Although there are oppositions, evolution has left much evidence.

Evidence for evolution in Darwin’s time came from several sources:

1. Fossils
2. Geography
3. Embryology
4. Anatomy
Fossils in different layers of rock (sedimentary rock strata) have shown:

- Evidence of the age of our planet (billions of yrs old).
- The gradual change of organisms over time.

Key Concept:
- Older fossils found in the bottom, newer fossils near the surface.
Evidence for Evolution: 2. Geography

- There are lots of different animals on different continents.
- However, those living in similar habitats show similar adaptations.
- **Biogeography** is the study of the distribution of organisms around the world.
- Darwin was the first to establish a relationship between island and mainland species saying island species had a common ancestor with the mainland species.
- Because of different ecosystems, the island species evolved new traits.
Evidence for Evolution: 3. Embryology

- **Embryo** - An organism in its early stages of development.
- Similarities in embryos is strong evidence for common descent / common ancestor.

Pharyngeal slits exist in these five vertebrate animals ...

- sea lamprey
- pond turtle
- chicken
- domestic cat
- human being

... evidence that all five evolved from a common ancestor.
Evidence for Evolution: 4. Anatomy

- Scientists noticed animals with backbones (vertebrates) had similar bone structure.
- The bones may differ in *form* or *function*, but they are still similar.
Homologous Body Structures

- **homologous structures** - structures that have different mature forms but develop from the same embryonic tissues.

- There is strong evidence that all four-limbed animals with backbones descended, with modification, from a common ancestor.

- This helps scientists classify/group animals.
Analogous Structures

- Suppose two organisms have similar needs caused by the environment.
- For example, two different organisms need to be able to fly. Both can develop similar adaptations using different body parts.
- **analogous structures** – structures that perform a similar function (ex: flying), but are not similar in origin
- Ex: wings of a bat (has bones) and wings of insects (no bones)
Vestigial Organs

- Not all body structures serve important functions:

Vestigial Organs - a body part that has become small and lost its use because of evolutionary change.

- Ex: appendix in man, pelvic bones in a snake, wings of ostriches
- the nictitating membrane in a human eye (the nictitating membrane protects it from water or removes debris)
Vestigial Structure: Legs on a Skink
Lesson 16.3: Beyond Darwinian Theory
Lesson: Evolutionary Biology Today

Evolution Unit
Paleontology – the study of fossils or extinct organisms, continues to provide new information and support current hypotheses about how evolution occurs.

Darwin worried about the lack of transitional fossils between groups of organisms.

But since then, many transitional forms between species have been discovered, filling in large gaps in the fossil record. Ex: *Basilosaurus isis* (has a whalelike body, but limbs of land animals)
The more related two organisms are, the more similar their DNA will be.
“Master control genes” called **hox** or **homeobox genes**, guide development of major body structures in animals (which parts become front and rear, or top and bottom).

Small changes in the timing of cell differentiation and gene expression can make the difference between long legs and short ones, between long, slender fingers or short, stubby toes.
Darwin's Theory

- Individual organisms in nature differ from one another; some of this variation is inherited.
- Organisms in nature produce more offspring than can survive, and many of these offspring do not reproduce.
- Because more organisms are produced than can survive, members of each species must compete for limited resources.
Because each organism is unique, each has different advantages & disadvantages in the struggle for existence.

Individuals best suited to their environment survive & reproduce successfully, passing their traits to their offspring.

Species change over time. Over long periods, natural selection causes changes that may eventually lead to new species.
Species alive today have descended with modifications from species that lived in the past.

All organisms on Earth are united into a single Tree of Life by common descent.
Chapter 17: Population Genetics and Speciation

Evolution Unit
Lesson 17.1 Genetic Variation

Evolution Unit
We will not be covering information within this section.
Lesson 17.2 Genetic Change

Evolution Unit
Genetic variation leads to phenotypic variation, increases the chance that some individuals will survive.

Phenotypic variation is necessary for natural selection.

Genetic variation is stored in a population’s **gene pool**:
- made up of all alleles from all individuals in a population
- different allele combinations form when organisms have offspring

Key: The greater the variation in phenotypes, the more likely it is that some individuals can survive in a changing environment.
Ex: In a cold winter, short penguins might be able to stay warmer. But if there is a shortage of food, tall penguins might be better divers, allowing them to catch more food.
Gene Pools

• **KEY CONCEPT:** A population shares a common gene pool.

• Some gene pools can have great variation
  • Sexual reproduction is a key to this variation

• When the frequency of alleles changes from generation to generation, microevolution can occur
  • microevolution = small genetic changes over time
Gene Pools cont...

- **allele frequencies** measure genetic variation.
  - measures how common a certain allele is in a population
  - can be calculated for each allele in gene pool

**Calculating Allele Frequencies**

- **G codes for green**  
  - 7 Gs in gene pool  
  - 12 total alleles for skin color trait in gene pool  
  - Frequency of allele $G = \frac{7}{12} = 0.583 \approx 58.3\%$

- **g codes for brown**  
  - 5 gs in gene pool  
  - Frequency of allele $g = \frac{5}{12} = 0.417 \approx 41.7\%$
Sources of Genetic Variation

1. Mutation is a random change in the DNA of a gene.
   - can form new allele
   - can be passed onto offspring if in reproductive cells

2. Recombination forms new combinations of alleles
   - usually occurs during meiosis
   - parents’ alleles arranged in new ways in gametes
Hybridization is the crossing of two different species. It occurs when individuals can’t find a mate of their own species. It is a topic of current scientific research. Examples of hybrid animals include the liger, a cross between a tiger and a lion, and the zorse, a hybrid of a horse and a zebra.
Gene Flow

- **Gene flow** is the movement of alleles between populations.
- Gene flow occurs when individuals join new populations and reproduce.
- Gene flow keeps neighboring populations similar.
- Low gene flow increases the chance that two populations will evolve into different species.

eagle migration – map shows where eagles were found during the first summer after hatching
Genetic Drift & Bottleneck

- **Genetic drift** is a change in allele frequencies due to chance; causes a loss of genetic diversity in a population.
  - It is most common in small populations.
- A bottleneck event can lead to genetic drift.
  - It occurs when an event drastically reduces population size.
  - Usually due to a disaster.
  - The **bottleneck effect** is genetic drift that occurs after a bottleneck event.

Ex: hunting of elephant seals
  - Reduced population to 20 seals
  - Very little genetic diversity
  - Some alleles were lost completely
The **founder effect** is genetic drift that occurs after the start of a new population.

The founding of a small population can lead to genetic drift.

It occurs when a few individuals colonize a new area. The gene pools of the new population are often very different from those of the larger populations.
Genetic drift can have negative effects on a population.

- Less likely to have some individuals that can adapt
- Harmful alleles can become more common due to chance

Ex: Huntington’s disease (brain/nervous disorder)
**Mutations**

- **mutation** = a change in the DNA sequence of an organism
  - May *not have any effect at all*
  - May be *harmful effect*
  - May be *helpful effect* for the organisms’ survival
  - When mutations are transmitted, you will get more variation!
Sexual Selection

- Sexual selection occurs when certain traits increase mating success.
- There are two types of sexual selection:
  - **intrasexual selection**: competition among males; winner mates with female
  - **intersexual selection**: males display certain traits to females; ex: peacocks fanning out their tails, bright colors, singing, dancing, etc.
Lesson 17.3 Speciation

Evolution Unit
Reproductive Isolation

- reproductive isolation – some kind of reproductive barrier keeps the two species from interbreeding.

- **Ex: temporal isolation** – The eastern spotted skunk (upper) breeds in later winter, whereas the western spotted skunk (lower) breeds in the fall.
G. Reproductive Isolation

- **Ex: behavioral isolation** – these birds (eastern and western meadowlarks) remain separate species because their courtship rituals differ, including the songs that attract mates.

- **Ex: geographic isolation** – some species are adapted to different habitats in the same general location like the some fish might be bottom feeders and some live in the open water feeding on plankton.

- **Ex: mechanical** – reproductive structures are physically incompatible; insects may transfer pollen only to certain plants, etc.
Patterns in Evolution

Evolution Unit
Species can become extinct.

**extinction** is the elimination of a species from Earth

Background extinctions occur continuously at a very low rate.

- occur at roughly the same rate as speciation
- usually affects a few species in a small area
- caused by local changes in environment

Liberian Lynx is the world’s most endangered feline.
Mass Extinction

- Mass extinctions are rare but much more intense.
  - destroy many species at global level
  - thought to be caused by catastrophic events
  - at least five mass extinctions in last 600 million years