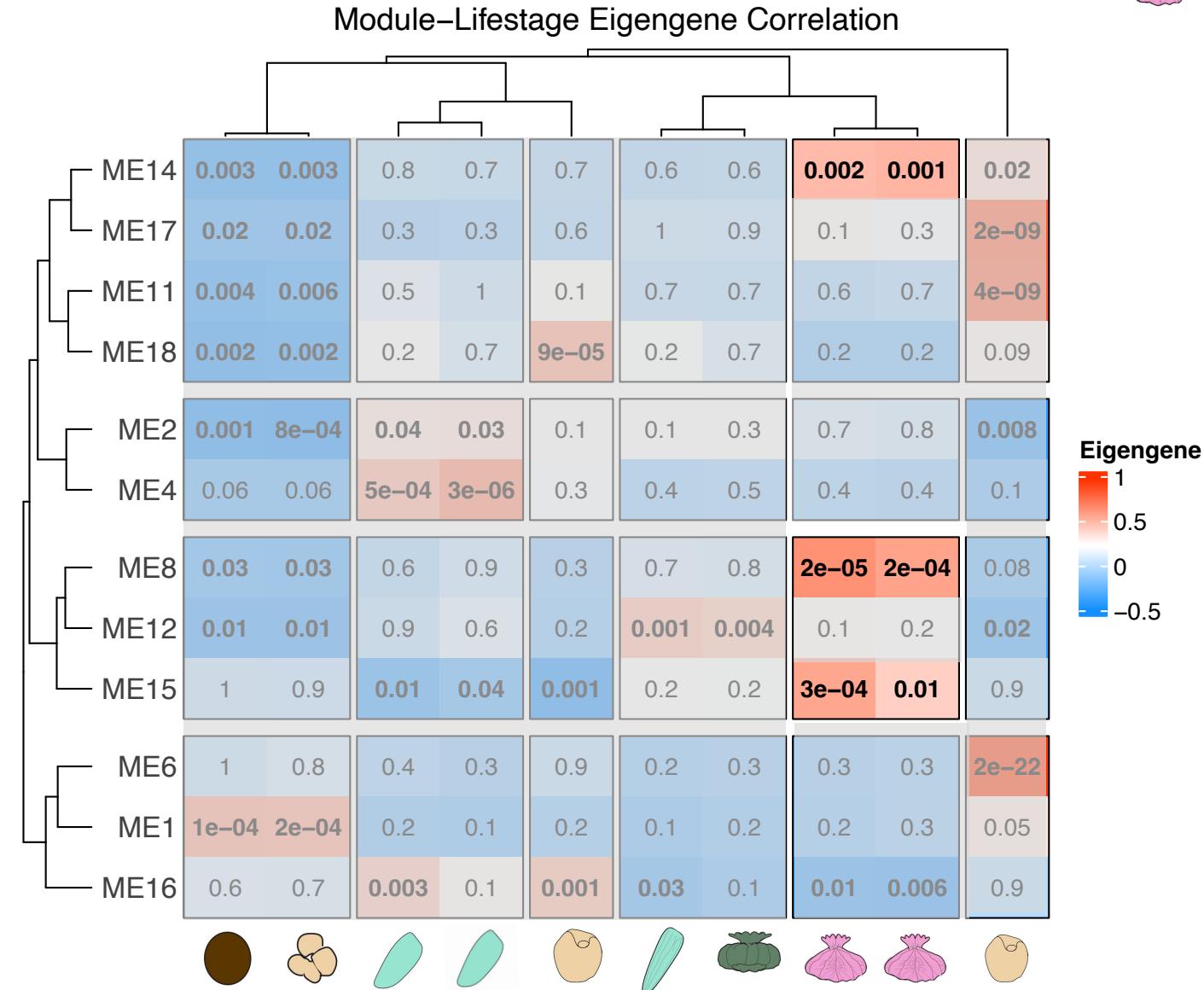


# ATTACHED RECRUITS

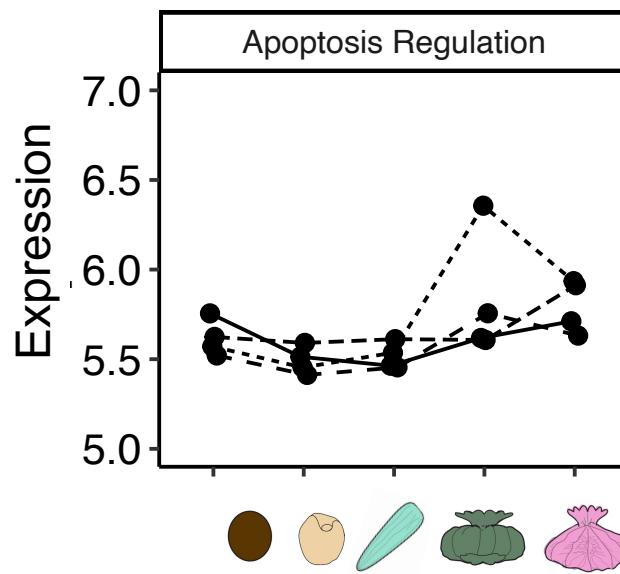
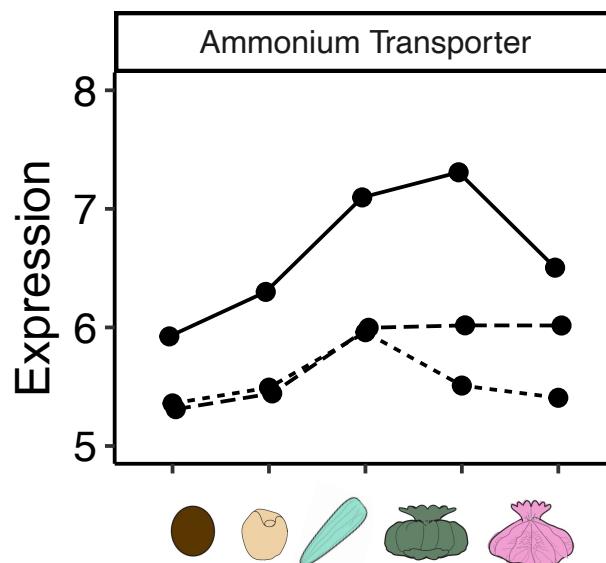
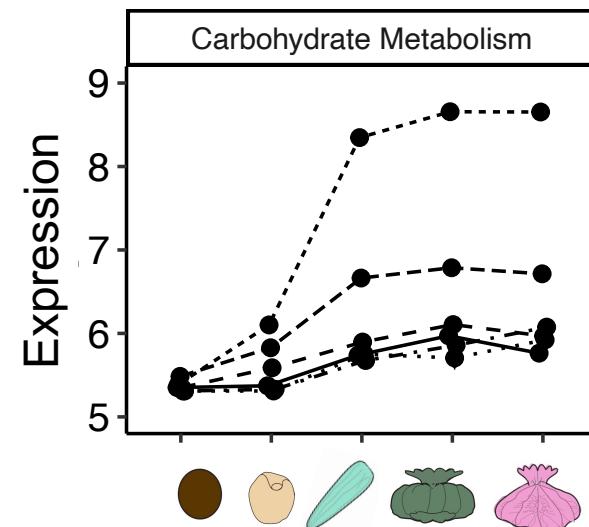
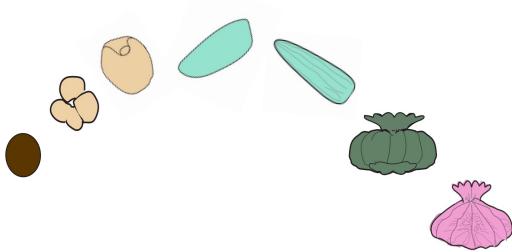
## 183-231 hpf



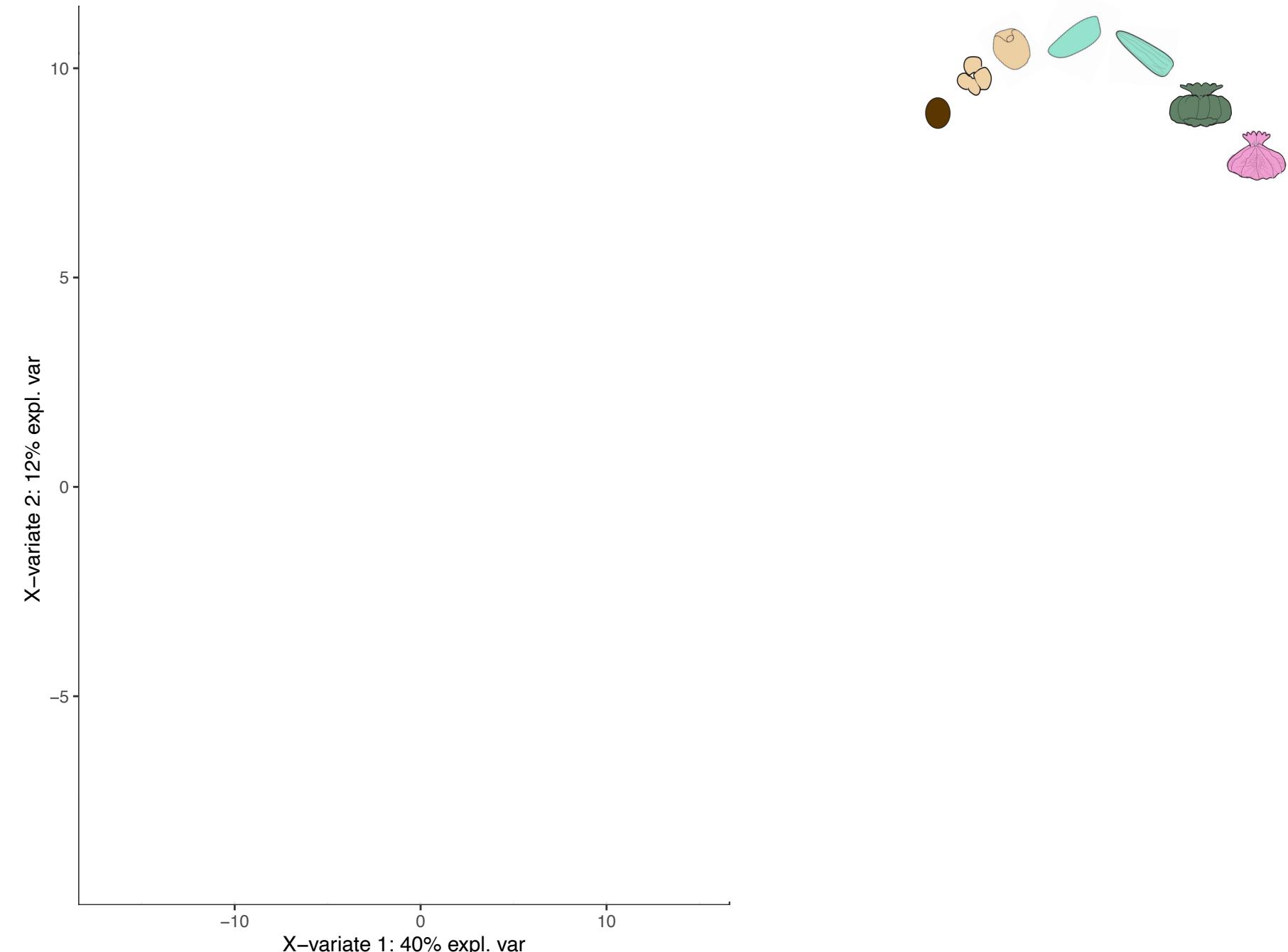
*Cell communication, membrane transport, homeostasis, lipid metabolism, carbohydrate metabolism*



# GENE EXPRESSION SIGNATURES OF SYMBIOSIS



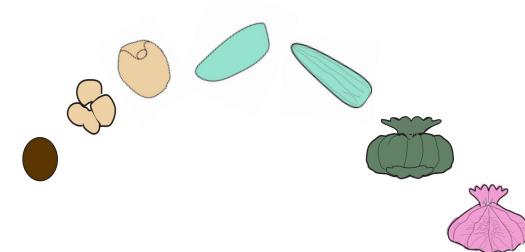
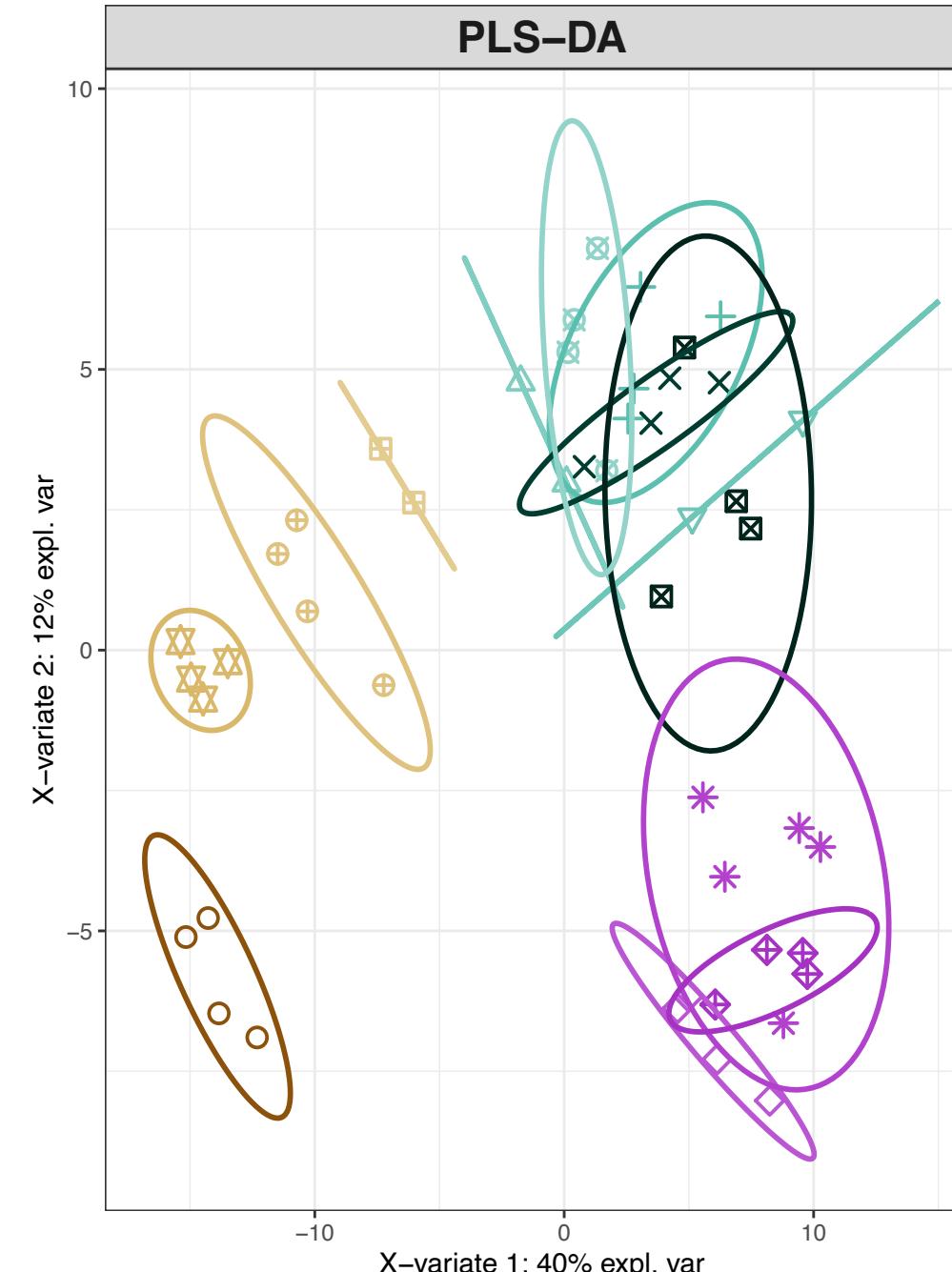
# Distinct metabolomic profiles across ontogeny



Untargeted metabolomics  
LC-MS

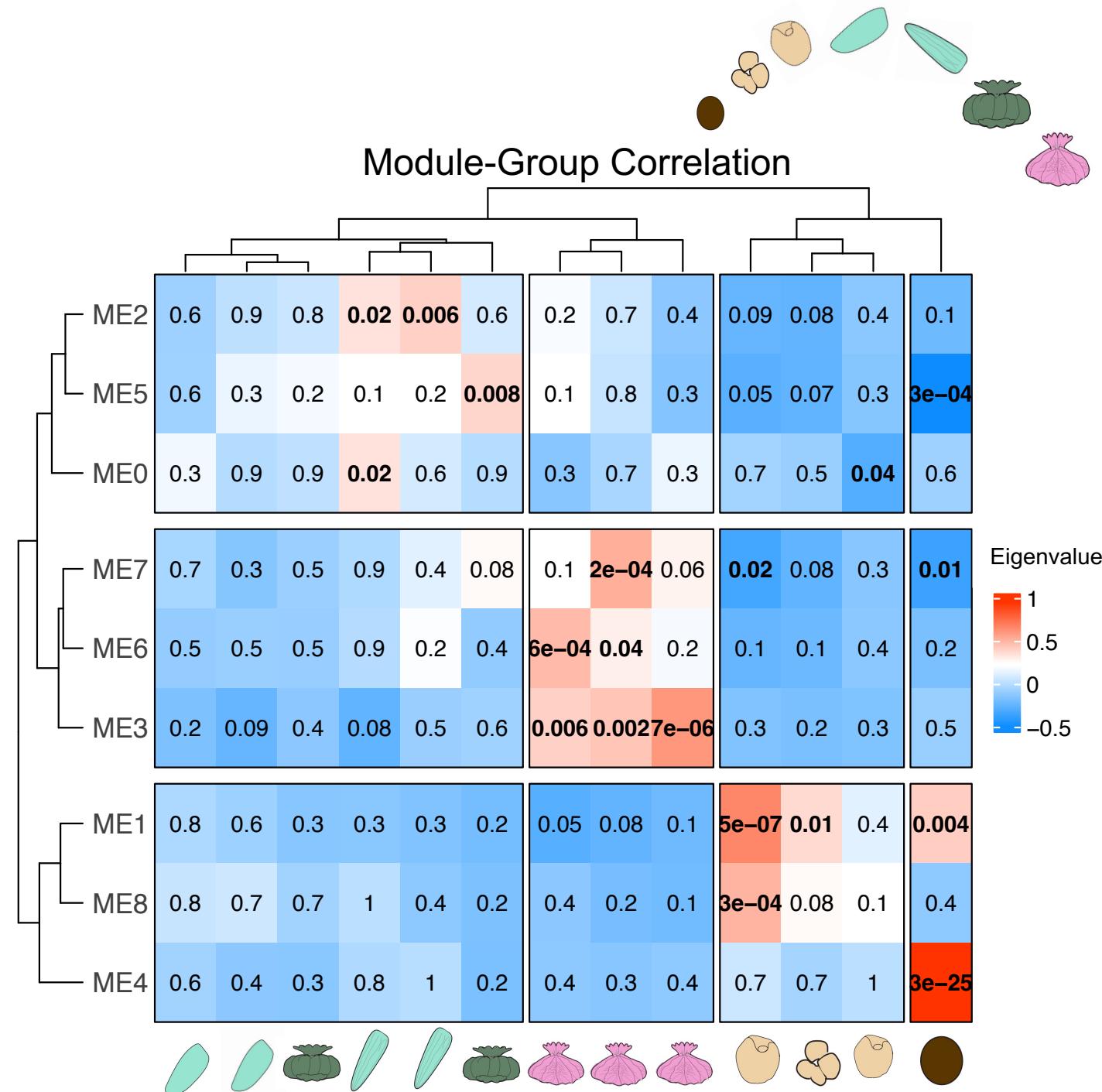
Rutgers Cancer Institute Metabolomics Facility

# Distinct metabolomic profiles across ontogeny



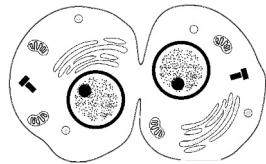
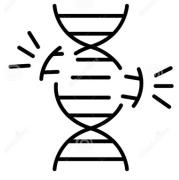
# Distinct metabolomic profiles across ontogeny

*Weighted correlation network analysis*



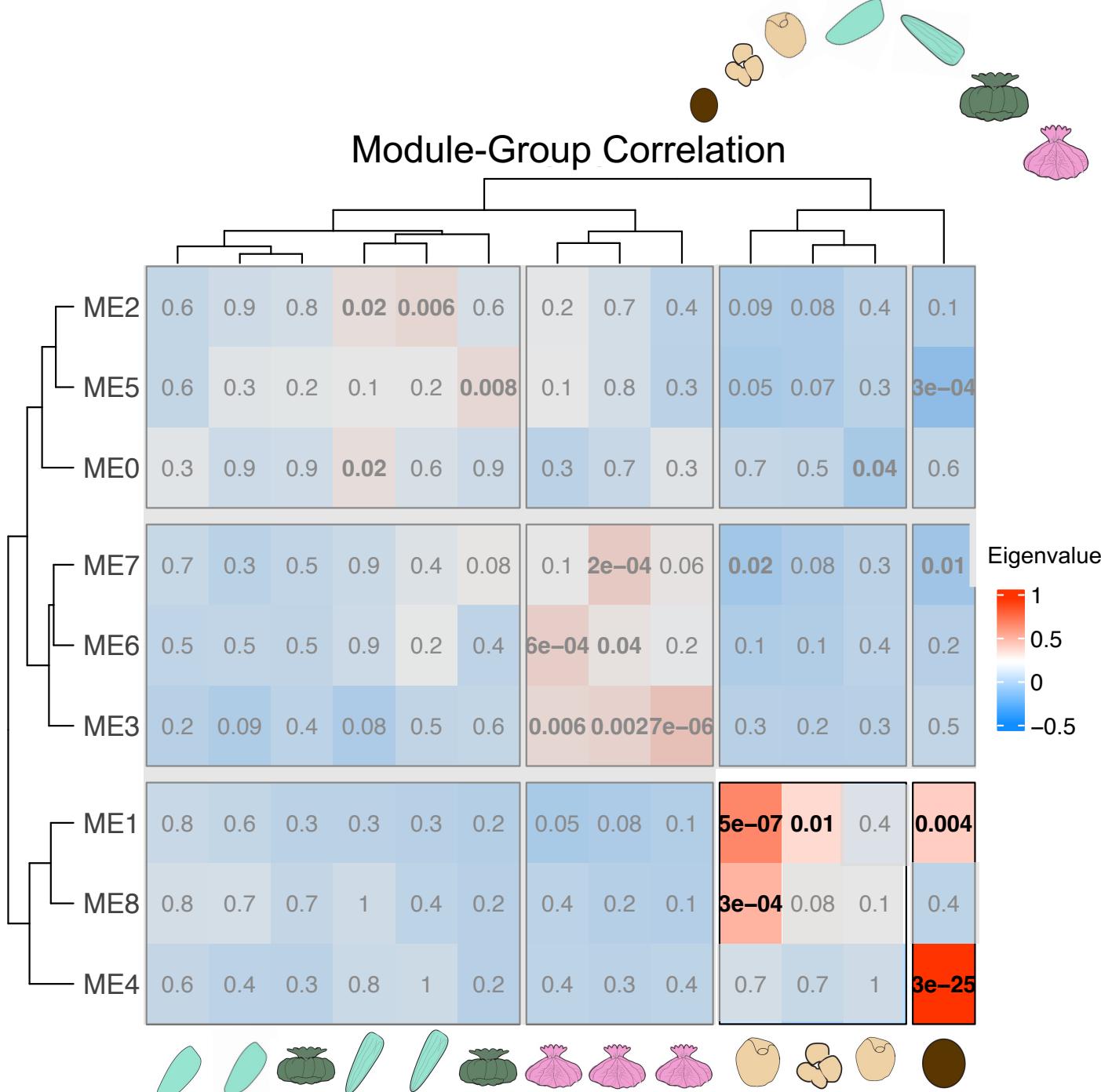
# EGGS & EMBRYOS

1 hpf-65 hpf



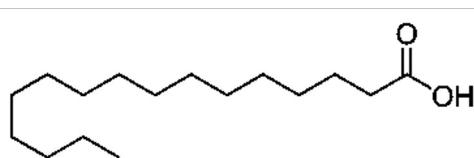
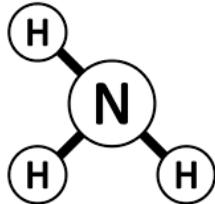
***Embryonic development  
Cell division and differentiation***

Module-Group Correlation



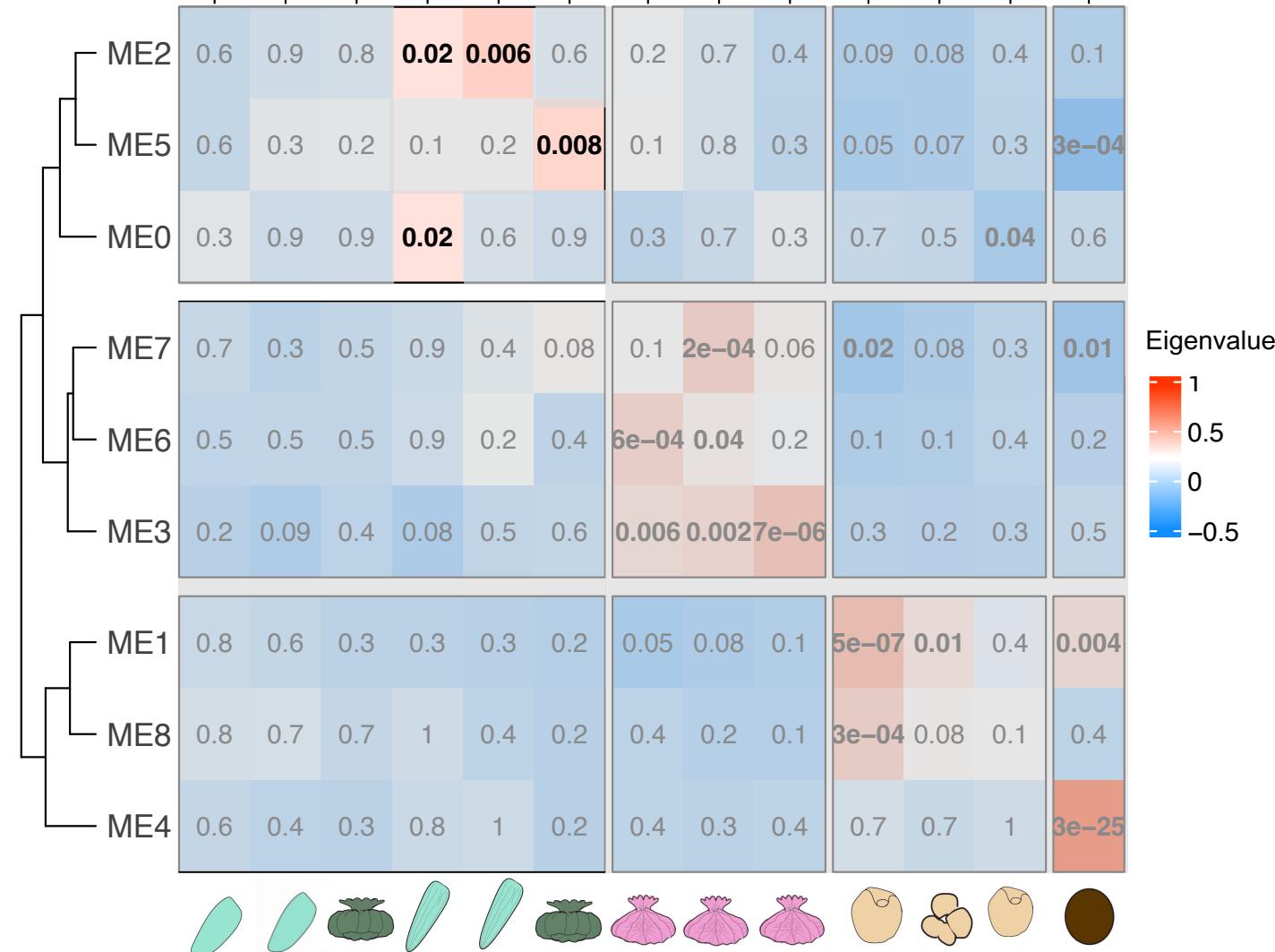
# LARVAE & METAMORPHOSED POLYPS

93 hpf-231 hpf



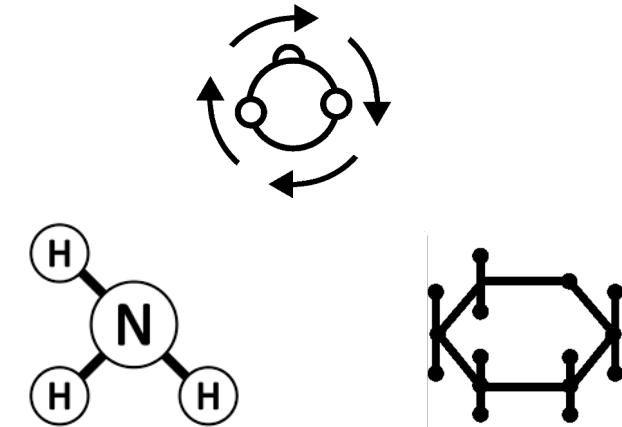
**Nitrogen, protein, fatty acid metabolism**

Module-Group Correlation

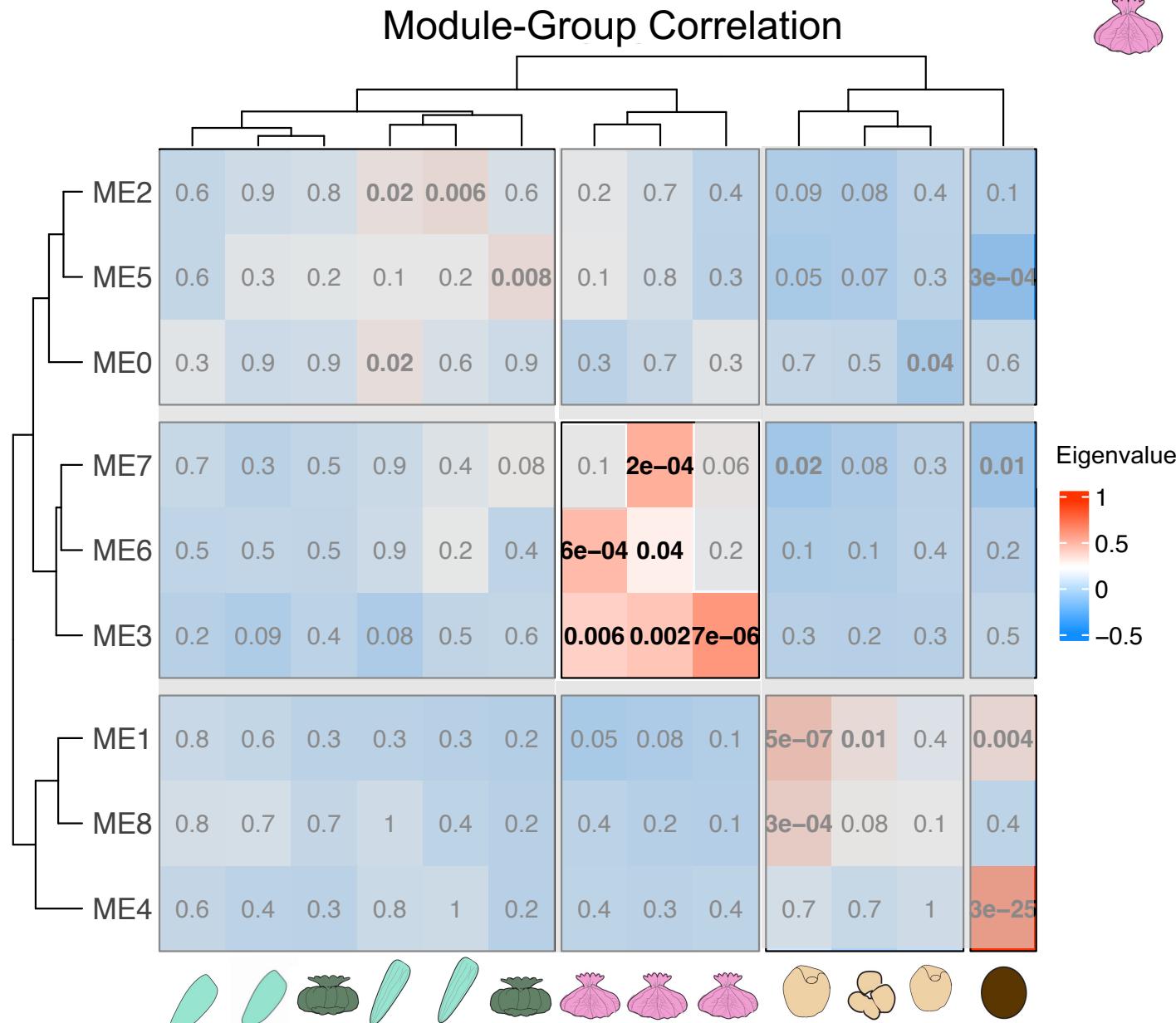


# ATTACHED RECRUITS

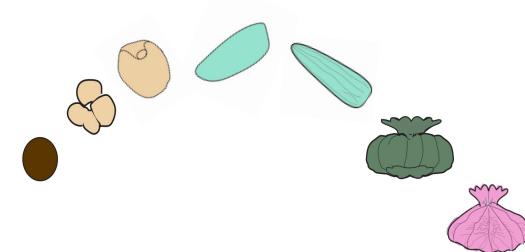
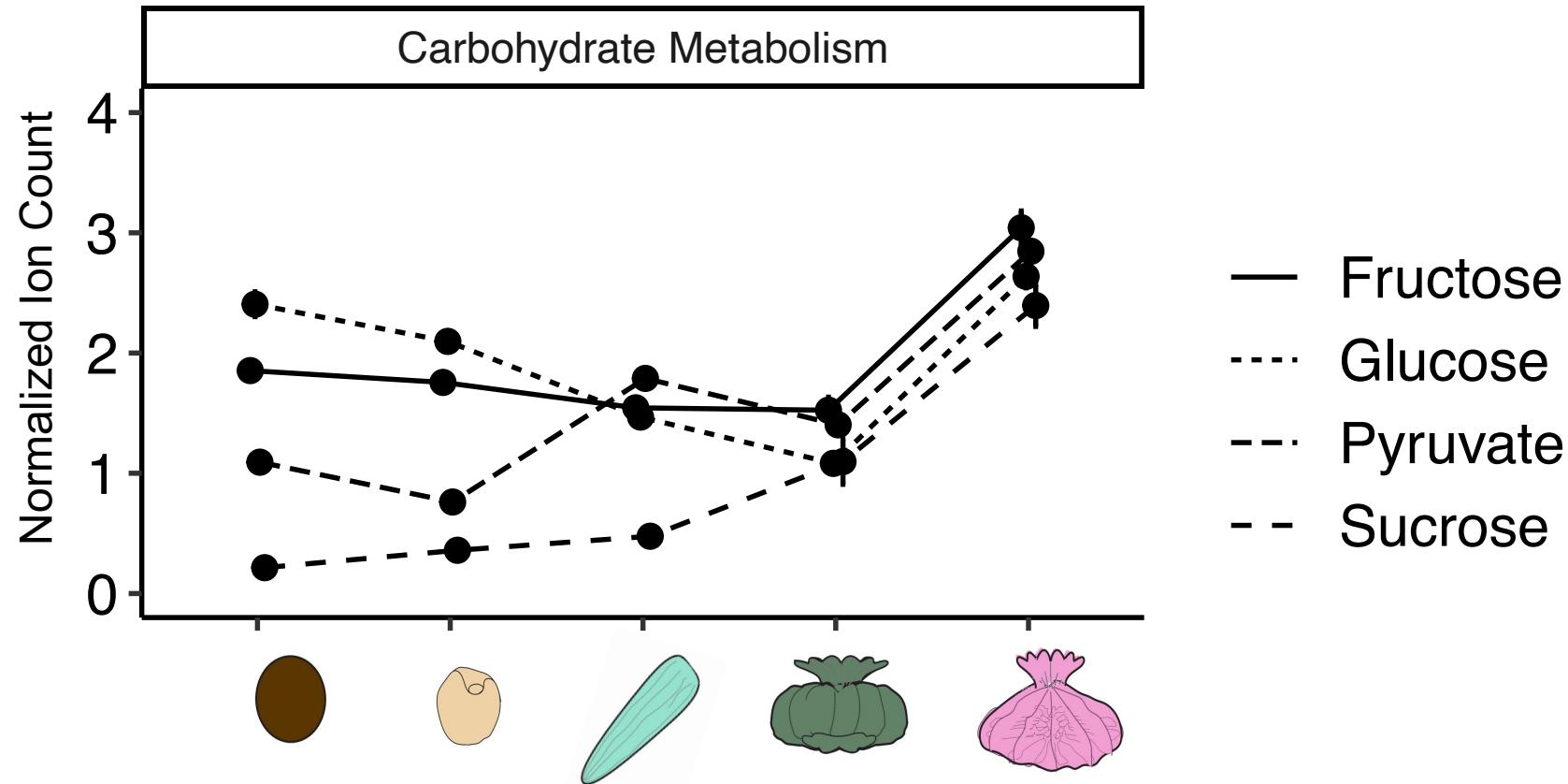
## 183 hpf-255 hpf



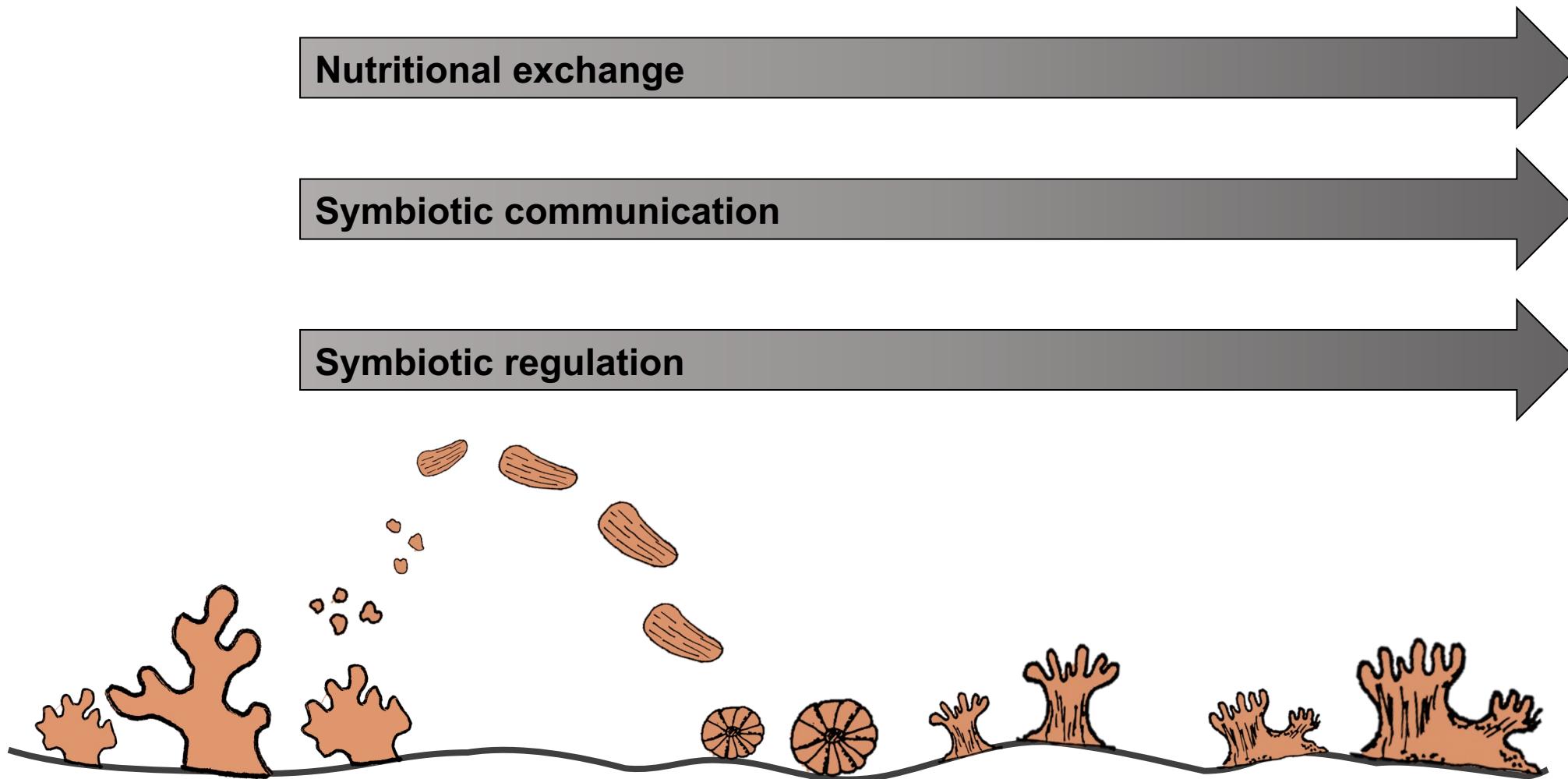
**Nitrogen, carbohydrate metabolism**



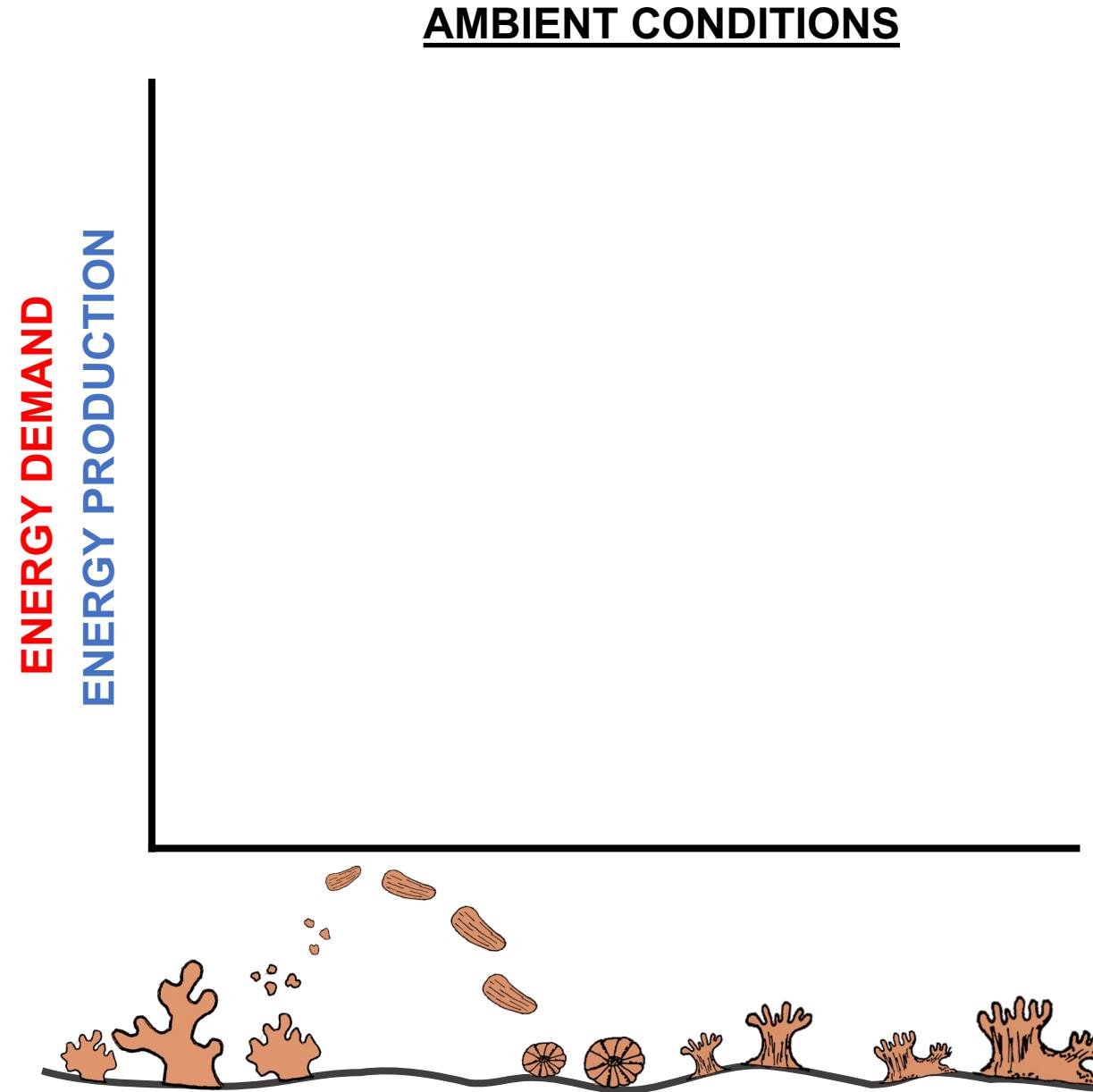
# CARBON METABOLISM



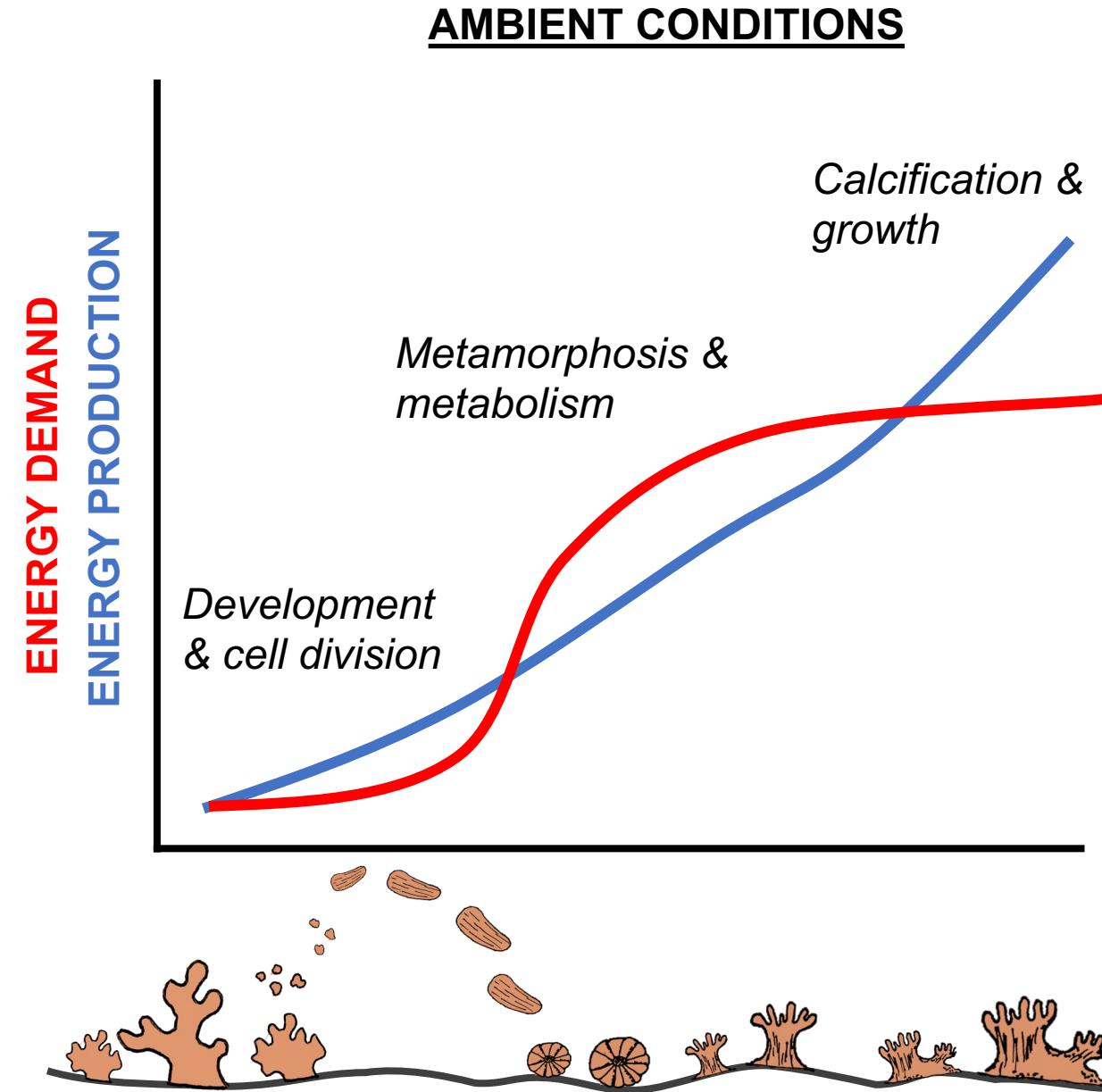
# *Transitions towards nutritional exchange with development*



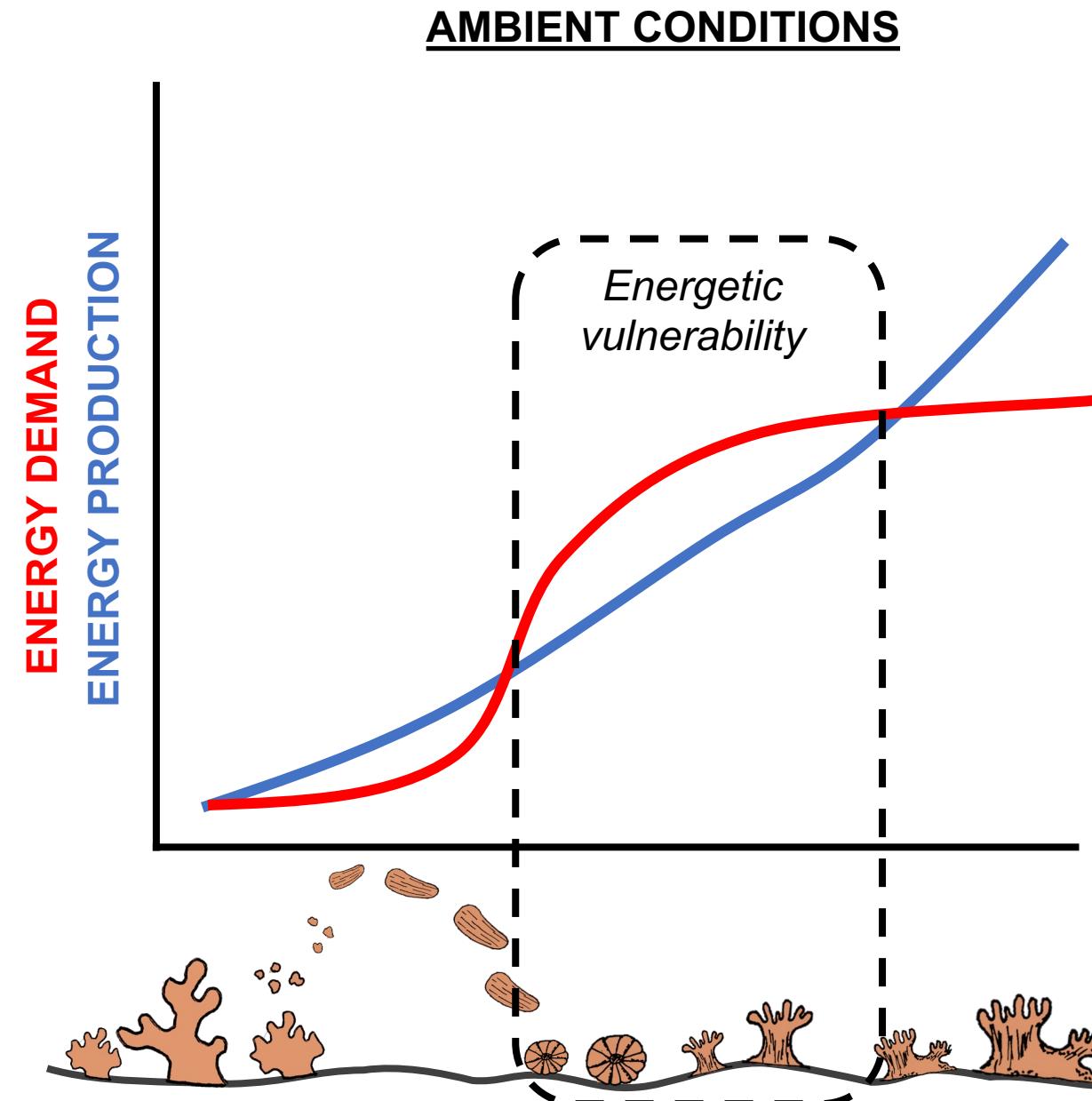
# *How does nutritional exchange impact energetic capacity during recruitment?*



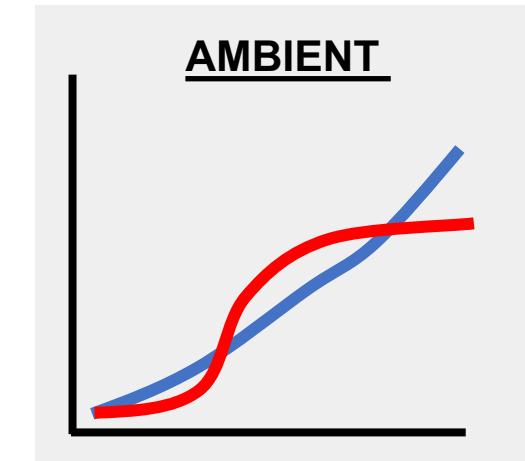
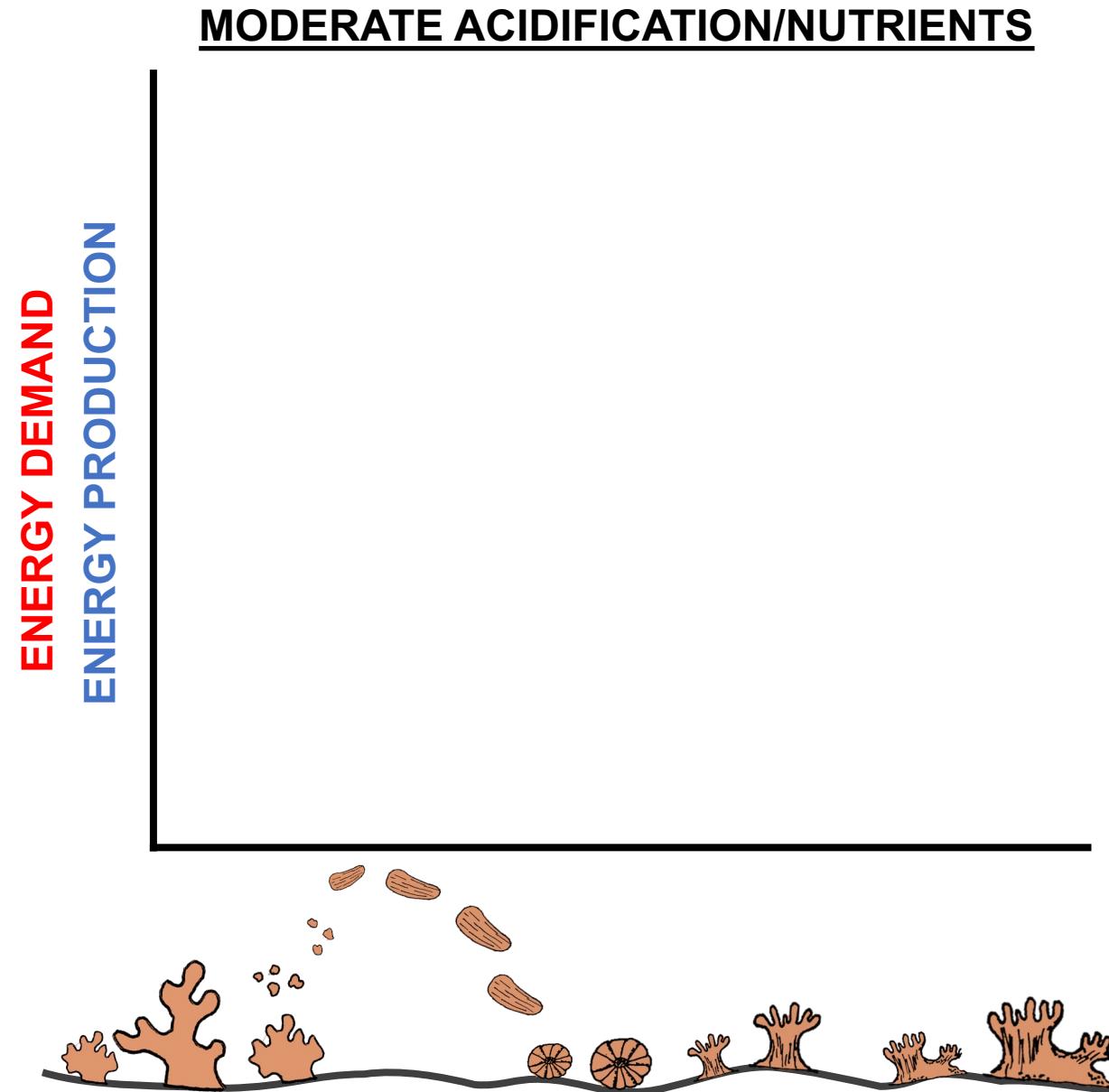
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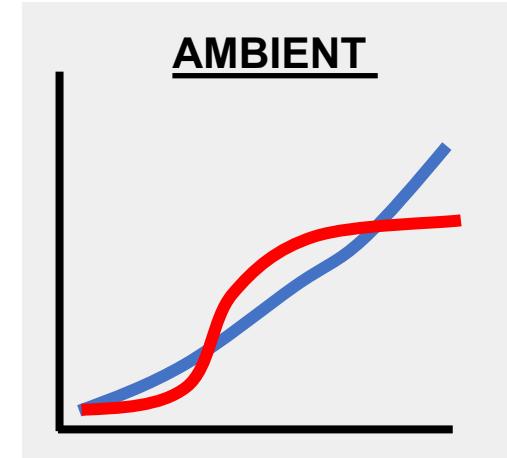
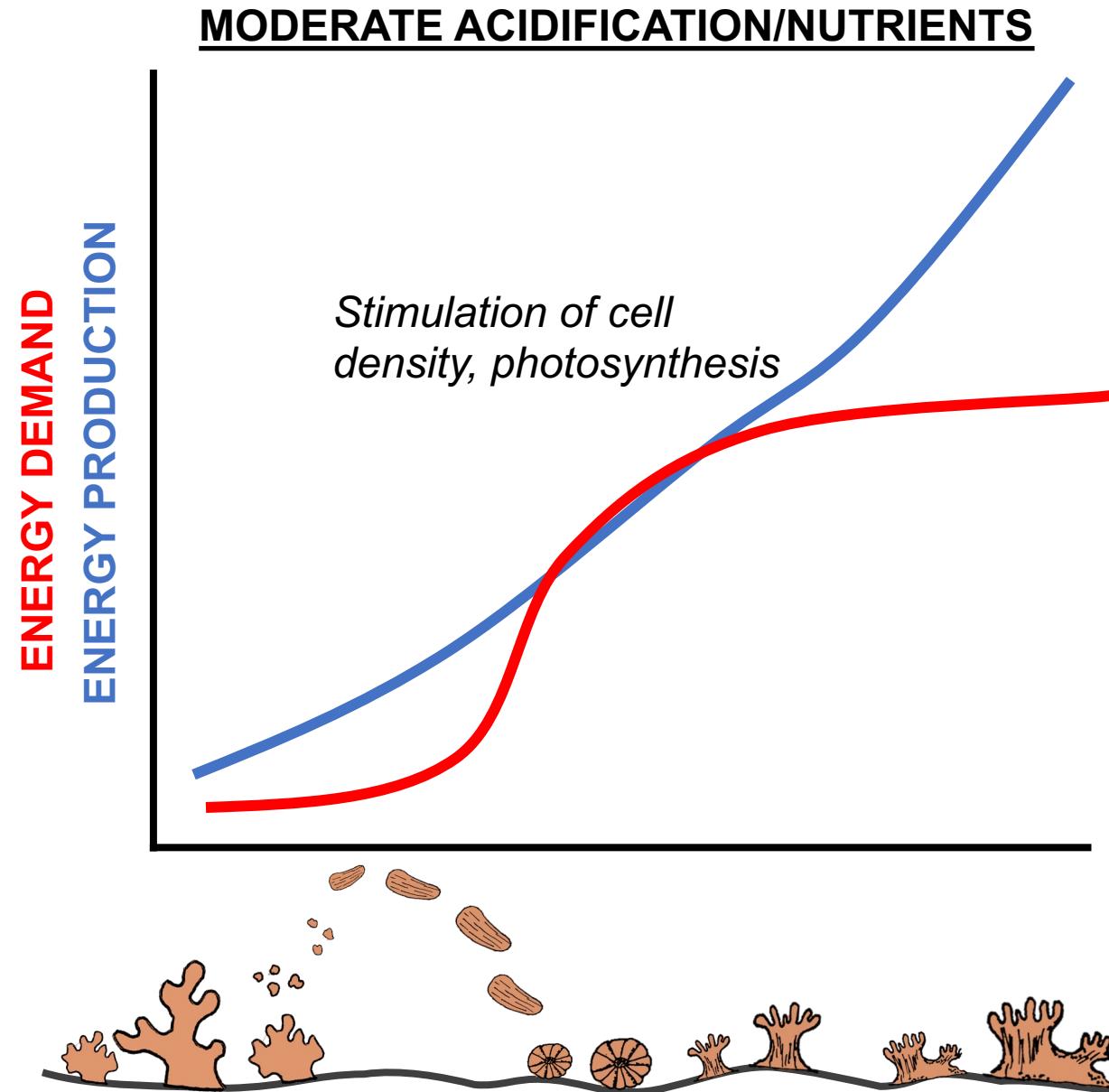
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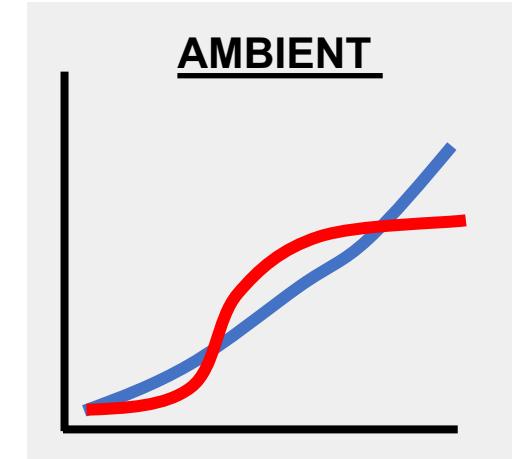
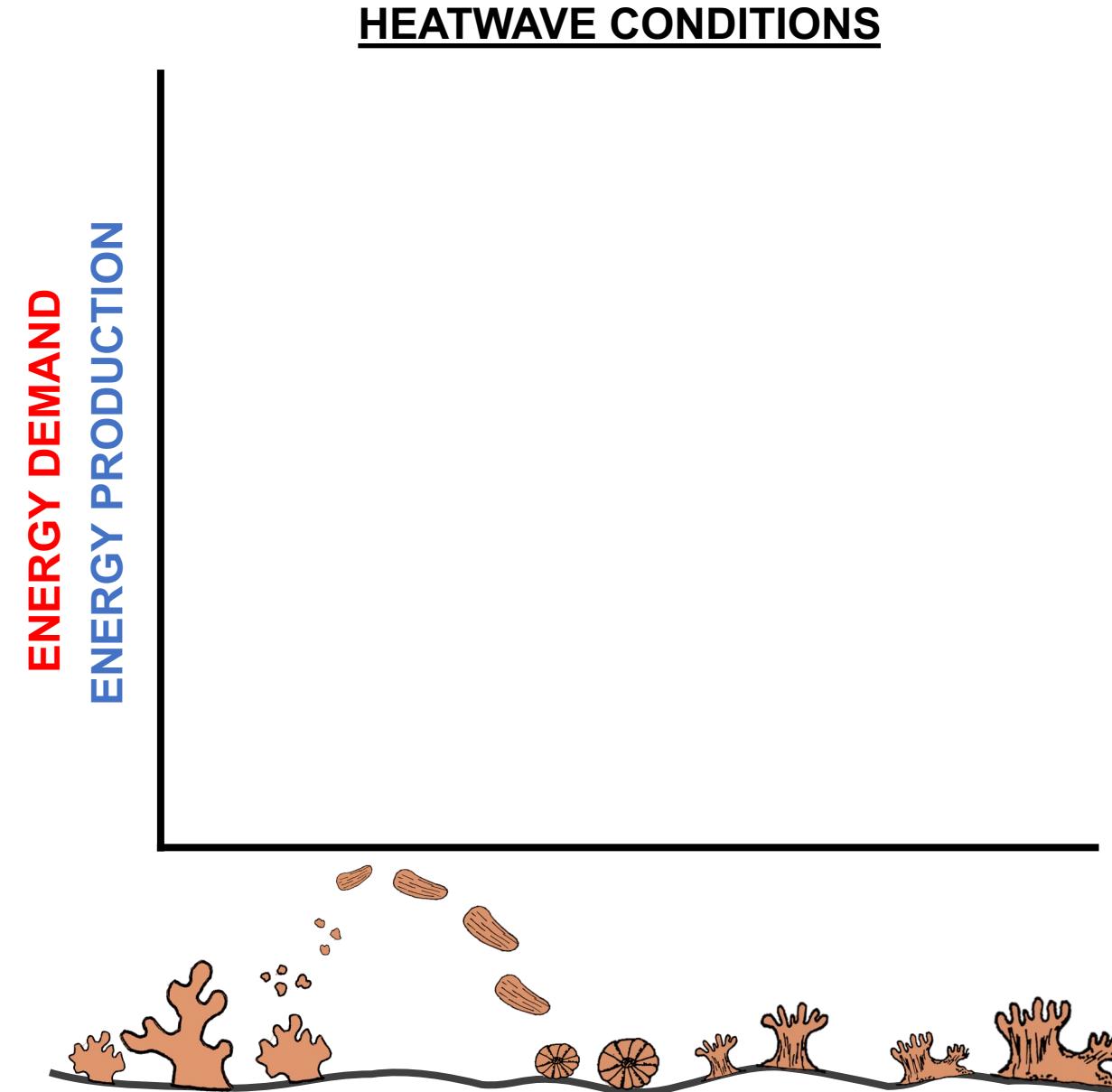
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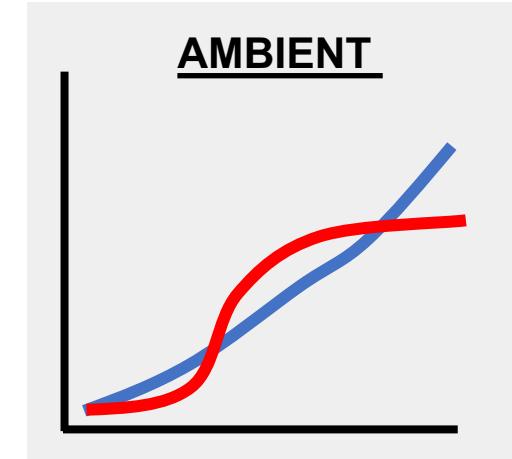
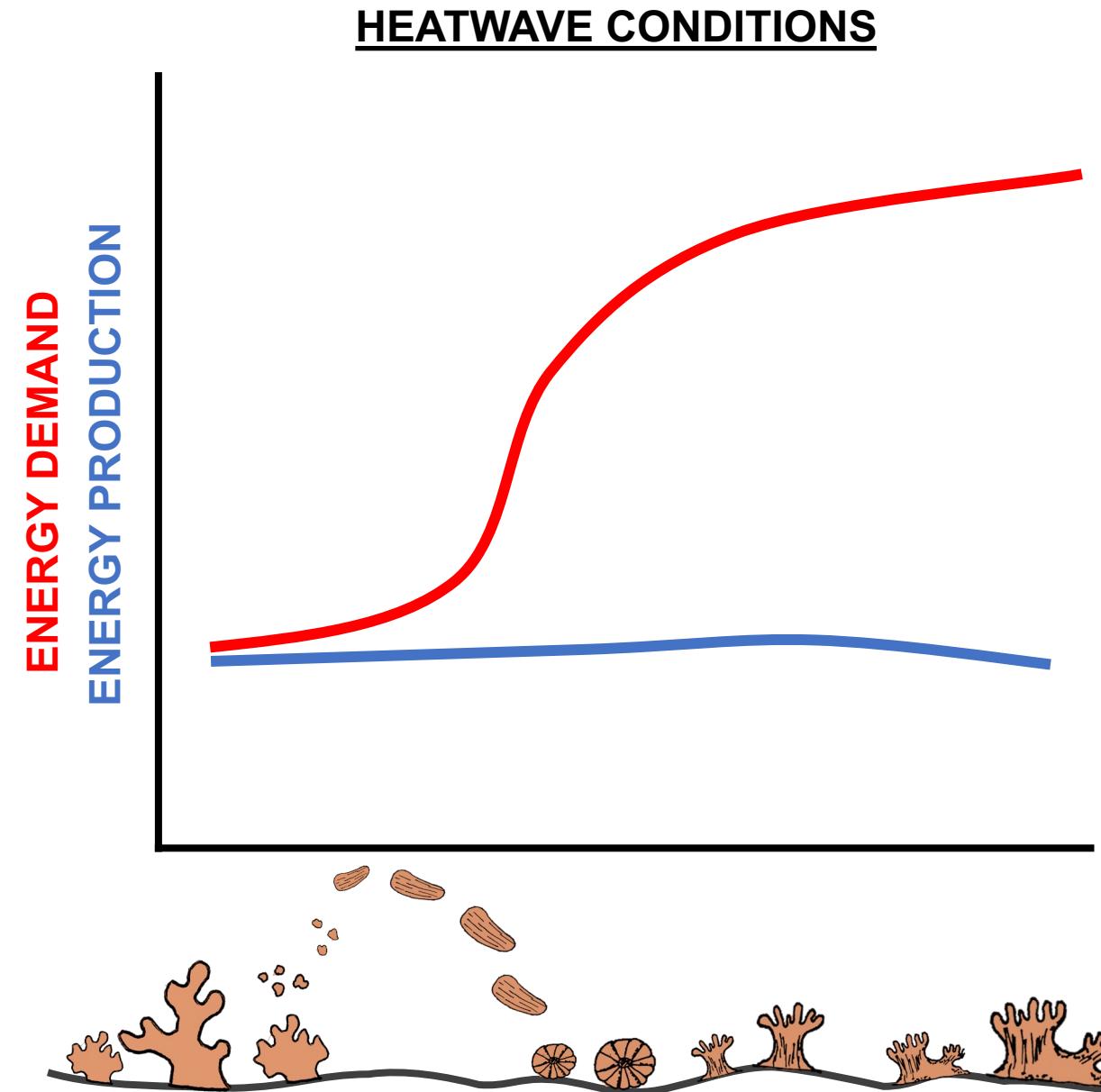
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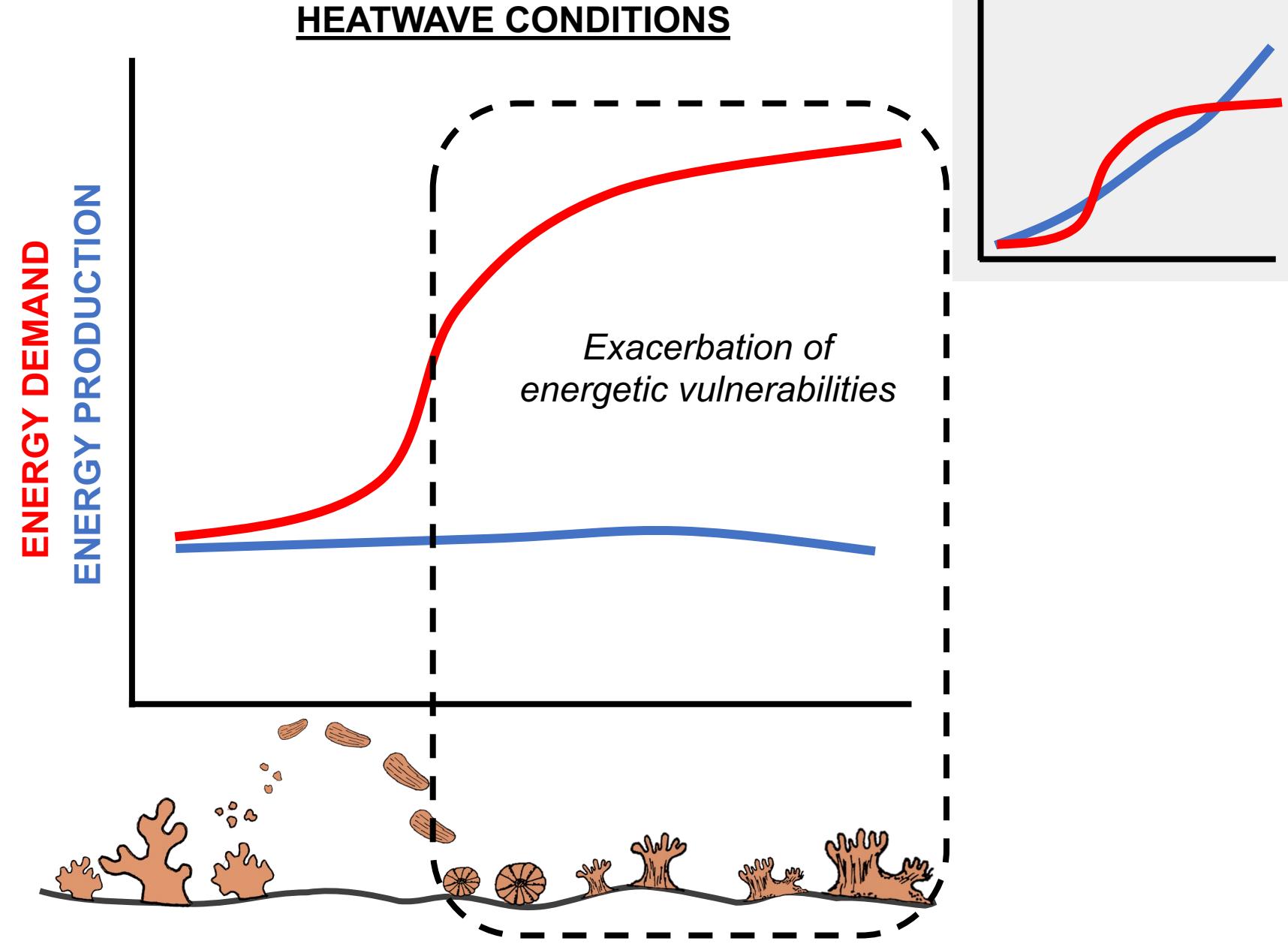
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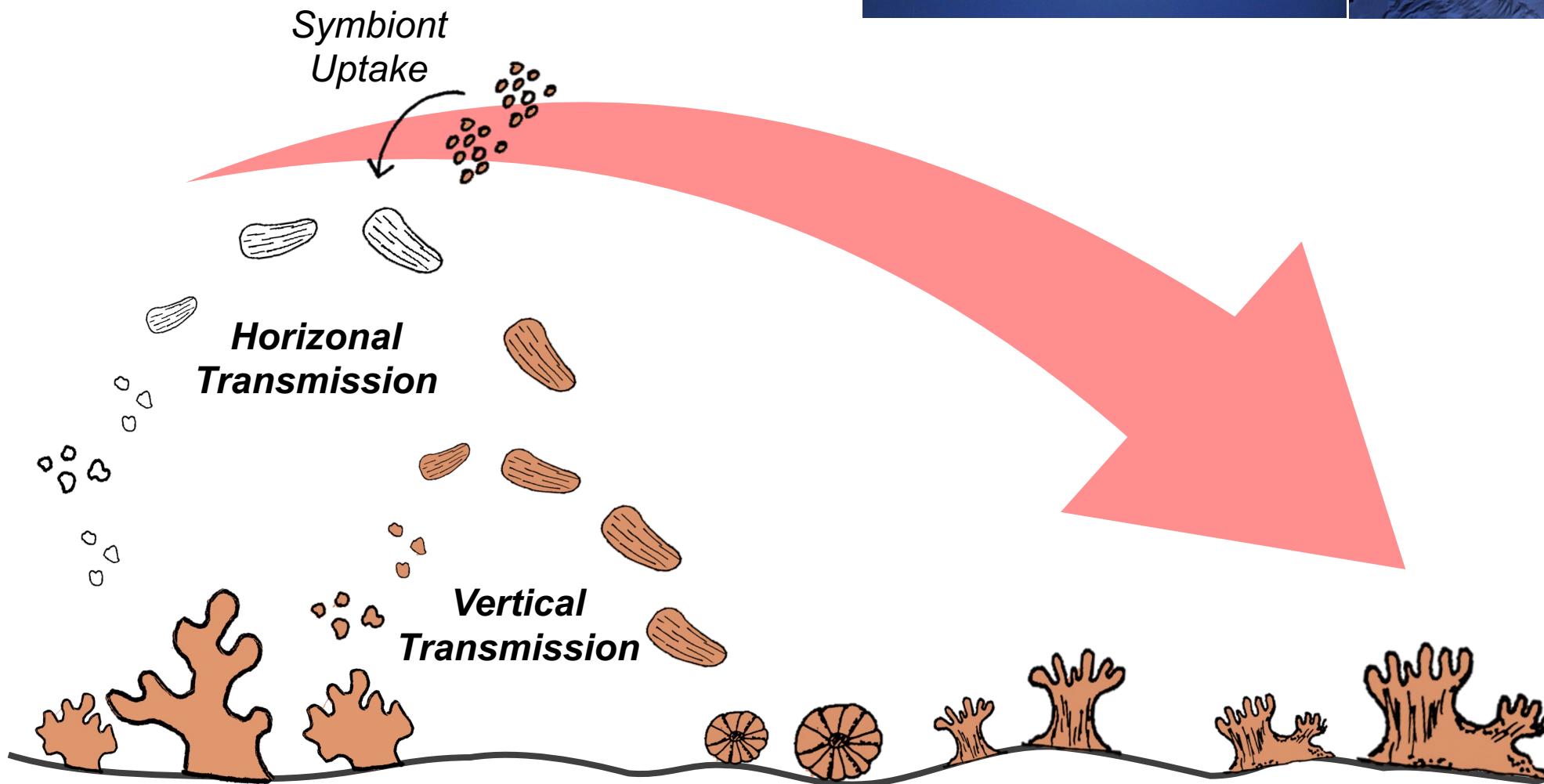
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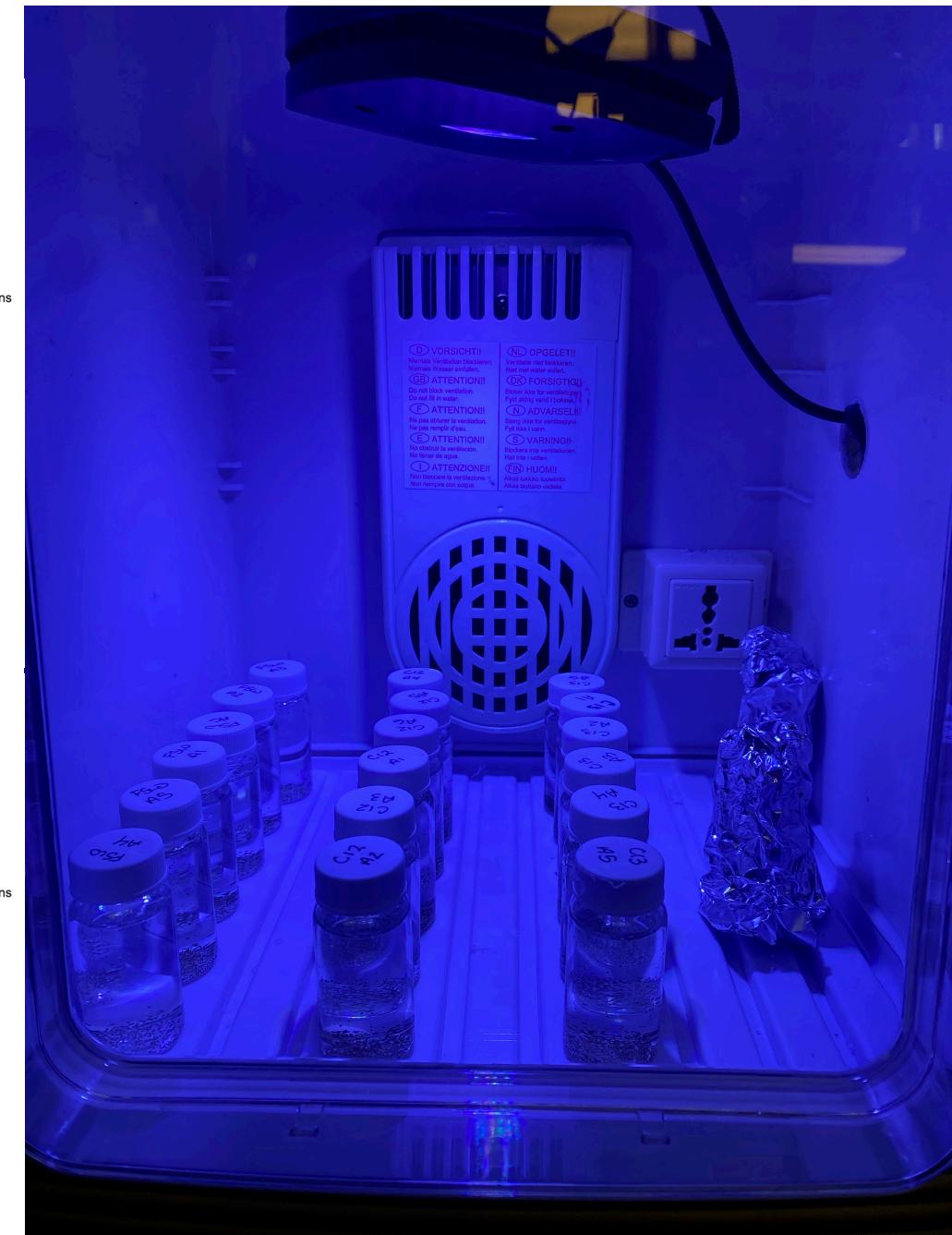
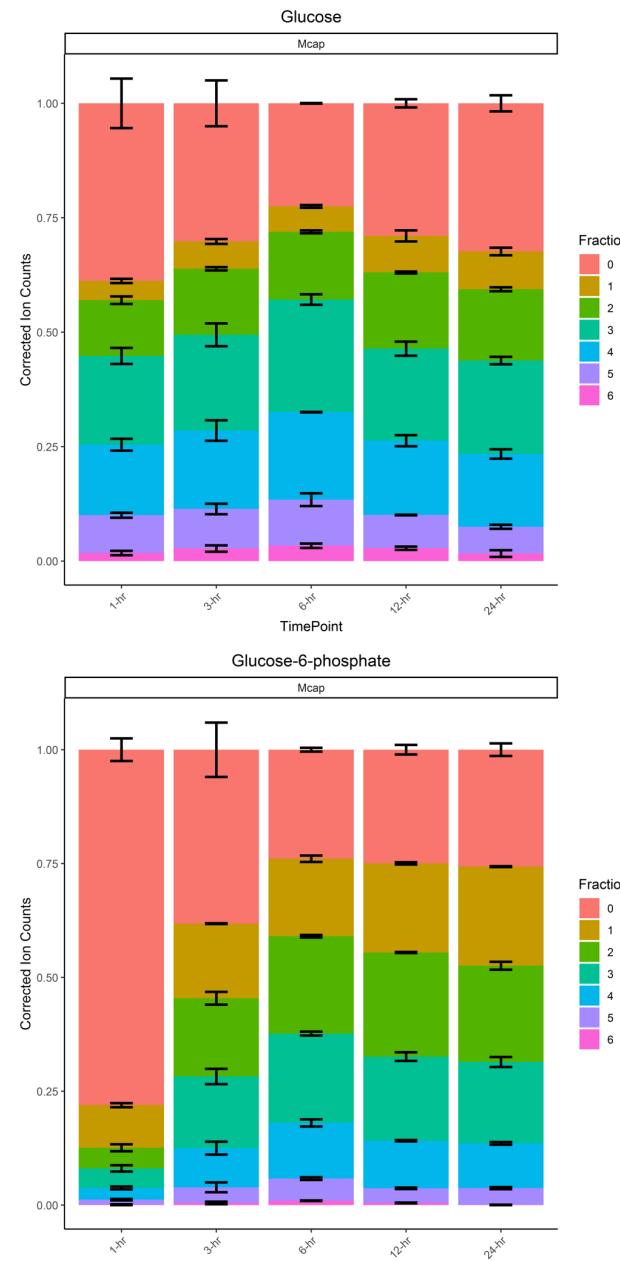


# **Current work: How does thermal stress impact nutritional exchange?**



# Stable isotope metabolomics

*What is the identity and pool size of metabolites translocation from symbiont to host?*

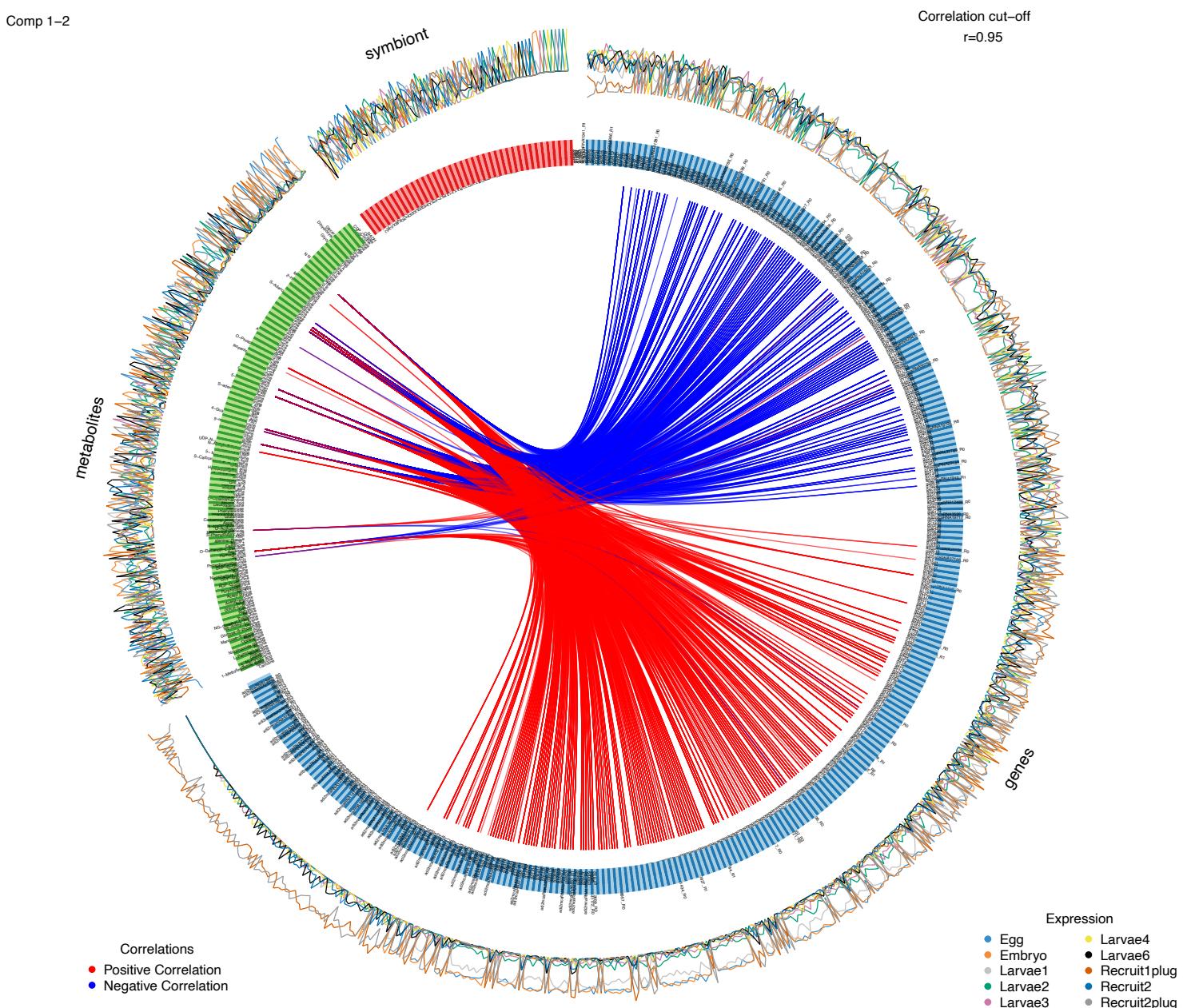


# Multi-omic integration

1. Identify holobiont signatures of nutritional transitions

*Integration of bacterial, symbiont, metabolomic, and gene expression data across developmental time series*

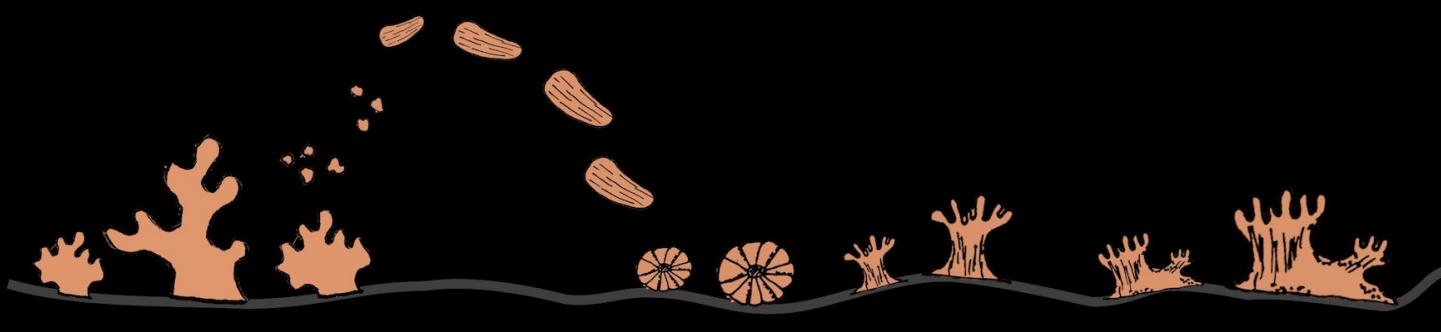
2. Predict nutritional phenotypes under stressful conditions



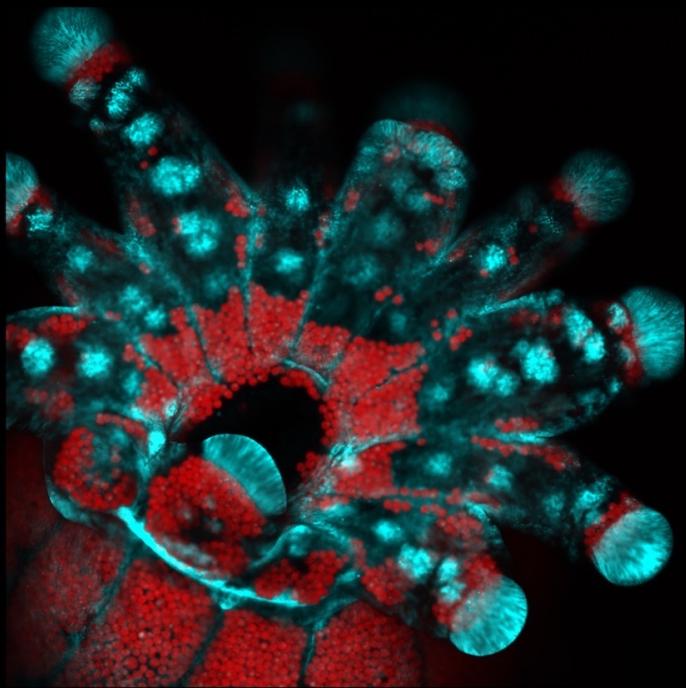


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*Early life history coral reef ecophysiology and symbiosis*



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AHuffmyer

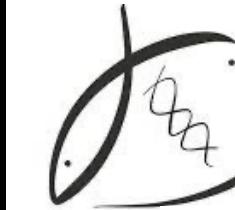
THE  
UNIVERSITY  
OF RHODE ISLAND



**PUTNAM LAB**



**E5  
Coral**



**Roberts Lab**

School of Aquatic and Fishery Sciences  
University of Washington



UNIVERSITY of WASHINGTON  
eScience Institute

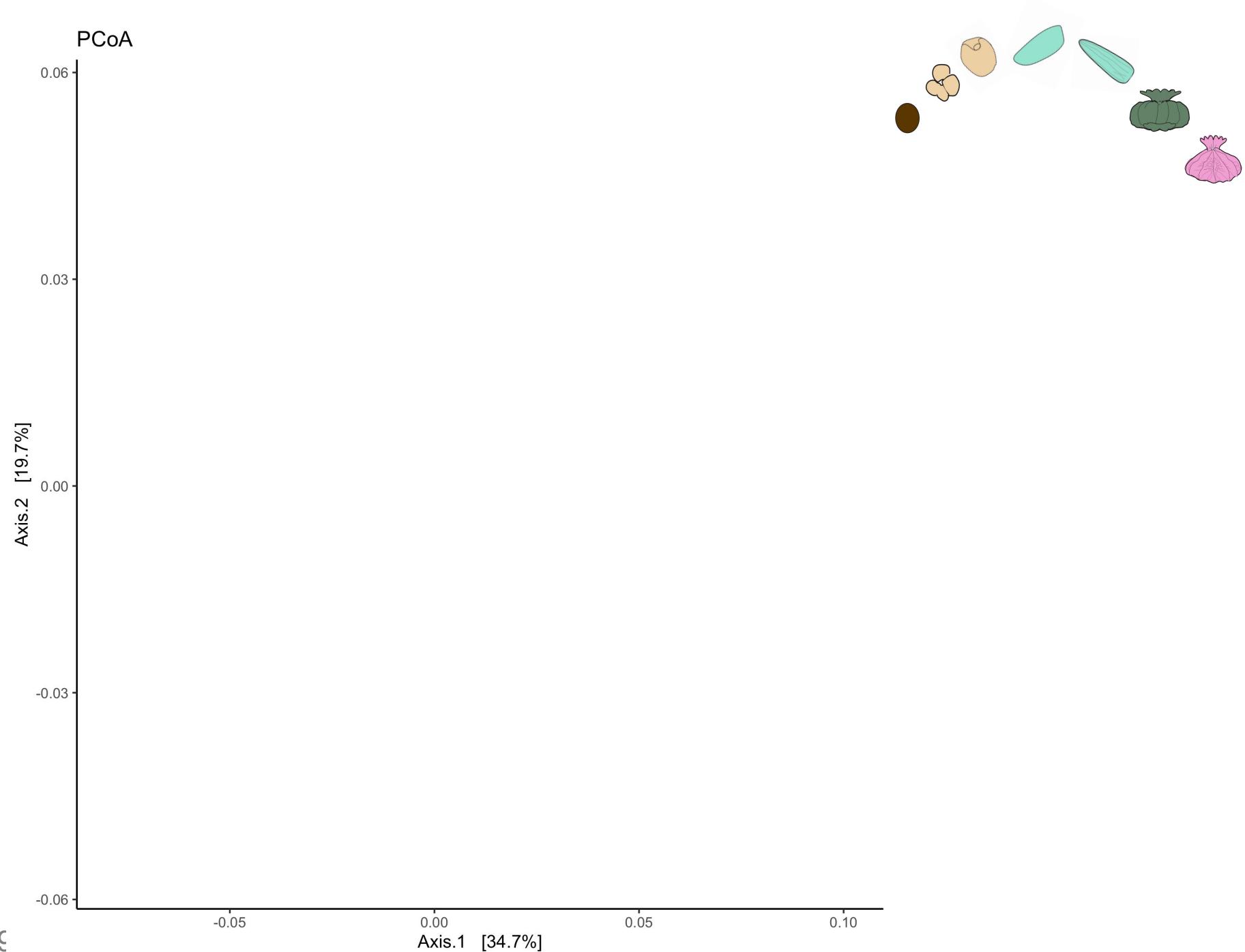


**RUTGERS**  
THE STATE UNIVERSITY  
OF NEW JERSEY



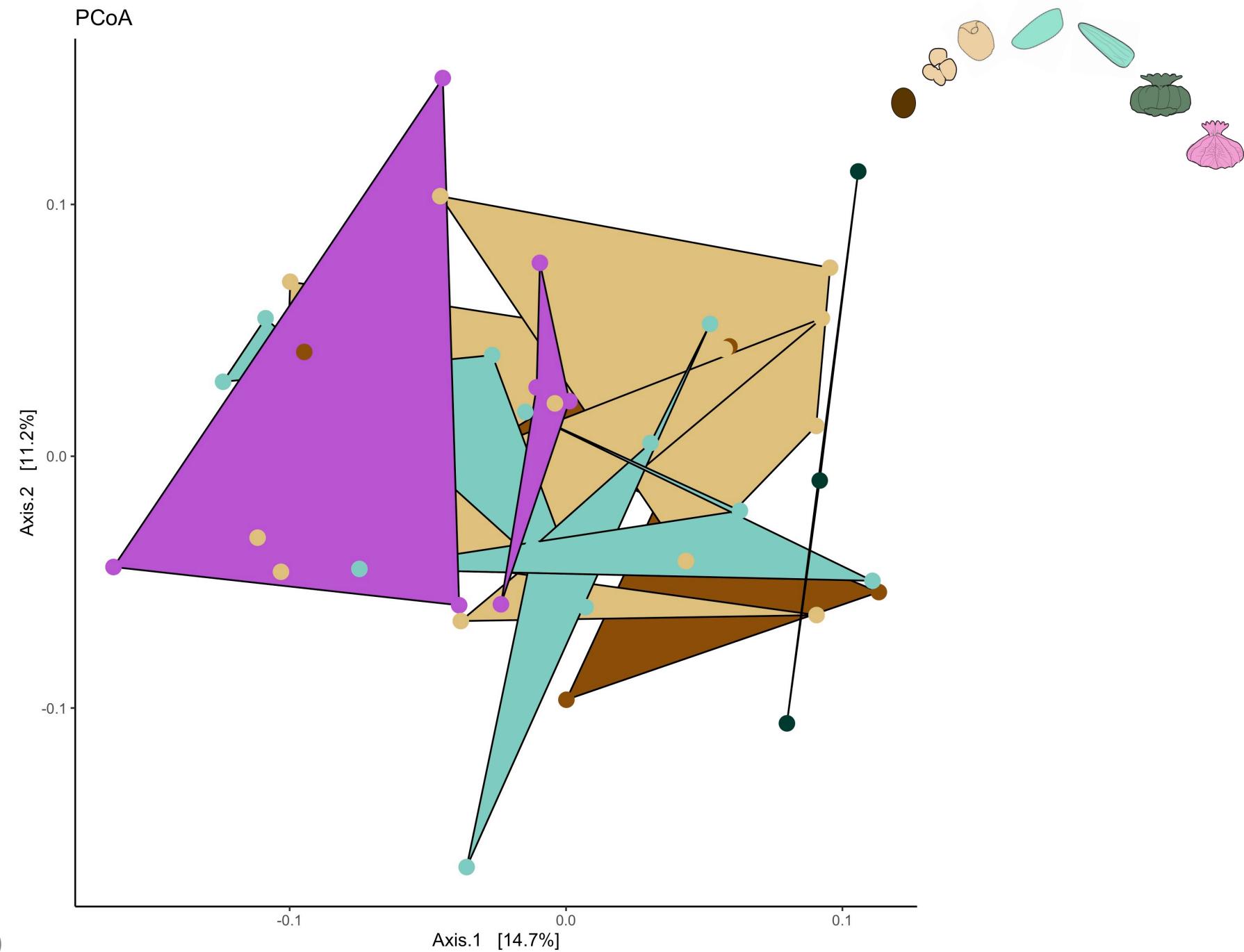
# Stable symbiotic community across ontogeny

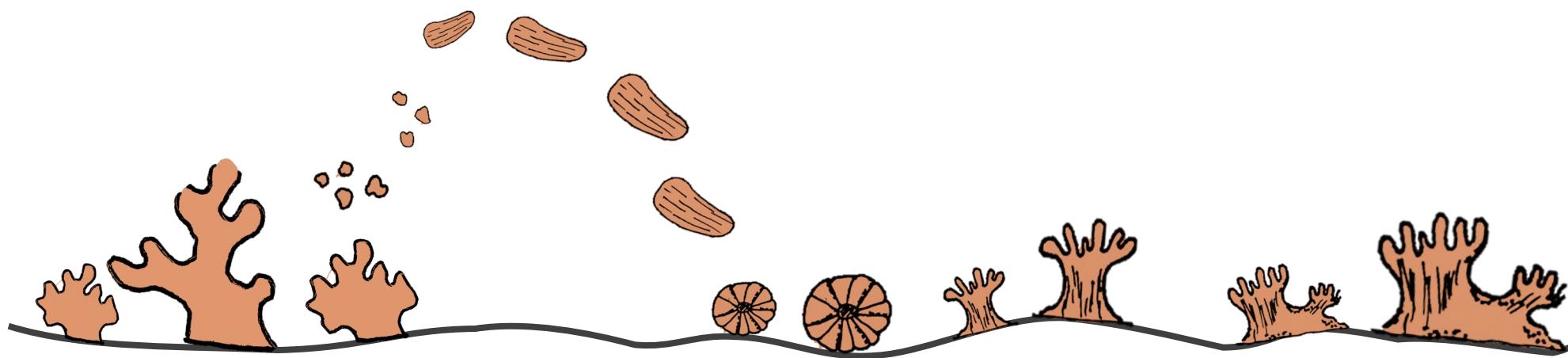
ITS2 Amplicon Sequencing  
SymPortal profiling (Hume et al. 2019)

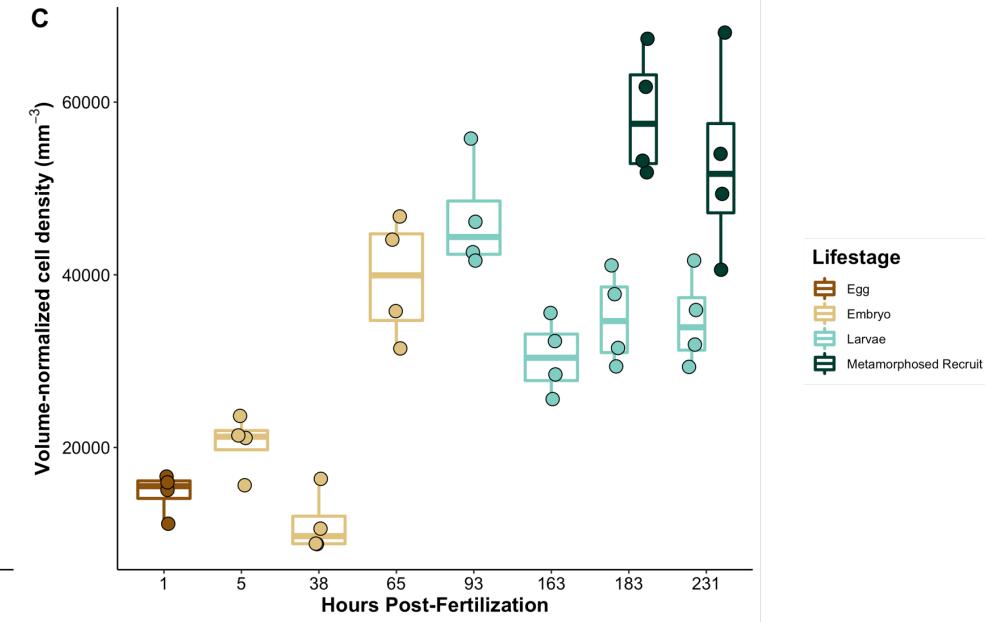
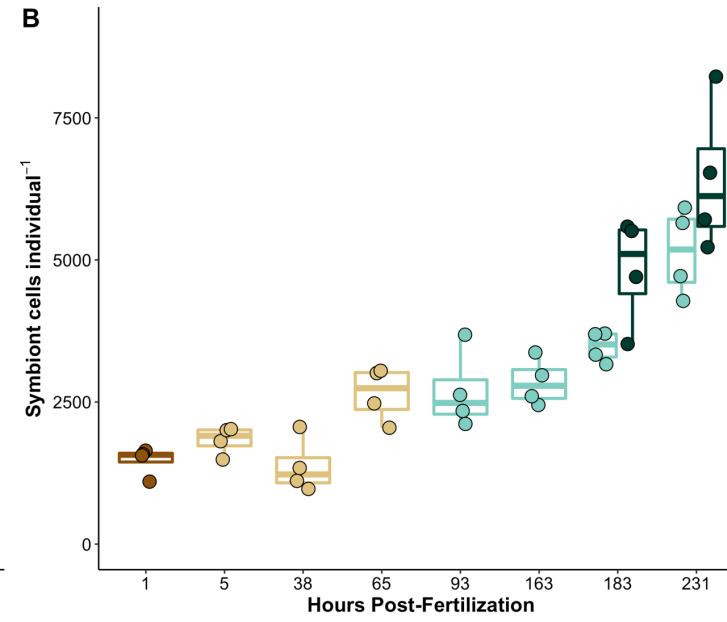
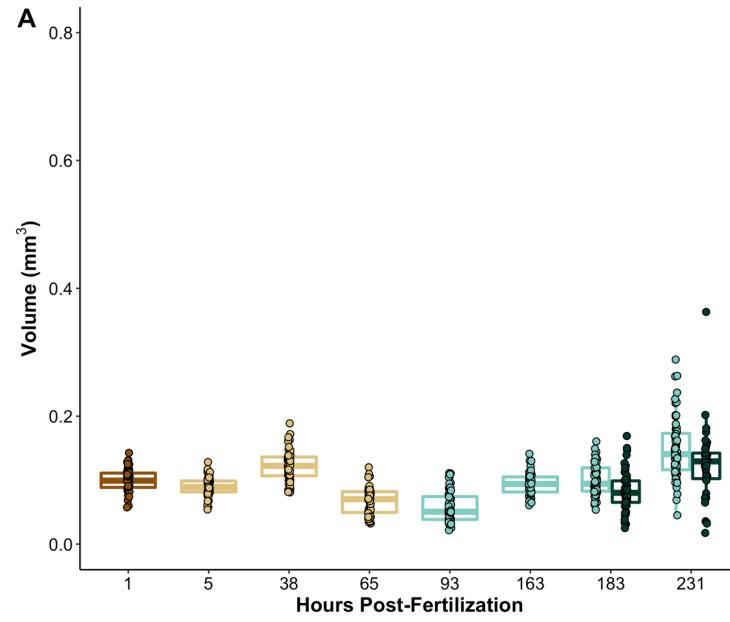


# Stable symbiotic community across ontogeny

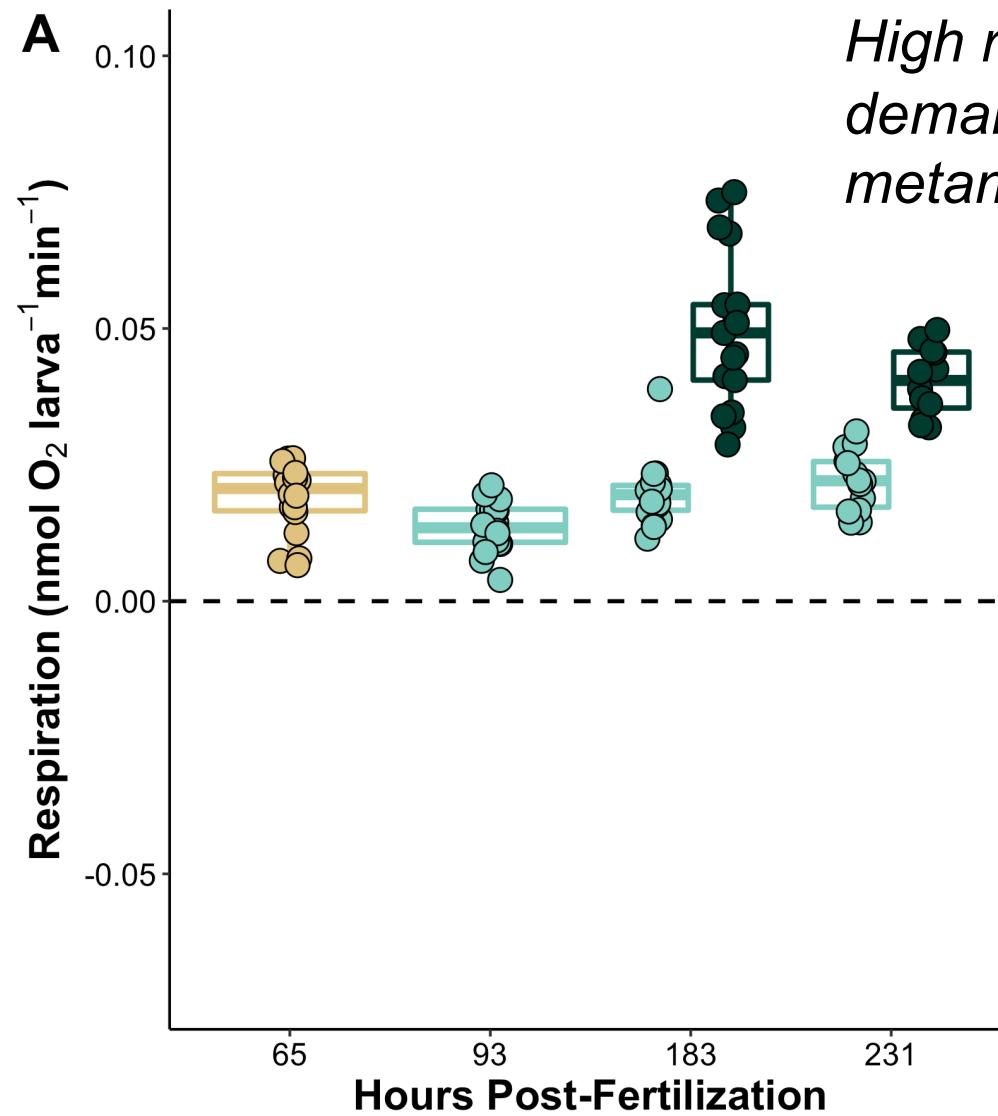
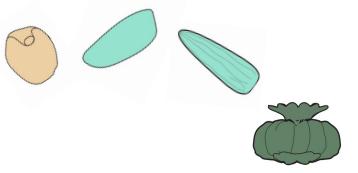
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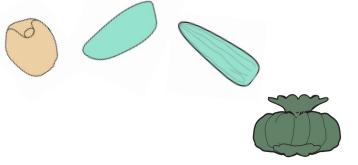
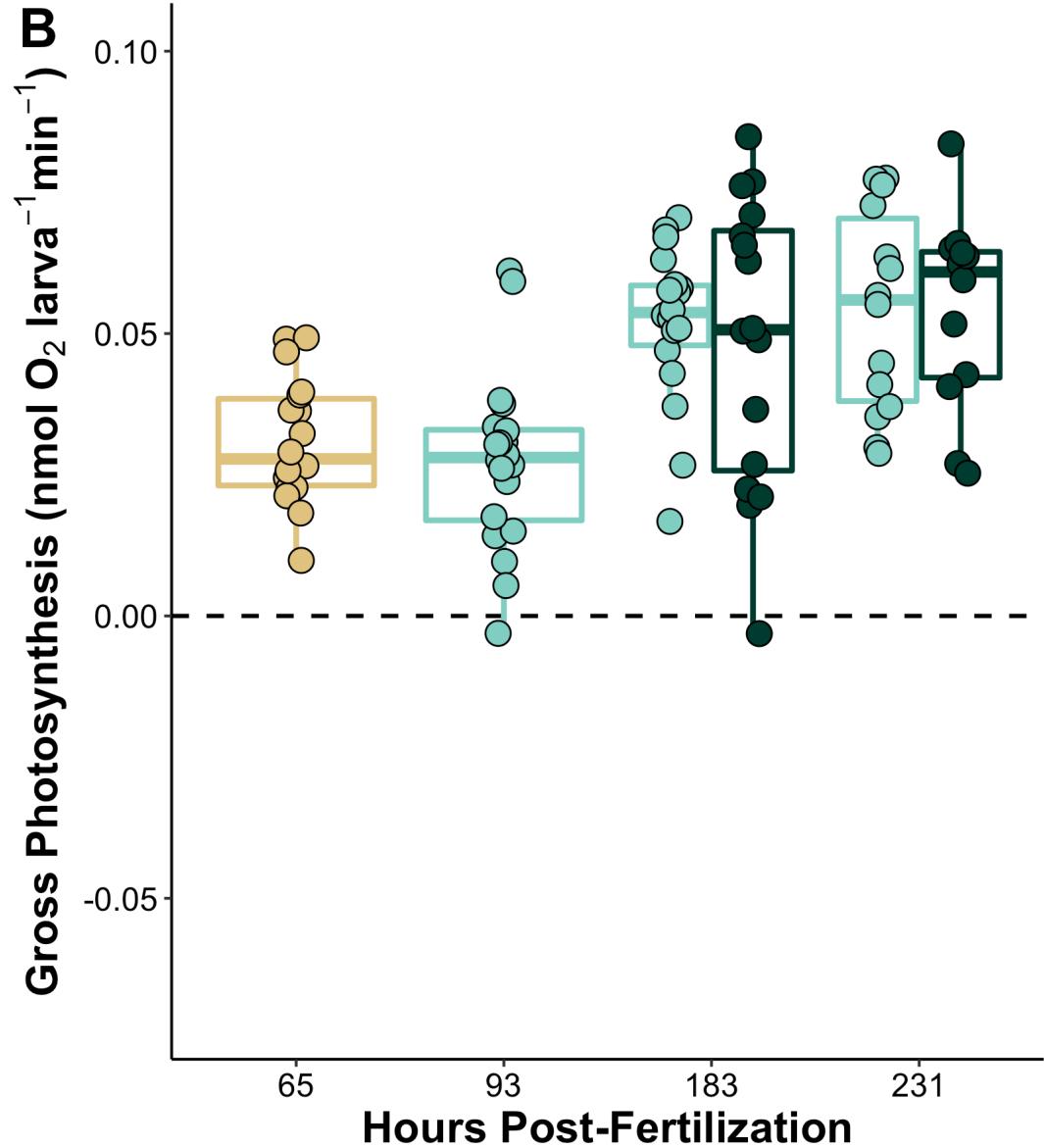


# Energetic vulnerability during metamorphosis



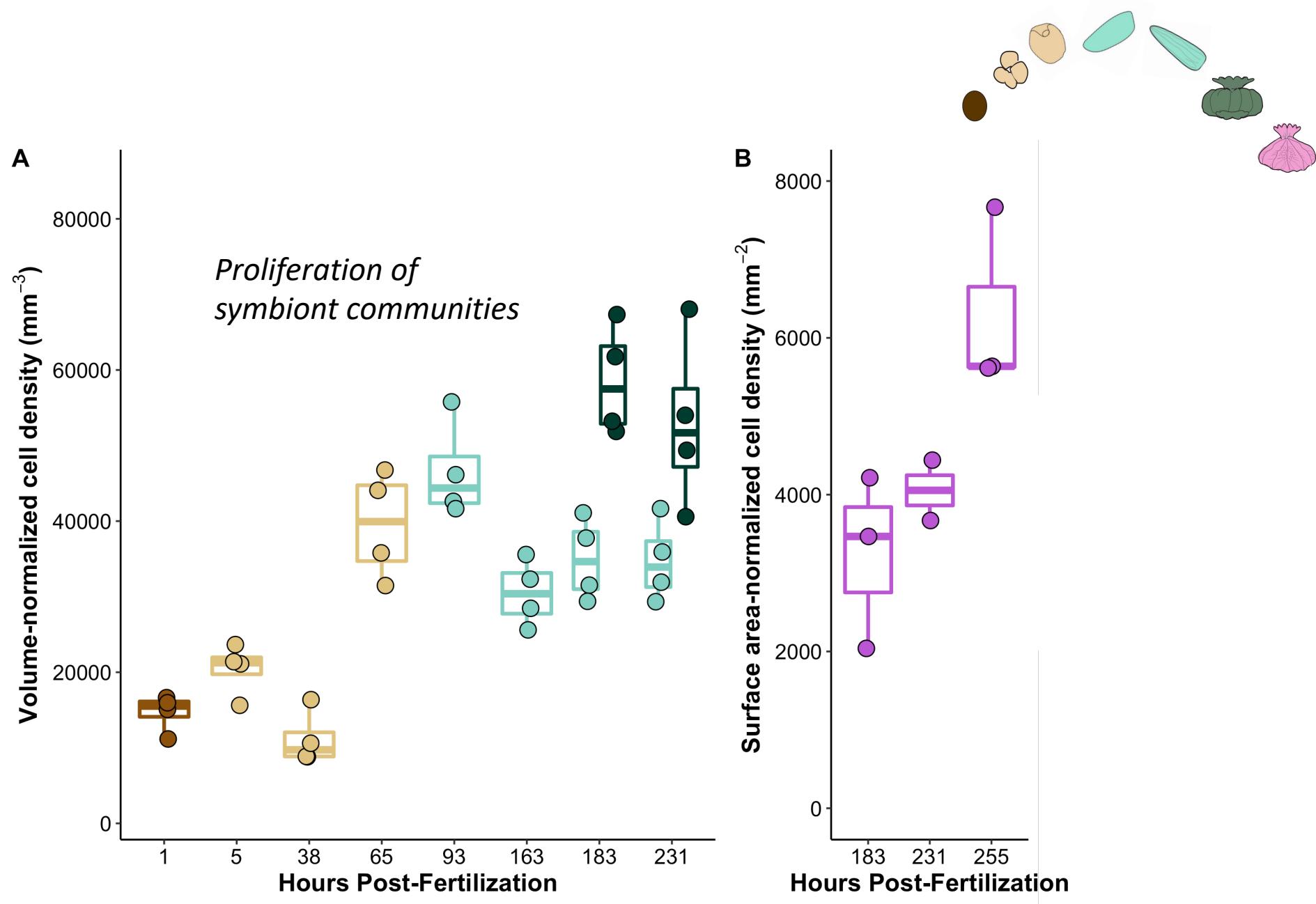
*High respiratory demand during metamorphosis*

# Energetic vulnerability during metamorphosis



*Photosynthetic output increases across ontogeny*

# Symbiont cell densities increase across ontogeny



# Energetic vulnerability during metamorphosis

