

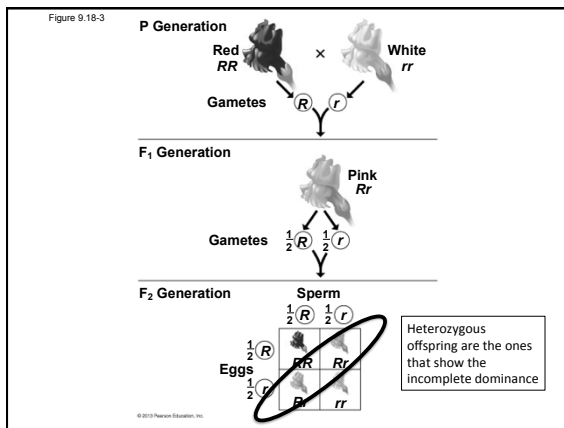
Figure 9.18.2
VARIATIONS ON MENDEL'S LAWS

- Some patterns of genetic inheritance are not explained by Mendel's laws.
 - Incomplete Dominance:** F₁ hybrids have an appearance **between** the phenotypes of the two parents.

I remember incomplete dominance in the form of an example like so:
RED Flower x WHITE Flower → PINK Flower
 - Codominance:** F₁ hybrids have an appearance in which **both** the phenotypes of the two parents appear.

I remember codominance in the form of an example like so:
red x white → r d & w h t s o f d

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Example of Incomplete Dominance in Plants and People

- Hypercholesterolemia**
 - Is characterized by dangerously high levels of cholesterol in the blood.
 - heterozygotes have blood cholesterol levels about twice normal, and
 - homozygotes have about five times the normal amount of blood cholesterol and may have heart attacks as early as age 2.

Figure 9.19

GENOTYPE	<i>HH</i> Homozygous for ability to make LDL receptors	<i>Hh</i> Heterozygous	<i>hh</i> Homozygous for inability to make LDL receptors
PHENOTYPE	 Normal	 Mild disease	 Severe disease

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ABO Blood Groups: An Example of Multiple Alleles and Codominance





Blood Group (Phenotype)	Genotypes	Red Blood Cells	Antibodies Present in Blood
A	$I^A I^A$ or $I^A i$	 Carbohydrate A	Anti-B
B	$I^B I^B$ or $I^B i$	 Carbohydrate B	Anti-A
AB	$I^A I^B$		—
O	ii		Anti-A Anti-B

Figure 9.20a


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ABO Blood Groups: An Example of Multiple Alleles and Codominance

- If a donor’s blood cells have a carbohydrate (A or B) that is foreign to the recipient, the blood cells may clump together, potentially killing the recipient.
- The clumping reaction is the basis of a blood-typing lab test.
- The human blood type alleles I^A and I^B are **codominant**, meaning that both alleles are expressed in heterozygous individuals who have type AB blood.

AB

$I^A I^B$



—

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VARIATIONS ON MENDEL’S LAWS

- Some patterns of genetic inheritance are not explained by Mendel’s laws.

- Pleiotropy** is when one gene influences several characters.
 - EX: Sickle-cell disease

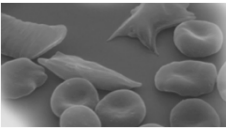


Figure 9.18-2

- Polygenic inheritance** is the additive effects of two or more genes on a single phenotype.

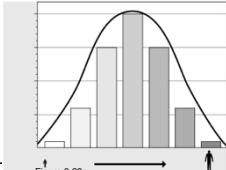
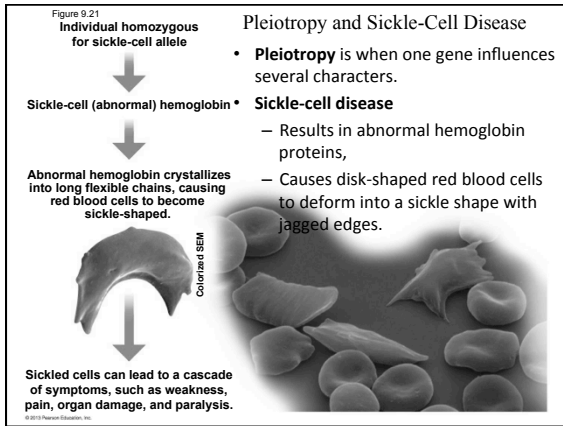
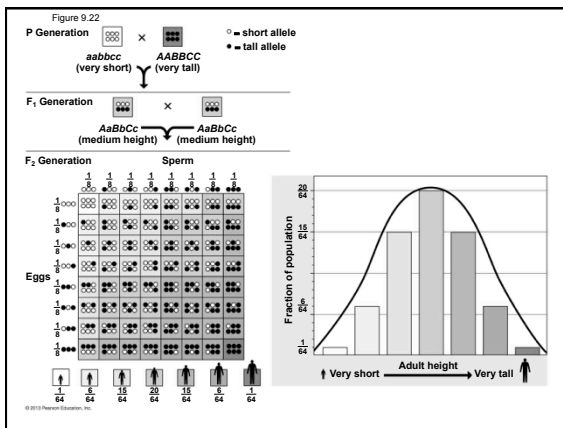
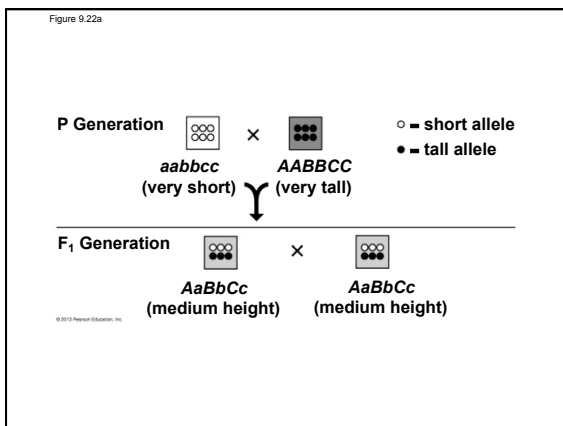


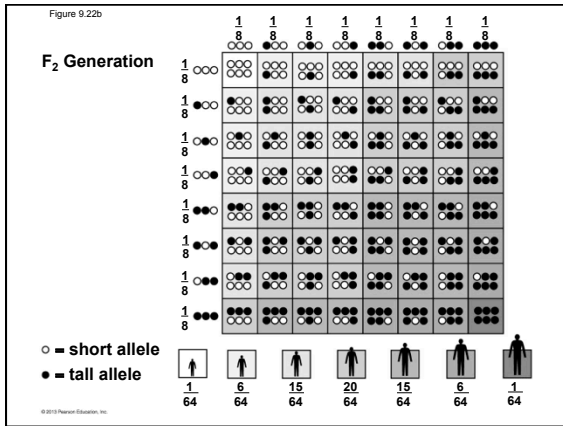
Figure 9.22c

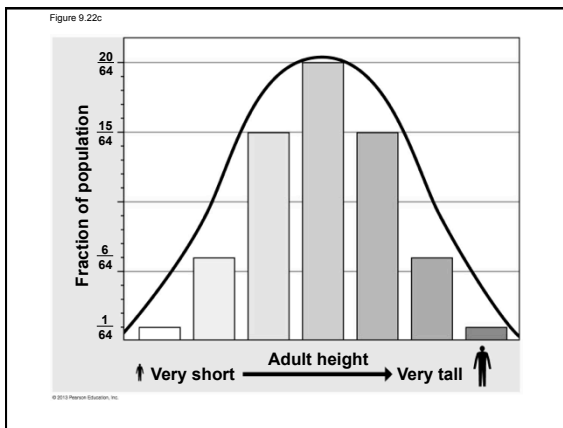
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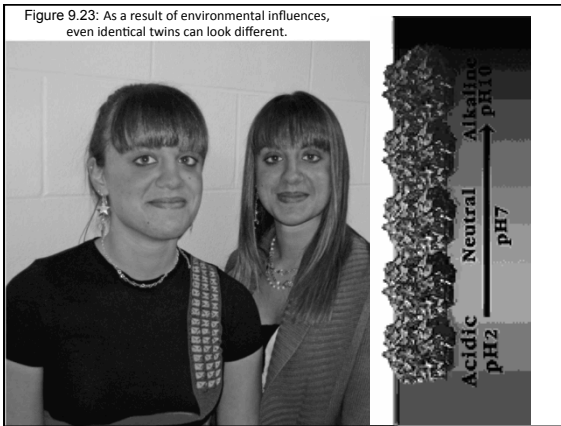




The Role of Environment

- Many human characters result from a combination of
 - heredity and
 - **environment**.
- Only genetic influences are inherited.

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Important Latin Roots					
Homo	ology				
• one	• Study of • form				

Chapter 13	
How Populations Evolve	

**Biology and Society:
Mosquitoes, Microbes, and Malaria**

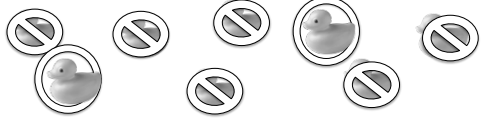
- In the 1960s, the World Health Organization (WHO) launched a campaign to eradicate the mosquitoes that transmit malaria.
- It used DDT, to which some mosquitoes have evolved resistance.



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**Biology and Society:
Mosquitoes, Microbes, and Malaria**

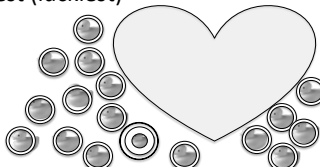
– The evolution of pesticide-resistant insects is just one of the ways that evolution affects our lives.

DDT 

– Survival of the fittest (luckiest)

An understanding of evolution informs every field of biology, for example,

- Medicine,
- Agriculture,
- Biotechnology
- Conservation biology.






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CHARLES DARWIN & *THE ORIGIN OF SPECIES*

– Biology came of age on November 24, 1859.

– Charles Darwin published *On the Origin of Species by Means of Natural Selection*, an assemblage of facts about the natural world.

Darwin made three observations from these facts.

1	2	3
<p>Life shows rich diversity.</p>  <p>(a) The diversity of life</p>	<p>There are similarities in life that allow the classification of organisms into groups nested within broader groups.</p>  <p>(b) Patterns of similarities</p>	<p>Organisms display many striking ways in which they are suited for their environments.</p>  <p>(c) An insect suited to its environment</p>

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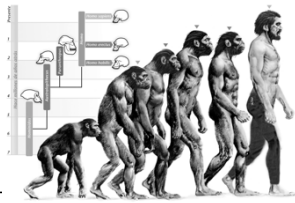
CHARLES DARWIN AND THE ORIGIN OF SPECIES

- In *The Origin of Species*, Darwin
 - proposed a hypothesis, a scientific explanation for his observations,
 - used hundreds of pages in his book to describe the evidence supporting his hypothesis,
 - made testable predictions, and
 - reported the results of numerous experiments he had performed.

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CHARLES DARWIN AND THE ORIGIN OF SPECIES

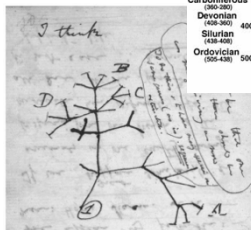
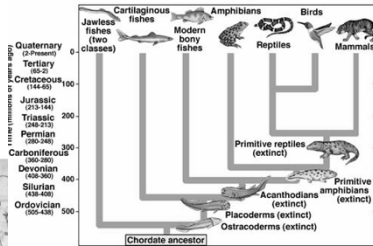
- Darwin hypothesized that
 - Present-day species are the descendants of ancient ancestors that they still resemble in some ways and
 - Change occurs as a result of "descent with modification," with natural selection as the mechanism.



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Figure 13.2

Vertebrate Family Tree





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CHARLES DARWIN AND THE ORIGIN OF SPECIES

– **Natural selection** is a process in which organisms with certain inherited characteristics are more likely to survive and reproduce than are individuals with other characteristics.

– Q: What was the character natural selection acted on in the rubber ducky/mosquito example?

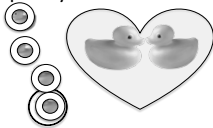
 

– As a result of natural selection, a **population**, a group of individuals of the same species living in the same place at the same time, changes over generations.

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CHARLES DARWIN AND THE ORIGIN OF SPECIES

– Natural selection leads to **evolutionary adaptation**, a population's increase in the frequency of traits suited to the environment.



– Natural selection thus leads to **evolution**, seen either as

- a change in the genetic composition of a population over time or
- on a grander scale, the entire biological history, from the earliest microbes to the enormous diversity of organisms that live on Earth today.

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CHARLES DARWIN AND THE ORIGIN OF SPECIES

– Natural selection leads to

- a **population** (a group of individuals of the same species living in the same place at the same time) changing over generations and
- evolutionary adaptation.

– In one modern definition of **evolution**, the genetic composition of a population changes over time.

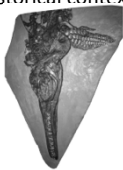
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Darwin's Cultural and Scientific Context


- *The Origin of Species* was fundamentally different from the prevailing scientific and cultural views of Darwin's time.
- Let's place Darwin's ideas in their historical context.

Fixed Idea of a Species:

- The Greek philosopher Aristotle held the belief that species are fixed and do not evolve.
- The Judeo-Christian culture fortified this idea with
 - A literal interpretation of the biblical book of Genesis and
 - The suggestion that Earth may only be 6,000 years old.
- Naturalists were grappling with the interpretation of **fossils**, imprints or remains of organisms that lived in the **Past**.



(b) Icthyosaur skull and paddle-like forelimb



(a) "Snakestone"

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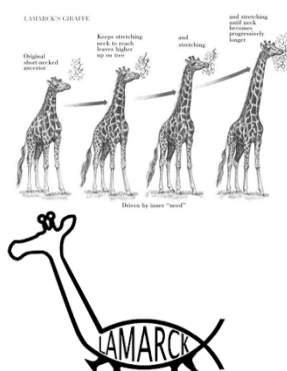
Lamarck and Evolutionary Adaptations

- Naturalists compared fossil forms with living species and noted patterns of similarities and differences.
- In the early 1800s, French naturalist Jean Baptiste Lamarck suggested that life evolves, and explained this evolution as the refinement of traits that equip organisms to perform successfully in their environment.

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Lamarckian Evolution

- Pro: Saw Change over time
- Con: Thought it was about effort
 - Use it or lose it
- Set the stage for Darwin



The Voyage of the Beagle

- Darwin was intrigued by
 - the geographic distribution of organisms on the Galápagos Islands and
 - similarities between organisms in the Galápagos and those in South America.

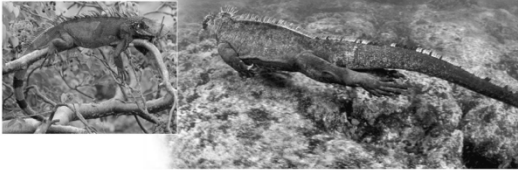
PLAY Video: Galápagos Sea Lion

PLAY Video: Galápagos Tortoise

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Figure 13.5

PLAY Video: Galápagos Marine Iguana



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The Voyage of the Beagle

- Darwin was strongly influenced by the writings of geologist Charles Lyell.
- Lyell suggested that Earth
 - is very old and
 - was sculpted by gradual geological processes that continue today.
- Darwin reasoned that the extended time scale would allow for gradual changes to occur
 - in species and
 - in geologic features.

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Descent with Modification

- Darwin made two main points in *The Origin of Species*.
 1. Organisms inhabiting Earth today descended from ancestral species. = Common ancestor
 2. Natural selection is the mechanism for descent with modification.

EVIDENCE OF EVOLUTION

- Evolution leaves observable signs.
- We will examine five of the many lines of evidence in support of evolution:
 1. the fossil record,
 2. biogeography,
 3. comparative anatomy,
 4. comparative embryology, and
 5. molecular biology.

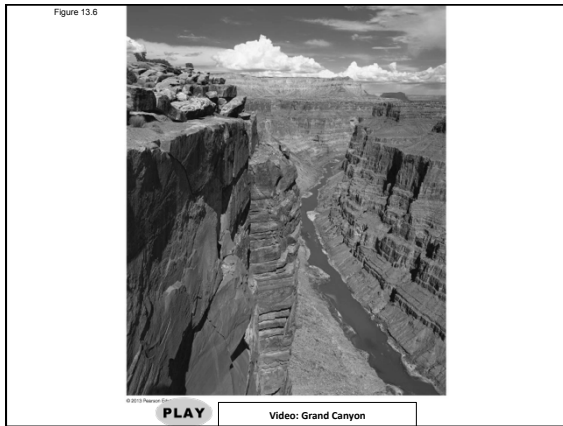
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The Fossil Record

- Fossils are
 - imprints or remains of organisms that lived in the past
 - often found in sedimentary rocks.

- is the ordered sequence of fossils as they appear in rock layers,
- reveals the appearance of organisms in a historical sequence, and
- fits with the molecular and cellular evidence that prokaryotes are the ancestors of all life.

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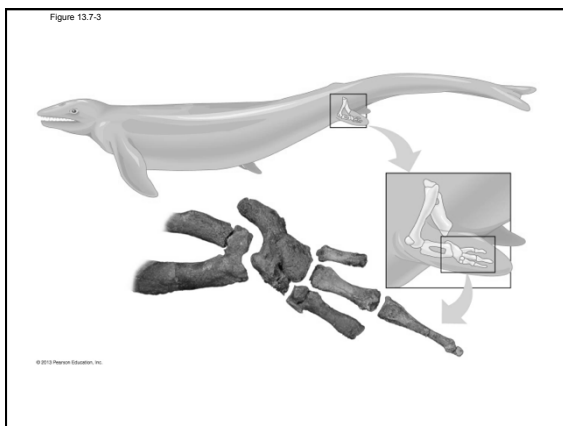


The Fossil Record

– Paleontologists (scientists who study fossils) have discovered many transitional forms that link past and present.

– Transitional fossils include evidence that

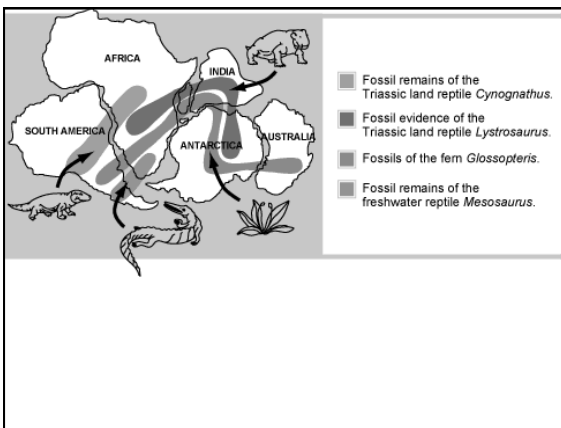
- birds descended from one branch of dinosaurs and
- whales descended from four-legged land mammals.

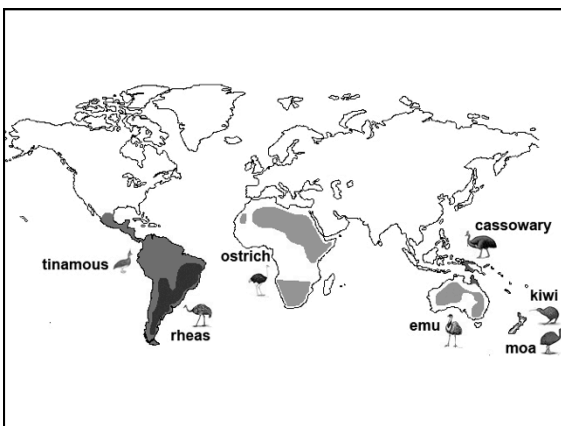


Biogeography

- **Biogeography**, the study of the geographic distribution of species, first suggested to Darwin that today's organisms evolved from ancestral forms.
- Darwin noted that Galápagos animals resembled species of the South American mainland more than they resembled animals on similar but distant islands. (*Look like neighbors*)
- Many examples from biogeography would be difficult to understand, except from an evolutionary perspective.
- One example is the distribution of marsupial mammals in Australia.

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Why does the pronghorn antelope run so fast?


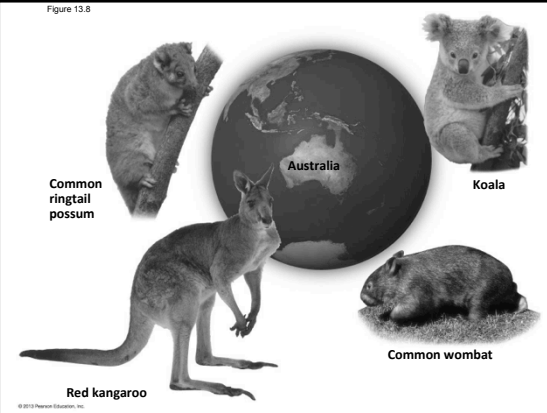


Figure 13.8



Common ringtail possum

Koala

Red kangaroo

Common wombat

Australia

Comparative Anatomy

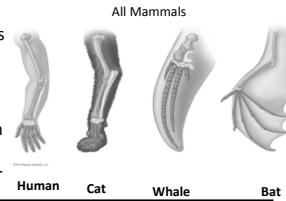
PLAY Blast Animation: Evidence for Evolution: Homologous Limbs

– **Comparative anatomy**

- is the comparison of body structure between different species and
- attests that evolution is a remodeling process in which ancestral structures become modified as they take on new functions.

– **Homology** is

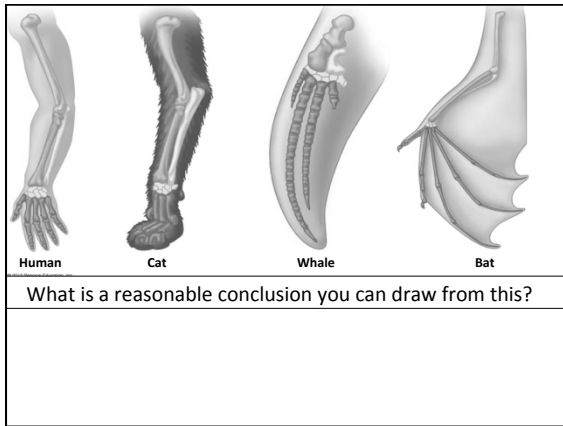
- the similarity in structures due to common ancestry and
- illustrated by the remodeling of the pattern of bones forming the forelimbs of mammals for different functions.



Human Cat Whale Bat

All Mammals

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Comparative Anatomy

- **Vestigial structures**
 - Are remnants of features that served important functions in an organism's ancestors and
 - Now have only marginal, if any, importance.

Inflamed appendix

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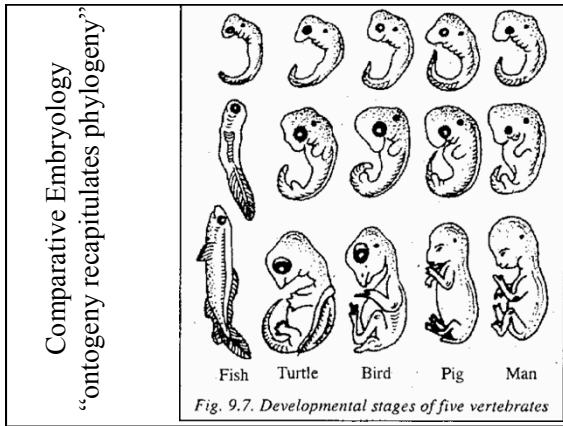
Comparative Embryology

- Early stages of development in different animal species reveal additional homologous relationships.
 - For example, pharyngeal pouches appear on the side of the embryo's throat, which
 - develop into gill structures in fish and
 - form parts of the ear and throat in humans.
 - Comparative embryology of vertebrates supports evolutionary theory.

Pharyngeal pouches


Post-anal tail

Chicken embryo Human embryo



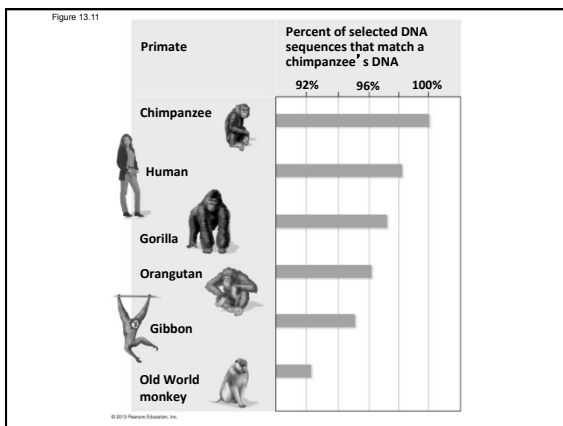
Molecular Biology

- The hereditary background of an organism is documented in
 - its DNA and
 - the proteins encoded by the DNA.
- Evolutionary relationships among species can be determined by comparing
 - genes and
 - proteins of different organisms.



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NATURAL SELECTION

– Darwin noted the close relationship between adaptation to the environment and the origin of new species.


– The evolution of finches on the Galápagos Islands is an excellent example.



(a) The large ground finch



(b) The warbler finch



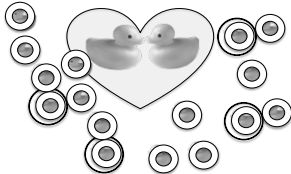
(c) The woodpecker finch

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Darwin's Theory of Natural Selection

– Darwin based his theory of natural selection on two key observations.

1. All species tend to produce excessive numbers of offspring.
2. Organisms vary, and much of this variation is heritable.



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Darwin's Theory of Natural Selection

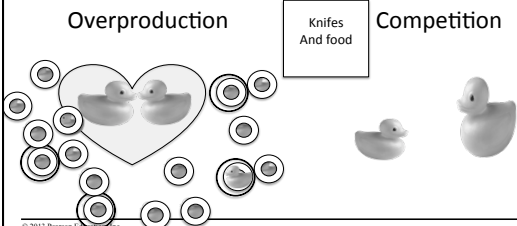
– **Observation 1: Overproduction and competition**

- All species have the potential to produce many more offspring than the environment can support.
- This leads to inevitable competition among individuals.

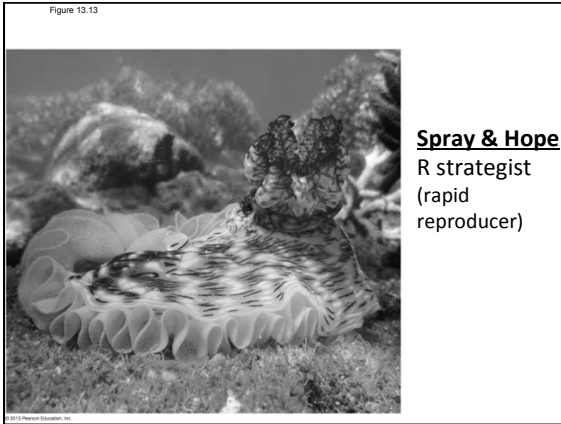
Overproduction

Knives
And food

Competition



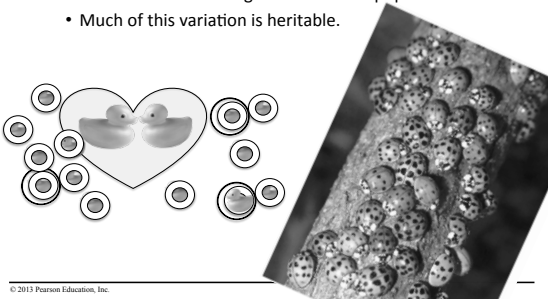
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Darwin's Theory of Natural Selection

– **Observation 2: Individual variation**

- Variation exists among individuals in a population.
- Much of this variation is heritable.




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Darwin's Theory of Natural Selection

– **Inference: Unequal reproductive success (natural selection)**

- Those individuals with traits best suited to the local environment generally leave a larger share of surviving, fertile offspring.



2 peacocks

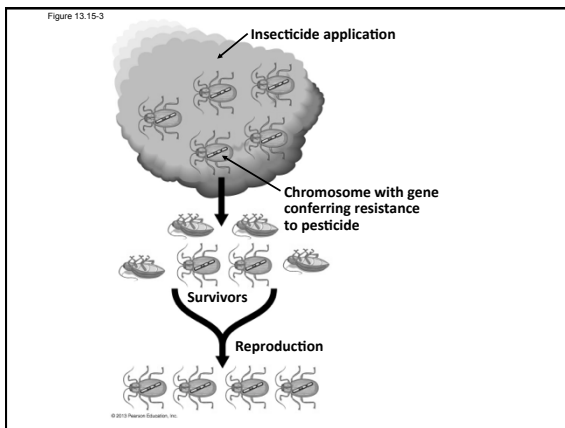
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Natural Selection in Action

– Examples of natural selection include

- pesticide-resistant insects,
- antibiotic-resistant bacteria, and
- drug-resistant strains of HIV.

PLAY ▶▶ Animation: Evidence for Evolution: Antibiotic R...
▶▶ Animation: Natural Selection



The Process of Science: Does Predation Drive the Evolution of Lizard Horn Length?

– **Observation:** Flat-tailed horned lizards defend against attack by

- thrusting their heads backward and
- stabbing a shrike with the spiked horns on the rear of their skull.

– **Question:** Are longer horn length and spread a survival advantage?

– **Hypothesis:** Longer horn length and spread are a survival advantage.

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The Process of Science: Does Predation Drive the Evolution of Lizard Horn Length?

- **Prediction:** Live horned lizards have longer and more widely spread horns than dead ones.
- **Experiment:** Measure the horn lengths and the tip-to-tip spread distance of side horns from the skulls of
 - 29 killed and
 - 155 living lizards.



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The Process of Science: Does Predation Drive the Evolution of Lizard Horn Length?

- **Results:** The average horn length and spread of live lizards is about 10% greater than that of killed lizards.



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Figure 13.16



(a) A flat-tailed horned lizard



(b) The remains of a lizard impaled by a shrike



(c) Results of measurement of lizard horns

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