



Evolution and Natural Selection

Key Ideas:

- How does evolution work?
- Under what conditions does natural selection occur?

Old Words

Mutation: change in genetic material

Heritable: something that can be passed down from parent to offspring

Gene: section of DNA that codes for a trait

Allele: A form or type of trait

New Words

Evolution: Species changing over time

Fitness: ability to survive and reproduce

Adaptation: heritable characteristic that helps an individual survive

Natural Selection: process where individuals who are best adapted to their environment survive and reproduce

Cha-cha-cha-cha-changes!

Ever wonder why there are more and more cases of drug resistant bacteria? Ever think to yourself how there are so many different living things on Earth? From oak trees to dogs to slime molds to flesh eating bacteria, scientists estimate there could be nearly 9 million different types of living things on our planet! How did we get all this diversity?

Scientists explain the variety of life with the theory of **evolution**, Over long periods of time, species change. These changes are based on the traits and adaptations that allow organisms to survive best in their environment. Over time, this creates new kinds of species.

Warning



Misconception Ahead

Misconception: Evolution is a theory and a theory is just a guess.

Fact: In science, theories explain an observation in nature. A theory is based on evidence and experiments that have been repeated over and over.

Examples: Atomic Theory, Theory of Relativity, Big Bang Theory. Bazinga!

How does it work?

In our hip, modern, human society, we tend to define success as having a good job, being popular, and having a lot of money, among many other desirable traits. However in evolution, success boils down to one thing: being able to reproduce. We call an organism's ability to survive and reproduce in their current environment **fitness**. Individuals who are more fit produce more offspring, and are therefore more successful.

An **adaptation** is any heritable trait that helps an individual survive. Adaptations can be body parts, such as a giraffe's neck; colors, like a leopard's fur; mimicry, such as leaf katydids' ability to blend it with their surroundings; or physiological, like a plant that carries out photosynthesis. However, an adaptation must be something that is heritable and be passed down genetically. Learned behaviors, like how to hunt or which plants to eat are not adaptations.

Consider the following:

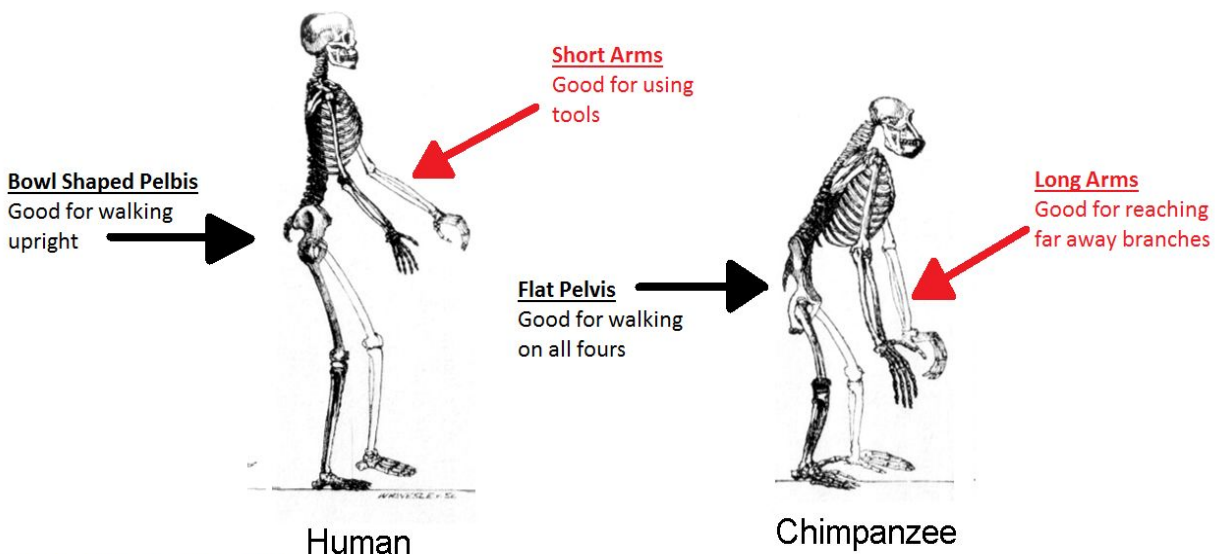


Photo Credit: Science Over Everything

- Notice the different adaptations in the human and chimpanzee. How do their adaptations help each survive in their environment?
- What would happen to a chimp who had short arms? Would they be better at surviving? Would they have a higher chance of reproducing?
- What other adaptations can you see? In the feet? In the skulls? How do those adaptations help each species survive?

Natural selection is the process through which the individuals with the best traits to survive in their environment produce the most offspring. Natural selection occurs when there is a competition for survival. When there are more individuals than the environment can support, there is competition for resources like food, water, shelter, sunlight and mates. Only individuals with the best traits - the most fit - will survive and reproduce.

What determines which traits are best? It all depends on the environment for that species. If the local environmental conditions change, different traits will make an organism better fit. **This is when species change and evolution really happens - when the environment changes and species must have different traits in order to survive.** This is why variability is so important. The more variation a species has in its gene pool, the greater the chance that one of those traits will help that individual survive should the environment change. If a species has little variability, they are at higher risk for extinction if the environment changes.

An example of natural selection is how strains of bacteria are becoming resistant to antibiotics. When we become sick or infected, we take antibiotics to kill the bacteria. However, some of these bacteria have a gene that allow them to survive even if you take antibiotics. By taking medicine, we kill the bacteria that are not resistant. Since the only bacteria that survive are the ones who are drug resistant, they go on, reproduce, and the species as a whole becomes immune to antibiotics.

Consider the following:



Photo Credit: *Natural Selection*

- a.) Which bunnies do you think would be the best at surviving in their current environment? Which do you think will have the most offspring? Why?
- b.) What if all the snow melted? Who would be the best at surviving then?

Warning



Misconception Ahead

Misconception: Traits get more advanced as evolution goes on

Fact: Fitness only refers to the ability to survive and have offspring. Adaptations don't have to be perfect, only good enough for that individual to survive, have offspring and pass down their traits. There is no "direction" in evolution, only what helps an organism survive in its current environment.

Example: Humans did not evolve to have firebreath. Sadly, there was no advantage in having firebreath to help them survive or produce offspring.

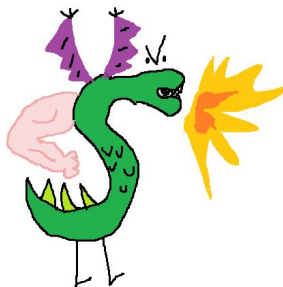


Photo Credit: Science Over Everything

How do we get new traits?

Every heritable trait that you, your pet hamster, and every other living thing on Earth have is based off of genes. Genes are sections of DNA that code for a trait; blue eyes, brown hair, height, etc. The order of the DNA determines each trait. When parents of any living thing have offspring, they make a copy of their DNA. That copy is then passed to the next individual. However, sometimes there are mistakes made during the copying process.

Original Sequence



Point Mutation



Photo Credit: Science Over Everything

Most of the time, this change does nothing. But sometimes, the change in DNA will create a new trait. If that trait helps with that individual's fitness, the trait will be passed down to the next generation, and the species will evolve.

Remember that these changes do not and can not happen in the short term. It takes thousands of generations and some cases millions of years for these change to show themselves. However, it all depends on how fast the species reproduces. For most of the animals and plants that we see in our daily life, these changes happen very, very slowly - much longer than a human lifetime. But with bacteria, like in the example discussed above, their generation time is short, sometimes only a few hours. These changes we can and do see right before our eyes.

Warning

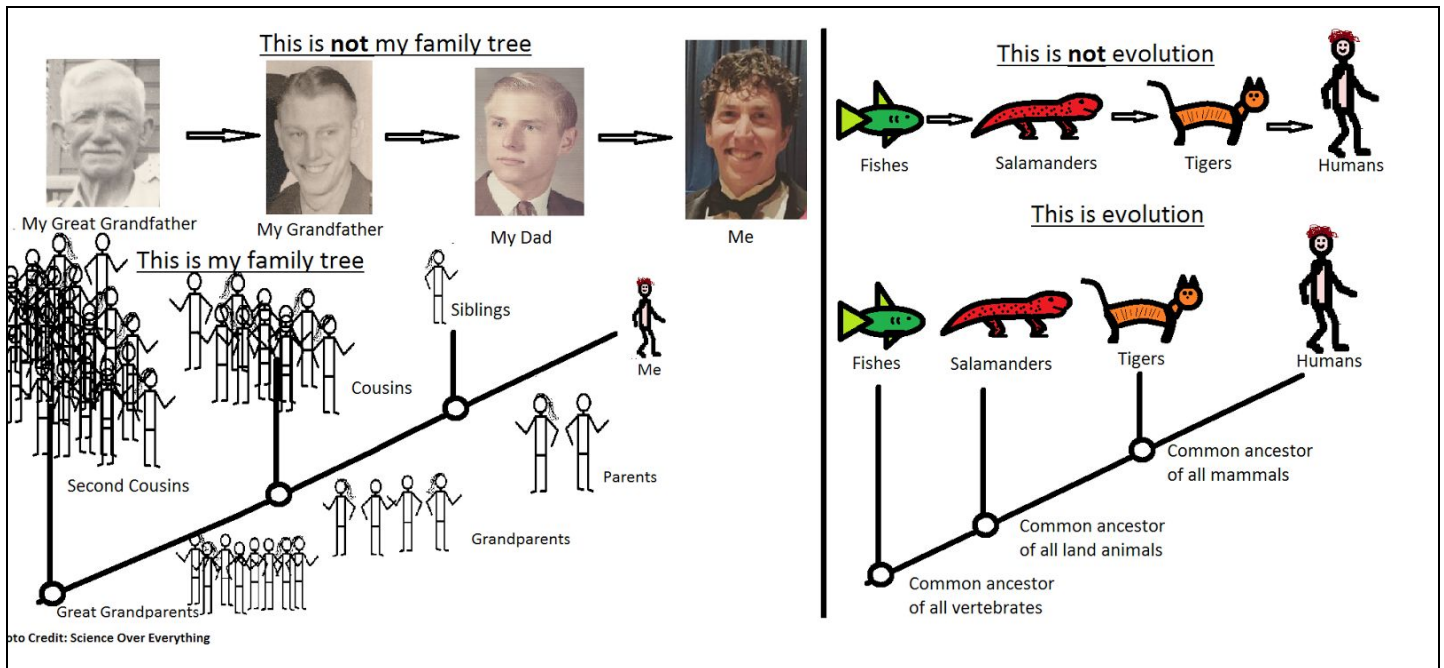


Misconception Ahead

Misconception: Humans evolved from chimpanzees.

Fact: Humans and chimps share a *common ancestor*, a species that lived millions of years ago that eventually gave rise to both us. All living things share a *common ancestor* if you go back far enough in time.

Analogy: You didn't evolve from your cousin. You and your cousin share a *common ancestor* with your grandparents.



Text Citations

Miller, K., & Levine, J. (2010). *Miller & Levine biology* (Foundation ed.). Boston, Mass.: Pearson.