CHAPTER 7

BIOLOGICAL DIVERSITY

Means

BIODIVERSITY

How are Organisms Named and Classified?

- **Organisms are placed into categories on the basis of their evolutionary relationships.**
- **These categories form a nested hierarchy in which each level includes all the ones before it.**
- **There are eight major categories:**
  - **Domain, kingdom, phylum, class, order, family, genus, species.**

How are Organisms Named and Classified?

Table 16-1 Classification of Selected Organisms, Reflecting Their Degree of Relatedness*

	Human	Chimpanzee	Wolf	Fruit Fly	Sequoia Tree	Sunflower
Domain	**Eukarya**	**Eukarya**	**Eukarya**	**Eukarya**	**Eukarya**	**Eukarya**
Kingdom	**Animalia**	**Animalia**	**Animalia**	**Animalia**	**Plantae**	**Plantae**
Phylum	**Chordata**	**Chordata**	**Chordata**	Arthropoda	Coniferophyta	Anthophyta
Class	**Mammalia**	**Mammalia**	**Mammalia**	Insecta	Coniferosida	Dicotyledoneae
Order	**Primates**	**Primates**	Carnivora	Diptera	Coniferales	Asterales
Family	Hominidae	Pongidae	Canidae	Drosophilidae	Taxodiaceae	Asteraceae
Genus	*Homo*	*Pan*	*Canis*	*Drosophila*	*Sequoiadendron*	*Helianthus*
Species	*sapiens*	*troglodytes*	*lupus*	*melanogaster*	*giganteum*	*annuus*

**Boldface categories are those that are shared by more than one of the organisms classified. Genus and species names are always italicized or underlined.*

How are Organisms Named and Classified?

- **The scientific name of an organism is a two-part name formed from the genus and species categories.**

- **Each genus includes a group of closely related species, and within each species are individuals that can interbreed.**

How are Organisms Named and Classified?

- **For example: The genus *Sialia* (bluebirds) includes similar birds (group of closely related species) that do not interbreed:**

  The eastern bluebird (*Sialia sialis*),

  The western bluebird (*Sialia mexicana*),

  The mountain bluebird (*Sialia currucoides*).

How are Organisms Named and Classified?

- **Three species of bluebird**

(a) Eastern bluebird

(b) Western bluebird

(c) Mountain bluebird

How are Organisms Named and Classified?

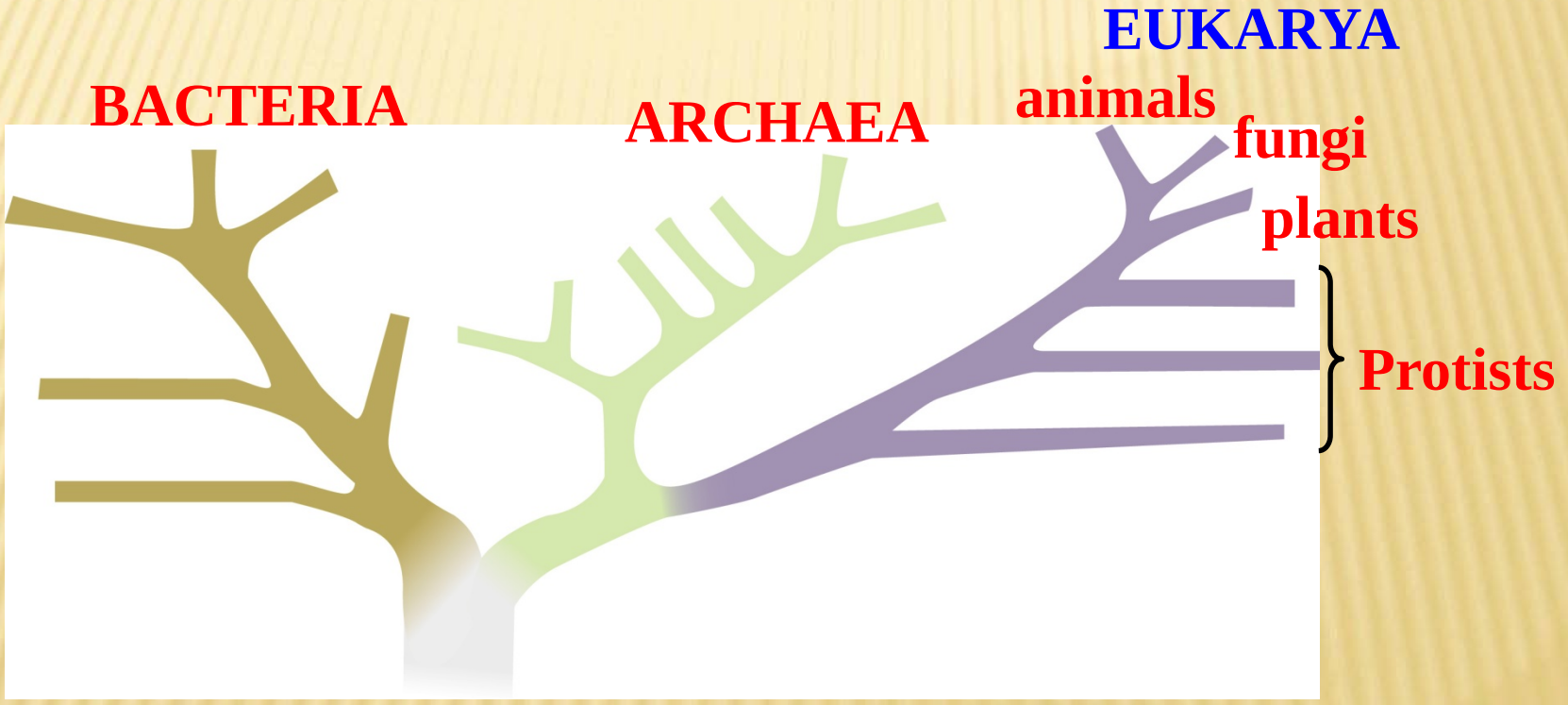
- **Each two-part scientific name is unique; referring to an organism by its scientific name rules:**
  - **Scientific names are underlined or *italicized*.**
  - **The first letter of the genus name is always capitalized, and the first letter of the species name is always lowercase.**
  - **The species name is never used alone but is always paired with its genus name.**

How are Organisms Named and Classified?

- **Biologists identify features that reveal evolutionary relationships.**
  - **Scientists must distinguish informative similarities caused by common ancestry from uninformative similarities that result from convergent evolution.**
  - **In the search for informative similarities, biologists look at many kinds of characteristics.**
    - **Anatomical similarities play a key role in classification.**
    - **Molecular similarities are also useful in classification.**

What Are The Domains of Life?

- The three domains: Bacteria, Archaea, and Eukarya.



What are The Domains of Life?

- **Kingdom-level classification remains unsettled.**
- **Biologists recognized:**
  - **15 kingdoms among the Bacteria.**
  - **3 kingdoms in the Archaea**
  - **4 kingdoms among the Eukarya, these are**

• **Animals**	• **مملكة الحيوانات**
• **Plants**	• **مملكة النباتات**
• **Fungi**	• **مملكة الفطريات**
• **Protists**	• **مملكة الأوليات**

Bacteria and Archaea

- Earth's first organisms were prokaryotes
  - In terms of abundance, prokaryotes are Earth's predominant form of life.
  - Prokaryotes include Bacteria and Archaea
  - They are single-celled microbes that lacked organelles such as a nucleus, chloroplasts and mitochondria.

Bacteria and Archaea

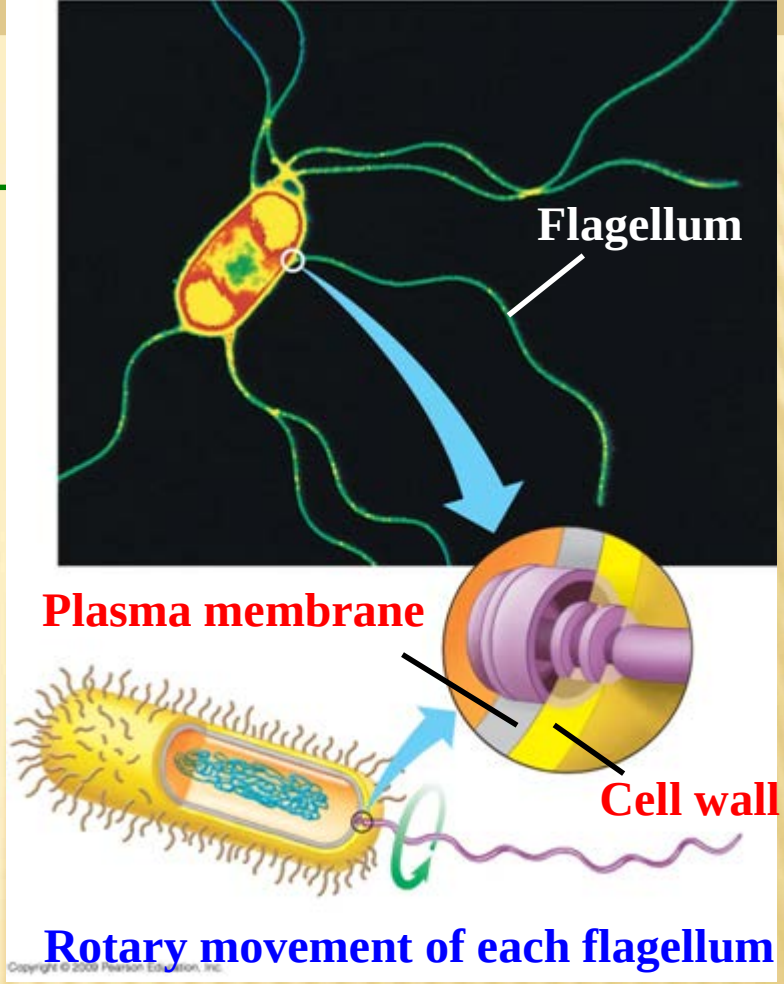
- **Bacteria and Archaea are fundamentally different.**
  - **Bacterial cells contain molecules of the polymer peptidoglycan, which strengthens the cell wall.**
  - **They also differ in the structure and composition of the plasma membrane, ribosomes, and RNA polymerases, as well as in the processes of transcription and translation.**

Bacteria and Archaea

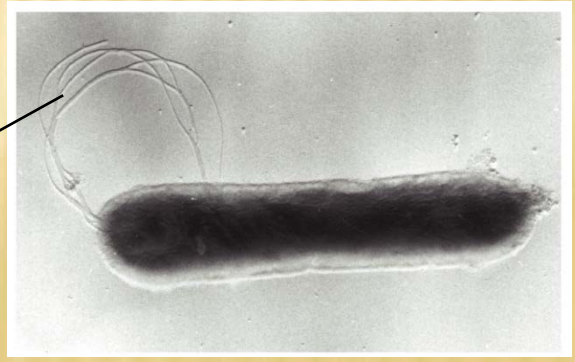
- The biochemical differences between archaea and bacteria make distinguishing the two domains easy.
- Classification within each domain is difficult.
- Prokaryotes have been classified on the basis of shape, means of locomotion, pigments, nutrient requirements, the appearance of colonies and staining properties.
- More recently, the comparisons of DNA and RNA nucleotide sequences have been used in prokaryotic classification.

Bacteria and Archaea

- **Some prokaryotes are mobile; some may have flagella.**
  - **Flagella can rotate rapidly and propel the organism through the environment.**



EM micrograph showing flagella



Bacteria and Archaea

- Protective endospores allow some bacteria to withstand adverse conditions.
  - The endospore forms within the bacterium, and contains genetic material and a few enzymes encased in a thick protective coat.
  - Metabolic activity ceases until the spore encounters favorable conditions, which may take an extremely long period of time.

Bacteria and Archaea

- **Prokaryotes are specialized for specific habitats.**
  - **Prokaryotes occupy virtually every habitat, including those where extreme conditions keep out other forms of life.**
  - **Many archaea can live in hot springs at temperatures up to 110°C; they can live at extreme pressures beneath the Earth's surface, and at very cold temperatures of the Antarctic.**
  - **They can live in the Dead Sea, with salt concentrations seven times those of the ocean.**

1-“Salt-loving” archaea
extreme halophiles

Archaea growing in seawater-evaporating ponds
The purplish color of the ponds (top of photo) is due to a unique photosynthesizer archaean (*Halobacterium halobium)* withy purple molecule that traps solar energy

2-“Heat-loving” archaea
extreme thermophiles

Orange and yellow colonies of extreme “heat-loving” archaea, thermophiles, growing in a Nevada geyser

Bacteria and Archaea

- **Prokaryotes exhibit diverse metabolisms.**
  - **Many prokaryotes are anaerobes; their metabolisms do not require oxygen.**
  - **Others are opportunistic, using anaerobic respiration when oxygen is absent and switching to aerobic respiration when oxygen is available.**

Bacteria and Archaea

- Prokaryotes feed on many things, including sugars, proteins and fats, but also petroleum, methane, benzene and toluene; some can use hydrogen, sulfur, ammonia, iron, and nitrate.

- Some prokaryotes possess chlorophyll and are photosynthetic.

Bacteria and Archaea

- Most prokaryotes reproduce asexually by binary fission.
  - They produce identical copies of the original cell.
  - They reproduce rapidly and can evolve quickly to adapt to changing conditions.

Bacteria and Archaea

- **Prokaryotes affect humans and other organisms.**
  - **Prokaryotes play important roles in animal nutrition.**
  - **Many animals that eat plants cannot digest the cellulose in plants themselves and rely on symbiotic bacteria in their digestive tracts, which are able to digest cellulose, to liberate nutrients from this food source.**

Bacteria and Archaea

- Many foods that humans eat are produced by the actions of bacteria, including cheese, yogurt and sauerkraut.

- Some bacteria in human intestines feed on undigested food and synthesize nutrients, such as vitamin K and vitamin B_{12}, which the human body absorbs.

Bacteria and Archaea

- **Prokaryotes are nature's recyclers.**
  - **Prokaryotes consume the organic molecules in the dead bodies of plants and animals, decomposing their wastes and recycling them to the environment.**
  - **Prokaryotes can clean up pollution.**

Bacteria and Archaea

- Nearly anything that human beings can synthesize can be broken down by some prokaryote, including detergents, toxic pesticides and harmful industrial chemicals.
- Even oil can be broken down by prokaryotes.
- The breakdown of pollutants by bacteria is called bioremediation.

Bacteria and Archaea

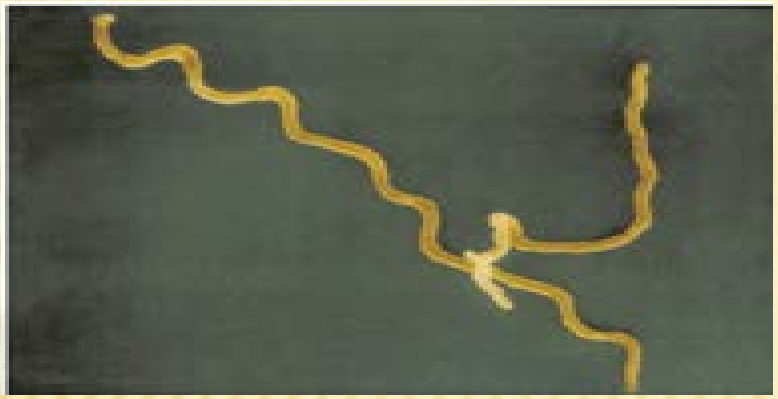
- **Some anaerobic bacteria produce dangerous poisons.**
  - **Some bacteria produce toxins that attack the nervous system.**
  - ***Clostridium tetani* causes tetanus (neck and muscle spasm).**
  - ***C. botulinum* causes botulism (lethal food poisoning).**

Bacteria and Archaea

- **Pathogenic (disease-causing) bacteria synthesize toxic substances that cause diseases in humans.**
  - **Bubonic plague ("Black death") killed 100 million people during the fourteenth century.**
  - **Tuberculosis, gonorrhea, syphilis and cholera are bacterial diseases long associated with humans.**
  - **Lyme disease, a bacterial disease transmitted by ticks to humans.**

Bacteria and Archaea

Spirochete that causes Lyme disease



Tick that carries Lyme disease bacterium

Bacteria and Archaea

- **Common bacterial species can be harmful.**
  - **Streptococcus causes strep throat.**
  - **Another causes pneumonia, which clogs the lungs with fluid.**
  - **A common bacterium of the human digestive tract, *E. coli* (*Escherichia coli*), normally is benign but can transform into a pathogenic form that can be transmitted from human to human.**

- **The *bacterium* that causes anthrax can be used as biological weapons**
- **Weaponizing anthrax involves manufacturing endospores that disperse easily in air, where they are inhaled and germinate in lungs**

Cleaning up after an anthrax attack in October 2001

Domain Eukarya

Domain Eukarya is divided into four kingdoms:

- **Protists (everything that doesn't fit into the other three kingdoms)**
- **Plants**
- **Fungi**
- **Animals**

Protists

- **The protists are eukaryotes that are not a plant, an animal, or a fungus.**
  - **Most protists are small and single-celled.**
  - **They are incredibly diverse in their modes of reproduction and in their structural and physiological innovations.**
  - **Some of the larger protists are colonies of single-celled individuals, while others are multicellular organisms.**

Protists

- **Protists have both positive and negative effects upon humans and other organisms.**
  - **The primary positive impact comes from the ecological roles of photosynthetic marine protists.**
  - **On the negative side are the many human diseases caused by parasitic protists.**

Protists

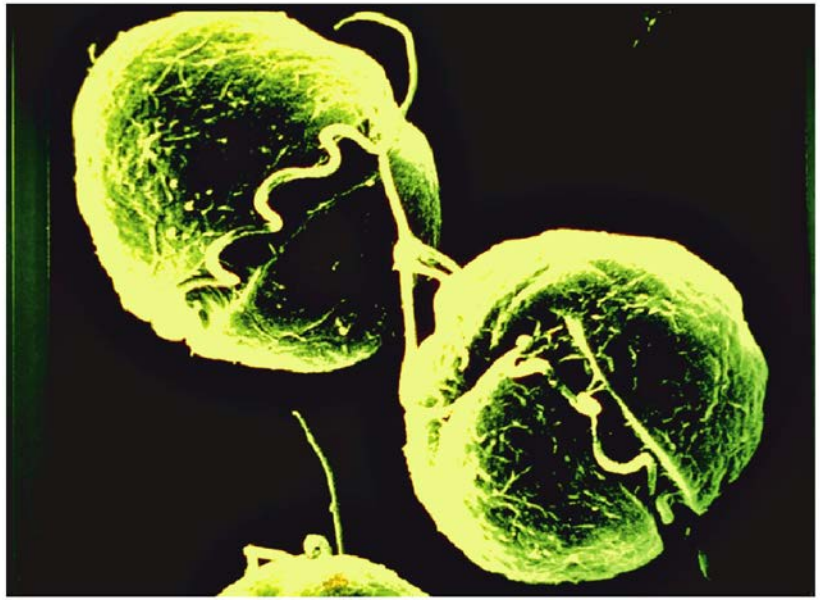
- **Brown algae dominate in cool coastal waters and form multicellular aggregations known as brown algae seaweeds.**

(a) *Fucus*

(b) Kelp forest

Protists

- **Alveolates** include parasites, predators, and phytoplankton.
  - **Dinoflagellates** are important components of the phytoplankton and are food sources for larger organisms.
  - Most dinoflagellates are photosynthetic and move with the use of their two whiplike flagella.



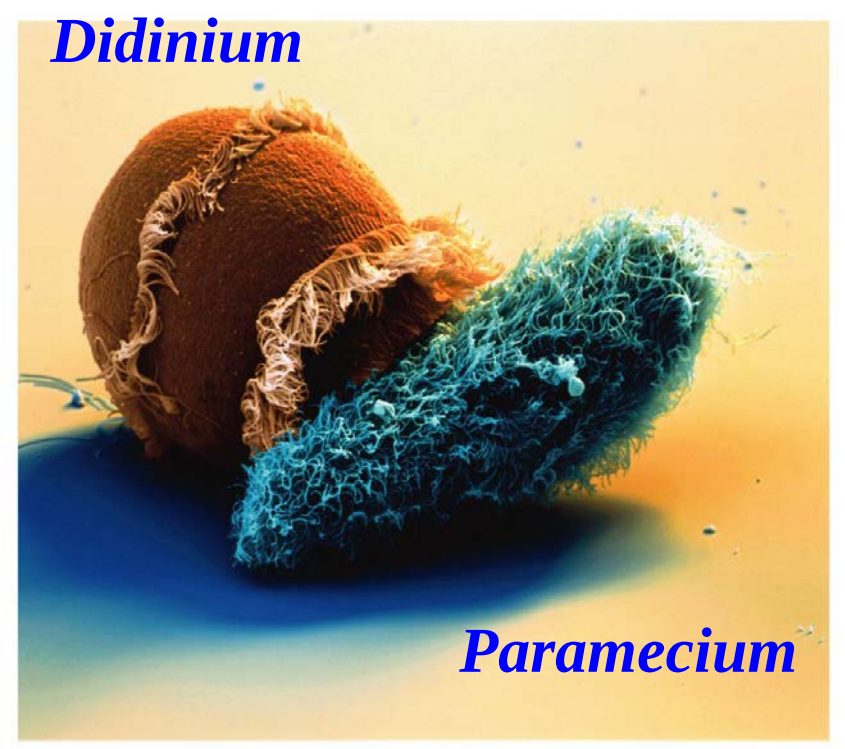
Dinoflagellates

Protists

- **Ciliates are the most complex of the alveolates.**

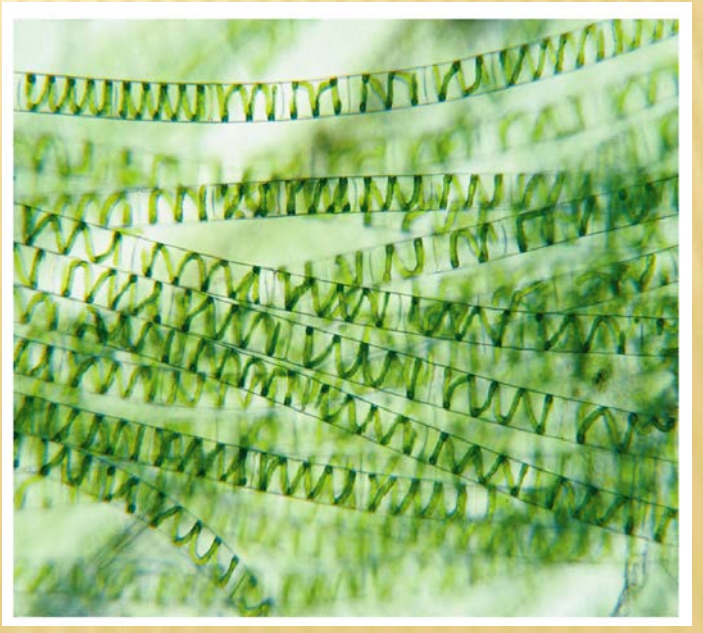
- **They possess hair-like outgrowths of the plasma membrane that are used for locomotion.**

- **Two examples are *Paramecium* and the predator, *Didinium*.**



Protists

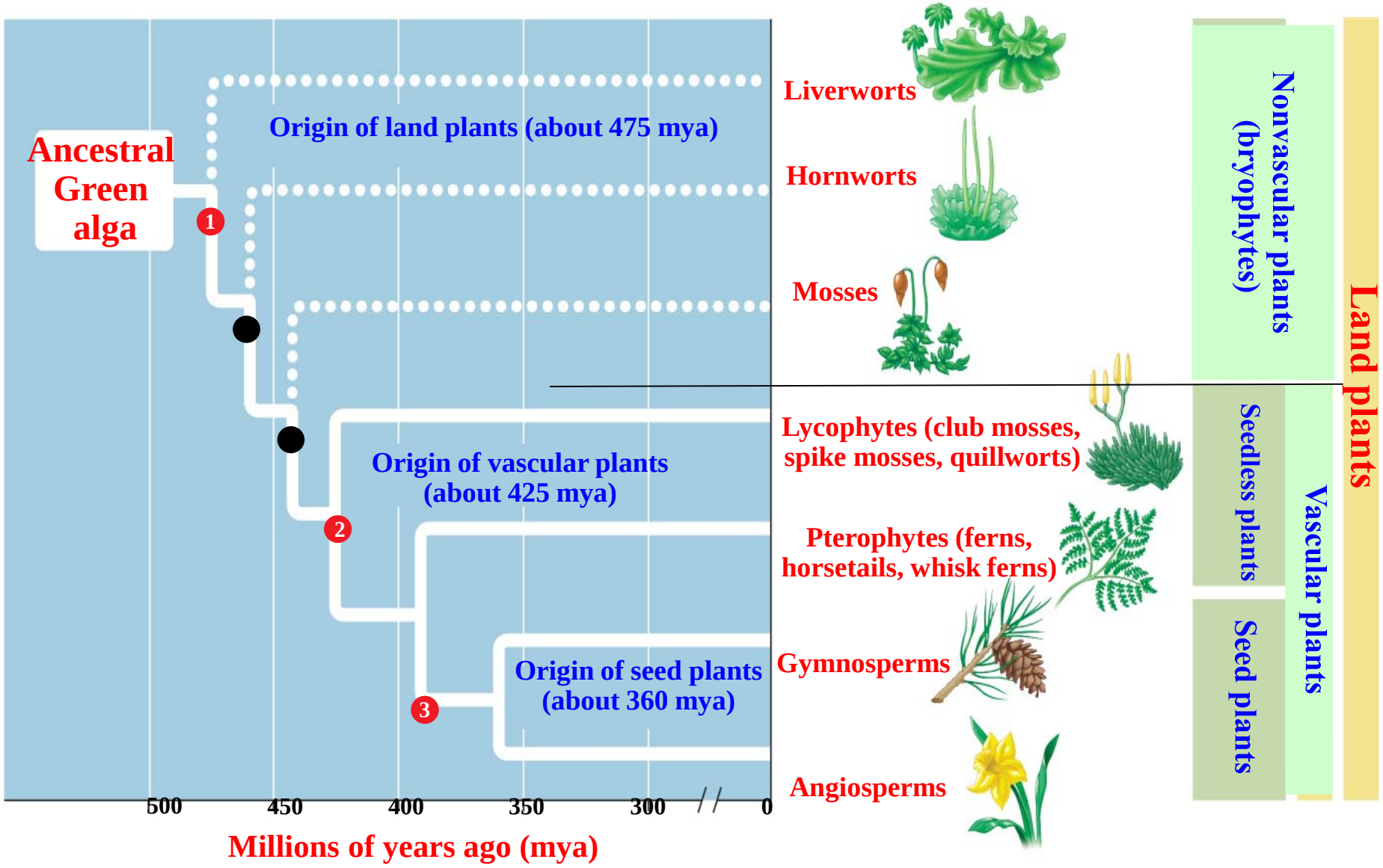
- **Green algae** live mostly in ponds and lakes.
  - Some forms are small and live in freshwater, such as *Spirogyra*, which forms thin filaments from long chains of cells.
  - A marine example, *Ulva*, or sea lettuce, has leaves the size of lettuce leaves.
  - Green algae is believed to be the ancestral to the earliest plants.



Green algae

Plants

- **Properties that distinguish plants from other organisms:**
  - **Plants have chlorophyll for photosynthesis.**
  - **Plant reproduction features alternation of generations.**
  - **Plants have dependent embryos.**
  - **Plants have roots or root-like structures that anchor it and absorb water and nutrient from the soil.**
  - **Plants have a waxy cuticle that covers the surface of leaves and stems, limiting water loss.**



Some highlights of plant evolution
(Dotted lines indicate uncertain evolutionary relationships)

Plants

- Two major groups of land plants arose from ancient algal ancestors: the nonvascular plants and the vascular plants.
- Nonvascular plants lack conducting structures, true roots, leaves, or stems.
  - They have rhizoids that anchor the plant and bring water and nutrients into the plant body.
  - Body size is limited due to the lack of conducting tissues, and slow diffusion must distribute water and nutrients throughout the plant body.
  - Nonvascular plants include hornworts, liverworts, and mosses.

Plants

- **Nonvascular plants**

(a) Hornwort

(b) Liverwort

(c) Moss

Plants

- **The reproductive structures of nonvascular plants are protected.**
  - **An adaptation to terrestrial life is their enclosed reproductive structures, which prevent the gametes from drying out.**
  - **There are two types of structures, one in which eggs develop and one in which sperm are formed.**
  - **In all vascular plants, the sperm must swim to the egg through a film of water.**

Plants

- **Vascular plants have conducting vessels that also provide support.**
  - **The conducting cells of vascular plants are called vessels, which contain lignin that serve support and conducting functions.**
  - **Vascular plants can grow tall because of vessels that provide support to these structures as well as conducting of water and nutrients between the roots to the leaves.**
  - **There are two groups of vascular plants: the seedless vascular plants and the seed plants.**

Plants

- **Seedless vascular plants include the club mosses, horsetails, and ferns.**
  - **They require swimming sperm and water for reproduction.**
  - **They propagate by spores, not seeds.**
  - **Their ancestors were larger than present-day forms, and they dominated the landscape hundreds of millions of years ago.**

Plants

- **Seedless vascular plants**

(a) Club moss

(b) Horsetail

(c) Fern

Plants

- **Seed plants are grouped into two general types:**

1- Gymnosperms, which lack flowers

2- Angiosperms, the flowering plants.

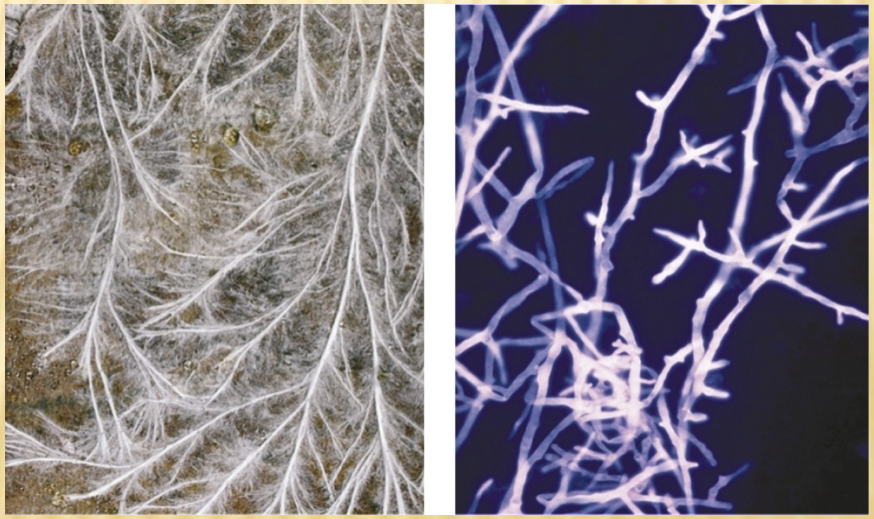
- **Gymnosperms evolved earlier than the flowering plants.**

Fungi

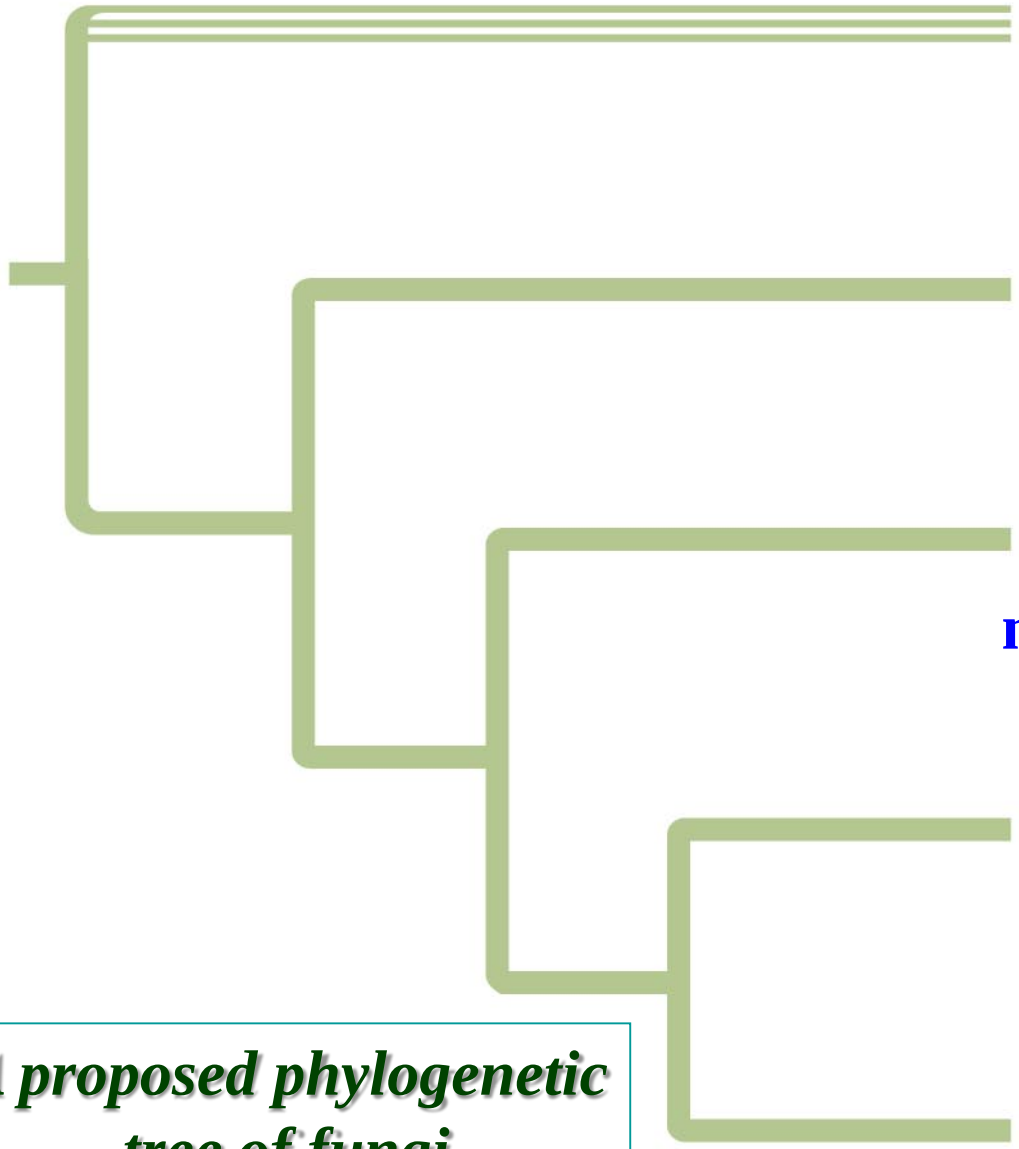
- **Fungi have distinctive adaptations.**
  - **A typical fungus is a mushroom, which is actually the reproductive part of a more extensive organism.**
  - **Fungi feed off dead material by secreting digestive fluids that break down their food outside of their bodies.**

Fungi

- The body of a fungus is called a mycelium and is one-cell thick.
- The mycelium is made up of extensive numbers of filaments called hyphae, which grow across a food source.



(a) Mycelium (b) Hyphae



Chytrids

Zygomycetes
(zygote fungi)

Glomeromycetes
(arbuscular
mycorrhizal fungi)

Ascomycetes
(sac fungi)

Basidiomycetes
(club fungi)

A proposed phylogenetic tree of fungi

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Fungi

- **Fungi affect humans and other organisms.**
  - **Fungi play a major role in the destruction of dead plant tissue by being able to digest both lignin and cellulose, the molecules that make up wood.**
  - **Fungi are saprophytes (feeding on dead organisms) and consume the dead of all kingdoms.**
  - **The activities of fungi and bacteria return nutrients and minerals to the environment.**
  - **Antibiotics (such as penicillin, oleandomycin, and cephalosporin) are made from fungi to combat bacterial diseases.**

Fungi

- **Fungi attack plants that are important to people.**
  - **Fungi cause the majority of plant diseases, and some of the plants that they infect are important to humans.**
  - **Especially damaging are plant pests called rusts and smuts, which cause billions of dollar's worth of damage to grain crops annually.**

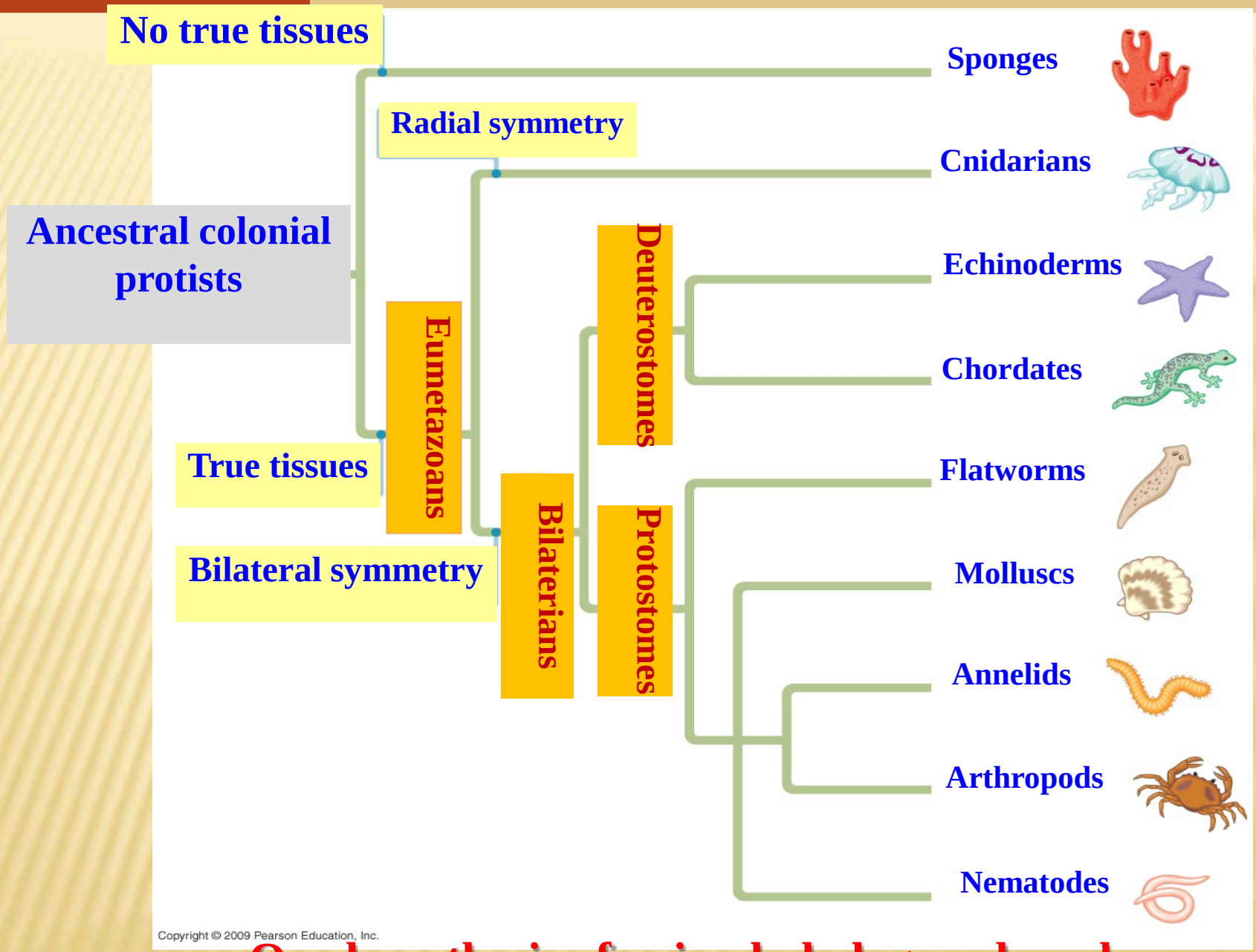
Corn smut

Fungi

- **Fungi include parasites that attack humans directly.**
  - **Some of these are athlete's foot, jock itch, vaginal infections and ringworm.**
- **Fungi can produce toxins.**
  - **Molds of the genus *Aspergillus* produce highly toxic, carcinogenic compounds known as aflatoxins.**
  - **Some foods, such as peanuts, seem to be especially susceptible to attack by *Aspergillus*.**

Animals

- **Characteristics of animals**
  - **Animals are multicellular.**
  - **Animals get their energy by consuming other organisms.**
  - **Animals reproduce sexually.**
  - **Animal cells lack a cell wall.**
  - **Animals are mobile.**
  - **Animals react rapidly to external stimuli.**



One hypothesis of animal phylogeny based on morphological comparisons

Animals

- **For convenience, animals are categorized as:**
  - **1- Vertebrates (with backbones)**
  - **2- Invertebrates (without backbones).**
- **Sponges**
  - **Sponges have a simple body plan, lack tissues or organs, and are colonies of single-celled organisms.**

(a) Encrusting sponge

(b) Tubular sponge

Animals

- **Sponges**
  - **Water enters through numerous tiny pores in the body, and leaves through fewer, large openings.**
  - **Oxygen and food is filtered out of the water during passage.**
  - **Reproduction can be asexual through budding, or sexual by the release of eggs and sperm into the water.**

Animals

- **Arthropods are the dominant animals on Earth.**
  - **Arthropoda includes:**

    1- Insects

    2- Arachnids,

    3- Crustaceans.
  - **They all have an exoskeleton; in insects, the body is divided into three parts: head, thorax, and abdomen.**
  - **Insects are the only flying invertebrates.**

Animals

- **Insects**
  - During their development, insects undergo metamorphosis, a radical change from a juvenile body form to an adult body form.
    - Larva is the immature stage of the insect, which grows until it reaches maximum size.
    - It then forms a non-feeding stage called a pupa.
    - An adult emerges from the pupa.

(a) Aphid

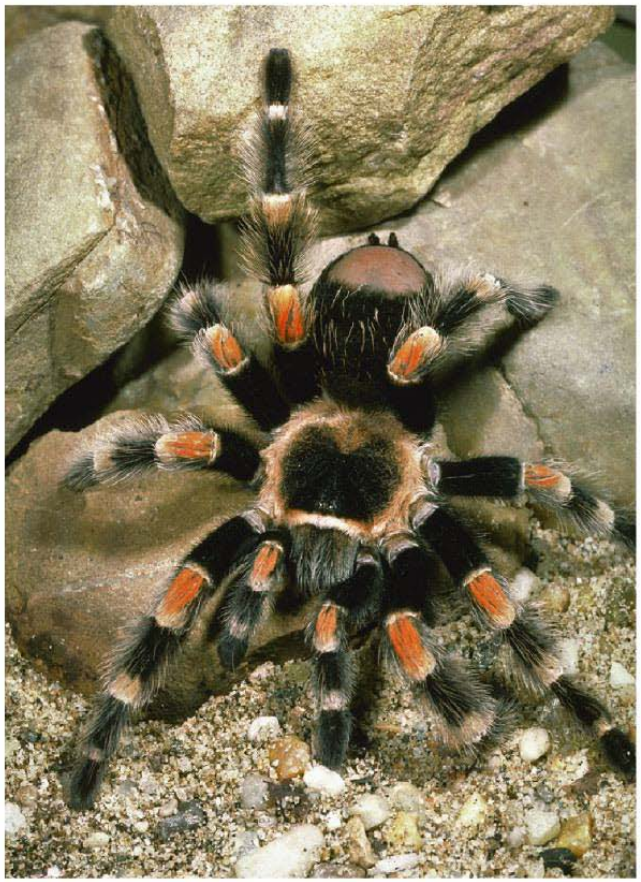
(b) Beetles mating

(c) Beetle flying خنفساء طائرة

(d) Moth larva يرقة العث

Animals

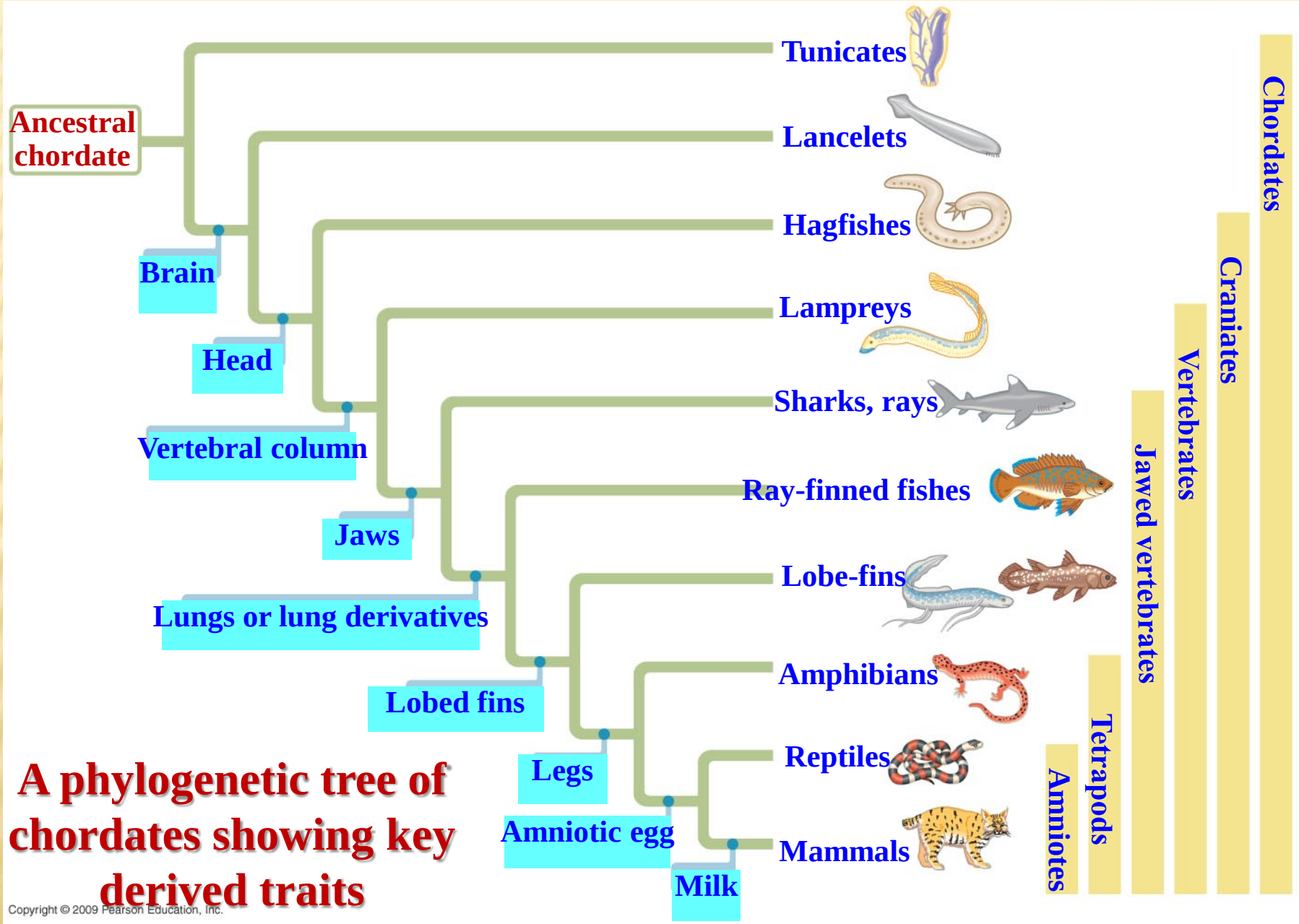
- **The arachnids include spiders, mites, ticks, and scorpions.**



(a) Spider

(b) Scorpion

(c) Ticks



A phylogenetic tree of chordates showing key derived traits

Animals

- **Chordates include both invertebrates and vertebrates.**
- **They have the following features:**
  - **The notochord: a stiff, flexible rod that extends the length of the body and provides attachment for muscles.**
  - **The nerve cord: a dorsal hollow tube; one end becomes the brain during development.**
  - **Pharyngeal gill slits: these may develop into functional gills or just remain as grooves in early development**
  - **A post-anal tail: extends beyond the body, past the anus**

Animals

- **The invertebrate chordates live in the seas.**
  - **The invertebrate chordates are the lancelets and the tunicates.**
  - **Larvae of lancelets lack a backbone, but adults possess all four chordate features.**
  - **The tunicates (sea squirts) have a larva that swims and has all chordate features.**
  - **Adults are attached to the sea bottom and do not move.**

Sea squirt

Animals

- **Vertebrates have a backbone.**
  - **For vertebrates, the embryonic notochord is normally replaced during development by a backbone, or vertebral column.**
  - **Vertebrates are represented by fish, amphibians, reptiles, birds and mammals**
  - **There are more ray-finned fishes than any of the other vertebrate groups.**

Animals

- **Amphibians**
  - They straddle the boundary between aquatic and terrestrial existence.
  - They have a three-chambered heart.
  - Lungs are poorly developed and they are supplemented by skin respiration.
  - They reproduce in water; many undergo metamorphosis with aquatic larval forms and terrestrial adults.


(a) Tadpole


(b) Frog


(c) Salamander

Animals

Reptiles

- They include lizards, snakes, turtles, alligators and crocodiles.
- Many species are completely independent of water as a result of three adaptations:
  - Evolution of a tough, scaly skin that resists water loss and protects the body
  - Evolution of internal fertilization
  - Evolution of a shelled egg

(a) Snake

(b) Alligator

(c) Tortoise

Animals

- **Birds**
  - One very distinctive group of reptiles is the birds.
  - Birds have developed feathers, which are highly specialized versions of reptilian scales.
  - Modern birds retain scales on their legs as evidence of the ancestry they share with reptiles
  - Birds have hollow bones for flight, and produce a shelled egg.

(a) Hummingbird

(b) Frigate bird

(c) Ostrich

Animals

- **Mammals**
  - One branch of reptiles gave rise to a group that evolved hair and diverged to form the mammals.
  - Mammals are named for the milk-producing mammary glands used by female members of the group to suckle their young.
  - In most mammals, fur protects and insulates the warm body.
  - The mammals are divided into three groups: monotremes, marsupials and placentals.

Animals

- **Mammals**
  - **Monotremes are found only in Australia and New Guinea, and include the platypus and two species of spiny anteaters, also known as echidnas.**
  - **Monotremes lay eggs.**

(a) Platypus

Animals

- All mammals except monotremes have embryos that develop in the uterus of the female reproductive tract.
  - In marsupials, embryos are only in the uterus for a short time and are then born at a very immature stage of development.
  - Immediately after birth, they crawl to a nipple, firmly grasp it, and complete their development.
  - In many marsupial species, this post birth development takes place in a protective pouch.

Animals

- **Marsupials**

(b) Wallaby

Animals

- **Most mammal species are placental mammals.**
  - **Compared to marsupials, placental mammals retain their young in the uterus for a much longer period, so that offspring complete their embryonic development before being born.**
  - **The bat, mole, impala, whale, seal, monkey, and cheetah exemplify the radiation of mammals into nearly all habitats, with bodies adapted to their varied lifestyles.**
  - **The largest group of placental mammals are the bats and rodents.**

Animals

- **Placental mammals**

(c) Whale

(d) Bat