

# The Teacher Institute for Evolutionary Science



Our belief is that *teachers*  
should be *leaders* in their  
professional communities.

# Blake Touchet

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- B.S. Secondary Biology Education (University of Louisiana at Lafayette)
- M.S. Biological Sciences (Mississippi State University)
- Currently pursuing Ed.D. in Curriculum Leadership (University of Louisiana at Lafayette)
- 8 years of experience teaching science grades 7 through 12 and beyond.

# What is TIES?



Richard Dawkins  
Foundation  
for Reason & Science



*Created by a Nationally Board Certified middle school science teacher, TIES provides middle school teachers with free valuable classroom resources and full-day workshops to teach evolution, all based on the Next Generation Science Standards. The inaugural workshop took place April 3, 2015, at the Frost Museum of Science in Miami.*

Our inaugural workshop took place at Miami's Frost Museum of Science on April 3<sup>rd</sup>, 2015.



We presented 10 workshops in 2015 and have presented completed or confirmed more than 100 workshops so far...



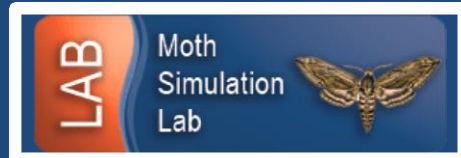
# The Teacher Institute for Evolutionary Science

In addition to our face-to-face workshops, TIES has one of the most comprehensive educational resources page on the Internet. It includes:

- An online version of our workshop, “Evolution for Educators”
- Video clips of middle school students completing our signature labs.
- Links to the Internet’s best Evolution games, videos, and labs.
- A Facebook page and Twitter account
- Monthly webinars led by capable educators like you.

The screenshot shows the main navigation menu with links for Home, About Us, Contact for Inquiry, Log In, and Contact Us. The main header features the TIES logo and the tagline "Unlocking the Wonders of Life for Teachers and their Students". Below this, there are sections for "What is TIES?", "Meet the Director: Bertha Vazquez", "Follow TIES" with social media icons, "TIES Online Learning", and "Join our TIES Teacher Corps". At the bottom, there are three featured images: "LABS", "WORKSHOPS WEBINARS", and "ONLINE RESOURCES".

The screenshot shows the "Online Learning" section of the website. It features the TIES logo and the text "Online Learning Page". Below this, there are several sections: "What is the TIES Online Learning Resource?", "You Can Change Lives!", "TIES Workshop Walk-Through" with three numbered steps (Part 1, Part 2, Part 3), "Have Resources? Share Them!", "We're Social! Follow Us!" with social media icons, "Teacher Materials" with a list of resources, and "Webinar Schedule" and "In-Person Workshop Schedule".





TEACHER INSTITUTE FOR  
EVOLUTIONARY SCIENCE

## *Our ready-to-go classroom resources include:*



- ***Evolution Exam***
- ***Classroom slide presentation with live video links***
- ***Hands-on activity on natural selection, “This Lab is for the Birds”***
- ***Online links to reading assignments, educational websites, and videos at <https://richarddawkins.net/ties/>***

***For more information about our resources or if you are interested in presenting a TIES workshop in your area, please contact Bertha Vazquez, TIES Director, at [bertha@richarddawkins.net](mailto:bertha@richarddawkins.net)***

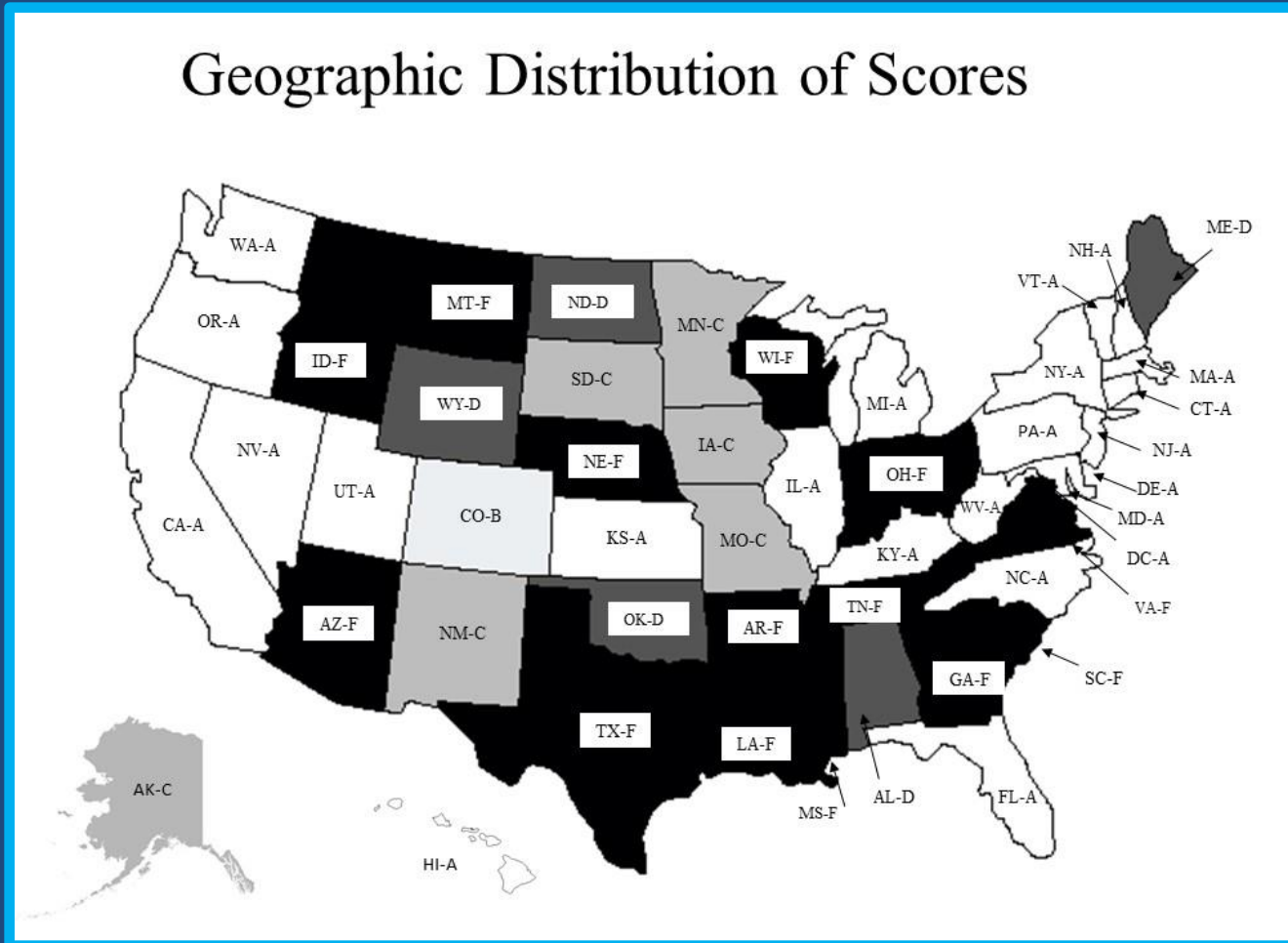
# The Teacher Institute for Evolutionary Science presents TIES Partnerships



Bringing teachers and biologists together to  
enhance the classroom experience.

# A Comparative Study of Middle School Science Standards across the United States

## Geographic Distribution of Scores



17/23 "A" States are the NGSS States

# Learning Progressions: DCI – LS4.A

## Evidence of Common Ancestry and Diversity

3-5	6-8	High School
<p>UE.LS4A.a Some kinds of plants and animals that once lived on Earth are no longer found anywhere.</p> <p>UE.LS4A.b Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.</p>	<p>MS.LS4A.a The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.</p> <p>MS.LS4A.b Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.</p> <p>MS.LS4A.c Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.</p>	<p>HS.LS4A.a Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from observable anatomical and embryological evidence.</p>

# Learning Progressions: DCI – LS4.B

## Natural Selection

3-5	6-8	High School
<p>UE.LS4B.a Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.</p>	<p>MS.LS4B.a Natural selection leads to the predominance of certain traits in a population and the suppression of others.</p> <p>MS.LS4B.b Genetic engineering techniques can manipulate the DNA within various organisms. Technology has changed the way humans influence the inheritance of desired traits in organisms. (e.g., selective breeding, gene modification, gene therapy, or other methods)</p>	<p>HS.LS4B.a Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population (e.g. mutations and sexual reproduction) and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. Natural selection leads to populations that have more individuals with behavioral, anatomical, and physiological adaptations.</p>

# Learning Progressions: DCI – LS4.C

## Adaptation

3-5	6-8	High School
<p>UE.LS4C.a For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.</p>	<p>MS.LS4C.a Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.</p>	<p>HS.LS4C.a Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.</p> <p>HS.LS4C.b Adaptation also means that the distribution of traits in a population can change when conditions change.</p> <p>HS.LS4C.c Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.</p> <p>HS.LS4C.d Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.</p>

# Learning Progressions: DCI – LS4.D

## Biodiversity and Humans

K-2	3-5	6-8	High School
<p>LE.LS4D.a There are many living things in any area, and they exist in different places on land, in water, and in air.</p>	<p>UE.LS4D.a Populations live in a variety of habitats, and change in those habitats affects the organisms living there.</p>	<p>MS.LS4D.a Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services on which humans rely.</p>	<p>DCI.LS.HS.4D.a Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity is also having adverse impacts on biodiversity through overpopulation,</p>
			<p>overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.</p>

# 3<sup>rd</sup> grade LS-4

## Performance Expectations

- 3-LS4-1: Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
- 3-LS4-2: Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
- 3-LS4-3: Construct and support an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- 3-LS4-4: Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

# 7th grade LS-4

## Performance Expectations

- 7-MS-LS4-4: Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
- 7-MS-LS4-5: Gather, read, and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.

# 8th grade LS-4

## Performance Expectations

- 8-MS-LS4-1: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
- 8-MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships
- 8-MS-LS4-3: Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
- 8-MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations of species over time.
- \*\*8-MS-ESS1-4: Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's geologic history.

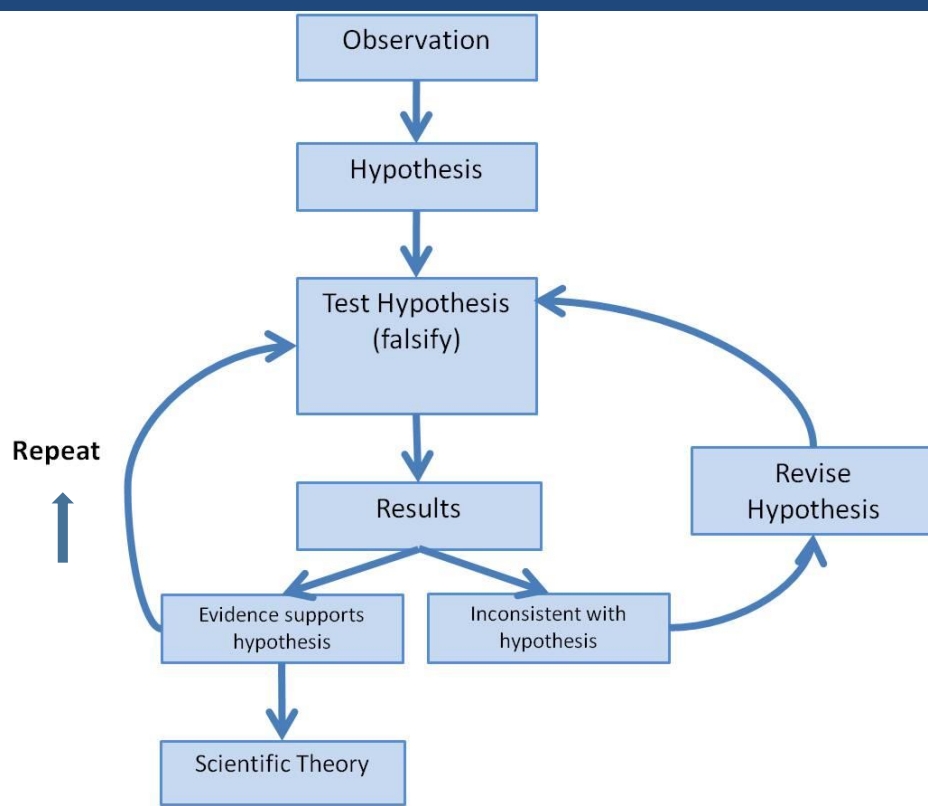
# Biology LS-4

## Performance Expectations

- HS-LS4-1: Analyze and interpret scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- HS-LS4-2: Construct an explanation based on evidence that biological diversity is influenced by (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- HS-LS4-3: Apply concepts of statistics and probability to support explanations that populations of organisms adapt when an advantageous heritable trait increases in proportion to organisms lacking this trait.
- HS-LS4-4: Construct an explanation based on evidence for how natural selection and other mechanisms lead to genetic changes in populations.
- HS-LS4-5: Evaluate evidence supporting claims that changes in environmental conditions can affect the distribution of traits in a population causing: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

# Simplified Evolution Standards

1. The scientific theory of evolution is the organizing principle of life science.
2. The scientific theory of evolution is supported by multiple forms of evidence.
3. Natural selection is the primary mechanism leading to change over time in organisms.



In Science,  
the word  
“Theory” is a  
**BIG DEAL!**

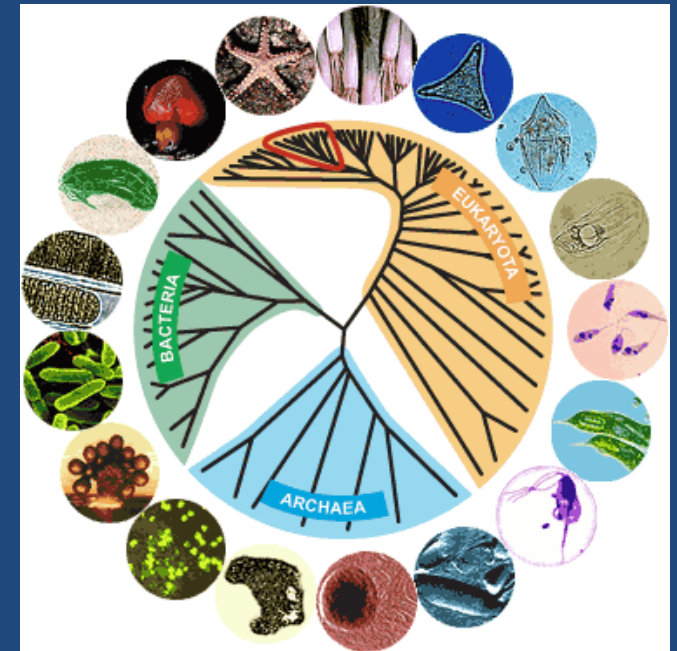
A theory is a well-substantiated, supported,  
and documented explanation for our observations.

A theory is NOT a hunch NOR does it become a law.

I: The scientific theory of evolution is the organizing principle of life science.

## What does Evolution claim?

- The millions of different species of plants, animals, and microorganisms that live on earth today are all related by descent from common ancestors.



## What is the result of Evolution?

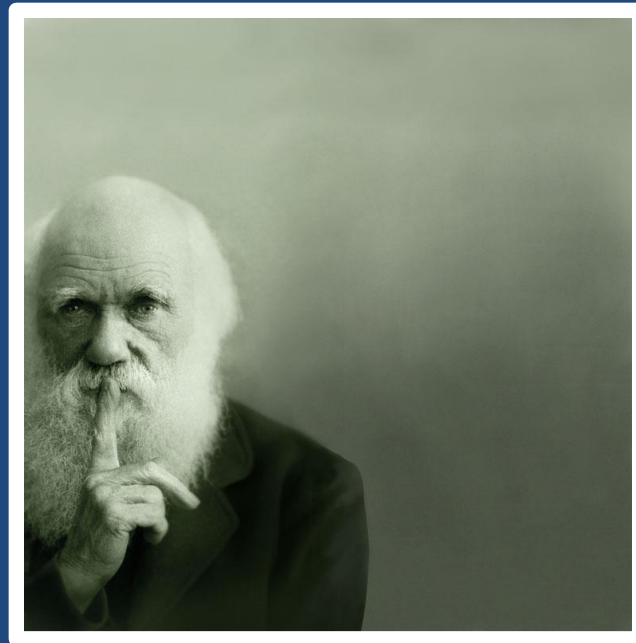
- The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.

Evolution is the unifying theme, the binding force of all life sciences.



**"Nothing in Biology Makes Sense  
Except in the Light of Evolution"**  
[Theodosius Dobzhansky](#)

The concepts of common descent and natural selection were first proposed by Charles Darwin in his famous book, *The Origin of Species* in 1859



[Who Was Charles Darwin?](#)



## II: Evidence for Evolution comes from different sources and various disciplines:

1. Fossils
2. Biogeography
3. The Law of Superposition
4. Artificial Selection
5. Vestigial Structures: The evolutionary legacy we carry within our own bodies
6. Similarities: Comparative Anatomy
7. Overwhelming Genetic Evidence (not available in Darwin's time)

# Evidence for Evolution

## 1. Fossils:

### Traces of long-dead organisms

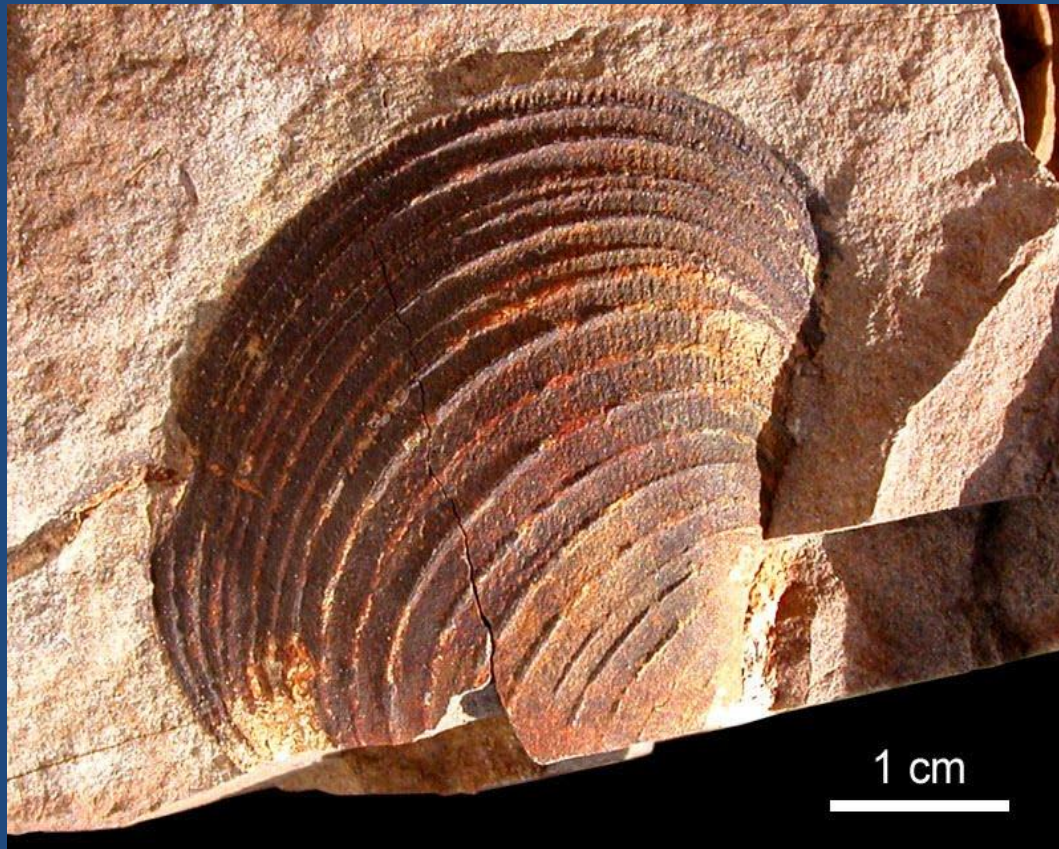
There are different types of fossils here are just a few.



A body fossil is the actual remains of the organism. The most common body fossils found are from the hard parts of the body, including bones, claws and teeth.

# Types of Fossils

A fossil mold is formed by the impression left in rock by the remains of an organism.



# Types of Fossils

A cast fossil occurs when the mold is filled in by precipitating minerals.



# Types of Fossils

Amber: fossilized tree resin that can contain organisms



# Types of Fossils

Petrified wood forms when plant material is buried by sediment and protected from decay by oxygen and organisms. Then, groundwater rich in dissolved solids flows through the sediment replacing the original plant material with organic material.

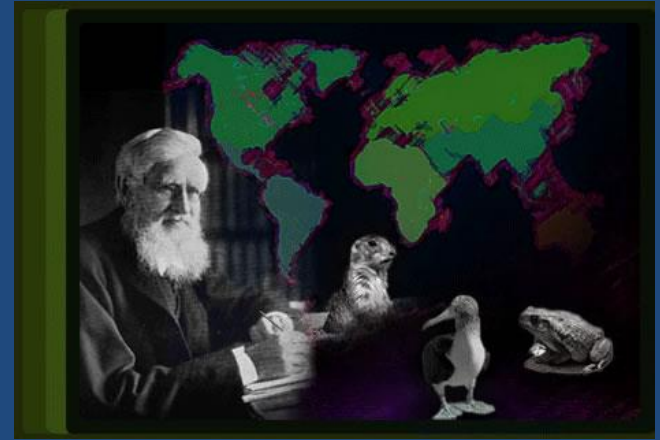


To learn more about the many different types of fossils, check out: [The National Center for Science Education's Article](#)



# Evidence for Evolution

## 2. Biogeography: the study of the geographical distribution of fossils.



- For example, in the *Origin of Species*, Darwin pointed out that fossils of giant armadillos and ground sloths are found only in the Americas, not in the Old World or Australia.
- He thought that it was probably not a coincidence that modern-day armadillos and tree sloths are only found naturally in the Americas as well.



[More here!](#)



# Evidence for Evolution

## 3. The Law of Superposition

- Successive layers of rock or soil were deposited on top of one another by wind or water
- The lowest layer (stratum) will be the oldest.
- Relative age: a given fossil is younger or older than what is below or above it
- Absolute age: actual age based on amount of sediment around fossil
- The fossil record shows five mass extinctions in Earth history



# 3. The Law of Superposition

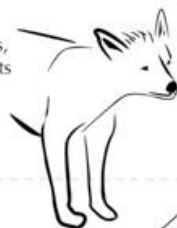
from Neil Shubin's  
***Your Inner Fish***  
***A Journey into the 3.5-Billion-Year History of the Human Body***

Pattern at the zoo

Everything with heads,  
limbs, hair, and breasts  
that walks on two legs



Everything with heads,  
limbs, hair, and breasts



Everything with heads  
and limbs



Everything with heads



Fossil record

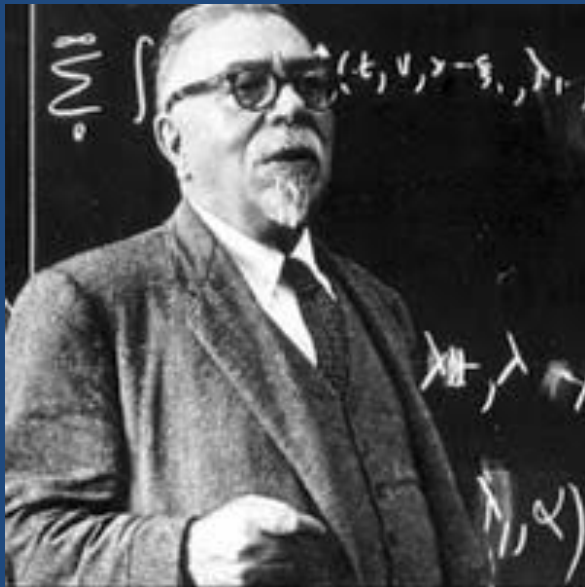


The oldest  
rock (lowest)  
contains the  
oldest  
organisms.

What we discover on our walk through the zoo mirrors how fossils are laid out in the rocks of the world.

# What would make you change your mind about Evolution?

- The famous biologist, J.B.S. Haldane, answered, “Find me a rabbit fossil in Pre-Cambrian Rock.”



(nobody has!)

# Evidence for Evolution

## 4. Artificial Selection

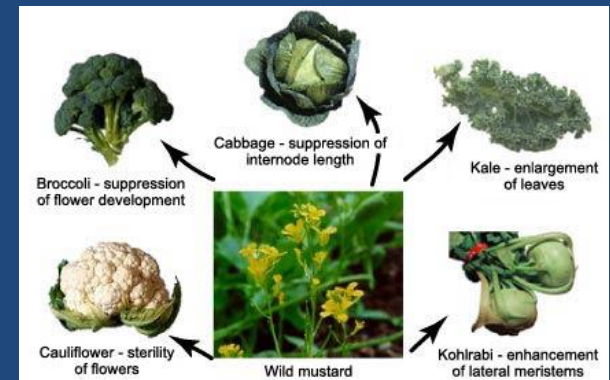
Darwin noticed how farmers and breeders allowed only the plants and animals with desirable characteristics to reproduce, causing the evolution of farm stock. He used this as evidence in *Origin of Species*.



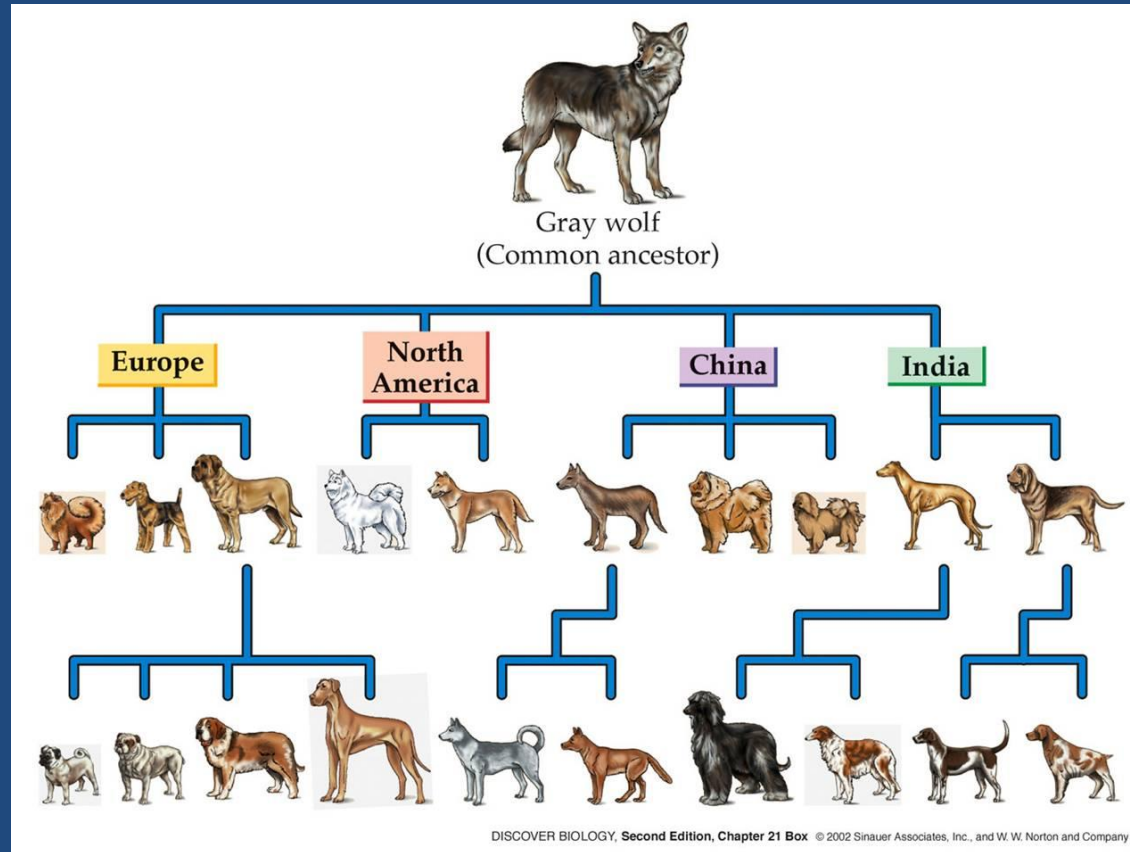
Cows being milked in ancient Egypt



These pics both show the same animal, feral vs. domestic pigs.



# A Great Example of Artificial Selection



“Artificial selection provides a model that helps us understand natural selection. It is a small step to envision natural conditions acting selectively on populations and causing natural changes.”

And now for something really  
amazing...



From NOVA's [Dogs Decoded \(35:00\)](#), a look a  
modern-day experiment on artificial selection

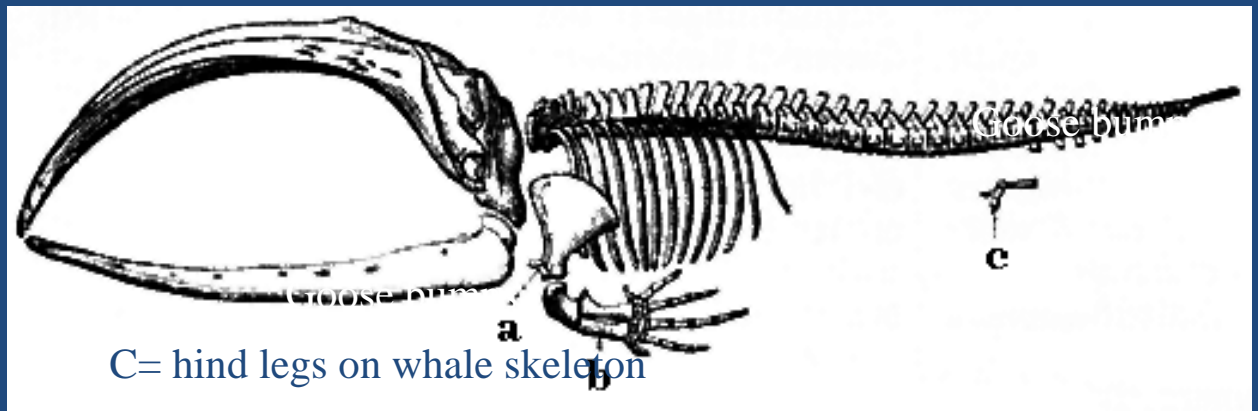
# Evidence for Evolution

**5. VESTIGIAL STRUCTURES** are features that were adaptations for an organism's ancestor but have evolved to no longer perform their original function due to a change in the organism's environment.

[Vestigial structures in humans](#)



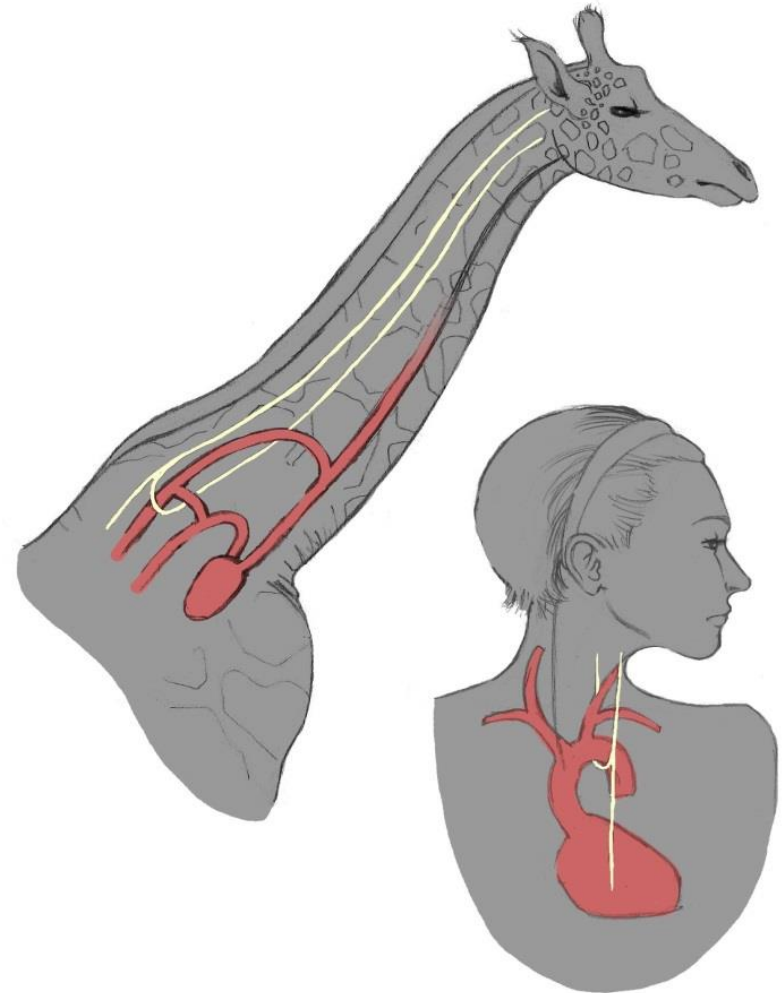
Anal spurs  
on a ball  
python



[How did whales evolve?](#)

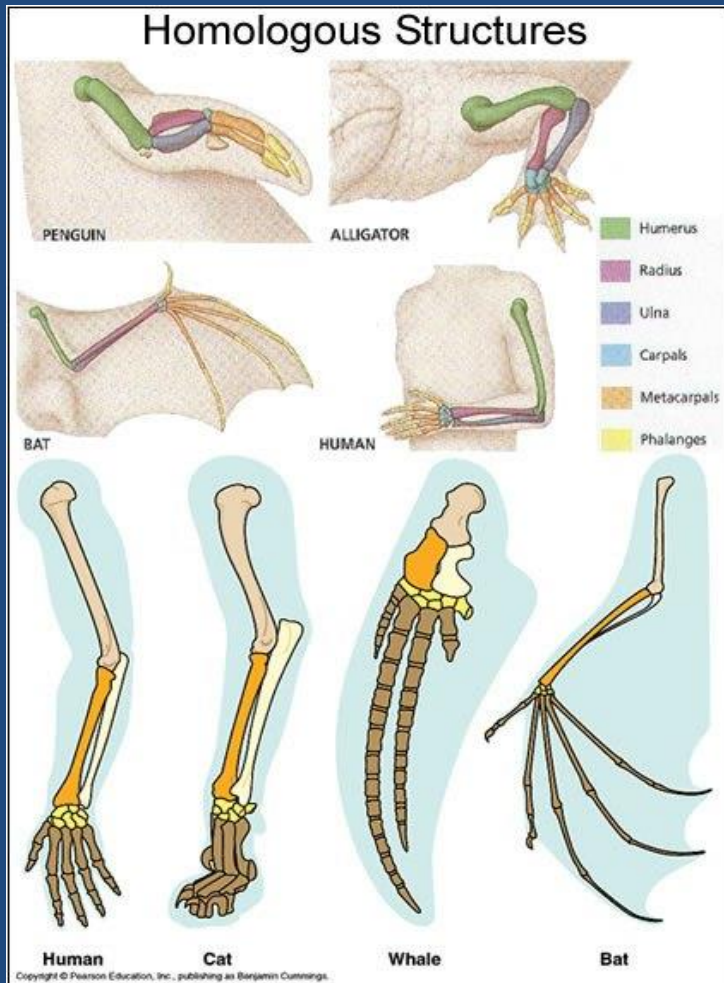
We carry our evolutionary history  
within our own bodies.

The fascinating case  
of the Recurrent  
Laryngeal Nerve



# Evidence for Evolution

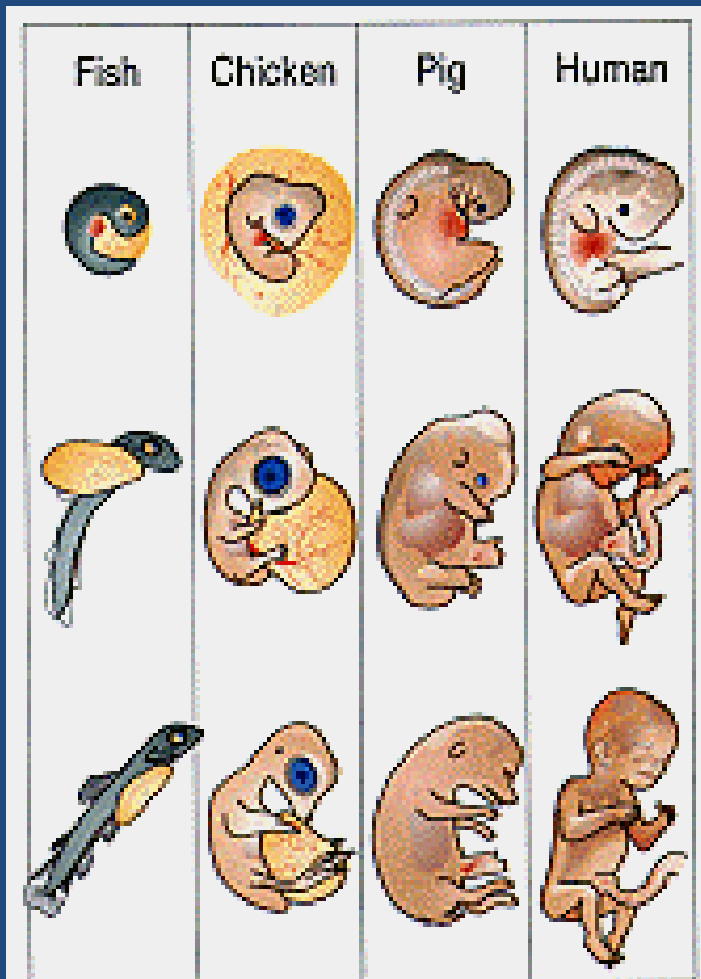
## 6. Similarities among related organisms:



Comparative Anatomy:  
The study of Homologous structures (ex. forearms) features in different species that are similar because those species share a common ancestor.

Embryonic development is also strikingly similar among related organisms.

Comparative Embryology:

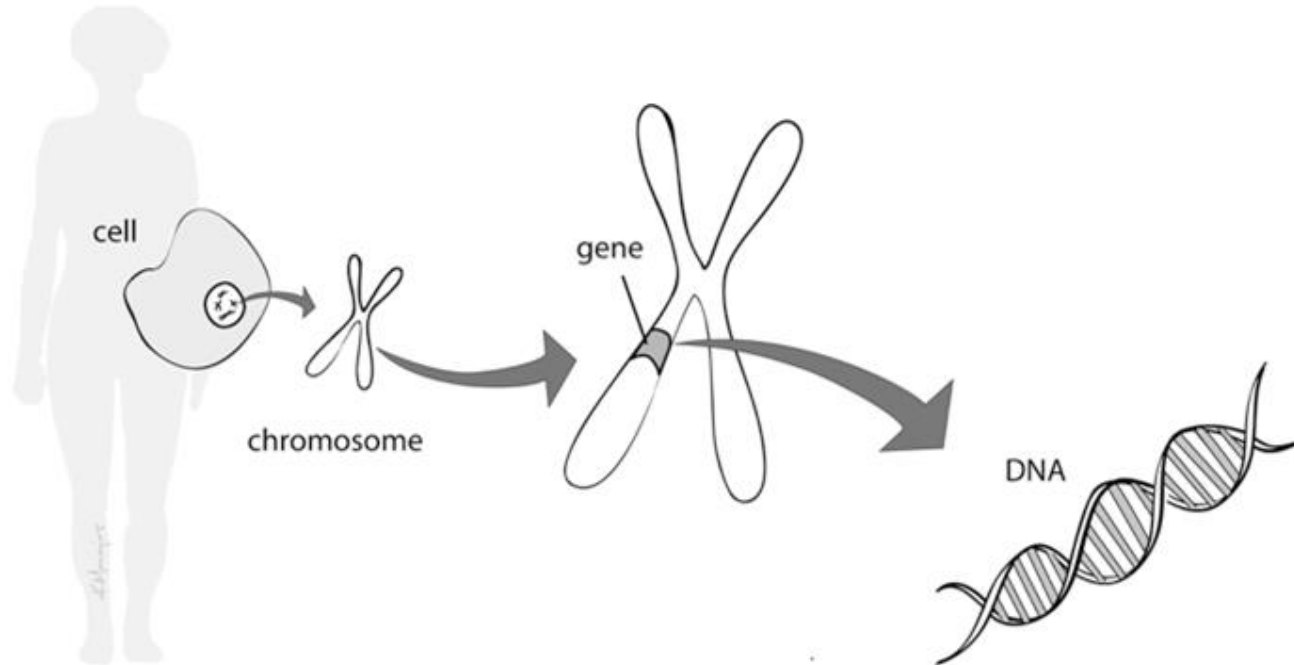


# Evidence for Evolution

## 7. The latest overwhelming evidence for evolution comes from molecular biology

- **Molecular Biology**: is the strongest evidence for evolution. Not even known in Darwin's time, it involves comparing the DNA of different species to determine their relatedness.
- Just like our forelimbs or embryos are similar, so are our genes!
- **Genes are also homologous structures.**

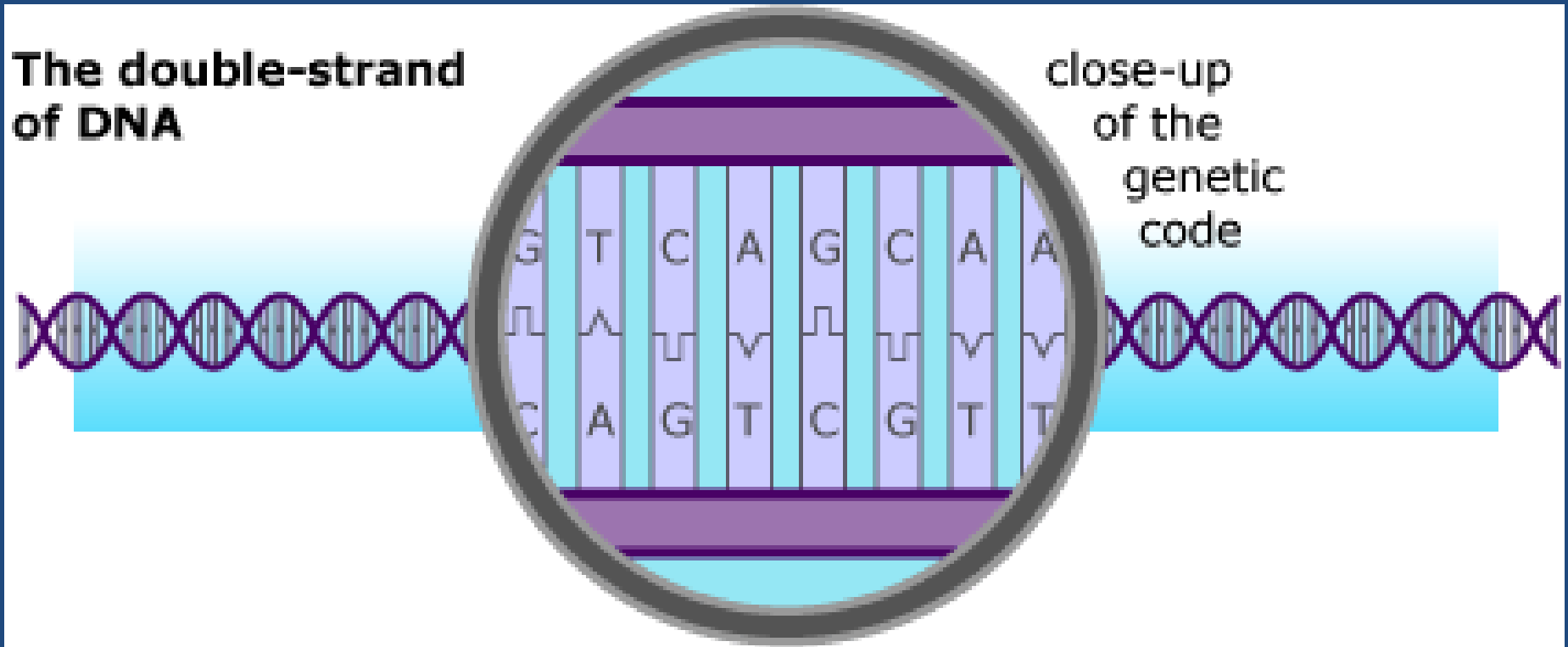
# So What is a Gene?



Genes are stretches of DNA contained in every cell of our bodies.

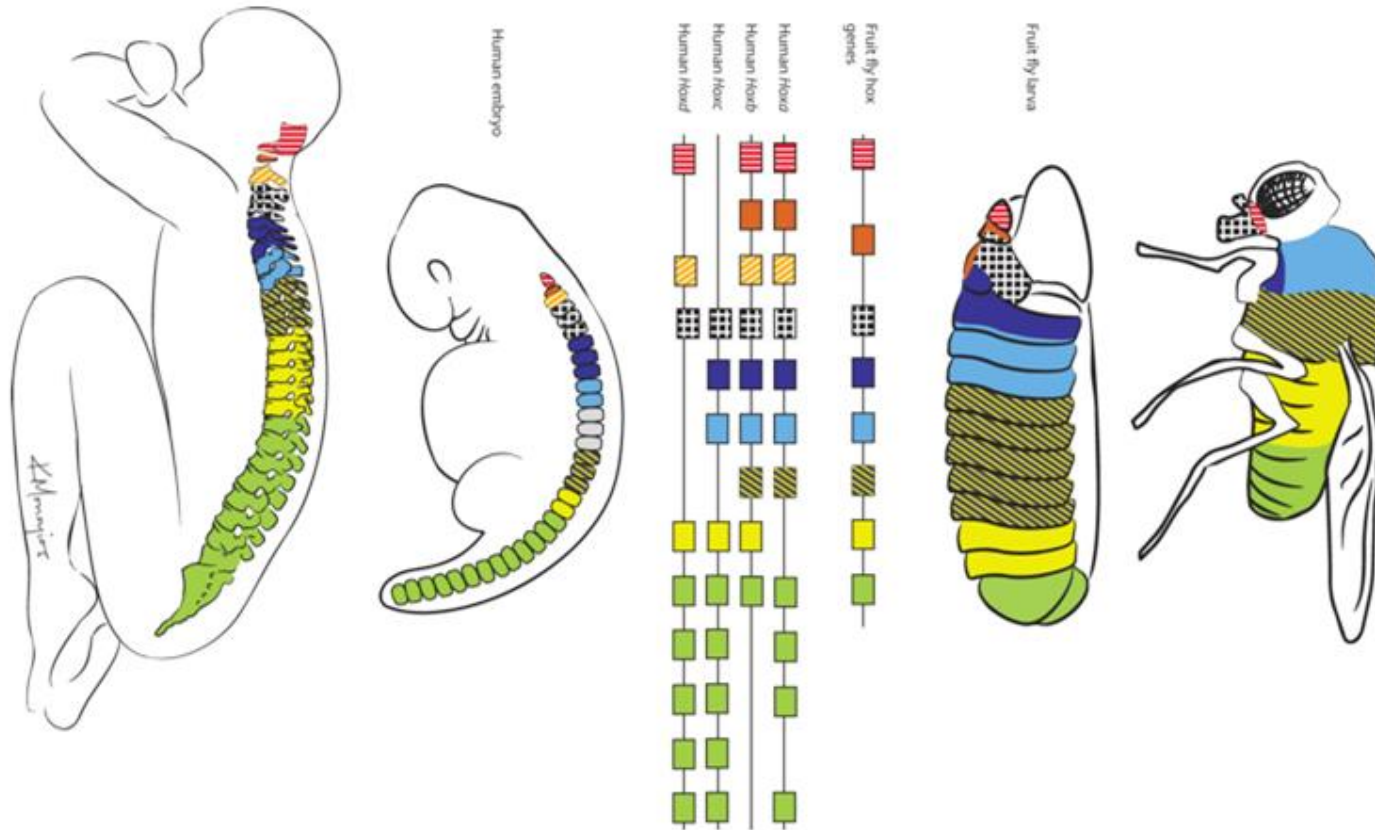
[Journey into DNA](#)

# And what is DNA?



The function of DNA is to store and transmit the genetic information that tells cells which proteins to make and when to make them

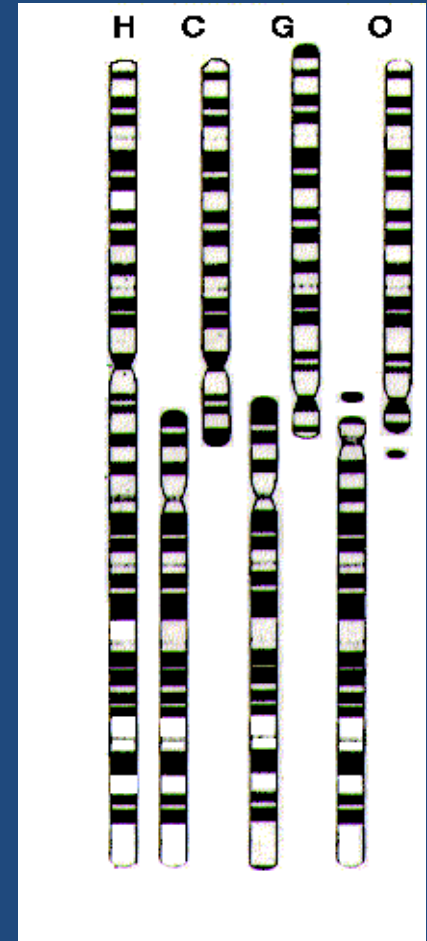
# Hox Genes are similar in all animals



*Hox* genes in flies and people. The head-to-tail organization of the body is under the control of different *Hox* genes. Flies have one set of eight *hox* genes, each represented as a little box in the diagram. Humans have four sets of these genes. In flies and people, the activity of a gene matches its position on the DNA: genes active in the head lie at one end, those in the tail at another, with genes affecting the middle of the body lying in between.

# Two excellent resources for genetic evidence for evolution:

- [Professor Richard Dawkins at the University of Nebraska State Museum](#)
- [Dr. Kenneth Miller compares ape and human chromosomes](#)



Human chromosome #2  
and its ape analogs

III. Natural Selection is a primary mechanism leading to change over time in organisms. It is the driving force behind evolution.

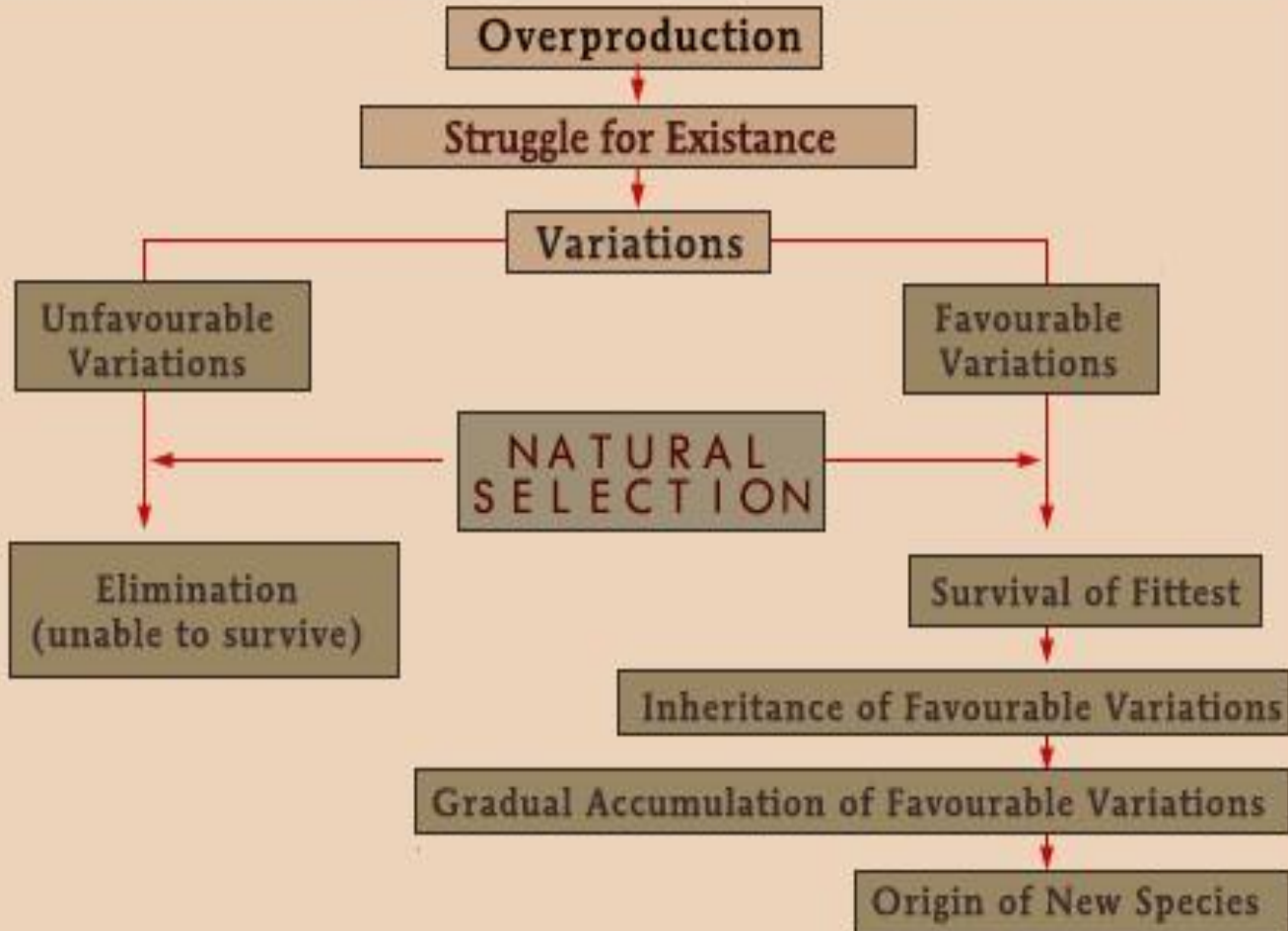


# For Natural Selection to occur, 4 conditions must be met:

1. Traits in a population of organisms exhibit variation.
2. In any given population, not all individuals survive to reproduce.
3. Survival is NOT random. Survivors must have an advantage over those that don't survive. A favorable trait gives the organisms an adaptive advantage.
4. The survivor's advantageous traits MUST be heritable. High fitness means an organism's ability to reproduce successfully.

See flowchart on next slide.....

## CENTRAL THEME OF DARWINISM



Look at just how well adapted these organisms are to their environment.



[Click here to meet the Mud Skipper!](#)



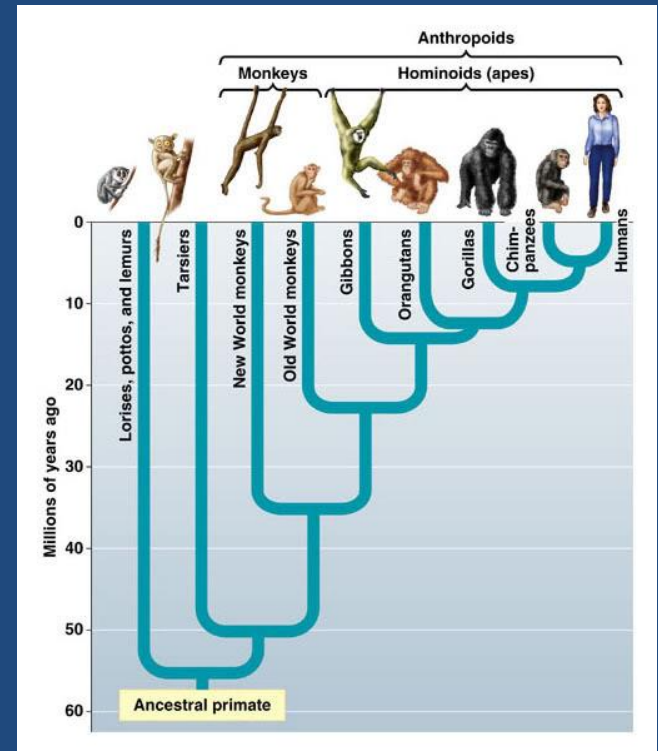
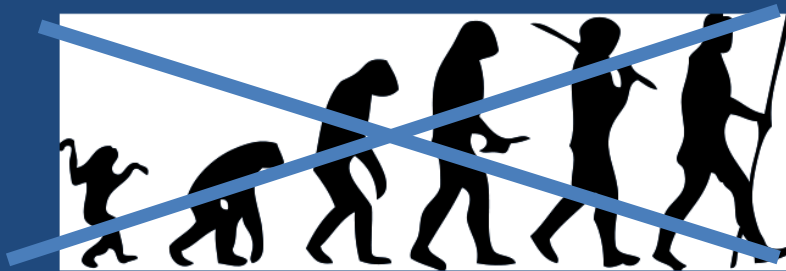
[Click here for an animation illustrating Natural Selection in a changing environment](#)

# Some important vocabulary:

- Population: A group of organisms all of the same species living in the same area.
- Genotype: The actual set of genes (strips of DNA in the chromosomes) that an organism has inherited.
- Phenotype: The outward, physical expression of those genes.
- Mutation: A permanent change in the DNA of an organism. If it is passed on to the organism's offspring, it may be harmful, harmless, or helpful for the offspring.

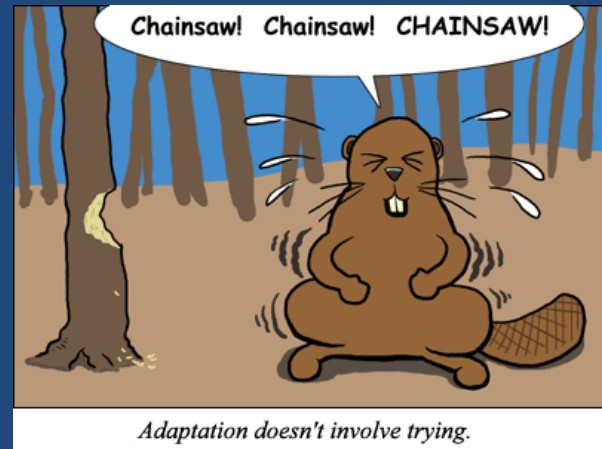
# Two Common Misconceptions about Natural Selection

1. The population or individual does not "want" or "try" to evolve, and natural selection cannot try to supply what an organism "needs." Natural selection just selects among whatever variations exist in the population. The result is evolution.



The Blind Cave Fish from the deep caves of Mexico is a good illustration of this concept.

Over many generations in the dark, the species has lost its eyes since vision no longer gave the fish an advantage. Natural selection has no foresight, if the light returns to their ecosystem, they will be at a disadvantage.



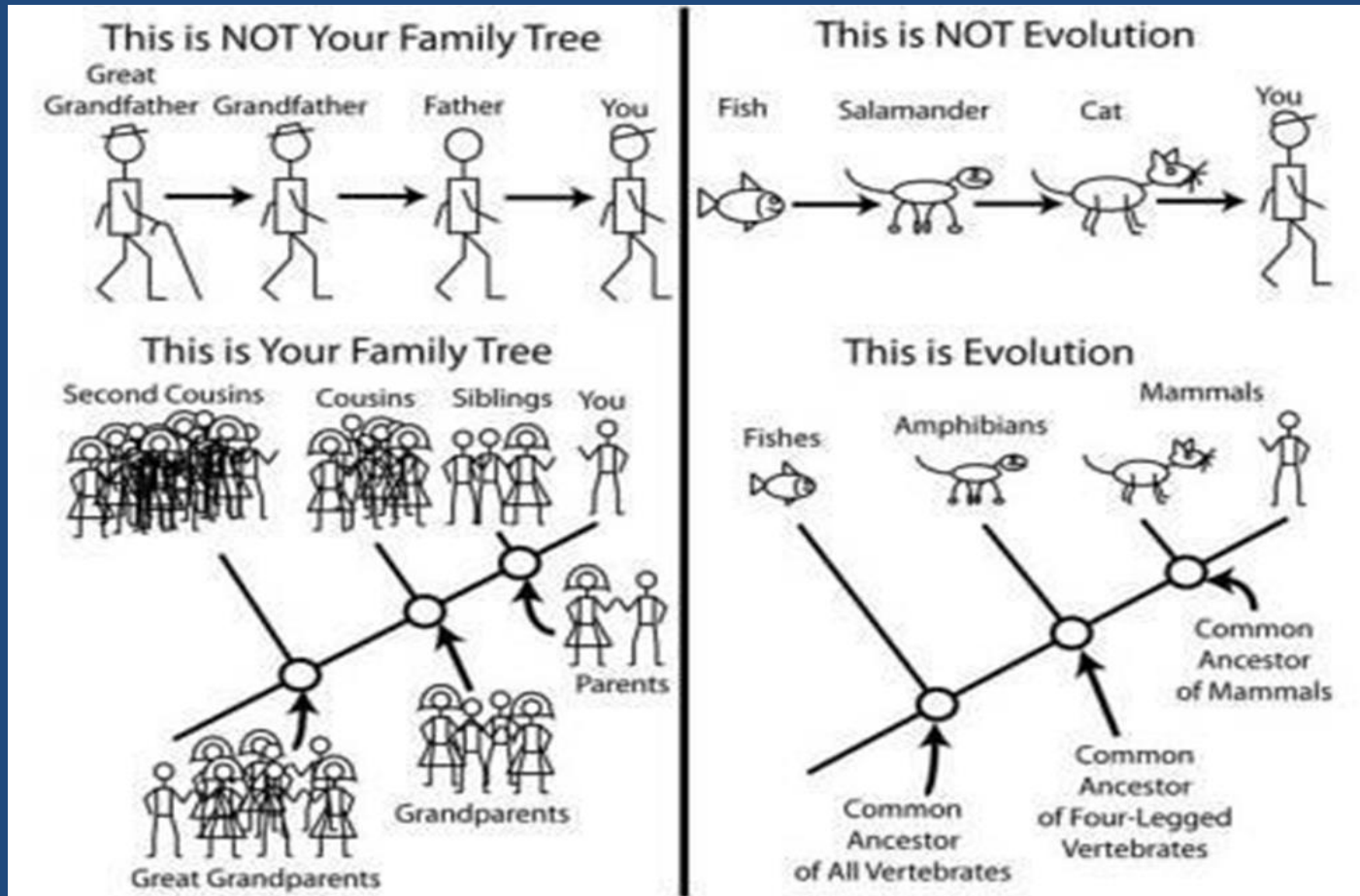
# Misconceptions about Natural Selection, continued

2. Natural selection is sometimes interpreted as a random process. The genetic variation that occurs in a population because of mutation is random — but selection acts on that variation in a very non-random way: genetic variants that aid survival and reproduction are much more likely to become common than variants that don't. Natural selection is NOT random!



# Misconceptions about Evolution

[An amusing link to an excellent explanation of common misconceptions](#)



[Another Link to Misconceptions about Evolution](#)

# Correcting Misconceptions

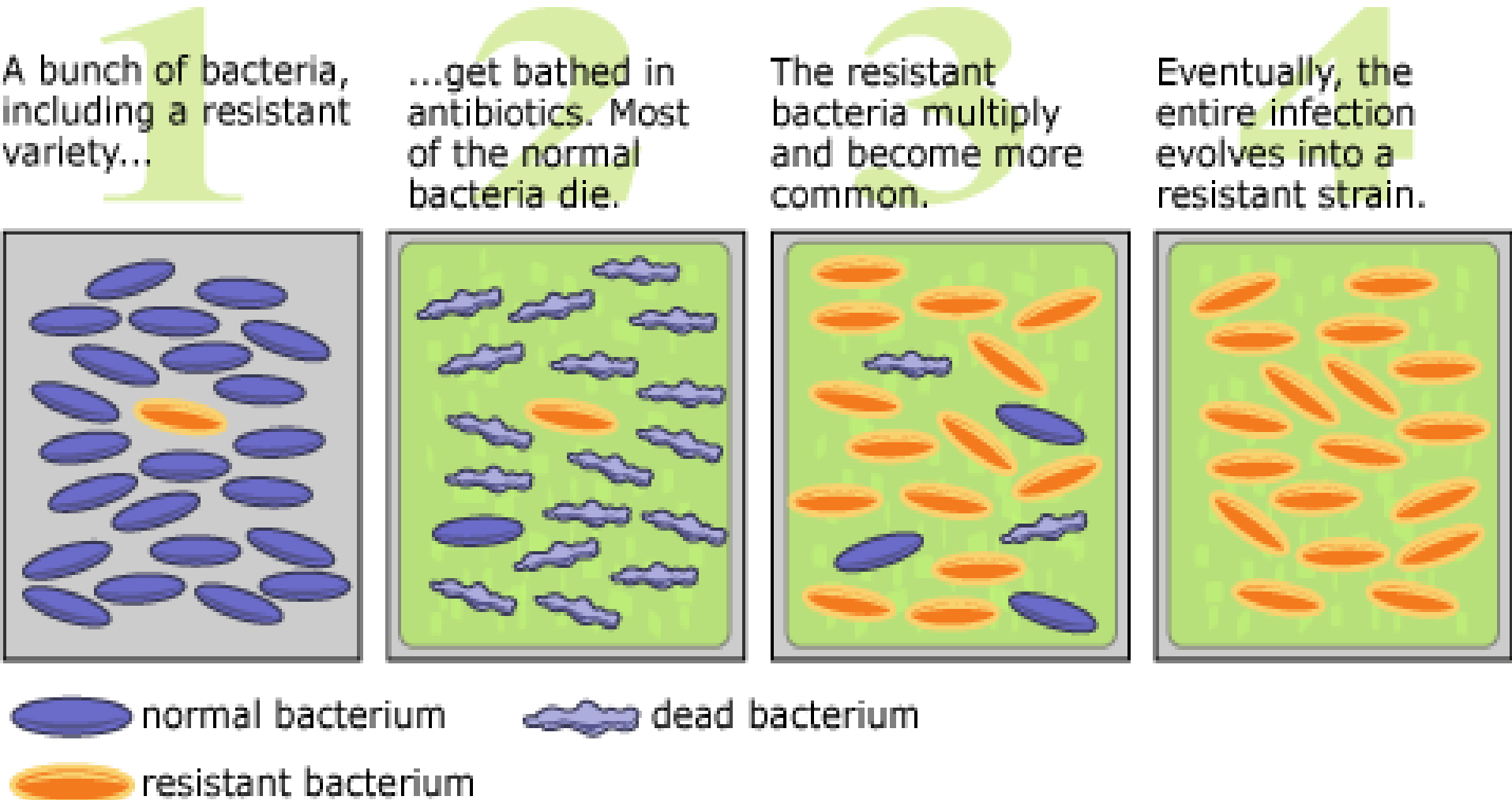


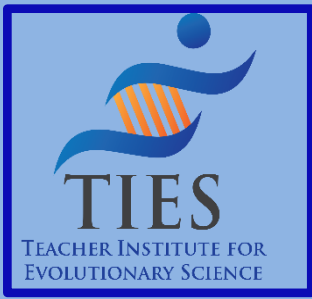
- [The Position of the NSTA, the National Science Foundation and Evolution.Berkeley](#)

Check out our website for these helpful links, including the NSTA Statement on teaching Evolution.

# How does natural selection play a role in our own lives?

## Ex: Antibiotic resistance





If you have something to offer in promoting the quality science education in your district or state, please become a part of our TIES Teacher Corps.

Join us!



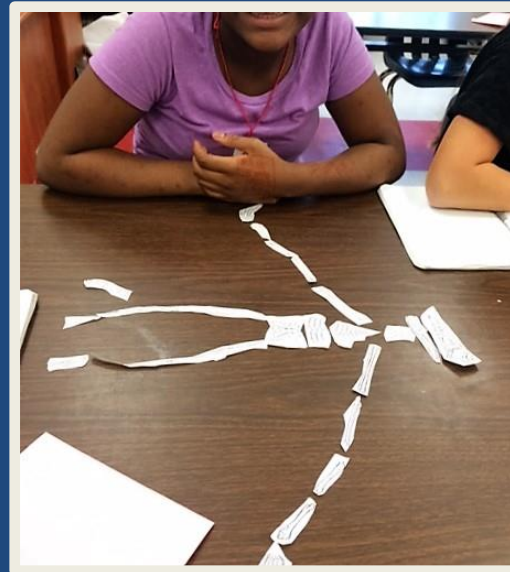
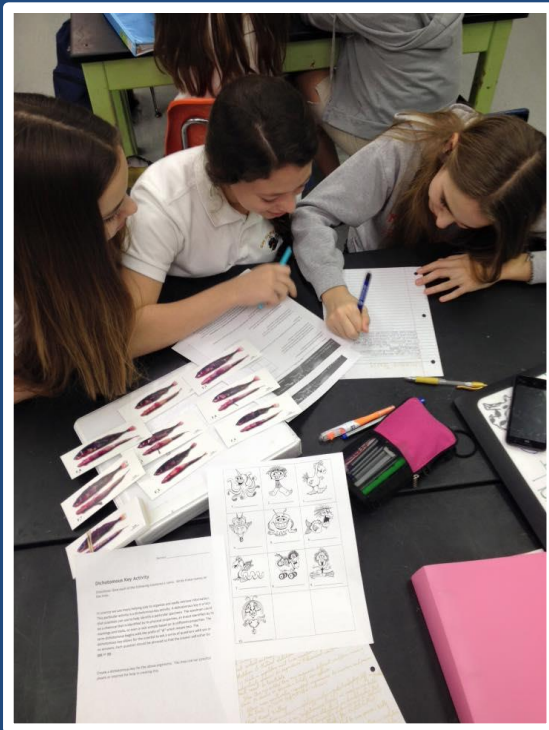
Calling all Teacher Leaders!

# Meet some more TIES Teacher Corps Members

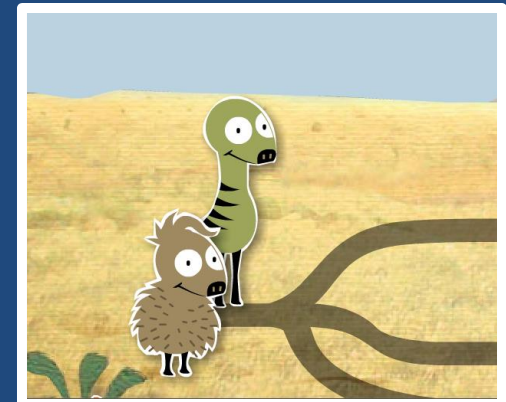




TIES is all about  
teacher leadership!

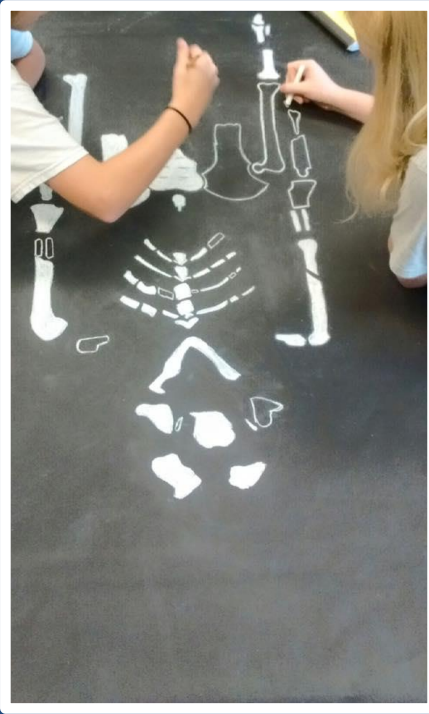
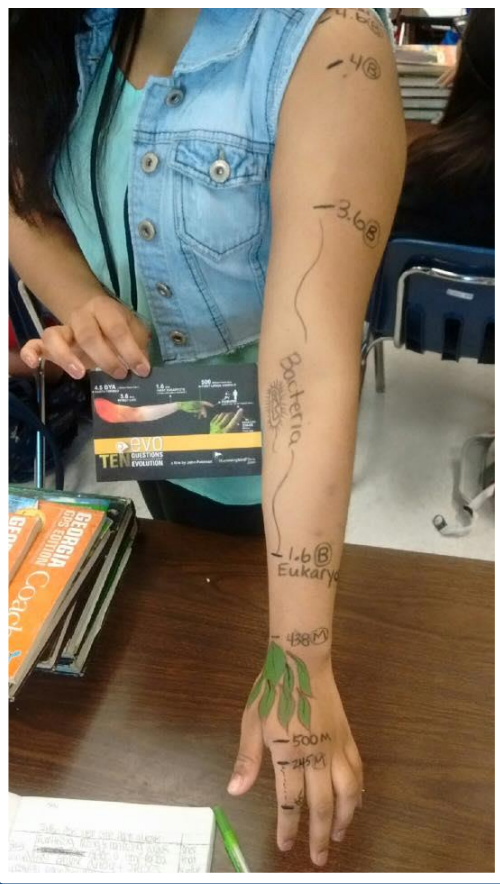


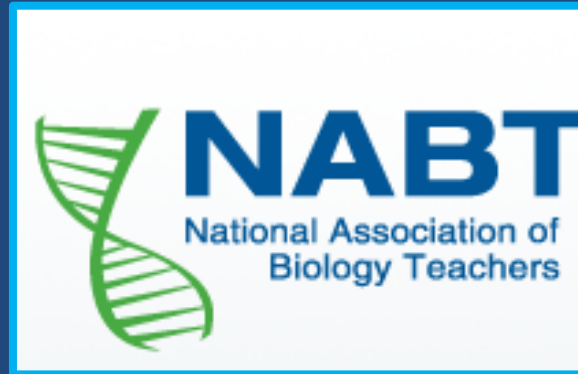
Well-trained teachers means better  
educated children!!





Students participate in varied activities, varied assessments, data collection, making conclusions





Spreading the word about TIES



Unlocking the Wonders of Life for Teachers and their Students

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#gagymuolstraday 308k Tweets  
#FduChalabAlMadie 65.5k Tweets  
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**Teacher Institute for Evolutionary Science**  
Published by Bertha Vazquez (?) · 7 mins ·

Congratulations to TIES Teacher Corps member, Katie Green, for wrapping up her doctoral study using the data collected from her TIES workshops. Now that's taking care of two birds with one stone! Her study is titled, "Examining teleological misconceptions about evolution in pre- and in-service science teachers."

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Blake Touchet Chronological

Blake Touchet I'd be very interested in reading that study. Congratulations!  
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