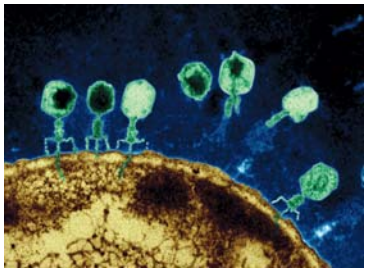
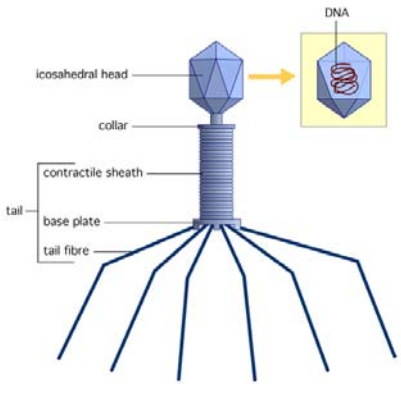
Grade 11 Biology

Diversity of Living Things

Class 2

Viruses





- Viruses are small, non-living particles with no cytoplasm
  - **Capsid** – protein capsule that surrounds the genetic material (either DNA or RNA)
- Cannot grow or reproduce on their own
- Do not produce or use energy; do not create waste
- Requires a host to replicate

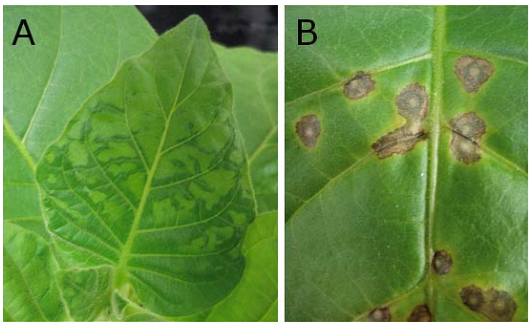
Viruses and Disease

- Responsible for many human diseases (i.e. common cold, chicken pox, AIDS, Ebola)
- **Epidemic** – a large rapidly spreading outbreak of disease in a particular region
- **Pandemic** – an epidemic that spreads to a global scale
- Viruses can caused uncontrolled cell division leading to cancers
  - Hepatitis C virus is linked to liver cancer
  - Human Papillomavirus is linked to cervical cancer

Table 1 Disease-Causing Viruses

DNA viruses	**Disease**
hepadnavirus	hepatitis B
herpesvirus	cold sores, genital herpes, chicken pox
adenovirus	respiratory infections, tumours
RNA viruses	**Disease**
paramyxovirus	measles, mumps, pneumonia, polio, common cold
retrovirus	HIV/AIDS
rhabdovirus	rabies

- Viruses can cause diseases in animals and plants which can damage crop yield
- **Bacteriophage** – viruses that infect bacterial cells
  - Inject their DNA into the bacterium while the viral protein capsule remains on the outside

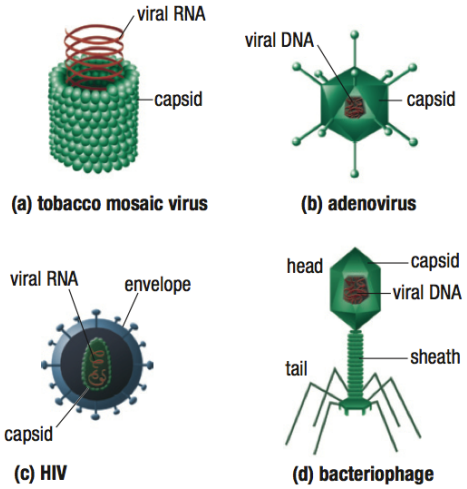


Classification and Phylogeny

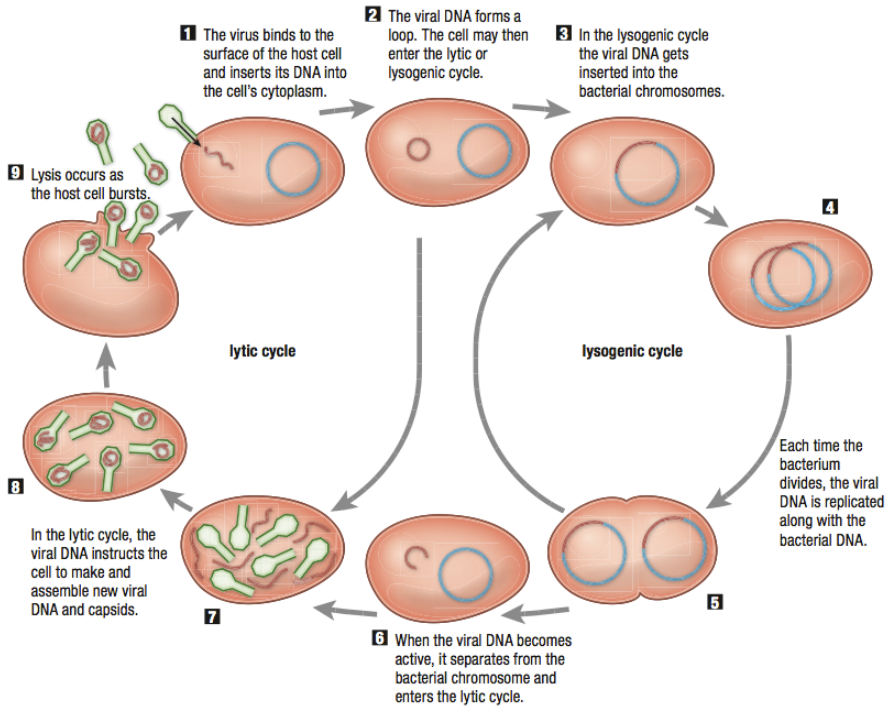
- Viruses are classified into order, families, genera and species based on size, shape and type of genetic material

Characteristics

- All contain DNA or RNA surrounded by a capsid
- Some have an envelope made of the host cell's membrane (i.e. HIV)



Infectious Cycles



- **Lytic Cycle** - lysis occurs as the host cell ruptures releasing 100-200 new viruses into the host cells surroundings
- **Lysogenic Cycle** – viral DNA stays in a dormant state and the host continues to grow and divide normally but it makes a copy of the viral DNA each time
- When the cell's environment changes, the viral DNA becomes active, separates from the bacterial chromosome and enters the lytic cycle

Ex: Herpes Virus

- Remains dormant in the cytoplasm but during periods of stress, virus becomes active and destroys nearby cells
- Forms ulcers or cold sores
- Viruses can be transmitted through air, physical contact, insect bites or the exchange of bodily fluids

Table 2 Viral Transmission

Disease	Method of transmission
rabies	bite by infected mammal
HIV/AIDS	exchange of body fluids
influenza, common cold, chicken pox	airborne and by contact
measles, mumps	direct contact

Vaccinations and Human Health

- Vaccines contain weakened parts of a dangerous virus to cause your body to trigger an immune response without causing an infection
- Immune system can now react quickly to an infection of the real virus by triggering memory immune cells
- Virus can constantly change so new vaccines must be made every year

Figure 6 The last recorded case of smallpox was in 1977.

Benefits of Viruses

- Viruses can control the population of animals, plants and bacteria
- Can be used in **gene therapy** – the treatment of diseases using genes by delivering drugs or genes to targeted cells using virus capsules

Table 3 Applications of Technologies That Use Viruses

Technology	Application or possible application
using a virus capsule to deliver a drug	• This method may be used to deliver drugs to targeted cells in the body, for example, to deliver toxic chemotherapy drugs to cancerous tumour cells.
using a virus to insert a new copy of a gene	• This method may be used to insert corrective genes into individuals who suffer from a genetic disorder.
using a virus to insert a gene taken from one species into another species	• This method can be used to create genetically modified organisms. • It is widely used in the genetic engineering of plants.

Viroids

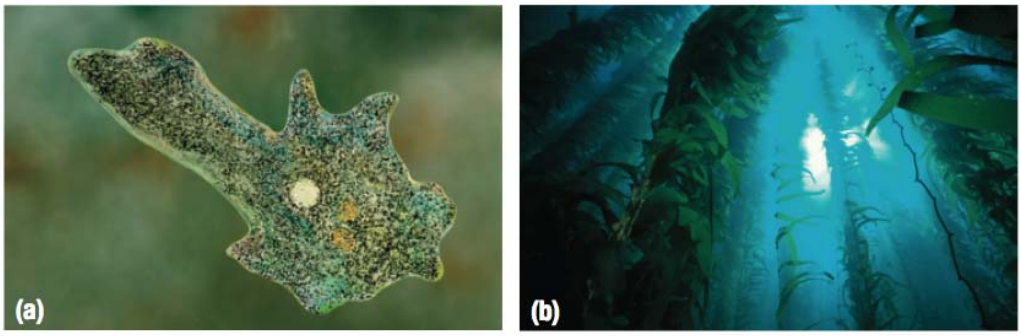
- Viroids – small, infectious pieces of RNA that do not have a capsid
  - Plant pathogens that can interfere with the normal and functioning of RNA within the host cell

Prions

- Prions – abnormally shaped proteins found in the brain and nervous tissue of infected animals
- When the infected tissues are eaten, the prions are transferred to the animals' bloodstream and brain
- Ex: Mad Cow Disease or Creutzfeldt-Jakob disease (human-equivalent)

Protists

- Eukaryotes that range in size from microscopic single-celled organisms to multicellular species

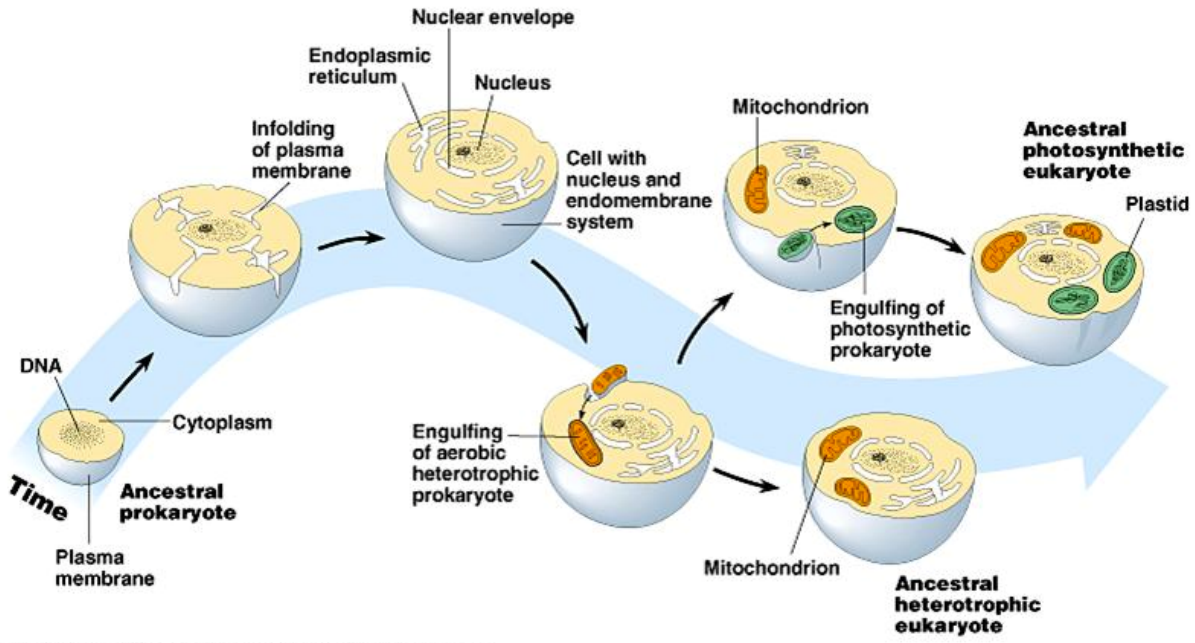


Origins of Eukaryotes

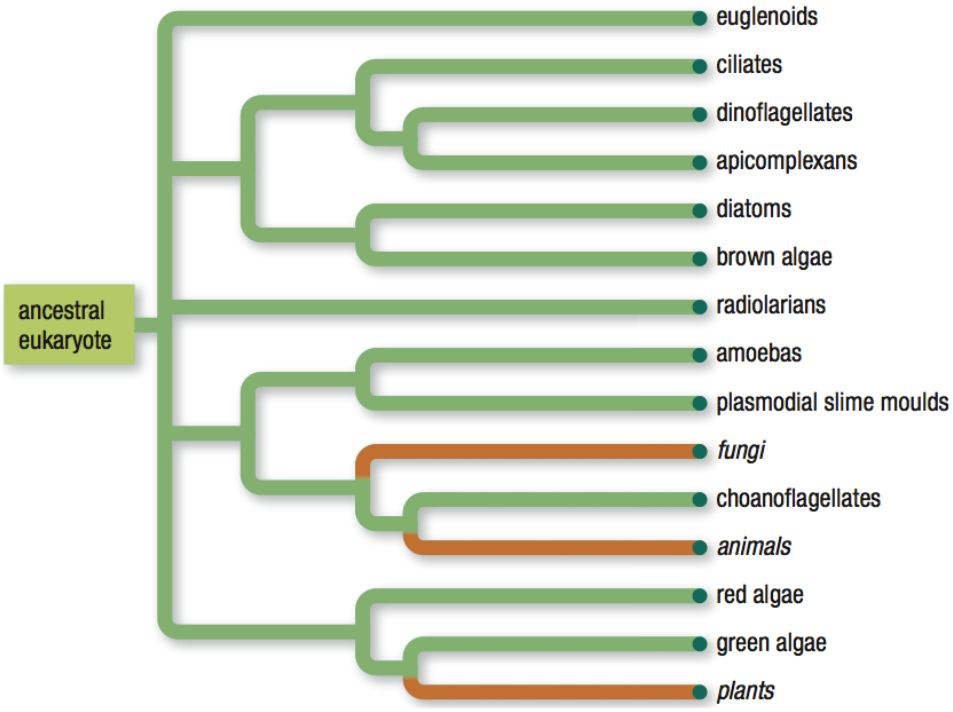
- Protists were the first eukaryotes with cells that have a nucleus and organelles bound by membranes
- Organelles were likely prokaryotic cells – **endosymbiosis** – when one type of cell lives within another type of cell
- Ex: Mitochondria and Chloroplasts were once prokaryotic organisms but were engulfed by a eukaryotic cells

Evidence of Endosymbiotic Theory

- Present day mitochondria and chloroplasts have two membranes
- The inner membrane is similar to the prokaryote while outer membrane matches the eukaryote
- Mitochondria and chloroplasts have their own internal chromosomes, which are similar to prokaryotic chromosomes
- Mitochondria and chloroplasts reproduce independently within the eukaryote by binary fission

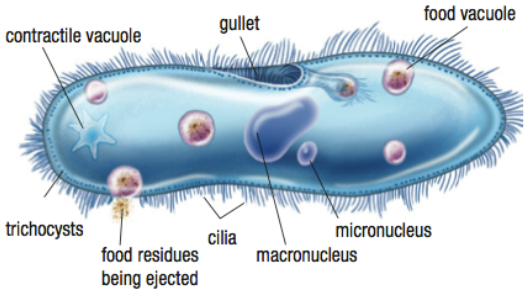


Classification and Phylogeny



Characteristics

- No typical protist; the only characteristic that they share is that they are not animals, plants or fungi



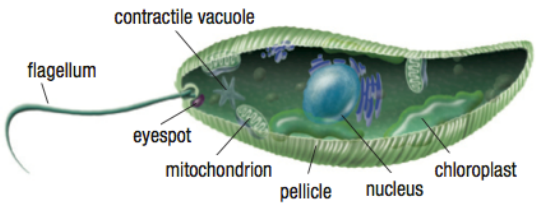


Table 1 Characteristics of Representative Protists

Group	Energy source	Key features
euglenoids	autotrophs, photosynthetic	• They are unicellular. • They usually have two flagella for moving. • Their outer surface covering consists of stiff proteins.
ciliates	heterotrophs	• They are unicellular. • They have very complex internal structures. • They have many cilia and no cell walls (**Figure 8**).
apicomplexa	heterotrophs	• They are unicellular. • They have no cell wall. • All are parasites of animals.
diatoms	autotrophs, photosynthetic	• They are unicellular (**Figure 9**). • They move by gliding. • They are covered by glass-like silica shells.
amoebas	heterotrophs	• Some have hard outer skeletons. • They move by extensions of the cytoplasm called pseudopods.
slime moulds	heterotrophs	• Their life cycles have unicellular stages and multicellular stages. • They move with flagella or pseudopods.
red algae	autotrophs, photosynthetic	• Almost all are multicellular. • They have no cilia or flagella. • Their cell walls are made of cellulose.

Interactions in Ecosystems

- Protists like green, red and brown algae called seaweed have gas-filled bladders that help them float toward the light for photosynthesis
- Protists like the zooxanthellae live within the bodies of coral in a symbiotic relationship
- Protists like *Plasmodium* causes malaria

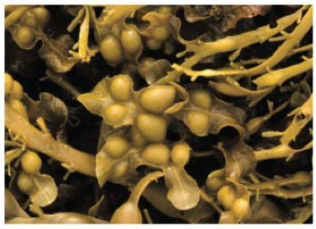
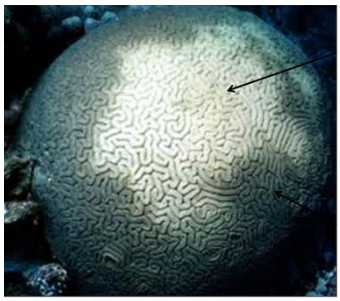


Figure 10 Gas "bladders" allow algae to float to the surface for more light.



Life Cycles

- Single-celled protists reproduce asexually and sexually
  - Asexually through binary fission
  - Sexually through conjugation in which cells align and exchange genetic material

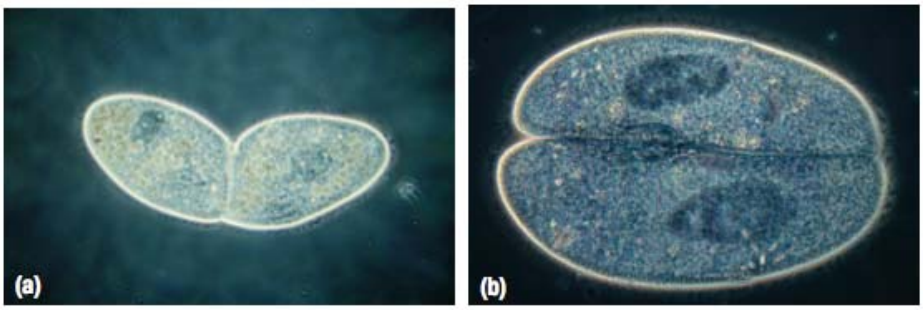
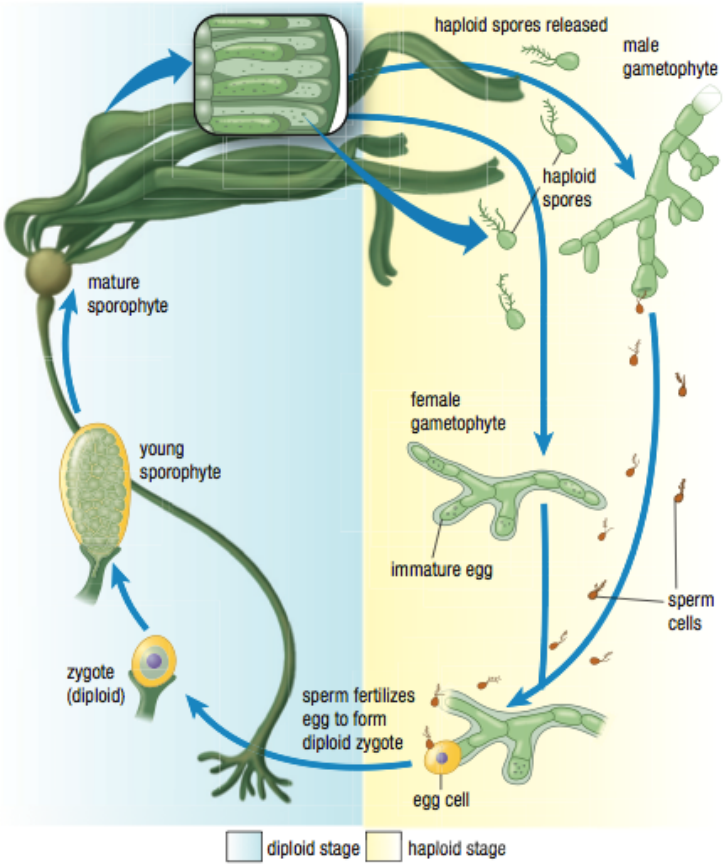


Figure 12 Paramecia reproduce (a) asexually by binary fission and (b) sexually by conjugation.

- Some multicellular protists undergo sexual reproduction
  - Sex cells such as the male sperm cells and female eggs are haploid (contain half the number of chromosomes in other cells)
  - When a sperm cell fuses with the egg, the result is a zygote which are diploid (two copies of every chromosome)
- Large brown algae undergo an alternation of generations which contains diploid sporophyte and haploid gametophyte stages



sporophyte a diploid organism that produces haploid spores in an alternation of generations life cycle

spore a haploid reproductive structure; usually a single cell; capable of growing into a new individual

gametophyte a haploid organism that produces haploid sex cells in an alternation of generations life cycle

alternation of generations a life cycle in which diploid individuals produce spores that create haploid individuals; the haploid individuals reproduce sexually, producing sporophyte individuals and completing the cycle

- Some protists are parasitic organisms that are completely dependent on other organisms

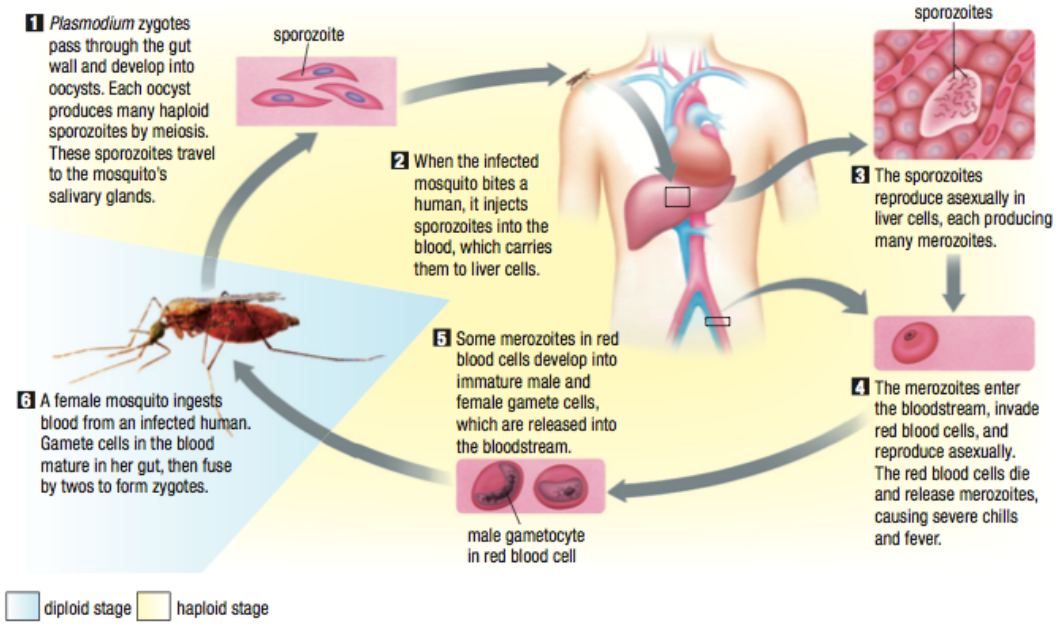


Figure 14 The life cycle of *Plasmodium*

Fungi

- Major decomposers on Earth responsible for cycling nutrients through the biosphere
- Plants rely on fungi to help them obtain nutrients from soil

Figure 2 (a) Fungi cause some diseases in plants, such as apple scab. (b) Fungi are also used in the production of foods such as blue cheese. (c) Fungi are the source of one of our most important antibiotics—penicillin.

Classification and Phylogeny

- Fungi are more closely related to animals than they are to plants
- Classified into five major phyla

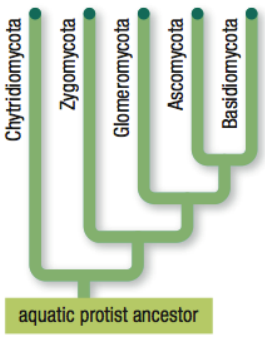


Table 1 Summary of the Five Major Phyla of Fungi

Phylum	Key features
Chytridiomycota (chytrids)	• They are the only fungi with swimming spores. • Most are saprophytes. • They can be single-celled or multicellular.
Zygomycota (zygomycetes)	• They include some familiar bread and fruit moulds. • Most are soil fungi. • Many are used commercially. • Many are parasites of insects.
Glomeromycota (glomeromycetes)	• All form symbiotic relationships with plant roots.
Ascomycota (ascomycetes)	• Many, such as yeast, are useful to humans. • Some cause serious plant diseases.
Basidiomycota (basidiomycetes)	• They include mushrooms, puffballs, and bracket fungi. • Most are decomposers. • Some form symbiotic relationships with plants.

Characteristics

- Bodies of fungi are a branching network of filaments called hyphae which form the body called the mycelium
- Hyphae are long tubes of cytoplasm containing nuclei surrounded by a cell wall made of chitin
- Tubes may be separated into compartments called septa which contain large pores allowing materials to move through the hyphae
- Hyphae form the “fuzz” surrounding the mould

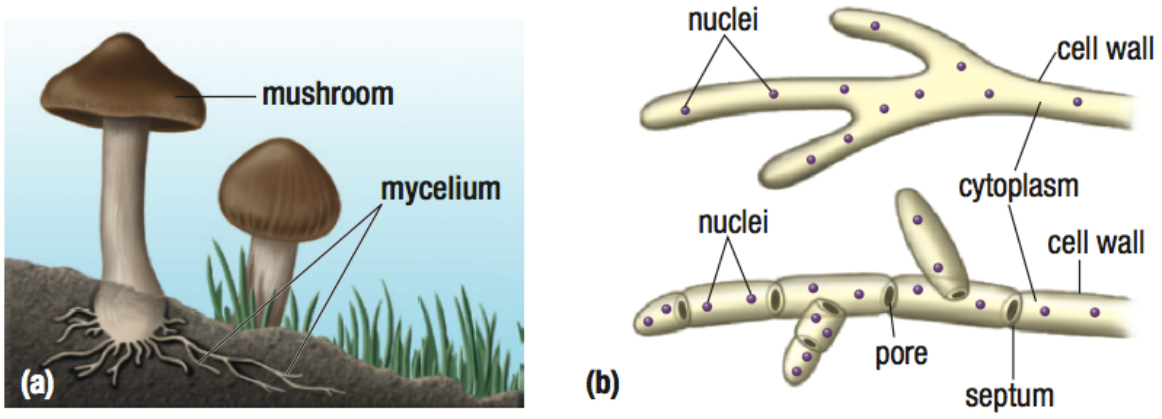


Figure 5 (a) The reproductive structure of a fungus is often the only part visible above ground. The mycelium forms the body of the fungus below ground. (b) Hyphae grow at their tips, and the nuclei multiply by mitosis as the hyphae grow.

- All fungi are heterotrophic – they get energy from living or dead organisms
- Digestion occurs outside the body by growing next to or within the food source and release digestive enzymes into their surroundings
- Nutrients are absorbed through the cell membrane of the hyphae

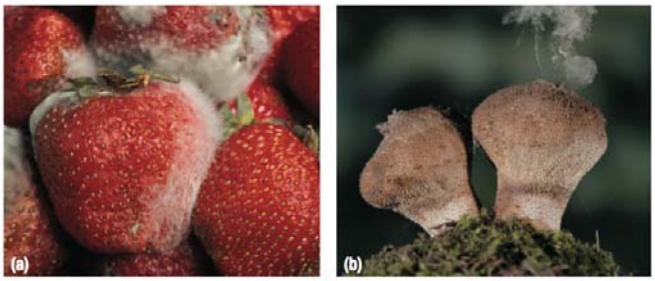
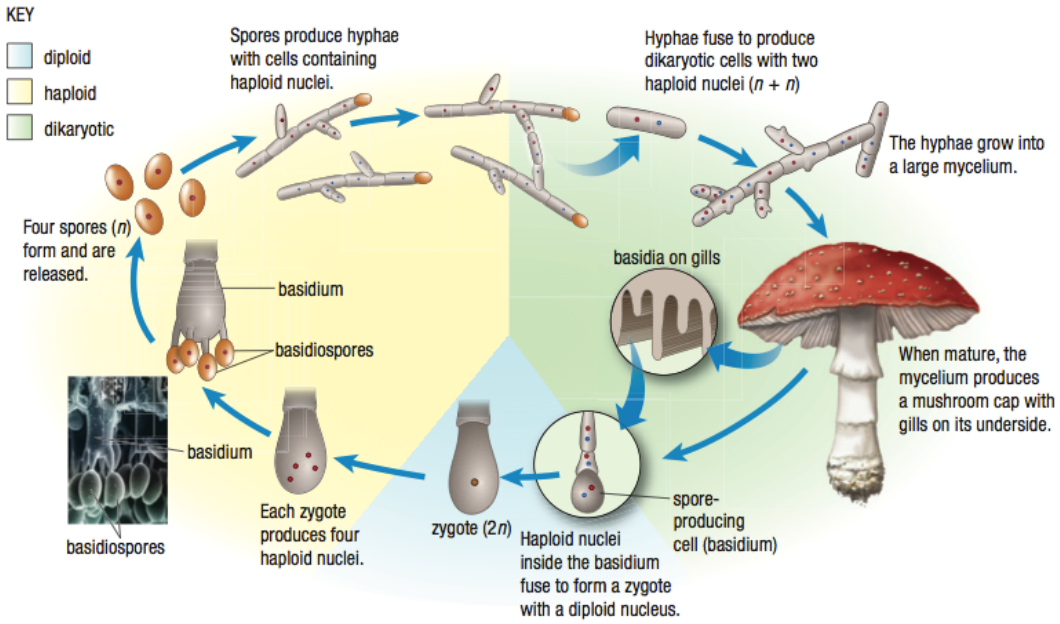


Figure 6 (a) The "fuzz" we associate with mouldy food is the hyphae of the fungus. (b) Even light contact with a mature puffball will cause the release of millions of microscopic spores.

Life Cycles



- Each spore contains a haploid nucleus which germinates and produces a hyphae with single nuclei separated by septa
- When two hyphae come into contact, they fuse forming a **dikaryotic** cell and grows into a mycelium
- When mycelium matures, it may produce a mushroom cap
- Underside of the cap contains spore-producing structures called basidia where two haploid nuclei fuse, forming a zygote that undergoes meiosis producing four haploid spores

Symbiotic Relationships in Ecosystems

- Lichen contains fungi which envelops and protects the cyanobacteria or algae and supplies them with water and mineral nutrients; Cyanobacteria and algae supply the fungi with food
- Leaf-cutter ants chew the leaves into a pulp and feed a fungus which in turn will provide food for the ants
- **Mycorrhiza** – symbiotic relationship between a fungus and a plant root in which the fungus supplies the plant with phosphorus or copper and the plant provides the fungi with energy-rich food molecules

Decomposers and Disease

- Fungi can cause athlete's foot, ringworm infections, and lung diseases
- Fungus on peanuts produces a chemical that can cause cancer

Plants

- Thought to have evolved from **charophytes** – a group of green algae because both contain chlorophyll *a* and chlorophyll *b*
- Both form cell walls made of cellulose and store excess food as starch

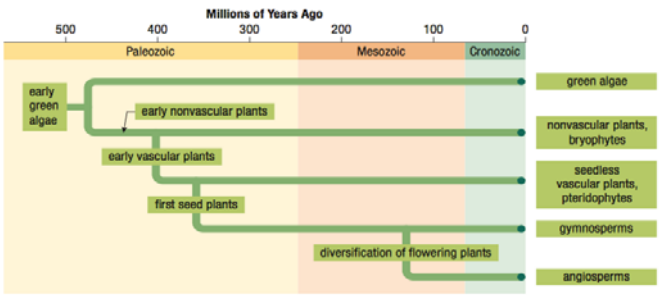
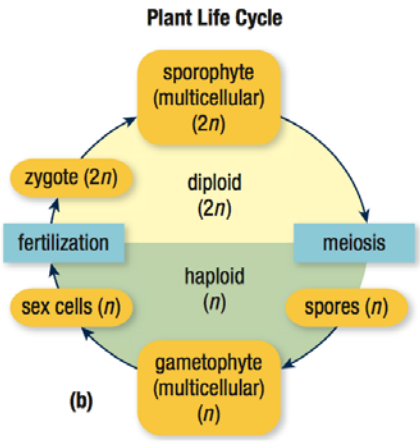


Figure 3 A simplified phylogenetic tree of the Plant Kingdom. Many biologists now include green algae within the Plant kingdom and refer to the other groups as the "higher plants."

Characteristics

- All are multicellular eukaryotic organisms and almost all perform photosynthesis
- Undergoes "alternation of generations" in its life cycle



- Diploid generation produces spores
- Haploid generation produces gametes

Adaptations for Life on Land

- Ability to prevent water loss through a waxy cuticle on their outer surfaces
- Ability for gas exchange through stomata, which are tiny openings between cells on the plant's surface
  - Stomata can open and close to allow gas to move in and out of the plant

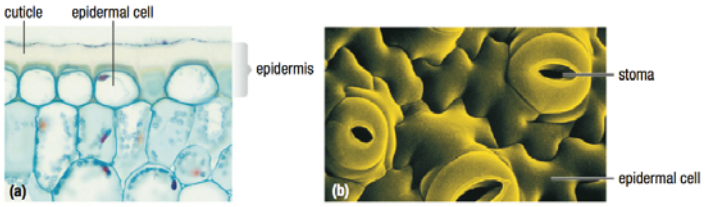
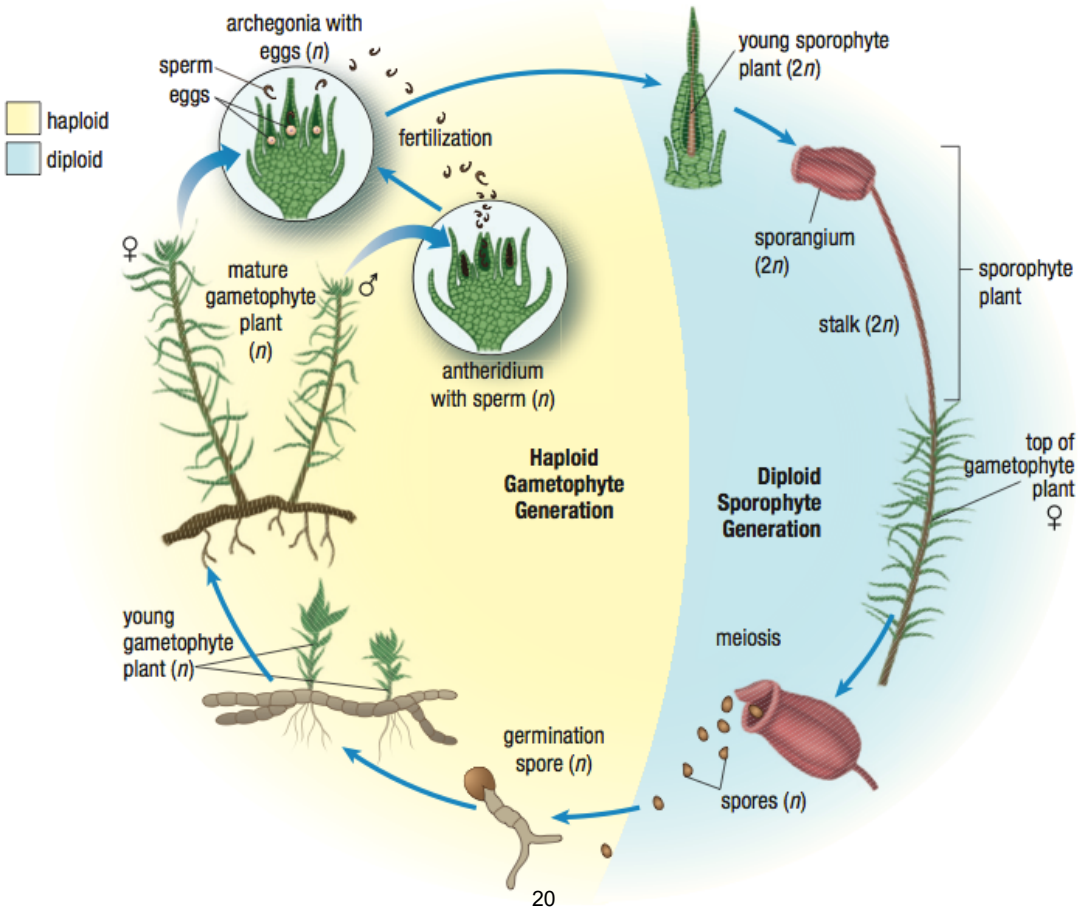


Figure 6 (a) Almost all plant surfaces produce a waterproof, waxy cuticle. (b) Stomata are small openings in the epidermis that allow gas exchange with the air. Most leaves have thousands of stomata per square centimetre.

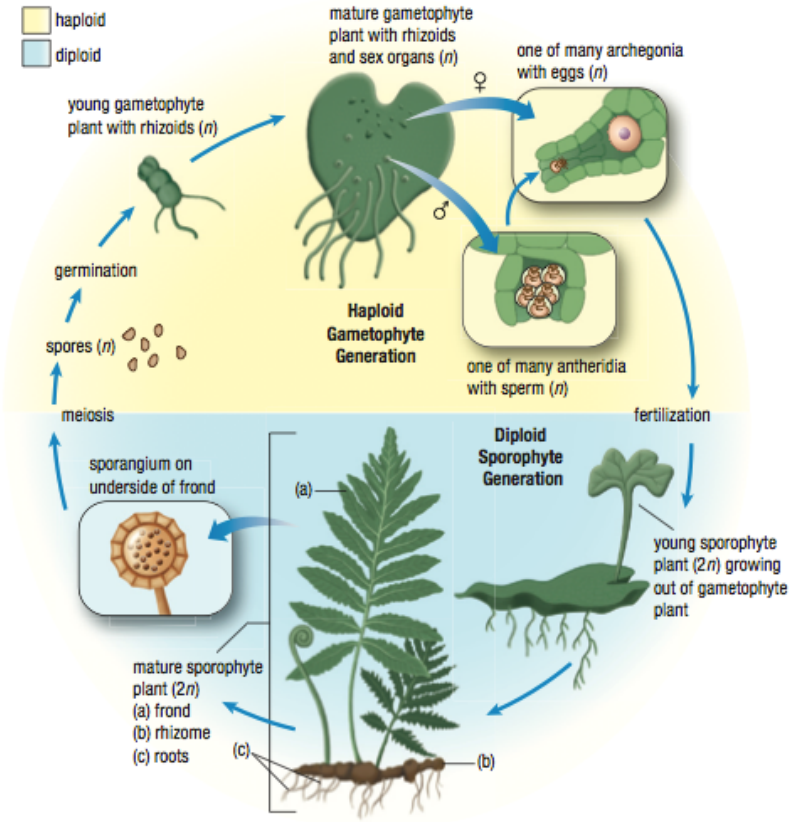
Bryophytes: The Mosses

- Includes mosses, liverworts and hornworts
- Have a waxy cuticle and stomata for gas exchange but do not have specialized vascular tissue or true leaves, roots or seeds
- Produce swimming sperm in structure called **antheridia** and eggs in structures called **archegonia** so they must live in wet conditions
- After fertilization, a structure called **sporangium** grows in which haploid spores are produced



Lycophytes and Pterophyte: The Ferns

- Includes club mosses and ferns are groups of seedless vascular plants
- Vascular tissue consists of xylem and phloem which are specialized for transportation of water and nutrients
- Reproduce sexually using sperm and eggs
- Stems of ferns form **rhizomes** – a horizontal underground stem
- **Frond** – a large green fern leaf


haploid
diploid
mature gametophyte plant with rhizoids and sex organs (n)
one of many archegonia with eggs (n)
young gametophyte plant with rhizoids (n)
germination
spores (n)
Haploid Gametophyte Generation
one of many antheridia with sperm (n)
meiosis
fertilization
Diploid Sporophyte Generation
sporangium on underside of frond
(a)
young sporophyte plant (2n) growing out of gametophyte plant
mature sporophyte plant (2n)
(a) frond
(b) rhizome
(c) roots
(c)
(b)

Gymnosperms and Angiosperms: The Seed Plants

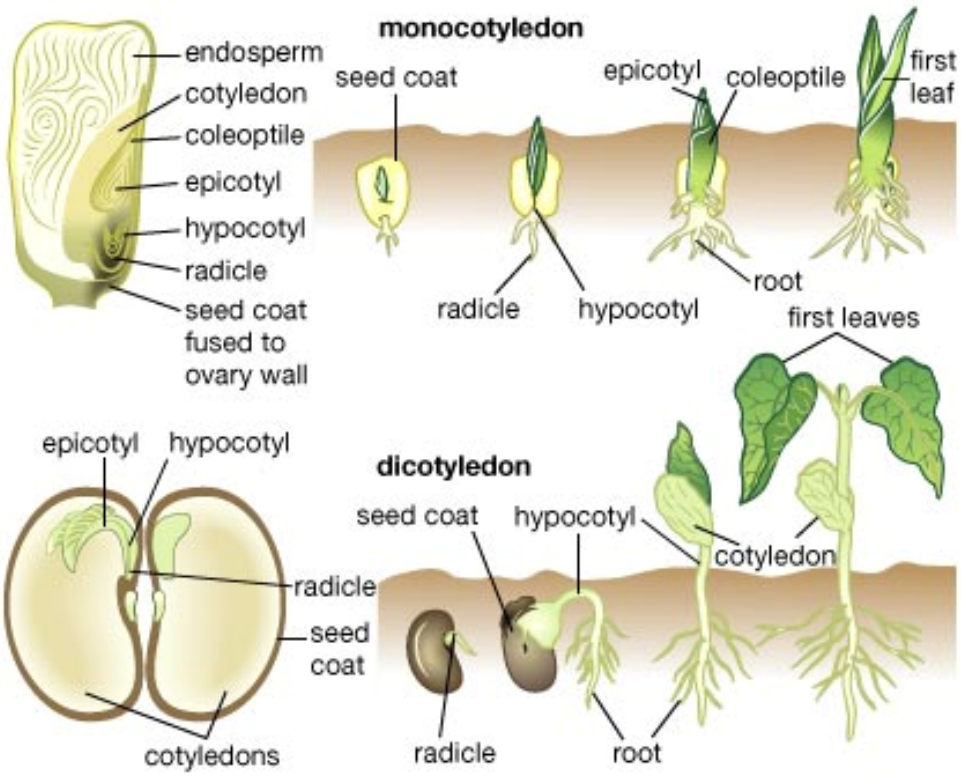
- When the male gamete in the pollen grain penetrates an ovule, it produces a diploid zygote which becomes a seed
- Seeds contain a food supply for the embryo inside the seed coat to grow a small root, a steam and leaves before it relies on photosynthesis
  - Ex: Wheat, Rice and Corn

Gymnosperms: The Conifers

- Includes coniferous trees such as pines, spruce, cedars and junipers
- Male cones produce and release pollen and female cones produce eggs; embryo develops within a seed in the cone
- Have large, shallow root systems that form a mycorrhizal relationship with symbiotic fungi
- Provide 85% of all wood used in the construction, and pulp and paper industries

Angiosperms: The Flowering Plants

- Flowers produce both the pollen and the eggs but the eggs are protected in an enclosed ovary
- After fertilization, seeds from the ovary become a fruit to help disperse the seeds
- **Cotyledons** – structures that store food used by the growing embryo during germination
- Plants that are small and drab looking are usually wind pollinated; plants that have colourful, fragrant flowers are animal-pollinated



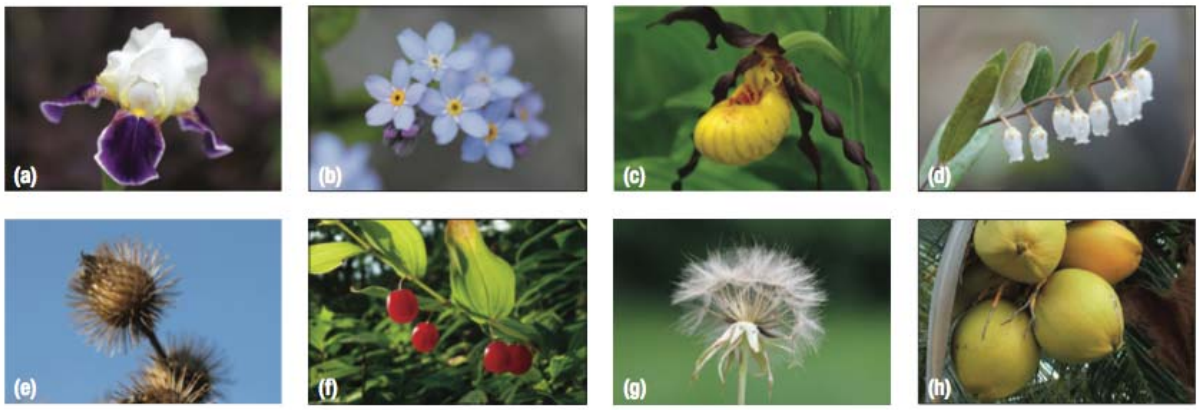


Figure 14 Flowers and fruits reflect the great diversity of the flowering plants. (a) Irises, (b) forget-me-nots, (c) yellow lady's-slippers, and (d) leatherleafs are all pollinated by animals. (e) Some fruits stick to animals, such as burdock, (f) some are eaten by animals, such as these twisted stalk berries, (g) some float in the air, such as this goat's beard, and (h) some float in the water, like these coconuts.

The Animals

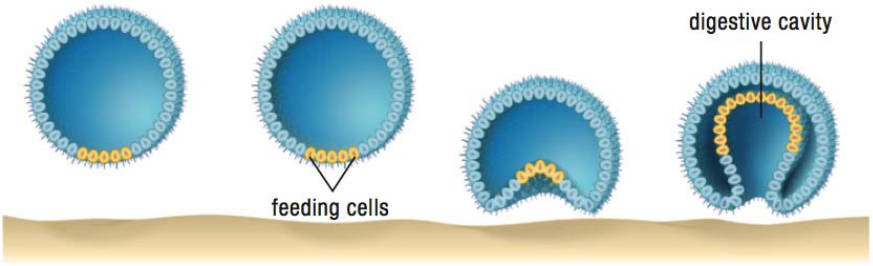


Figure 3 Scientists believe that animals evolved from colonial protists. The protists developed a hollow body cavity and specialized feeding cells. Over time, the colonies evolved into multicellular organisms with specialized tissues.

- Animals evolved from the colonial, flagellated protist that lived 700 million years ago

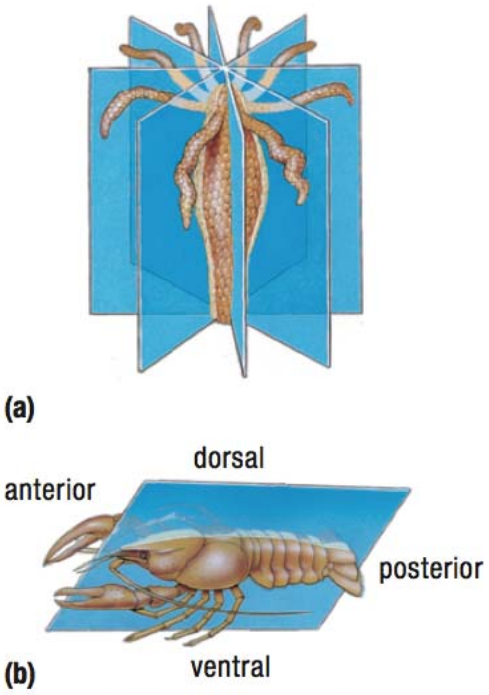
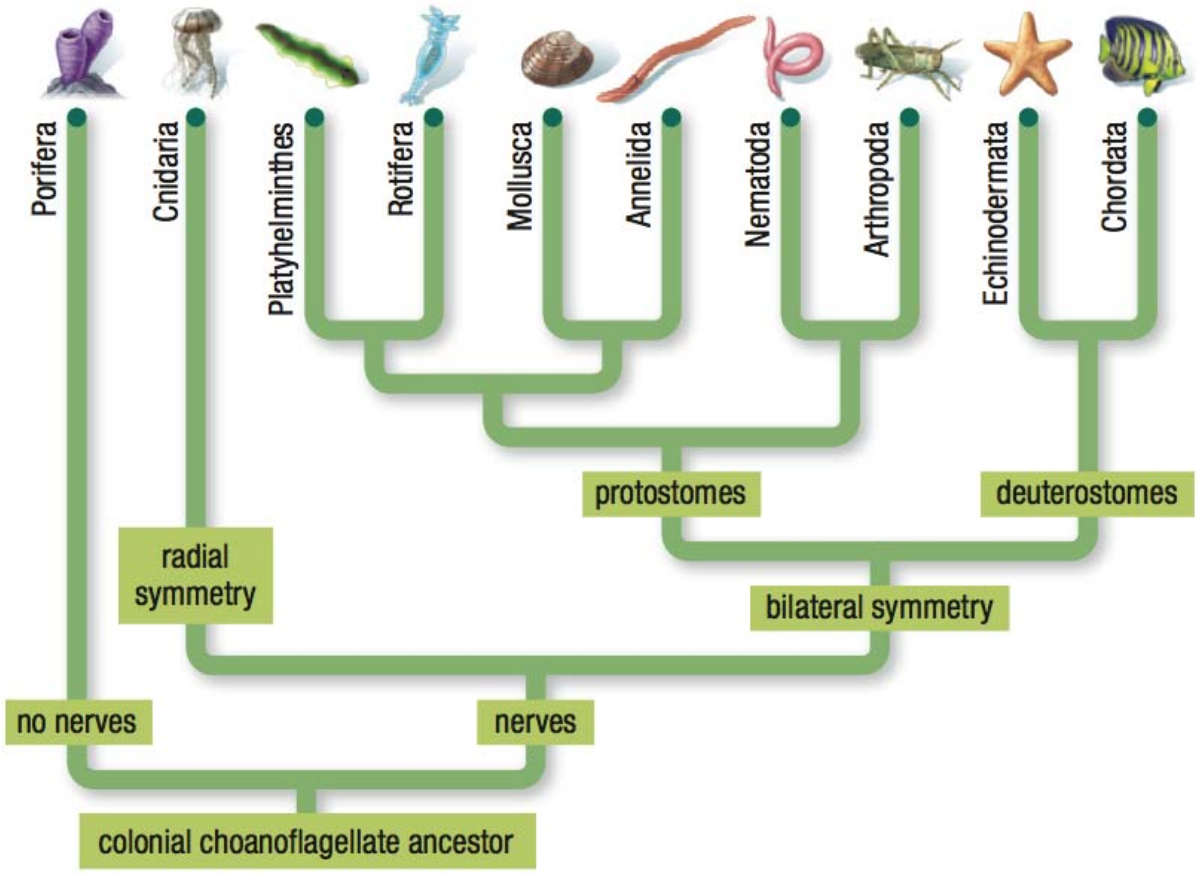


Figure 4 (a) Radial symmetry and (b) bilateral symmetry

- Some animals have **radial symmetry** – regularly arranged around a central axis (i.e. jellyfish, squid)
- Some animals have **bilateral symmetry** – left and right sides that are mirror images of each other (i.e. humans, lobster)

- Bilaterally symmetrical animals are divided into **protostomes** and **deuterostomes** based on embryonic development
  - Protostomes – mouth forms before the anus
  - Deuterostomes – anus forms before the mouth
- Humans belong in the deuterostome phylum Chordata which are mostly vertebrates – animals with a dorsal backbone or notochord



Characteristics

- All animals are multicellular heterotrophs that use oxygen for aerobic respiration without cell walls
- **Germ Layers** – the layers of cells in a developing embryo that give rise to specialized tissues
  - **Ectoderm** – outer layer
  - **Mesoderm** – the middle layer
  - **Endoderm** – the inner layer

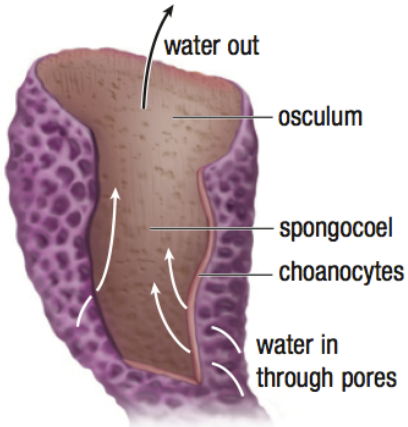


Figure 7 Sponges have a simple body plan with two main layers. The inner layer consists of specialized feeding cells called choanocytes that are similar in structure to some protists.

The Simplest Invertebrates

- Include sponges (Porifera) which have flagellated cells called choanocytes, lining a central cavity
- Flagella create a continuous current of water that passes through the pores in the body wall and exit through the top of the sponge

- Hydras, anemones, jellyfish and coral (Cnidaria) do not have a mesoderm and exhibit radial symmetry
  - Have tentacles with stinging cells that contain nematocysts – capsule containing toxins

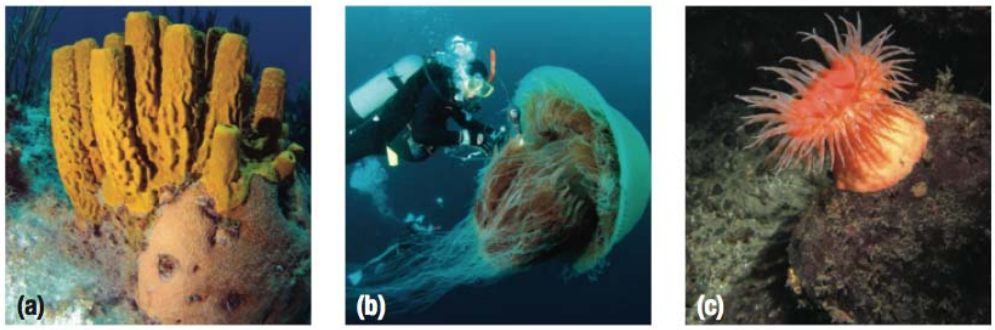
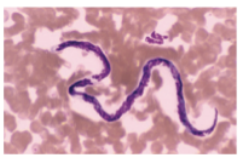


Figure 8 (a) Porifera like this tube sponge are considered the simplest animals. (b) Some cnidarians, like this giant Nomura jellyfish, can measure 2 m across and exceed 200 kg in weight. Some are free swimming, while others, like (c) this anemone, are sessile.

The Protostome Invertebrates

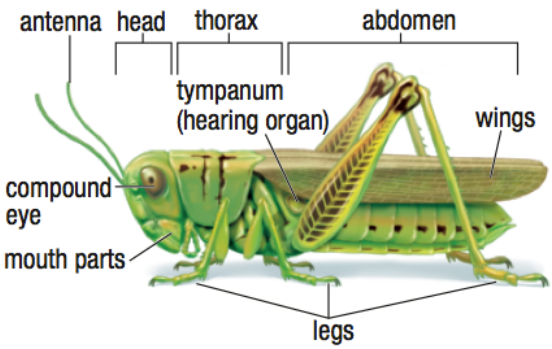
Phylum (common name)	Examples (Animals shown in the photos are bolded.)		Key features
Arthropoda (arthropods)	**insects**, spiders, mites, ticks, millipedes, centipedes, scorpions, daphnia, crabs, lobsters, shrimps, barnacles		• They have segmented bodies with jointed appendages. • They have complex sensory systems including antennae. • Their hard outer skeletons contain chitin. • They have highly variable body shapes. • They have complete digestive, excretory, and circulatory systems. • Their respiratory systems use gills or internal airways. • They range in size from 0.1 mm to 1 m in length. • They are extremely diverse and play vital roles in all aquatic and terrestrial ecosystems, often as the primary consumers. • Insects are the only invertebrates capable of flight. • About 1 100 000 species have been described (> 75 classes)
Nematoda (roundworms)	pinworms, **dog heartworms**		• They have unsegmented cylindrical bodies with complete digestive tracts. • Many are important parasites of other animals. • Some females can produce more than 100 000 eggs each day. • They live in very large numbers in the soil and aquatic sediments. • They range in size from 2 mm to 2 m in length. • About 20 000 species have been described (2 classes).
Annelida (segmented worms)	earthworm, **feather-duster worms**		• Their bodies and most of their internal organs are segmented. • They have complete digestive systems. • Gas is exchanged through the skin, gills, or other specialized body parts. • Most have bristles on their outer surface to help with movement. • Many are marine. • They range in size from 0.5 mm to 3 m in length. • About 14 000 species have been described (7 classes).

Mollusca (mollusks)	**snails**, clams, octopuses, squid		• They have three main unsegmented body parts: a foot, a visceral mass, and a mantle that secretes a shell. • Almost all have specialized file-like radula used for scraping and boring. • In some species the shell is reduced or absent. • They have complete digestive systems, circulatory systems, and gills. • They range in size from less than 1 cm to 20 m in length. • About 120 000 species have been described (8 classes).
Rotifera (rotifers)	**rotifers**		• They are small aquatic animals (less than 2 mm long). • They use cilia to direct food into their mouths. • Most live in fresh water. • They have no respiratory or circulatory system. • They are very important consumers in many aquatic food webs. • About 1800 species have been described (3 classes).
Platy-helminthes (flatworms)	**tapeworms**, liver flukes		• They are flattened, unsegmented worms. • Most have a digestive cavity with a single opening. • They do not have coeloms. • They range in size from 1 mm to 5 m in length. • Many are important parasites of other animals. • They have no circulatory or respiratory system. • About 14 000 species have been described (4 classes).

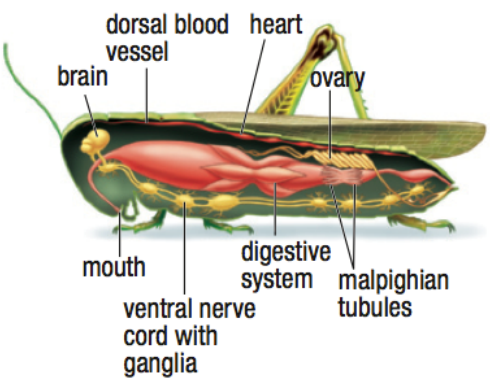
Body Plans and Life Cycles

- Body plan consists of nervous, digestive, respiratory, excretory and reproductive systems

external anatomy of a grasshopper



internal anatomy of a female grasshopper

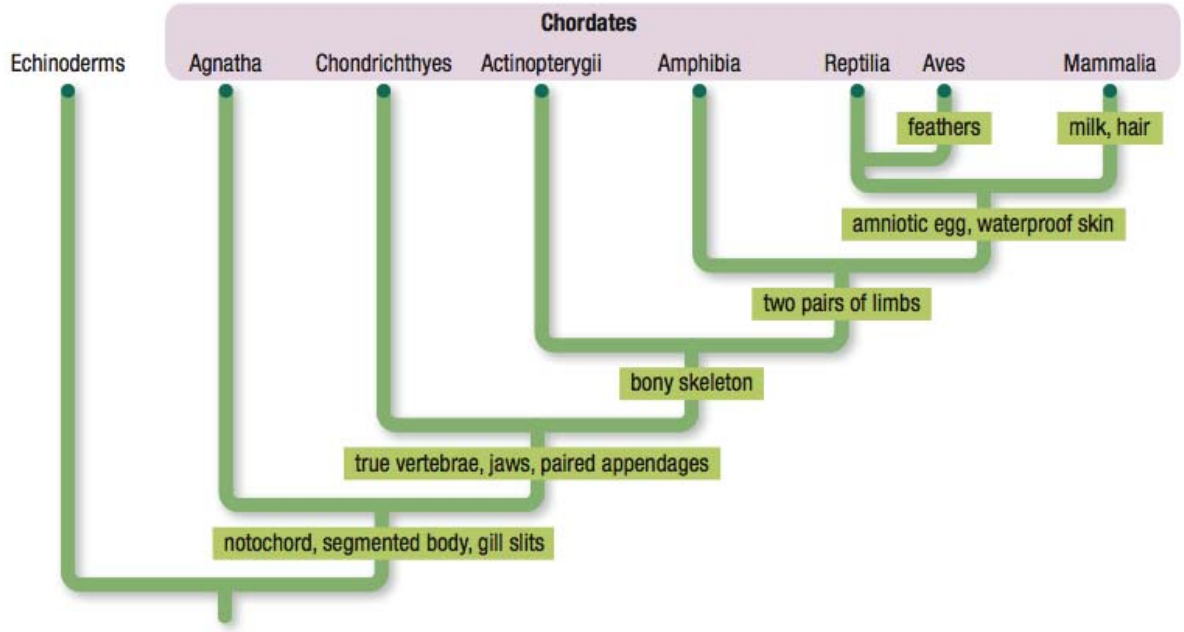


Human-Protostome Interactions

- Insects and humans compete for food
- Parasitic disease such as nematodes, tapeworms, and flukes infect the human body
- Ticks and mosquitos act as animal vectors and spread malaria, West Nile virus, Lyme disease
- Protostomes benefit humans as a food source (i.e. mollusks, crustaceans), materials (i.e. silk, honey) and pollination

The Deuterostomes

- Includes the echinoderms and chordates
- Echinoderms – starfish, sea urchins, sea cucumbers
  - Moves using a water-filled vascular system and hydraulic action
- Chordates – fish, amphibians, mammals, reptiles and birds
  - Development of a waterproof amniotic egg with an outer leathery or hard shell and internal membranes that protect and nourish the embryo



Class	Examples (Animals shown in the photos are bolded.)		Key features
Agnathans (jawless fishes)	**lamprey**, hagfish		• Their skeletons are made of cartilage, they have no jaws, and a notochord is present in adults. • They have gill slits but no paired appendages. • Hagfish are scavengers. • Many lampreys are parasites of fish. • Lampreys have larval forms that are filter feeders. • There are marine and freshwater species. • About 60 species have been described.
Chondrich-thyes (cartilaginous fishes)	**sharks**, rays, skates		• Their skeletons are made of cartilage. • They have jaws, vertebrae, gill slits, and paired appendages. • Their fins are often thick. • Many are predators of other fish. • Reproduction uses internal fertilization. • Most species are marine. • About 850 species have been described.
Actinopterygii (bony fishes)	most common fish—bass, **trout**, tuna, salmon		• Their skeletons are bony. • Most have a swim bladder—a gas-filled organ used to control buoyancy. • Their fins are often membrane-like with stiff "rays" for support. • Most species use external fertilization. • There are marine and freshwater species. • About 24 000 species have been described.
Amphibia (amphibians)	frogs, **salamanders**, caecilians		• Most have an aquatic larval stage with gills. • Adults are tetrapods—having four limbs adapted for moving on land (except caecilians). • Most species use external fertilization. • They breathe through their lungs and/or skin. • About 5000 species have been described.

Reptilia (reptiles and birds*) *Birds are described separately.	snakes, **lizards**, crocodilians		• Most are terrestrial tetrapods with dry scaly skin. • They breathe with lungs. • They use internal fertilization. • They have amniotic eggs with soft shells. • Turtles lack teeth and have a bony shell. Aquatic species have webbed feet. • Turtles are the most distantly related group within the reptile clade. • About 7300 species have been described.
Aves (birds)	birds		• They are tetrapods with forelimbs modified as wings. • Most species are capable of flight. • They have feathers. • They are warm-blooded (endothermic). • They have large brains and acute vision. • They use internal fertilization. • They lay hard-shelled amniotic eggs. • About 9700 species have been described.
Mammalia (mammals)	mammals		• They are tetrapods and have hair. • They nurse their young with milk produced in mammary glands. • They are warm-blooded (endothermic). • They have large brains and acute vision and sense of smell. • They use internal fertilization. • Most give birth to live young; a few species produce amniotic eggs. • About 4500 species have been described.

Feature	Examples
Size	• Blue whales can have a mass of more than 150 000 kg. Their hearts alone can have a mass of 600 kg. They give birth to a single calf with a mass of more than 2500 kg. The calf drinks 400 L of milk each day! • The smallest bird is the bee hummingbird of Cuba. It has a mass of just 1.8 g, the same as a dime. This extraordinarily small flying machine is capable of beating its wings 80 times per second and visiting more than 1000 flowers in a single day.
Sensory ability	• Echolocating bats can detect an echo off an object as small as a mosquito. They can also produce and detect sounds with frequencies far beyond the range of human hearing. • Pit viper snakes have the ability to detect infrared radiation. Special pits on the sides of their heads detect this thermal energy, which is given off by warm-blooded mammals and birds.
Behaviour	• The longest migration of any animal is that of the arctic tern. Their annual zigzagging return trip can cover a distance of over 71 000 km! • Arctic ground squirrels, in contrast, hibernate over the winter. Arctic winters are so long that these ground squirrels spend more than 80 % of their lives asleep!
Life cycles	• Finding a mate in the deep ocean is extremely difficult. So when the tiny male angler fish finds one, he bites onto the body of the female and remains attached to her for the rest of his life. The body of the female grows into the mouth of the male, and their circulatory systems fuse. When the female is releasing her eggs, hormones in her blood travel into the body of the male and cause it to release sperm. • Females of the recently extinct gastric brooding frog swallowed their fertilized eggs. The eggs hatched in their mother's stomach, and the tadpoles developed there fully before climbing up her throat and hopping away!