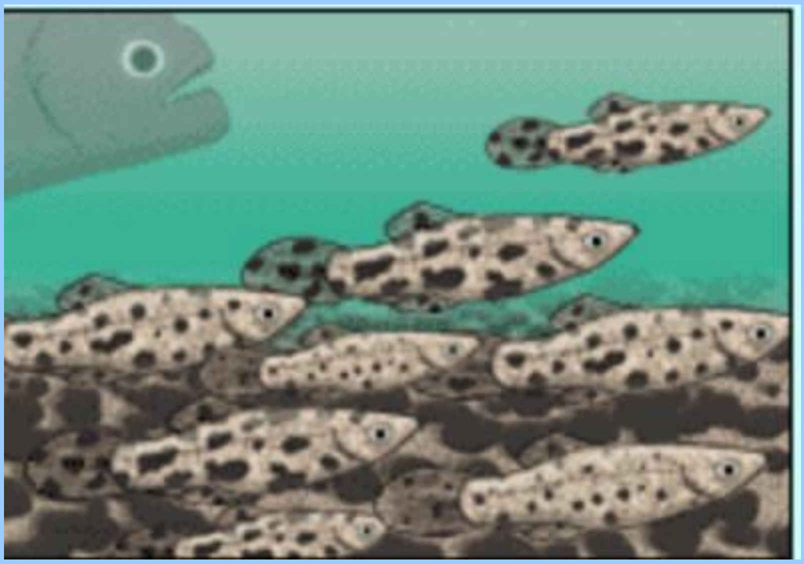
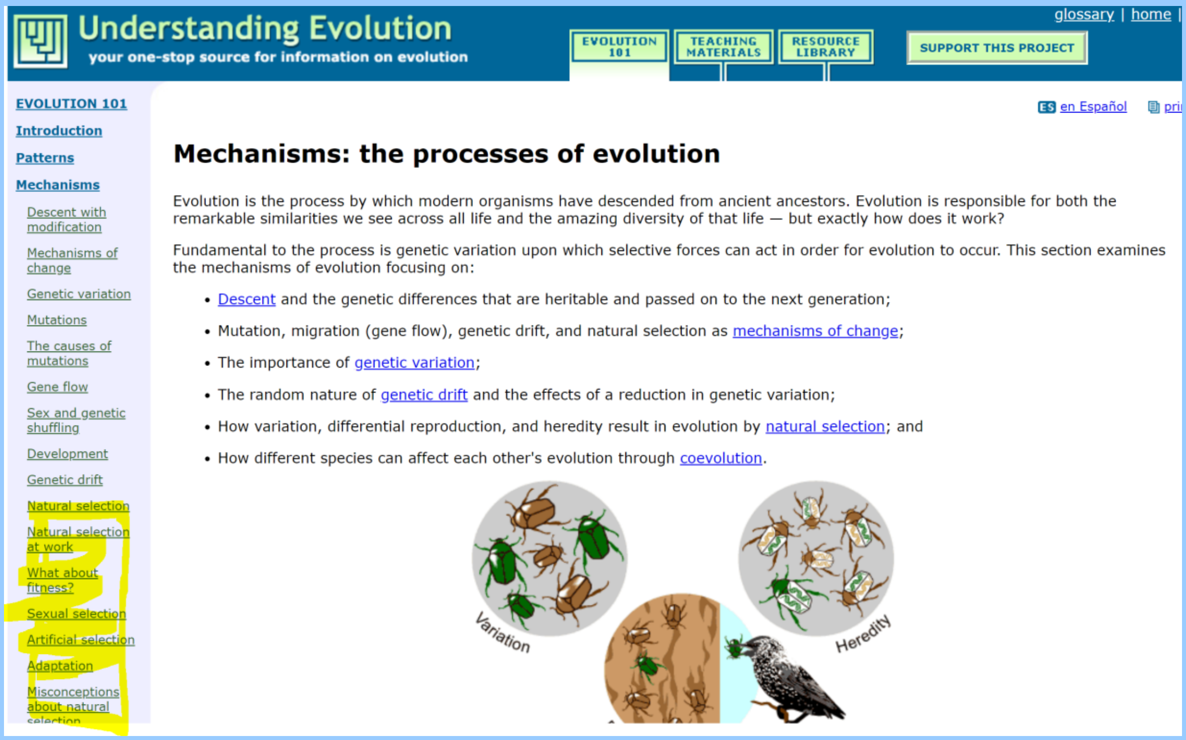
Natural Selection—Constraining Variability



Evolution Mechanisms or Process—the heart of how it works—please review these web pages carefully



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Understanding Evolution
your one-stop source for information on evolution

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Mechanisms: the processes of evolution

Evolution is the process by which modern organisms have descended from ancient ancestors. Evolution is responsible for both the remarkable similarities we see across all life and the amazing diversity of that life — but exactly how does it work?

Fundamental to the process is genetic variation upon which selective forces can act in order for evolution to occur. This section examines the mechanisms of evolution focusing on:

- Descent and the genetic differences that are heritable and passed on to the next generation;
- Mutation, migration (gene flow), genetic drift, and natural selection as mechanisms of change;
- The importance of genetic variation;
- The random nature of genetic drift and the effects of a reduction in genetic variation;
- How variation, differential reproduction, and heredity result in evolution by natural selection; and
- How different species can affect each other's evolution through coevolution.

Please carefully review the seven pages of [this section of the Understanding Evolution website] (from Descent with Modification to Genetic Drift). Then, write your two-paragraph summary with your opinion of these pages. This is a great foundation in the natural selection and other factors that constrain variability.

Natural Selection Simulators

Check out this “Evolution Game” natural selection simulation. Show me a screen shot of the simulation in action and then a paragraph tellin me what you think after watching the YouTube videos about it:.

Simulator from Minute Labs—I think it will work on any device, but probably better on bigger screen (you could play for hours)

Video introducing the simulator from Minute Labs (11 minutes)

Video about Natural Selection using the Simulator from Primer (10 minutes)

More Simulations

Here’s a couple of other simulations…more academic. The guppies is a classic that we’ll talk about in class.

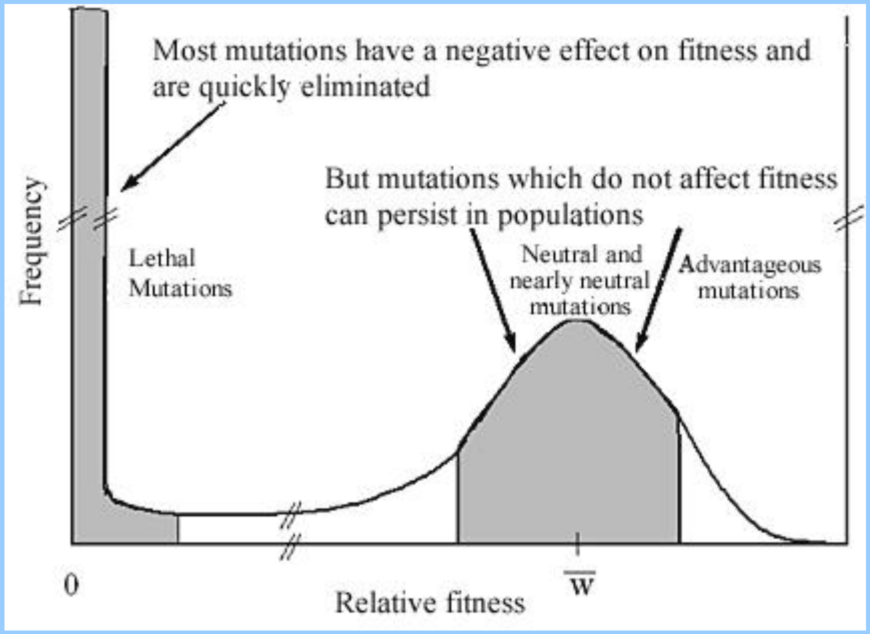
The Guppies: Based on the famous John Endler Guppy experiments. Still the best example of actually measuring natural selection in the wild, and in simulated lab environments. Choose the kind of guppy, the kind of predator and watch what happens. From PBS

Full gene frequency calculator. Let the simulation do all the math of the p's and q's. But you select initial gene frequencies, fitness, number of populations to simulate, number of individuals in the population and number of generations. You can play with this one for hours. Even has mutation rates and bottlenecks. From Radford University

Additional Resources

"Fitness, to a geneticist, is not the same as fitness to a movie director or a sports columnist. Fitness is not measured by physical attributes, it is measured by the number of offspring produced in the next generation that survive and reproduce. In a hunting-gathering society, the most fit person may have been the near sighted male who could not go on the hunt because he would stumble and make too much noise. If he were left behind to gather fruit and berries with the women, he may have become the most fit person in the tribe. Grandchildren, great-grandchildren, etc., are the best measures of the fitness of an individual. This has always been my favorite explanation of why so many of us are near sighted, and why society changed from hunting-gathering to agriculture. It's all population genetics!

"The most fit phenotype in the population is assigned a fitness of 1. If there are two equally fit phenotypes, each is assigned a fitness of 1. Those less fit must be assigned a fitness of less than 1. The difference between 1 and the fitness value is called the selection coefficient. The relationship between fitness, **w**, and the selection coefficient, **s**, is given by the equation, **w = 1-s**."

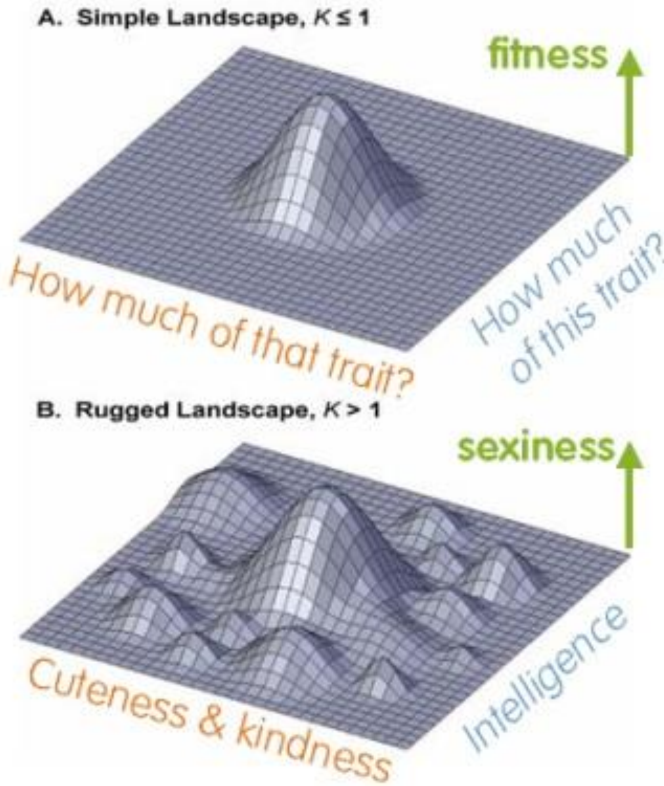


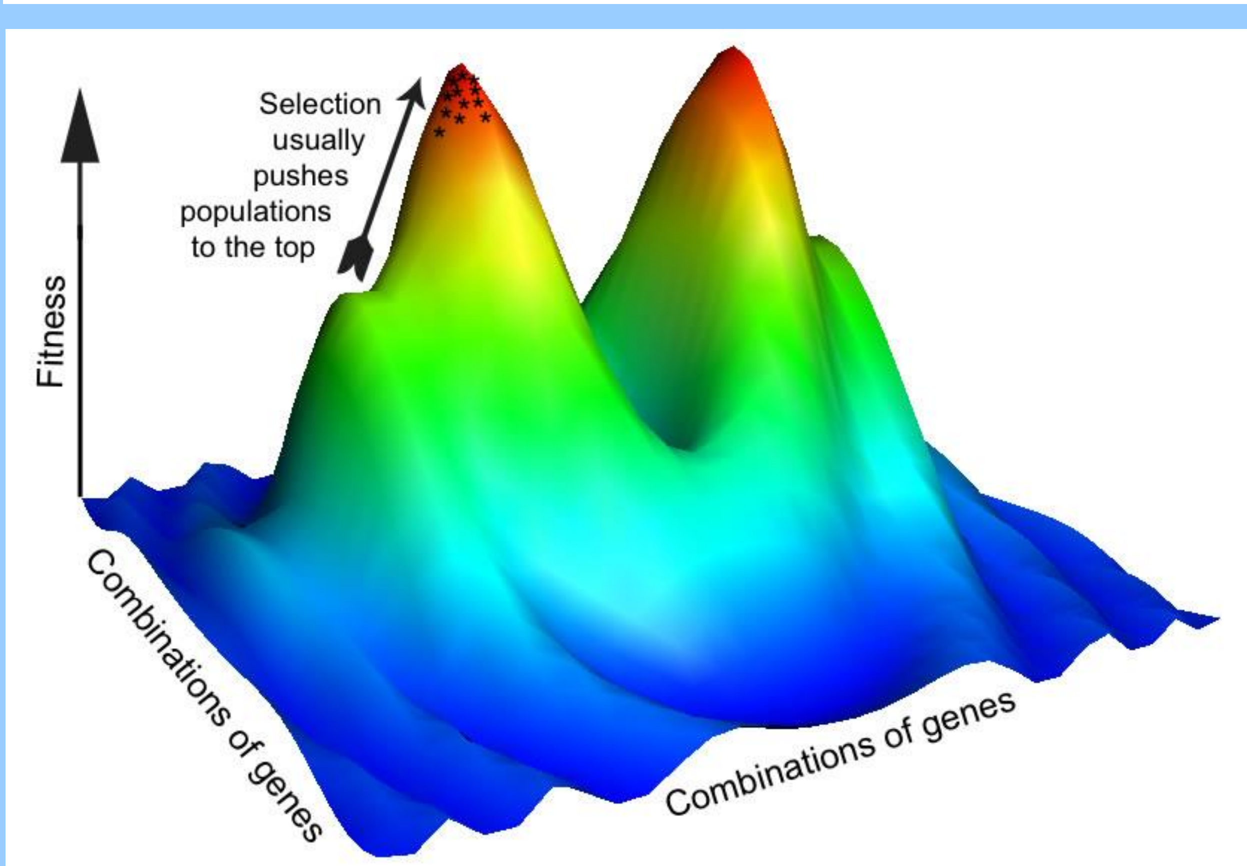
Fitness landscapes are visual evolution maps

Each generation, individuals change and occupy different positions in the landscape from their parents.

Simple landscapes have one clearly defined best behavior and natural selection will ultimately yield more of that behavior.

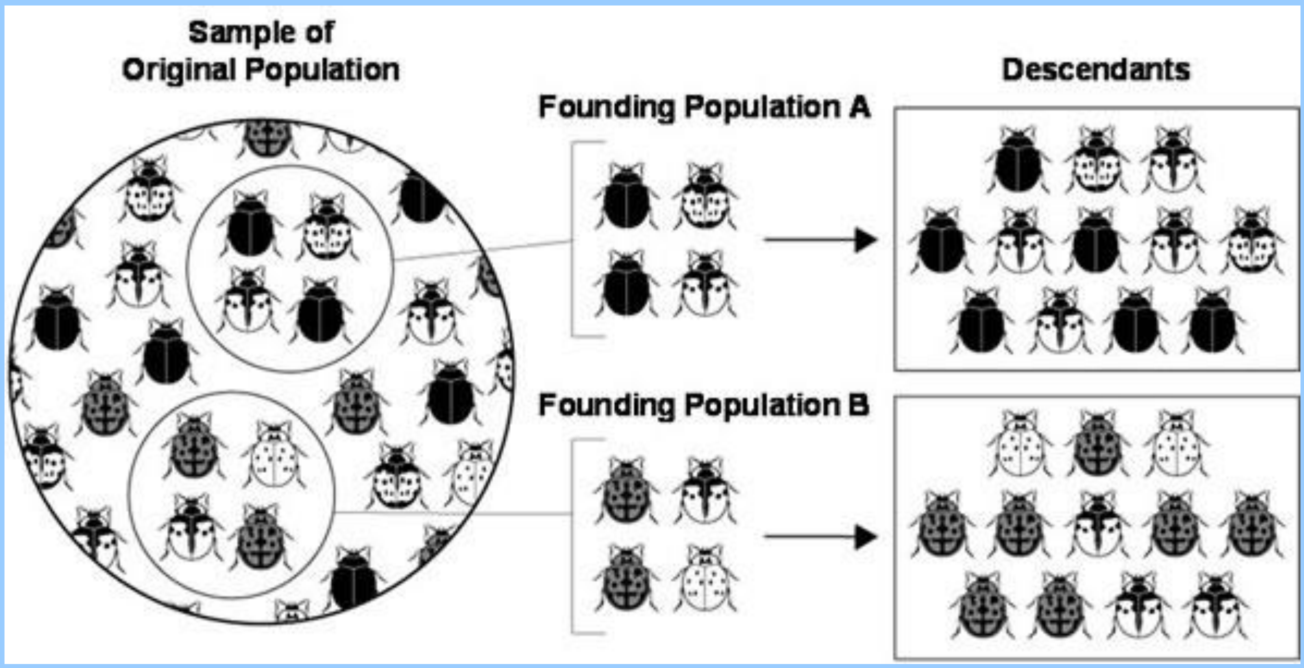
Rugged landscapes represent complex problems. Traits can get "stuck" in molehills and never converge on the big hill representing the "most fit" traits.



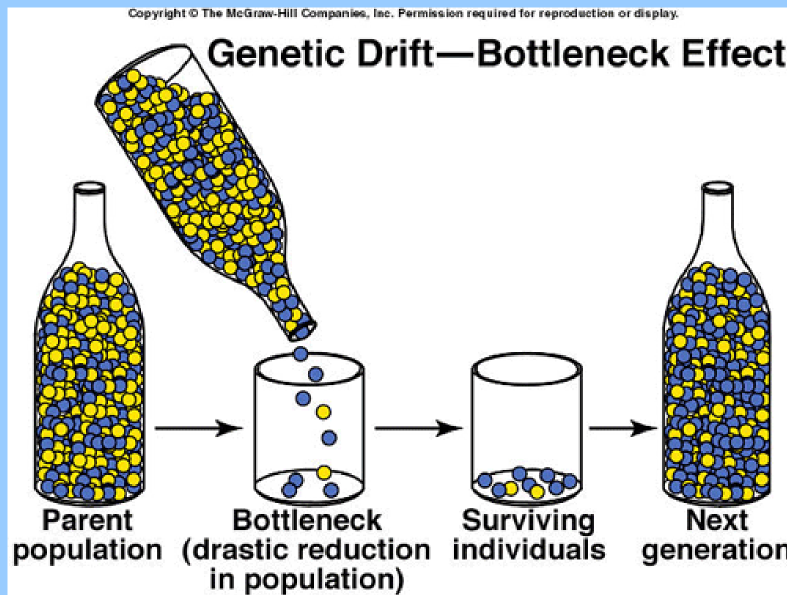


Genetic Drift and Founder Effects and Bottlenecks and Natural Selection—are they all the same?

[Nice article from FamilyPedia on genetic drift and all those other concpets--gives plain English and also the math]



Genetic Drift as the null hypothesis. How can we tell when evolutionary change is due to natural selection?
We can tell the story--we identify a difference in fitness and then we see a population change in a direction that the fitness difference should drive it.
But how can we be sure it's still not just random drift? The math can help, but so many other factors complicate it.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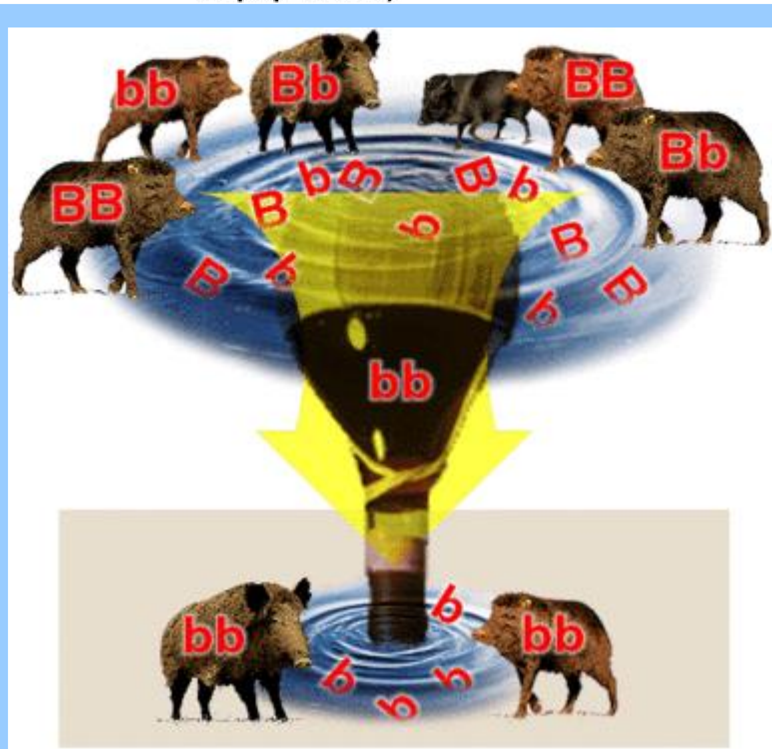
Genetic Drift—Bottleneck Effect
Parent population
Bottleneck (drastic reduction in population)
Surviving individuals
Next generation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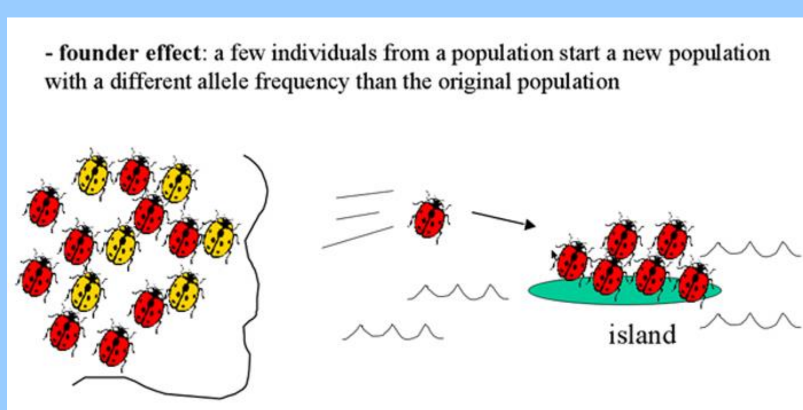
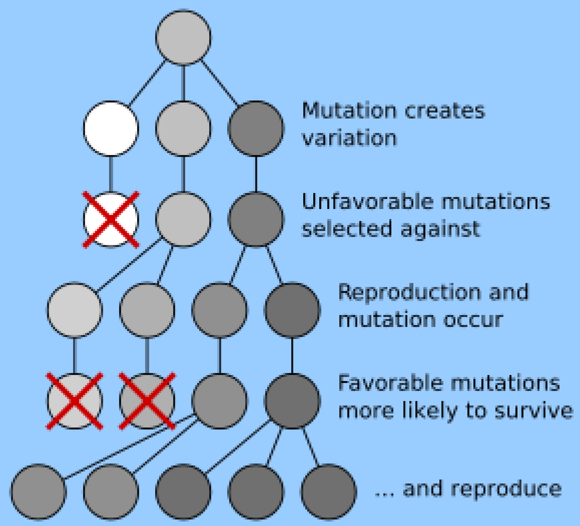
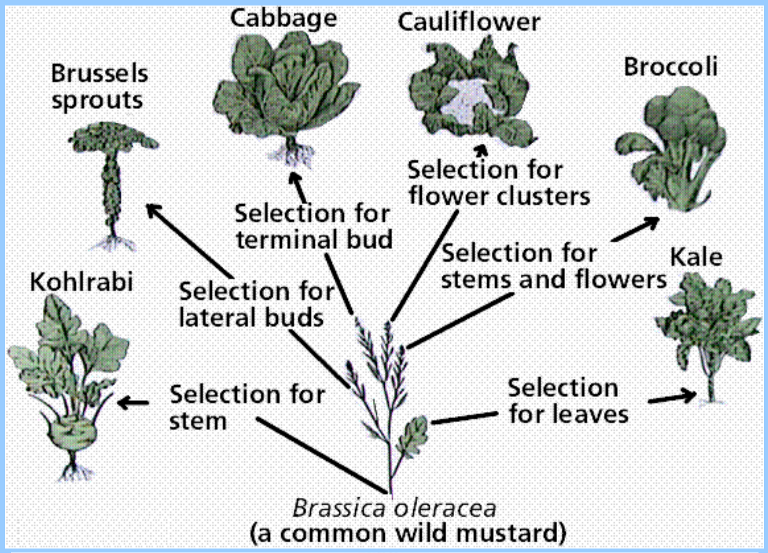
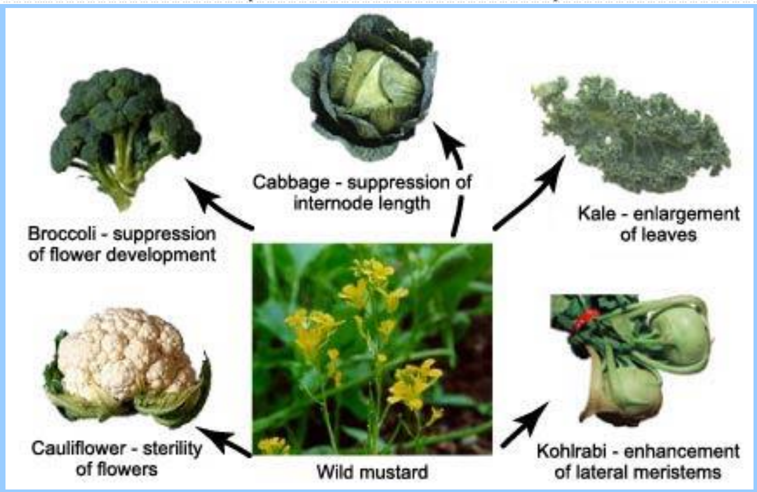

- founder effect: a few individuals from a population start a new population with a different allele frequency than the original population
island

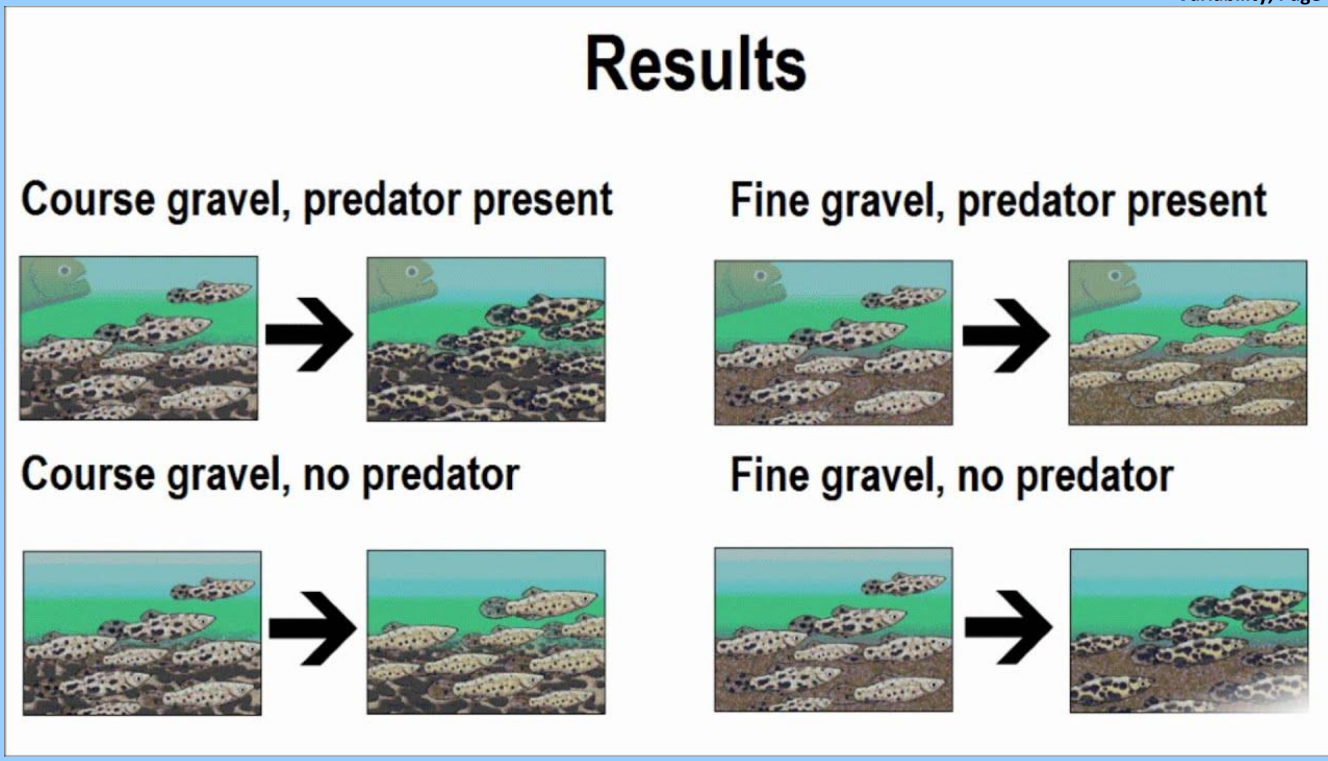


Natural Selection—how is it different from genetic drift—there's a selective force!

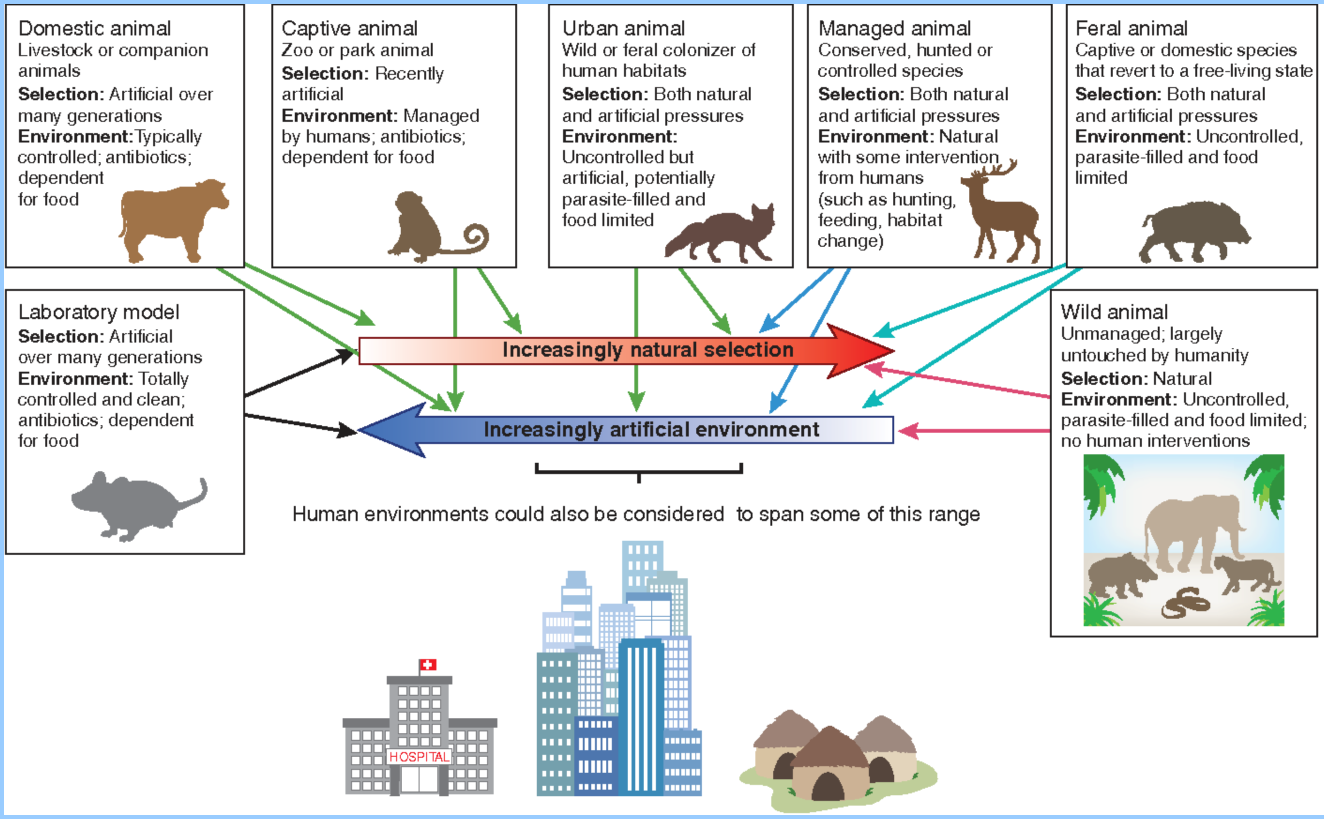




We humans as the selective force.

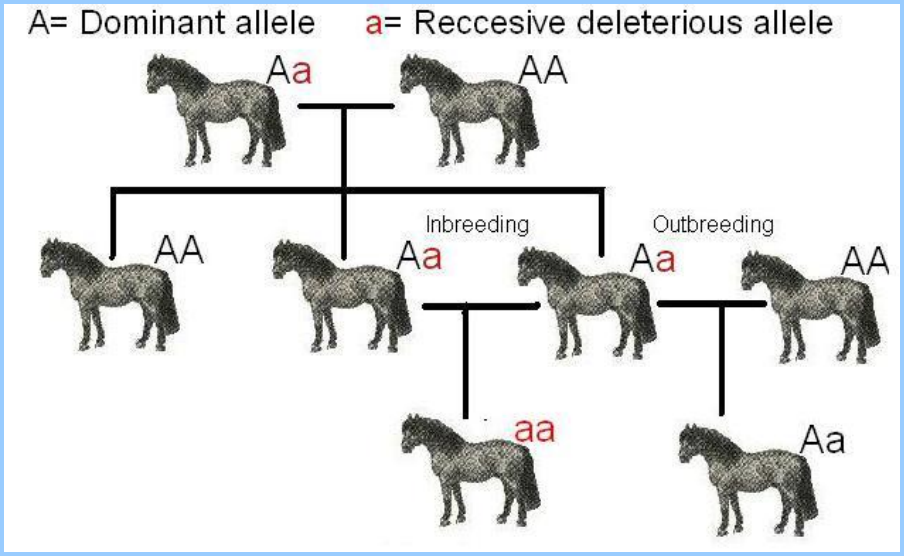


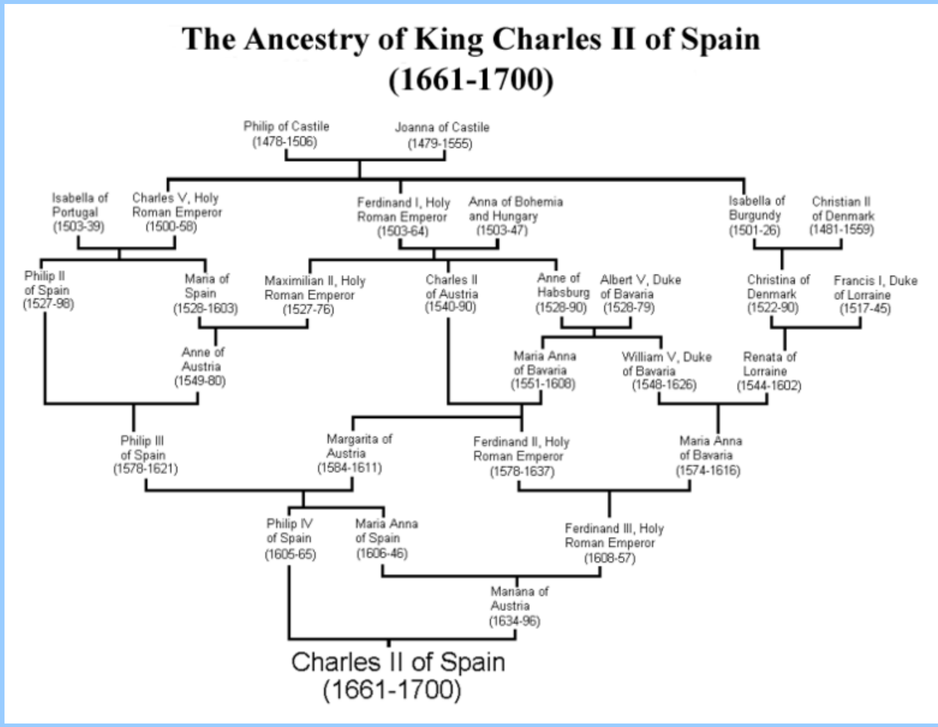
The Famous Guppies—selection in action in lab and in nature—see guppy simulator.



A gradient from "natural" to "artificial" (human-interaction) selection.

What happens when sex, or gene transfer, complicates things?





Inbreeding Depression. This is just the negative side of the variation produced by sex, as viewed at the population level.

What's interesting about inbreeding depression is that it takes us right back to the question of how the production of variation, and the factors that constrain that production, can lead to the parsing of organisms into species, and the parsing of biological organization into hierarchically stable components like cells, organisms, and species.

Yet More Resources

Great site for getting details of math on fitness, genetic drift and selection, all for plant pathogens--fascinating topic. Also explains all in good plain English.
Gene Flow from Nature magazine Knowledge Project--good graphics
University of Ilinois at Chicago--good review of basic genetic concepts for Mol Bio course
Evolution concepts applied to software designers
Lesson from Natural Selection for international aid workers
Nice review article on Fitness from Allen Orr (Nat Rev Genet.)