Chapter 26: Phylogeny and the Tree of Life

You Must Know

- The taxonomic categories and how they indicate relatedness.
- How systematics is used to develop phylogenetic trees.
- How to construct a phylogenetic tree that represents processes of biological evolution.
- The three domains of life, including their similarities and their differences
- The significance of widely conserved processes across the three domains.

26.1 Phylogenies Show Evolutionary Relationships

- _____ is the evolutionary history of a species or group of related species.
- _____is a discipline focused on classifying organisms and determining their evolutionary relationships.
- _____is the scientific discipline of how organisms are named and classified.
- A _____ consists of two components, instituted in the 18th century by _____ _____.
- The first part is the name of the _____to which the species belongs.
- The second part, called the _____ _____, is unique for each species within the genus.

Hierarchical Classification

- The hierarchical classification of organisms consists of the following levels with the most general or inclusive; _____, _____, _____, _____, _____, _____, _____, _____.
- Each categorization at any level is called a _____.
- Systematics use branching diagrams called _____ _____ to depict hypotheses about evolutionary relationships. The branches reflect the hierarchical classification of groups nested within more inclusive groups.
- The Linnaean system, places related genera in the same family, families into orders, orders into classes, classes into phyla, phyla into kingdoms, and kingdoms into domains.
- Common names for organisms-such as monkeys, finch, and lilac-convey meaning in the casual usage, but they can also cause confusion. Each of these names, for example, refers to more than one species. Moreover, some common names do not accurately reflect the kind of organism they signify. Consider three "fishes": jellyfish, crayfish, and silverfish.

How to read phylogenetic tree:

Figure 26.5

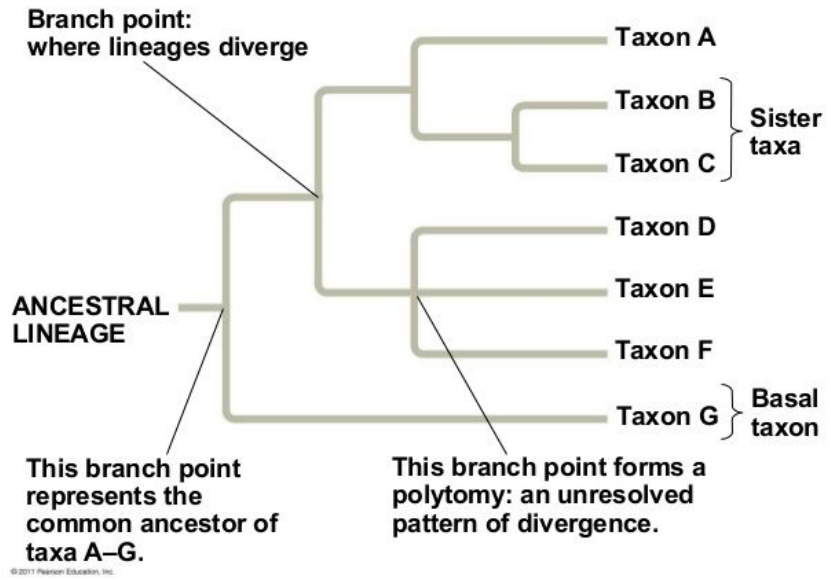


Figure 26.3

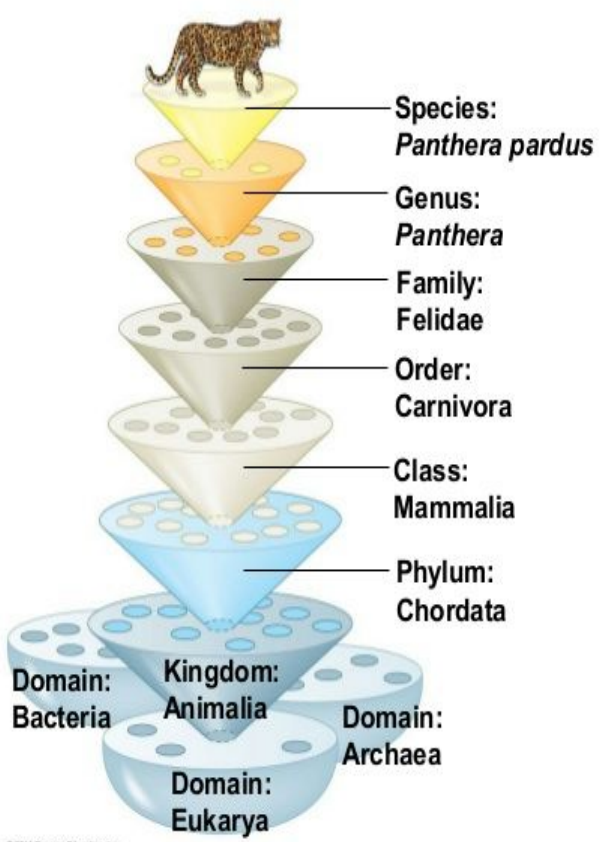
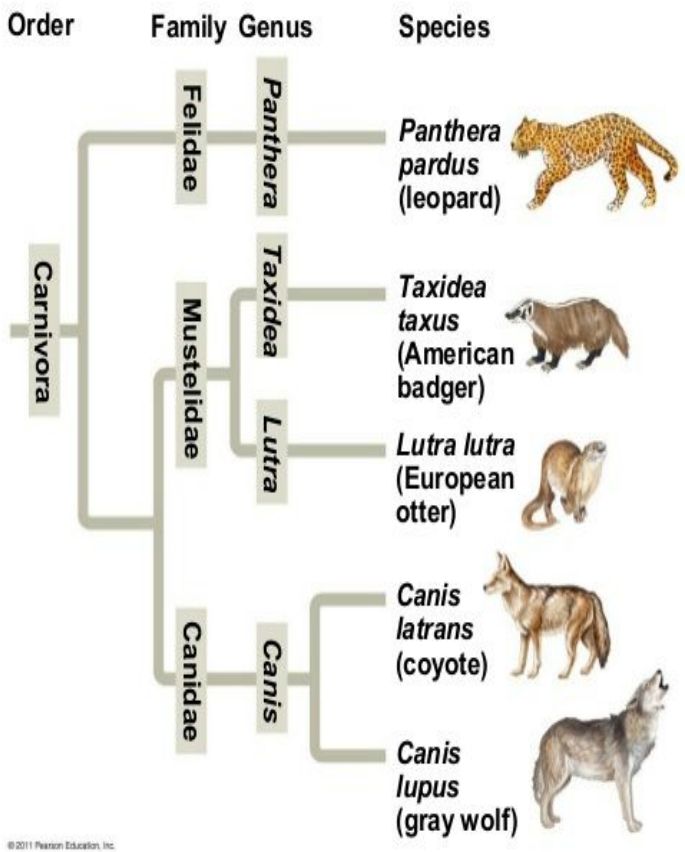


Figure 26.4



26.2: Phylogenies are inferred from morphological and molecular data

Morphological and Molecular Homologies

What are homologous structures?

Example of morphological homology:

- _____ or other _____ _____ are homologous if they are descended from sequences carried by a common ancestor.
- Organisms that share very _____ morphologies or DNA sequences are likely to be more _____ related than organisms with vastly _____ structures or sequences.
- In some cases, the morphological divergence between related species can be _____ and their genetic divergence _____ (or vice versa).

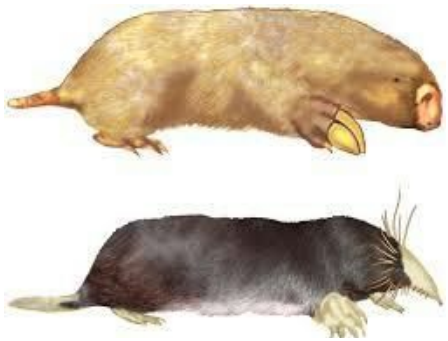
Example:

Homology or. Analogy

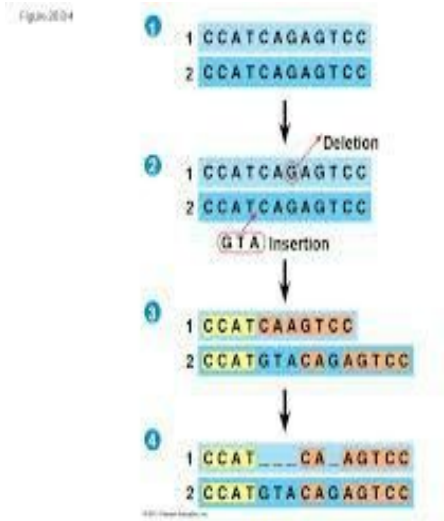
What is analogy?

- _____ _____ occurs when similar _____ pressures and _____ selection produce similar adaptations in organisms from different evolutionary lineages.

Example of convergent evolution:



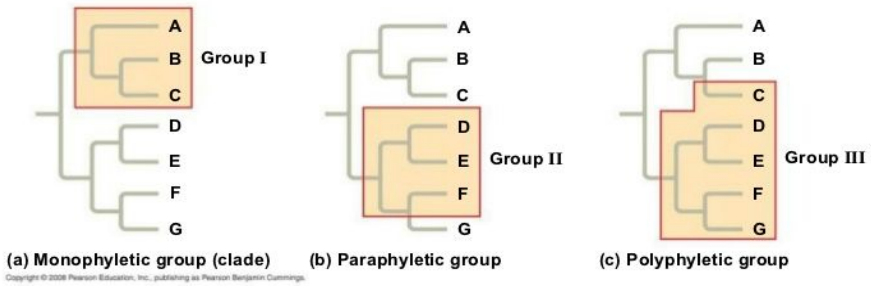
- Analogous structures that arise independently are called _____.
- The more elements that are similar in two complex structures, the more likely it is that they evolved from a _____ _____.
- _____ _____ uses DNA and other molecular data to determine evolutionary relationships.
- The more _____ the DNA sequences of the two organisms, the more _____ related they are evolutionarily.



26.3 Shared characters are used to construct phylogenetic trees

- _____- shows patterns of shared characteristics among taxa and forms the basis of a phylogenetic tree
- The _____within a tree is a group of species that includes an ancestral species and all its descendants. Clades are monophyletic.
- Shared derived characters are used to construct cladograms.
- E.g- hair is shared derived character of mammals
- A _____ _____ _____is one that originated in an ancestor of the taxon.
- E.g- all mammals have backbones but a backbone does not distinguish a mammal from another vertebrae

Figure 26.10



- _____ **group**- signifies that it consists of an ancestral species and all of its descendants
- _____ **group**- consists of an ancestral species and some, but not all, of its descendants
- _____ **group**- includes taxa with different ancestors

Chapter 26.4: An organism's evolutionary history is documented in its genome

- The rate of evolution of _____ sequences varies from one part of the _____ to another
- Comparing the different sequences helps us to investigate relationships between groups of organisms that _____ a long time ago
- DNA that codes for ribosomal RNA changes relatively slowly – useful for relationships between _____ that diverged hundreds of millions of years ago
- DNA that codes for mitochondrial DNA (mtDNA) evolves rapidly – useful for recent evolutionary events

Gene Duplications and Gene Families

- Gene duplication plays an important role in evolution because it _____ the number of genes in the genome, providing _____ opportunities for further evolutionary changes.
- There are two types of homologous genes:
  - Orthologous genes
  - Paralogous genes
- _____ genes are those found in different species, and their divergence traces back to the speciation events that produced the species
- _____ genes are the homology results from gene duplication; hence multiple copies of these genes have diverged from one another within a species

26.5 Molecular Clocks Help Track Evolutionary Time

- _____, a yardstick for measuring the absolute time of evolutionary change based on the observation that some genes and other regions of genomes appear to evolve at constant rates.
- To measure the molecular clock of a gene that has a reliable average rate of evolution, we graph the number of _____ _____
- The same gene may evolve at different rates in different groups of organisms.
- _____ Theory - much evolutionary change in genes and proteins has no effect on fitness and therefore is not influenced by natural selection.

Problems with Molecular Clocks

- Many irregularities are likely to be the result of natural selection in which certain DNA changes are favored over others
- Researchers attempt to extend molecular clocks beyond the time span documented by the fossil record.
- Making uncertain estimations

Solution

- Calibrate molecular clocks with many genes rather than just one or a few genes

Chapter 26.6: New Information Continues to revise our understanding of the tree of life

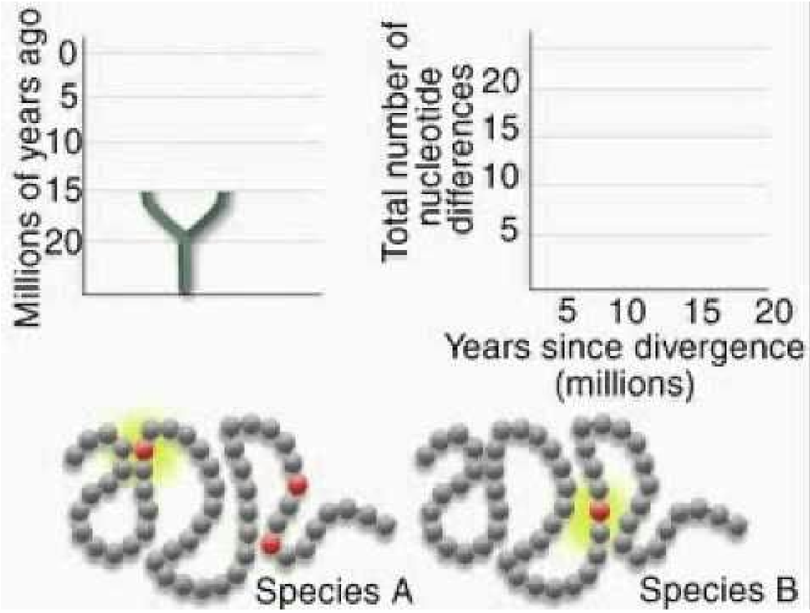
- What does the three-domain system consists of?

- The domains Bacteria and Archaea contain _____ organisms, and Eukarya contains _____ organisms.

Characteristics	***Bacteria***	***Archaea***	***Eukarya***
Nuclear envelope			
Membrane-enclosed organelles			
Introns			
Histone proteins associated with DNA			
Circular chromosome			

- List three ways Bacteria and Archaea are similar.

- How is Archaea are more closely related to Eukarya than Bacteria?


Millions of years ago
0
5
10
15
20
Total number of nucleotide differences
20
15
10
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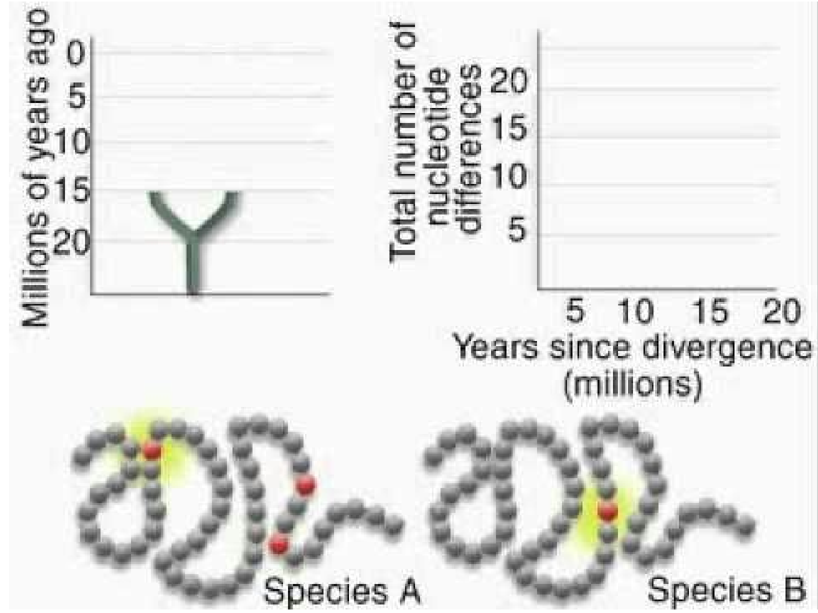
5 10 15 20
Years since divergence (millions)
Species A
Species B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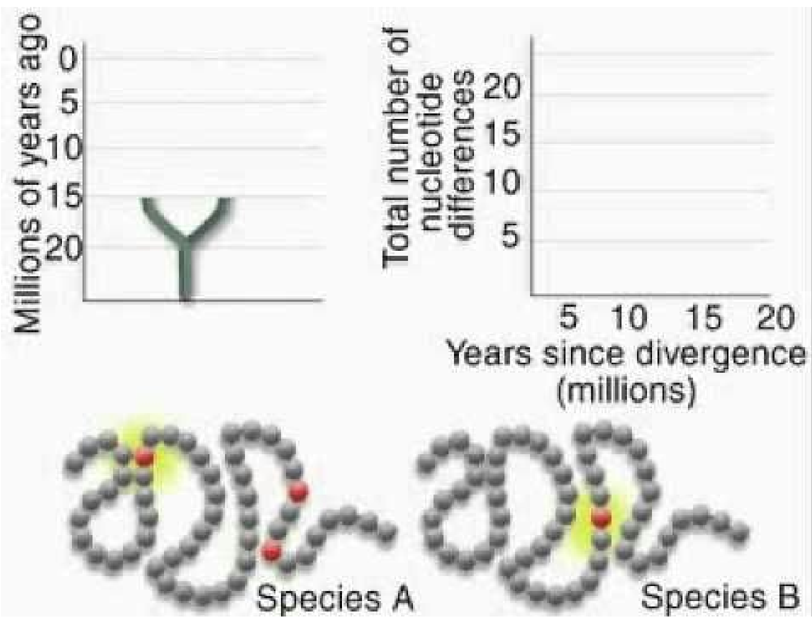
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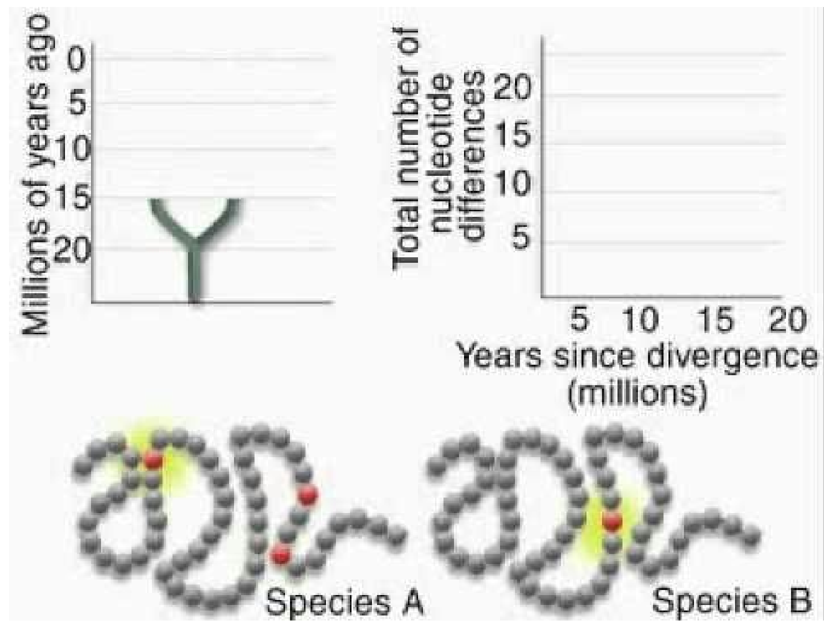
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