Station 1: Biogeography

Darwin recognized the importance of biogeography- patterns in the distribution of life. Two biogeographical patterns are significant to Darwin's theory: (1) closely related but different and (2) distantly related but similar.

To Darwin, the biogeography of Galápagos species suggested that populations on the island had evolved from mainland species.

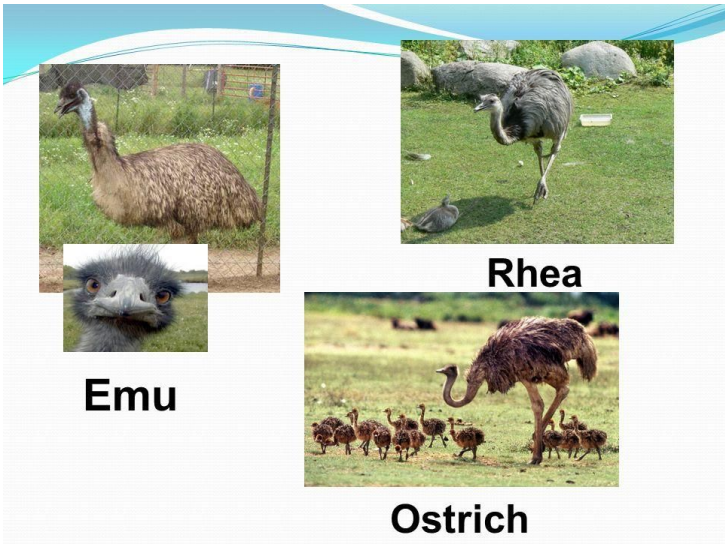
Galápagos tortoises are adapted for different feeding habits. The "saddle-backed" tortoises have shells that rise in the front like a saddle. This adaptation makes it easier for them to lift their necks and feed on taller cactus. "Dome-shaped" tortoises live on islands where most of the vegetation is close to the ground, making it unnecessary for them to raise their heads to feed.

Darwin saw the slightly different forms tortoises on the different islands as beginning stages in the development of new species from common ancestors. Over time, natural selection on the islands produced variations among populations that resulted in different, but closely related, island species.

On the other hand, similar habitats around the world are often home to animals and plants that are only distantly related.

Darwin noted that similar ground-dwelling birds (rheas, ostriches, and emus) inhabit similar grasslands in Europe, Australia, and Africa.

Differences in body structures among those animals provide evidence that they evolved from different ancestors. Similarities among those animals, however, provide evidence that similar selection pressures had caused distantly-related species to develop similar adaptations.



Station 6: Vestigial Structures

Wisdom Teeth in Humans

With all of the pain, time, and money that are put into dealing with wisdom teeth, humans have become just a little more than tired of these remnants from their large jawed ancestors. But regardless of how much they are despised, the wisdom teeth remain, and force their way into mouths regardless of the pain inflicted. There are two possible reasons why the wisdom teeth have become vestigial. The first is that the human jaw has become smaller than its ancestors -and the wisdom teeth are trying to grow into a jaw that is much too small. The second reason may have to do with dental hygiene. A few thousand years ago, it might be common for an 18 year old man to have lost several, probably most, of his teeth, and the incoming wisdom teeth would prove useful. Now that humans brush their teeth twice a day, it's possible to keep one's teeth for a lifetime. The drawback is that the wisdom teeth still want to come in, and when they do, they usually need to be extracted to prevent any serious pain.

Station 6: Vestigial Structures

Erector Pili and Body Hair

The erector pili are smooth muscle fibers that give humans "goose bumps". If the erector pili are activated, the hairs that come out of the nearby follicles stand up and give an animal a larger appearance that might scare off potential enemies and a coat that is thicker and warmer. Humans, though, don't have thick furs like their ancestors did, and our strategy for several thousand years has been to take the fur off other warm looking animals to stay warm. It's ironic actually that an animal, sensing danger is near, would puff up its coat to look scarier, but the human hunter would see the puffier coat as a warm prize, leaving the thinner haired weaker looking animals alone. Of course, some body hair is helpful to humans; eyebrows can keep sweat out of the eyes and facial hair might influence a woman's choice of sexual partner. All the rest of that hair, though, is essentially useless.

Station 6: Vestigial Structures

The Human Tailbone (Coccyx)

These fused vertebrae are the only vestiges that are left of the tail that other mammals still use for balance, communication, and in some primates, as a prehensile limb. As our ancestors were learning to walk upright, their tail became useless, and it slowly disappeared. It has been suggested that the coccyx helps to anchor minor muscles and may support pelvic organs. However, there have been many well documented medical cases where the tailbone has been surgically removed with little or no adverse effects. There have been documented cases of infants born with tails, an extended version of the tailbone that is composed of extra vertebrae. There are no adverse health effects of such a tail, unless perhaps the child was born in the Dark Ages. In that case, the child and the mother, now considered witches, would've been killed instantly.

Station 5: Genetics and Molecular Biology

All living cells use information coded in DNA and RNA to carry information from one generation to the next and to direct protein synthesis.

This genetic code is nearly identical in almost all organisms, including bacteria, yeasts, plants, fungi, and animals. At the molecular level, the universal genetic code provides evidence of common descent.

The image below compares a small portion of the DNA for the same gene in three animals—a mouse, a whale, and a chicken. Use this image to answer the questions for this station.

Animal	Sequence of Bases in Section of *Hoxc8*
Mouse	C A G A A A T G C C A C T T T T A T G G C C C T G T T T G T C T C C C T G C T C
Baleen whale	C **C** G A A A T G C C **T** C T T T T A T G G C **G** C T G T T T G T C T C C C T G C **G** C
Chicken	**A** A **A** A A A T G C C **G** C T T T T A **C** **A** G C **T** C T G T T T G T C T C **T** C T G C T **A**

Animals that Share Human DNA Sequences

Apes and Monkeys

Of the great apes, humans share 98.8 percent of their DNA with bonobos and chimpanzees. Humans and gorillas share 98.4 percent of their DNA. Once the apes are not native to Africa however, the differences in DNA increase. Humans and orangutans share 96.9 percent of their DNA. Humans and monkeys share approximately 93 percent.

Mice

Humans and mice share nearly 90 percent of human DNA. This is important because mice have been used in laboratories as experimental animals for research into human disease processes for years. Mice are currently used in genetic research to test gene replacement, and gene therapy because they have similar gene types to those of humans and will have similar reactions to diseases and disease processes.

Dogs

Humans and dogs share 84 percent of their DNA, which again, makes them useful animals to study human disease processes. Researchers are particularly interested in specific diseases that affect both dogs and humans .

Chickens

Of course, humans, dogs, mice and apes are going to have DNA in common. They are all mammals. Humans and birds are a different matter. Yet they, too, share a lot of DNA -- 65 percent.

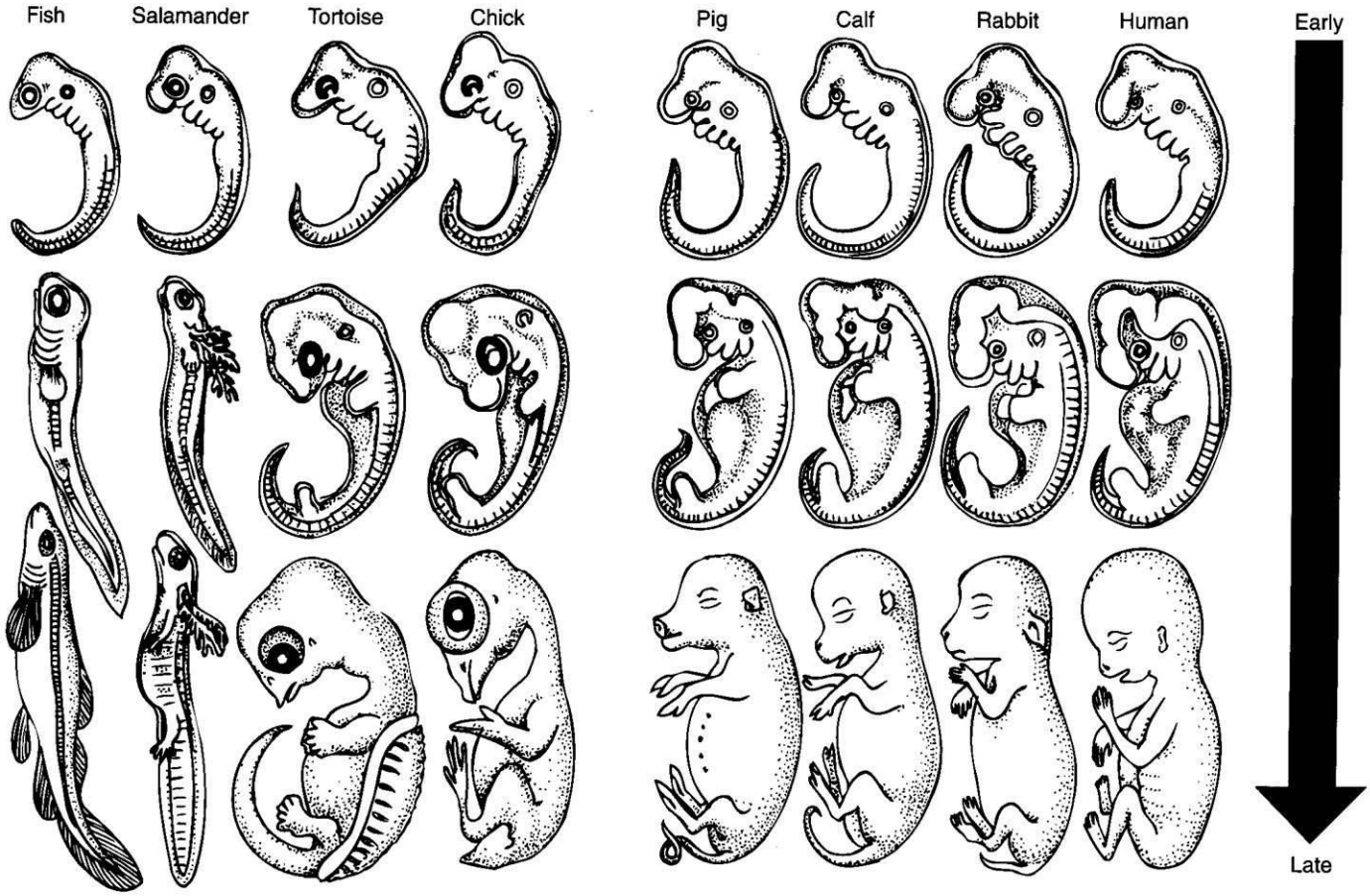
Station 4: Embryology

Embryology is the science dealing with the formation, development, structure, and functional activities of embryos and fetuses.

Recent observations make clear that the same groups of embryonic cells develop in the same order and in similar patterns to produce many homologous tissues and organs in vertebrates.

Similar patterns of embryological development provide further evidence that organisms have descended from a common ancestor.

The image below shows the embryonic development of a fish, salamander, tortoise, chick, pig, calf, rabbit, and human. Use this image to answer the questions for this station.



Station 3: Comparative Anatomy

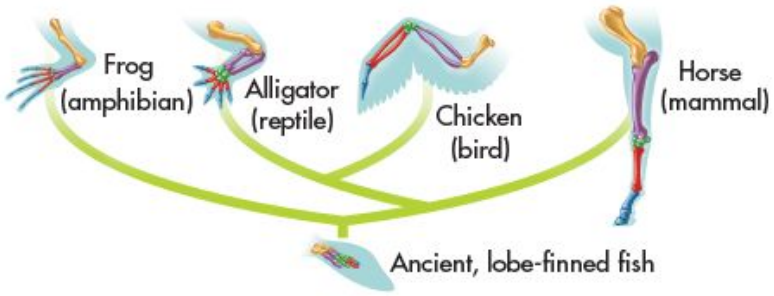
Darwin proposed that animals with similar structures evolved from a common ancestor with a basic version of that structure.

Structures that are shared by related species and that have been inherited from a common ancestor are called **homologous structures**.

Biologists test whether structures are homologous by studying anatomical details, the way structures develop in embryos, and the pattern in which they appeared over evolutionary history.

Similarities and differences among homologous structures help determine how recently species shared a common ancestor.

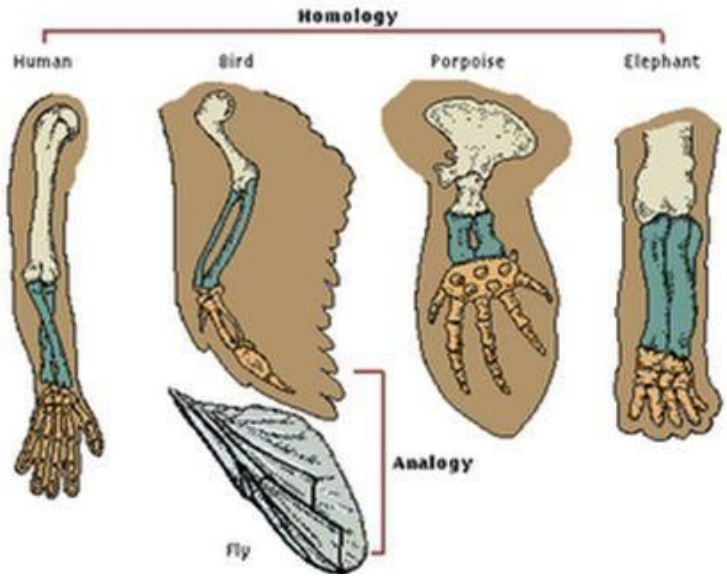
In the image below, the homologous bones are color-coded. These bones are the front limbs of vertebrates. These limbs evolved, with modifications, from the front limbs of a common ancestor whose bones resembled those of an ancient fish.



The clue to common descent is common structure, not common function.

Body parts that share a common function, but not structure, are called **analogous structures**. The wing of a bee and the wing of a bird are analogous structures. Wings have a common function in bees and insects (flying), but do not have the same structure.

In the image below, the homologous bones are color-coded. Notice that the fly wing does not have any homologous bones. Birds and insects developed wings independently of each other. They likely developed wings due to living in similar environments.



Station 2: Fossils

Evolution takes a long time. If life has evolved, then Earth must be very old. Hutton and Lyell argued that Earth was indeed very old, but technology in their day couldn't determine just how old.

Geologists now use radioactivity to establish the age of certain rocks and fossils. Radioactive dating indicates that Earth is about 4.5 billion years old—plenty of time for evolution by natural selection to take place.

Darwin's study of fossils had convinced him and other scientists that life evolved, but paleontologists in 1859 hadn't found enough fossils of intermediate forms of life to document the evolution of modern species from their ancestors.

Since Darwin, paleontologists have discovered hundreds of fossils that document intermediate stages in the evolution of many different groups of modern species.

The image below shows the fossil evidence for the evolution of modern whales from ancestors that walked on land. The transition from land to water took only 10 million years, which is a very short time in evolutionary terms. Use this image to answer the questions for this station.