

ENVS 212 - Evolution



Goal of this course

The present course surveys the major topics in evolutionary biology, introducing students to the fundamental mechanisms and patterns of evolution that help us to understand the incredible diversity of life

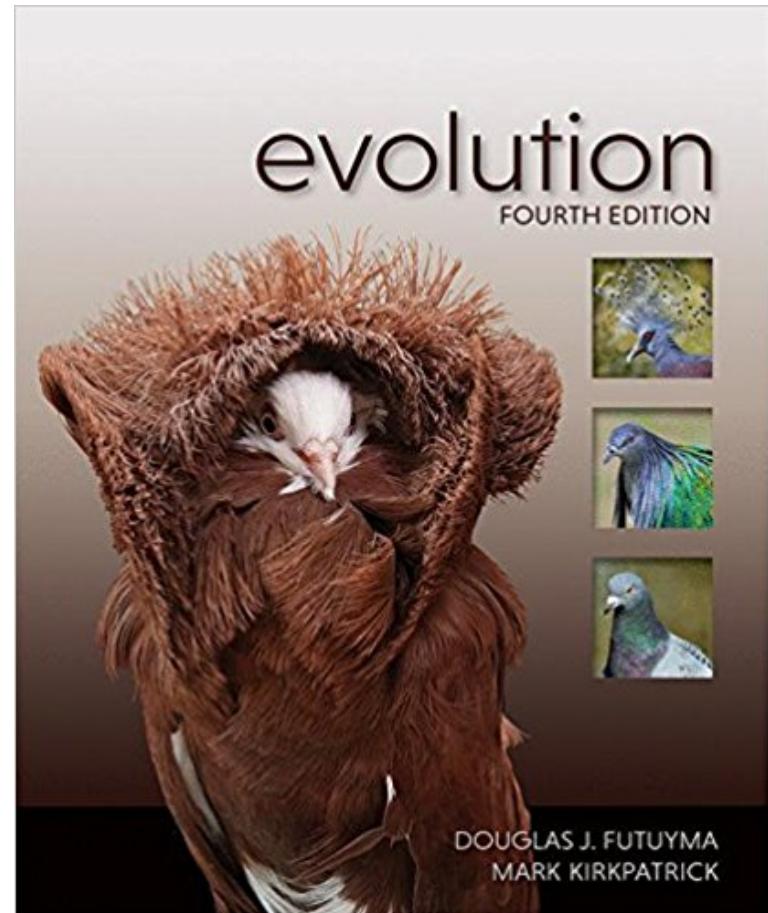
Introduction to the course

- 1) Syllabus / course requirements
- 2) What is evolution and why is it interesting?
- 3) Four misconceptions
- 4) Why I study evolution

Recommended textbook for ENVS 212

Evolution (4th edition)

Douglas J. Futuyma, Mark Kirkpatrick
Sinauer Associates
ISBN: 978-1605356051



ENVS 212 - Evolution syllabus

Dr. Dane Ward

Office: PISB 302

Email: dcw33@drexel.edu

Exams & Grading:

The exam format will be a combination of multiple choice (mostly) and short answer.

Makeup exams are not granted for exams 1 & 2. If you miss an exam due to an illness or university-approved absence, your grade will be prorated (based on other scores). You must email the instructor about your absence ***within 24 hours*** of a missed exam.

If you do not have a valid and University approved reason for missing the exam, you will receive a zero for that exam.

No student is permitted to miss the final exam. If you miss the final and you have a valid and University approved reason for doing so, you will receive a grade of Incomplete, and will have to make-up the exam after the academic quarter is over.

If you miss two exams in the course for any reason, you will be advised to withdraw from the course, or, if the withdraw deadline has passed, you will be asked to take an Incomplete. If you wish to remain in the class, the second exam missed will receive a score of zero.

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The **DO NOT COUNT** option: During Exam 1 or Exam 2, if you think you are doing poorly, you may write 'DO NOT COUNT' on the top of your exam, give your exam and questions to the TA and quietly leave the room. You will not be penalized for this and the potential points for that exam will be transferred to your cumulative final exam. Your Final Exam will then be worth 50% of your grade. You may use this option once, on Exam 1 OR Exam 2, BUT NOT ON BOTH EXAMS. Under no circumstances will you be allowed to drop your lowest grade for exams that you have already taken.

Lecture attendance and participation (via Tophat)	5%
Recitation attendance	10%
Recitation assignments and quizzes	20%
Exam 1 (No makeup) – Apr 23	20%
Exam 2 (No makeup) – May 21	20%
<u>Cumulative Final – TBA</u>	25%

ENVS 212 - Evolution syllabus

Teaching Assistant: (When emailing use ‘**ENVS 212**’ as the subject)

Johannes Krause – jrk339@drexel.edu

Recitation:

Recitation is an important part of your grade and your chance to join in group discussions on evolution. Be prepared for regular quizzes. Have your assignments ready to turn in on time. Your attendance, participation and performance in recitation will determine 30% of your final grade.

Although you are allowed an excused absence (with documentation), **consistent absences will not be permitted, even if documentation is provided (e.g. illness)**. If you are consistently unwell during the quarter and must miss multiple recitations, then you may need to consider a medical withdrawal or receive an incomplete. Otherwise you will have to accept the loss of attendance points.

Academic Honesty:

Students are expected to be familiar with and to abide by Drexel’s *Academic Honesty Policy*, available in the *Student Handbook*. Violations of this policy will be met with the strongest allowable sanction, possibly including expulsion from the university. (**Note that failing to report observed academic dishonesty is a violation of the policy.**)

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Academic Honesty:

The BEES Department has a **ZERO TOLERANCE** policy towards **FABRICATION, CHEATING, and ACADEMIC MISCONDUCT**. For this reason the Department has elected to impose the **MAXIMUM PENALTY** for cases of fabrication, cheating and academic misconduct. IF an act of fabrication, cheating or academic misconduct are determined to have occurred in a course within the department after consultation between the student, faculty member and representative from the department (Department Head, or Assistant or Associate Department Head) the penalty will be **FAILURE FOR THE ENTIRE COURSE** with the inability to withdraw from the course. This penalty will be applied for first and all violations.

ENVS 212 - Evolution syllabus

Top Hat

We will be using the Top Hat (www.tophat.com) classroom response system in class. You will be able to submit answers to in-class questions using Apple or Android smartphones and tablets, laptops, or via text message (SMS).

You can visit <http://tinyurl.com/THStudentRegistration> for the Student Quick Start Guide which outlines how you will register for a Top Hat account, as well as providing a brief overview to get you up and running on the system. An email invitation will also be sent to your email account (if you don't receive this email, you can register by visiting our direct Top Hat course URL <https://app.tophat.com/e/118271>

You get a 7 day free trial.

Top Hat will require a subscription. There are three options to choose from:

- \$24 for 4 months of unlimited access
- \$36 for 12 months of unlimited access
- \$72 for lifetime* access

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This course's join code is 118271

Introduction to the course

- 1) Syllabus / course requirements
- 2) What is evolution and why is it interesting?
- 3) Four misconceptions
- 4) Why I study evolution

What is evolution?

What is evolution?

Biological evolution – change in the genetic properties of groups of organisms (“populations”) over the course of generations

Often referred to more simply as ‘**descent with modification**’ or ‘genetic change over time’

Evolution is about change in *proportions*
through time

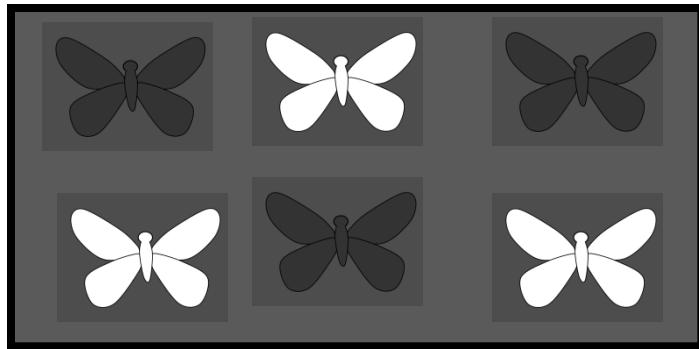
Within populations – change in gene frequencies between generations (e.g. shift in proportion of individuals with dark versus light wing coloration)



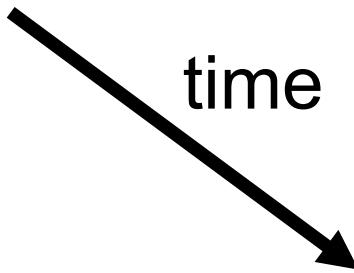
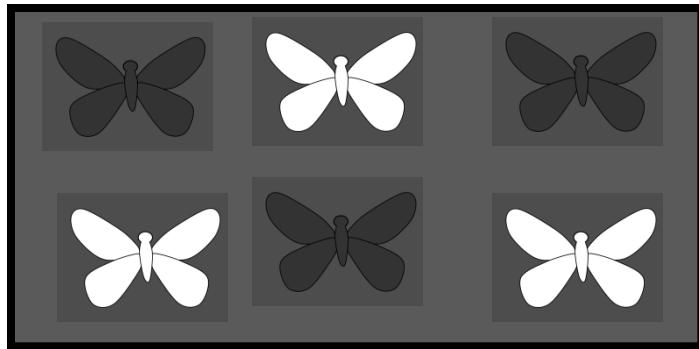
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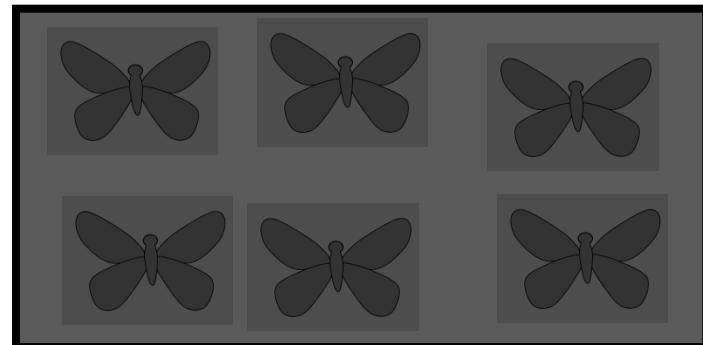
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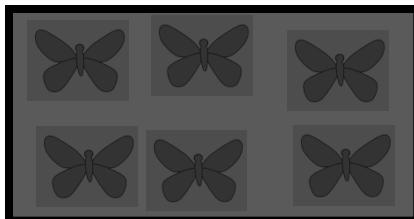
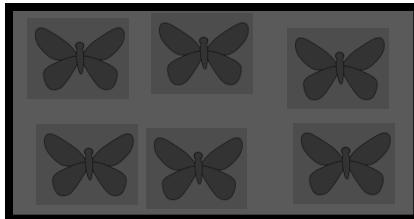
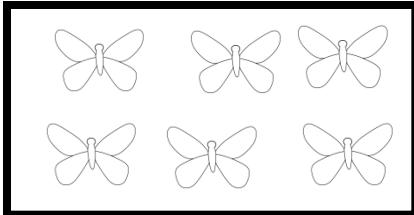
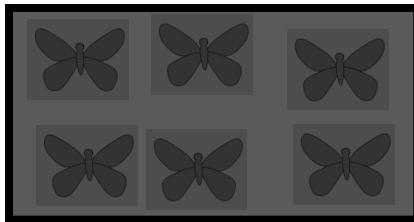
Within populations – change in gene frequencies between generations (e.g. shift in proportion of individuals with dark versus light wing coloration)



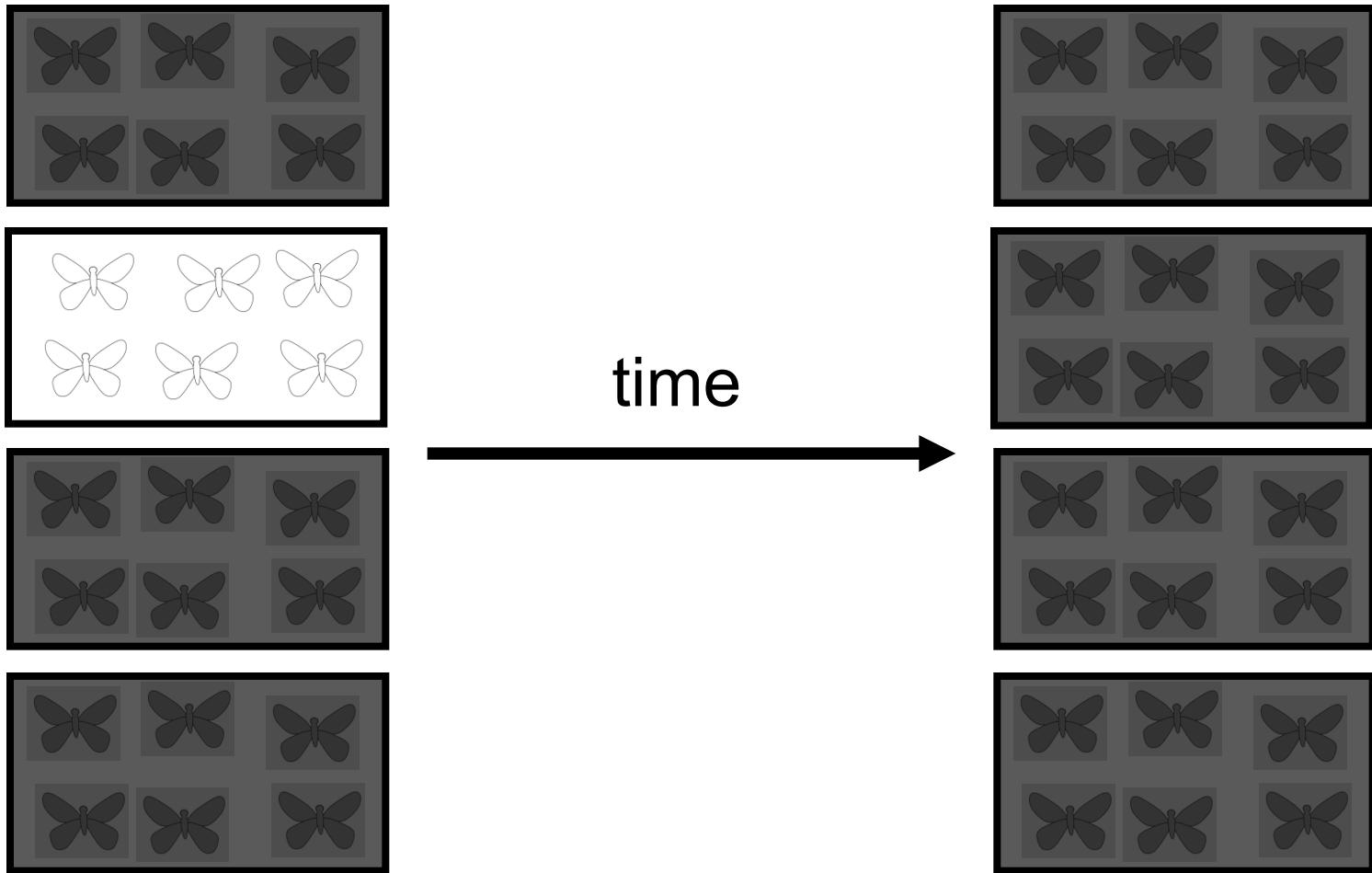
time



Between populations (or species) – change in proportion of genetically differentiated populations
(e.g. shift in proportion of populations with dark versus light wing-coloration)



Between populations (or species) – change in proportion of genetically differentiated populations
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What is evolution?

Biological evolution – change in the genetic properties of groups of organisms (“populations”) over the course of generations

Often referred to more simply as ‘**descent with modification**’ or ‘genetic change over time’

Why is evolution interesting?

Morphological diversity – why do whales have lungs and snakes lack legs?

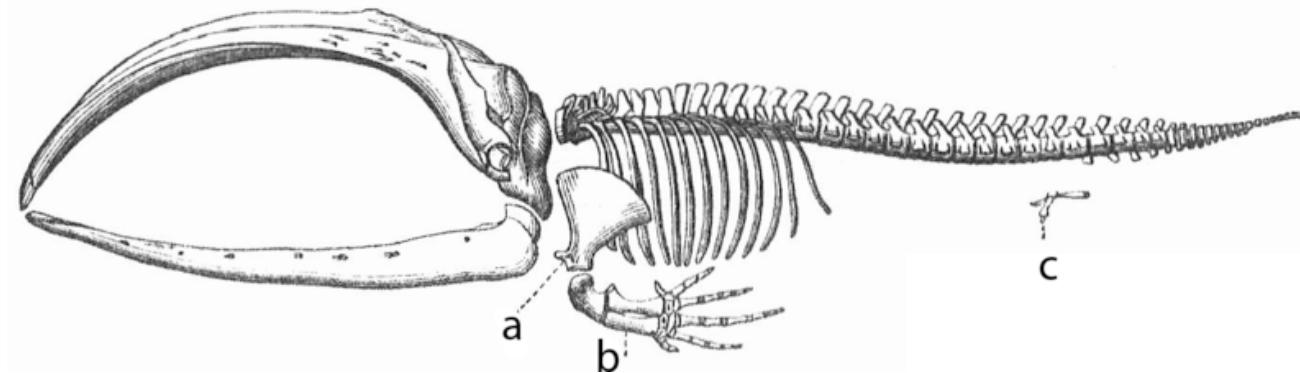
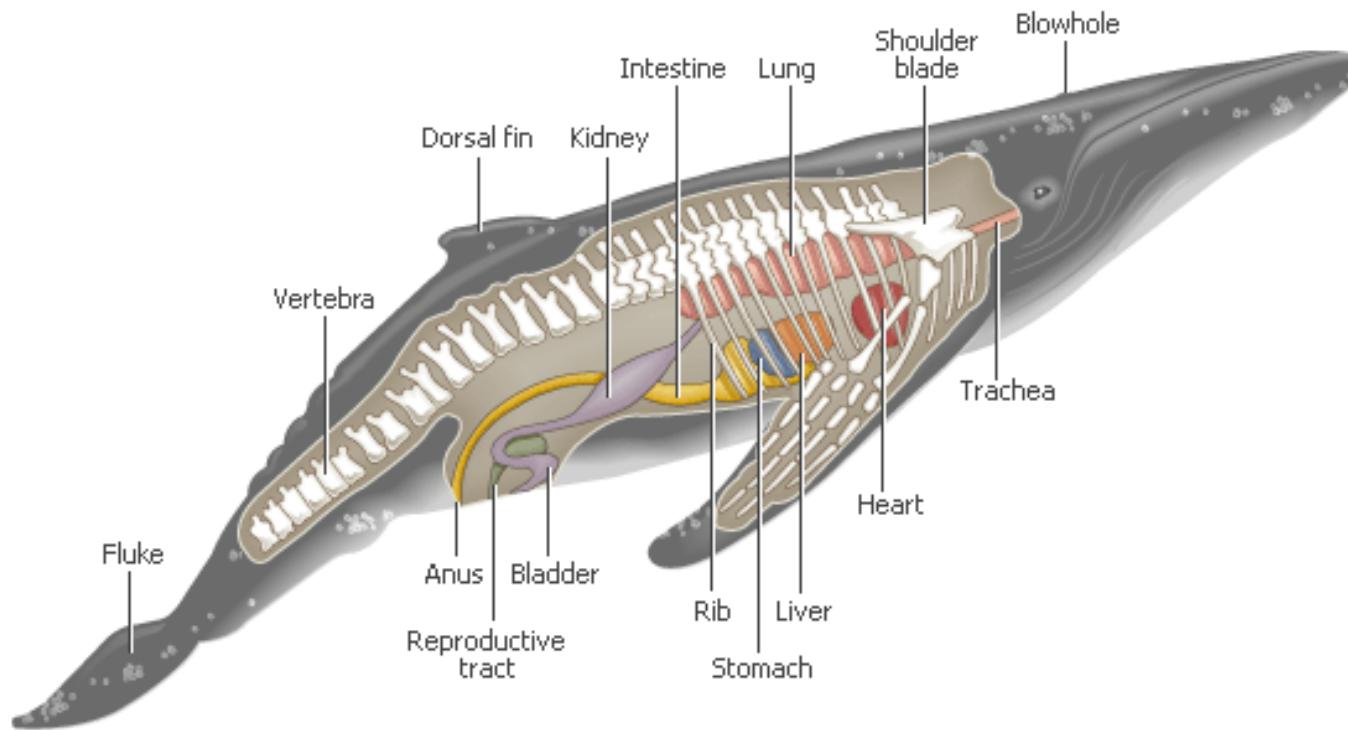
Genetic diversity – why do salamanders have 10X more DNA than humans?

Species diversity – Why are there so many species of beetles (400,000!)?

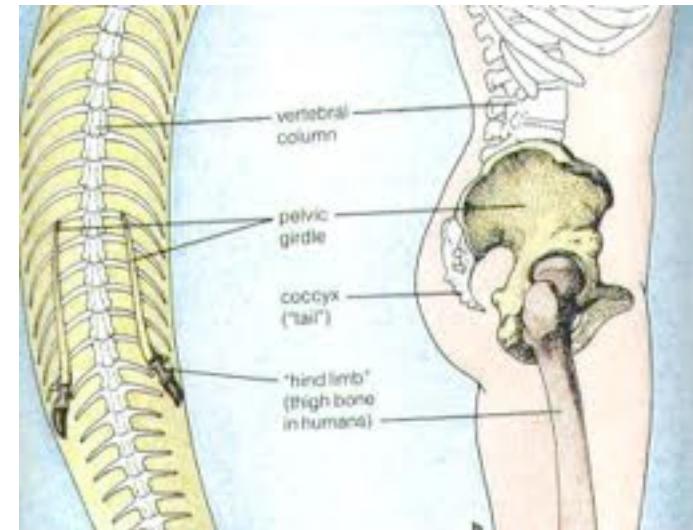
Medicine – How do bacteria, viruses and parasites counter our immune system? How do they evolve resistance to our medicines?

Technology – How do insects evolve resistance to pesticides?

Evolution is the only scientific explanation for many observed anatomical traits



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Why is evolution interesting?

Morphological diversity – why do whales have lungs and snakes lack legs?

Genetic diversity – why do salamanders have 10X more DNA than humans?

Species diversity – Why are there so many species of insects??

Medicine – How do bacteria, viruses and parasites counter our immune system? How do they evolve resistance to our medicines?

Technology – How do insects evolve resistance to pesticides?

Genetic diversity

- Human Genome ~3.2billion base pairs
- Some Salamanders ~120billion bps



Why is evolution interesting?

Morphological diversity – why do whales have lungs and snakes lack legs?

Genetic diversity – why do salamanders have 10X more DNA than humans?

Species diversity – Why are there so many species of insects??

Medicine – How do bacteria, viruses and parasites counter our immune system? How do they evolve resistance to our medicines?

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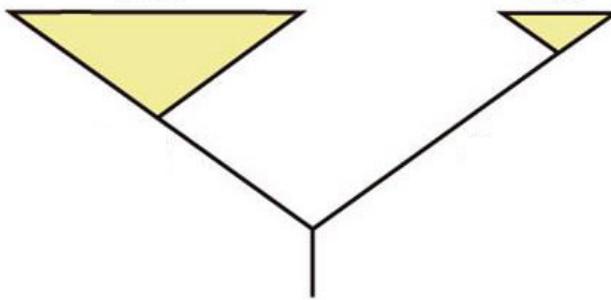
Species
richness:

Charaxes

189

Polyura

21





Species richness:

Charaxes

189

Polyura

21

Host-plant diversity:

247

9

Why is evolution interesting?

Phenotypic diversity – why do whales have lungs and snakes lack legs?

Genetic diversity – why do salamanders have 10X more DNA than humans?

Species diversity – Why are there so many species of insects??

Medicine – How do bacteria, viruses and parasites counter our immune system? How do they evolve resistance to our medicines?

Technology – How do insects evolve resistance to pesticides?

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Misconception #1

Evolution and natural selection are the same thing

Misconception #1

~~Evolution and natural selection are the same thing~~

Natural selection is ONE mechanism by which evolution occurs, but natural selection and evolution are NOT one and the same

Evolution is simply genetic change through time, to deny evolution is to deny genetic change occurs

But, **much** evolution occurs due to natural selection

Misconception #2

Individual organisms undergo biological evolution

Misconception #2

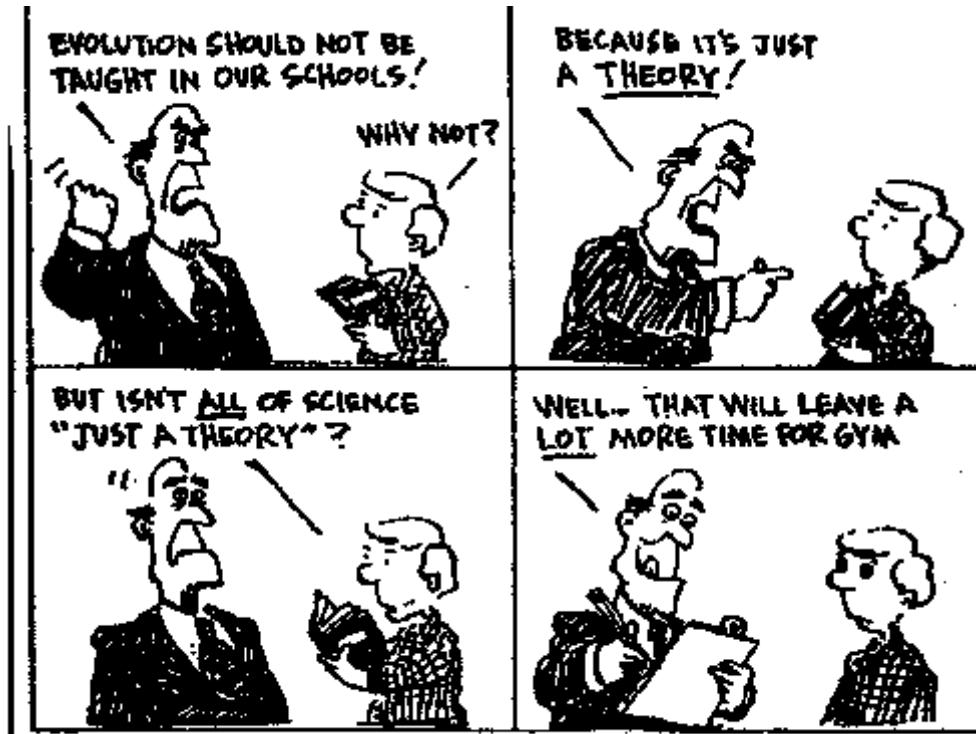
~~Individual organisms undergo biological evolution~~

Populations or groups of organisms undergo evolution

In biology, the change of individual organisms through their lifetime is termed “***development***”

Misconception #3

Evidence for evolution is limited, it is only an unsubstantiated theory



Misconception #3

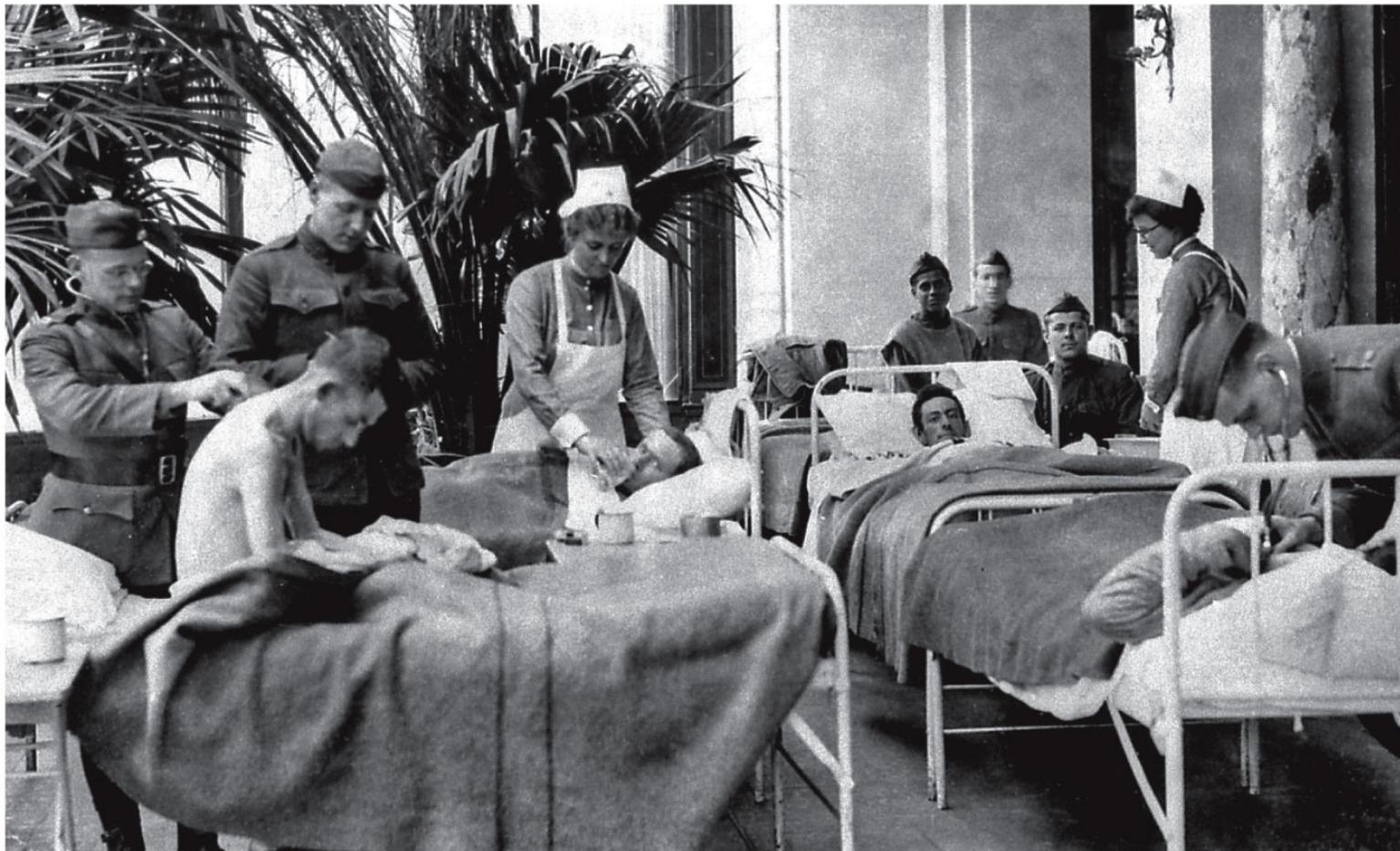
Evidence for evolution is limited, it is only an unsubstantiated theory

Evidence for evolution is abundant, stemming from numerous sources such as from the fossil record, DNA and genomic data, and direct observations in contemporary time

Three examples of evidence for evolution (many more will follow in the course!)

- 1) Antibiotic resistance
- 2) Pesticide resistance
- 3) Experimental evolution studies in the laboratory

A tuberculosis ward at a U.S. Army base hospital in France during World War I – at this point in time it was thought that antibiotics has conquered this bacterial disease



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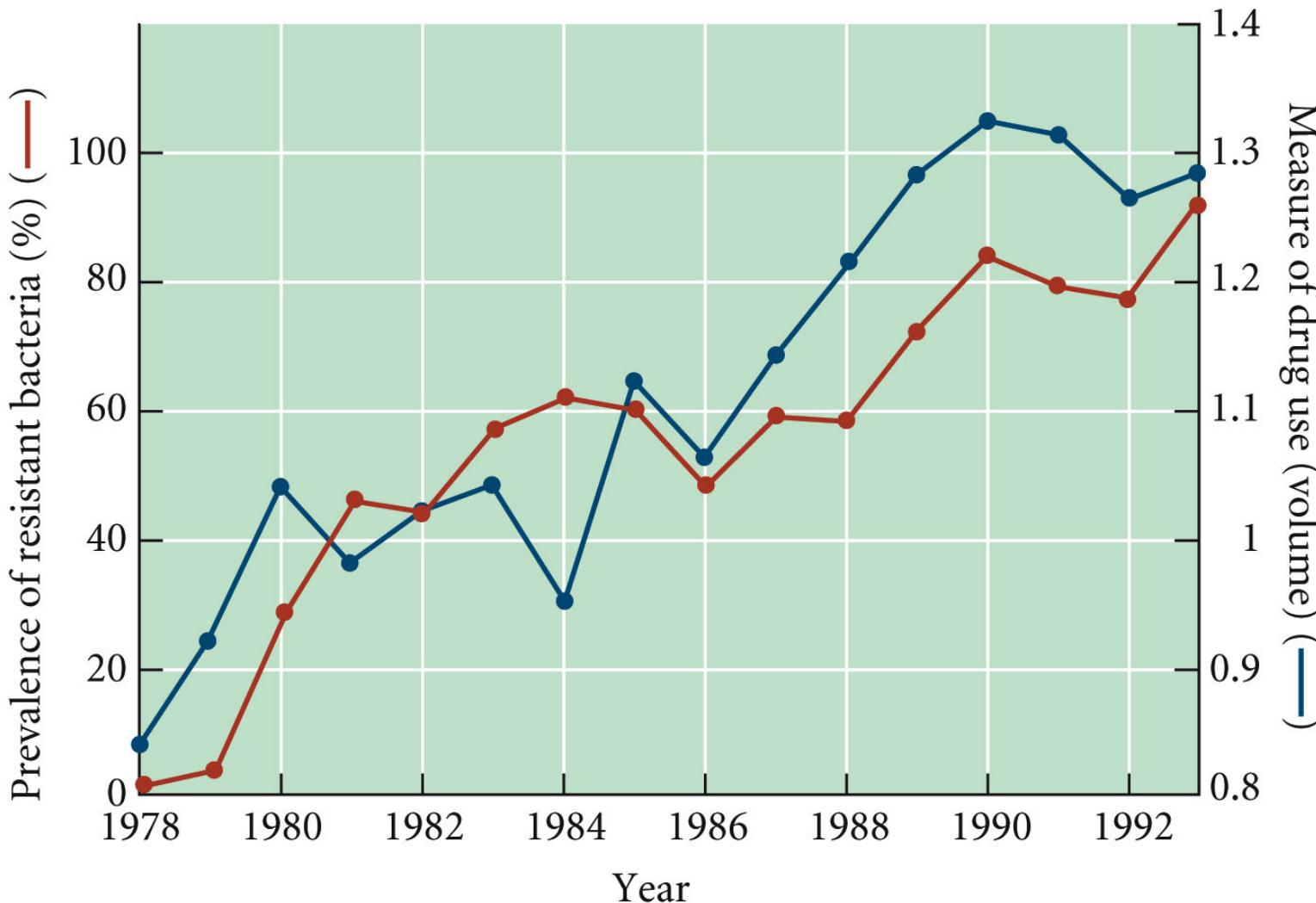
Health

Mumps outbreaks reported in Philadelphia region; most linked to Delaware dance party

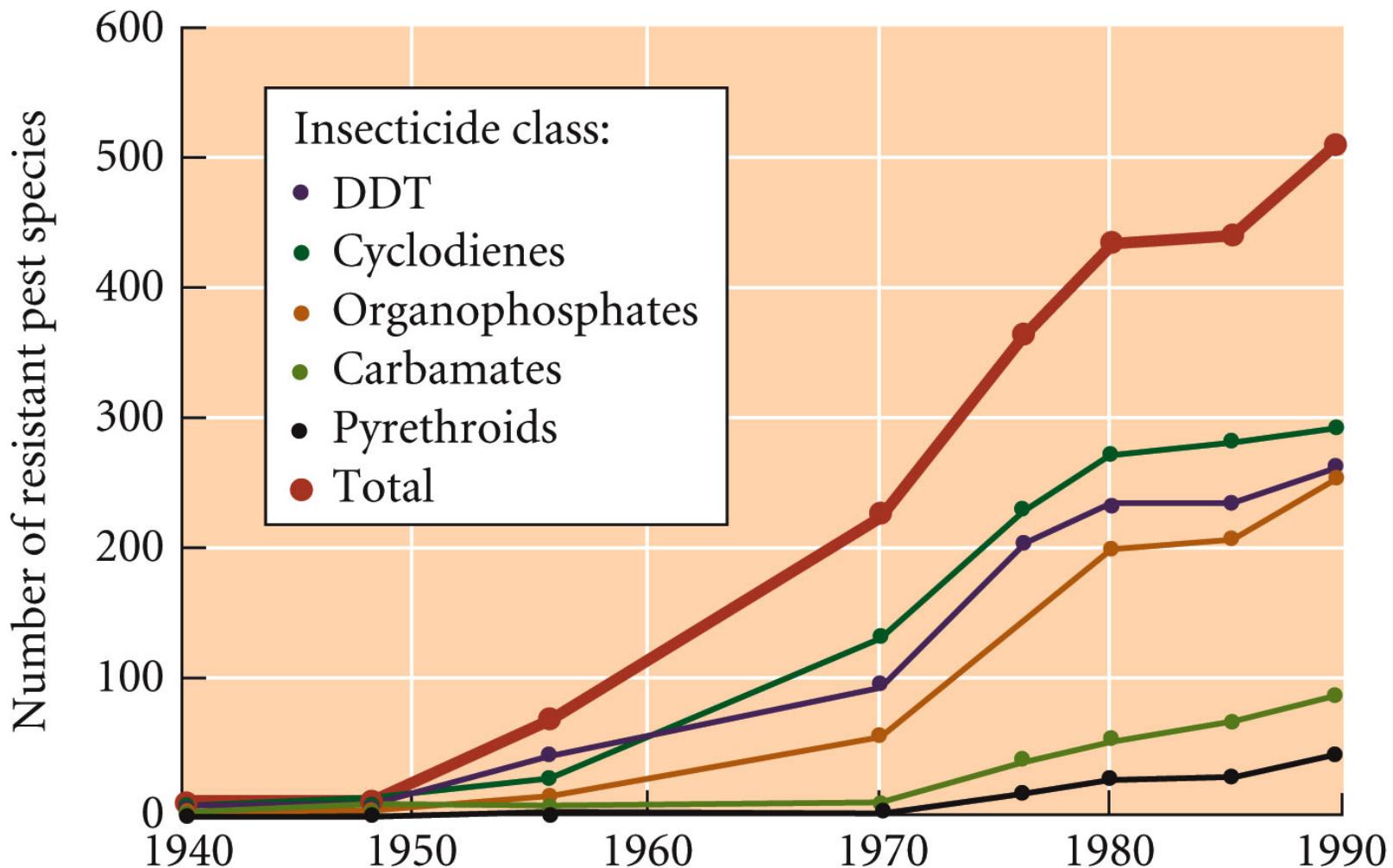
Updated: MARCH 28, 2018 — 2:18 PM



Evolution of drug resistance by the bacterium *Moraxella catarrhalisis*

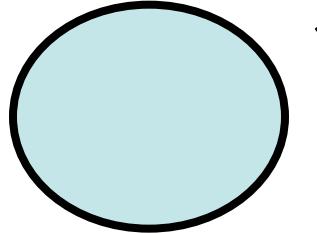


Cumulative numbers of arthropod pest species known to have evolved resistance to five classes of insecticides



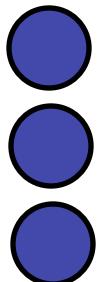
Evolution has also been observed
DIRECTLY numerous times in laboratory
studies

Evolution by natural selection in the laboratory



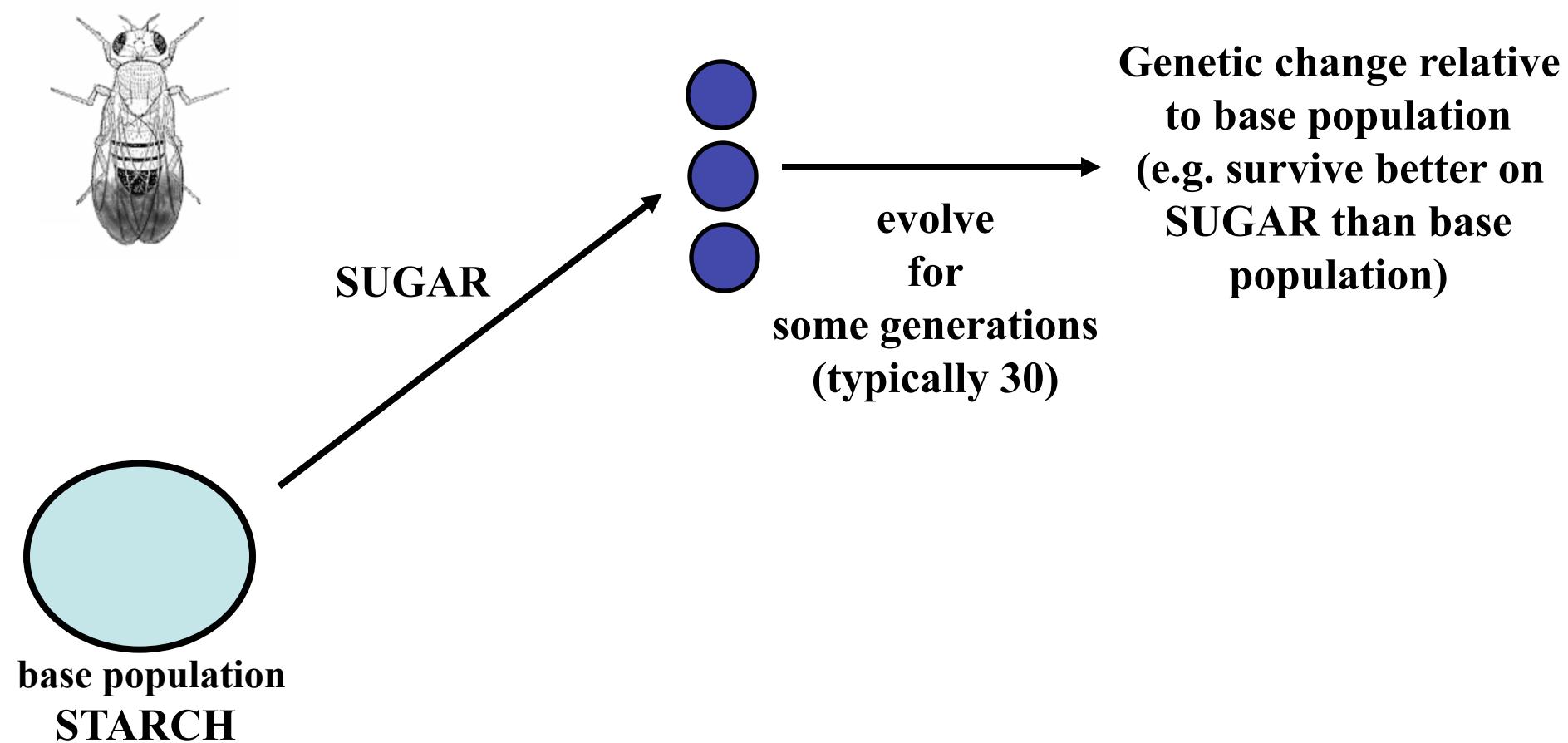
base population
STARCH

SUGAR



evolve
for
some generations
(typically 30)

Evolution by natural selection in the laboratory



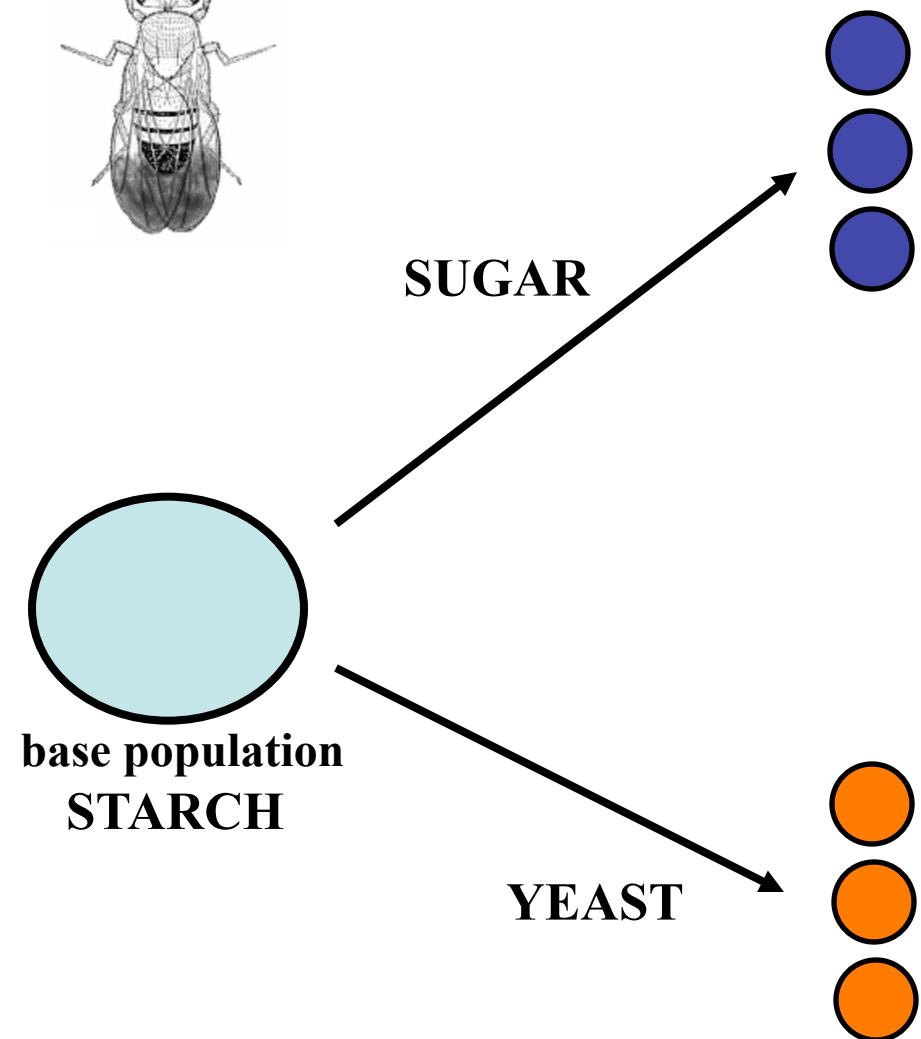
Misconception #4

Ok, evolution occurs within species, but it cannot explain the origin of new species

Misconception #4

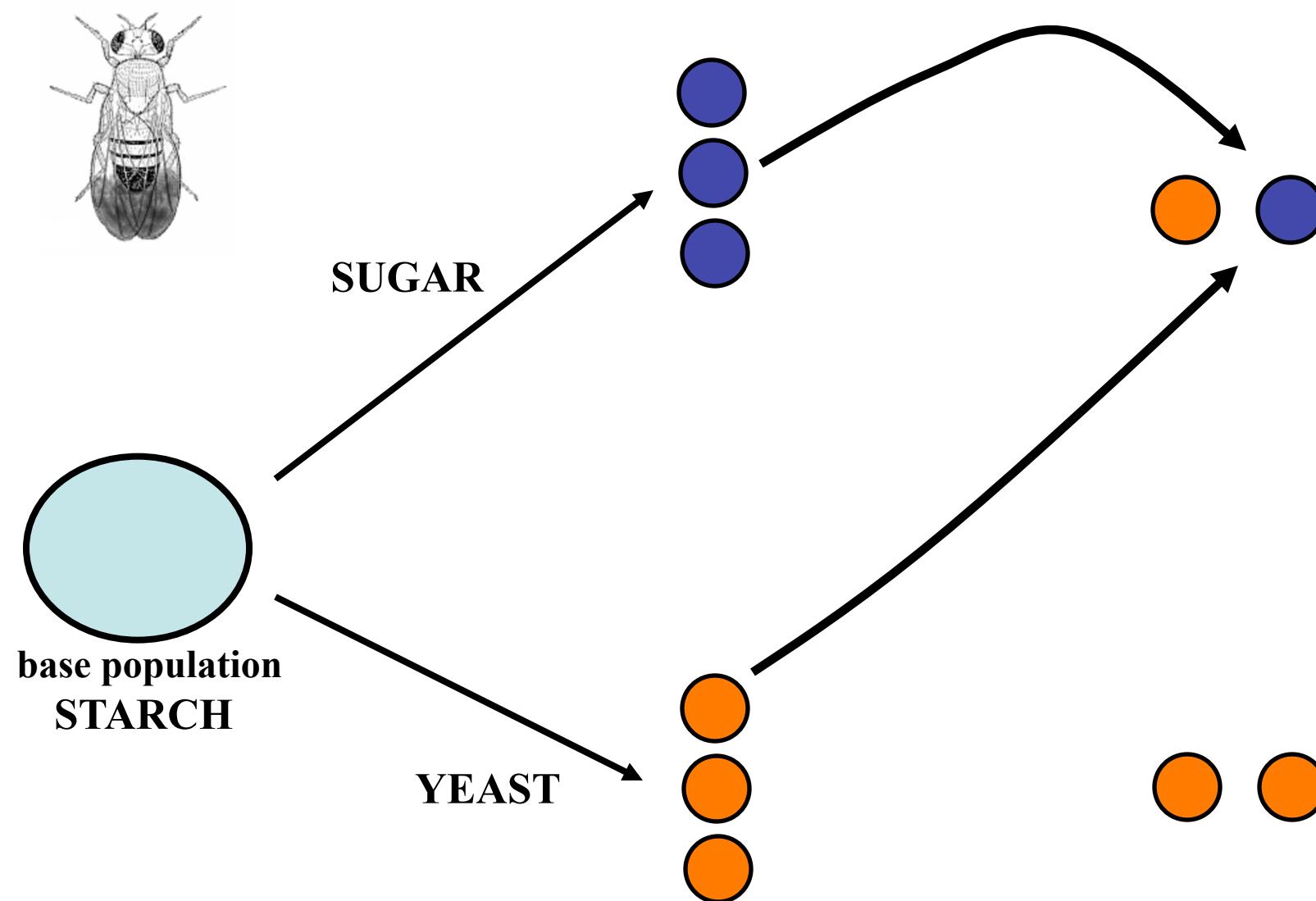
~~— Ok, evolution occurs within species, but it cannot explain the origin of new species~~

As for studies within species, there is abundant evidence that *new* species form via evolution

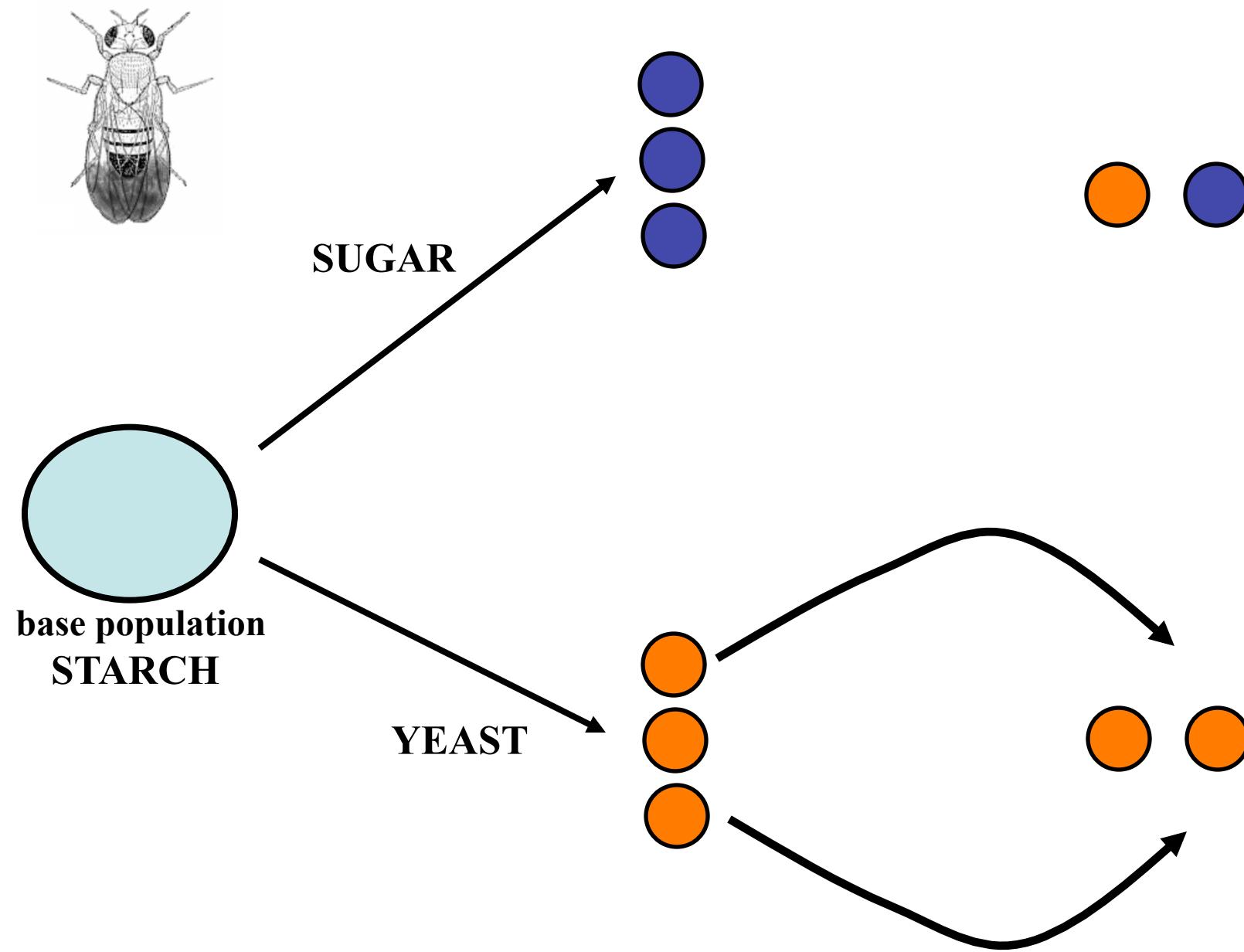


Has this evolutionary adaptation to different environments (diets) promoted the formation of new species?

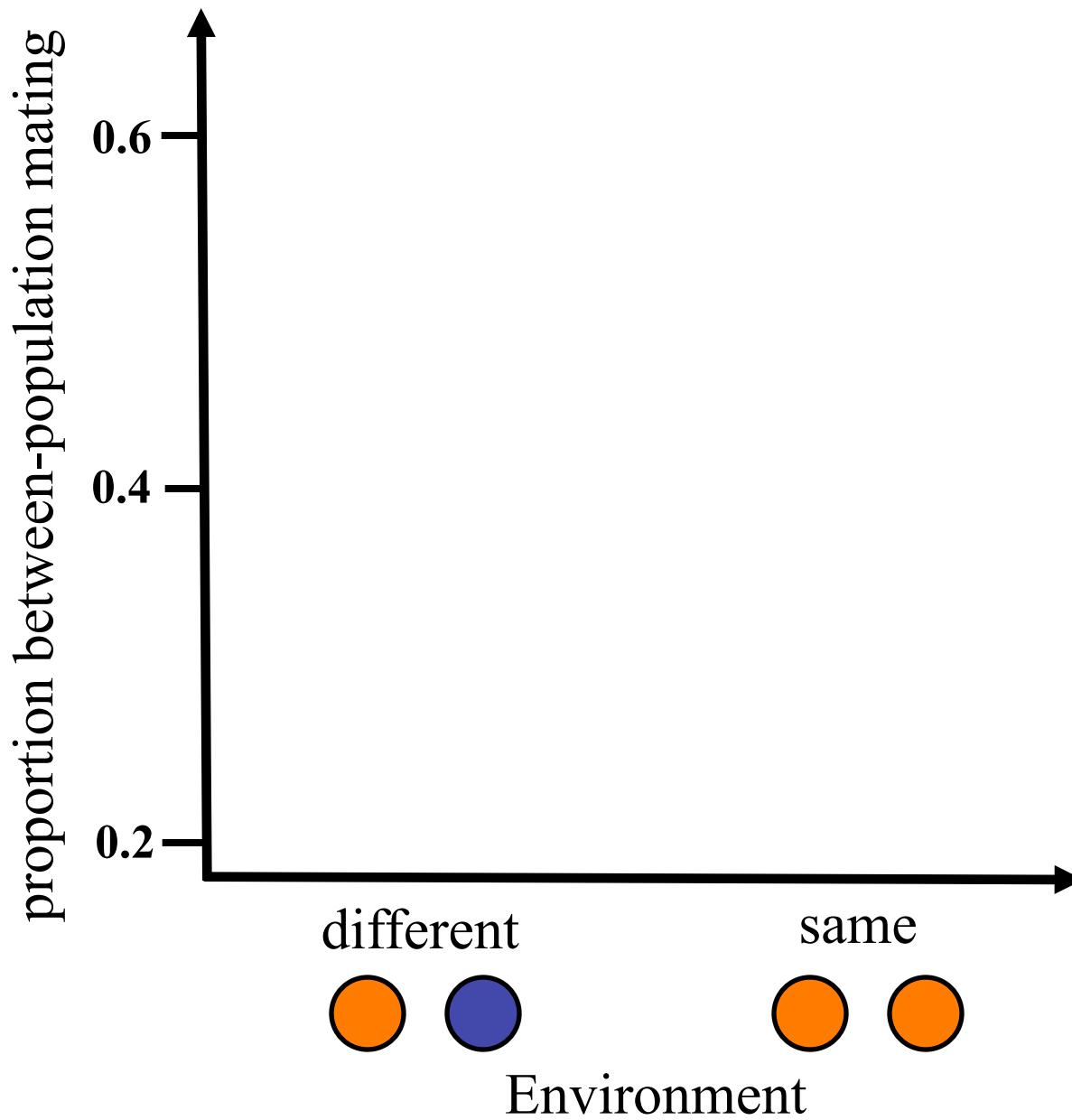
“Different environments”: sugar versus yeast



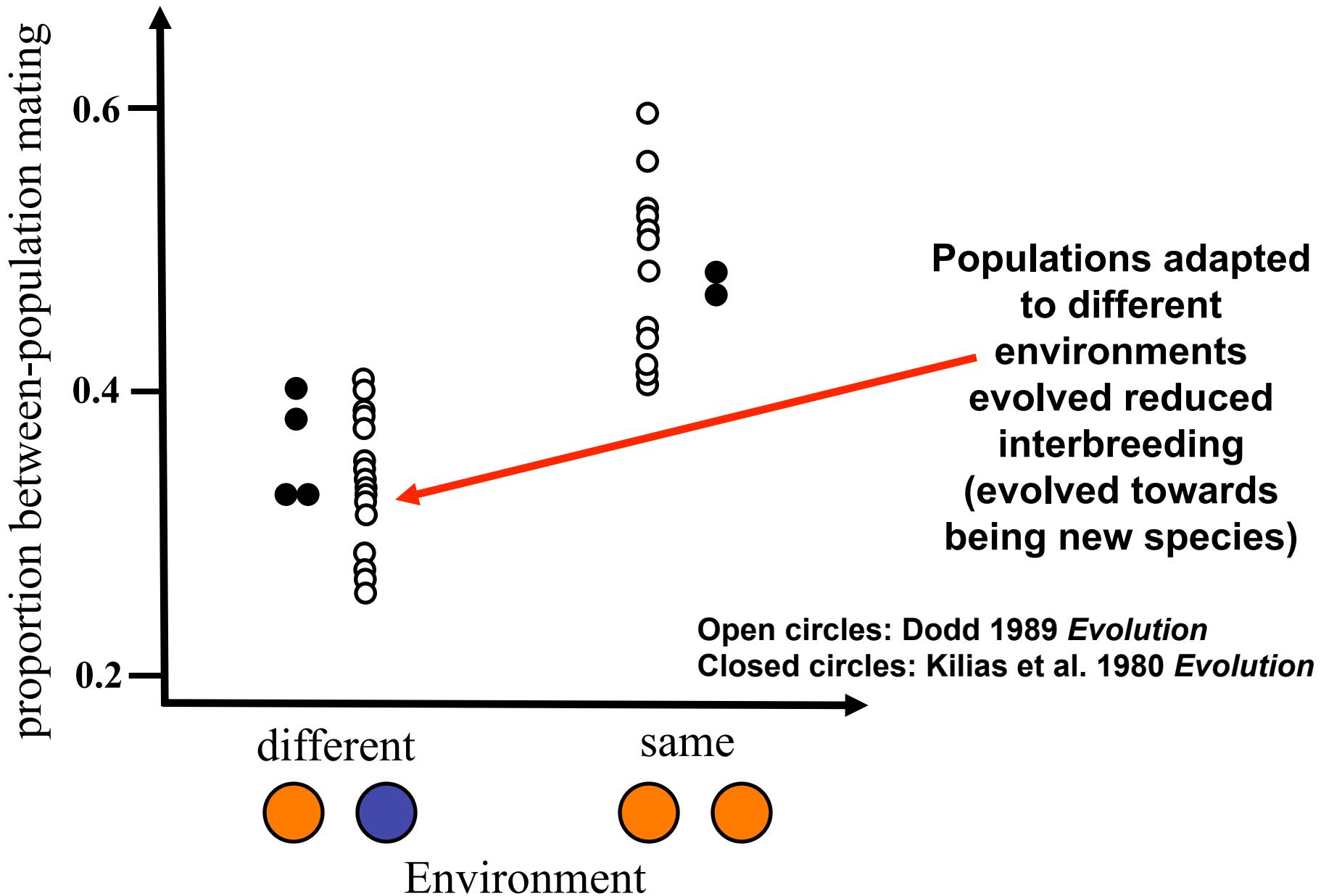
“Same environment”: yeast versus yeast



Evolution by natural selection in the laboratory



Evolution by natural selection in the laboratory





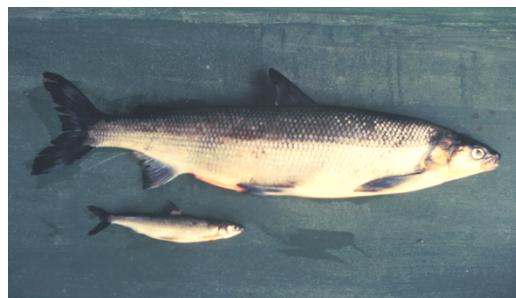
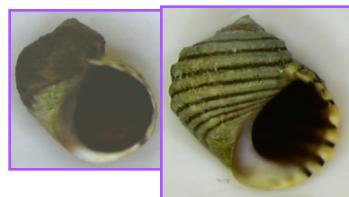
Alfalfa and Clover Pea Aphids
Via et al.



Limnetic and Benthic Stickleback
Schluter, Rundle et al.

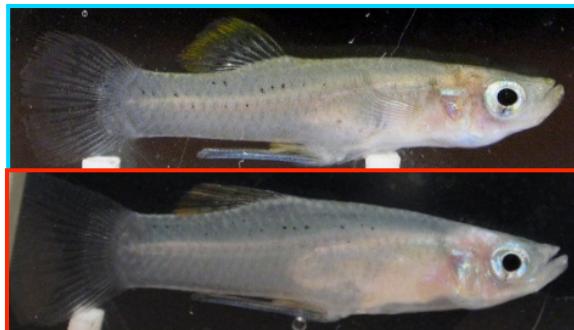


Mimetic Butterflies
Mallet, Jiggins et al.



Shore Ecotypes
Rolan-Alvarez,
Johansson et al.

Dwarf, Normal ecotypes
Bernatchez, Rogers et al.



Gambusia fishes
Langerhans et al.



Leaf Beetle Host Forms
Funk et al.



Host Forms of
Ladybird Beetles
Katakura et al.

M. lewisii *M. cardinalis*



Monkeyflowers
Schemske, Bradshaw
et al.

Evidence for evolution through the fossil record

There aren't any intermediate forms between major animal groups. There are few 'missing links'

Evidence for evolution through the fossil record

~~There aren't any intermediate forms between major animal groups. There are few 'missing links'~~

MANY intermediate forms and 'missing links' have been found, with more found all the time.

65 60 55 50 45 40 35 30 million years ago

Paleocene

Eocene

Oligocene



Mesonychids



Pakicetus



Ambulocetus



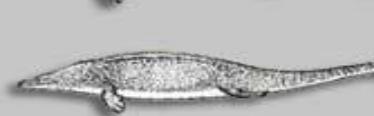
Dalanistes



Rodhocetus



Takracetus



Gaviocetus



Dorudon



Basilosaurus

Mysticetes



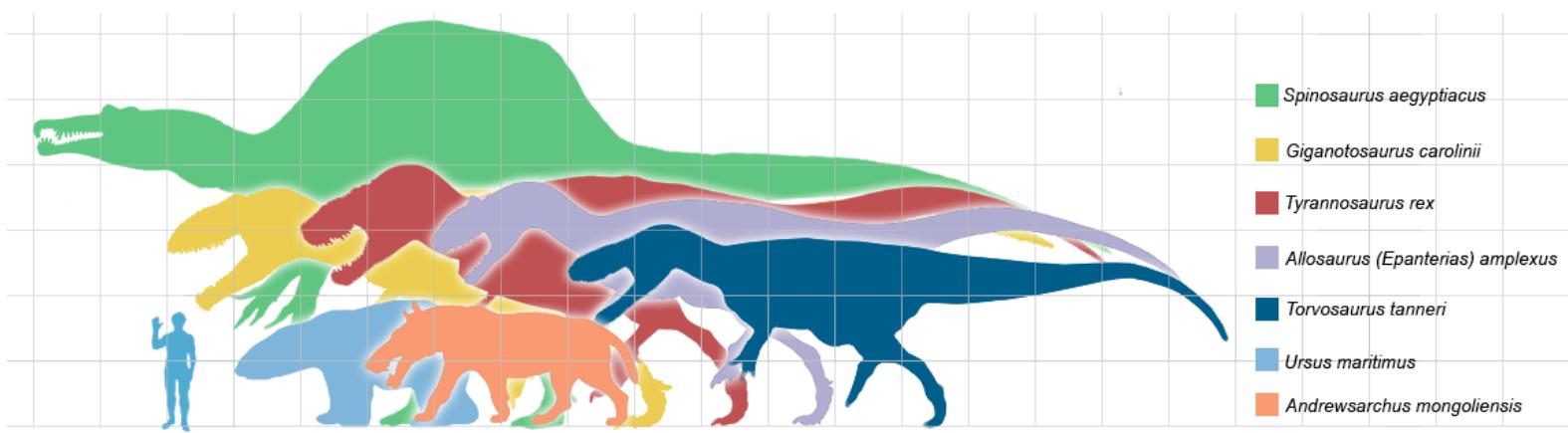
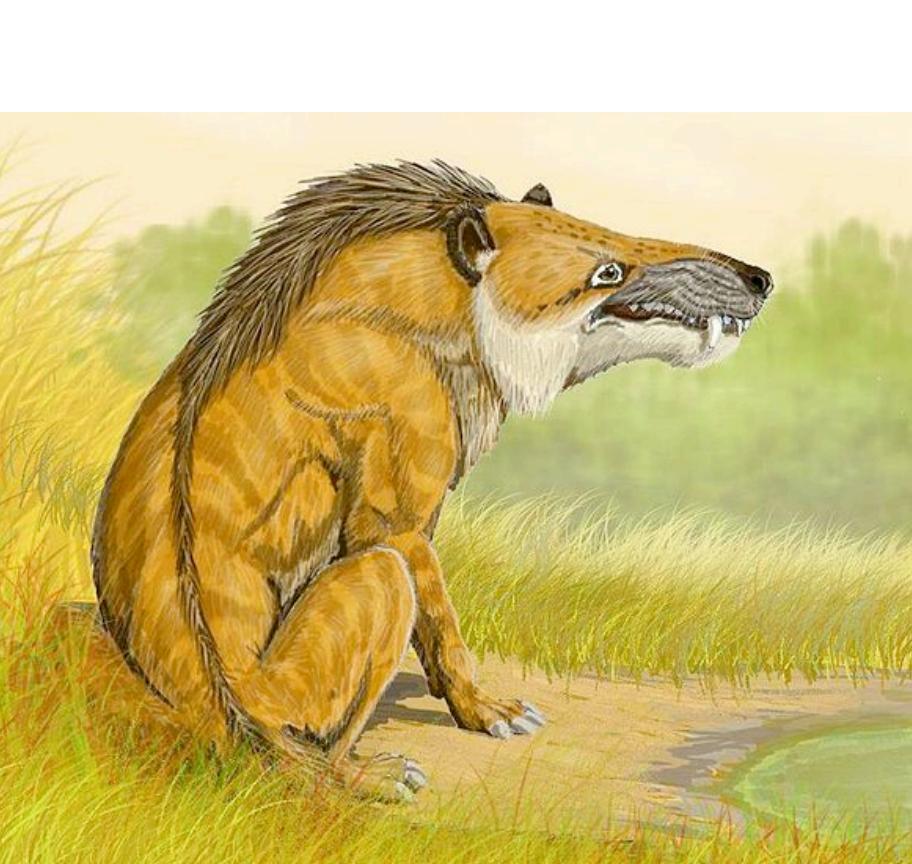
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Evolution: The Triumph of an Idea,
by Carl Zimmer.
New York: Harper Collins Publishers, 2001.

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cladogram from *At the Water's Edge*,
by Carl Zimmer, Free Press, 1998.

File source: *Cetacean Evolution (Whales, Porpoises, Dolphins)*
by Edward T. Babinski
<http://www.edwardtbabinski.us/whales/>



Odontocetes





Four misconceptions:

- 1) *Evolution and natural selection are the same thing*
- 2) *Individual organisms undergo biological evolution*
- 3) *Evidence for evolution is limited, it is only an unsubstantiated theory*
- 4) *Evolution occurs within species, but it cannot explain the origin of new species*