



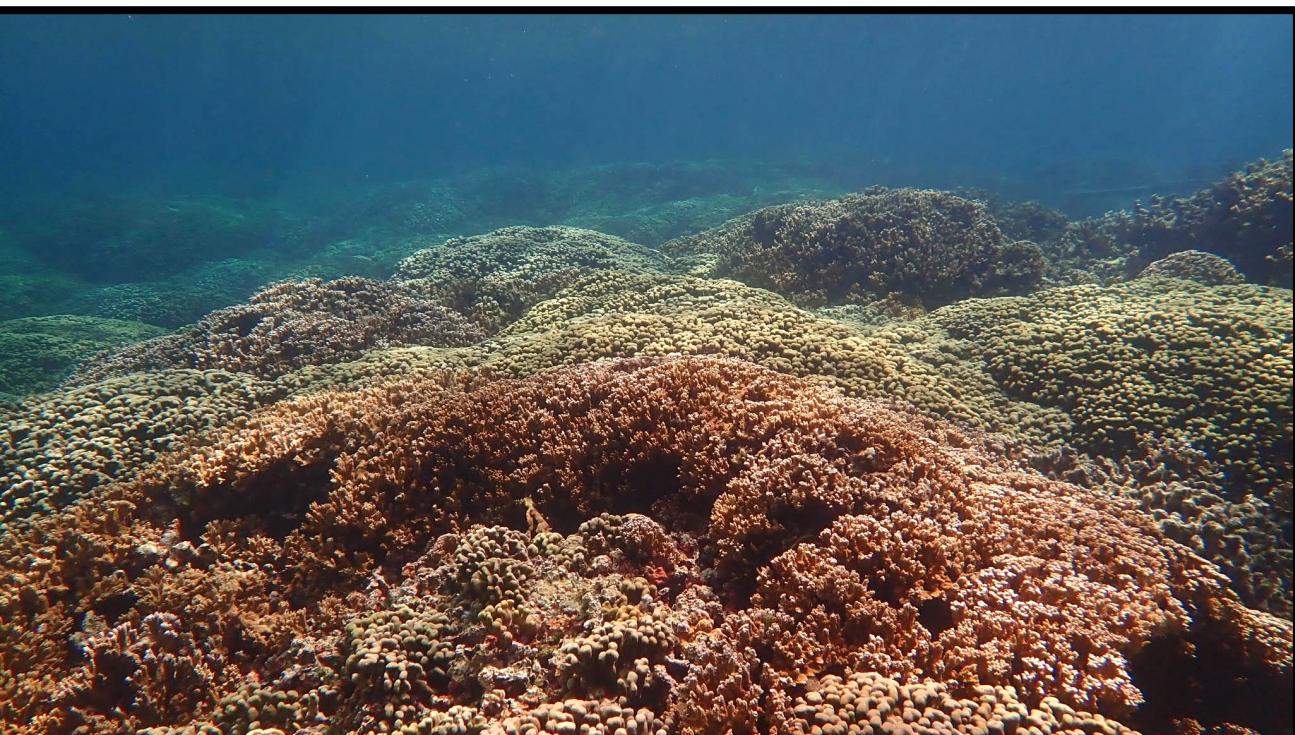
Physiological and multi-omic signatures of shifts in symbiotic nutritional exchange in reef-building coral early life history

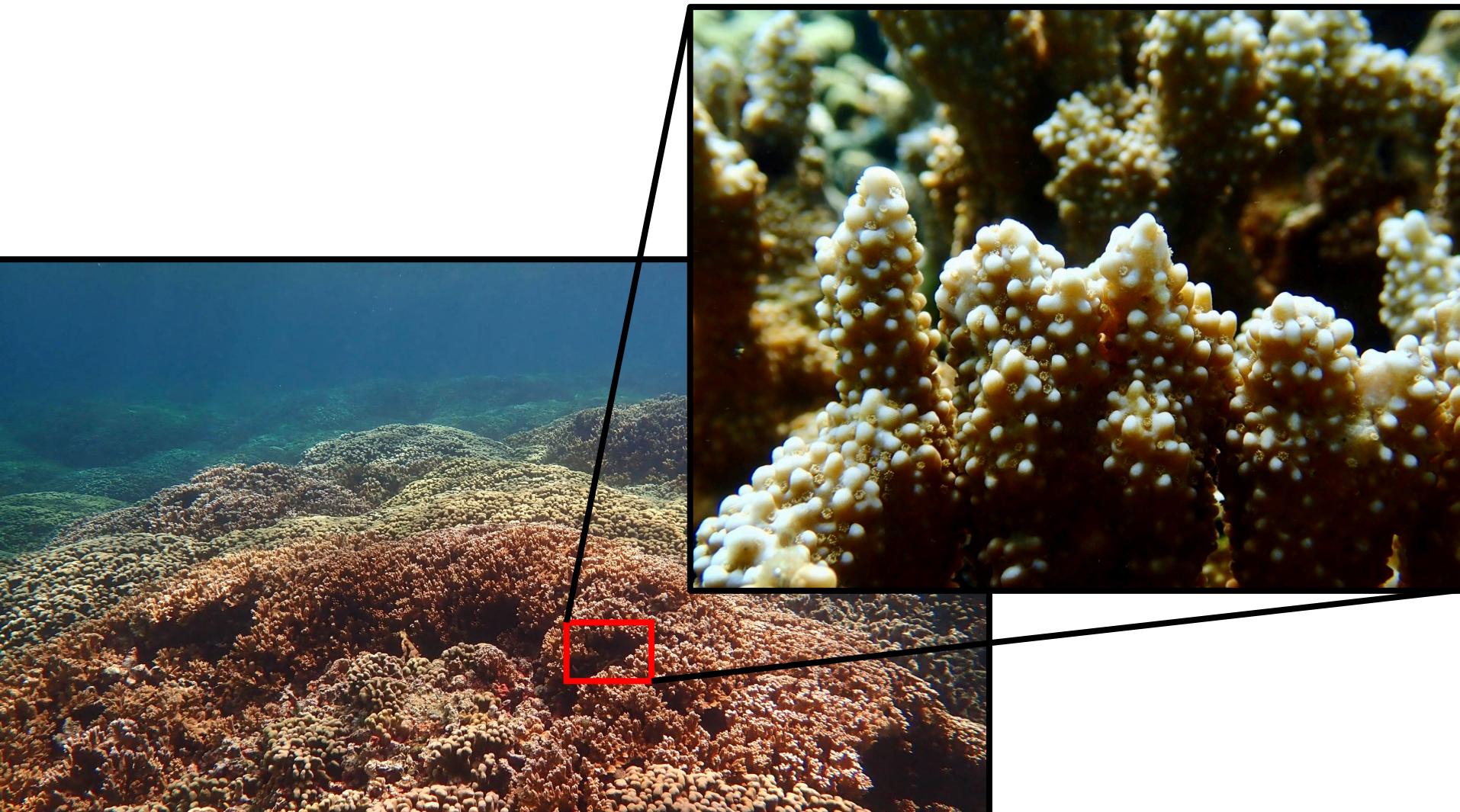
Ariana S. Huffmyer, PhD
University of Rhode Island | University of Washington

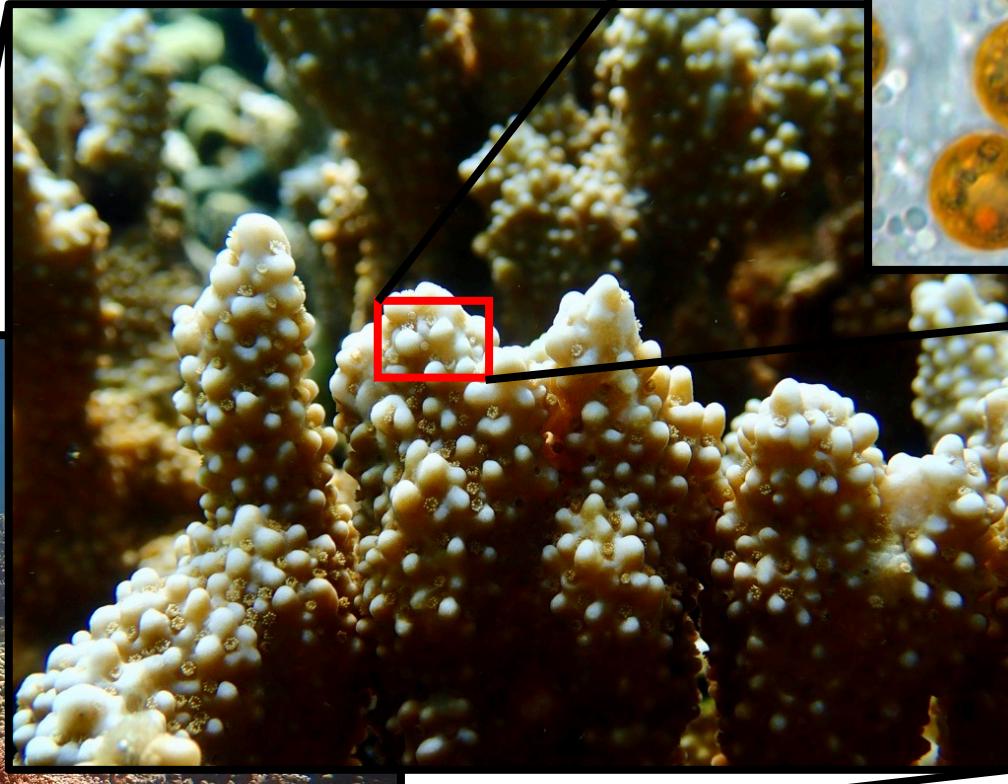
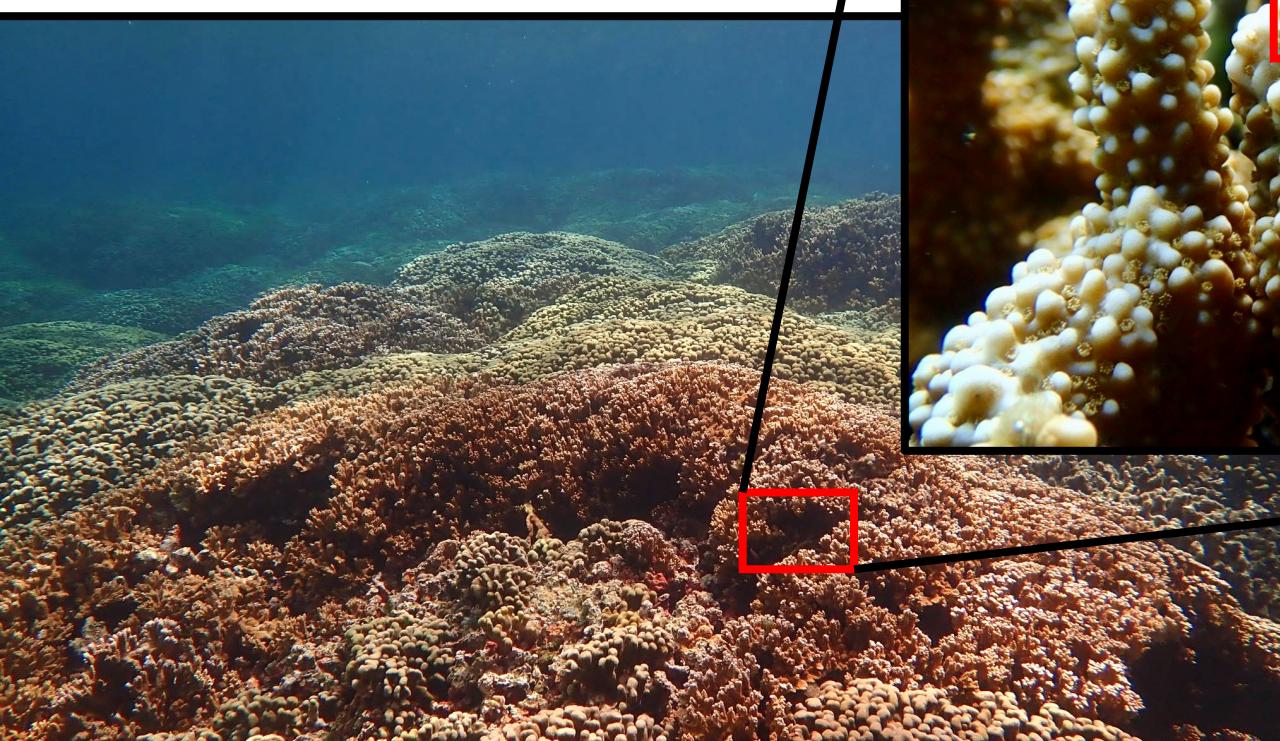
ashuffmyer@uri.edu

 AHuffmyer

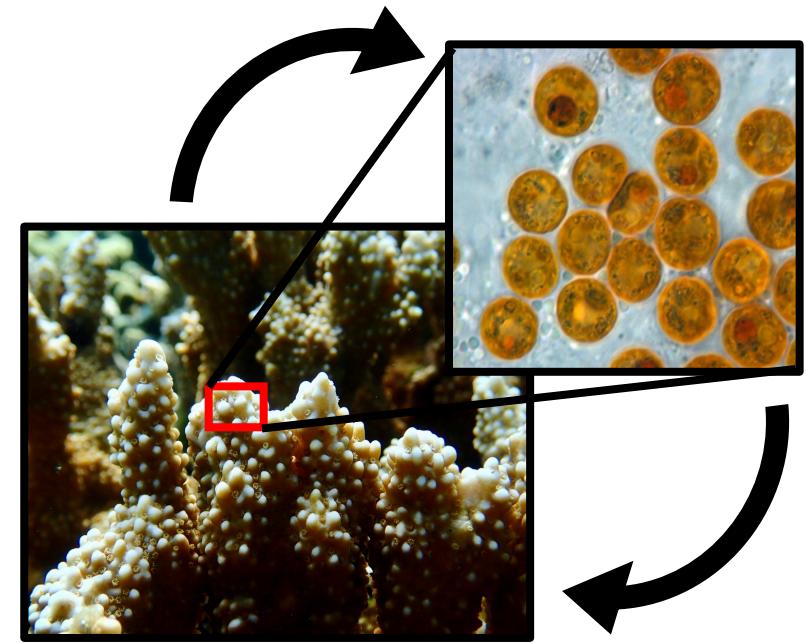
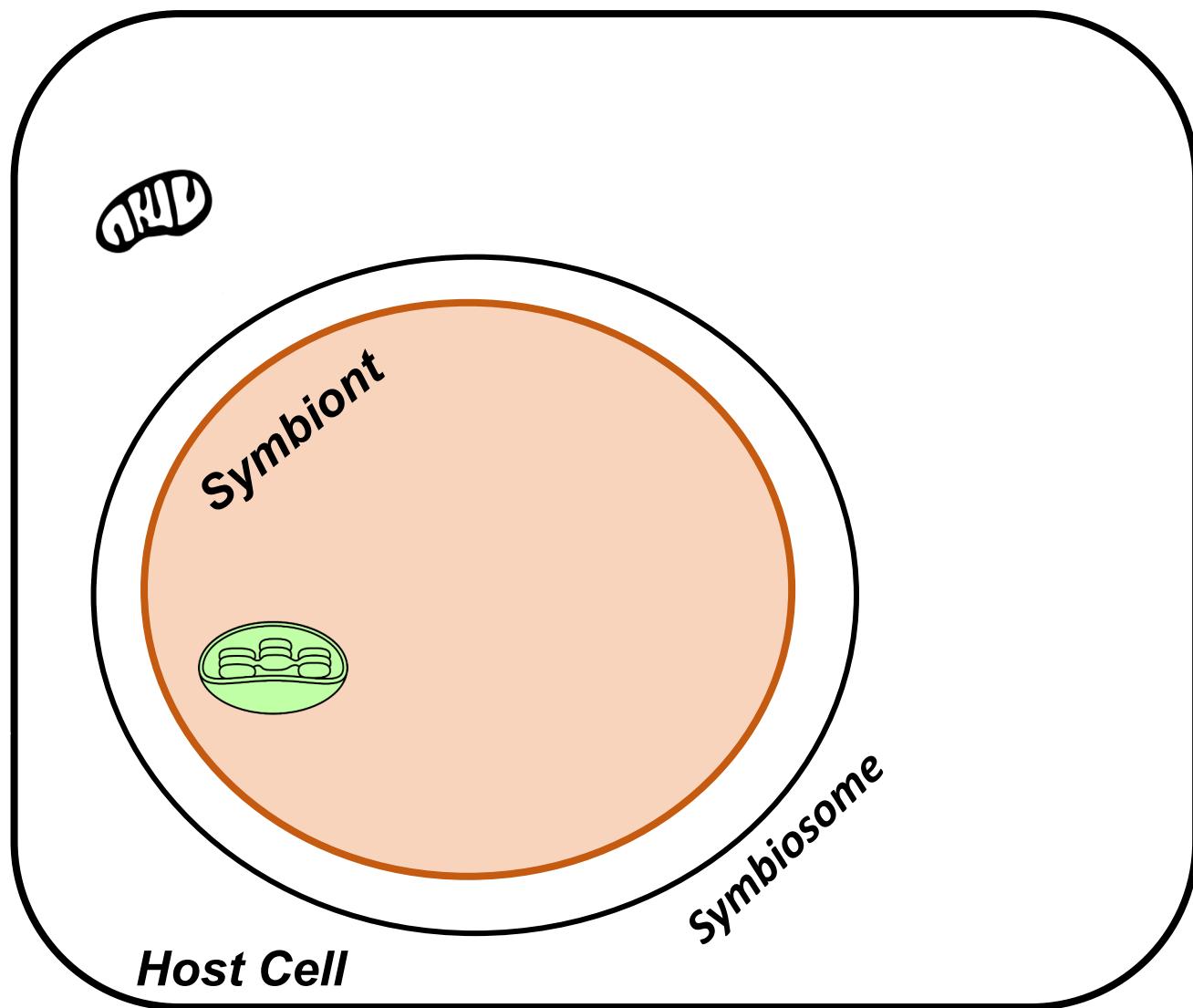
 @Dr_Cnidariana



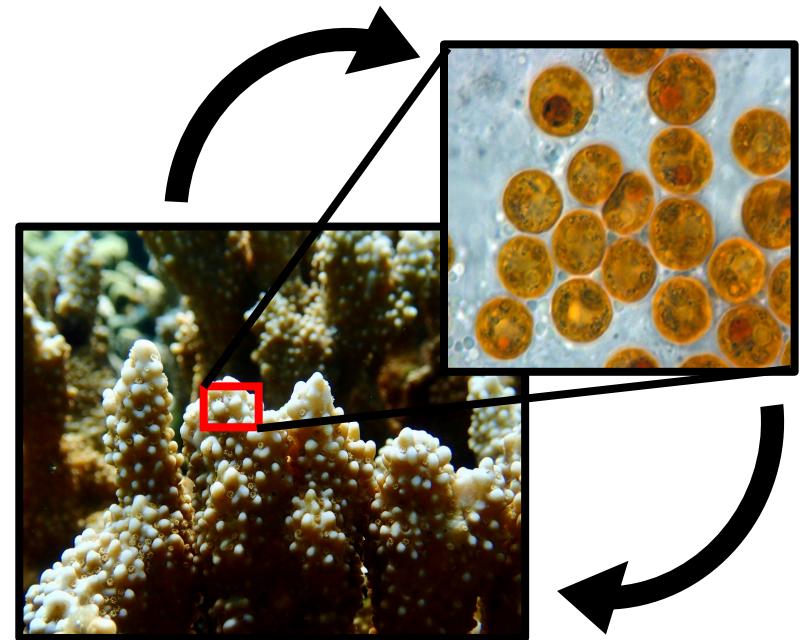
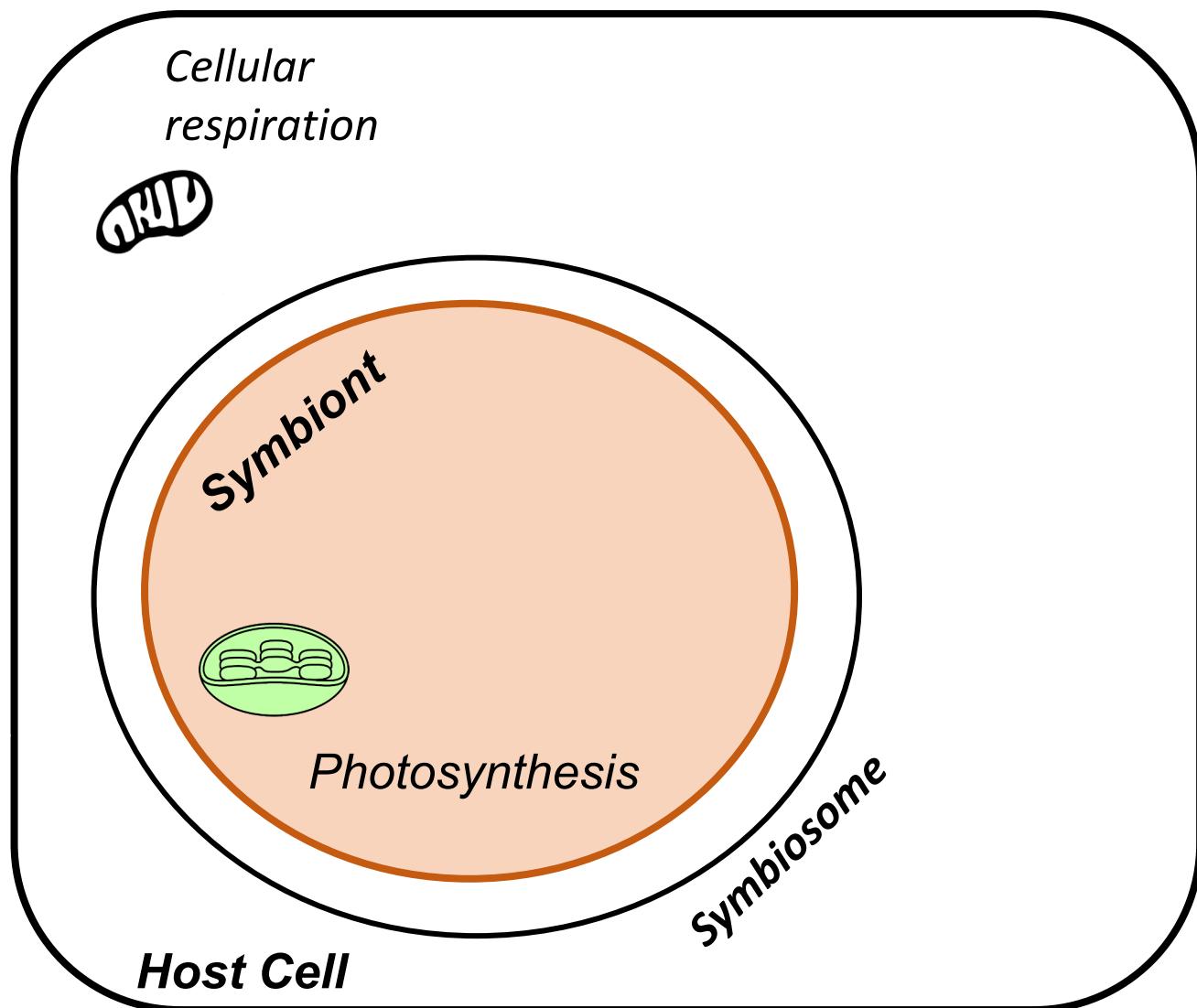




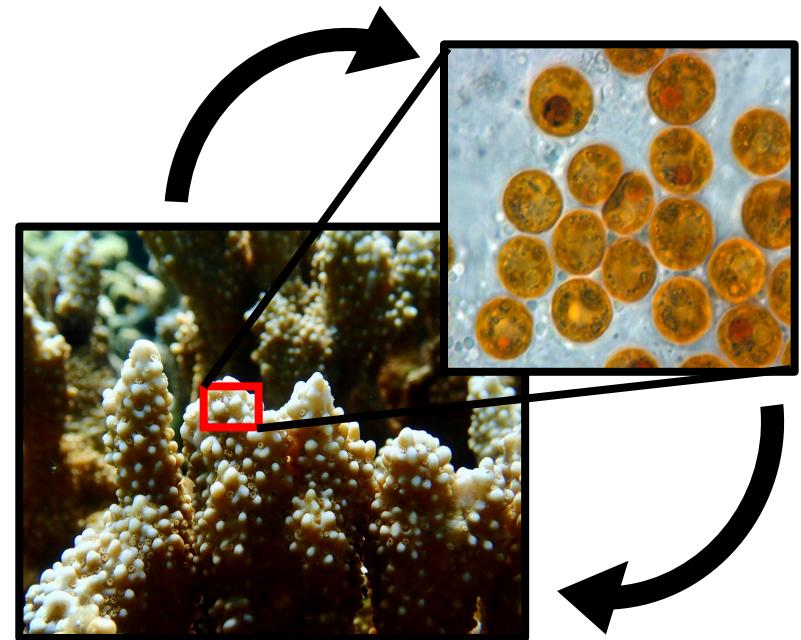
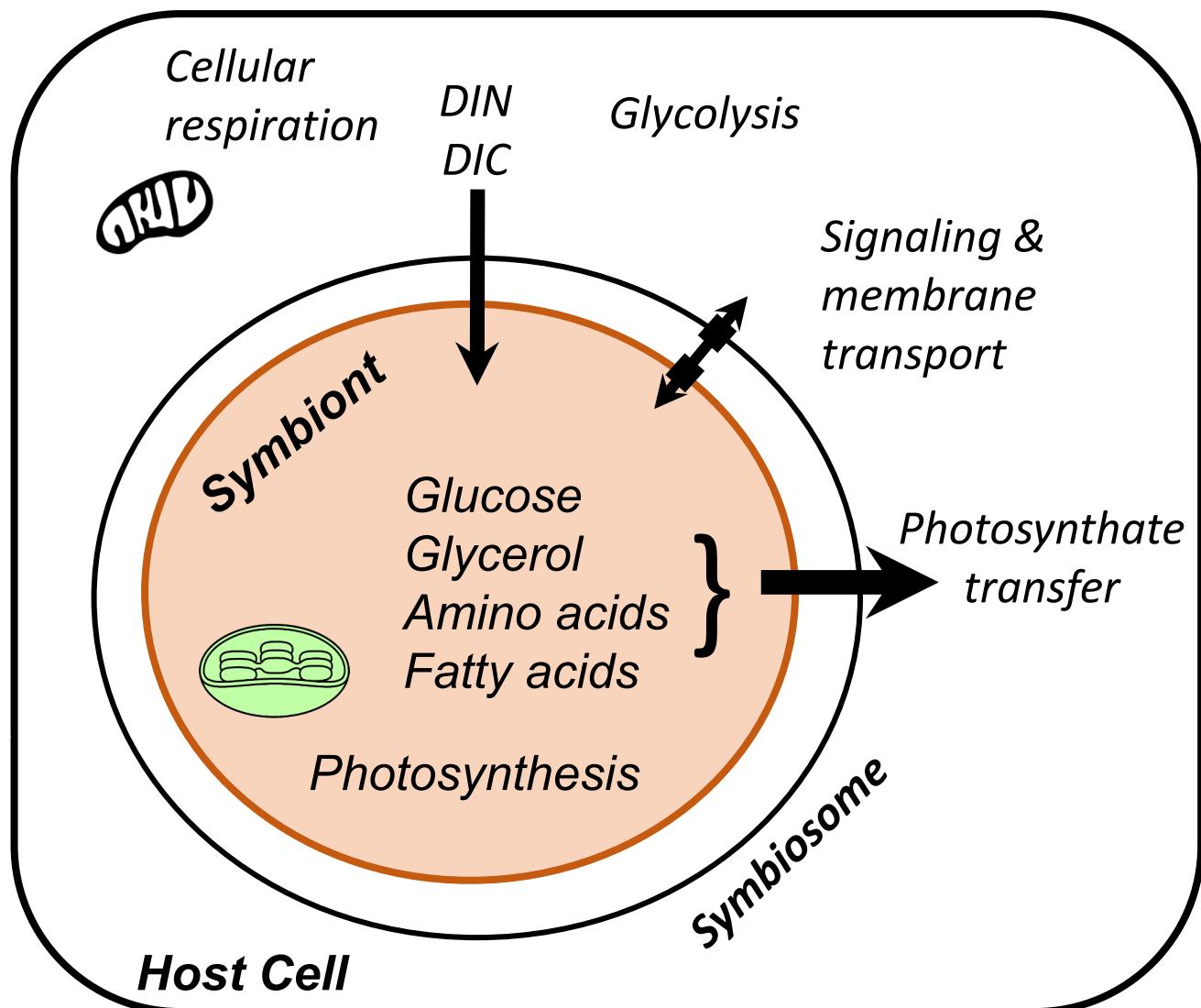
Coral-Symbiodiniaceae Nutritional Exchange



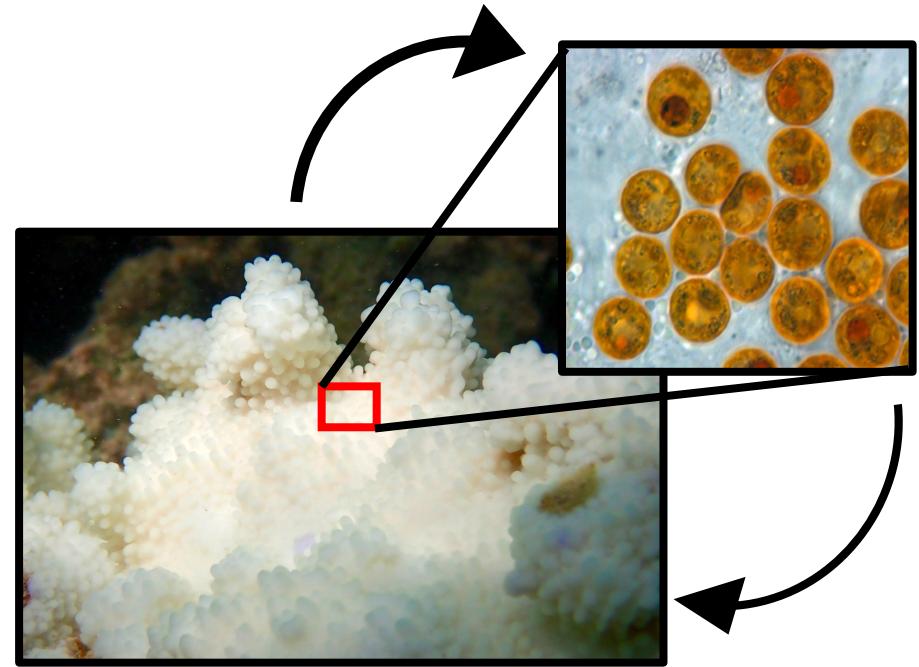
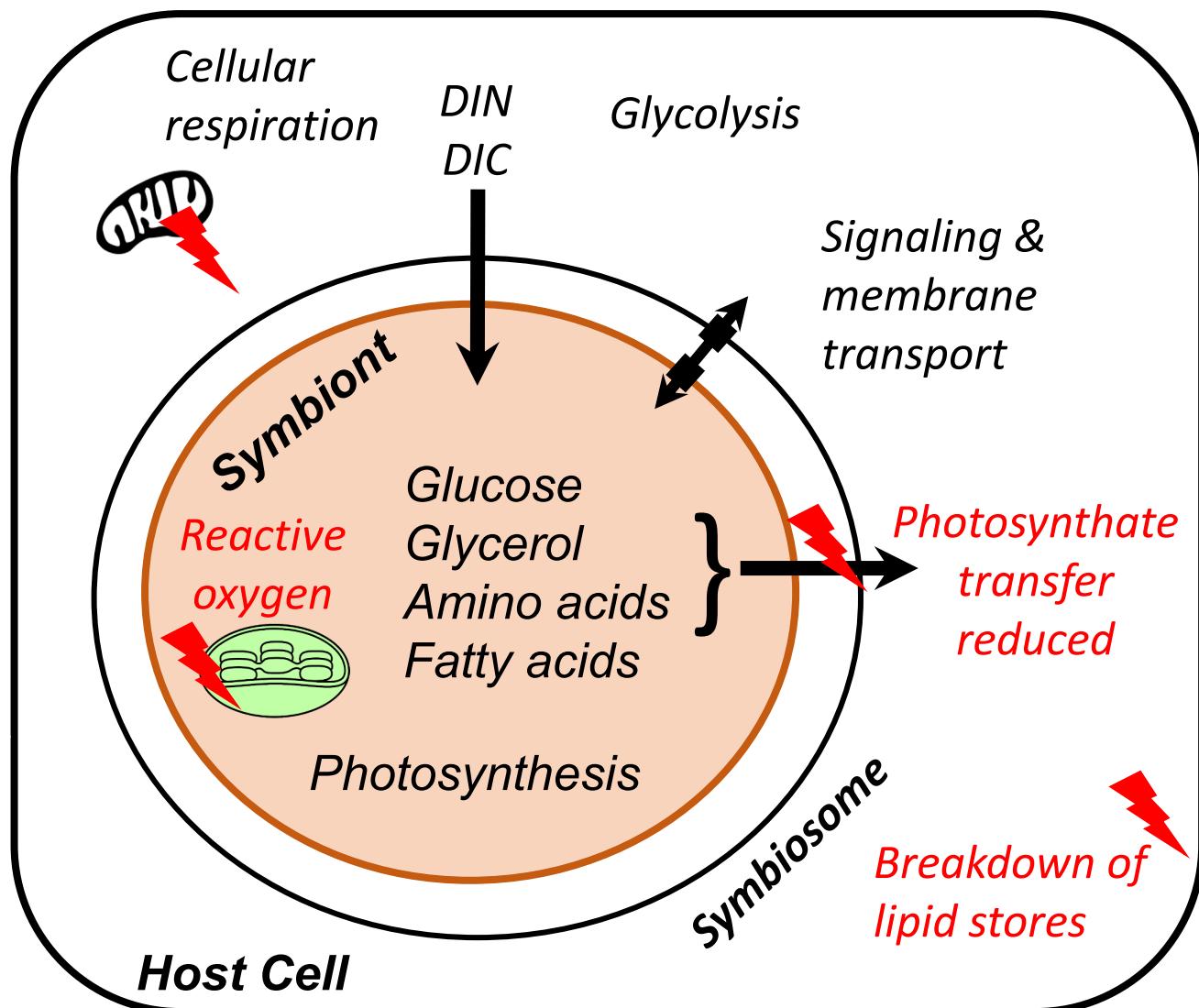
Coral-Symbiodiniaceae Nutritional Exchange



Coral-Symbiodiniaceae Nutritional Exchange



Coral-Symbiodiniaceae Nutritional Exchange

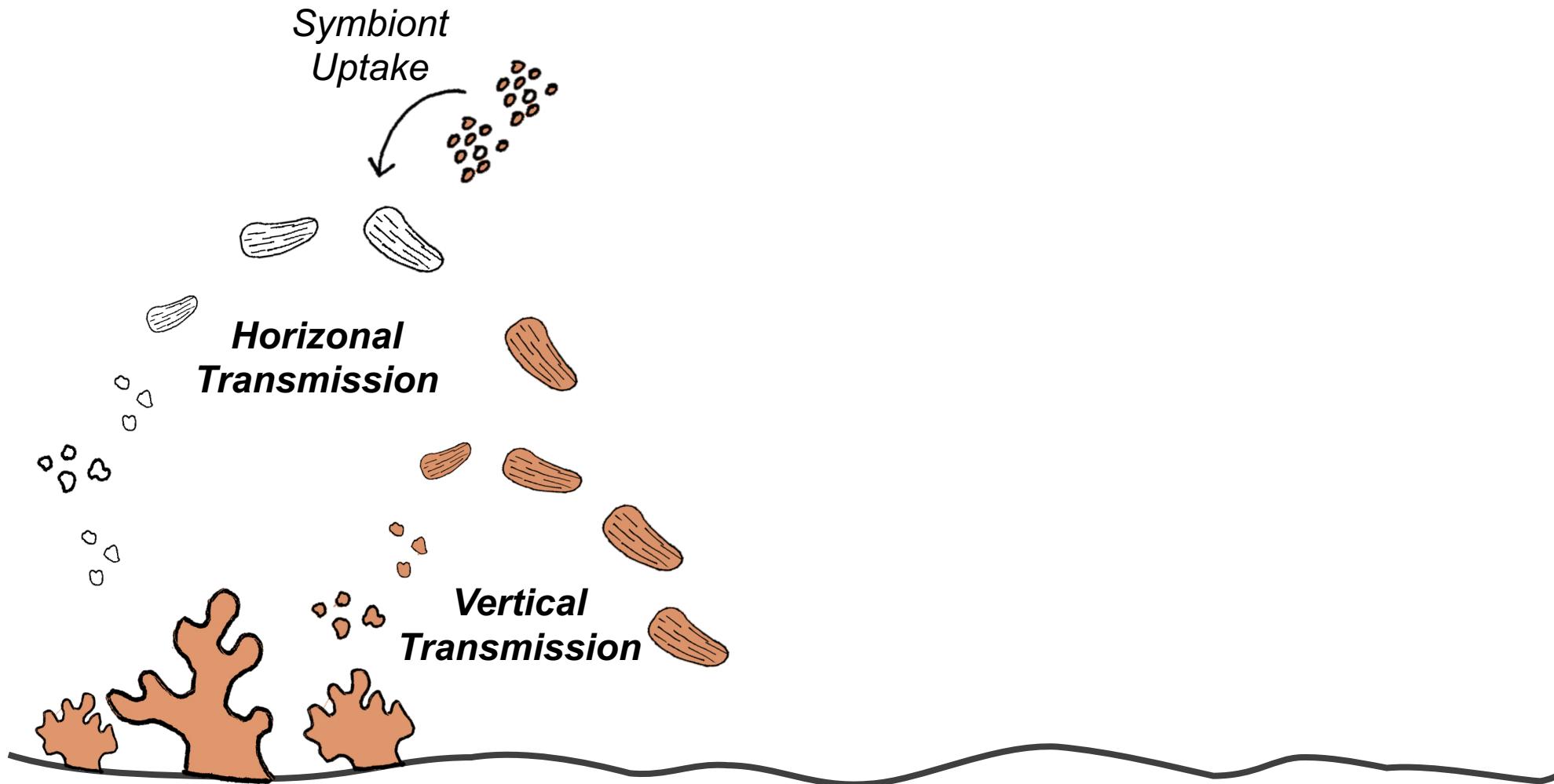


Symbiotic breakdown can lead to mass coral mortality during bleaching events

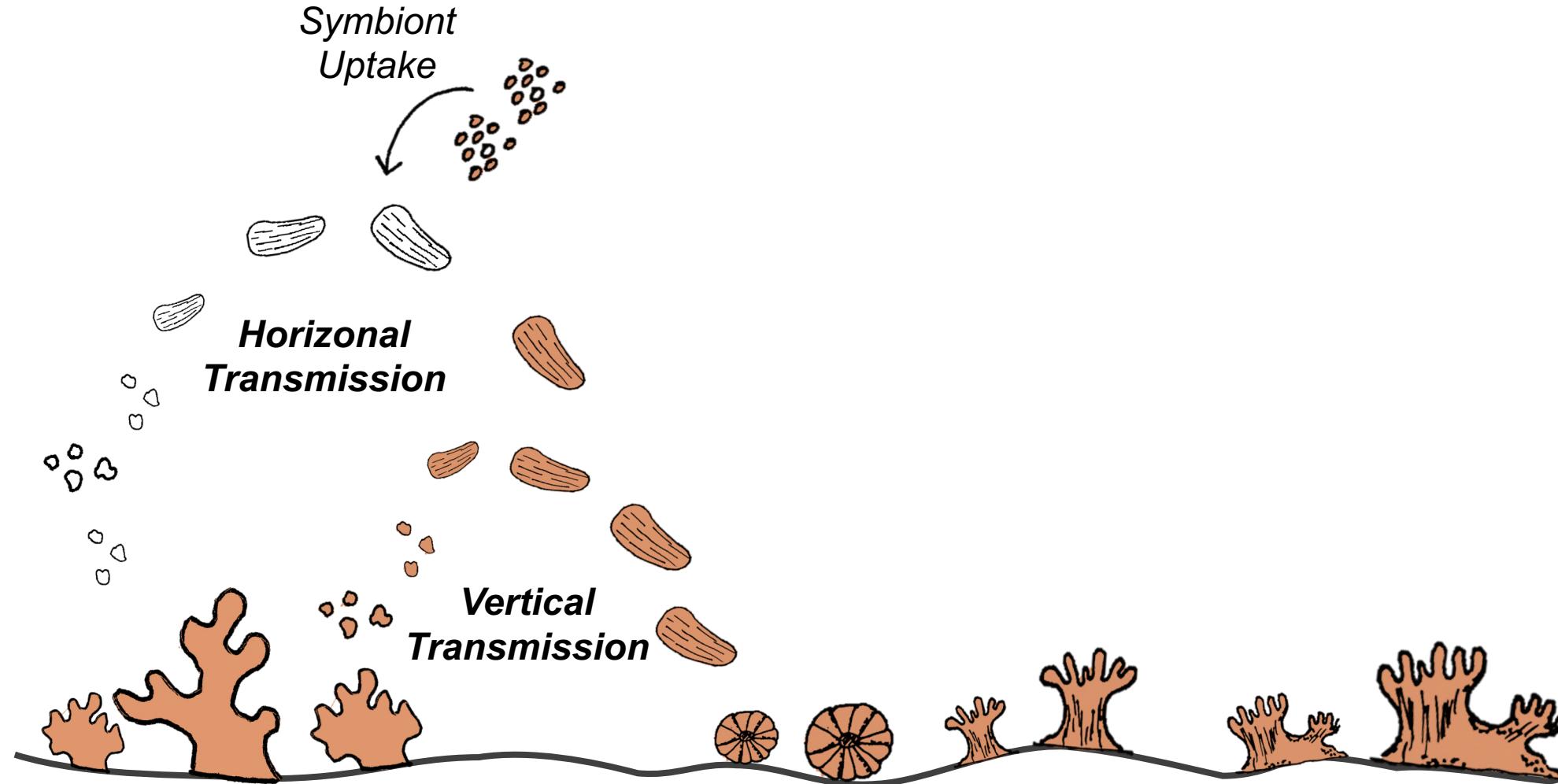
When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?



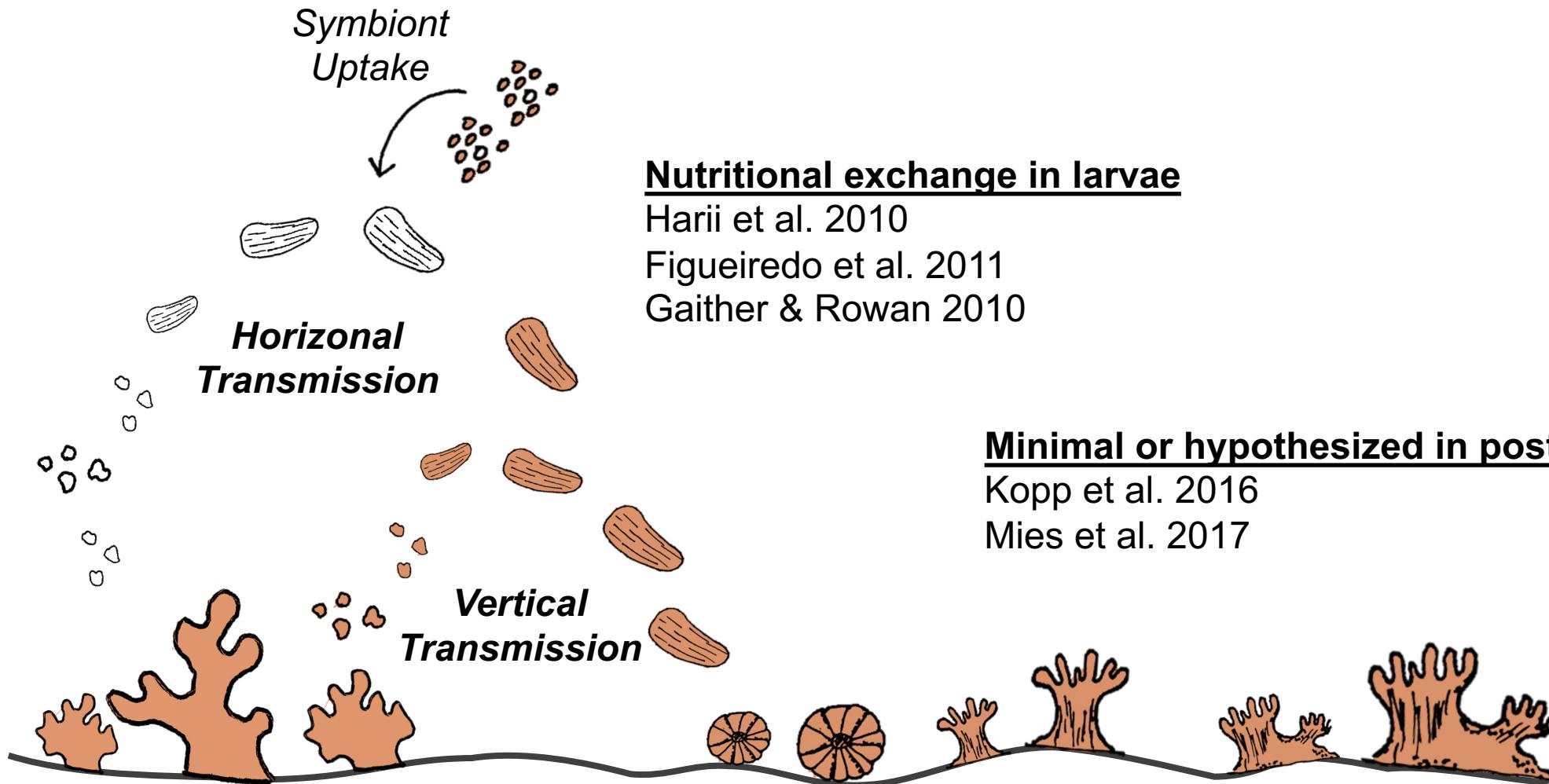
When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?



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



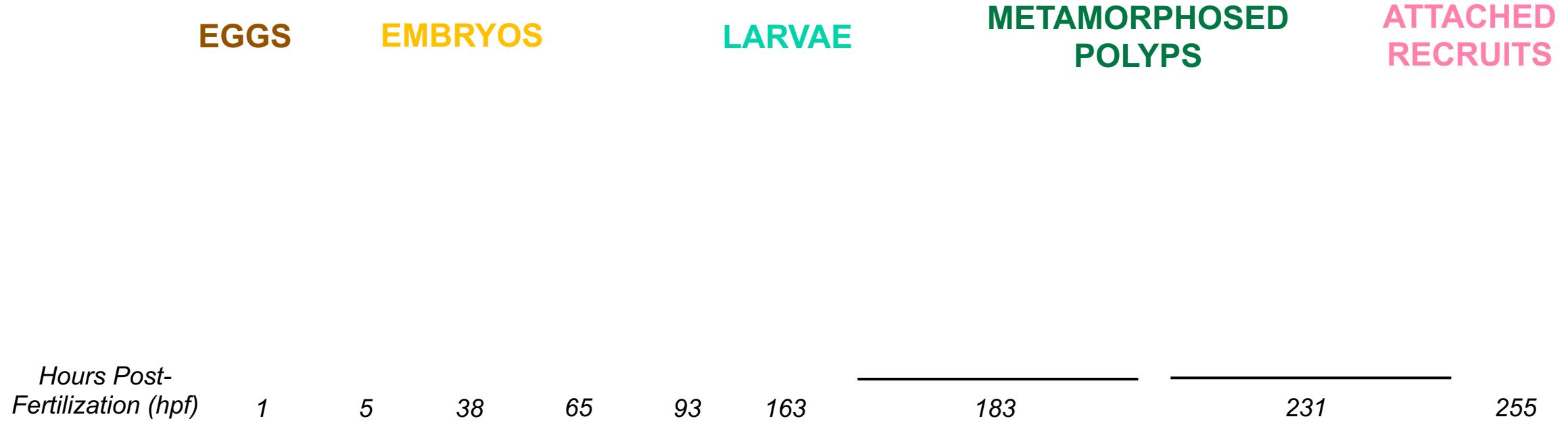
When does symbiotic nutritional exchange begin during development and how does it impact energetic capacity during recruitment?

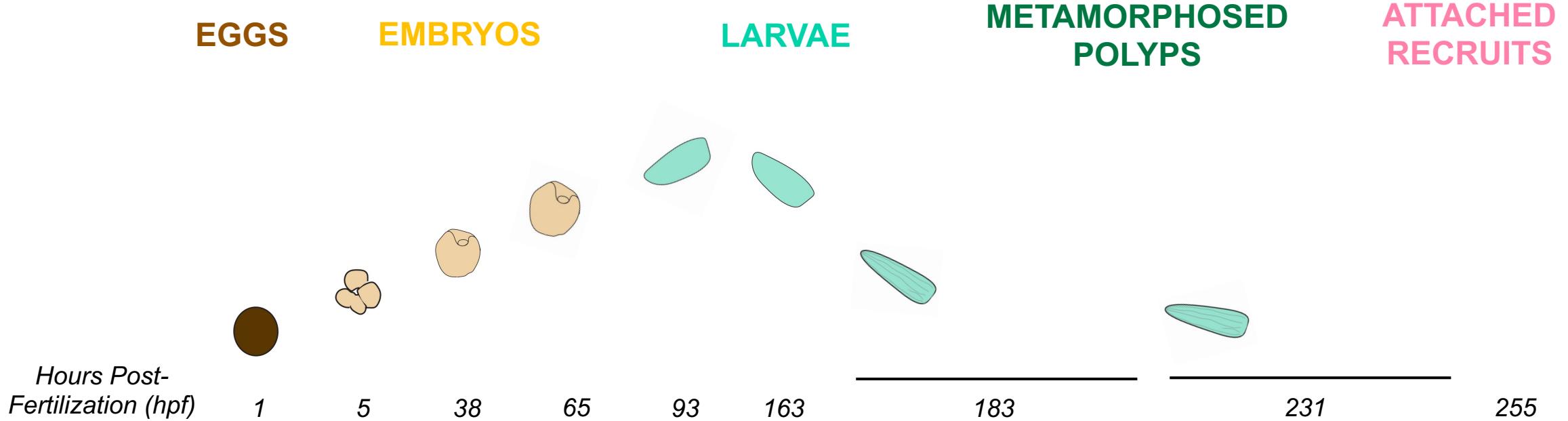


Montipora capitata

Hermaphroditic broadcast spawner
Vertical Symbiodiniaceae transmission







EGGS**EMBRYOS****LARVAE****METAMORPHOSED
POLYPS****ATTACHED
RECRUITS**

Hours Post-
Fertilization (hpf)

1

5

38

65

93

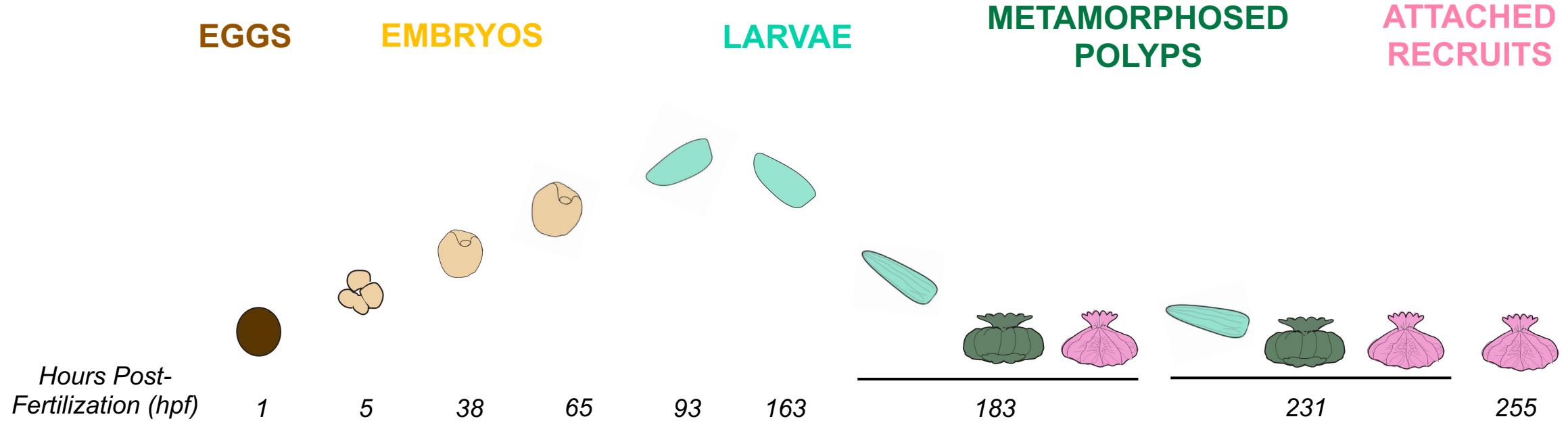
163

183

231

255





Respiration & Photosynthesis



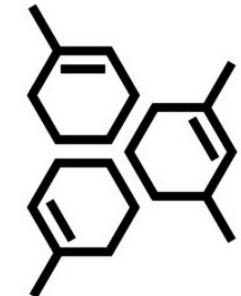
Symbiont Population

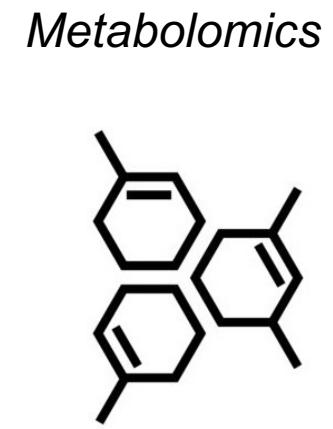
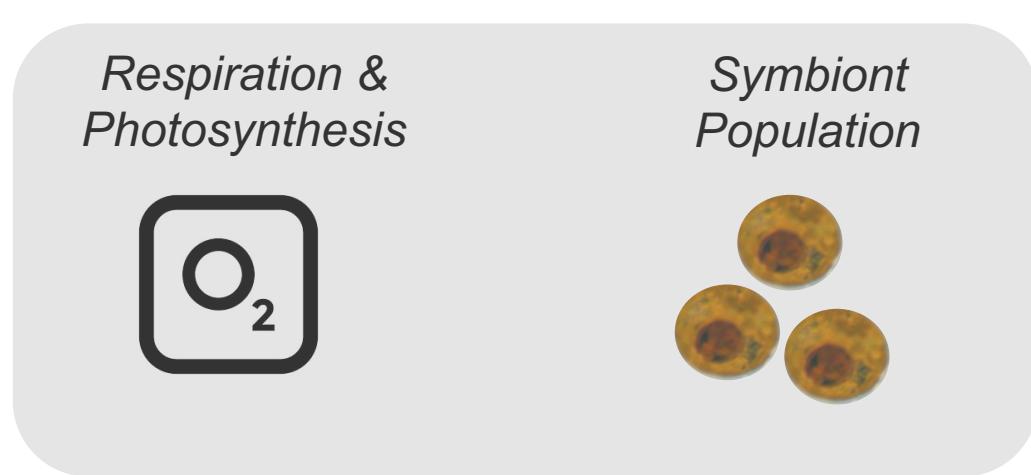
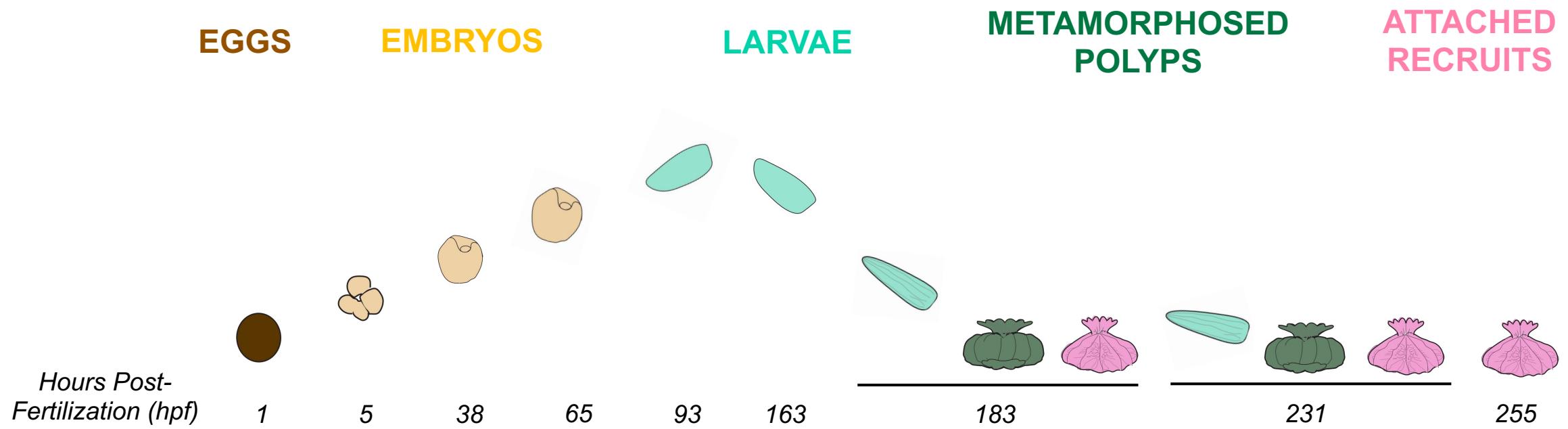


Gene Expression

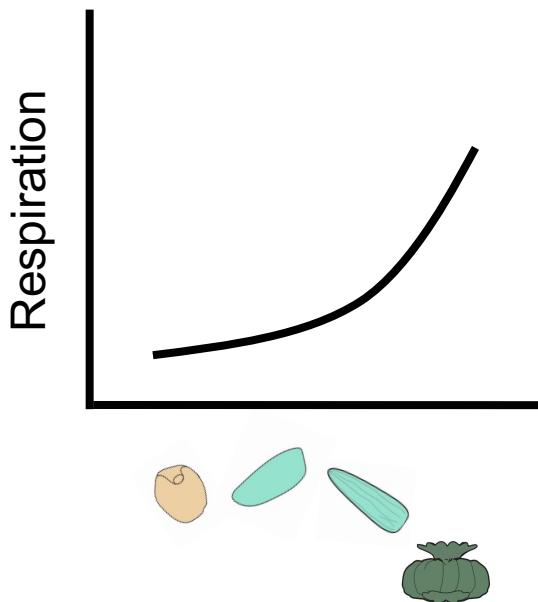


Metabolomics



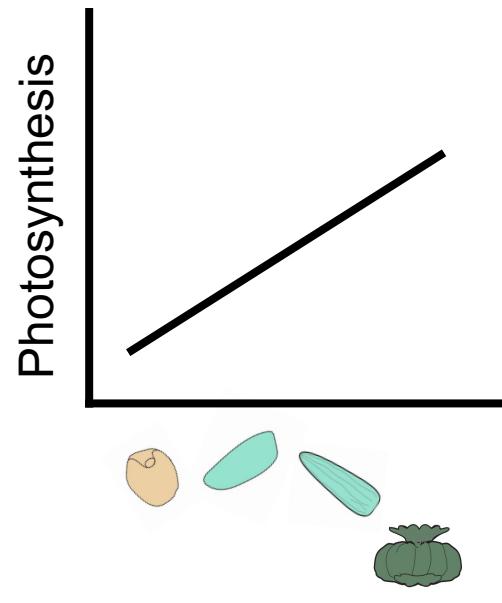
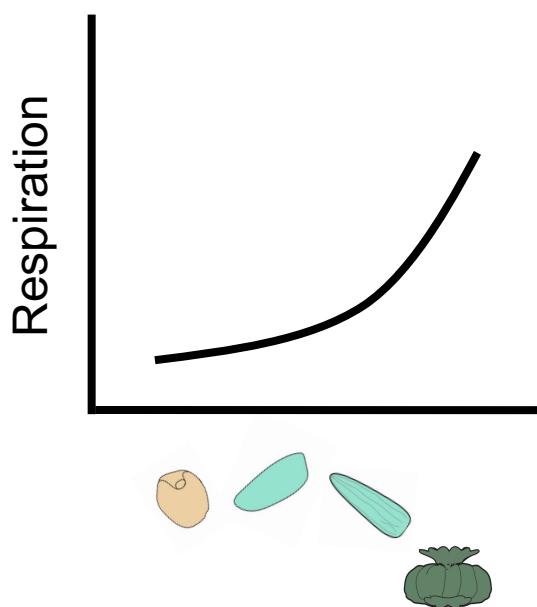


Energetic vulnerability & symbiont proliferation across development

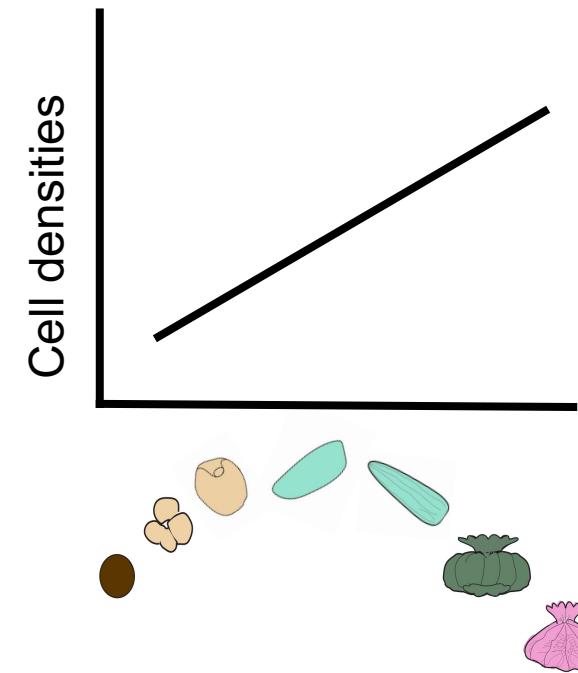
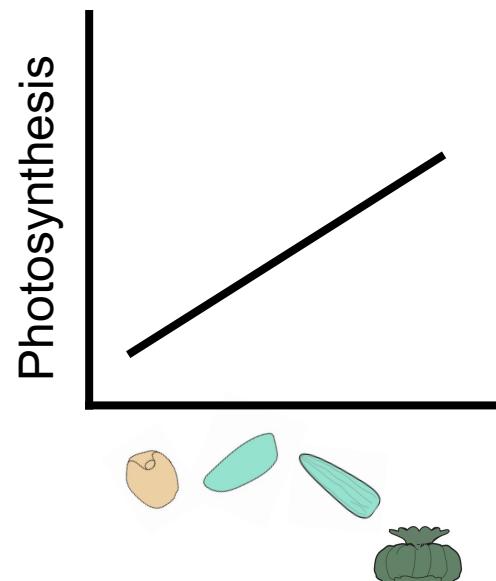
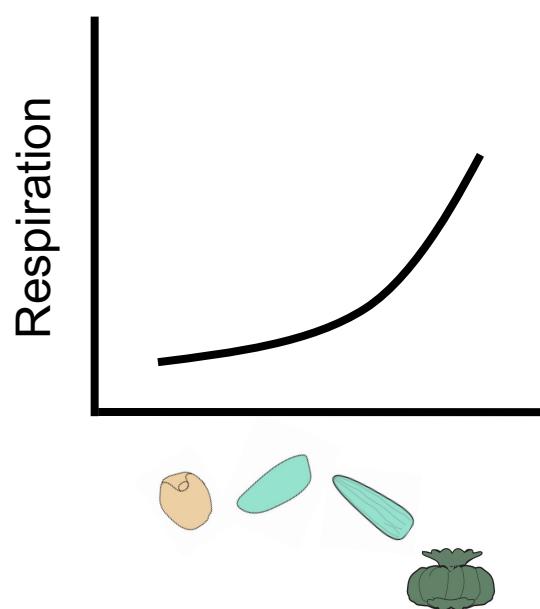


GLMM $p<0.001$
Individual normalized

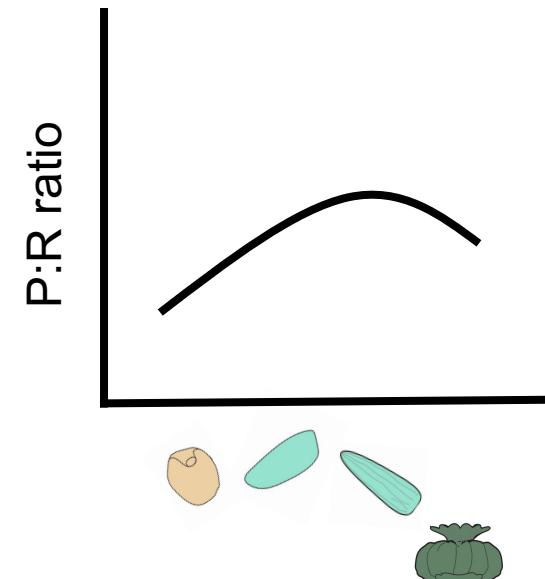
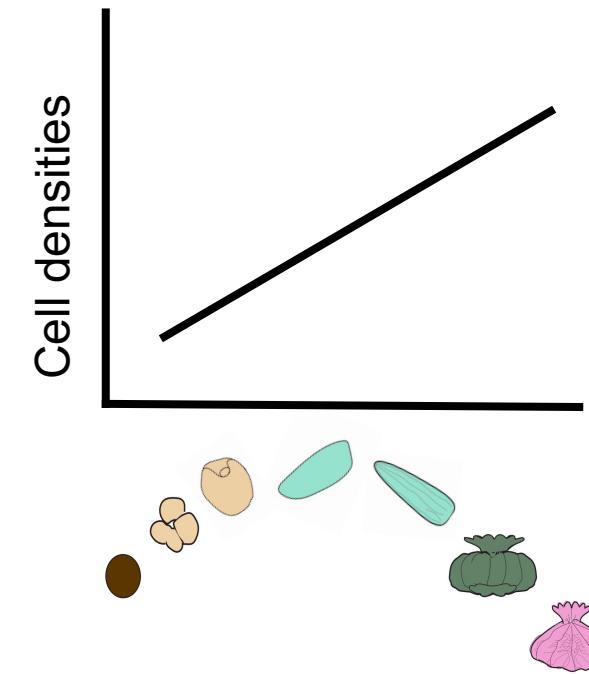
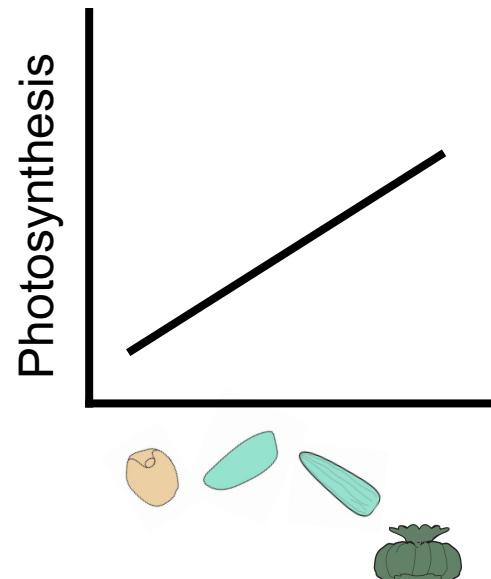
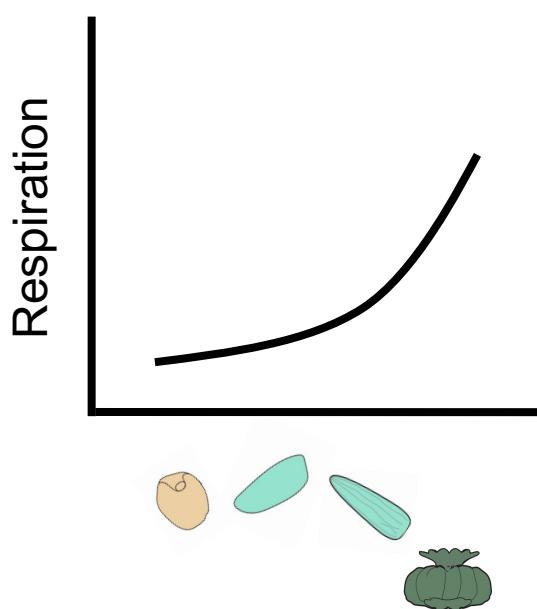
Energetic vulnerability & symbiont proliferation across development



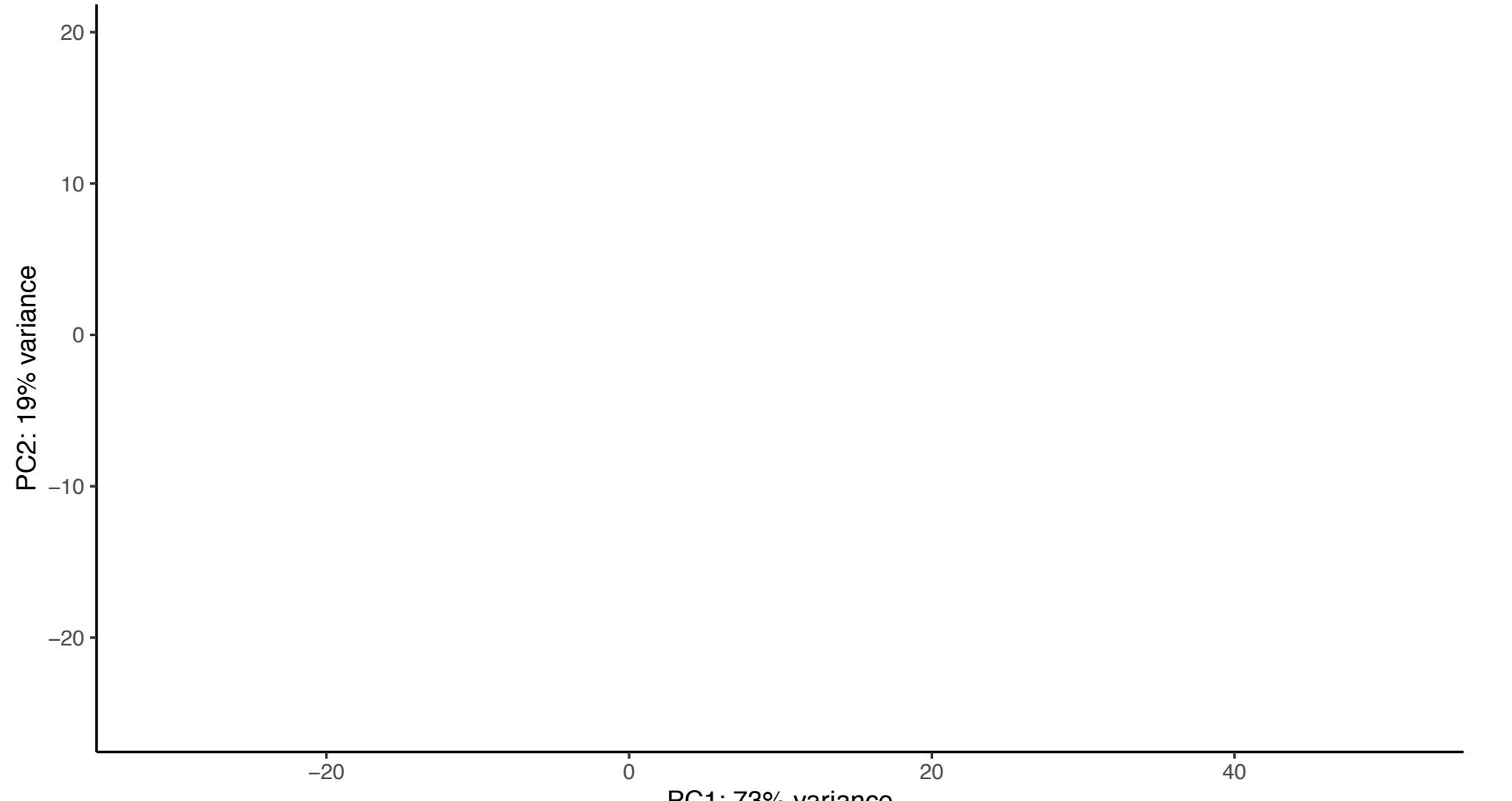
Energetic vulnerability & symbiont proliferation across development



Energetic vulnerability & symbiont proliferation across development



Distinct gene expression profiles across ontogeny

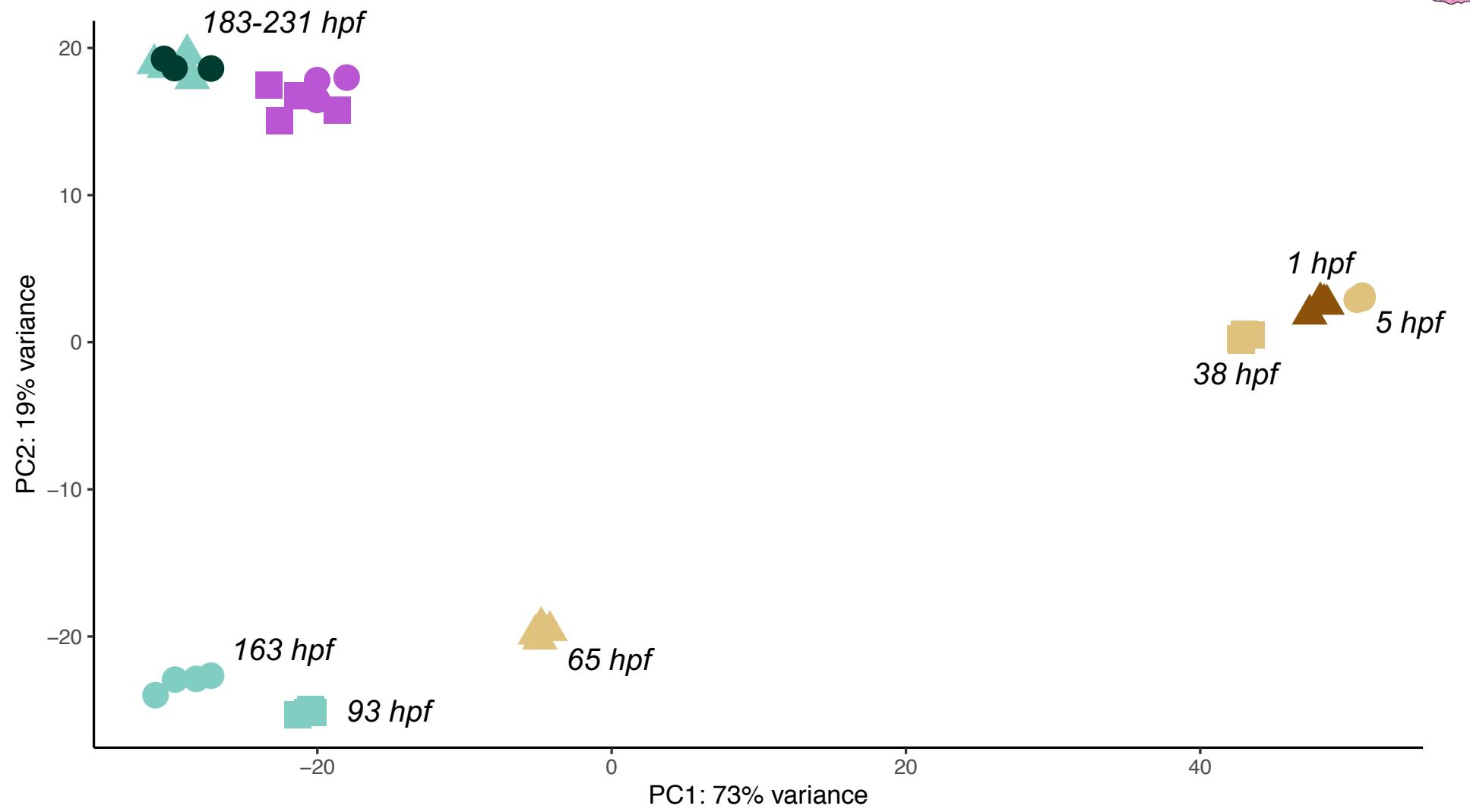


TagSeq (Lohman et al. 2016)

Illumina NovaSeq 100 bp sequencing (3-5 million read depth)

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

Distinct gene expression profiles across ontogeny



TagSeq (Lohman et al. 2016)

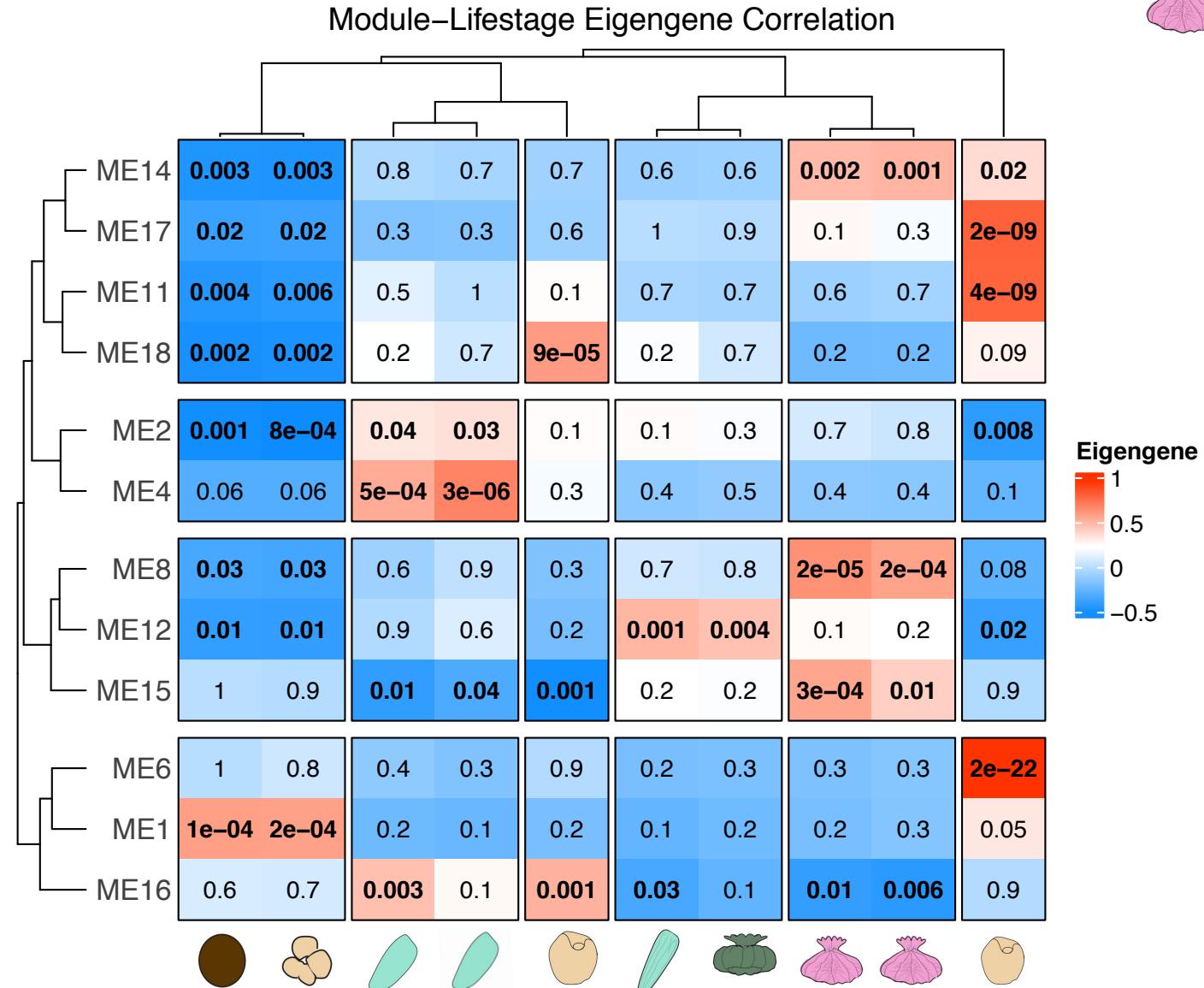
Illumina NovaSeq 100 bp sequencing (UT Austin)

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

Distinct gene expression profiles across ontogeny

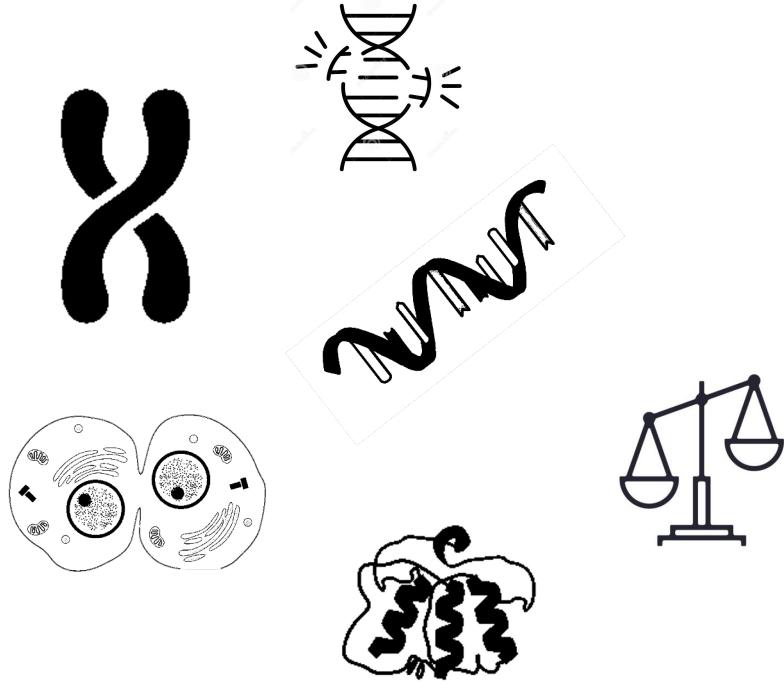
Weighted gene co-expression network analysis (WGCNA)

Dynamic tree cut module detection
GO-MWU functional enrichment (Wright et al. 2015)
Filtered FDR<0.05

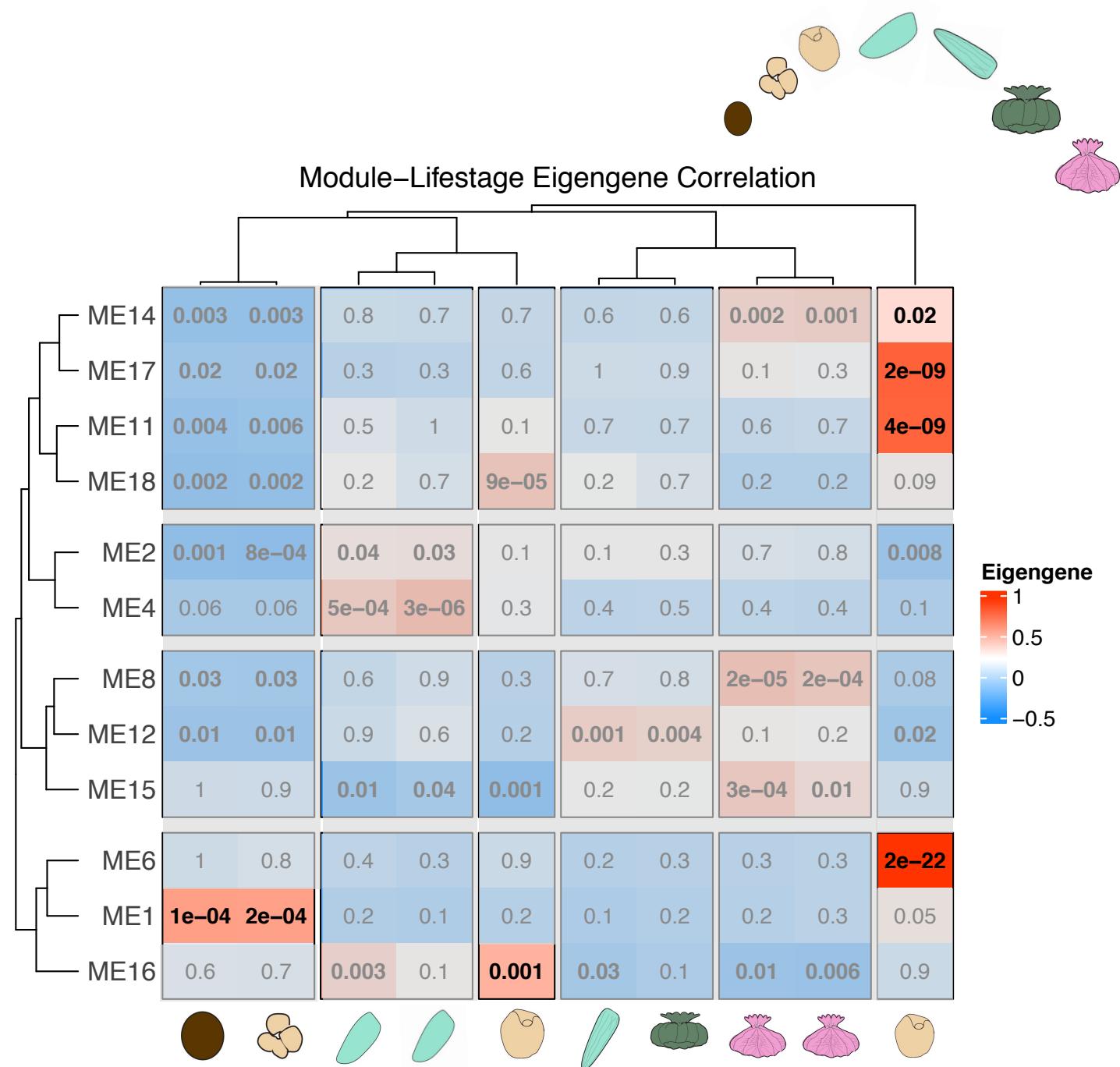


EGG-EMBRYOS

1 hpf - 65 hpf

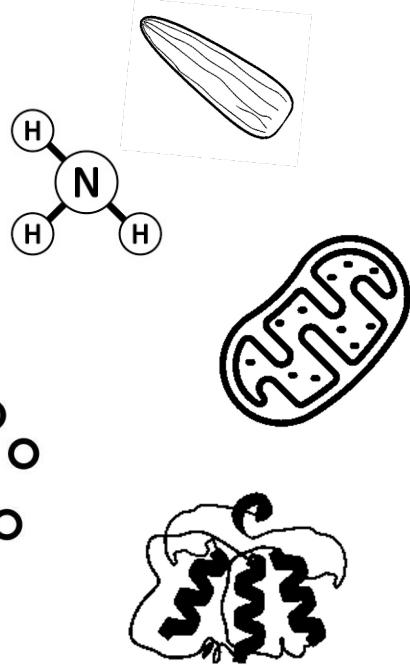
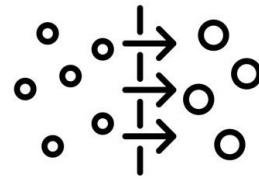


Cell division, transcription, embryonic development, DNA repair, homeostasis

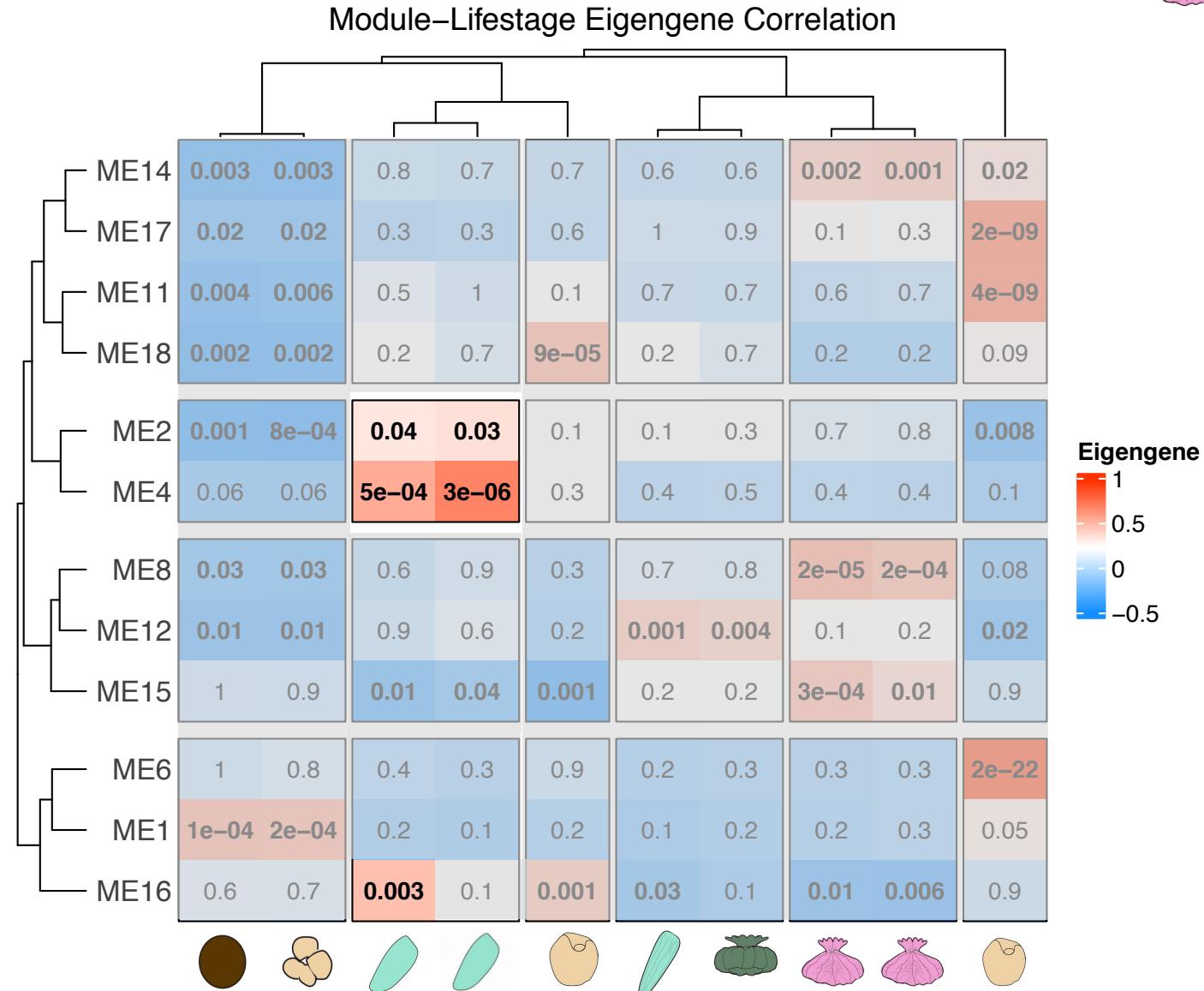


LARVAE

93 hpf – 163 hpf

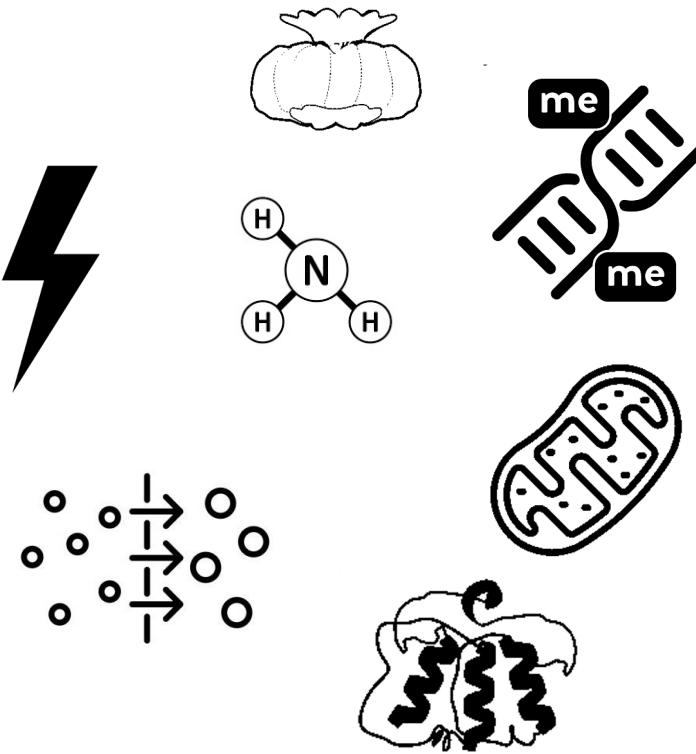


Nitrogen metabolism, structure development, ion transport

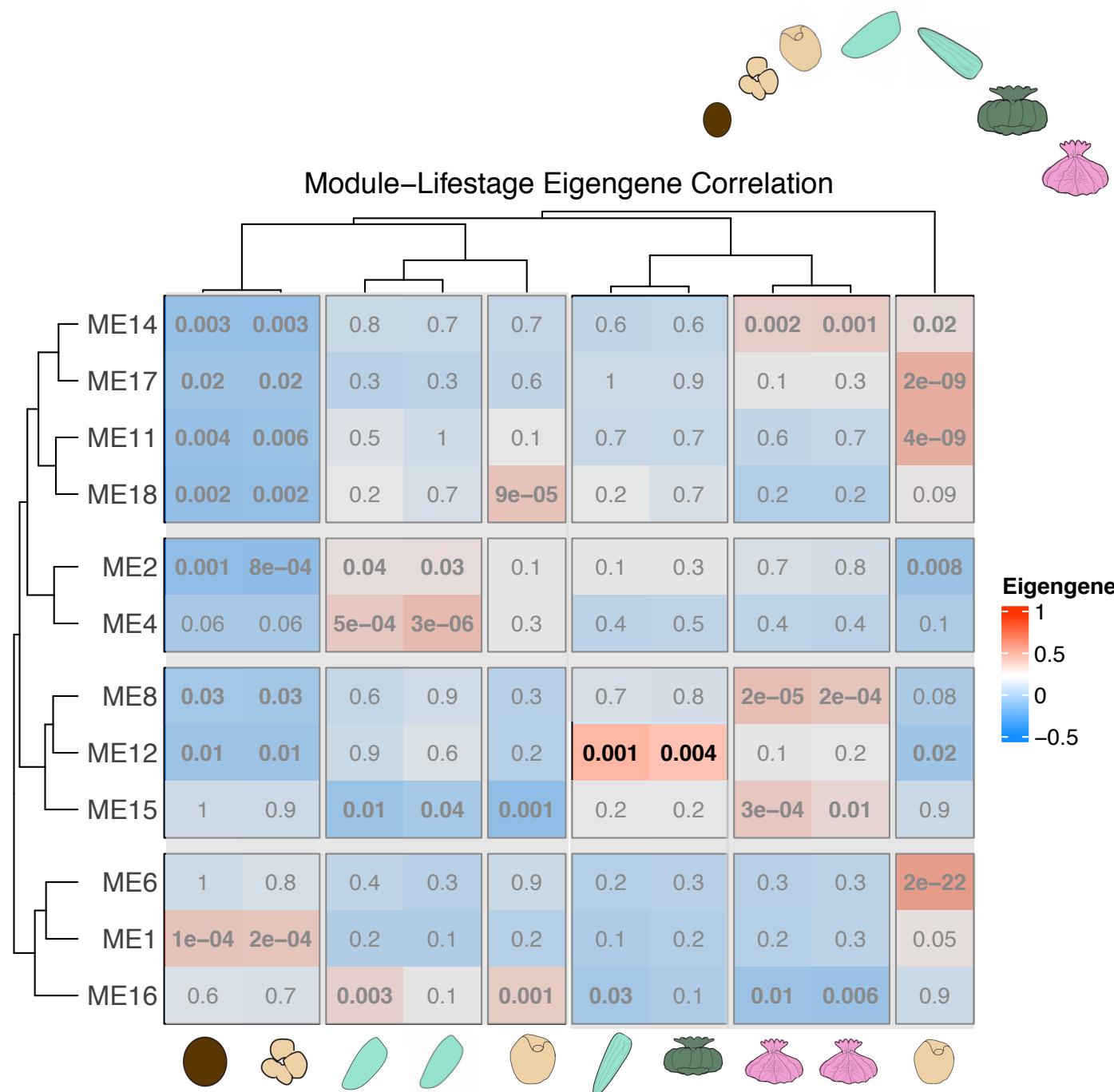


LARVAE & METAMORPHOSED POLYPS

231 hpf

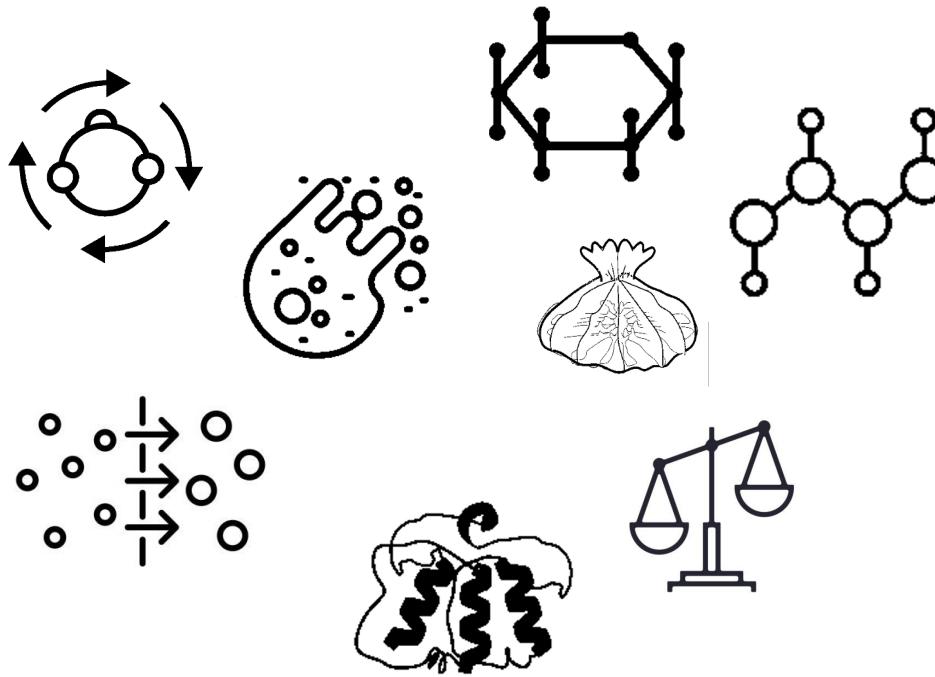


*Nitrogen metabolism, membrane transport,
protein transport, metamorphosis*

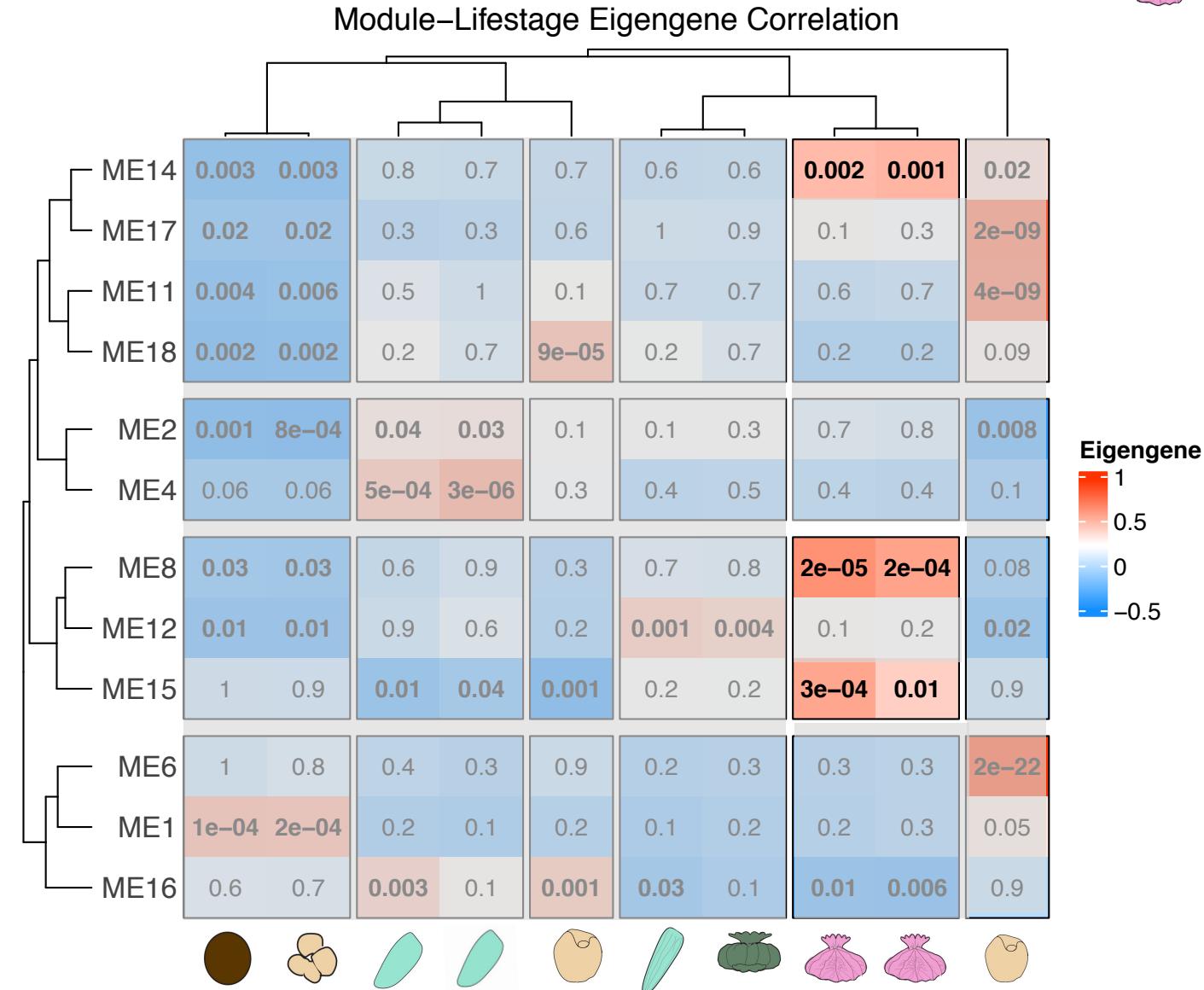


ATTACHED RECRUITS

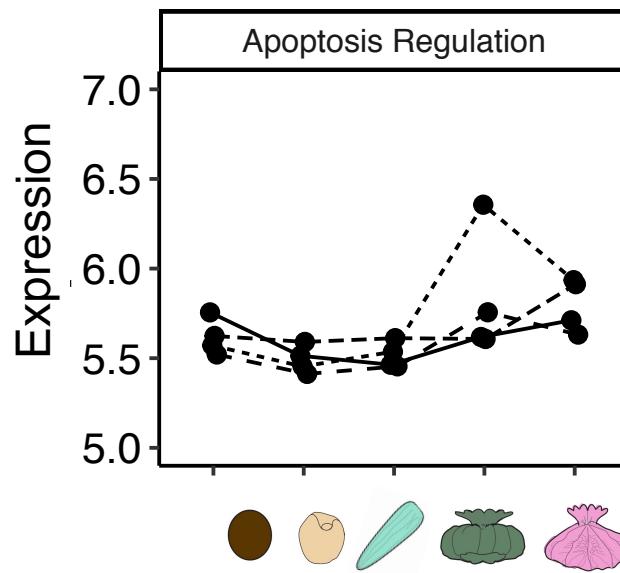
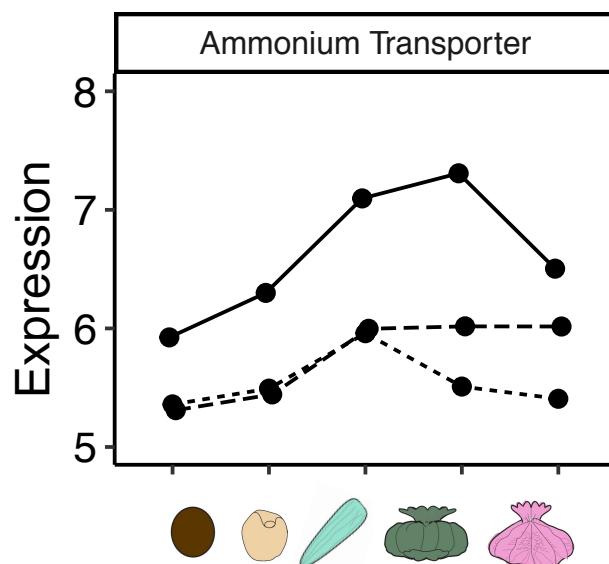
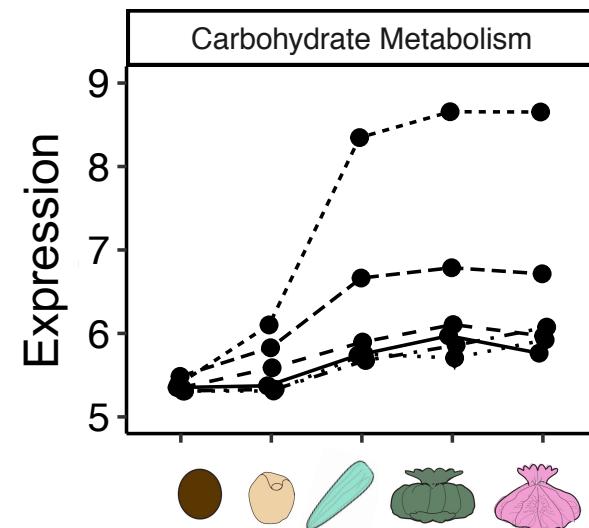
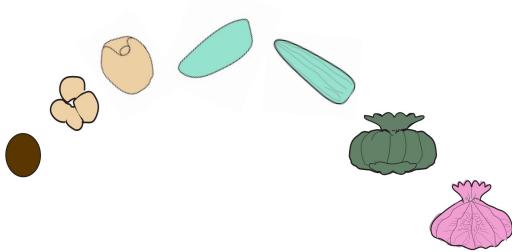
183-231 hpf



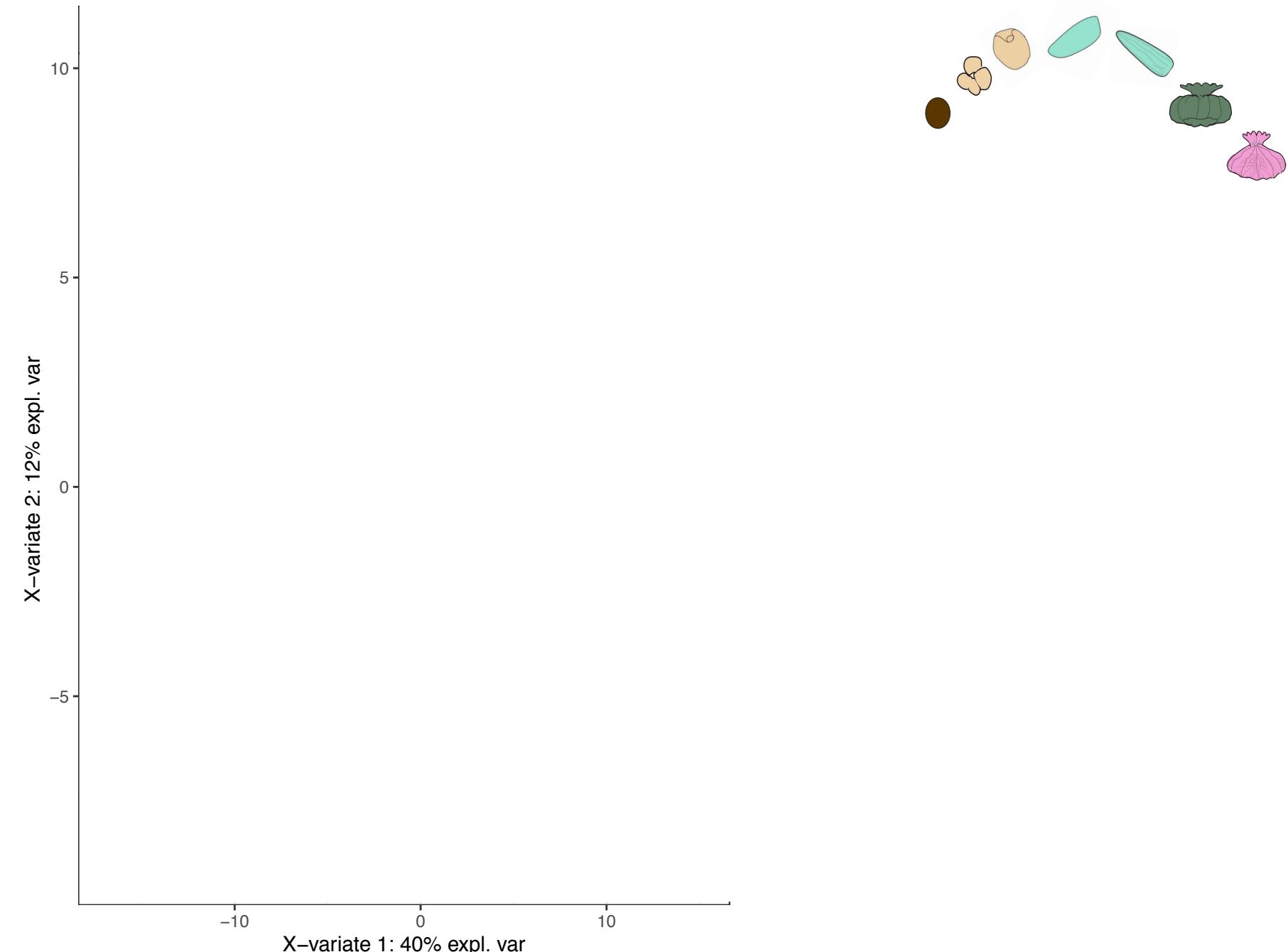
Cell communication, membrane transport, homeostasis, lipid metabolism, carbohydrate metabolism



GENE EXPRESSION SIGNATURES OF SYMBIOSIS



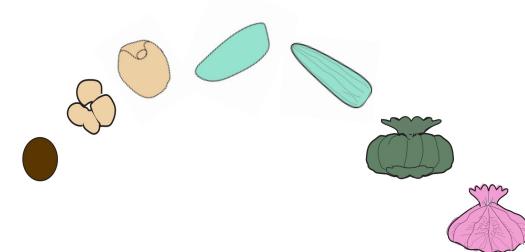
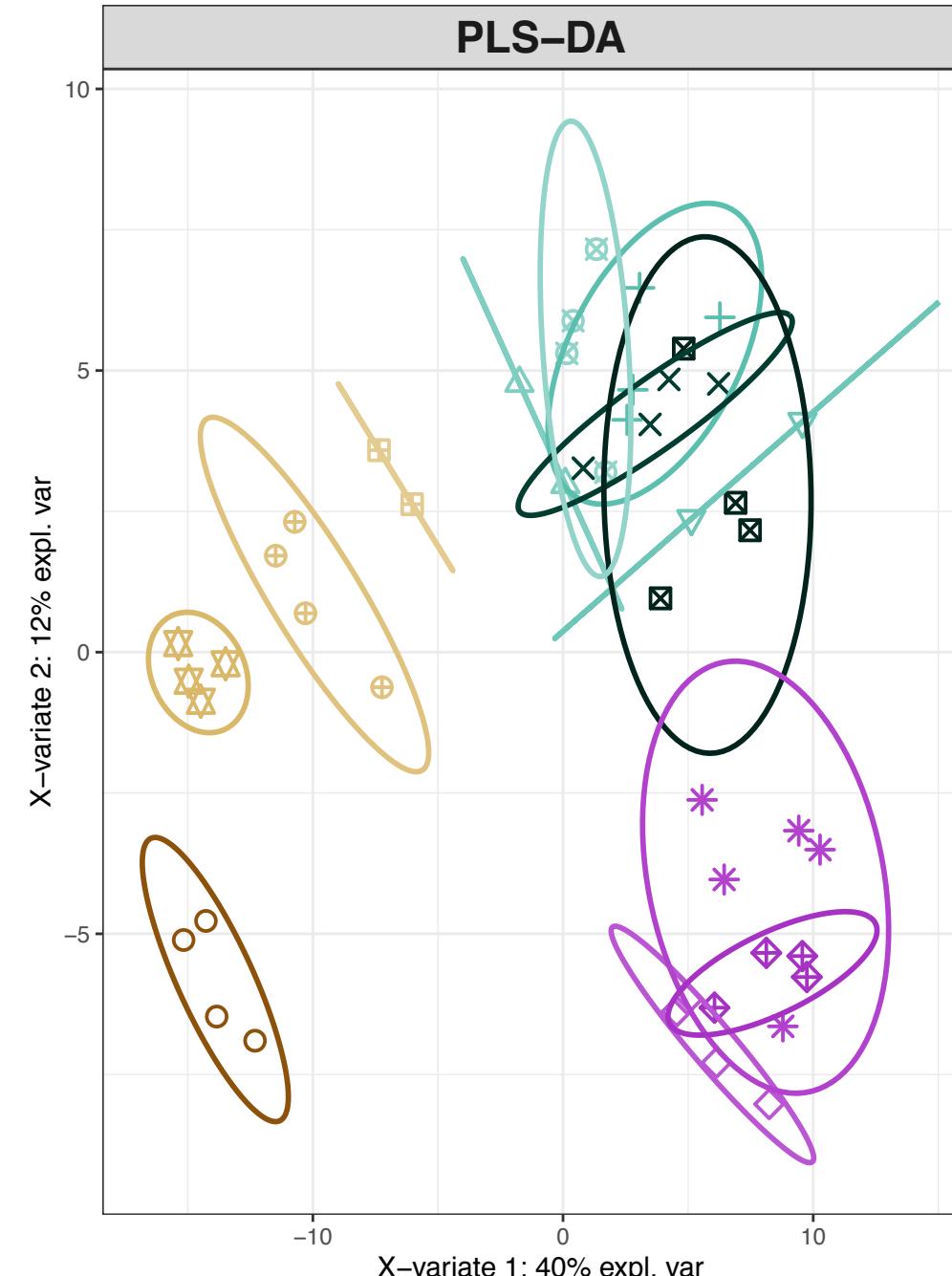
Distinct metabolomic profiles across ontogeny



Untargeted metabolomics
LC-MS

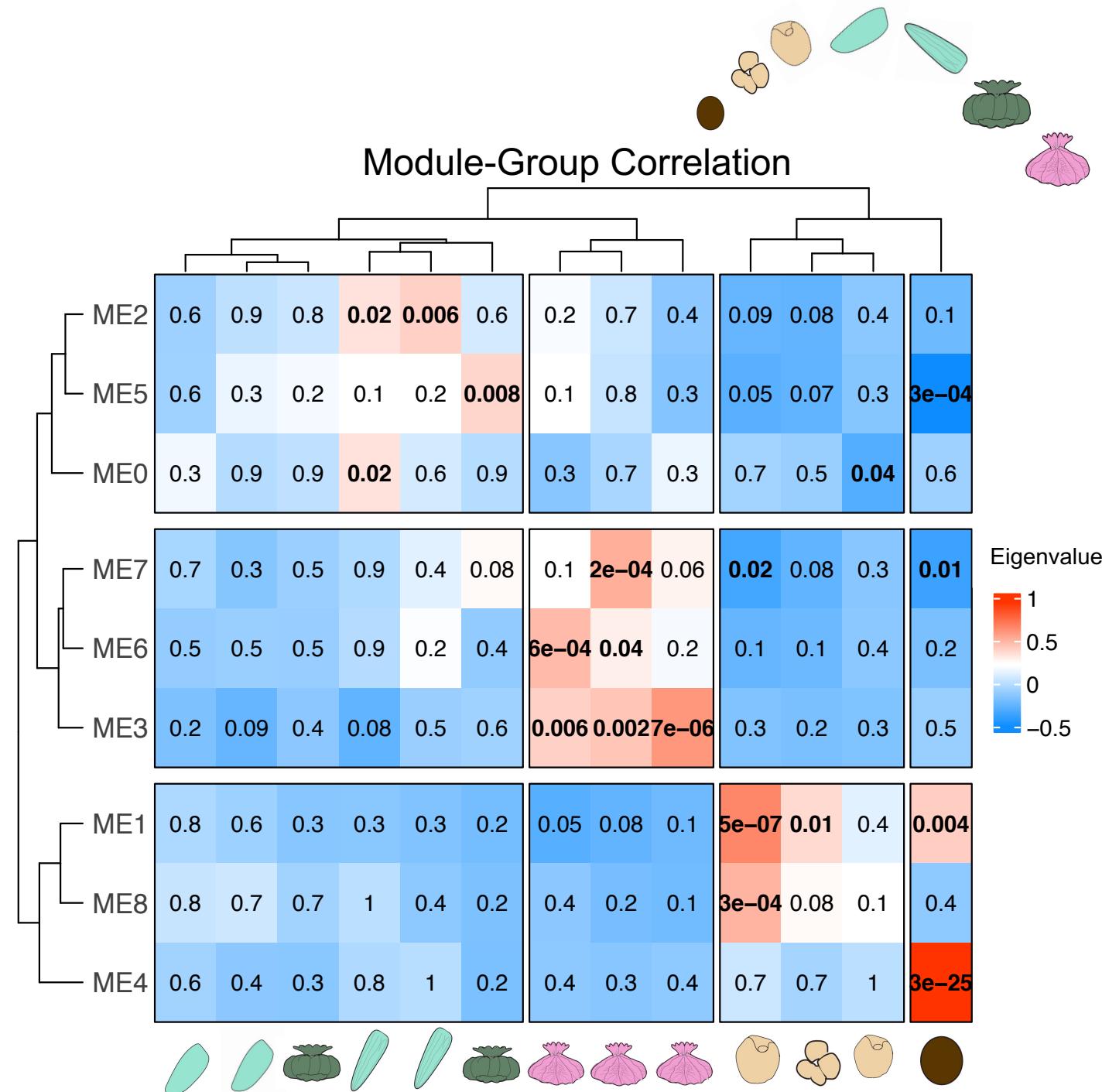
Rutgers Cancer Institute Metabolomics Facility

Distinct metabolomic profiles across ontogeny



Distinct metabolomic profiles across ontogeny

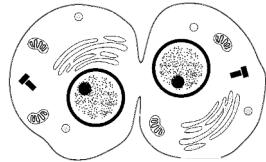
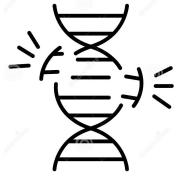
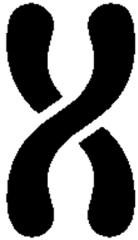
Weighted correlation network analysis



blockwiseModules module detection
Metaboanalyst 5.0 functional enrichment
Filtered FDR<0.05

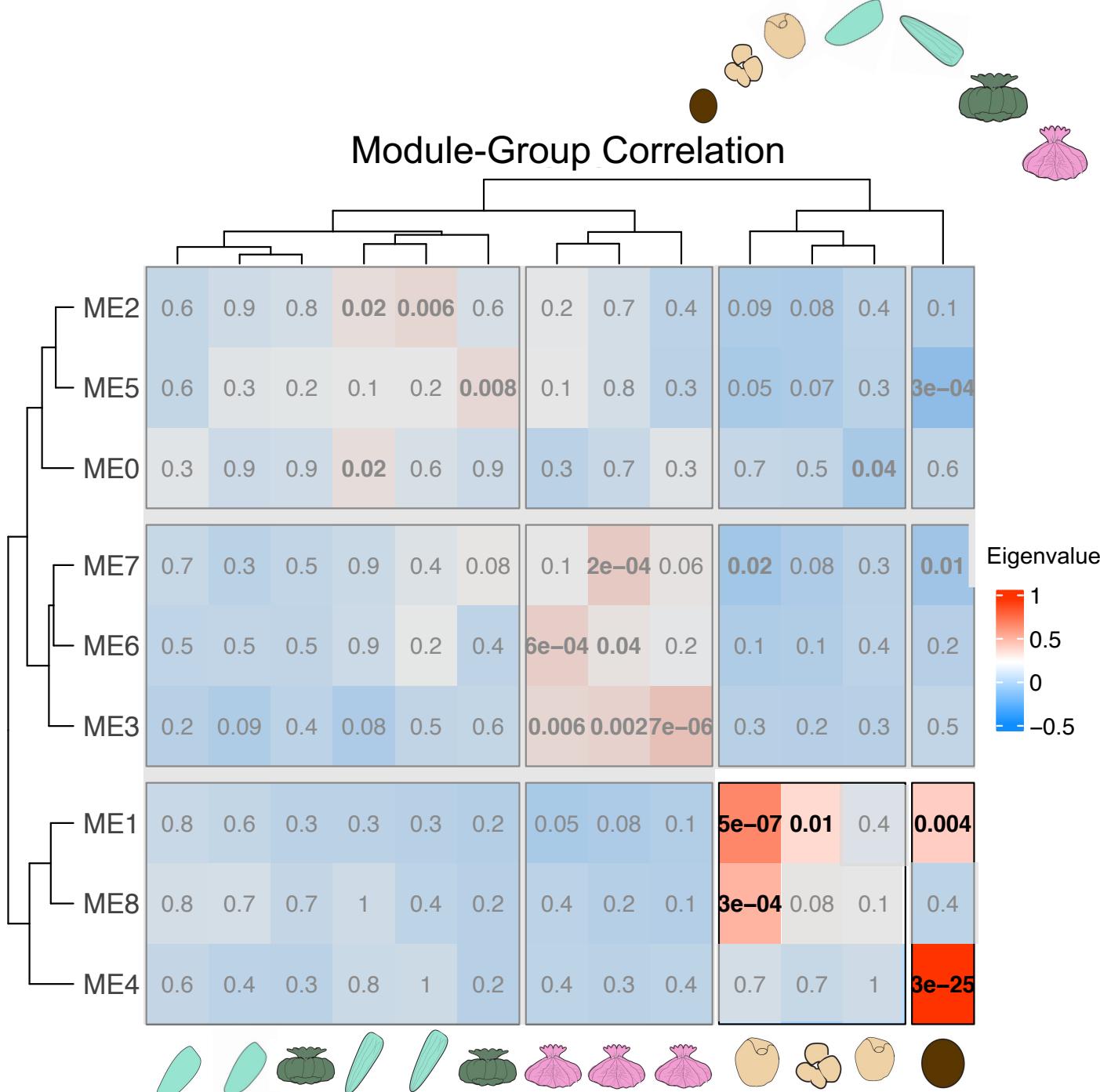
EGGS & EMBRYOS

1 hpf-65 hpf



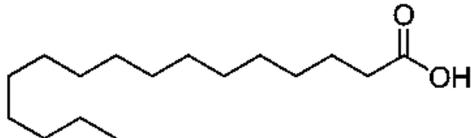
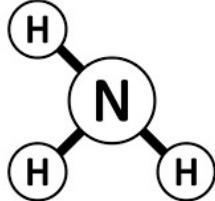
*Embryonic development
Cell division and differentiation*

Module-Group Correlation



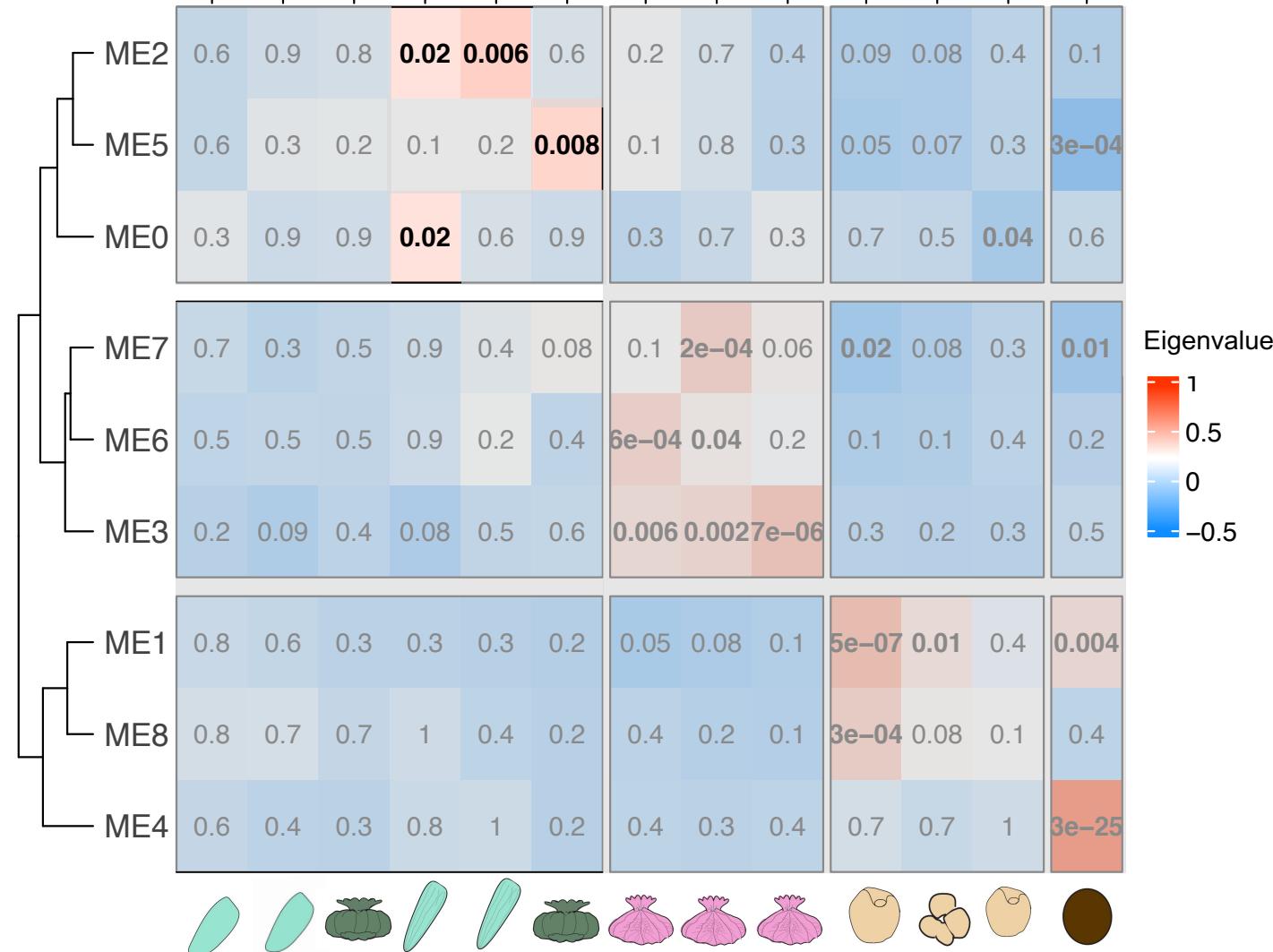
LARVAE & METAMORPHOSED POLYPS

93 hpf-231 hpf



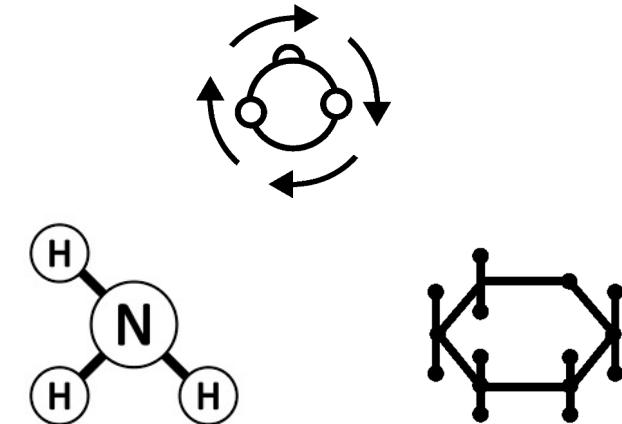
Nitrogen, protein, fatty acid metabolism

Module-Group Correlation

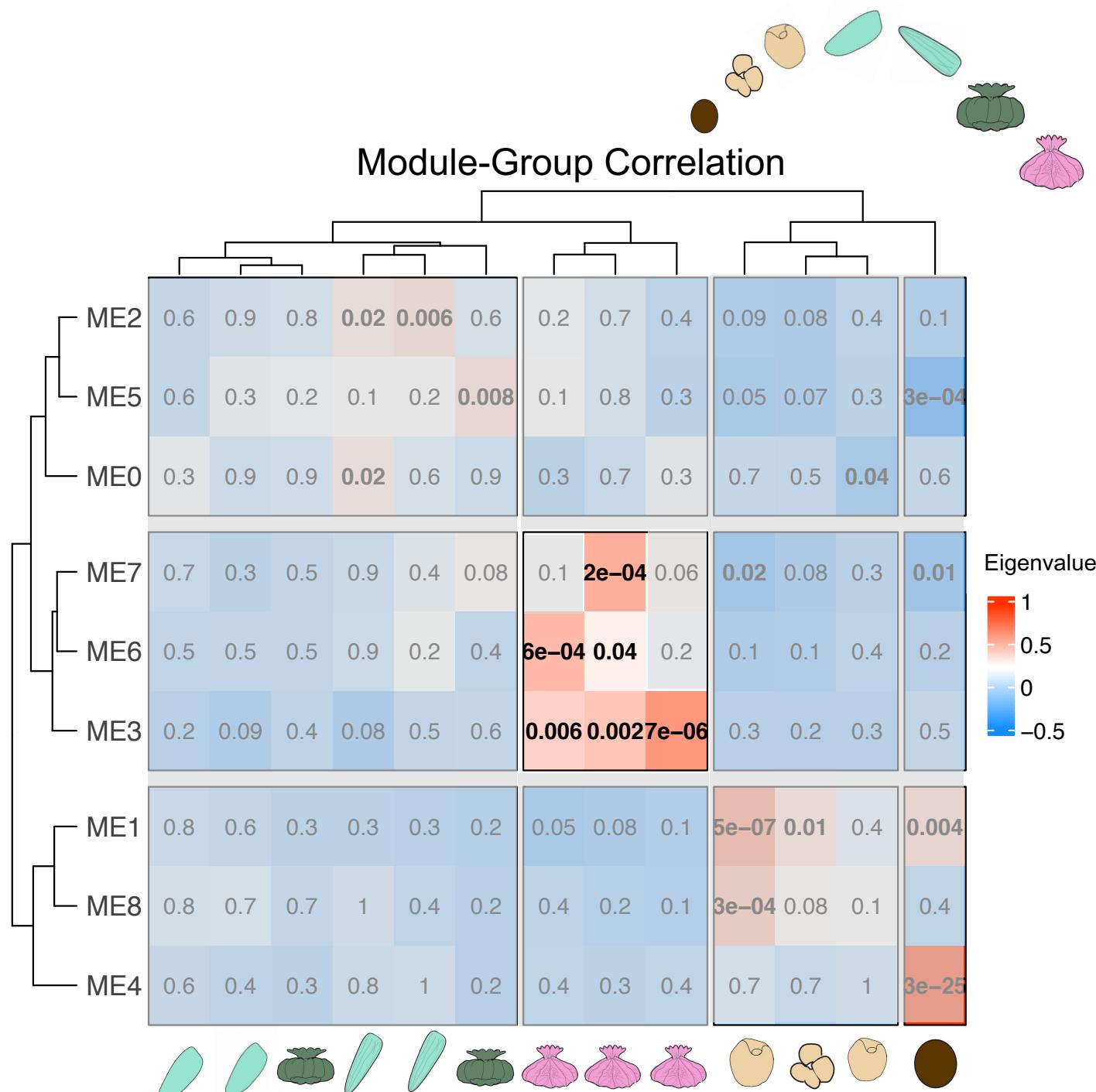


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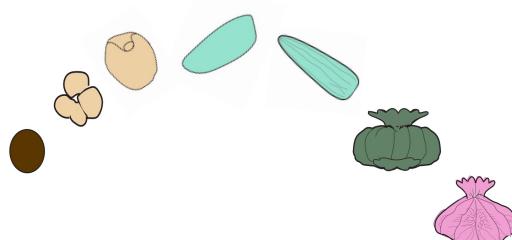
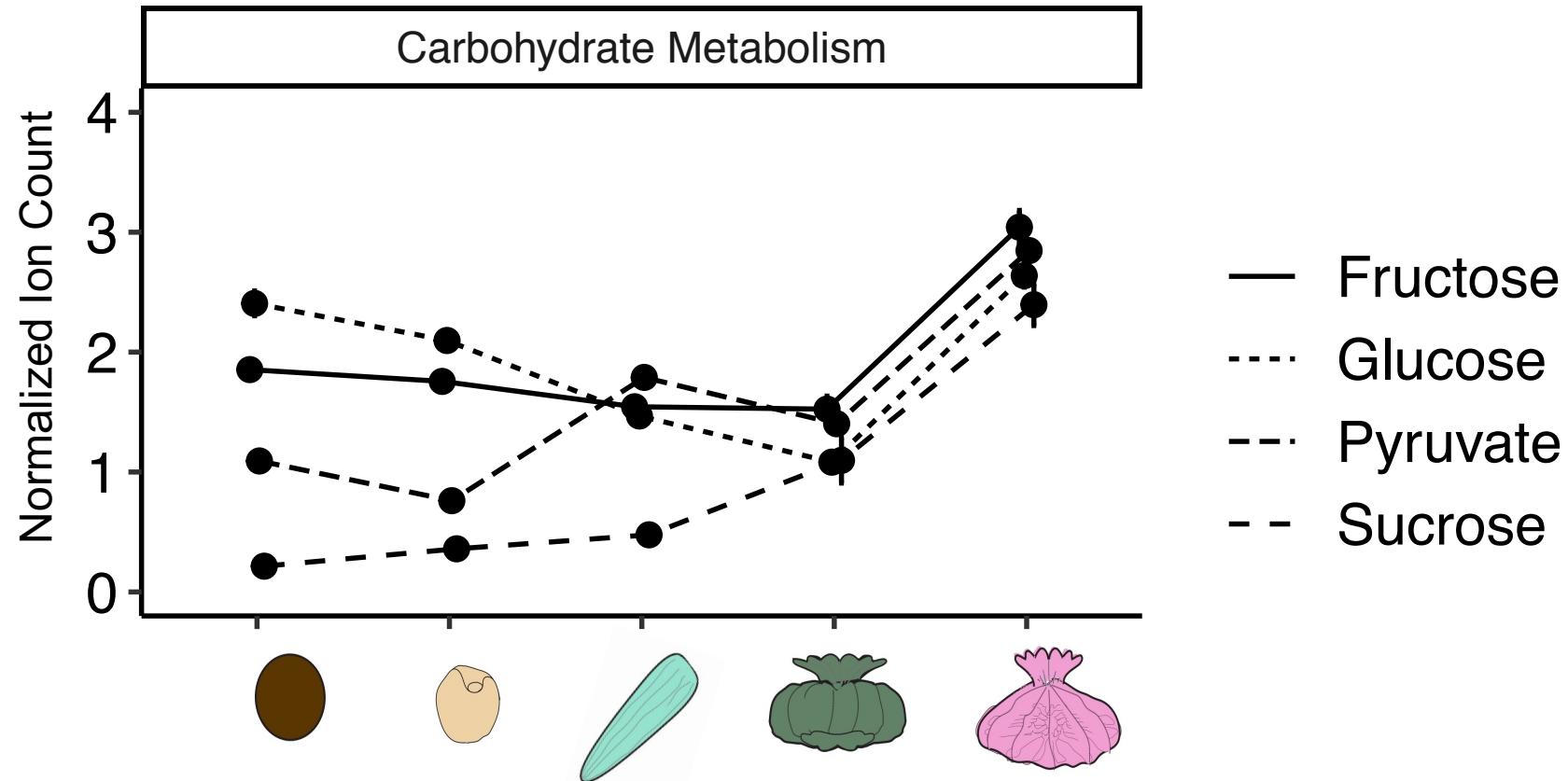
183 hpf-255 hpf



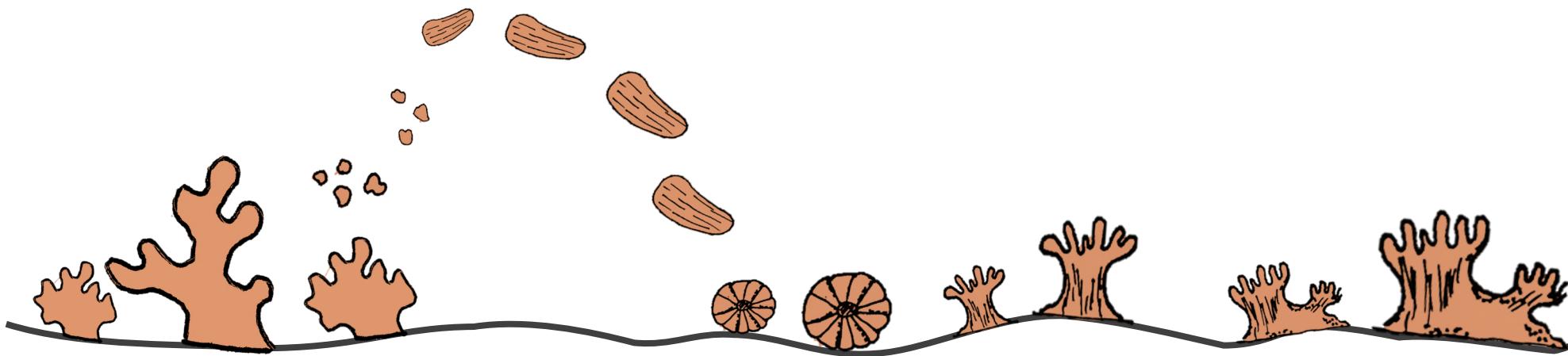
Nitrogen, carbohydrate metabolism



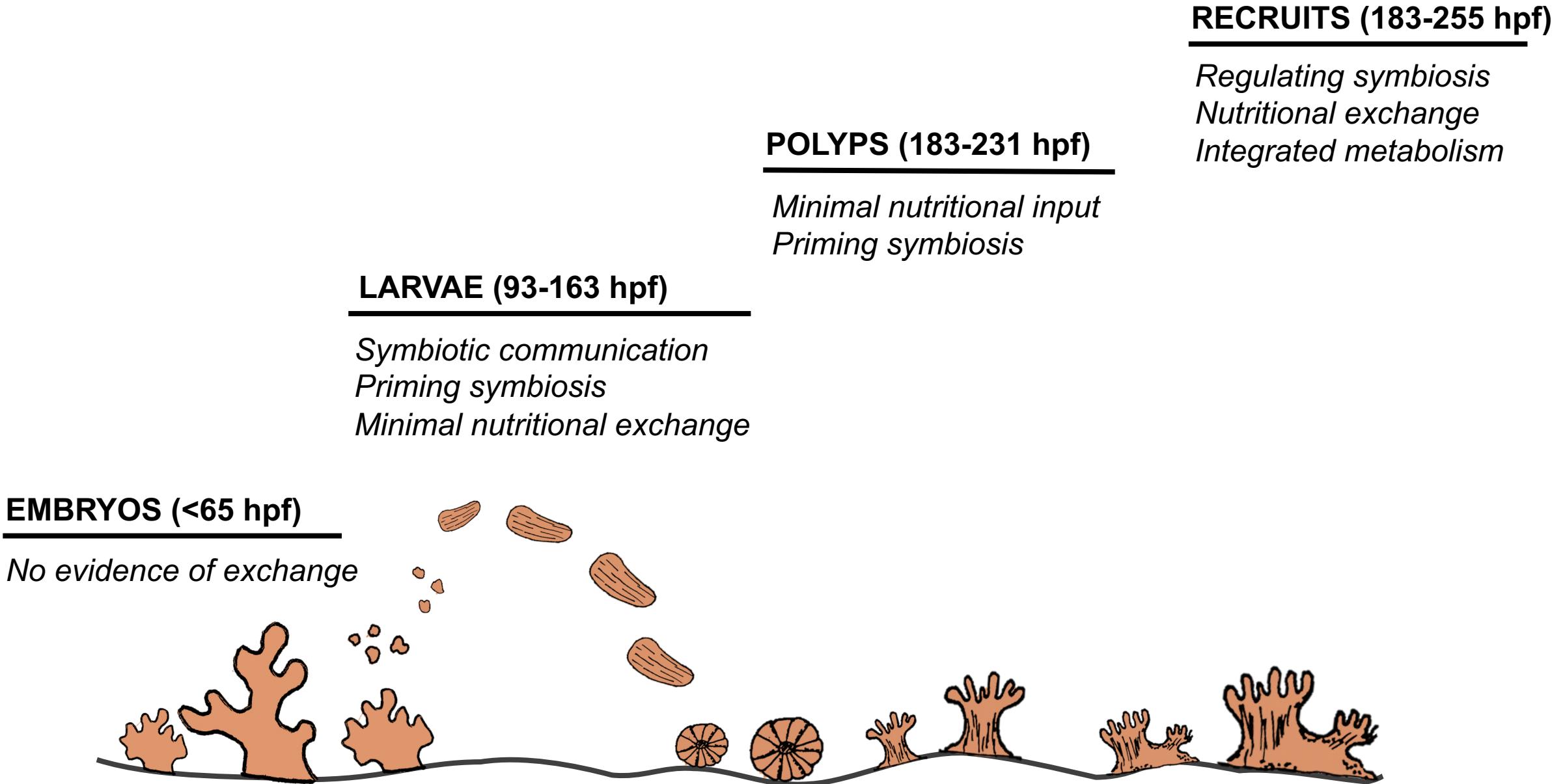
CARBON METABOLISM



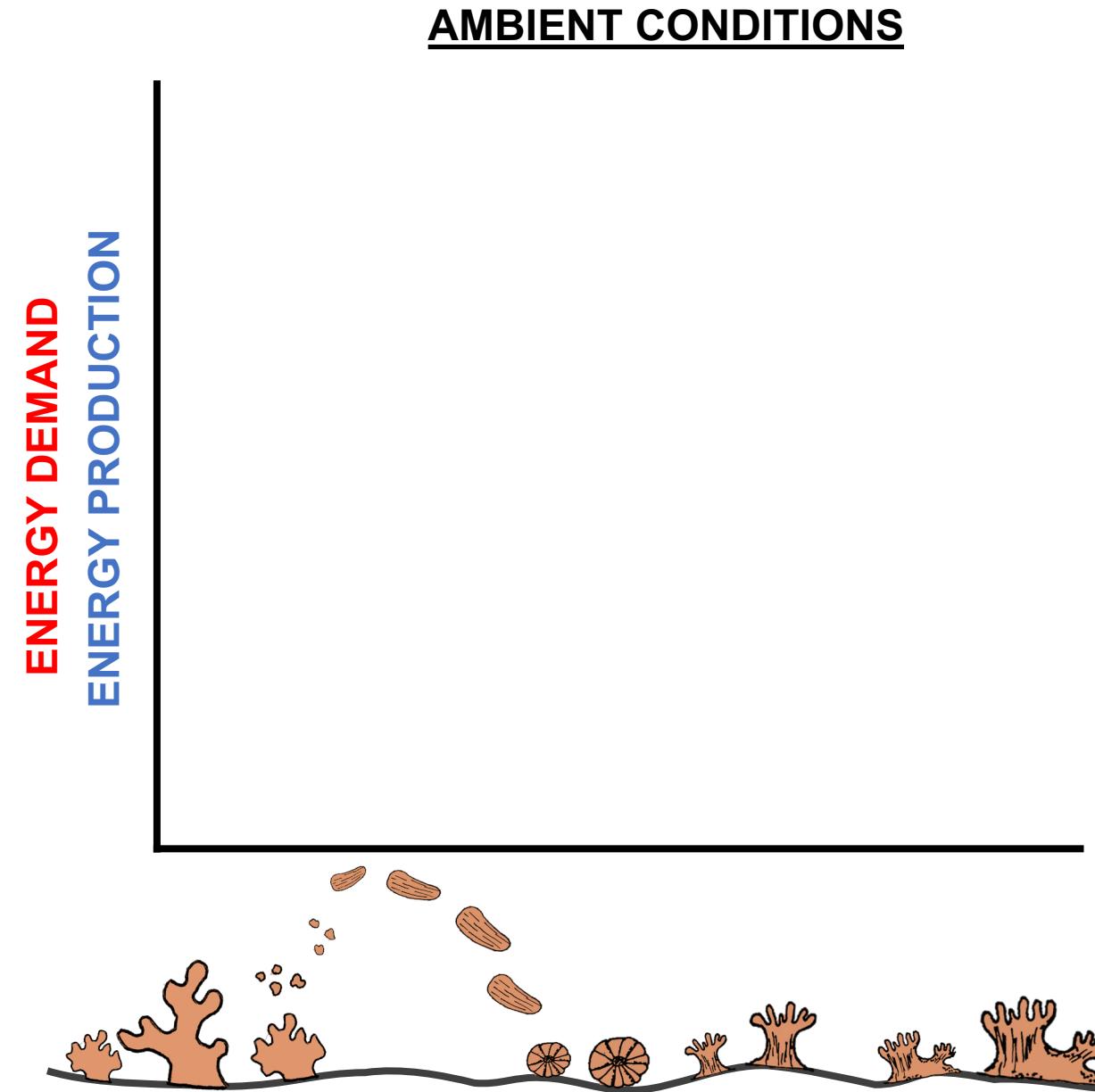
When does symbiotic nutritional exchange begin during development?



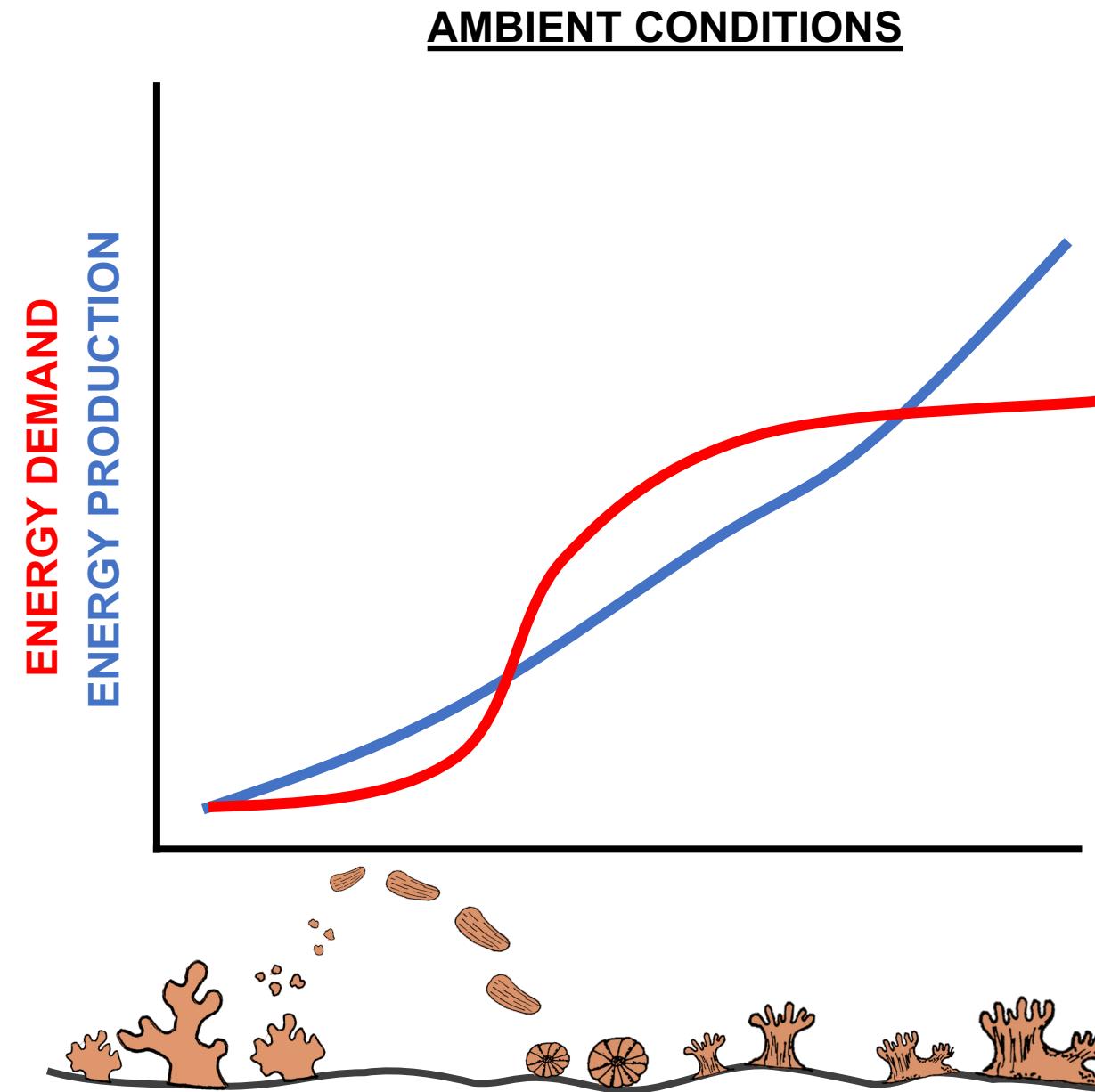
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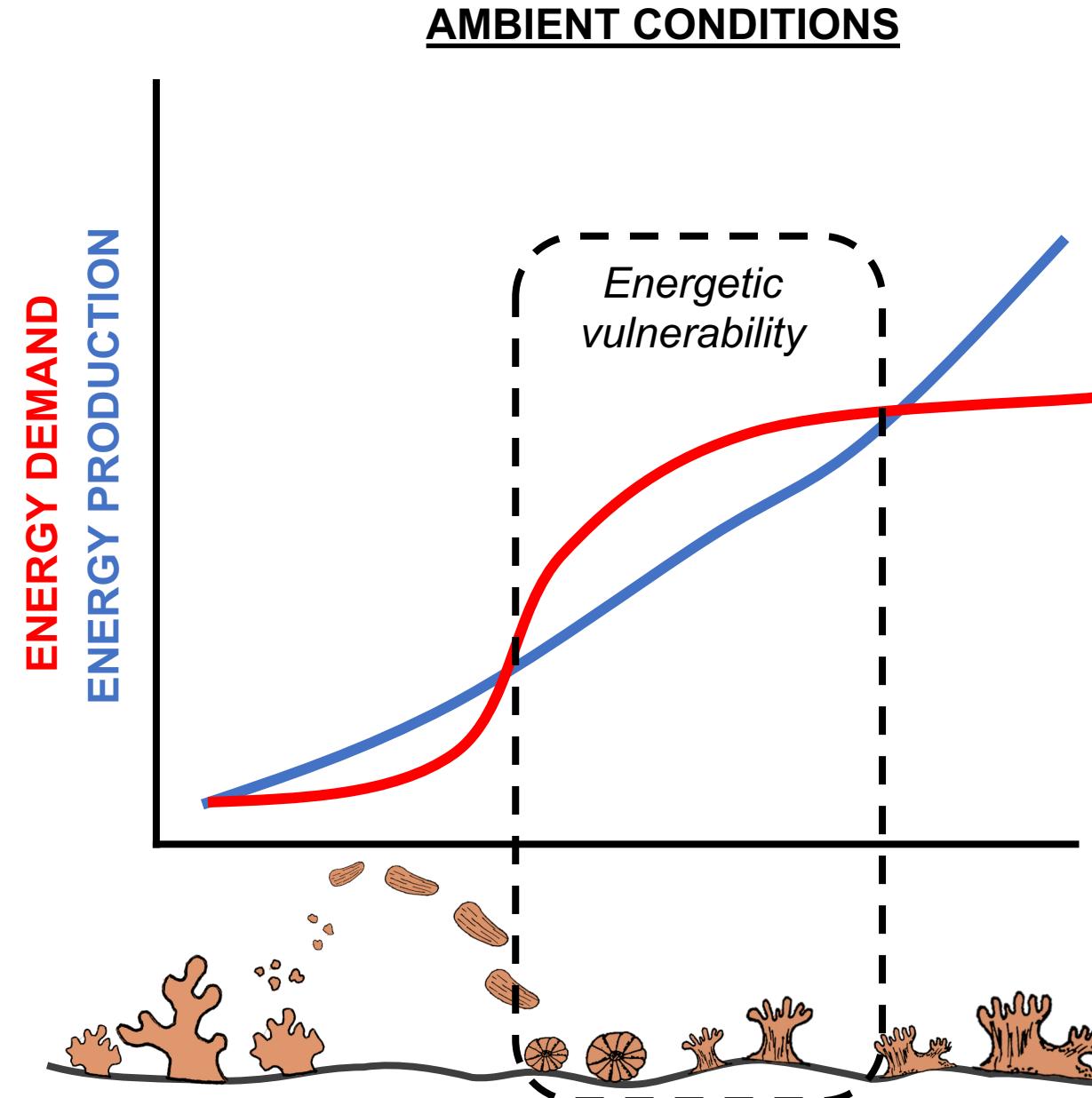
How does nutritional exchange impact energetic capacity during recruitment?



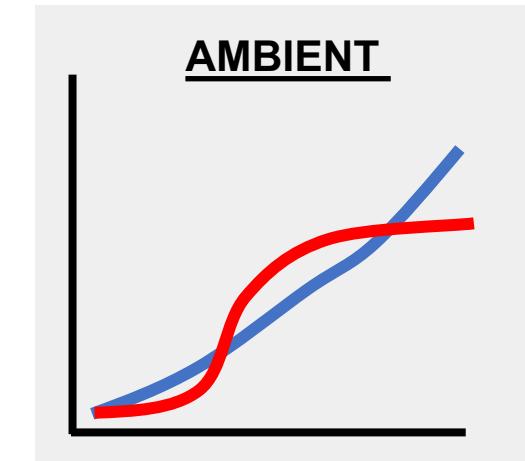
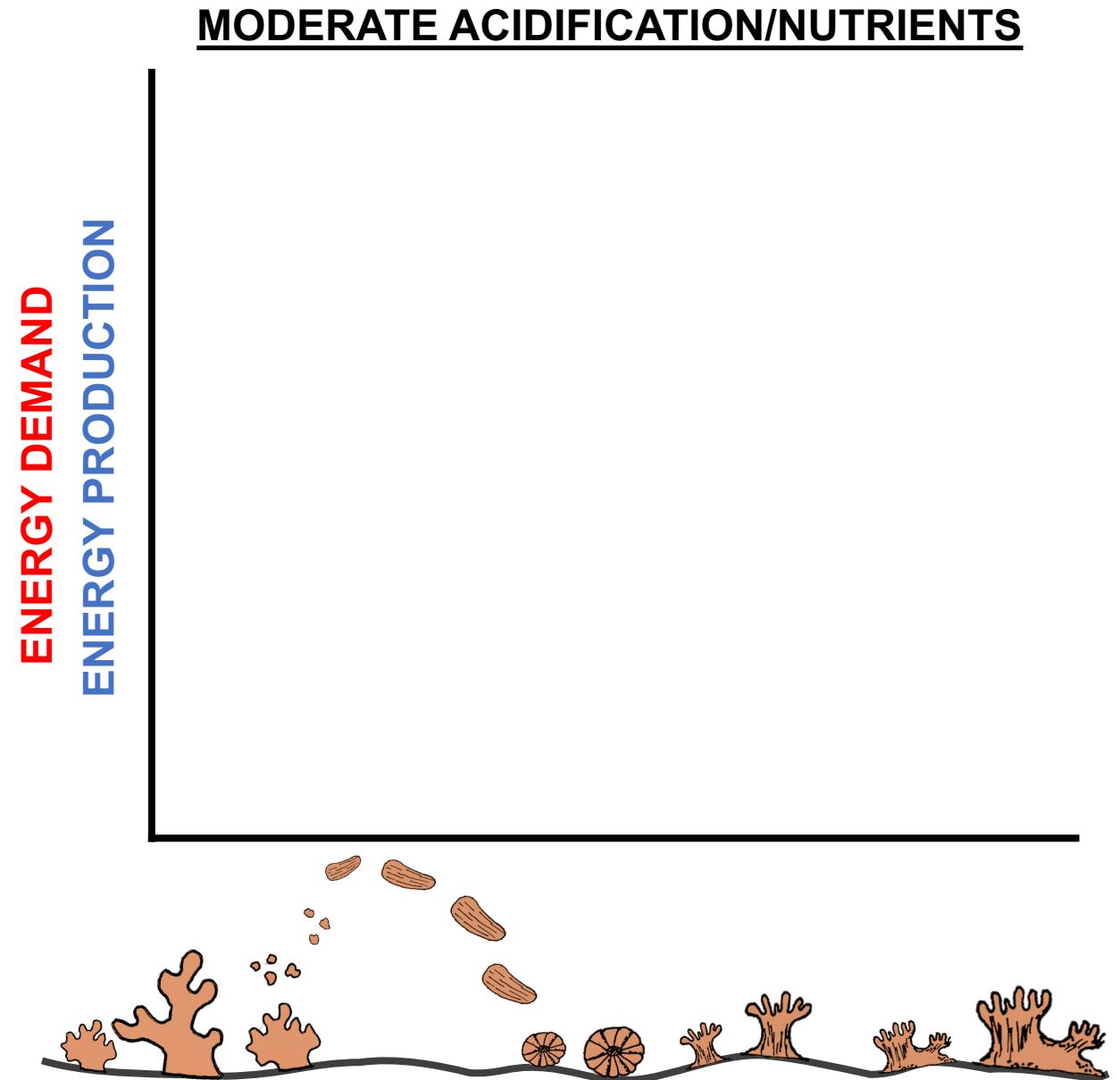
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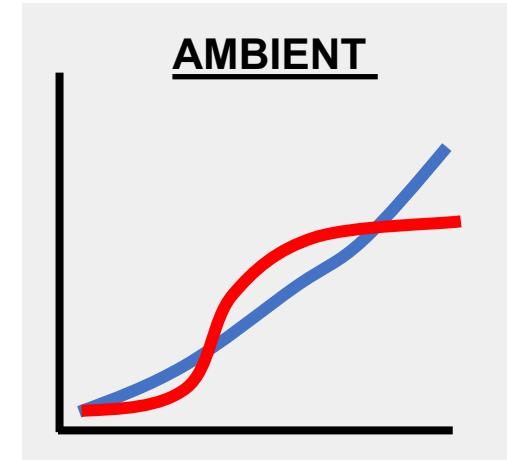
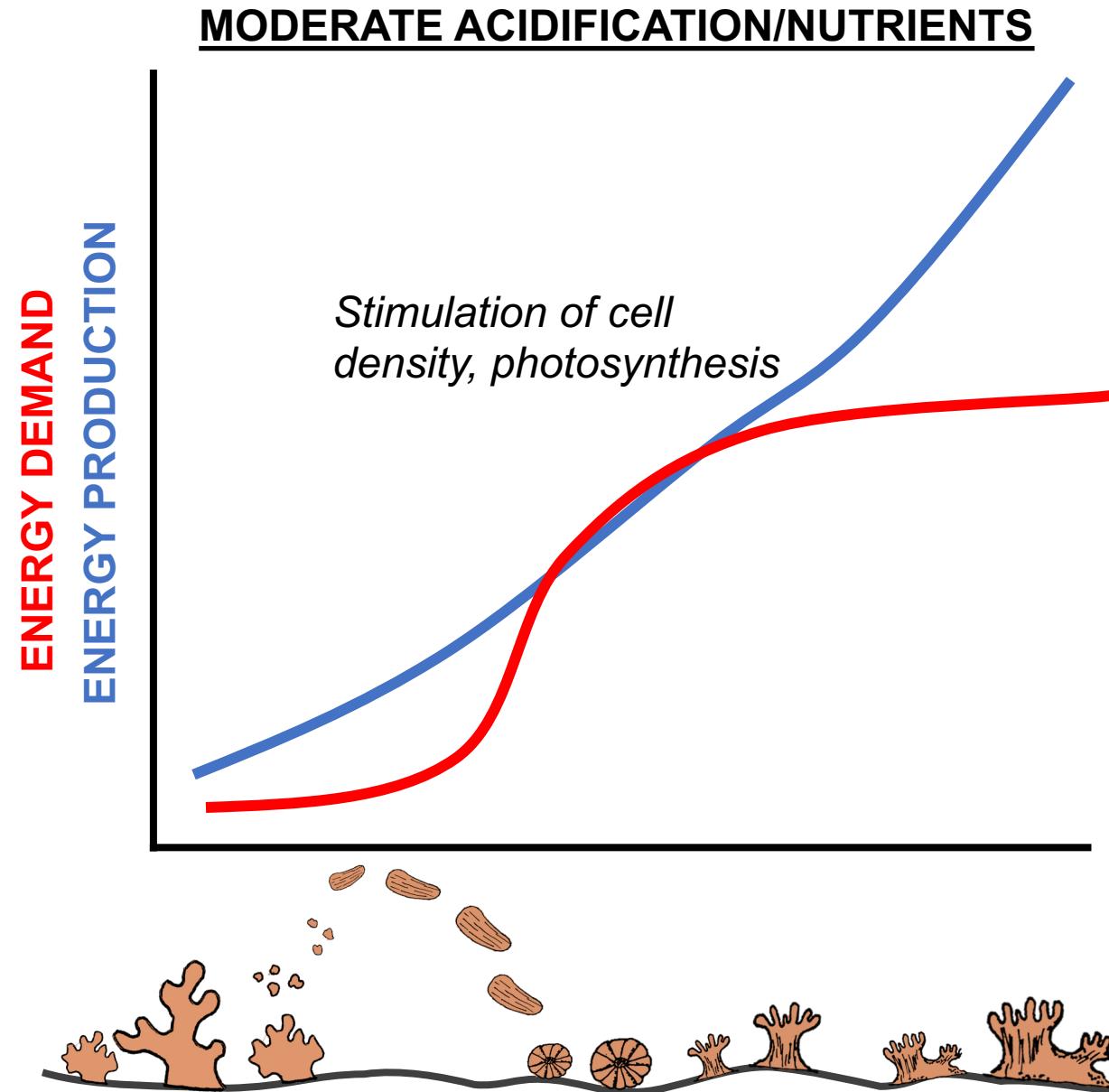
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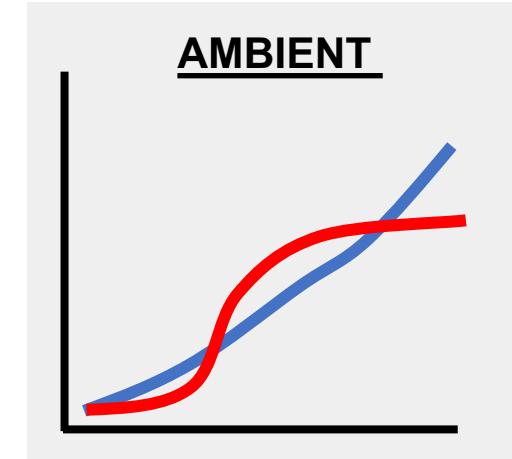
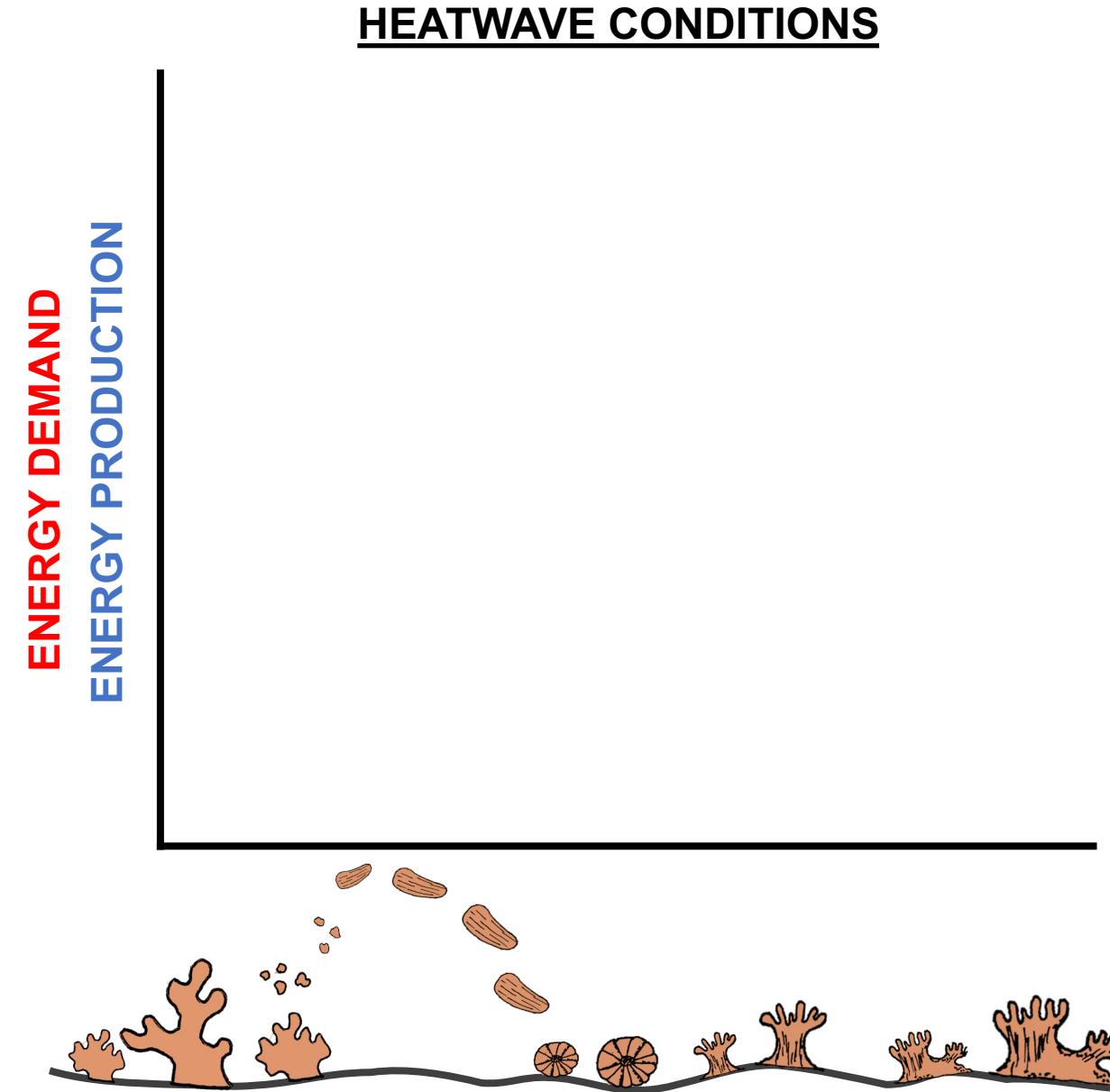
How does nutritional exchange impact energetic capacity during recruitment?



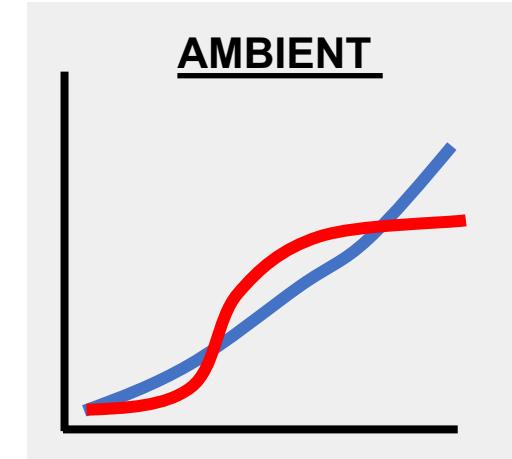
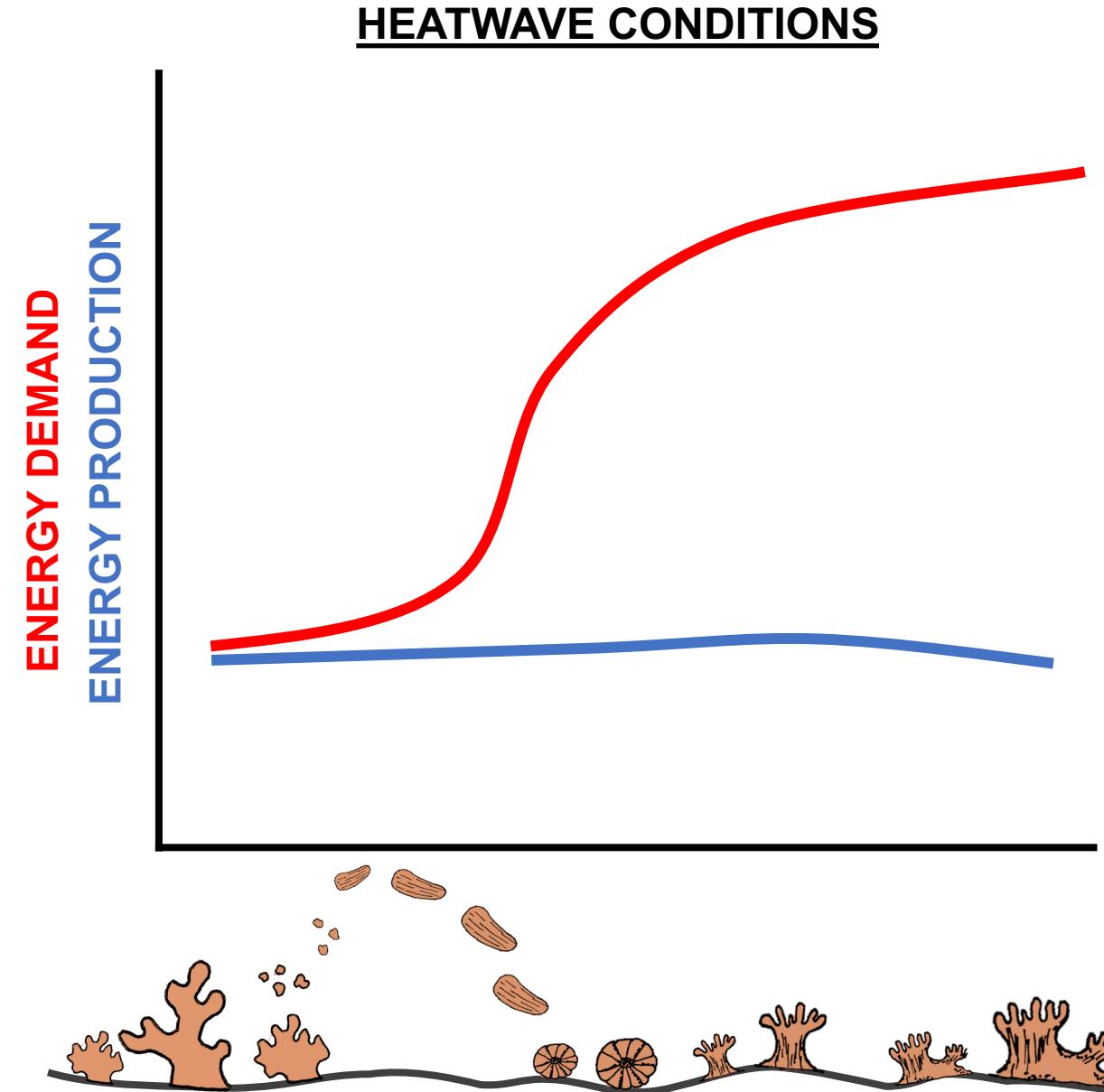
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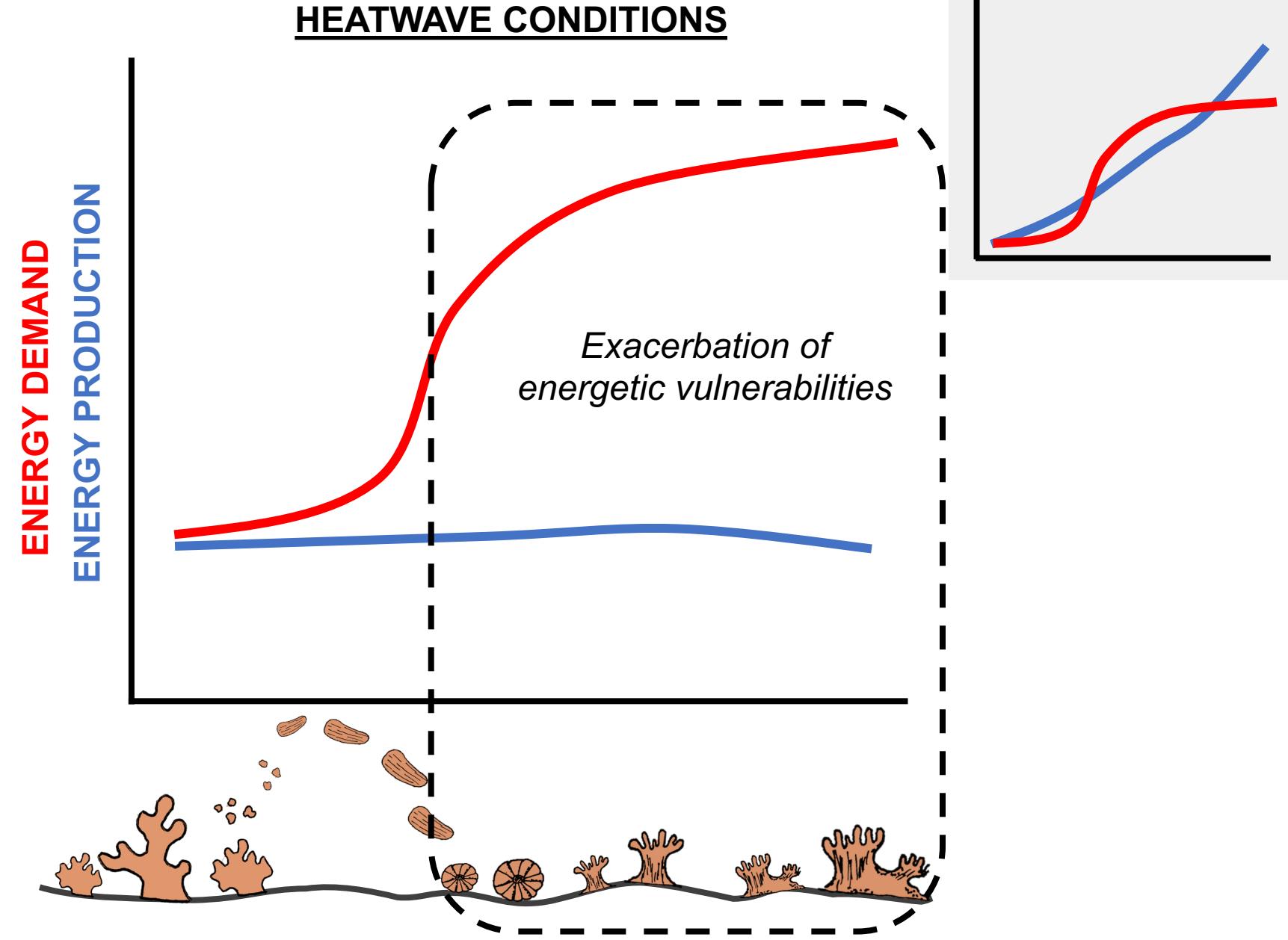
How does nutritional exchange impact energetic capacity during recruitment?



How does nutritional exchange impact energetic capacity during recruitment?



How does nutritional exchange impact energetic capacity during recruitment?



ACKNOWLEDGEMENTS

Funding

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E5 Rules of Life: Epigenetics
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Coral Resilience Lab
Crawford Drury
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Coauthors

Kevin Wong
Danielle Becker-Polinski
Hollie Putnam
Tali Mass

Laboratory Support

Maggie Schedl
Emma Strand

Mentors & Collaborations

Hollie Putnam
Steven Roberts
E5 RoL Coral Team

Analytical Support

URI Sequencing Core
Rutgers Cancer Institute
URI High Performance Computing
UT Austin Genomic Sequencing Facility

