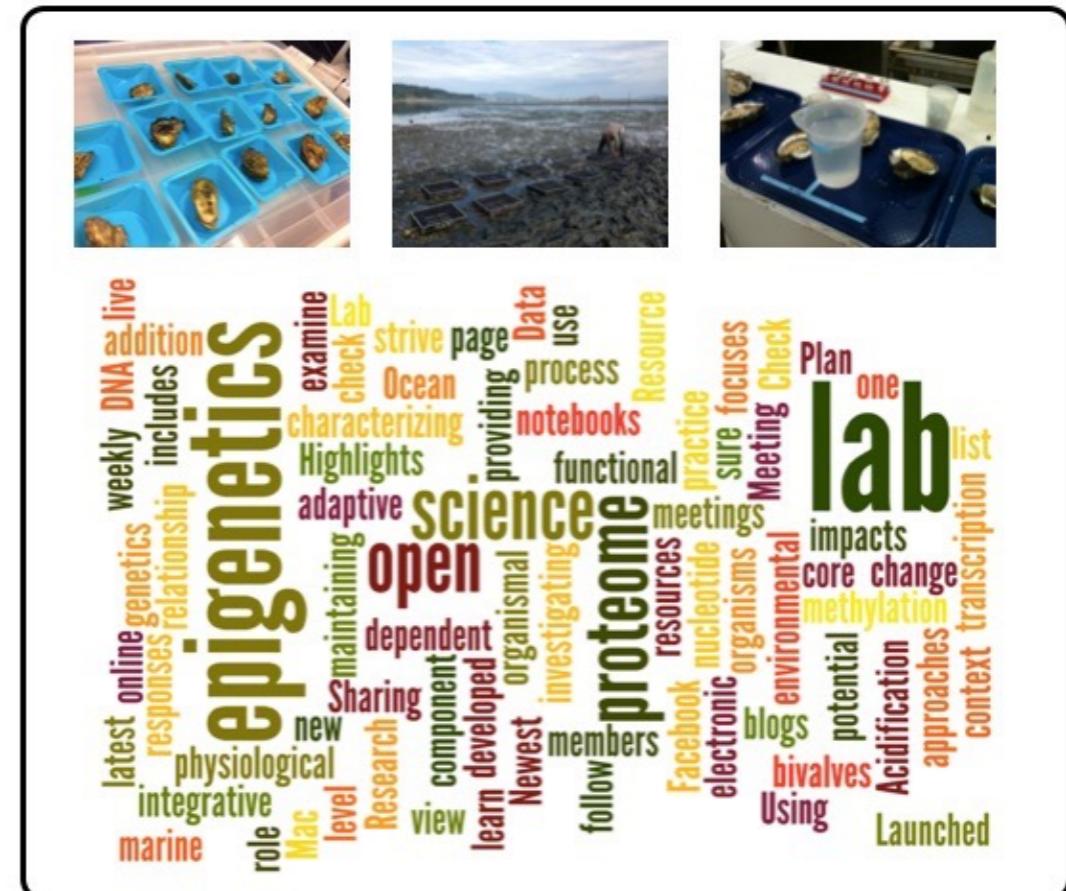


Towards a functional understanding of DNA methylation in shellfish

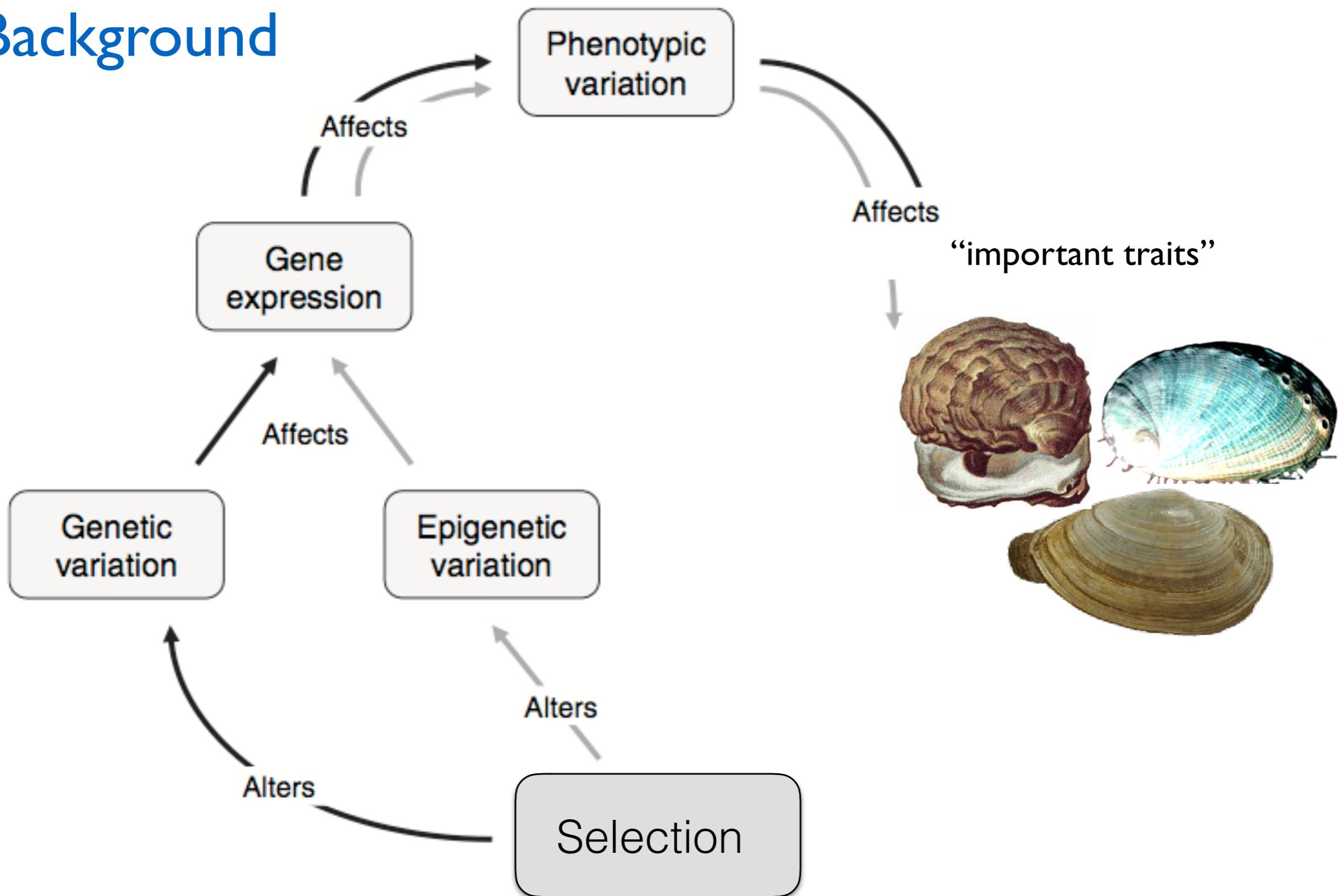
Steven Roberts

Kenneth K. Chew Endowed Professor
University of Washington
School of Aquatic and Fishery Sciences
robertslab.info

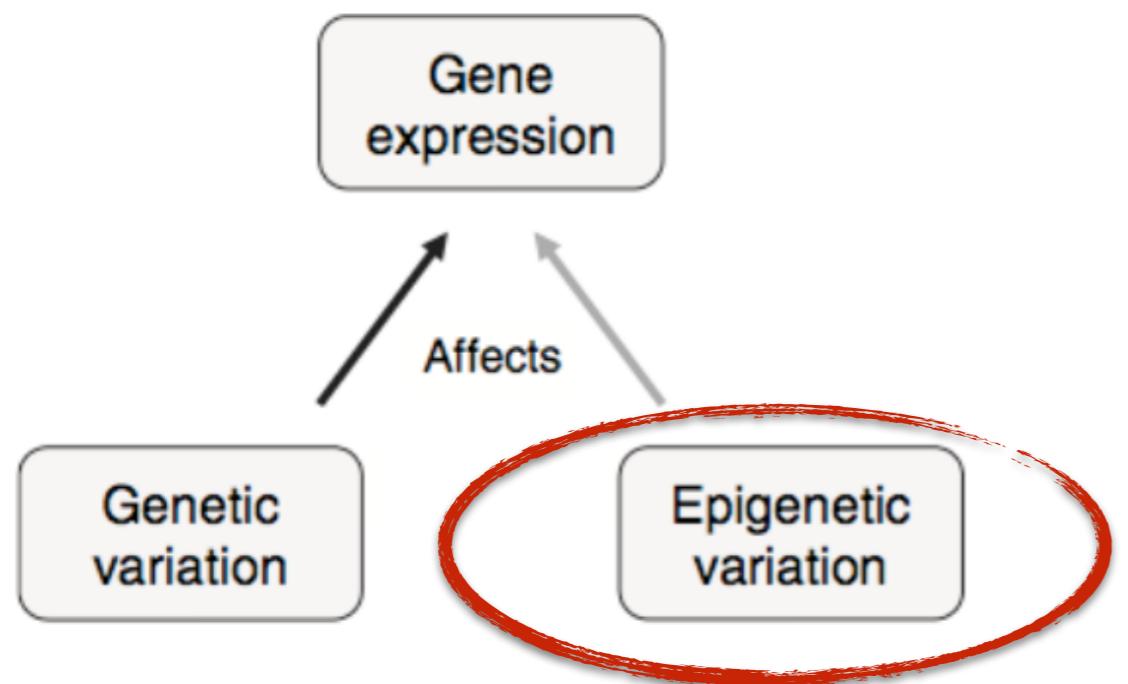
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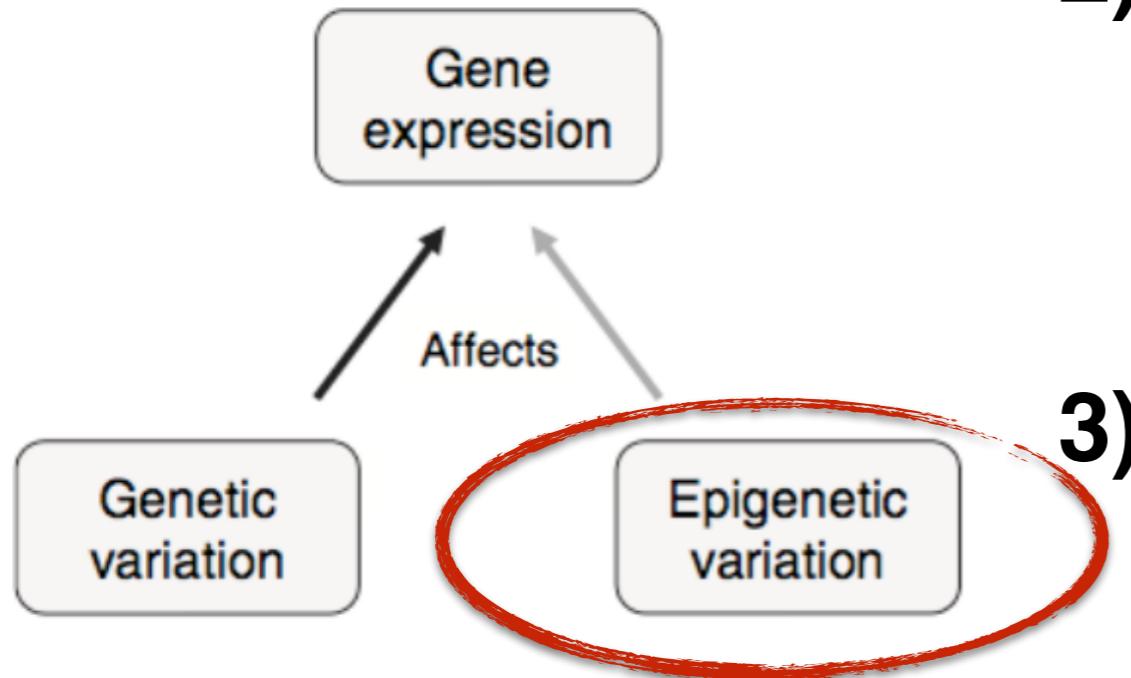
Background



Big Questions

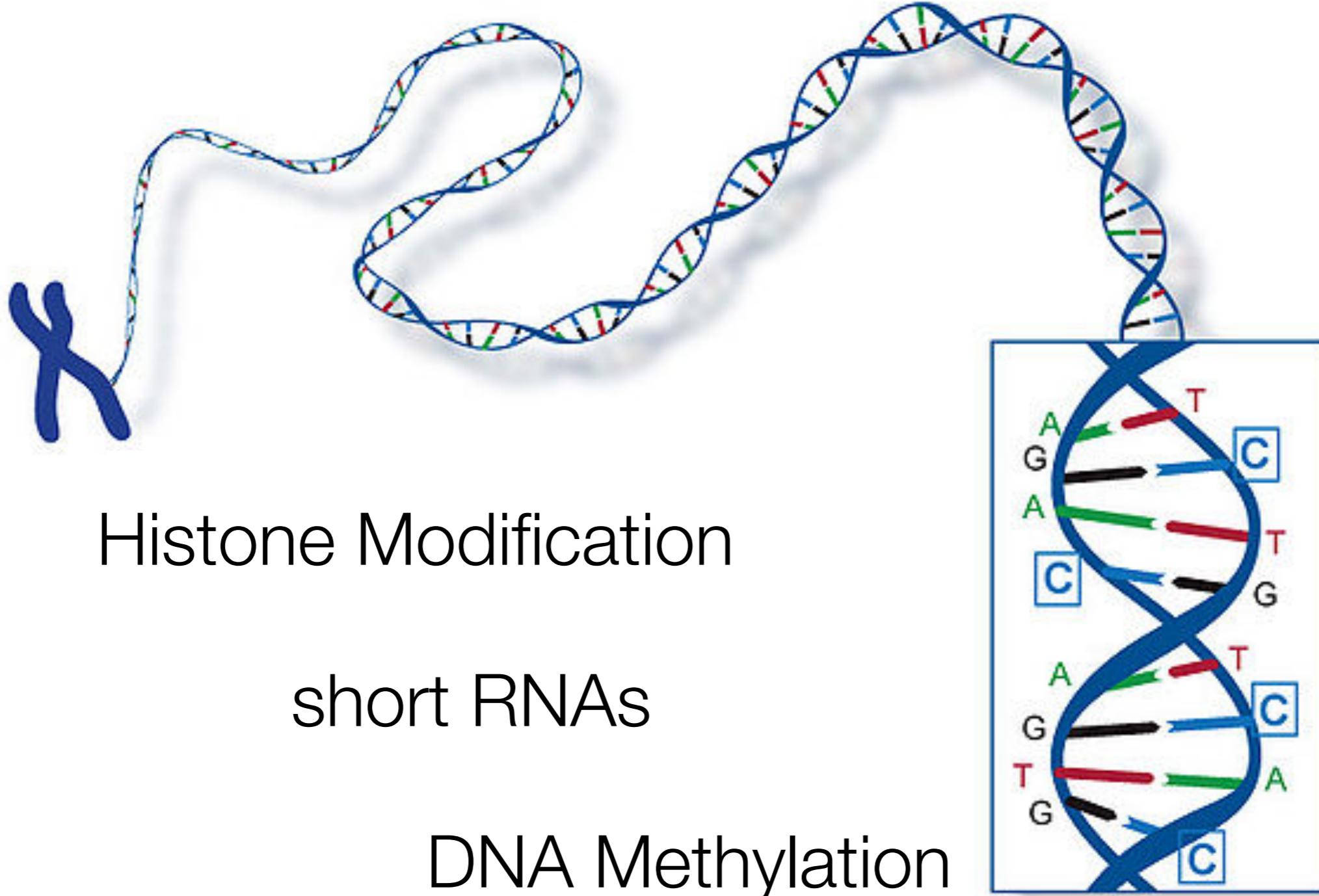


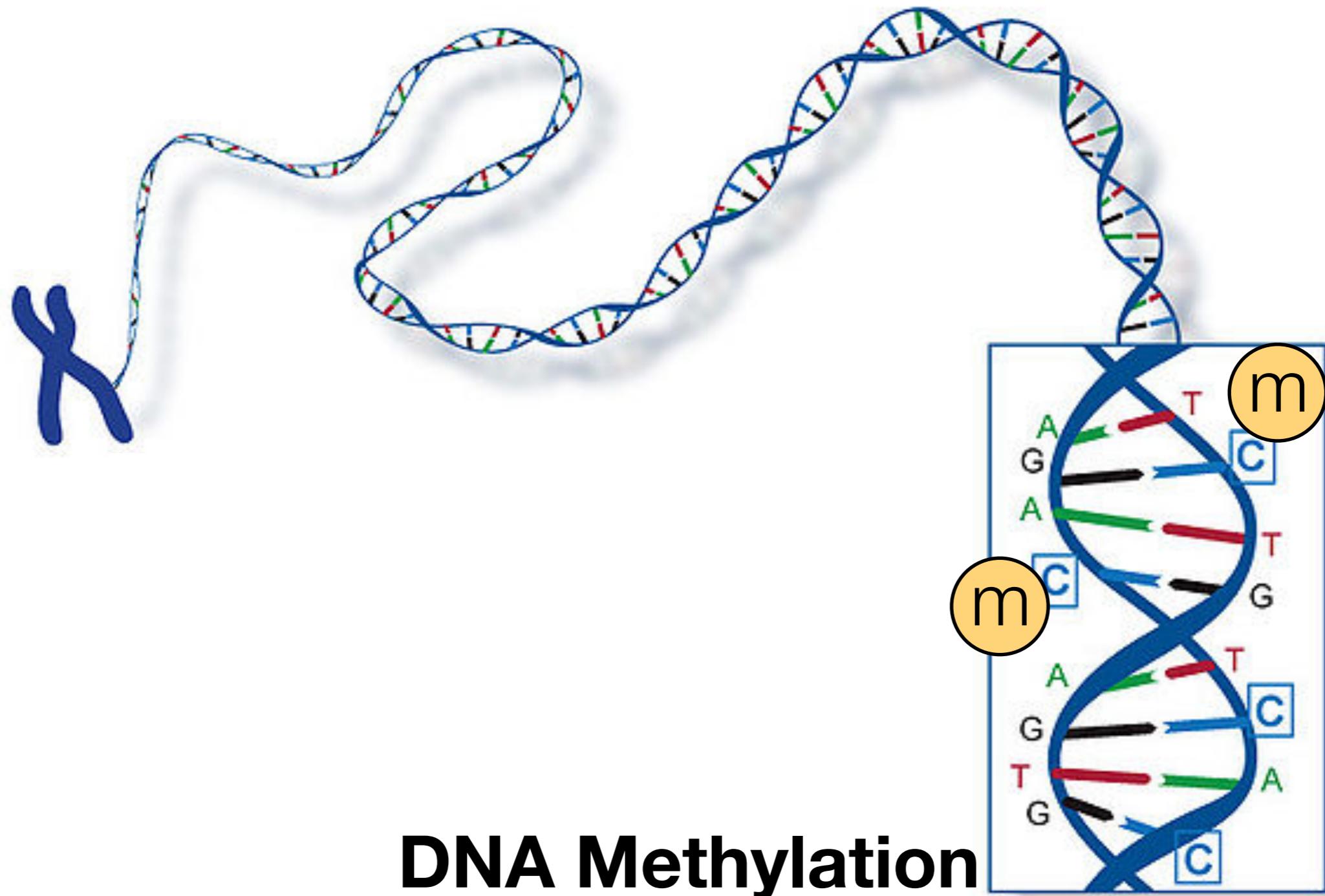
Big Questions



- 1) To what degree is epigenetic variation heritable?**
- 2) Is epigenetic variation independent of genetic variation?**
- 3) How do environmental conditions influence epigenetic variation?**
- 4) What type of epigenetic phenomenon contributes most to phenotype?**

Epigenetics





Outline

Methylation landscape

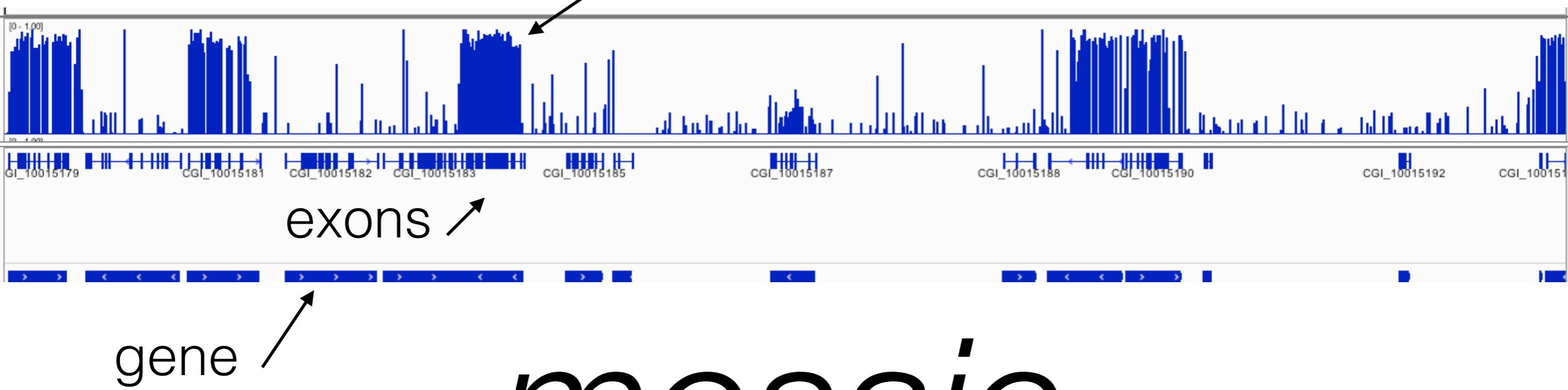
Population studies

Environmental change

- 1) To what degree is epigenetic variation heritable?
- 2) Is epigenetic variation independent of genetic variation?
- 3) How do environmental conditions influence epigenetic variation?

Methylation landscape

DNA methylation level (0-100%) @ cytosines



mosaic

associated with gene bodies

Methylation landscape

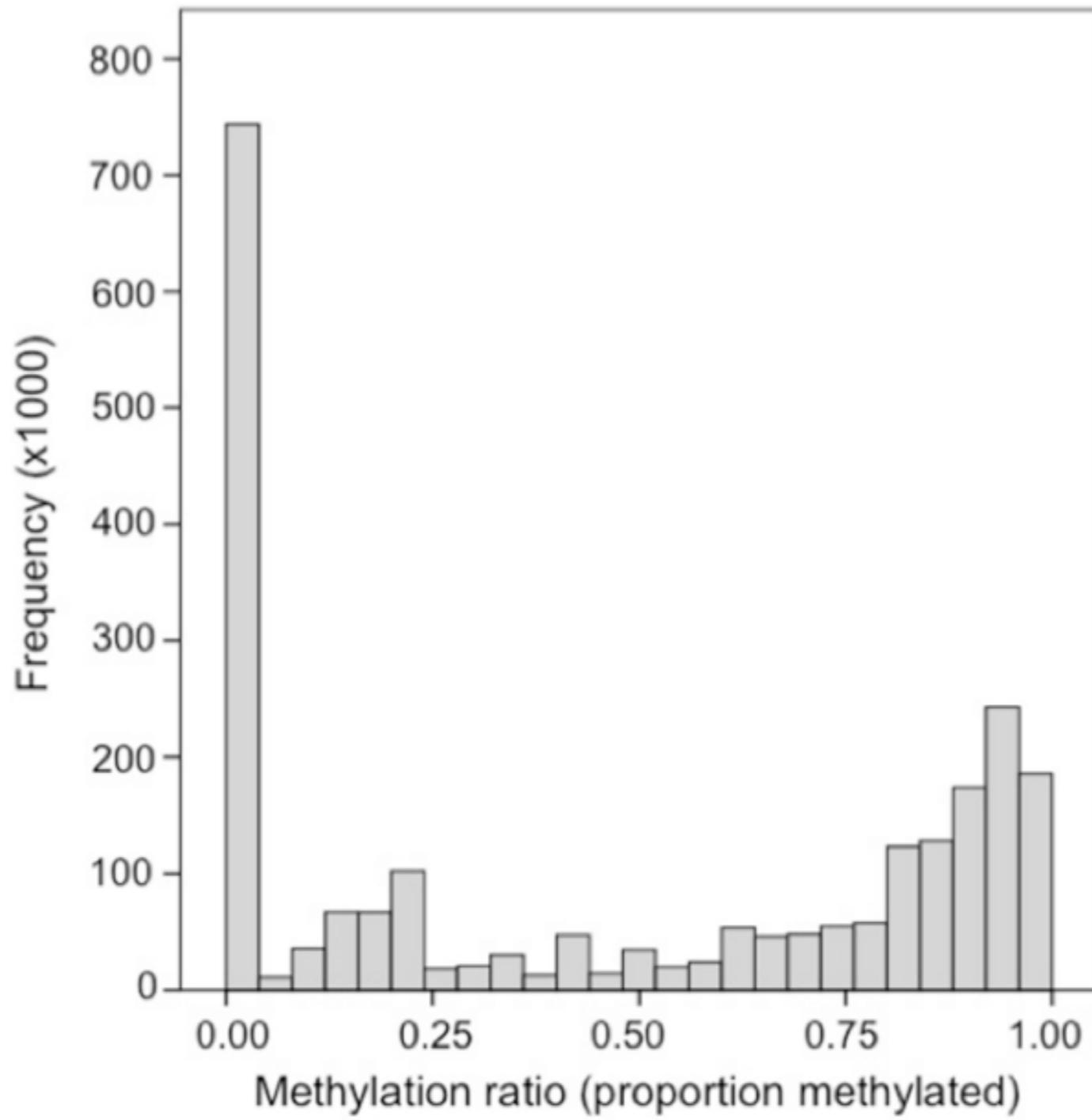
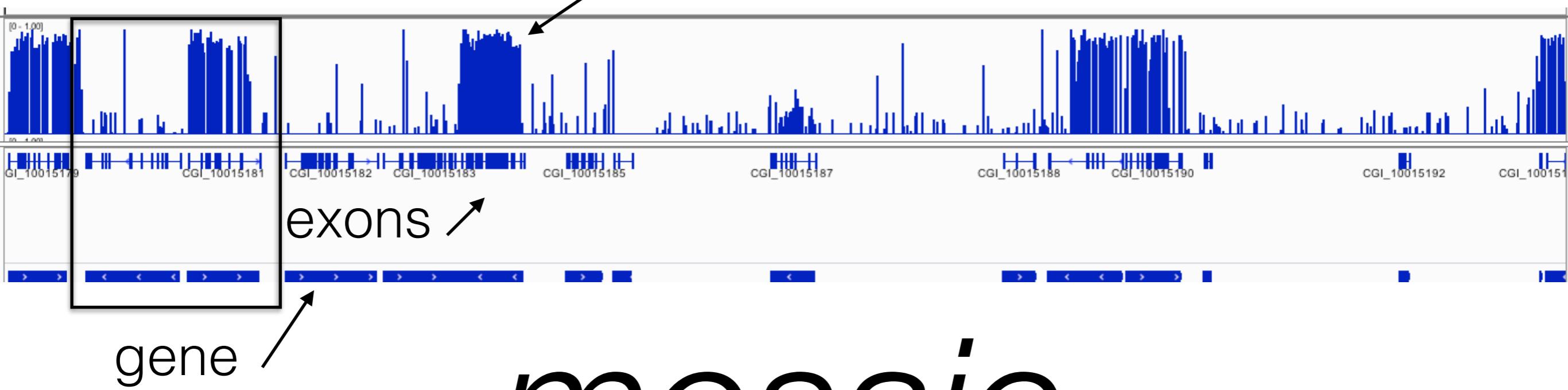


Figure 1 Frequency distribution of methylation ratios for CpG dinucleotides in oyster gill tissue. A total of 2,625,745 CpG dinucleotides with $\geq 5 \times$ coverage are represented.

Methylation landscape

DNA methylation level (0-100%) @ cytosines

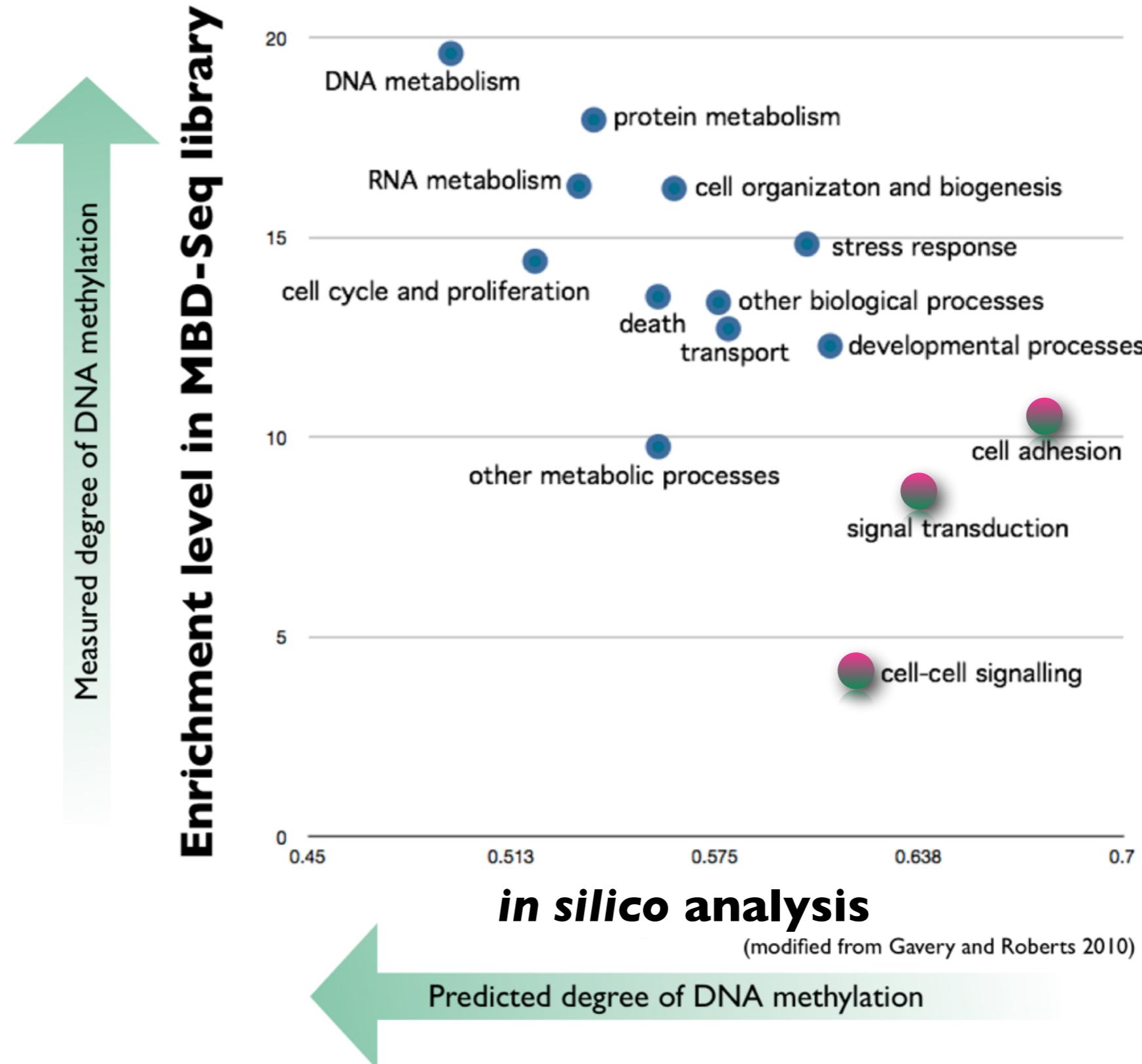


mosaic

Why are only a subset of genes methylated?

associated with gene bodies

Methylation landscape



Outline

1) To what degree is epigenetic variation heritable?

Methylation landscape

2) Is epigenetic variation independent of genetic variation?

Population studies

3) How do environmental conditions influence epigenetic variation?

Environmental change

Population studies



Reciprocal Transplant Experiment



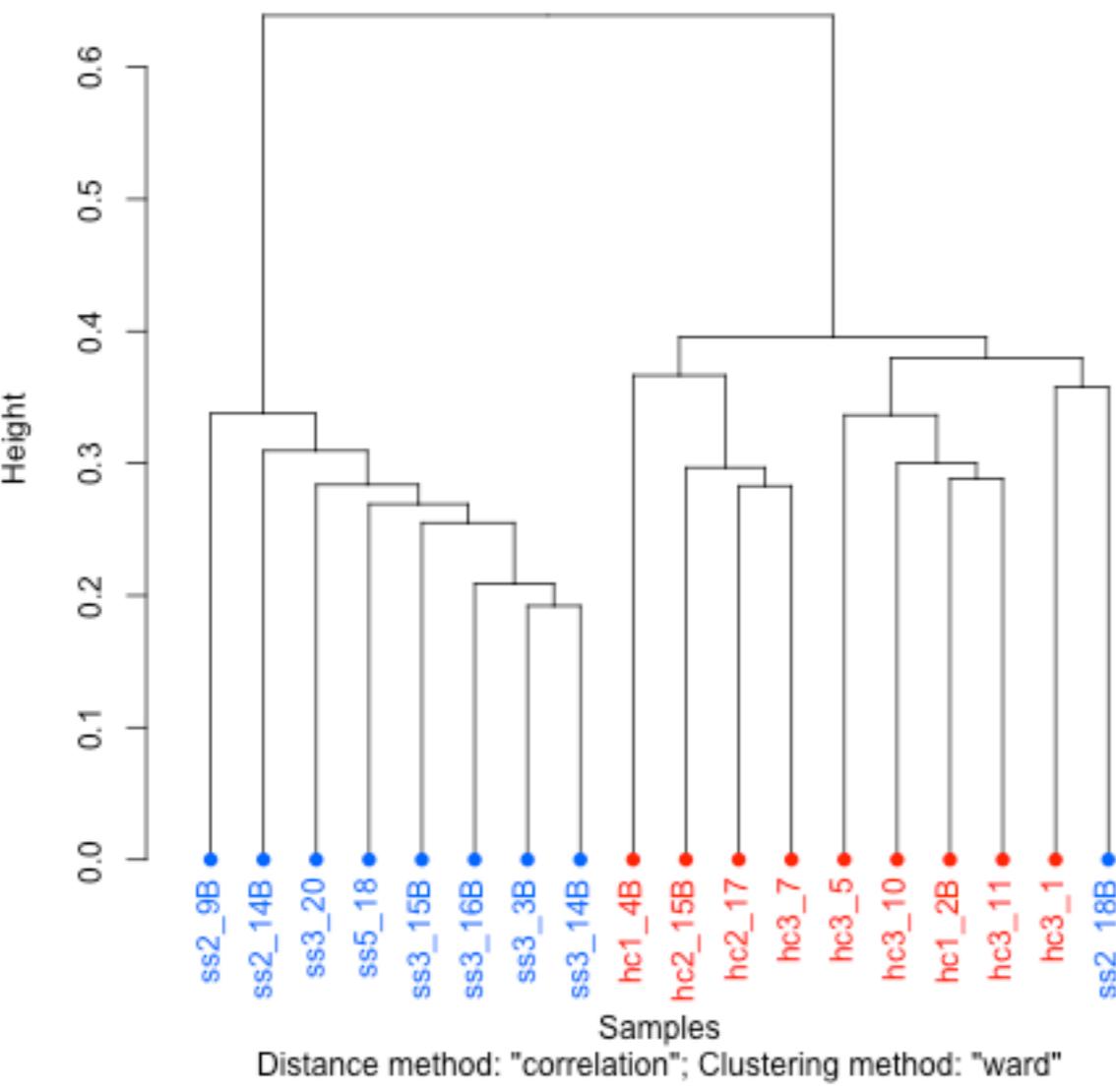
Manchester

Population studies



Reciprocal Transplant Experiment

CpG methylation clustering



Manchester

Population studies



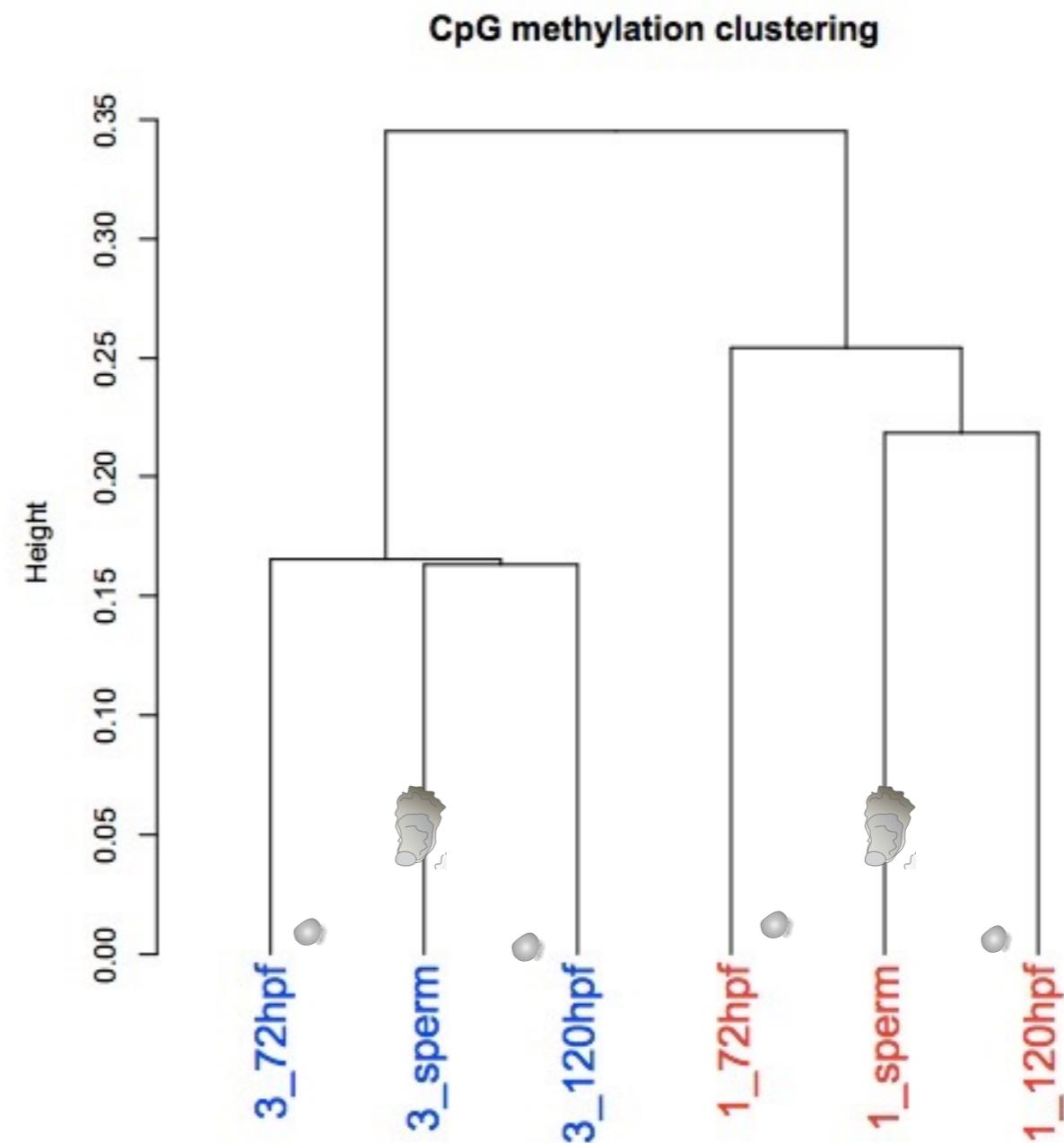
bioRxiv
beta
THE PREPRINT SERVER FOR BIOLOGY

New Results

Indication of family-specific DNA methylation patterns in developing oysters

Claire E. Olson , Steven B. Roberts

doi: <http://dx.doi.org/10.1101/012831>



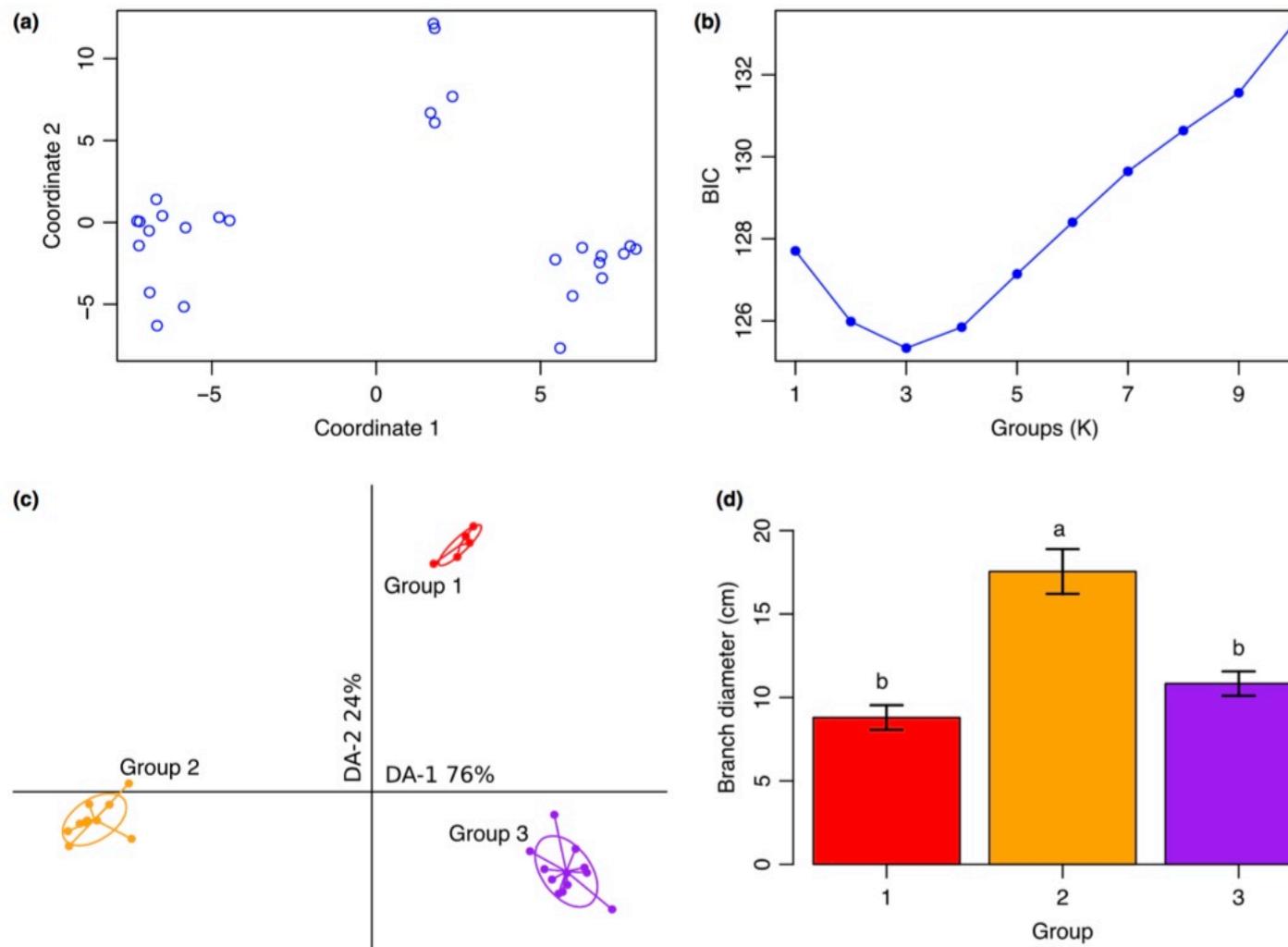
Population studies

ORIGINAL ARTICLE

WILEY MOLECULAR ECOLOGY

Genetic and epigenetic insight into morphospecies in a reef coral

James L. Dimond^{1,2} | Sanoosh K. Gamblewood² | Steven B. Roberts¹



SNP analysis detected 3 groups

Evidence for phenotypic differentiation between genetic groups

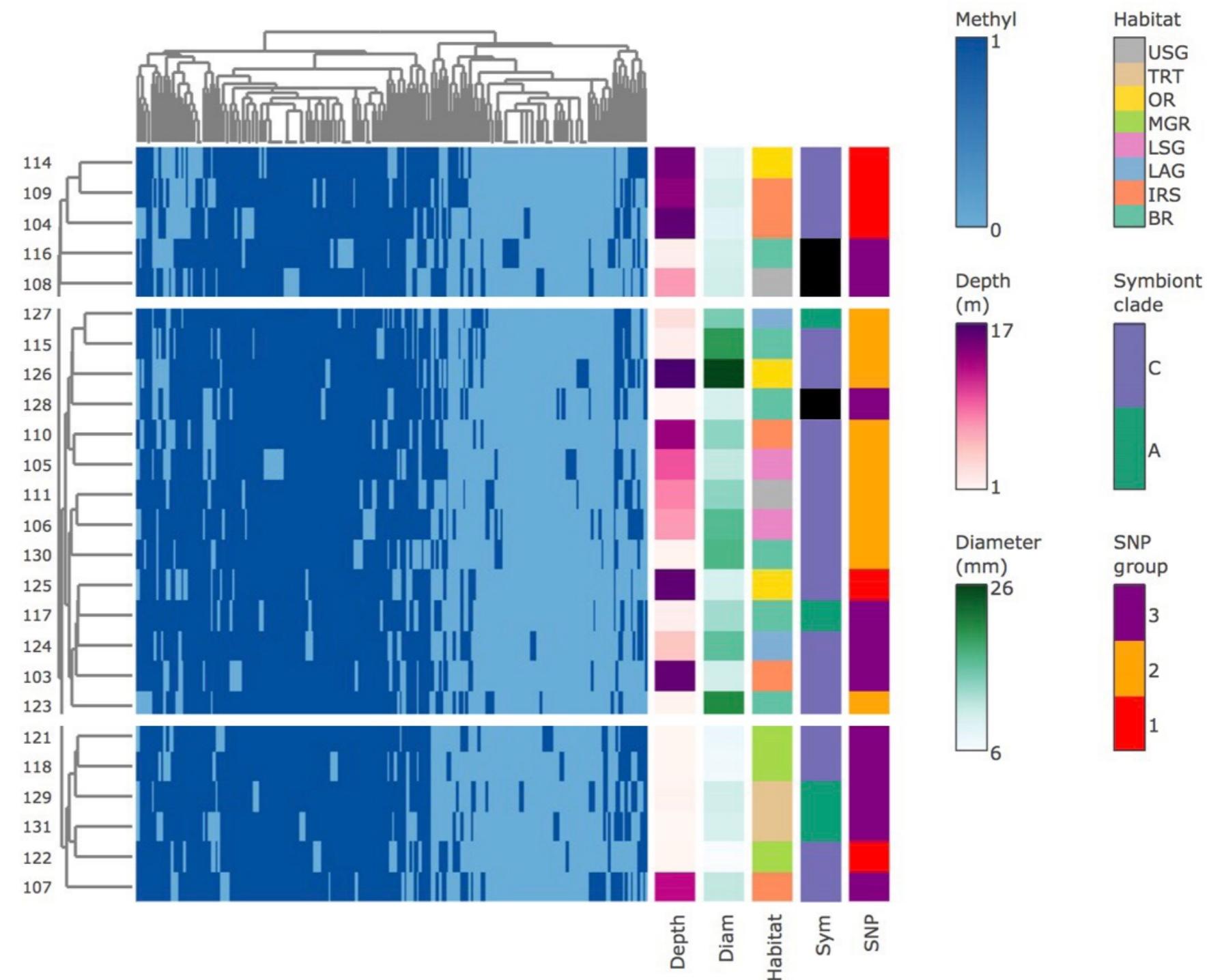
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1) To what degree is epigenetic variation heritable?

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Population studies

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Outline

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Environmental change



Environmental Epigenetics, 2017, 1–13

doi: 10.1093/eep/dvx004
Research article

RESEARCH ARTICLE

Effects of a parental exposure to diuron on Pacific oyster spat methylome

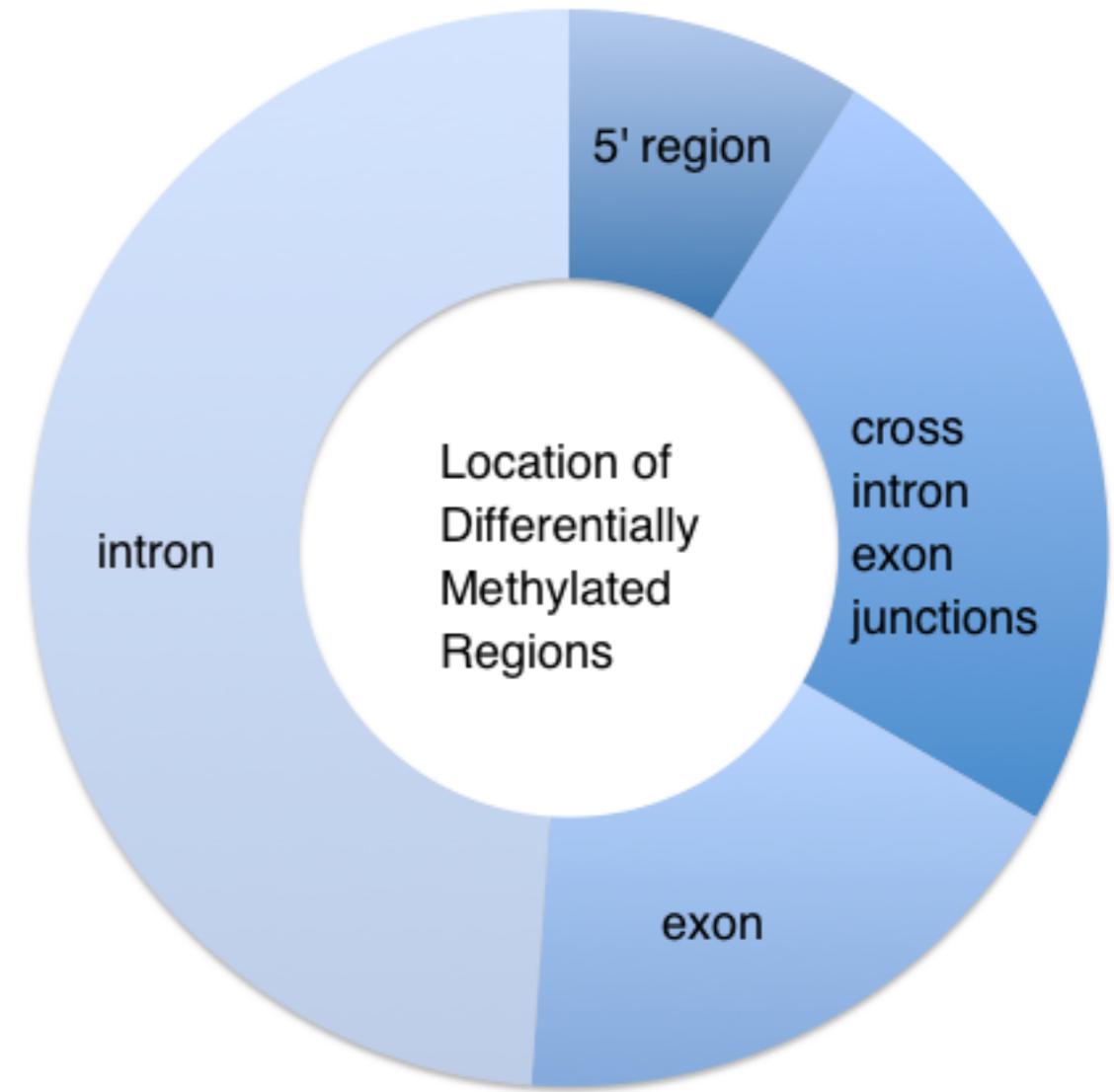
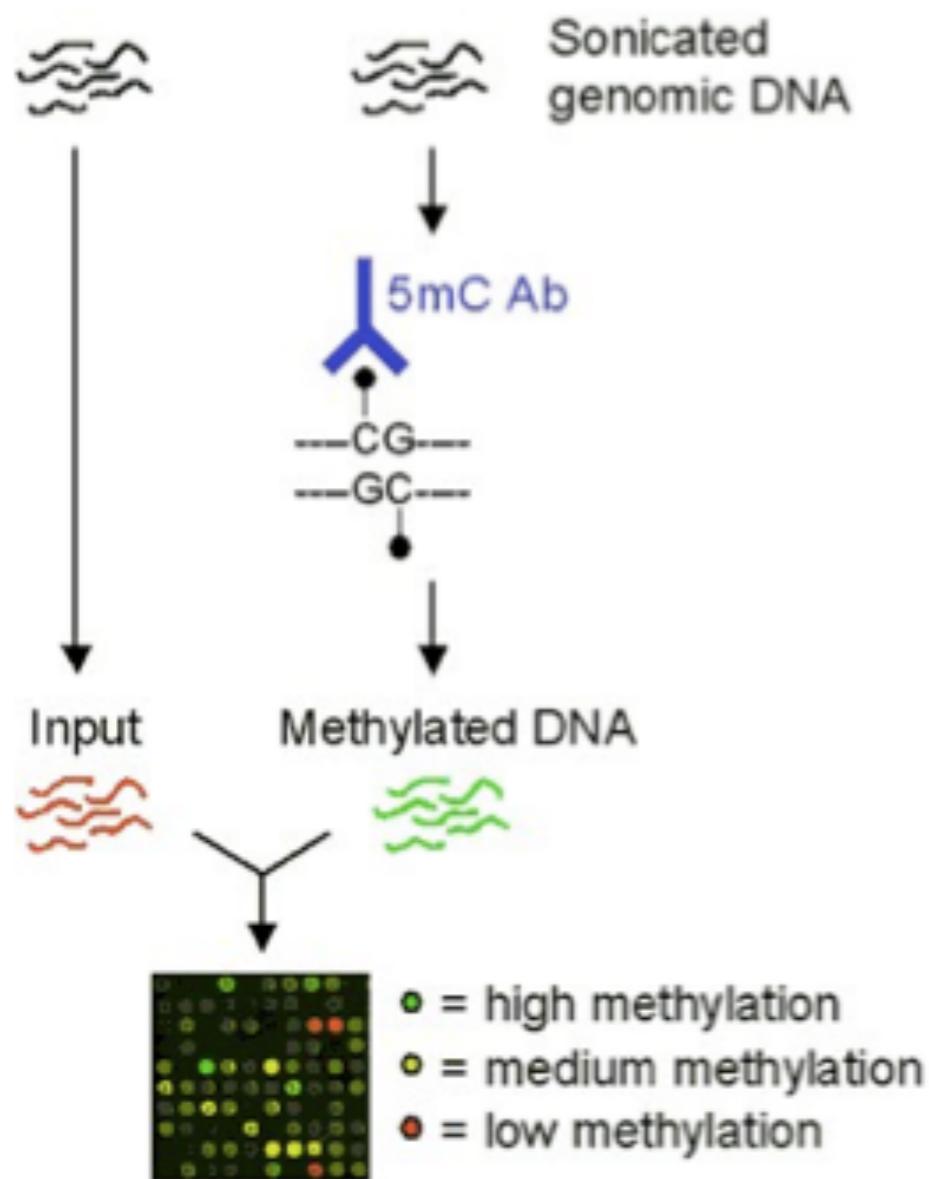
Rodolfo Rondon^{1,2}, Christoph Grunau², Manon Fallet², Nicolas Charlemagne³, Rossana Sussarellu³, Cristian Chaparro², Caroline Montagnani¹, Guillaume Mitta², Evelyne Bachère¹, Farida Akcha³ and Céline Cosseau^{2,*}

¹Ifremer, IHPE UMR 5244, Univ. Perpignan Via Domitia, CNRS, Univ. Montpellier, F-34095 Montpellier, France,

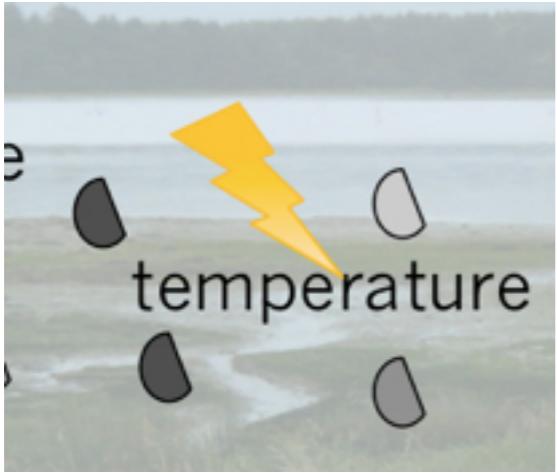
²Univ. Perpignan Via Domitia, IHPE UMR 5244, CNRS, IFREMER, Univ. Montpellier, F-66860 Perpignan, France

and ³Ifremer, Department of Biogeochemistry and Ecotoxicology, Laboratory of Ecotoxicology, Rue de l'ile d'Yeu, BP 21105, 44311 Nantes Cedex 03, France

Environmental change



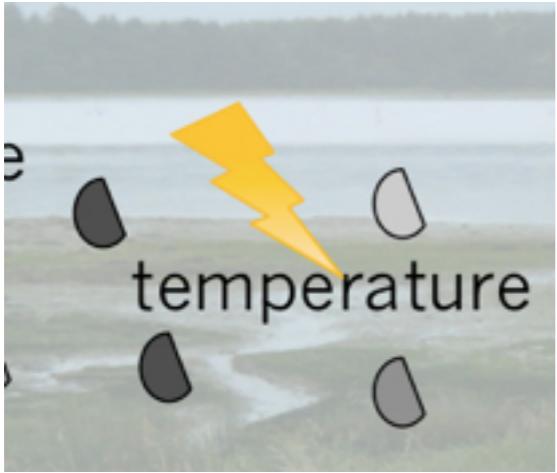
Environmental change



stochastic or targeted?

Oyster	Hypo-methylated	Hyper-methylated
2	7224	2803
4	6560	3587
6	7645	4044

Environmental change



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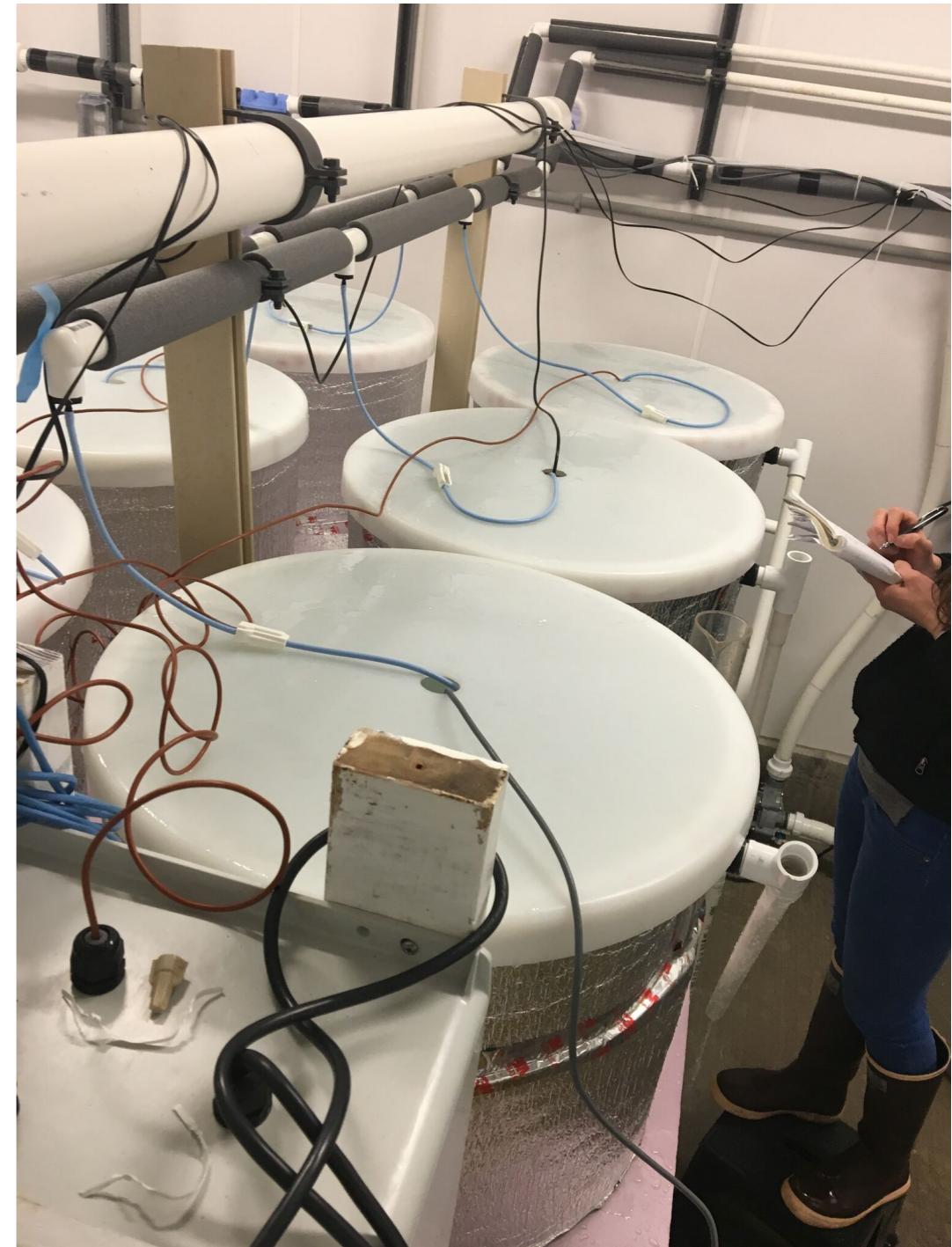
No obvious association
with genome feature
including *differentially
expressed
genes*

Environmental change

Very new data

Selection

Ocean Acidification

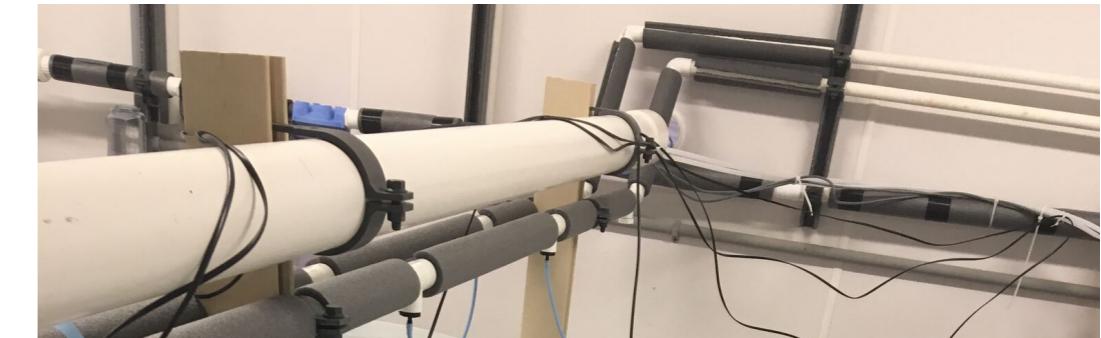


Environmental change

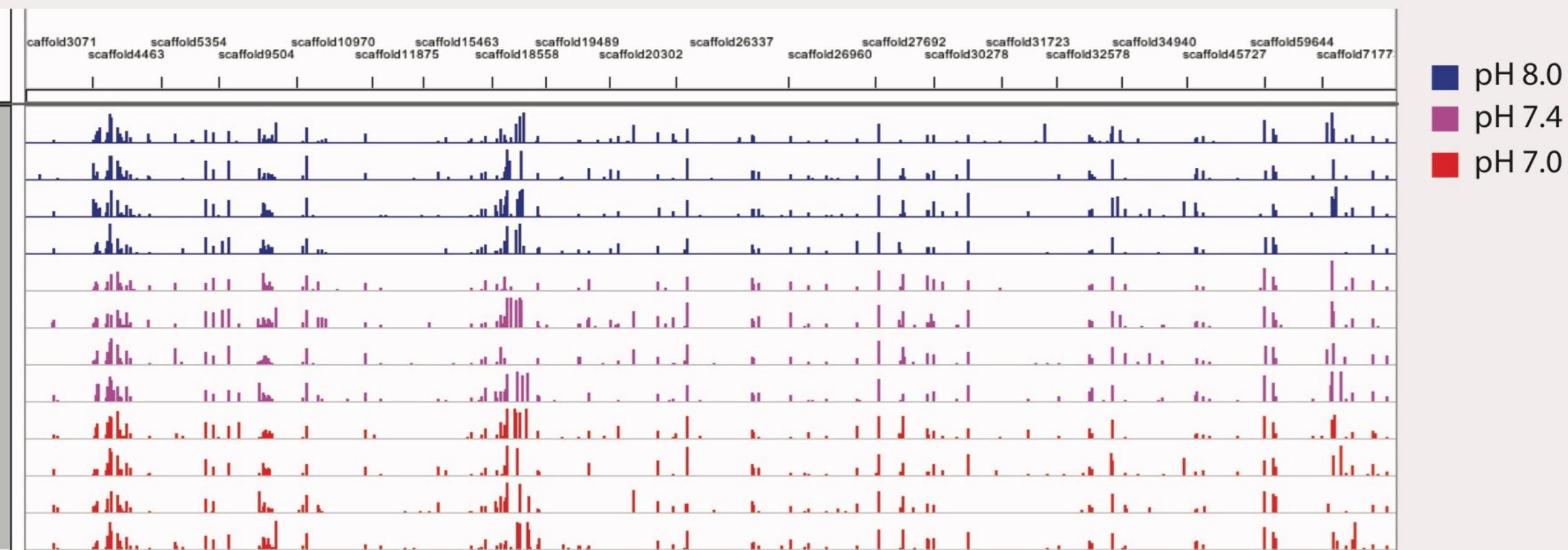
Very new data

Selection

Ocean Acidification



Day 10 DNA methylation patterns



Day 10

Proportion of sequences in pooled
larvae sample with given allele (G vs A)

Day 1

Control: Random Mortality

~42% ACGCTGATCGT

~38% ACGCTAATCGT

~42% ACGCTGATCGT
~38% ACGCTAATCGT

Day 10

High $p\text{CO}_2$
Ambient temperature

High $p\text{CO}_2$
High temperature

Ambient $p\text{CO}_2$
High temperature

Ambient $p\text{CO}_2$
Ambient temperature

Day 1

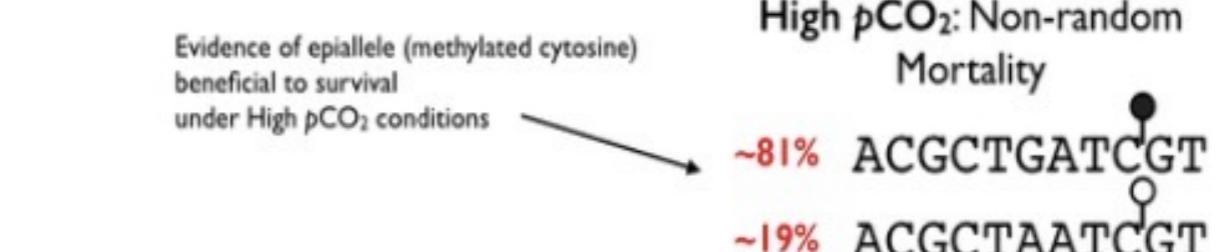
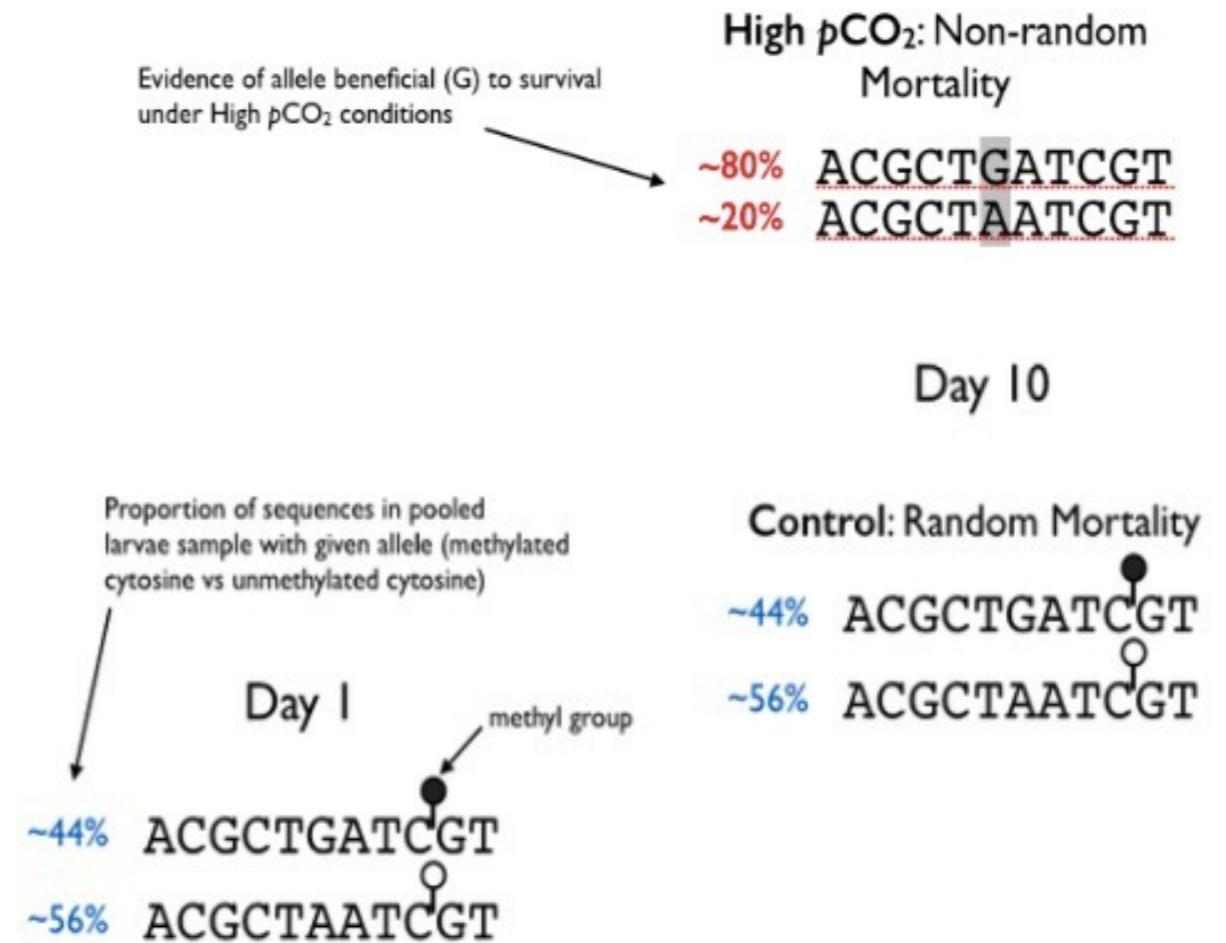
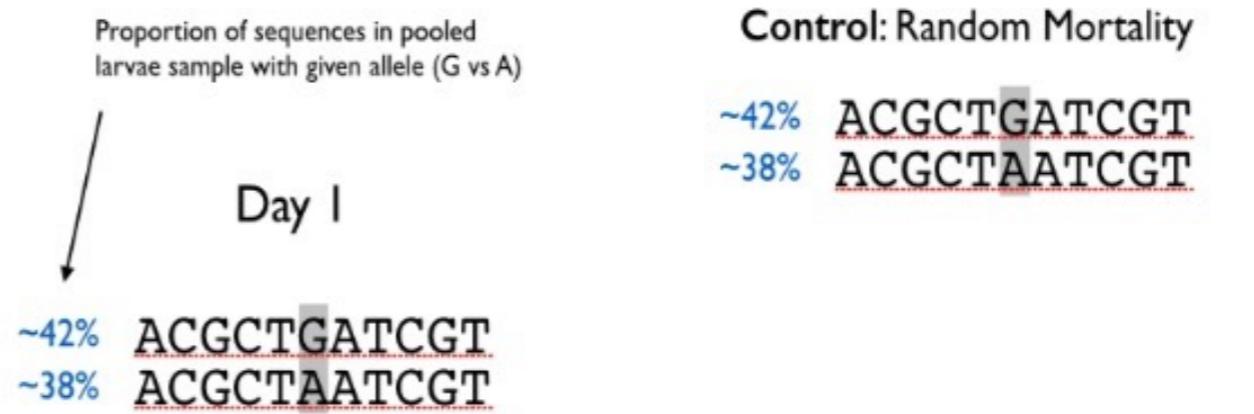
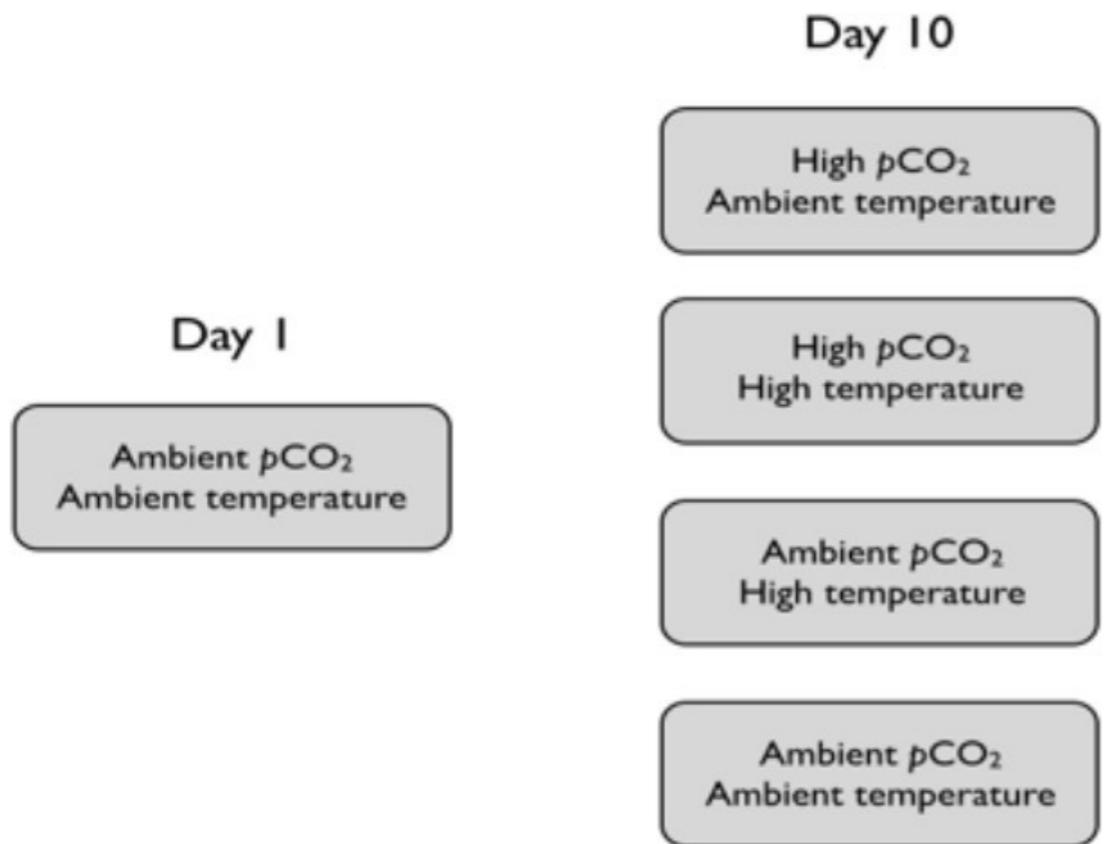
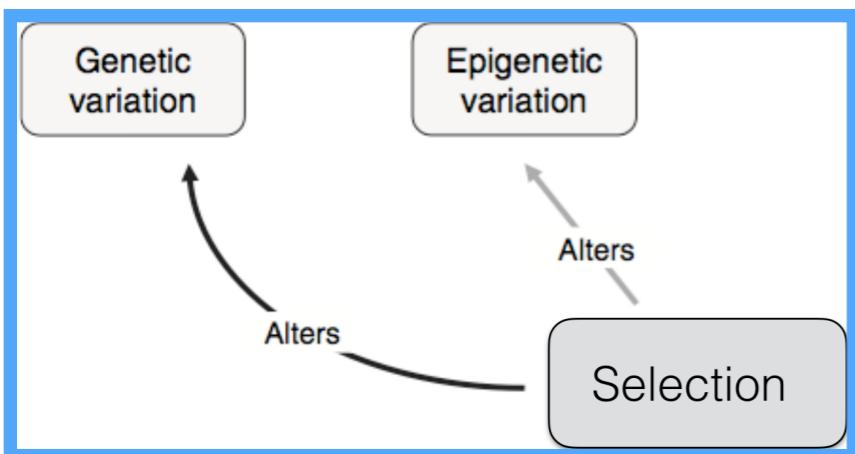
Ambient $p\text{CO}_2$
Ambient temperature

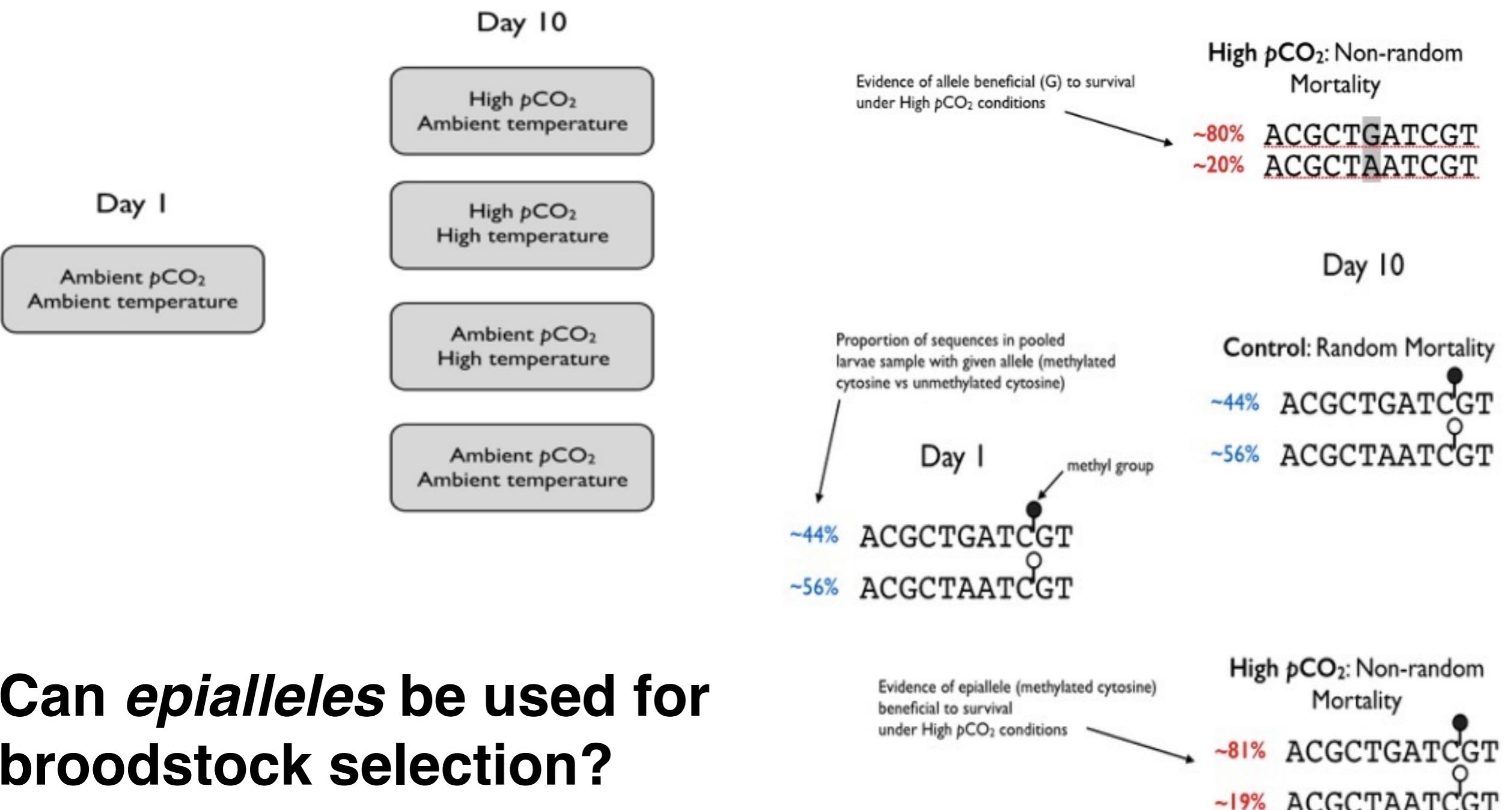
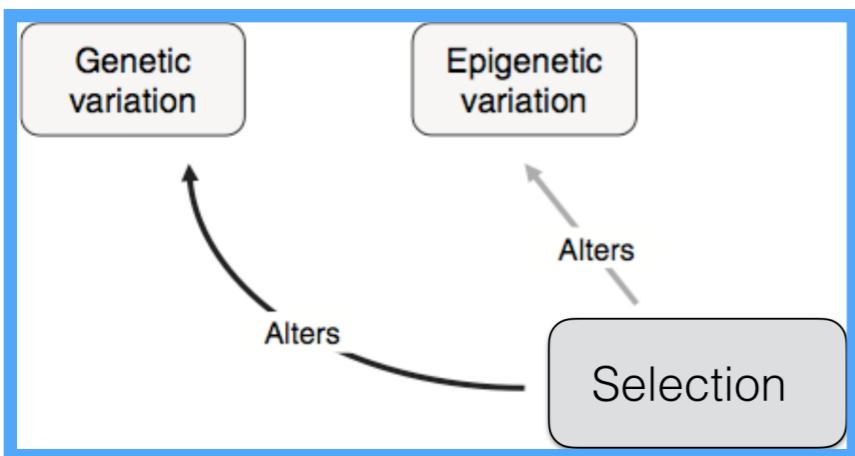
Evidence of allele beneficial (G) to survival
under High $p\text{CO}_2$ conditions

High $p\text{CO}_2$: Non-random
Mortality

~80% ACGCTGATCGT

~20% ACGCTAATCGT





Can *epialleles* be used for broodstock selection?

Summary

Particularly in *shellfish*, epigenetics should be given considerable attention in understanding and optimizing phenotype.

Two points

1. Epigenetics is an attractive lens through which to consider manipulation of traits through environmental memory or selection.
2. Epigenetics may also function to disrupt predictable phenotypes through the creation of unexpected variation.

Acknowledgements

Mackenzie Gavery

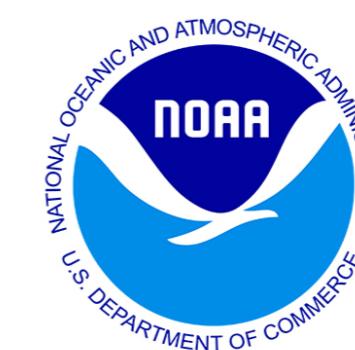
Claire Olson

Sam White

Brent Vadopalas

Hollie Putnam

Jay Dimond



slides, data & more @

<https://github.com/sr320/talk-ae-2017>