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Introduction to Phylogenetic Kingdoms

- **Monera** (Eubacteria and Archaeobacteria) - Prokaryotes, with or without peptidoglycan in cell walls
- **Protistia** - Eukaryotes, diverse, not fungi, plants, or animals
- **Fungi** - Eukaryotes, multicellular (except yeasts), heterotrophic, chitin in cell walls
- **Plantae** - Eukaryotes, multicellular, non-motile, autotrophic, cell wall containing cellulose
- **Animalia** - Eukaryotes, multicellular, motile, heterotrophic, no cell wall



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Introduction to Phylogenetic Kingdoms

In our previous presentation about phylogenetic classification, we introduced classifying organisms under a broad three-domain system versus classifying organisms using a five, six, or more kingdom approach. For the purpose of this discussion, we will refer to the traditional five-kingdom system. Organisms are divided into each of five kingdoms based on defining characteristics, such as: cell type; cell structures; whether the organism is unicellular, multicellular, or has both forms; and nutrition. As new information is gathered, classifying approaches are constantly being refined.

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Where Do Viruses Fit?

- Not “alive”?
- Not a cell
- Nucleic acids in protein shell
- Do not grow, do not maintain homeostasis, and do not metabolize on their own
- Use host cell to replicate
- Lytic and Lysogenic life cycles



Early Stage of
Influenza Virus



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Where Do Viruses Fit?

By themselves, viruses do not have all the characteristics of living organisms and are not considered “alive” by most definitions. Viruses are not cells, but consist of single or double stranded RNA or DNA surrounded by a protein shell called a capsid. The two major shapes of viruses are helical and polyhedral. Some viruses also have a protein/lipid outer membrane or envelope surrounding the capsid. Viruses do not grow, maintain homeostasis or metabolize on their own.

The structure and replication mode of viruses varies widely; however, all viruses can multiply only within a host cell (including bacteria). Phages (viruses that infect bacteria) are the best understood of all viruses and research has led to the discovery that some double stranded DNA viruses are able to reproduce using two alternative processes, the lytic and the lysogenic cycles. In the lytic cycle, the virus attaches to the host cell, injecting its DNA. The viral nucleic acid directs the host to produce new viral DNA and phage proteins. After assembly, new viral offspring particles are released when the host cell disintegrates, or “lyses.” In the lysogenic cycle, viral genomes remain dormant for long periods of time inside the host cell.

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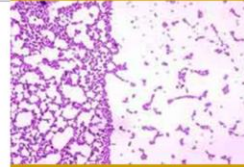
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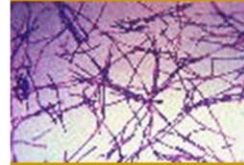
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The Kingdom Monera - Eubacteria

- Common name: Bacteria
- Unicellular prokaryotes
- No introns in genome
- Peptidoglycan in cell wall
- Basic shapes are cocci, bacilli, spirilla
- Diverse nutrition and respiration
- Reproduce by binary fission, conjugation, transformation, and transduction



Streptococcus mutans
(can cause endocarditis and dental caries)



Bacillus anthracis
(spores can live in soil for years)



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The Kingdom Monera- Eubacteria

Bacteria are the most numerous and ancient life forms found on Earth. They can live in places normally found inhospitable to other organisms (too cold, too dark, too hot, etc.). Bacteria are unicellular organisms that do not contain a nucleus or internal compartments, and their genome does not contain introns. Most species of bacteria can be assigned to two groups, based on the amount of peptidoglycan found in their cell walls. Bacteria with a thick layer of peptidoglycan in their cell walls are called “gram-positive” because they retain a blue color after staining (following a technique developed by Christian Gram.) Bacteria with a thin layer of peptidoglycan sandwiched between other layers stain orange-red following the same procedure and are called “gram-negative.” The three most common shapes of bacteria are spherical (cocci), rod (bacilli), and helices (spirilla).

The number of ways that bacteria can obtain nutrition and respire contributes to their ability to inhabit so many diverse places on Earth. To obtain energy and carbon, bacteria can be photoautotrophic– harness light energy to drive metabolic processes and use CO₂ as a carbon source, while others are chemoautotrophic– oxidize inorganic substances for energy and use CO₂ as a carbon source, photoheterotrophic– use light to generate energy but obtain carbon from other organic molecules, or chemoheterotrophic– consume organic molecules for both energy and carbon. The chemoheterotrophs include saprobes, decomposers that absorb their nutrients from the body fluids of living hosts. Bacteria also form many diverse symbiotic relationships with other organisms.

Bacteria exhibit wide variation in their use of oxygen and can be classified based on their dependence upon it. Obligate aerobes must have oxygen for cellular respiration; facultative anaerobes use oxygen if it is present, but also can grow by fermentation in an anaerobic environment. Obligate anaerobes can not tolerate oxygen at any level.

Bacterial reproduction normally occurs asexually by binary fission. Bacteria do have the ability to transfer genes or segments of genes, and they do so using three mechanisms: conjugation, transformation and transduction. Conjugation involves the direct transfer of genetic material between prokaryotes. In transformation, the cells absorb fragments of DNA from the surrounding environment (even from other species). Transduction occurs when bacterial viruses play a role in transferring genetic material between prokaryotes.

These abilities, along with a rapid reproductive rate, leaves little surprise as to why bacteria are “masters” of change and adaptation.

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The Kingdom Monera - Archaeobacteria

- Cell wall does not contain peptidoglycan
- Cell membrane contains unusual lipids not found in other organisms
- Genes are interrupted by introns
- Classified into three groups:
 - Methanogens – poisoned by O₂
 - Thermophiles – live in extreme temps.
 - Halophiles – live in high saline



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The Kingdom Monera- Archaeobacteria

A research team led by Carl Woese at the University of Illinois, first recognized the distinction between bacteria and archaea, also known as archaeobacteria. By analyzing RNA in subunits of ribosomes, they defined the early branching of the prokaryotes into Archaea and Eubacteria. In addition to their unique composition of ribosomal RNA, archaea also are distinguished by the lack of peptidoglycan in their cell walls and their unusual membrane lipids not found in other organisms. Unlike traditional bacteria, archaeobacterial genes contain introns similar to those found in eukaryotes.

Archaea live in the most extreme or harsh environments on Earth and are classified based on the environment in which they can be found. Methanogens produce energy from organic compounds in the presence of carbon dioxide, nitrogen and water. They produce methane and can not live in an oxygen-containing environment. Thermophiles live in very hot water found in areas around hot springs and ocean hydrothermal vents, and Halophiles are found in water with a high saline content, like the Great Salt Lake in Utah.

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Ecological Importance of Prokaryotes

- Decomposition
- Nitrogen fixation
- Mutualistic relationships
- Parasitic relationships
- Commercial uses



Treponema pallidum,
a spiral-shaped
bacteria which
causes Syphilis in
humans



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Ecological Importance of Prokaryotes

The majority of bacteria are not harmful and, in many cases, are beneficial to survival. Prokaryotes are the decomposers of the Earth. Many prokaryotes obtain energy by breaking down organic molecules and, in the process, make nutrients available for use by other organisms. Prokaryotes are the only organisms to metabolize inorganic nutrients such as sulfur, iron and nitrogen. Nitrogen recycling, or nitrogen fixation, is unique to Prokaryotes and is the only biological mechanism that makes atmospheric nitrogen available for the production of organic compounds. Mutualistic bacteria live inside our intestines aiding in digestion while other bacteria suppress the growth of yeasts and other microbes by altering pH levels in our body.

In the late 1800s, Louis Pasteur and other scientists linked bacteria to disease. Robert Koch was the first to identify the organisms that cause tuberculosis and anthrax. Since then, other pathogenic prokaryotes have been identified and linked to diseases, such as Lyme's disease, tetanus, cholera, diarrhea, botulism and syphilis. In industry, bacteria have been used in bioremediation and as metabolic "factories" that produce acetone as well as pharmaceuticals like insulin and antibiotics. Bacterial metabolic abilities are useful in separating sulfur compounds from copper and uranium in mining low grade ores.

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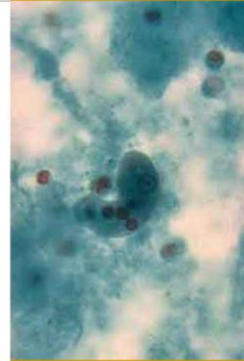
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The Kingdom Protista or Protoctista

- A classification problem
- Unicellular, colonial, and multicellular forms
- Autotrophic and heterotrophic
- Some move with flagella, pseudopods or cilia
- Animal-like, plant-like and fungus-like groups
- Reproduce by mitosis and meiosis



Entamoeba histolytica



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The Kingdom Protista or Protoctista

Members of the microbial kingdom Protista originally were defined by structure (mainly unicellular eukaryotes) and by the difficulty to classify them as either plant, fungi or animal. More recently, the concept of protists was expanded to include certain multicellular organisms such as kelp (Copeland, 1956). Thus defined, members of Protoctista range from microscopic one-celled organisms like dinoflagellates, to multicellular organisms, like seaweed. To untangle this confusing kingdom, biologists now are turning to molecular analysis.

When following the traditional five- or six-kingdom classification, the Protist group contains all eukaryotes that are not fungi, plants or animals. There are unicellular, colonial, and multicellular forms, some of which show cell specialization. Protists groups include both autotrophs and heterotrophs, some of which function as detritivores.

Animal-like groups are often referred to as Protozoans. The term Protozoa dates back to when members of this group were considered “first animals.” Plant-like forms are generally called algae.

Traits such as method of motility, presence or absence of a shell, manner of obtaining nutrition, and reproducing, are used to categorize and discuss this diverse group, but it is important to remember that these traits do not necessarily reflect evolutionary history. Recent work suggests that green and red algae are more closely allied with land plants, and that slime molds are more closely allied to animals (Baldauf, et al. 2000).

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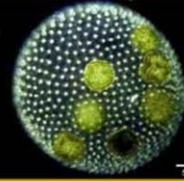
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Ecological Importance of Protists

- Important foundation in food chain
- Produce vast amount of O₂
- Decomposition
- Symbiotic relationships
 - Mutualistic
 - Parasitic
- Medicinal and Industrial Uses



Volvox
Colonial green alga



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Ecological Importance of Protists

Protists form a broad base across the bottom of the food chain, and they supply approximately one-half of the world's oxygen (unicellular algae compose a large portion of the world's phytoplankton). Protists, along with bacteria and fungi, are responsible for decomposing and recycling nutrients.

Many protists are helpful. *Euglena* are used to help treat sewage because of their unique ability to switch from an autotrophic to a heterotrophic nutritional mode, helping to maintain oxygen levels in the balance. Another helpful protist is *Trichonympha* which lives in the digestive system of termites and produces cellulase, an enzyme that enables termites to digest wood.

Animal-like protists are responsible for diseases such as malaria, amoebic dysentery, toxoplasmosis, African Sleeping Sickness and Giardiasis in humans. Some protists dramatically have affected human history. *Phytophthora infestans*, a water mold, destroyed potato crops throughout Ireland in the 1840s, leading to the Great Potato Famine and the eventual migration of large numbers of people into the United States.

Some protists have medicinal and industrial uses. Carrageenan, from algae, is used to produce a thickening agent in ice cream, pudding, and candy. Chemicals from algae are used to manufacture waxes, plastics, paints and lubricants. Other chemicals made from Protists are used in treatment of ulcers, high blood pressure, and arthritis.

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The Kingdom Fungi

- Eukaryotic
- Cell walls contain chitin
- Multicellular, except for yeasts
- Heterotrophic
- Main body multicellular fungi composed of hyphae
- Sexual and asexual reproduction



Puffball
Drops of rain trigger the release of spores



Pholiota spp
Degrades wood very quickly



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The Kingdom Fungi

Members of the kingdom Fungi are eukaryotic, heterotrophic, multicelled organisms (except for yeasts). Examples of fungi are “mushrooms,” puffballs, bracket fungi, molds, and mildews. Fungi cell walls contain chitin, which is the same material found in the exoskeletons of arthropods. Fungi are important decomposers in ecosystems as they break down organic materials such as dead organisms, leaves, old wood, and feces.

The body of the multicellular fungi consists of long, slender hyphae, some of which can specialize to hold spores, to anchor its body, to secrete enzymes, and to absorb decomposing material. Fungi break down potential food sources by excreting strong hydrolytic enzymes (exoenzymes). Once the food is broken down into smaller molecules, the fungi then absorb them into their bodies.

Fungi are generally described and grouped according to the way they reproduce. Reproduction can be both sexual and asexual, producing spores that disperse by wind or water.

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Ecological Importance of Fungi

- Decomposers
- Symbiotic
 - Parasitic
 - On plants
 - On animals
 - Mutualistic
 - Lichens
 - Mycorrhizae



Epidermophyton floccosum,
fungi causing
athlete's foot



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Ecological Importance of Fungi

As major decomposers, fungi serve an important role in ecosystems. Without decomposition, there would not be enough available nutrients to sustain or create new life.

Many fungi are parasites and thrive on living things, which is an association harmful to the host. Fungi cause plant diseases such as black spot, corn smut, wheat rust, and mildews that affect a variety of fruits. Most of us are familiar with fungi that cause human discomforts like athlete's foot, ringworm, and thrush.

Other kinds of fungi live together in a mutually beneficial relationship with other organisms. Lichens are symbionts of a fungus and a green algae, or a cyanobacterium. Mycorrhizae are mutualistic relationships between fungi and the roots of vascular plants. Fungi cells supply the plant with more nutrients and water than normally would be absorbed by the roots alone, and the plant provides the fungus with products of photosynthesis.

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The Kingdom Plantae

- Multicellular, non-motile, cell wall with cellulose, mostly autotrophic
- Plant life cycles
- Plant Structures relate to plant needs
 - Sunlight, water and minerals, gas exchange,
 - Reproduce without water to transmit male gamete (in Angiosperms)
 - Vascular tissue, roots, stems, leaves, seeds, flowers



Sunflowers in
Fargo, North Dakota



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The Kingdom Plantae

In the five-kingdom classification system, Plantae refers to green plants, excluding the green algae. The Kingdom Plantae includes the mosses, seed ferns, conifers, flowering plants and related groups. Plants are multicellular organisms that develop from embryos. Plants have cellulose in their cell walls that gives strength and structural support, and use chlorophyll *a* and *b* to transfer energy from the sun to chemical energy, a process called photosynthesis.

In the life cycle of plants, the two multicellular body forms, the gametophyte (1n) and sporophyte (2n), alternate. The predominant form and pattern of this cycle is a key characteristic of differing plant groups.

Plants are adapted primarily for life on land and have had to overcome problems of water loss and transport. Various groups of plants approach the problem of reproduction, support and transport with ingenious adaptations of vascular tissue, roots, stems, leaves, pollen, seeds, fruits, and flowers.

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Major Groups of Plants

- Three traditional groupings:
 - Bryophytes – nonvascular plants
 - Pteridophytes – vascular, seedless plants
 - Seed plants
 - Gymnosperms
 - Angiosperms



Ginkgo biloba

Ginkgos are often very long-lived. Some specimens are thought to be more than 3,500 years old.



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Major Groups of Plants

The Plant Kingdom is often separated into bryophytes (mosses and liverworts), pteridophytes (ferns), and seed plants. Seed plants are divided further into two groupings, gymnosperms and angiosperms. Gymnosperms are the cone-bearing plants such as pines and conifers. Angiosperms are the flowering plants, which are traditionally divided into monocots or dicots.

Bryophytes are plants that lack vascular tissue, true roots, stems, and leaves. They reproduce by dispersing large amounts of spores. These plants are small because of water transport problems, and they depend on diffusion and osmosis for movement of materials throughout the plant. The gametophyte (1n) generation is predominant. Examples of bryophytes are mosses, hornworts, and liverworts.

Pteridophytes have conducting tissue for nutrients, water and the products of photosynthesis. In this group, the sporophyte (2n) generation is dominant. The spores of these plants are resistant to drying. Examples include ferns, club mosses, and horsetails.

Evolution of the seed allowed plants to move further away from water, and to tolerate harsher climates. The seed offered new survival advantages for the embryo, such as protection, nourishment, dispersal, delayed growth.

Gymnosperms include pines, junipers, cycads, and ginkgoes. The gymnosperm seed, often described as “naked,” is not enclosed in a fruit. Wind dispersal of pollen means that large amounts of seeds are needed to insure fertilization. In the gymnosperms, the sporophyte (2n) generation is predominant.

Angiosperms are flowering plants that produce seeds surrounded by a fruit barrier. What we think of as fruit is actually a mature ovary. Fruits are classified as simple (like an apple), aggregate (like a strawberry), or multiple (like a pineapple). The most recent group to evolve, angiosperms produce pollen and seeds. Angiosperms are traditionally divided into two groups, monocots and dicots, but scientists are now considering adding a third group, the eudicots. Some examples of monocots are lilies, orchids, yuccas, grasses, and grain crops. Examples of dicots are oaks, maples and sycamores. Eudicots are sometimes referred to as euangiosperms and are classified based mainly on their pollen structures. Recently, phylogenetic analyses, based on both structural data and molecular sequences, have begun to unravel higher-level phylogenetic relationships within the eudicot group. Eudicots make up approximately 75% of all existing angiosperms.

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Importance of Plants to Humans

- Food source – Wheat, grains, fruits, vegetables
- Medicine – Aspirin, cancer treatments, stimulants
- Industry – Agriculture, wood products, cotton



Sugercane



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Importance of Plants to Humans

Animals, fungi and some protists, and bacteria are dependent on plants for food and oxygen. Humans have used plants for medicinal purposes since the emergence of the human mind, from about 1 million to 100,000 years ago. Today, medicines from plants include heart medications, pain relievers, decongestants, stimulants, and drugs for treatment of cancer.

Plants provide raw materials for construction and many kinds of manufacturing. Industrial uses for plants are numerous; for example, agriculture is a vital industry throughout the world, and wood is the next most valuable resource. Just stop for a minute and think of all the products made from wood: paper, rayon, cabinets, guitars, toys, framework for houses, just to name a few. Wood still is used as fuel for heating and cooking in many parts of the world. Cotton is one of the world's most important fibers.

It is important to think about plant diversity and the problem of extinction. Many plants are lost every day to exploding human populations and to the destruction of natural habitats to make room for human settlements. According to E.O. Wilson, a leading voice for the preservation of biodiversity, ninety-nine percent of all species that ever lived are now extinct. "An awful symmetry of another kind binds the rise of humanity to the fall of biodiversity: the richest nations preside over the smallest and least interesting biotas, while the poorest nations, burdened by exploding populations and little scientific knowledge, are stewards of the largest," he said. Wilson wrote that biological diversity is the key to the maintenance of the world as we know it.

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The Kingdom Animalia

- No cell wall
- Heterotrophic
- Motile
- Sexual reproduction
- Three distinct layers of tissues (except sponges)
- Multi-celled/specialized tissues and functions
- Distinct body plan



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The Kingdom Animalia

Animals are heterotrophic, which means they rely directly or indirectly on other organisms for their nourishment. Animals are multicellular organisms, and unlike plants, their cells do not have cell walls. All animals are motile at some time in their life, some even from the moment of birth. While a few animal groups are able to reproduce asexually, most reproduce sexually. Most animals are diploid, and the cells of adults contain two copies of the genetic material. Embryological development in animals is characterized by distinct stages. Following fertilization, the first divisions of the cell forms what is called a zygote. After one hundred or so mitotic divisions, the hollow ball of cells develops into a blastula. When the blastula folds in on itself, it forms a double-walled structure, the gastrula, that has an opening to the outside called the blastopore. The inner layer of the gastrula becomes the endoderm, or the digestive tract. The outer layer usually develops into the ectoderm, or the nerve and epidermal cells of the adult. A third layer is the mesoderm, which develops into the other internal organs.

Animals have their own body plan, or symmetry, and internal organization. While sponges are asymmetrical, virtually all other animals exhibit radial or bilateral symmetry. The Cnidarians (hydras, jellies, coral polyps, and sea anemones) and Ctenophora (comb jellies) include radially symmetric animals. Bilateral symmetry is associated with cephalization.

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Invertebrates and Vertebrates

- Invertebrates
 - 99% of the Animal Kingdom
 - Absence of backbone
 - Includes sponges, cnidarians, mollusks, worms, arthropods, and echinoderms
- Vertebrates
 - Internal skeleton (bone or cartilage)
 - Includes fish, amphibians, reptiles, birds, and mammals



Asian ladybeetle
Harmonia axyridis

Notice the “false”
white eye markings
behind the head.



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Invertebrates and Vertebrates

The kingdom Animalia has traditionally been divided into two groups, the invertebrates and the vertebrates. Invertebrates constitute approximately ninety-nine percent of the Kingdom Animalia, and the largest group of all the animals is the Arthropods. Invertebrates are a large and diverse group of animals, characterized by the absence of a backbone. Parazoa, or sponges, are considered the most ancient invertebrates. The remainder of invertebrates fall into the Eumetazoa that includes all animals with true tissues.




Vertebrates include animals with an internal skeleton, which includes a vertebral column that surrounds and protects the spinal cord and a cranium which protects the brain. Vertebrates have a distinctive endoskeleton made up of an axial and appendicular skeleton. Vertebrates may not comprise the majority of the members of the Kingdom Animalia, but they are the most well-known and most recognized animals in the Kingdom.

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<h2 style="text-align: center;">Invertebrate Animals I</h2> <hr/> <ul style="list-style-type: none"> ■ Sponges ■ Cnidarians ■ Worms ■ Mollusks ■ Arthropods ■ Echinoderms 	 <p style="text-align: center;">Colony of sponges</p>  <p style="text-align: center;">Chambered Nautilus</p>
 BioEd Online	

Invertebrate Animals I

Sponges have specialized cells that allow them to digest and reproduce sexually. They are sessile (non-motile) as adults but have a larval form that is able to swim. Of all the animals, sponges least have the appearance of an “animal” and for a long time were classified with plants.

Cnidarians (sea anemones, jellyfish, coral, sea fans, and hydra) are mostly marine organisms. Many are characterized by special “stinging cells.” They have two body forms, the medusa and polyp.

The **worms** include the flatworms (planaria, tapeworms, flukes), roundworms (hookworms, *Trichinella*) and segmented worms (earthworm, polychetes). In general worms have long tubular bodies. Many forms of worms are free-living but others are parasitic. The roundworms are the first group to exhibit a “mouth to anus” digestive system. The Annelids are segmented and have a true coelom (body cavity), and exhibit organ systems.

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Earthworm Inquiry Activity

- Students list information they think they know about the earthworm
 - Opportunity to assess prior knowledge and identify misconceptions (you should guide students to correct these during the activity)
- Students spend some time observing live earthworms
 - Ask probing questions
 - Record observations
- Students formulate questions they have about some of the observations they have made
- Students design an investigation to answer their questions
- Students carry out their investigation
- Students write reflections dealing with the entire process in their journal



Invertebrate Animals II

- Sponges
- Cnidarians
- Worms
- Mollusks
- Arthropods
- Echinoderms



Ixodes scapularis
Deer tick



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Invertebrate Animals II

The **mollusks** have a soft body and, usually, either an internal or external shell. This group includes Bivalves (clams, oysters), Gastropods (snails, slugs), and Cephalopods (octopuses, squid, nautilus). Mollusks have a visceral mass, mantle, foot, and most respire with gills.

Arthropods are found in almost all habitats in our biosphere, and they are the most numerous and successful of all members of the Animalia phyla. Arthropods have jointed appendages, an exoskeleton, and a segmented body plan. They usually are classified by structure and number of body segments and appendages. Chelicerates (spiders and scorpions), Crustaceans (shrimp, barnacles, crayfish), and Uniramians (insects, ticks, mites) are the major groups within this phylum.

Echinoderms (star fish, sea urchins, sand dollars) have pentaradial symmetry, spiny skin, and a water vascular system.

References

Campbell, N. E. & Reece, J. B. (2002) *Biology* (6th ed.). Benjamin Cummings.

Image Reference

Bauer, S. *Adult deer tick, Ixodes scapularis*. USDA Agricultural Research Service. Retrieved 12-11-2006 from <http://www.ars.usda.gov/is/graphics/photos/>

Vertebrate Animals

- Chordates
- Fish
 - Agnatha (jawless fish/lamprey)
 - Chondrichthyes (sharks, skates, rays)
 - Osteichthyes (bass, tuna, salmon)
- Amphibians
- Reptiles
- Birds
- Mammals



Ardea herodias
Great Grey Heron



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Vertebrate Animals

A chordate is an animal that has a dorsal, hollow nerve cord, a notochord, pharyngeal pouches, and tail that extends beyond the anus at some time in its life cycle. Of the chordates, only the tunicates and lancelets are non-vertebrates. A vertebrate has an endoskeleton, bilateral symmetry, cephalization, a closed circulatory system and a chambered heart.

Fish have two chambered hearts, gills, and most have scales. The evolution of jaws and paired fins were key developments in the evolution of fish. Bony fish are the most abundant in the vertebrate group.

Most **amphibians** (which means “double life”) undergo metamorphosis from an aquatic larva to terrestrial adults with lungs and a three-chambered hearts, but remain “tied” to the water in order to reproduce. The three major groups are the salamanders, frogs and toads, and caecilians.

Reptiles are ectothermic, meaning they must use environmental energy and have behavioral adaptations to regulate their body temperature. Reptiles are characterized by scales, lungs, and they produce an amniote egg which can be laid on dry land. The major groups are snakes and lizards, crocodylians, turtles and tortoises.

Birds are endothermic, which means they use their own metabolic energy to maintain a constant body temperature. Birds have wings, feathers and four chambered hearts. Almost every part of birds’ bodies are structured so they can achieve flight. Their bones are honeycombed to reduce weight; they have an active metabolism to compensate for the energy expended during flight; and even their lungs are designed to reduce weight and maximize heat loss. Birds have complex behaviors such as nest building, migration, and courtship.

Mammals are endothermic animals with hair. They nourish their young with milk. The three groups are monotremes (duck-billed platypus), marsupials (kangaroo, koalas), and placentals (seals, tigers, humans).

References

Campbell, N. E. & Reece, J. B. (2002) *Biology* (6th ed.). Benjamin Cummings.

Image References

Bauer, S. *Great Grey Heron*. USDA Agricultural Research Service. Retrieved 12-11-2006 from <http://www.ars.usda.gov/is/graphics/photos/>

Introduction to Phylogenetic Kingdoms Comparison Activity

- Directions:
 - Label Kingdoms
 - Write characteristics and examples of organisms found within each Kingdom on “self-sticking” note paper
 - Divide class into groups/give each a set of “sticky notes” to sort
 - Students place notes with characteristics under the appropriate Kingdom
 - Review and discuss the results as a class



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The **objective** of this activity is for *Options* students to identify at least 4 major attributes and 3 examples of organisms of each of the kingdoms, as a part of the review for the TEXES biology exam. Embedded within this activity are opportunities for *Options* students to observe and identify several instructional strategies to use in the high school biology classroom.

Overview of Comparison Activity:

Begin the activity by listing each of the kingdoms (for simplicity, we used a traditional five kingdom system). Using “flip chart” paper, poster board, or chalk board space, place a label for each kingdom around the room. Divide the class into groups or teams and give each a zip-lock bag with a variety of characteristics and examples from the different kingdoms written on “self-stick removable” notes. Teams can use existing knowledge or references you specify to place “sticky” notes from their bag under the appropriate kingdom label (for example, “cell wall with chitin” would be placed under Kingdom Fungi). As teams finish, they should move from kingdom to kingdom and see what characteristics have been placed under each and make a list of things they disagree with or have questions about. To conclude the activity, discuss the attributes of each kingdom, make corrections, and draw conclusions.

Options Students Participate in Comparison of Phylogenetic Kingdoms Activity

- Distribute materials
- Sort and discuss
- Arrange under the correct category
- Review choices
- Discuss and expand



Thank You

- This concludes a survey of representative organisms in each of the kingdoms of life.

