

CHAPTER 14

How Biological Diversity Evolves

Figures 14.1 – 14.7

PowerPoint® Lecture Slides for
Essential Biology, Second Edition & *Essential Biology with Physiology*

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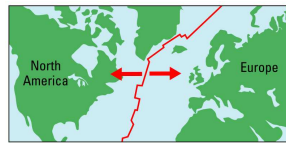
Presentation prepared by Chris C. Romero

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- Biological Diversity is Beautiful



- North America and Europe are drifting apart at a rate of about 2 cm per year.



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Biologists estimate that there are 5–30 million species of organisms currently on Earth

Microevolution is population level evolution.

Macroevolution includes multiplication of species p. 272

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- Our own scientific name, *Homo sapiens*, means “wise man”



- Globally, the rate of species loss may be 50 times higher now than at any time in the past 100,000 years.

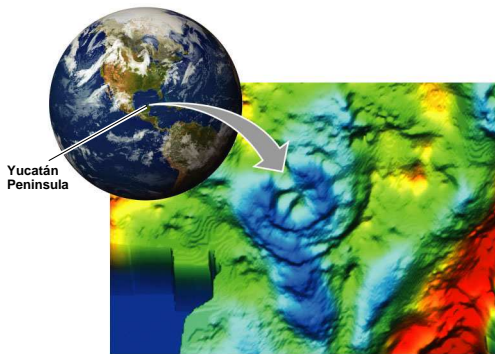


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BIOLOGY AND SOCIETY: THE IMPACT OF ASTEROIDS

- Many paleontologists
 - Have concluded that a large meteorite hit Earth
 - Believe that the meteor impact contributed to the extinction of the dinosaurs.

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Figure 14.1

MACROEVOLUTION AND THE DIVERSITY OF LIFE

- Macroevolution
 - Encompasses the major biological changes evident in the fossil record
 - Includes the multiplication of species.

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- Speciation
 - Is the focal point of macroevolution
 - May occur based on two contrasting patterns.

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- In nonbranching evolution, a population changes and becomes a new species.



Figure 14.2a

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- In branching evolution, one or more new species branch from a parent species that may continue to exist.



(b) Branching evolution

Figure 14.2b

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THE ORIGIN OF SPECIES

- *Species* is a Latin word meaning “kind” or “appearance”. “The biological species concept defines species as ‘groups of interbreeding natural populations that are reproductively isolated from other such groups’”. P. 273
- Individuals within a species can interbreed and produce fertile offspring.

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What Is a Species?

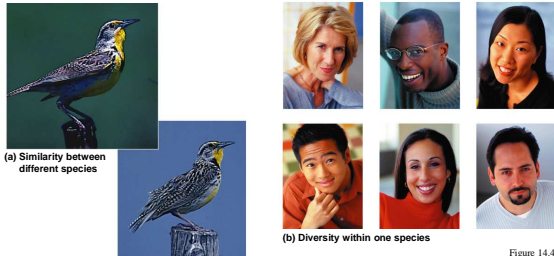
- Ernst Mayr
 - Led an expedition into New Guinea and found a great diversity of birds
 - Distilled his observation into the biological species concept.



Figure 14.3

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- The biological species concept defines species as “groups of interbreeding natural populations that are reproductively isolated from other such groups”



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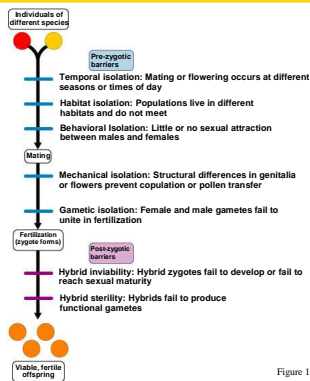
Figure 14.4

- The biological species concept cannot be applied in all situations, for example, with fossils and asexual organisms.

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Reproductive Barriers Between Species

- Pre-zygotic barriers impede mating between species or hinder fertilization of eggs.



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- Pre-zygotic barriers include
 - Temporal isolation
 - Habitat isolation
 - Mechanical isolation
 - Gametic isolation

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- Behavioral isolation



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Courtship rituals or other identification requirements for mates can also function as reproductive barriers (behavioral isolation; a form of pre-zygotic barriers). P. 274

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- Post-zygotic barriers
 - Are backup mechanisms that operate should interspecies mating actually occur and produce hybrid zygotes.

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- Post-zygotic barriers include
 - Hybrid inviability
 - Hybrid sterility.



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Hybrid inviability is when hybrid offspring die before reaching reproductive maturity.
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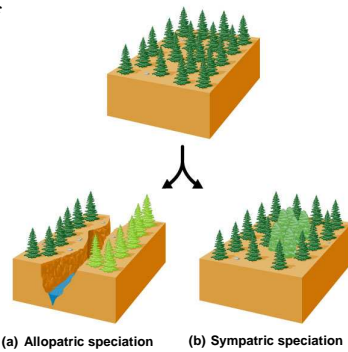
Mechanisms of Speciation

- A key event in the potential origin of species occurs when a population is somehow severed from other populations of the parent species.

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- The two modes of speciation are

- Allopatric speciation
- Sympatric speciation



(a) Allopatric speciation (b) Sympatric speciation

Figure 14.8

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Allopatric Speciation

- Geological processes
 - Can fragment a population into two or more isolated populations
 - Can contribute to allopatric speciation

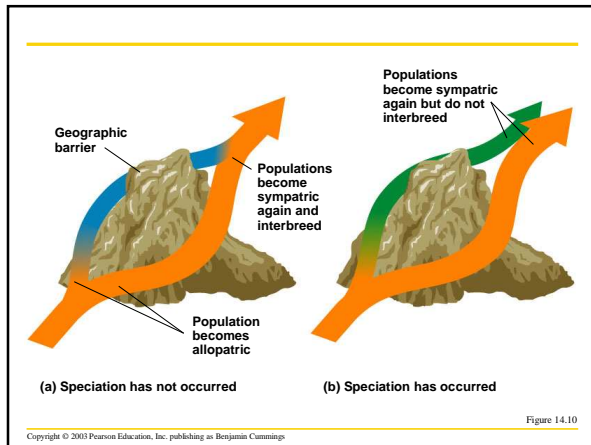


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- Speciation occurs only with the evolution of reproductive barriers between the isolated population and its parent population.

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Sympatric Speciation

- Sympatric speciation occurs if a genetic change produces a reproductive barrier between mutants and the parent population

– Polyploidy, a mechanism of sympatric speciation, was first observed by Hugo de Vries.



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- Polyploids
 - Originate from accidents during cell division
 - Can lead to sympatric speciation

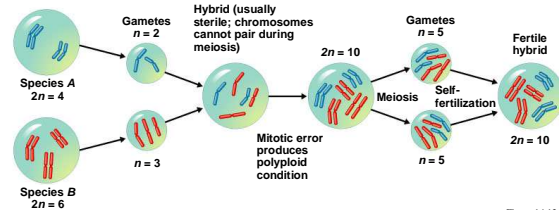


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- Many domesticated plants are the result of sympatric speciation.

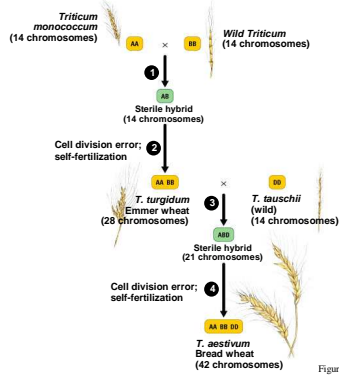


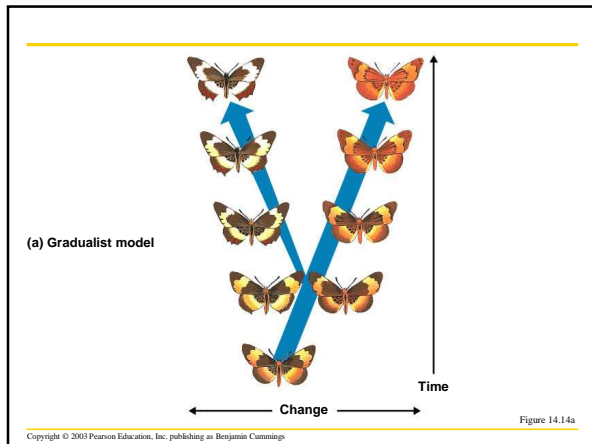
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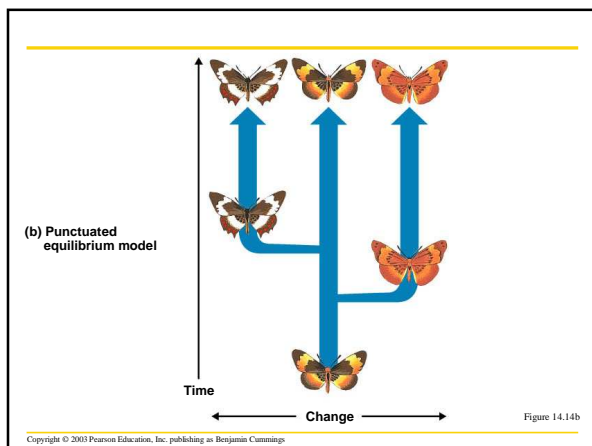
What Is the Tempo of Speciation?

- Traditional evolutionary trees diagram the descent of species as gradual divergence.

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- Punctuated equilibrium
 - Is a contrasting model of evolution
 - States that species most often diverge in spurts of relatively rapid change
 - Accounts for the relative rarity of transitional fossils
 - Demonstrates the greatest change in appearance.
- Figure 14.14b
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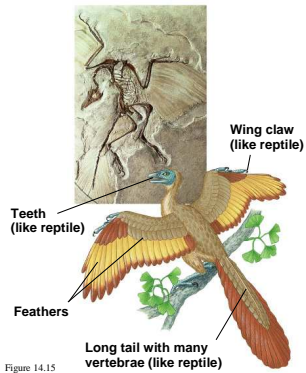
THE EVOLUTION OF BIOLOGICAL NOVELTY

- What accounts for the evolution of biological novelty?

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Adaptation of Old Structures for New Functions

- Birds
 - Are derived from a lineage of earthbound reptiles
 - Developed from flightless ancestors, but how?



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- Exaptation

- Involves a structure that evolves in one context gradually becoming adapted for other functions
- Is a mechanism for novel features to arise gradually.

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“Evo-Devo”: Development and Evolutionary Novelty

- A subtle change in developmental genes can have profound effects.

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- Paedomorphosis

- Is the retention of juvenile body features in the adult
- Is important in human evolution.



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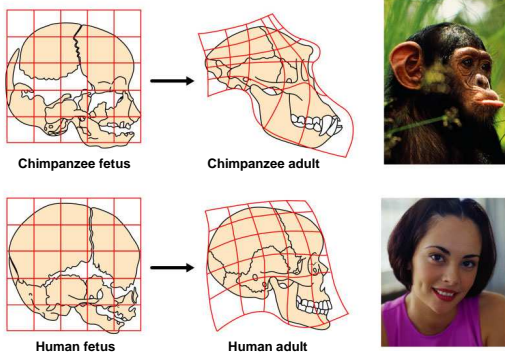


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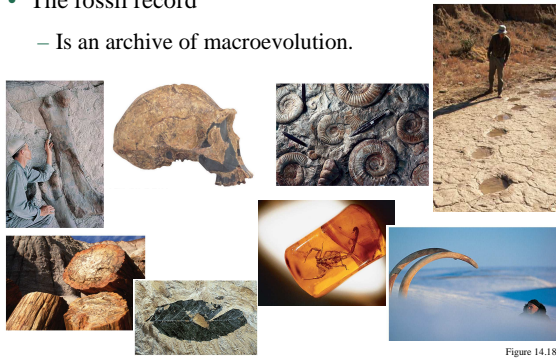
EARTH HISTORY AND MACROEVOLUTION

- Macroevolution
 - Is closely tied to the history of the Earth.

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Geologic Time and the Fossil Record

- The fossil record
 - Is an archive of macroevolution.



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- Geologists have established a geologic time scale reflecting a consistent sequence of geologic periods.

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Continental Drift and Macroevolution

- About 250 million years ago
 - Plate movements formed the supercontinent Pangaea
 - Many extinctions occurred, allowing survivors to diversify.

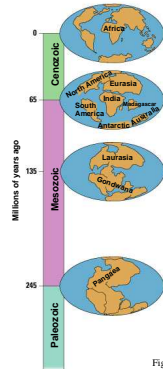


Figure 14.20

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“Many important geologic processes, including mountain building, volcanic activity, and earthquakes, occur at plate boundaries.” p. 285

Earthquakes result from continental plates moving against each other.

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- About 180 million years ago
 - Pangaea began to break up, causing geographic isolation.

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Mass Extinctions and Explosive Diversifications of Life

- The fossil record reveals long, relatively stable periods punctuated by mass extinctions that are followed by explosive diversification of certain survivors.

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- Scientists believe that about 65 million years ago, at the end of the Cretaceous period

- A meteor impact contributed to the extinction of the dinosaurs
- Mammals were allowed to diversify.



Figure 14.21

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CLASSIFYING THE DIVERSITY OF LIFE

- Systematics
 - Is the study of biological diversity, past and present
- Taxonomy
 - Is the identification, naming, and classification of species.

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Some Basics of Taxonomy

- Carolus Linnaeus
 - Developed the formal naming system used today
 - Known as Binomial Nomenclature it includes a Genus and a species name.

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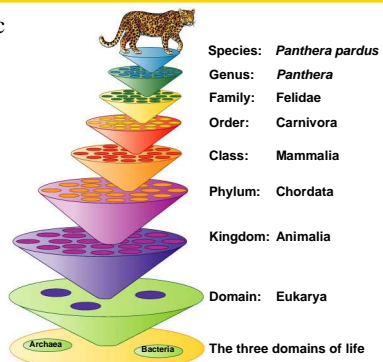
Naming Species

- Each organism is assigned a two-part name: Genus and species.

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Hierarchical Classification

- The taxonomic hierarchy.



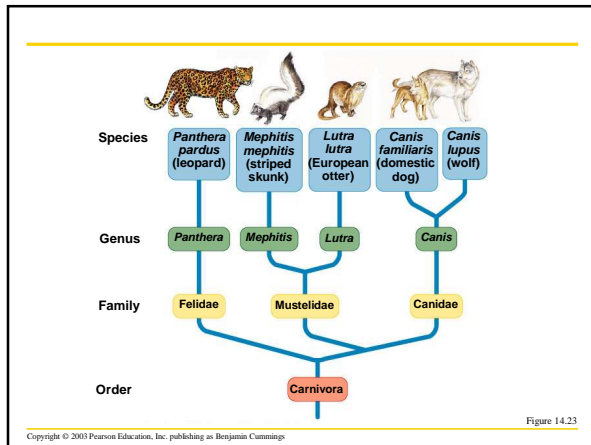
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Figure 14.22

Classification and Phylogeny

- The goal of classification is to reflect phylogeny, the evolutionary history of a species.

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Sorting Homology from Analogy, p. 288

- Homologous structures
 - Are one of the best sources of information about phylogenetic relationships.

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-
- Convergent Evolution
 - Involves superficially similar structures in unrelated organisms based on natural selection
 - Provides a pitfall for homology
 - Analogy
 - Is similarity due to convergence, p. 289 For example: wings of insects and birds.

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Molecular Biology as a Tool in Systematics

- Molecular systematics
 - Compares DNA and amino acid sequences between organisms
 - Can reveal evolutionary relationships.



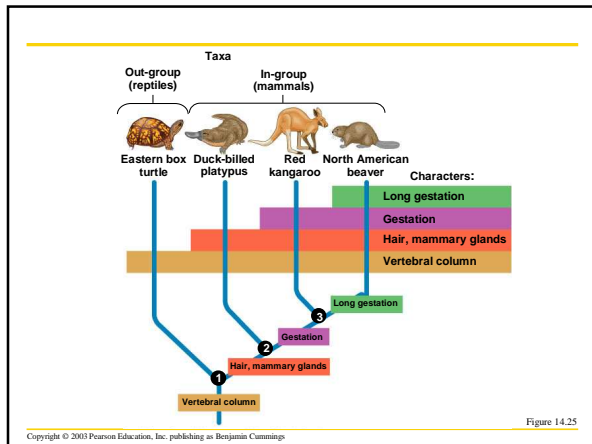
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The Cladistic Revolution

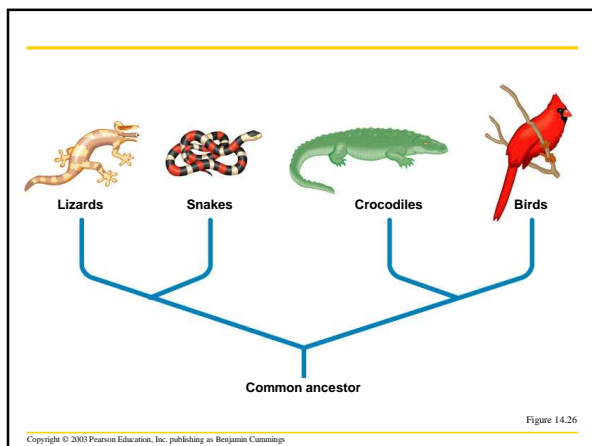
- Cladistic analysis
 - Is the scientific search for clades, distinctive branches in the history of life.

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- Cladistic analysis
 - Has changed traditional classification of some organisms.

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Arranging Life into Kingdoms: A Work in Progress

- The five-kingdom system
 - Arranges life into kingdoms based on specific characteristics.

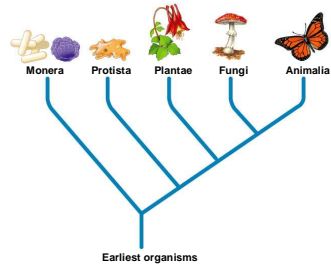


Figure 14.27a

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The three-domain system

- Is one alternative to the five-kingdom system.

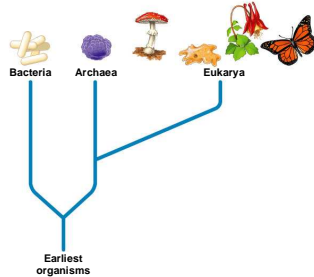
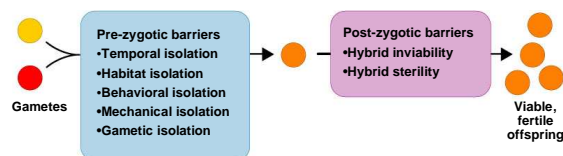


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SUMMARY OF KEY CONCEPTS

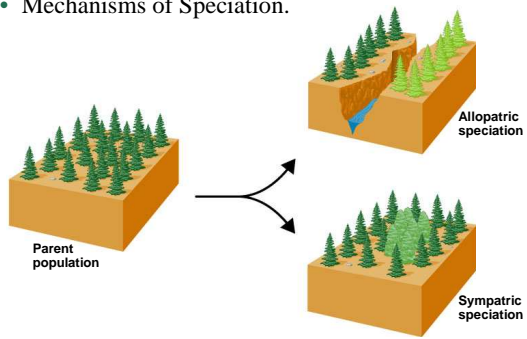
Reproductive Barriers Between Species.



Vistal Summary 14.1

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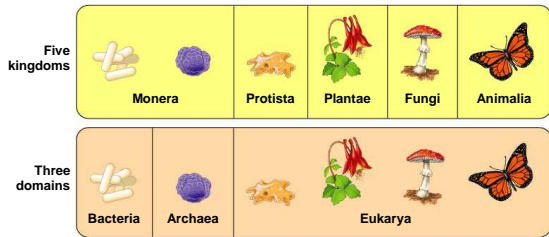
• Mechanisms of Speciation.



Visual Summary 14.2

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• Arranging Life into Kingdoms: A Work in Progress



Visual Summary 14.3

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