#### **Interactive Classroom**

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Glencoe Science

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Section 1: The History of Classification

Section 2: Modern Classification

Section 3: Domains and Kingdoms

EXIT

# Early Systems of Classification

 Biologists use a system of classification to organize information about the diversity of living things.

| Aristotle's Classification System |                                               |                       |  |  |
|-----------------------------------|-----------------------------------------------|-----------------------|--|--|
| Plants                            |                                               |                       |  |  |
| Herbs                             | Shrubs                                        | Trees                 |  |  |
| Violets<br>Rosemary<br>Onions     | Blackberry bush<br>Honeysuckle<br>Flannelbush | Apple<br>Oak<br>Maple |  |  |
| Animals with red blood            |                                               |                       |  |  |
| Land                              | Water                                         | Air                   |  |  |
| Wolf<br>Cat<br>Bear               | Dolphin<br>Eel<br>Sea bass                    | Owl<br>Bat<br>Crow    |  |  |











# Aristotle's System

- More than 2000 years ago, Aristotle developed the first widely accepted system of biological classification.
- Aristotle classified organisms as either animals or plants.



- Animals were classified according to the presence or absence of "red blood."
- Animals were further grouped according to their habitats and morphology.
- Plants were classified by average size and structure as trees, shrubs, or herbs.



## Linnaeus's System

 Linnaeus's system of classification was the first formal system of taxonomy.



Bird of prey



Perching bird



Wading bird



**Binomial Nomenclature** 

- Linnaeus's method of naming organisms, called binomial nomenclature, gives each species a scientific name with two parts.
- The first part is the genus name, and the second part is the specific epithet, or specific name, that identifies the species.



 Biologists use scientific names for species because common names vary in their use.



Ursus americanus American black bear



### **17.1 The History of Classification**

- When writing a scientific name, scientists use these rules:
  - The first letter of the genus name always is capitalized, but the rest of the genus name and all letters of the specific epithet are lowercase.
  - If a scientific name is written in a printed book or magazine, it should be italicized.
  - When a scientific name is written by hand, both parts of the name should be underlined.
  - After the scientific name has been written completely, the genus name will be abbreviated to the first letter in later appearances (e.g., *C. cardinalis*).



Taxonomic Categories

- The taxonomic categories used by scientists are part of a nested-hierarchal system.
- Each category is contained within another, and they are arranged from broad



are arranged from broadest to most specific.



# **Species and Genus**

- A named group of organisms is called a taxa.
- A genus (plural, genera) is a group of species that are closely related and share a common ancestor.



# Family

A family is the next higher taxon, consisting of similar, related genera.



# **Higher Taxa**

- An order contains related families.
- A class contains related orders.
- A phylum or division contains related classes.
- The taxon of related phyla or divisions is a kingdom.
- The domain is the broadest of all the taxa and contains one or more kingdoms.



- **17.2 Modern Classification**
- **Typological Species Concept**
- Aristotle and Linnaeus thought of each species as a distinctly different group of organisms based on physical similarities.
- Based on the idea that species are unchanging, distinct, and natural types.



**Biological Species Concept** 

 The biological species concept defines a species as a group of organisms that is able to interbreed and produce fertile offspring in a natural setting.



- **17.2 Modern Classification** 
  - **Phylogenic Species Concept**
- Phylogeny is the evolutionary history of a species.
- The phylogenic species concept defines a species as a cluster of organisms that is distinct from other clusters and shows evidence of a pattern of ancestry and descent.



#### **Species Concepts**

| Species Concept                    | Description                                                                                                                   | Limitation                                                                                                                                     | Benefit                                                                                                             |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Typological<br>species<br>concept  | Classification is determined by the<br>comparison of physical<br>characteristics with a type<br>specimen.                     | Alleles produce a wide variety of<br>features within a species.                                                                                | Descriptions of type specimens<br>provide detailed records of the<br>physical characteristics of many<br>organisms. |
| Biological<br>species<br>concept   | Classification is determined by<br>similar characteristics and the<br>ability to interbreed and produce<br>fertile offspring. | Some organisms, such as wolves<br>and dogs that are different species,<br>interbreed occasionally. It does not<br>account for extinct species. | The working definition applies<br>in most cases, so it is still used<br>frequently.                                 |
| Phylogenetic<br>species<br>concept | Classification is determined by<br>evolutionary history.                                                                      | Evolutionary histories are not<br>known for all species.                                                                                       | Accounts for extinct species and<br>considers molecular data.                                                       |









# Characters

- To classify a species, scientists construct patterns of descent by using characters.
- Characters can be morphological or biochemical.



**Morphological Characters** 

- Shared morphological characters suggest that species are related closely and evolved from a recent common ancestor.
- Analogous characters are those that have the same function but different underlying construction.
- Homologous characters might perform different functions, but show an anatomical similarity inherited from a common ancestor.



**17.2 Modern Classification** 

#### **Birds and Dinosaurs**

- Compare birds and dinosaurs:
  - Hollow bones
  - Theropods have leg, wrist, hip, and shoulder structures similar to birds.
  - Some theropods may have had feathers.



Haliaeetus leucocephalus



**Oviraptor philoceratops** 



- **17.2 Modern Classification**
- **Biochemical Characters**
- Scientists use biochemical characters, such as amino acids and nucleotides, to help them determine evolutionary relationships among species.
- DNA and RNA analyses are powerful tools for reconstructing phylogenies.



### **17.2 Modern Classification**

The similar appearance of chromosomes among chimpanzees, gorillas, and orangutans suggests a shared ancestry.

Chimpanzee

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Pan troglodytes

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Gorilla

Gorilla gorilla

Orangutan

Pongo pygmaeus

**17.2 Modern Classification** 

# **Molecular Clocks**

 Scientists use molecular clocks to compare the DNA sequences or amino acid sequences of genes that are shared by different species.



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 The differences between the genes indicate the presence of mutations.

The more mutations that have accumulated, the more time that has passed since divergence.



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- **17.2 Modern Classification**
- The Rate of Mutation is Affected
- Type of mutation
- Where the mutation is in the genome
- Type of protein that the mutation affects
- Population in which the mutation occurs



**Phylogenetic Reconstruction** 

- Cladistics reconstructs phylogenies based on shared characters.
- Scientists consider two main types of characters when doing cladistic analysis.
- An ancestral character is found within the entire line of descent of a group of organisms.
- Derived characters are present members of one group of the line but not in the common ancestor.



# Cladograms 🕥

 The greater the number of derived characters shared by groups, the more recently the groups share a common ancestor.





# **Grouping Species**

- The broadest category in the classification used by most biologists is the domain.
- The most widely used biological classification system has six kingdoms and three domains.
- The three domains are Bacteria, Archaea, and Eukarya.
- The six kingdoms are Bacteria, Archaea, Protists, Fungi, Plantae, and Animalia.



**17.3 Domains and Kingdoms** 

# **Domain Bacteria**

- Eubacteria are prokaryotes whose cell walls contain peptidoglycan.
- Eubacteria are a diverse group that can survive in many different environments.



A photomicrograph of Mycobacterium tuberculosis



### **Domain Archaea**

- Archaea are thought to be more ancient than bacteria and yet more closely related to our eukaryote ancestors.
- Archaea are diverse in shape and nutrition requirements.
- They are called extremophiles because they can live in extreme environments.



# Domain Eukarya

- All eukaryotes are classified in Domain Eukarya.
- Domain Eukarya contains Kingdom Protista, Kingdom Fungi, Kingdom Plantae, and Kingdom Animalia.



# **Kingdom Protista**

- Protists are eukaryotic organisms that can be unicellular, colonial, or multicellular.
- Protists are classified into three different groups plantlike, animallike, and funguslike.



# Kingdom Fungi

- A fungus is a unicellular or multicellular eukaryote that absorbs nutrients from organic materials in its environment.
- Member of Kingdom
  Fungi are



heterotrophic, lack motility, and have cell walls.



**17.3 Domains and Kingdoms** 

# **Kingdom Plantae**

- Members of Kingdom Plantae form the base of all terrestrial habitats.
- All plants are multicellular and have cell walls composed of cellulose.



 Most plants are autotrophs, but some are heterotrophic.


# **17.3 Domains and Kingdoms**

## **Kingdom Animalia**

- All animals are heterotrophic, multicellular eukaryotes.
- Animal organs often are organized into complex organ systems.
- They live in the water, on land, and in the air.





## **17.3 Domains and Kingdoms**

| Kingdom Characteristics |                                  |                                        |                                         |                        |                           |               |
|-------------------------|----------------------------------|----------------------------------------|-----------------------------------------|------------------------|---------------------------|---------------|
| Domain                  | Bacteria                         | Archaea                                | Eukarya                                 |                        |                           |               |
| Kingdom                 | Eubacteria                       | Archaebacteria                         | Protista                                | Fungi                  | Plantae                   | Animalia      |
| Example                 | Pseudomonas                      | D. radiodurans                         | Paramecium                              | Mushroom               | Moss                      | Earthworm     |
| Cell type               | Prokaryote                       |                                        | Eukaryote                               |                        |                           |               |
| Cell walls              | Cell walls with<br>peptidoglycan | Cell walls<br>without<br>peptidoglycan | Cell walls with<br>cellulose in<br>some | Cell walls with chitin | Cell walls with cellulose | No cell walls |
| Number<br>of cells      | Unicellular                      |                                        | Unicellular and multicellular           | Most<br>multicellular  | Multicellular             |               |
| Nutrition               | Autotroph or heterotro           |                                        | ph                                      | Heterotroph            | Autotroph                 | Heterotroph   |









# **17.3 Domains and Kingdoms**

# Viruses—An Exception

- A virus is a nucleic acid surrounded by a protein coat.
- Viruses do not possess cells, nor are they cells, and are not considered to be living.
- Because they are nonliving, they usually are not placed in the biological classification system.



# **Chapter Resource Menu**



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Biology

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biologygmh.com

**Glencoe Biology** Transparencies



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<u>Vocabulary</u>

Image Bank



Animation

Click on a hyperlink to view the corresponding lesson.



Chapter Diagnostic Questions



On what characteristics did Linnaeus base his system of classification?

A. red blood and bloodless
B. evolutionary history
C. behavior and habitat
D. body structure



Chapter Diagnostic Questions



What is the term for a named group of organisms?

A. genus B. family C. phylum D. taxon



Chapter Diagnostic Questions



Determine which scientific specialist studies classifications and identifies new species.

A. ecologist
B. evolutionary geneticist
C. systematist
D. biologist





Which was the first formal system of organizing organisms according to a set of criteria?

A. classification
B. nomenclature
C. systematics
D. taxonomy

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17.1 Formative Questions



# Which was a limitation of Linnaeus' system of classification?





A. It did not include evolutionary relationships.

- B. It did not use binomial nomenclature to name organisms.
- C. It identified and classified species based on natural relationships.
- D. It was based on morphology and behavior of organisms.



17.1 Formative Questions



# Which of these is the highest level of classification?

A. class B. family C. order D. phylum





Which branch of biology combines taxonomy with paleontology, molecular biology and comparative anatomy?

A. biotechnologyB. evolution

C. morphology D. systematics

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Llamas and Alpacas are classified as different species, yet they can interbreed and produce fertile offspring. For which species concept does this represent a limitation?

A. biological species concept
B. genetic species concept
C. phylogenic species concept
D. taxonomic species concept





Which species concept defines a species in terms of patterns of ancestry and descent?

A. ancestral species concept
 B. evolutionary species concept
 C. phylogenic species concept
 D. typological species concept





Which inherited features are *not* used by scientists to construct patterns of evolutionary descent?

A. analogous characters
B. biochemical characters
C. homologous characters
D. morphological characters





Which task will require collaboration among systematists, molecular biologists, earth scientists and computer scientists?

A. Creating a comprehensive molecular clock.
B. Constructing a comprehensive tree of life.
C. Developing a dichotomous all known species.
D. Properly naming all known organisms.





The five-kingdom classification system had to be changed to a three-domain, six-kingdom system because of the discovery of \_\_\_\_\_.

A. fungi
B. protists
C. archaebacteria
D. prokaryotes





Which is a characteristic of the species classified in Domain Archaea?

A. They are anaerobic.
B. They are autotrophic.
C. They are extremophiles.
D. Their cell walls contain peptidoglycan.





Which kingdom contains heterotrophic, multicellular eukaryotes?

A. Animalia
B. Fungi
C. Plantae
D. Protista





Which cell wall material distinguishes all of the organisms in Kingdom Plantae?

A. cellulose
B. chitin
C. hyphae
D. peptidoglycan





Which group of dissimilar organisms were placed into the same kingdom partly because they don't fit into any other kingdoms?

A. eubacteria
B. eukaryotes
C. fungi
D. protists



Chapter Assessment Questions

What does this image represent?

A. phylogeny of species
B. molecular clock
C. cladogram
D. tree of life

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Chapter Assessment Questions

CheckPoint

What do the colored bands in the figure represent?

A. mutations
B. molecular clock
C. time
D. gene



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Chapter Assessment Questions



Which is not one of the three domains?

A. Archaea B. Bacteria C. Eukarya D. Fungi



Standardized Test Practice



For which organism would it be best for scientists to use the scientific name rather than the common name?

A. great blue heron
B. bottlenose dolphin
C. sea horse
D. whitetail deer



Standardized Test Practice



Which pair of organisms is more closely related?

- 1. Quercus alba
- 2. Cornus alba
- 3. Quercus rubra

A. 1 and 2 B. 2 and 3 C. 1 and 3

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#### Standardized Test Practice



How do systematists use this model to determine the degree of relationship among species?





#### Standardized Test Practice



- A. It shows the chromosomal structure of different species.
- B. It shows the genetic makeup of a common ancestor.
- C. It shows the rate of mutation for different species.
- D. It shows the relative time of divergence of a species.



Standardized Test Practice



Which two groups share the most derived characters?

A. sponges and cnidarians
B. arthropods and echinoderms
C. arthropods and chordates
D. echinoderms and chordates



Standardized Test Practice



Why aren't mushrooms classified as plants?

- A. They are heterotrophs.
  - B. They don't have cell walls.
  - C. They don't absorb nutrients from their environment.
  - D. They lack motility—the ability to move.



## **Glencoe Biology** Transparencies





## Vocabulary

# Section 1

- Classification
  - taxonomy
  - 🕑 binomial
    - nomenclature
  - taxon
  - ) genus
  - ) family

order
class
phylum
division
kingdom
domain



### Vocabulary

# Section 2

- e phylogeny
- Character
- molecular clock
- Cladistics
- cladogram



## Vocabulary

# Section 3

- 🕣 eubacteria
- Archaea
- eprotist
- 🕣 fungus


## Animation



## Visualizing the Tree of Life

