

PowerLecture:

Chapter 17

Evidence of Evolution

Section 17.0: Weblinks and InfoTrac

See the **latest Weblinks and InfoTrac articles** for this chapter online

Videos: CNN

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➤ Biology, 2002, Vol. 6, *Biggest Mass Extinction* (1:40)

Impacts, Issues: **Measuring Time**

➤ Asteroids – rocky bodies, a few meters to 1,000 kilometers across

➤ Asteroid impacts on Earth correspond to mass extinctions (dinosaurs)

Impacts, Issues: **Measuring Time**

➤ Knowing what an asteroid impact will do to us allows us to figure out how impacts affected life in the past

➤ Requires an understanding of geologic time

Impacts, Issues Video

Section 17.1: Weblinks and InfoTrac

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➤ Environmental Science, 2004, Vol. 7, *Creation vs. Evolution* (2:31)

Selective Breeding & Evolution

➤ Evolution is genetic change in a line of descent through successive generations

➤ Selective breeding practices yield evidence that heritable changes do occur

Domestication of Dogs

➤ Began about 50,000 years ago

➤ 14,000 years ago - artificial selection

● Dogs with desired forms of traits were bred

➤ Modern breeds are the result

Results of Artificial Selection

➤ Extremes in size

● Great Dane and Chihuahua

➤ Extremes in form

● Short-legged dachshunds

● English bulldog

- Short snout and compressed face
- Extreme traits lead to health problems

Evolutionary Theories

- Widely used to interpret the past and present, and even to predict the future
- Reveal connections between the geological record, fossil record, and organism diversity

Early Scientific Theories

- Hippocrates - All aspects of nature can be traced to their underlying causes
- Aristotle - Each organism is distinct from all the rest and nature is a continuum or organization

Confounding Evidence

- Biogeography
- Comparative anatomy
- Geologic discoveries

Biogeography

- Size of the known world expanded enormously in the 15th century
- Discovery of new organisms in previously unknown places could not be explained by accepted beliefs
 - How did species get from center of creation to all these places?

Comparative Morphology

- Study of similarities and differences in body plans of major groups
- Puzzling patterns:
 - Animals as different as whales and bats have similar bones in forelimbs
 - Some parts seem to have no function

Geological Discoveries

- Similar rock layers throughout world
- Certain layers contain fossils
- Deeper layers contain simpler fossils than shallow layers
- Some fossils seem to be related to known species

Section 17.2: Weblinks and InfoTrac

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19th Century - New Theories

- Scientists attempt to reconcile evidence of change with traditional belief in a single creation event
- Two examples

- Georges Cuvier - multiple catastrophes
- Jean Lamarck - inheritance of acquired characteristics

The Theory of Uniformity

- Lyell's *Principles of Geology*
- Subtle, repetitive processes of change had shaped Earth
- Challenged the view that Earth was only 6,000 years old

Darwin's Voyage

- At age 22, Charles Darwin began a five-year, round-the-world voyage aboard the *Beagle*
- In his role as ship's naturalist, he collected and examined the species that inhabited the regions the ship visited

Section 17.3: Weblinks and InfoTrac

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Galapagos Finches

- Darwin observed finches with a variety of lifestyles and body forms
- On his return, he learned that there were 13 species
- He attempted to correlate variations in their traits with environmental challenges

Galapagos Finches

Galapagos Finches

Malthus - Struggle to Survive

- Thomas Malthus, a clergyman and economist, wrote essay that Darwin read on his return to England
- Argued that as population size increases, resources dwindle, the struggle to live intensifies, and conflict increases

Darwin's Theory

A population can change over time when individuals differ in one or more heritable traits that are responsible for differences in the ability to survive and reproduce.

Natural Selection

- A difference in the survival and reproductive success of different phenotypes

- Acts directly on phenotypes and indirectly on genotypes

Reproductive Capacity

& Competition

- All populations have the capacity to increase in numbers
- No population can increase indefinitely
- Eventually the individuals of a population will end up competing for resources

Variation in Populations

- All individuals have the same genes that specify the same assortment of traits
- Most genes occur in different forms (alleles) that produce different phenotypes
- Some phenotypes compete better than others

Change over Time

- Over time, the alleles that produce the most successful phenotypes will increase in the population
- Less successful alleles will become less common
- Change leads to increased fitness
 - Increased adaptation to environment

Alfred Wallace

- Naturalist who arrived at the same conclusions Darwin did
- Wrote to Darwin describing his views
- Prompted Darwin to finally present his ideas in a formal paper

Section 17.4: Weblinks and InfoTrac

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Fossils

- Recognizable evidence of ancient life
- What do fossils tell us?
 - Each species is a mosaic of ancestral and novel traits
 - All species that ever evolved are related to one another by way of descent

Stratification

- Fossils are found in sedimentary rock
- This type of rock is formed in layers
- In general, layers closest to the top were formed most recently

Fossilization

- Organism becomes buried in ash or sediments
- Organic remains become infused with metal and mineral ions
- Carbon 14 dating

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Radiometric Dating

Radioisotope decay

Radiometric Dating

Radiometric dating

Record Is Incomplete

- Fossils have been found for about 250,000 species
- Most species weren't preserved
- Record is biased toward the most accessible regions

Geologic

Time

Scale

- Boundaries based on transitions in fossil record

Geologic Time Scale

Geologic time scale

Section 17.6: Weblinks and InfoTrac

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Continental Drift

- Idea that the continents were once joined and have since "drifted" apart
- Initially based on the shapes
- Wegener refined the hypothesis and named the theoretical supercontinent Pangea

Changing Land Masses

Drifting continents

Evidence of Movement

- Wegener cited evidence from glacial deposits and fossils
- Magnetic orientations in ancient rocks do not align with the magnetic poles
- Discovery of seafloor spreading provided a possible mechanism

Plate Tectonics

- Earth's crust is fractured into plates
- Movement of plates driven by upwelling of molten rock

Plate Margins

Plate margins

Geologic Forces

Geologic forces

Section 17.7: Weblinks and InfoTrac

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Comparative Morphology

- Comparing body forms and structures of major lineages
- Guiding principle:

- When it comes to introducing change in morphology, evolution tends to follow the path of least resistance

Transitional Forms

Morphological Divergence

Morphological divergence

Morphological Convergence

- Individuals of different lineages evolve in similar ways under similar environmental pressures
- Produces analogous structures that serve similar functions

Comparative Development

- Each animal or plant proceeds through a series of changes in form
- Similarities in these stages may be clues to evolutionary relationships
- Mutations that disrupt a key stage of development are selected against

Section 17.8: Weblinks and InfoTrac

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Altering Developmental Programs

- Some mutations shift a step in a way that natural selection favors
- Small changes at key steps may bring about major differences
- Insertion of transposons or gene mutations

Similar Vertebrate Embryos

- Alterations that disrupted early development have been selected against

Similar Vertebrate Embryos

Development of Larkspurs

- Two closely related species have different petal morphology
- They attract different pollinators

Development of Larkspurs

- Petal difference arises from a change in the rate of petal development

Developmental Changes

- Changes in the onset, rate, or time of completion of development steps can cause allometric changes
- Adult forms that retain juvenile features

Proportional Changes in Skull

Mutation and proportional changes

Section 17.9: Weblinks and InfoTrac

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Comparative Biochemistry

- Kinds and numbers of biochemical traits that species share is a clue to how closely they are related
- Can compare DNA, RNA, or proteins
- More similarity means species are more closely related

Comparing Proteins

- Compare amino acid sequence of proteins produced by the same gene
- Human cytochrome *c* (a protein)
 - Identical amino acids in chimpanzee protein
 - Chicken protein differs by 18 amino acids
 - Yeast protein differs by 56

Sequence Conservation

- Cytochrome *c* functions in electron transport
- Deficits in this vital protein would be lethal
- Long sequences are identical in wheat, yeast, and a primate

Sequence Conservation

Cytochrome C comparison

Nucleic Acid Comparison

- Use single-stranded DNA or RNA
- Hybrid molecules are created, then heated
- The more heat required to break hybrid, the more closely related the species

Molecular Clock

- Assumption: "Ticks" (neutral mutations) occur at a constant rate
- Count the number of differences to estimate time of divergence