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**

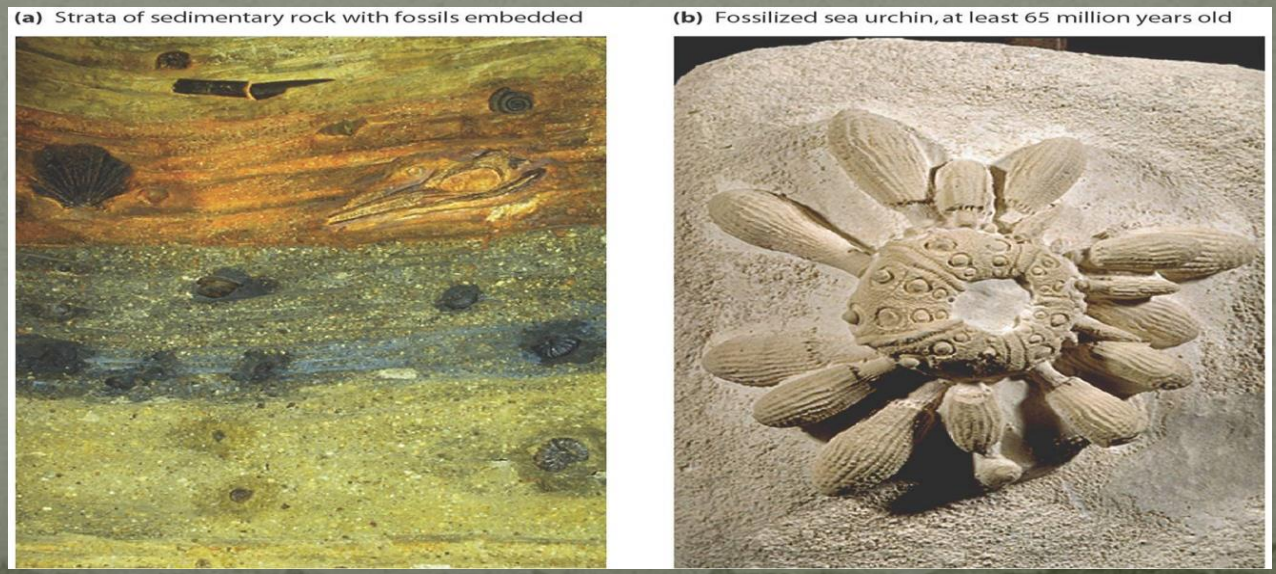
Evidence for Evolution: 1. Fossils

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.

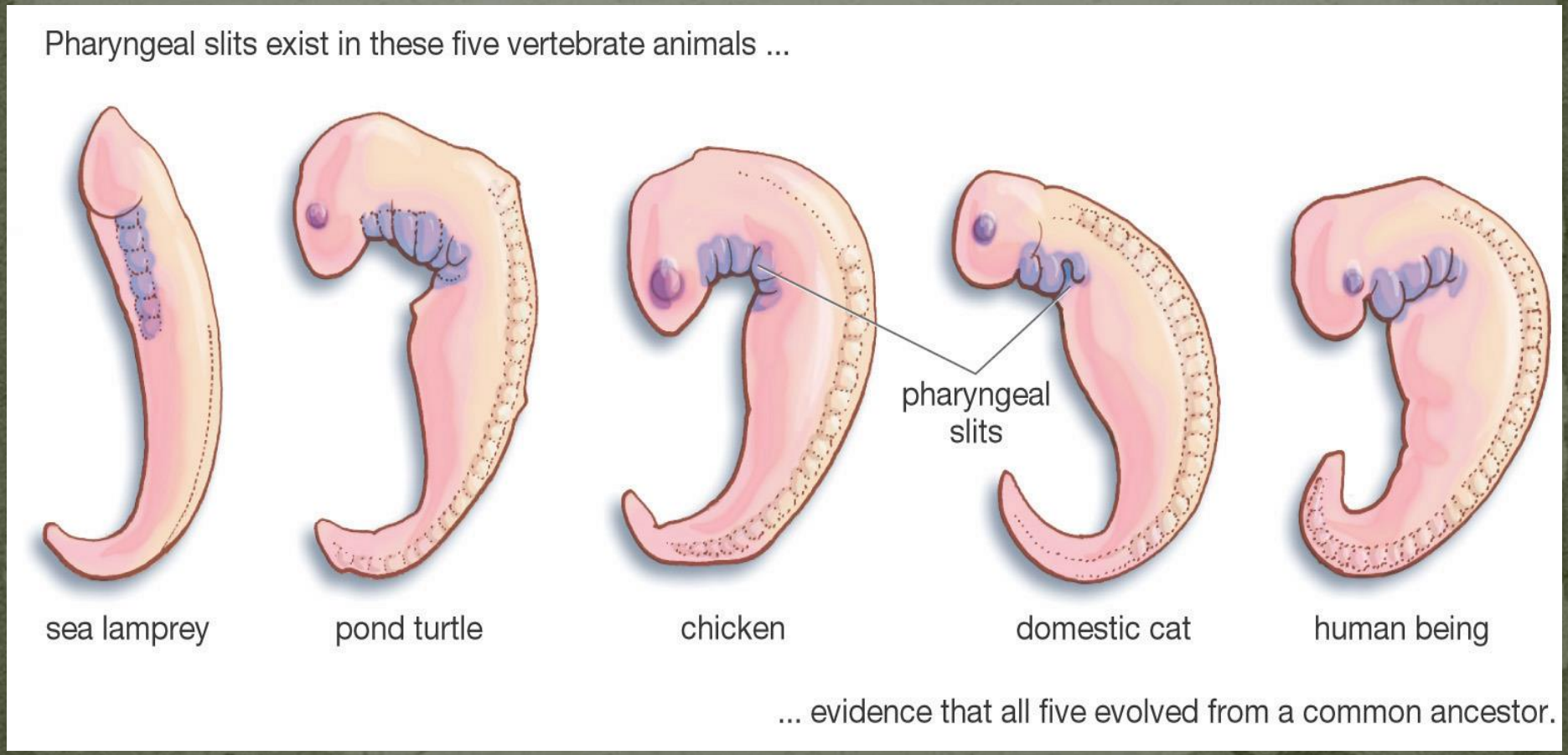


Evidence for Evolution: 2. Geography

- 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.

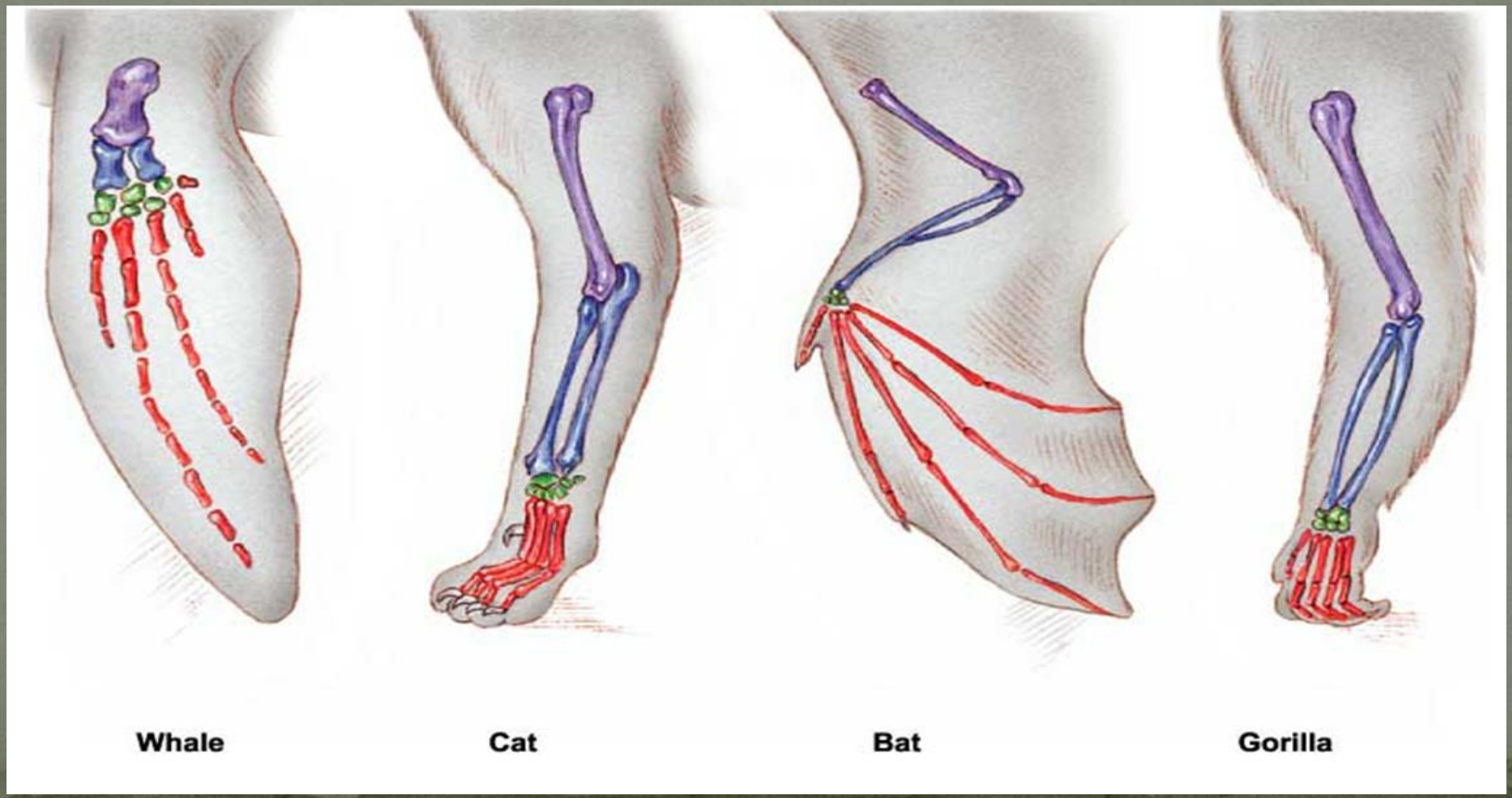
Evidence for Evolution: 3. Embryology

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



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

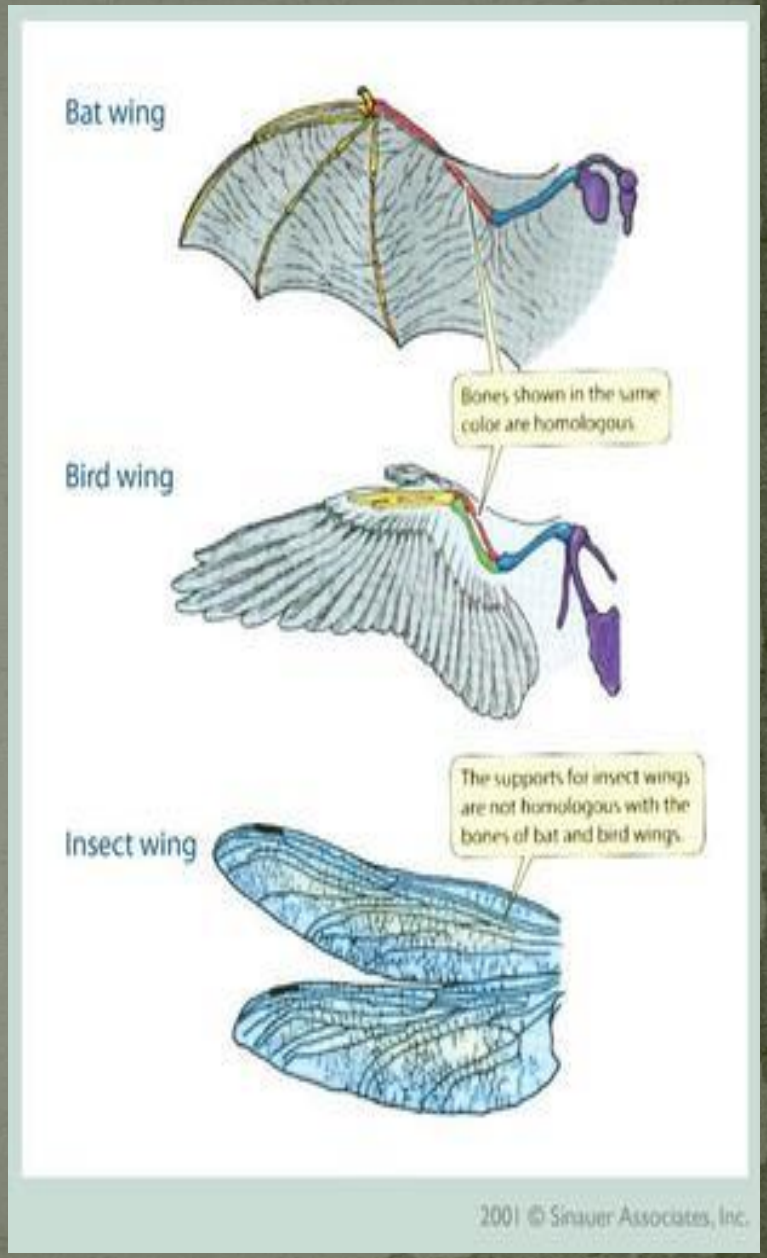
- homologous structures - structures that have different mature forms but develop from the same embryonic tissues

- 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)

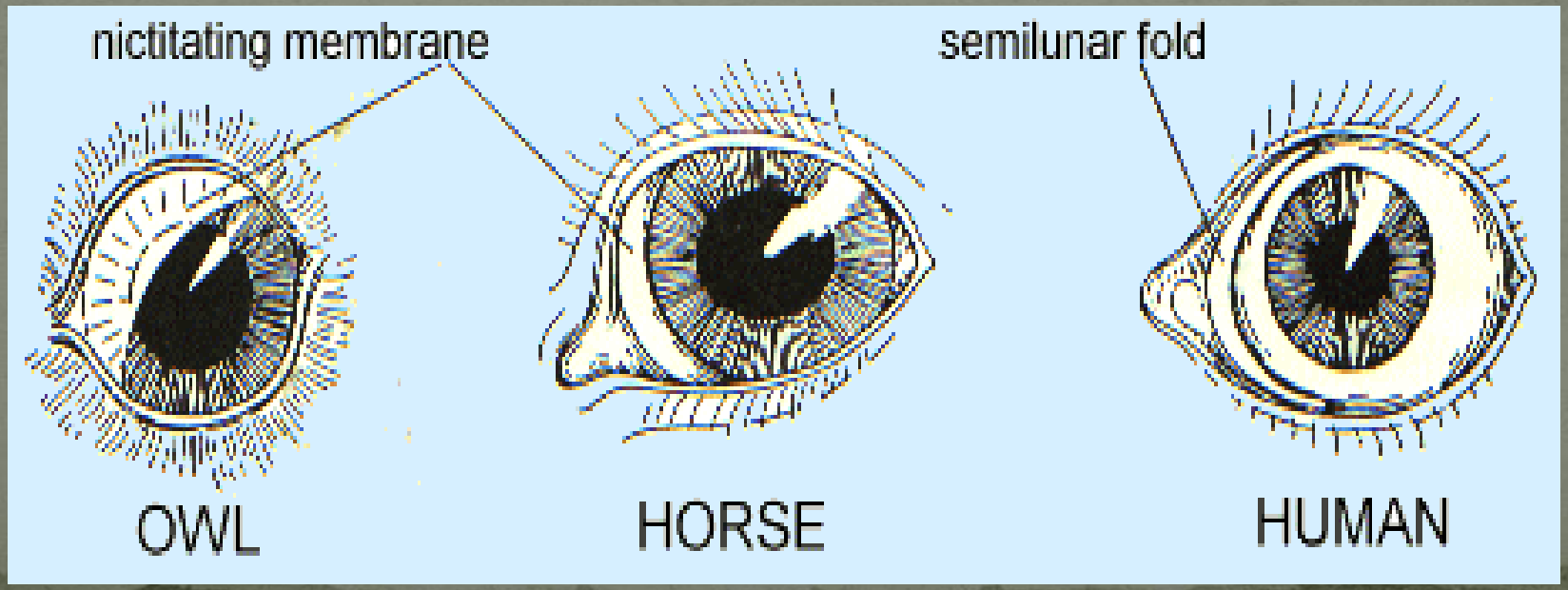


Vestigial Organs

- 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

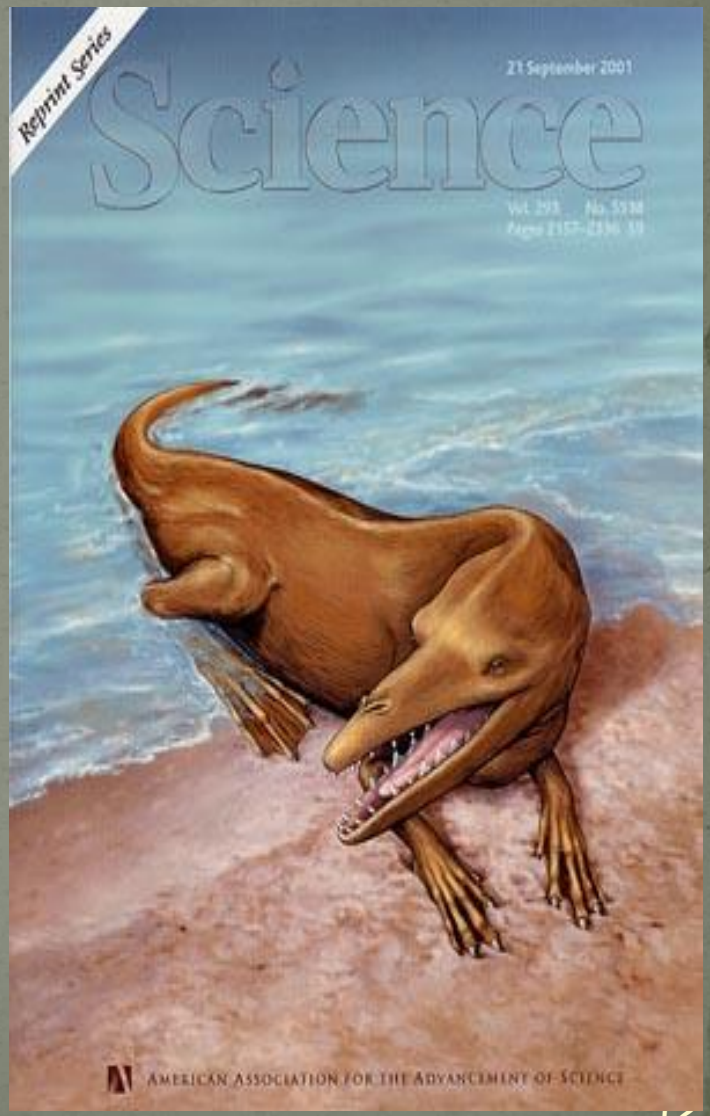
Evolution Unit

Lesson : Evolutionary Biology Today

Evolution Unit

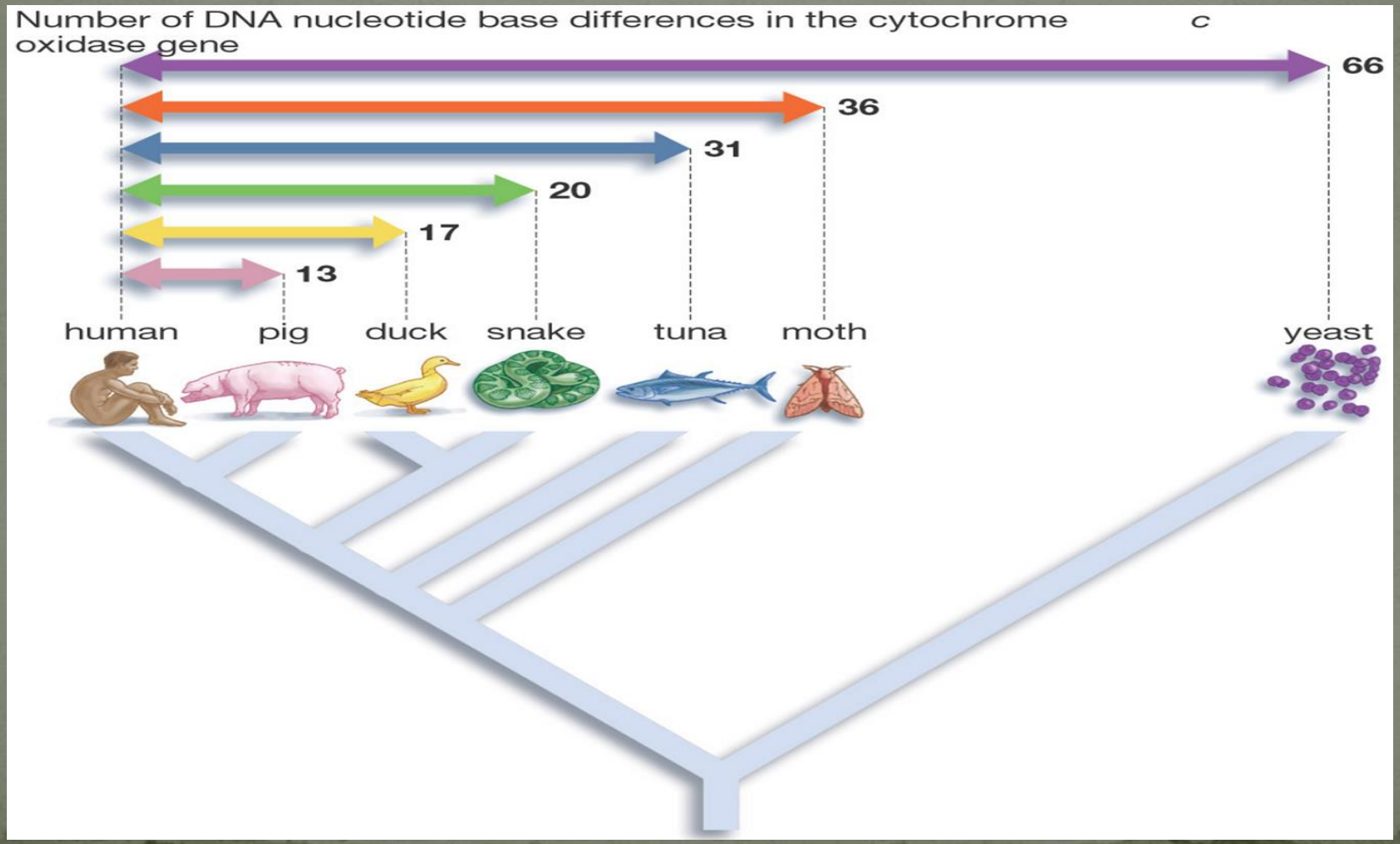
Fossils provide a record of evolution.

- 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)



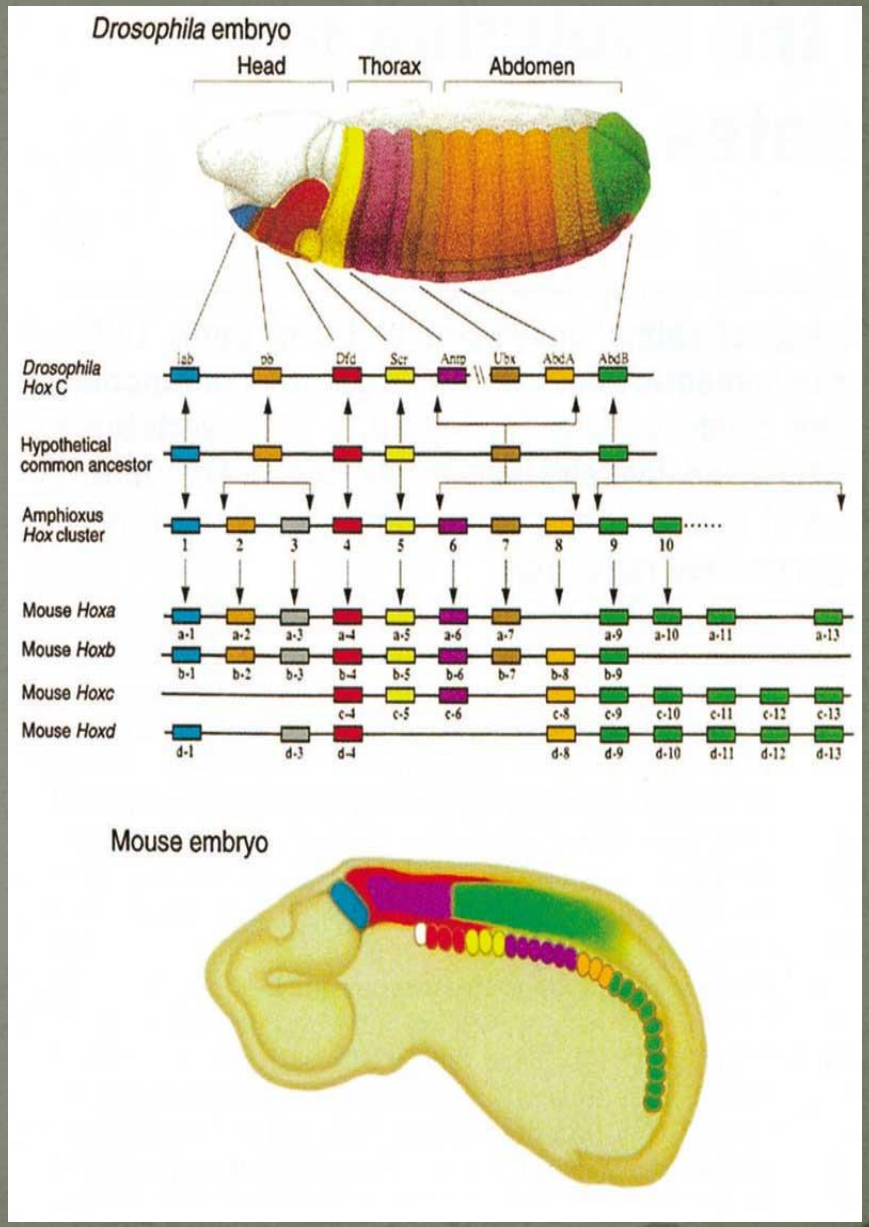
Molecular and Genetic Evidence: DNA Sequence Analysis

- The more related two organisms are, the more similar their DNA will be.



Molecular and Genetic Evidence: Homeobox Genes

- "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.**

Darwin's Theory

- 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.

Darwin's Theory

- 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

Gene Pools

- 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.

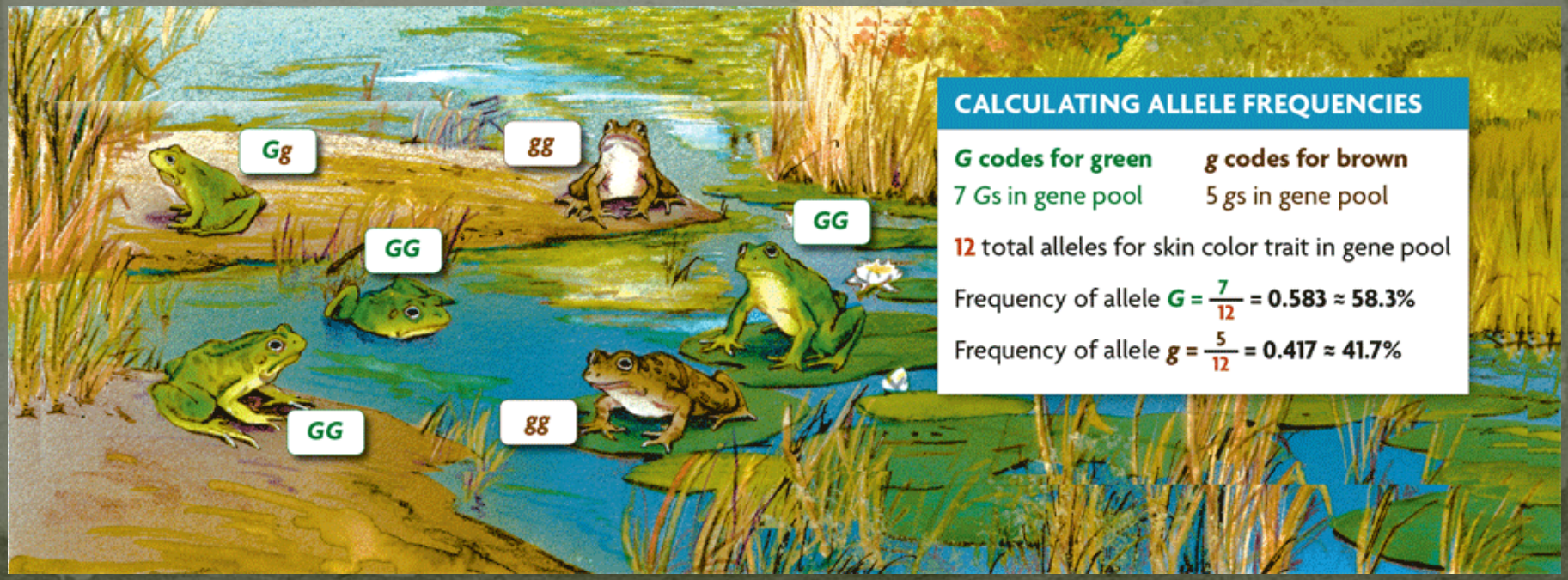
Ex: In a cold winter, short penguins might be able to stay warmer. But if there is a shortage of food, tall penguins might be better divers, allowing them to catch more food.

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…

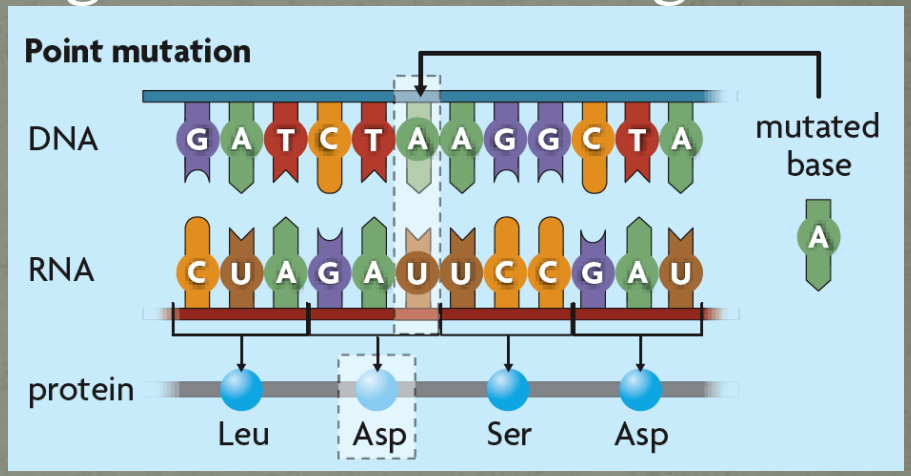
- **allele frequencies** measure genetic variation.
  - measures how common a certain allele is in a population
  - can be calculated for each allele in gene pool



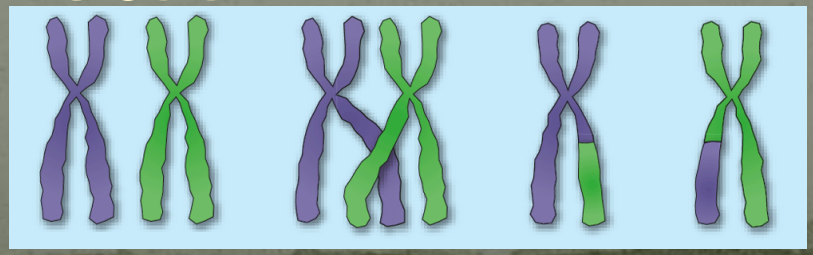
Sources of Genetic Variation

- Genetic variation comes from several sources:

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

- Hybridization is the crossing of two different species.
  - occurs when individuals can't find mate of own species
  - topic of current scientific research

tiger + lion = liger

horse + zebra = zorse

male

Lions

female

Tigers

Liger

Donkey

Horse

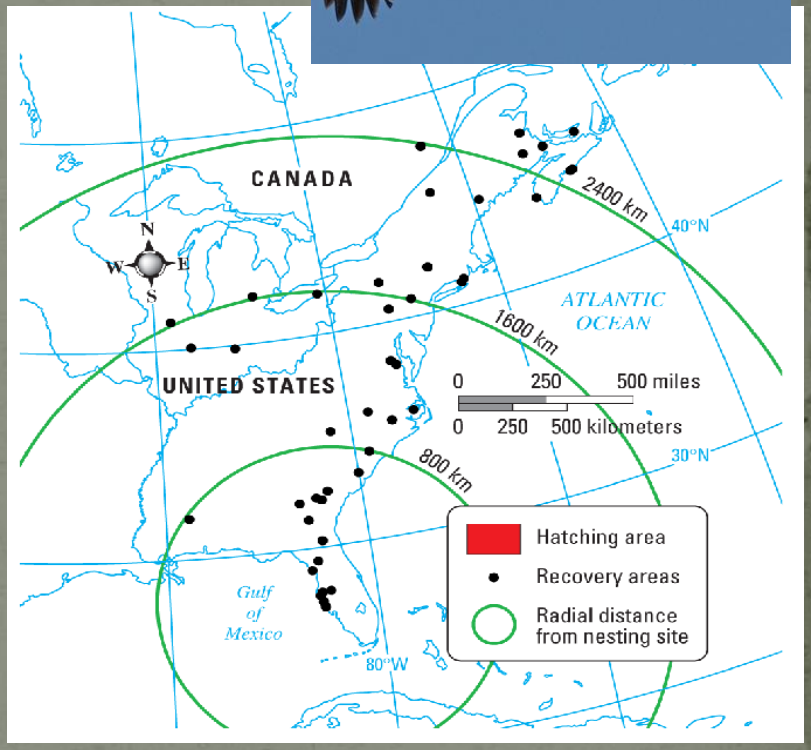
Gene Flow

- **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.

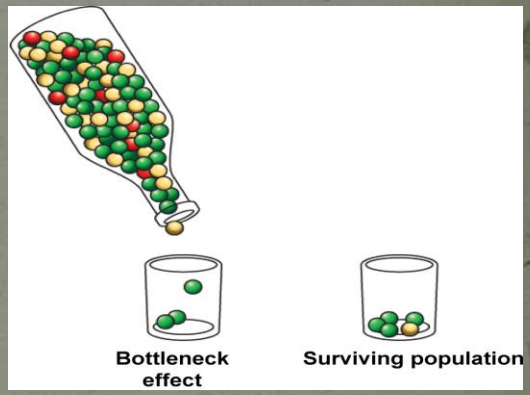
•- Low gene flow increases the chance that two populations will evolve into different species.



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.



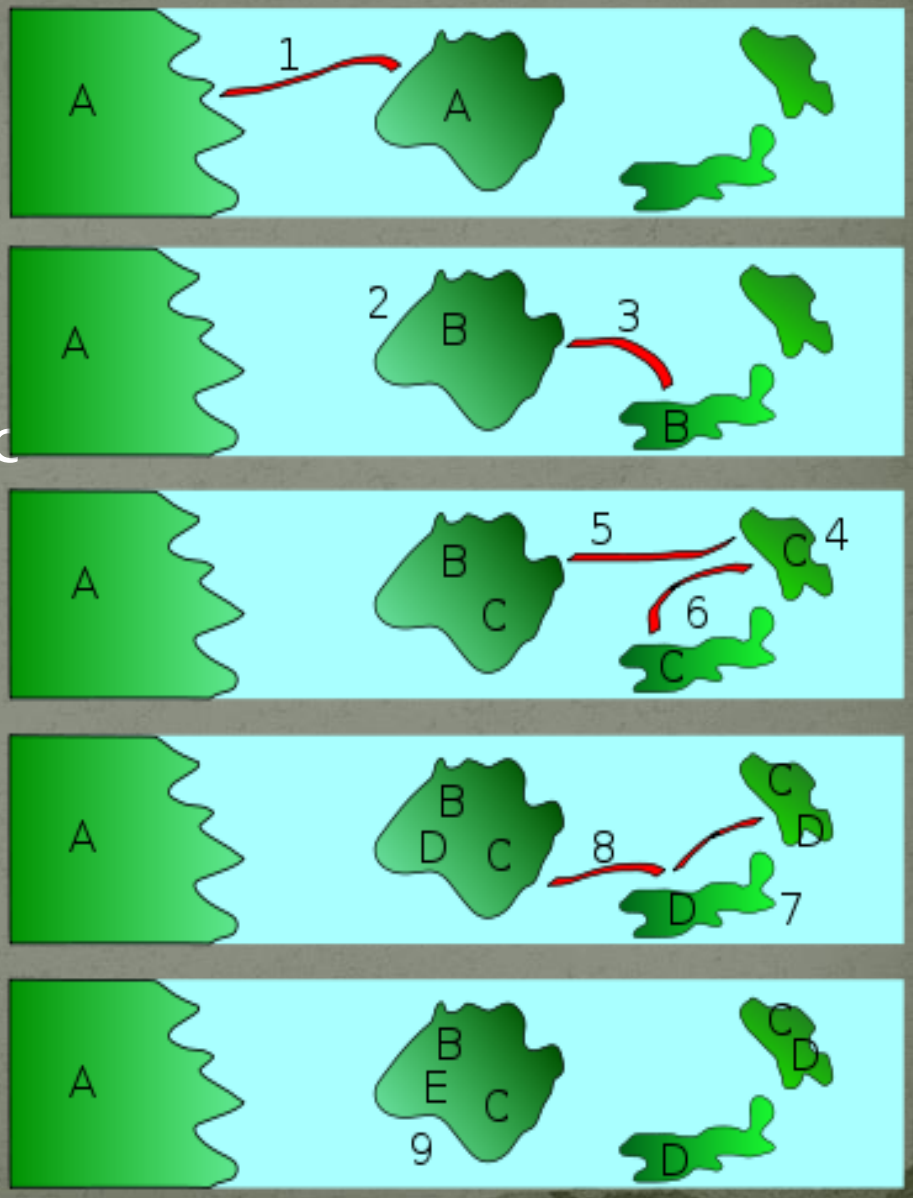
Ex: hunting of elephant seals

- Reduced population to 20 seals
- Very little genetic diversity
- some alleles were lost completely

Founder Effect

- The **founder effect** is genetic drift that occurs after start of 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.

What if birds migrated and colonized a new area?

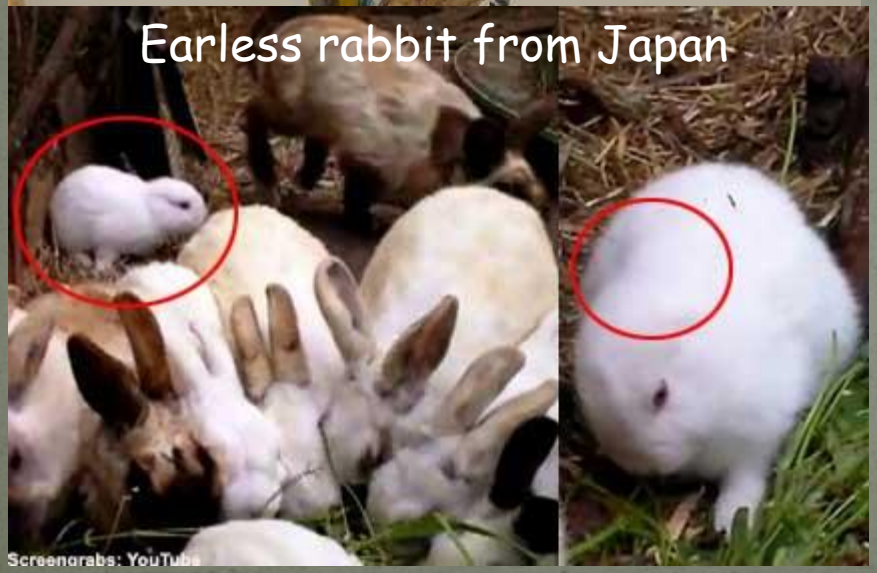


Effects of Genetic Drift

- 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 feeing on plankton
- **Ex: mechanical** – reproductive structures are physically incompatible; insects may transfer pollen only to certain plants, etc.

Patterns in Evolution

Evolution Unit

Background Extinction

- 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