

A Visual Guide to The Diversity of Life



▲ The Chambered Nautilus, found today in the Pacific Ocean, is one of the few living representatives of a group that once flourished in ancient seas 265 million years before the dinosaurs evolved. This Visual Guide will give you a glimpse of life's great variety and evolutionary history.



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HOW TO USE THIS GUIDE

Use this visual reference tool to explore the classification and characteristics of organisms, including their habitats, ecology, behavior, and other important facts. This guide reflects the latest understandings about phylogenetic relationships within the three domains of life. Divided into six color-coded sections, the Visual Guide begins with a brief survey through the Bacteria and Archaea domains. It next discusses the major groups of protists, fungi, and plants. The final section provides information on nine animal phyla.

1 See how the group of organisms relates to others on the tree of life.

2 Learn about the general characteristics that all members of the group share.

3 Discover the members of the group and learn about their traits.

Animals

Cnidarians

KEY CHARACTERISTICS

Cnidarians are aquatic, mostly carnivorous, and the simplest animals to have specialized tissues [outer skin and lining of the gastrovascular cavity] and body symmetry [radial]. Their tentacles have stinging cells called nematocysts used in feeding.

Feeding and Digestion Predatory, stinging prey with nematocysts; digestion begins extracellularly in gastrovascular cavity and is completed intracellularly; indigestible materials leave body through single opening; many, especially reef-building corals, also depend on symbiotic algae, or zooxanthellae.

Circulation No internal transport system; nutrients typically diffuse through body.

Eco-Alert

Coral Symbionts

The color of this star coral is caused by zooxanthellae algae living within it.

Reproduction Diffusion through body walls

Excretion Cellular wastes diffuse through body walls

Response Some specialized sensory cells, nerve cells in nerve net, statocysts that help determine up and down, eyespots (ocelli) made of light-detecting cells

Movement Polyps stationary, medusas free-swimming; very slowly; others move using muscles that work with a hydrostatic skeleton and water in gastrovascular cavity; medusas such as jellyfish move by jet propulsion generated by muscle contractions.

Reproduction Most—alternate between sexual (most species by external fertilization) and asexual (polyps produce new polyps or medusae by budding)

GROUPS OF CNIDARIANS
There are more than 9000 species of cnidarians.

HYDROZOA: Hydras and their relatives
Hydras and their relatives spend most of their time as polyps and are either colonial or solitary. They reproduce asexually (by budding), sexually, or they alternate between sexual and asexual reproduction. Examples: hydra, Portuguese man-of-war.

ANTHOZOA: Corals and sea anemones
Corals and sea anemones are colonial or solitary polyps with no medusa stage. The central body is surrounded by tentacles. They reproduce sexually or asexually. Examples: reef corals, sea anemones, sea pens, sea fans.

SCYPHOZOA: Jellyfishes
Jellyfishes spend most of their time as medusas; some species bypass the polyp stage. They reproduce sexually and sometimes asexually by budding. Examples: lion's mane jellyfish, moon jelly, sea wasp.

DOL • 32

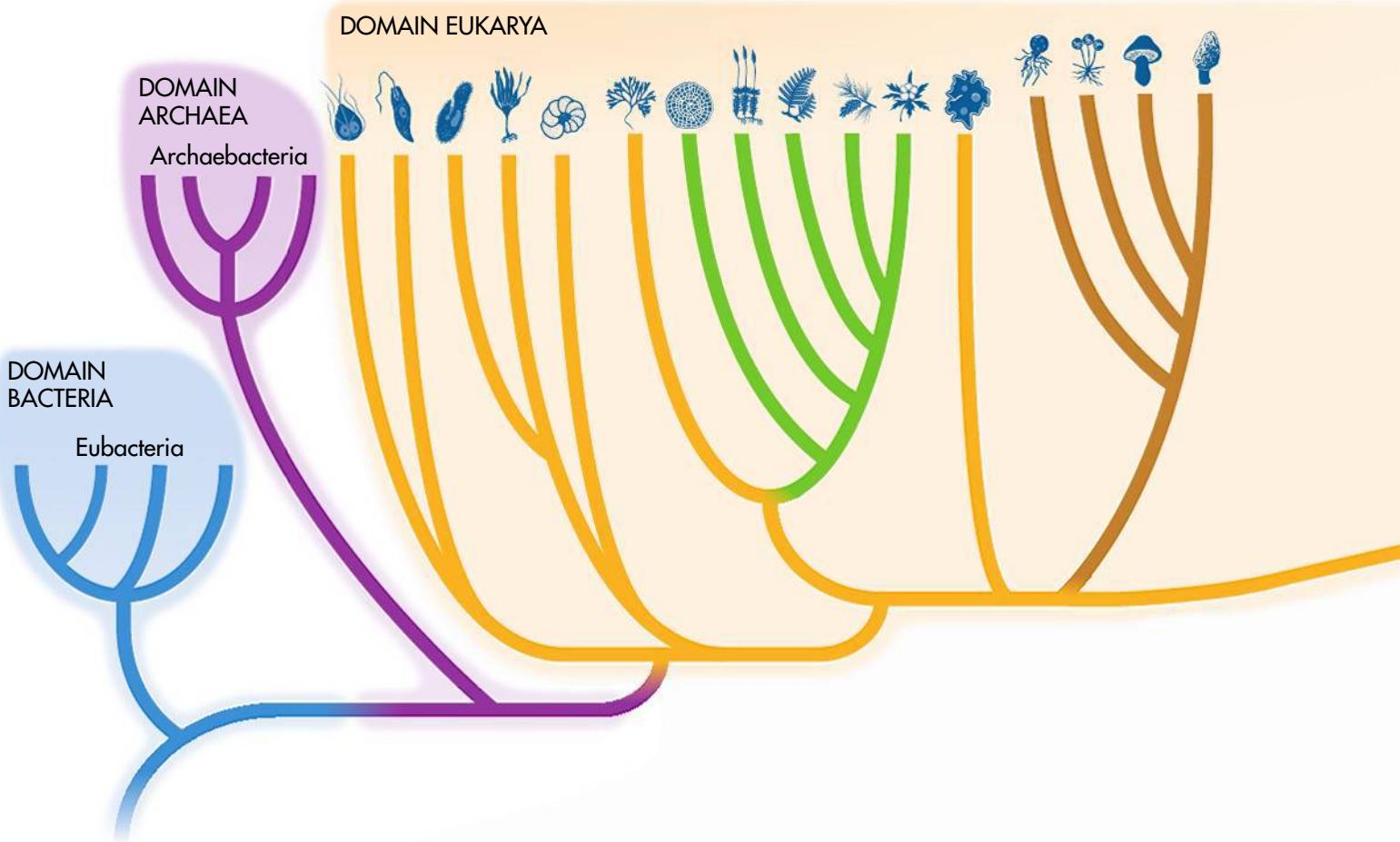
DOL • 33

4 Investigate current news and interesting facts about the group.

5 See photographs of representative animals within each group.



THE TREE OF LIFE



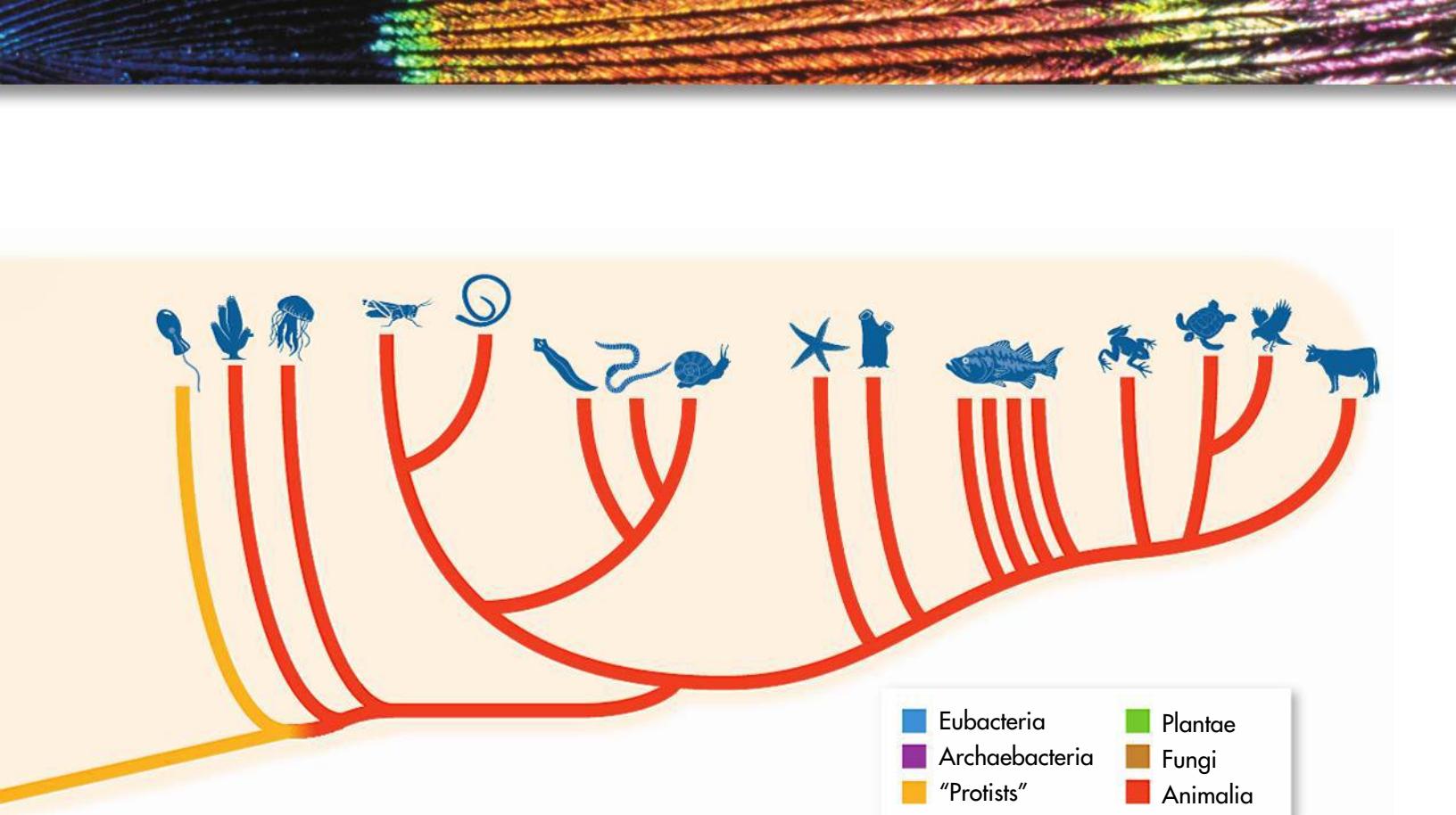
Before you begin your tour through the kingdoms of life, review this big picture from Chapter 18. The pages that follow will give you a glimpse of the incredible diversity found within each of the "branches" shown here.

DOMAIN BACTERIA

Members of the domain Bacteria are unicellular and prokaryotic. The bacteria are ecologically diverse, ranging from free-living soil organisms to deadly parasites. This domain corresponds to the kingdom Eubacteria.

DOMAIN ARCHAEA

Also unicellular and prokaryotic, members of the domain Archaea live in some of the most extreme environments you can imagine, including volcanic hot springs, brine pools, and black organic mud totally devoid of oxygen. The domain Archaea corresponds to the kingdom Archaebacteria.



Eubacteria	Plantae
Archaeabacteria	Fungi
"Protists"	Animalia

DOMAIN EUKARYA

The domain Eukarya consists of all organisms that have cells with nuclei. It is organized into the four remaining kingdoms of the six-kingdom system: Protista, Fungi, Plantae, and Animalia.

THE "PROTISTS"

Notice that the branches for the kingdom Protista are not together in one area, as is the case with the other kingdoms. In fact, recent molecular studies and cladistic analyses have shown that "eukaryotes formerly known as Protista" do not form a single clade. Current cladistic analysis divides these organisms into at least six clades. They cannot, therefore, be properly placed into a single taxon.

FUNGI

Members of the kingdom Fungi are heterotrophs. Most feed on dead or decaying organic matter. The most recognizable fungi, including mushrooms, are multicellular. Some fungi, such as yeasts, are unicellular.

ANIMALS

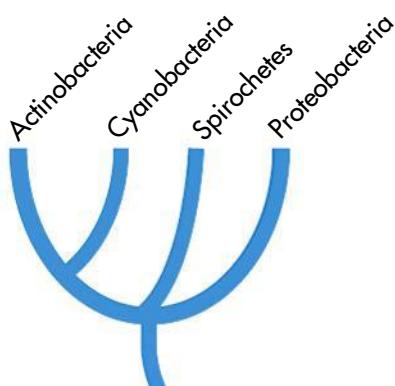
Members of the kingdom Animalia are multicellular and heterotrophic. Animal cells do not have cell walls. Most animals can move about, at least for some part of their life cycle.

PLANTS

Members of the kingdom Plantae are autotrophs that carry out photosynthesis. Plants have cell walls that contain cellulose. Plants are nonmotile—they cannot move from place to place.



Bacteria



Salmonella typhimurium (green)
invading human epithelial cells
(SEM 16,000 \times)



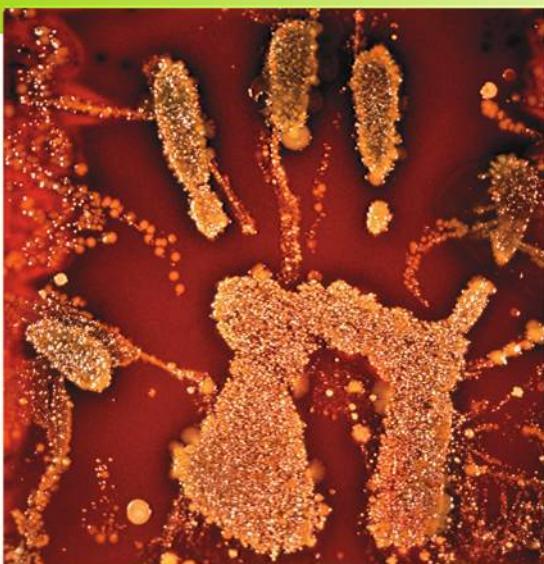
KEY CHARACTERISTICS

Bacteria are prokaryotes—cells that do not enclose their DNA in membranous nuclear envelopes as eukaryotes do. Many details of their molecular genetics differ from those of Archaea and Eukarya.

Cell Structure Variety of cell shapes, including spherical, rodlike, and spiral; most have cell walls containing peptidoglycan. Few if any have internal organelles. Some have external flagella for cell movement.

Genetic Organization All essential genes are in one large DNA double helix that has its ends joined to form a closed loop. Smaller loops of DNA (plasmids) may carry nonessential genes. Simultaneous transcription and translation; introns generally not present; histone proteins absent

Reproduction By binary fission; no true sexual reproduction; some achieve recombination by conjugation.



Did You Know?

A World of Bacteria

Putting Bacteria in Proper Perspective

“Planet of the Bacteria” was the title of an essay by the late Stephen Jay Gould. He pointed out that the dominant life forms on planet Earth aren’t humans, or animals, or plants. They are bacteria. They were here first, and they inhabit more places on the planet than any other form of life. In fact, bacteria make up roughly 10 percent of our own dry body weight! In terms of biomass and importance to the planet, bacteria truly do rule this planet. They, not we, are number one.

► The bacterial colonies shown here are growing in the print of a human hand on agar gel.

GROUPS OF BACTERIA

There is no generally agreed phylogeny for the bacteria. Included here are some of the major groups within the domain.

PROTEOBACTERIA

This large and diverse clade of bacteria includes *Escherichia* (*E. coli*), *Salmonella*, *Helicobacter*, and the nitrogen-fixing soil bacterium *Rhizobium*.



► *Helicobacter pylori* is rod-shaped and has several flagella used for movement. This bacterium infects the stomach lining and causes ulcers in some people. (TEM 7100 \times)

The spiral-shaped bacterium that causes syphilis is *Treponema pallidum*. (SEM 10,000 \times) ▼

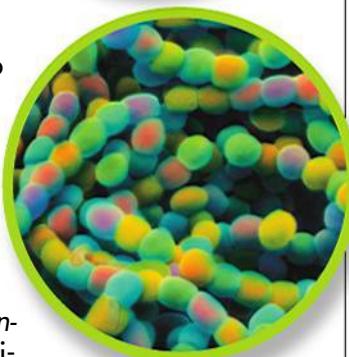
SPIROCHAETES

The spirochaetes (spy roh keets) are named for their distinctive spiral shape. They move in a corkscrew-like fashion, twisting along as they are propelled by flagella on both ends of the cell. Most are free-living, but a few cause serious diseases, including syphilis, Lyme disease, and leptospirosis.



ACTINOBACTERIA

A large number of soil bacteria belong to this group. Some form long filaments. Members include the *Streptomyces* and *Actinomyces*, which are natural producers of many antibiotics, including streptomycin. A related group is the *Firmicutes*. The *Firmicutes* include *Bacillus anthracis* (anthrax), *Clostridia* (tetanus and botulism), and *Bacillus thuringiensis*, which produces a powerful insecticide used for genetic engineering in plants.



▲ Chains of spores of soil bacteria, genus *Streptomyces* (SEM 3400 \times)

CYANOBACTERIA

The cyanobacteria are photosynthetic prokaryotes that were once called "blue-green algae." They are among the oldest organisms on Earth, having been identified in rocks dating to more than 3 billion years ago. They are found in salt water and fresh water, in the soil, and even on the surfaces of damp rocks. They are the only organisms on Earth that are able to fix carbon and nitrogen under aerobic conditions, and this enables them to play critical roles in the global ecosystem, where they serve as key sources of carbon and nitrogen.

▼ Many cyanobacteria form long filaments of attached cells, like those shown here (genus *Lyngbya*, SEM 540 \times). ▶



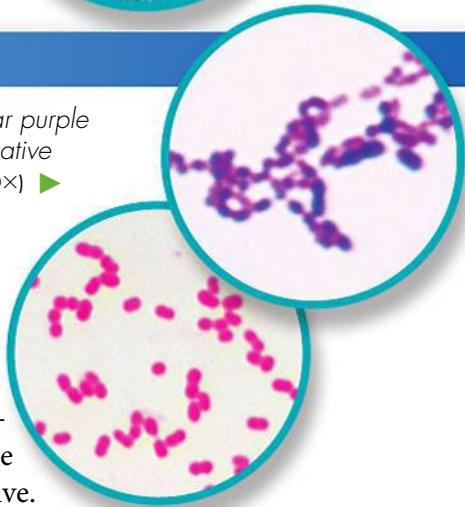
•A Closer Look

The Gram Stain

A Microbiologist's Quick Diagnostic

The Gram stain, developed by the nineteenth-century Danish physician Hans Christian Gram, allows microbiologists to categorize bacteria quickly into one of two groups based on their cell wall composition. Gram-positive bacteria lack a membrane outside the cell wall and take up the stain easily. Gram-negative bacteria, on the other hand, have an outer membrane of lipids and carbohydrates that prevents them from absorbing the gram stain. Many gram-negative bacteria are found among the proteobacteria. On the other hand, actinobacteria are mostly gram-positive.

Gram-positive bacteria appear purple after staining, while gram-negative bacteria appear pink. (LM 1000 \times) ▶



Archaea



KEY CHARACTERISTICS

Archaea are prokaryotes that differ from bacteria in so many details of structure and metabolism that they are viewed as a different domain than bacteria. Genetically, they have more in common with eukaryotes than with bacteria. Their cell walls do not contain peptidoglycan.

Cell Structure Cells similar to those of bacteria in appearance; many have flagella that are different in structure and biochemical composition from bacterial flagella. Cell membrane lipids also different from those of bacteria; few internal organelles

Genetic Organization As in bacteria, all essential genes are in one large DNA double helix that has its ends joined to form a closed loop. Proteins responsible for transcription and translation are similar to those of eukaryotes. Also like eukaryotes, most species contain introns, and all species contain DNA-binding histone proteins.

Reproduction By binary fission; no true sexual reproduction, but some achieve recombination by conjugation.

▼ These halophilic archaea thrive in salty environments.
(SEM 25,000×)



▲ The volcano Solfatara, near Naples, Italy, is home to many archaea in the genus *Sulfobolus*.

Did You Know?

Hot Enough for You?

The Original Extremists

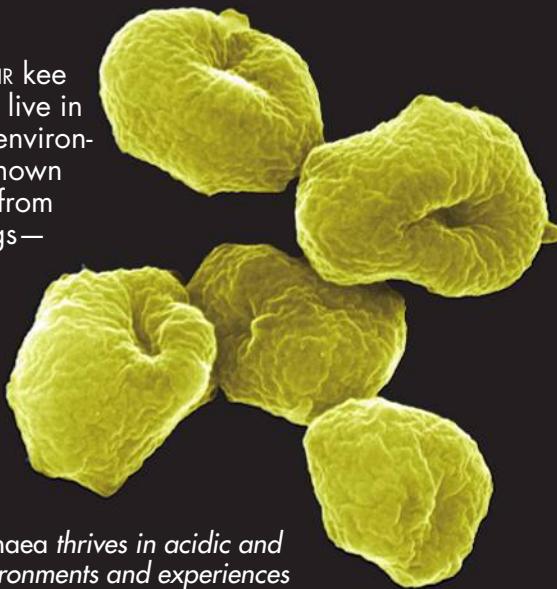
Way before extreme sports and extreme reality TV shows came the archaea—the original and ultimate extremists. When archaea were first discovered, biologists called them *extremophiles*, a term that literally means “lovers of the extreme.” For many archaea, the name still fits. In fact, they have proven especially difficult to grow in the lab, since they require such extreme temperatures and dangerous chemical conditions to thrive. One species will grow only in sulfuric acid! Archaea found in deep-sea ocean vents thrive in temperatures exceeding 100° Celsius, while others enjoy life in the frigid waters of the Arctic.

GROUPS OF ARCHAEA

To date, four major clades of archaea have been identified. Biologists continue to debate how these clades are related to one another.

CRENARACHAEOTES

The crenarchaeotes (kren AHR kee ohts) include organisms that live in the hottest and most acidic environments known. Most of the known species have been isolated from thermal vents and hot springs—the prefix *cren-* means “spring.” Some species grow using organic compounds as energy sources, but others fix carbon from carbon dioxide, using hydrogen or sulfur to provide chemical energy.



► *Sulfolobus* archaea thrives in acidic and sulfur-rich environments and experiences optimal growth at 80° Celsius. (SEM 33,200×)

KORARCHAEOTES

Scientists recently discovered the korarchaeote (kawr AHR kee oht) lineage in Obsidian Pool, Yellowstone National Park, and have since discovered more species in Iceland. Their DNA sequences place them apart from other archaea. The korarchaeotes may in fact be one of the least-evolved lineages of modern life that has been detected in nature so far.



▲ Korarchaeotes from Obsidian Pool are shown in a lab culture with other microbes from their community. (SEM 6000×)

▼ Colony of *Methanoscincina* archaea (SEM 40,000×)

EURYARACHAEOTES

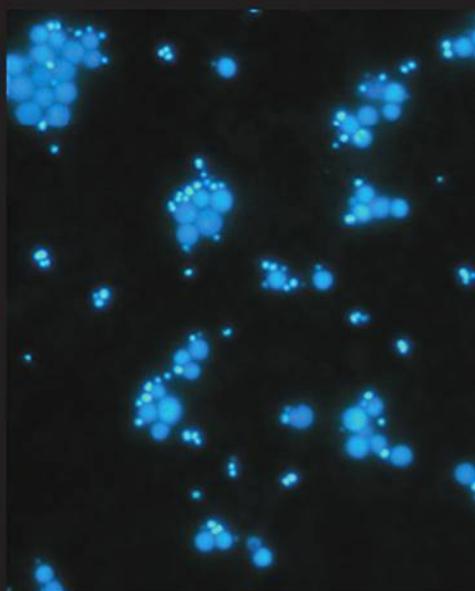
The euryarchaeotes (yoor ee AHR kee ohts) are a very diverse group of archaea, living in a broad range of habitats. The prefix *eury-* comes from a Greek word meaning “broad.” The methanogens are a major group of euryarchaeotes that play essential roles in the environment. They help to break down organic compounds in oxygen-poor environments, releasing methane gas in the process. Another group, the *Halobacteria*, are found in salt ponds, where the concentration of sodium chloride approaches saturation.



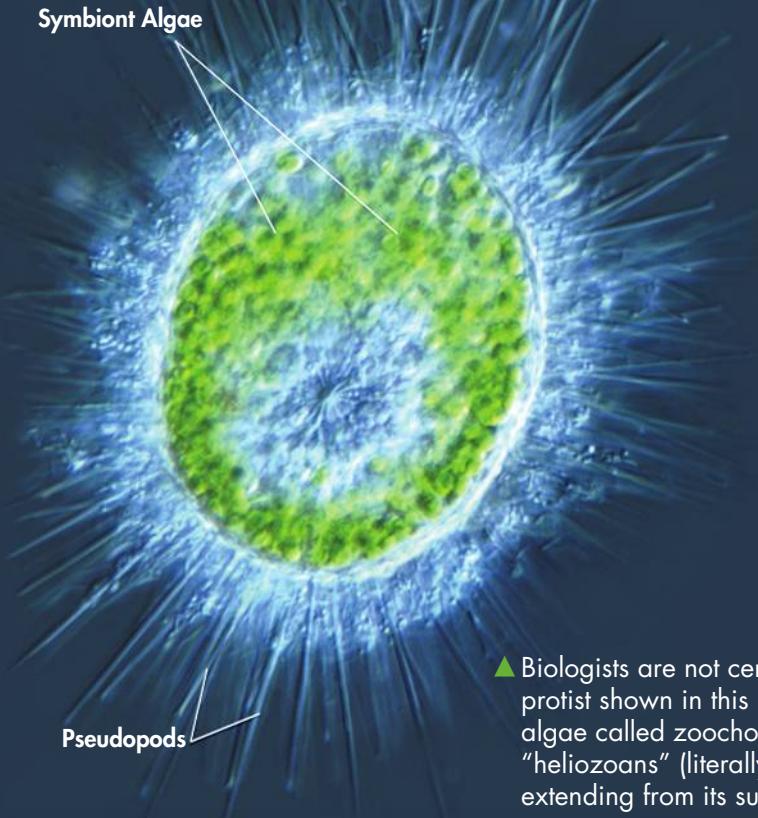
NANOARACHAEOTES

Only a single species of this group has been discovered, in 2002, attached to a much larger crenarchaeote! Nanoarchaeotes (na noh AHR kee ohts) grow in hot vents near the coastal regions of the ocean and show definite molecular differences from other archaea. More research is needed to characterize this group, but what is known is that they have the smallest known genome of any organism.

▼ The newly discovered *Nanoarchaeum equitans* (smaller cells) is shown attached to its host, genus *Ignicoccus* (larger cells). (LM 2000×)



Protists



KEY CHARACTERISTICS

A protist is a eukaryote, generally single-celled, that does not fit into any of the other major taxonomic groups. The protists do not make up a true kingdom.

Organization Great diversity of cell organelles and organization: some have cell walls, some have chloroplasts, most have mitochondria or organelles related to mitochondria; those that are multicellular have relatively little differentiation into tissues.

Movement Some move by cilia or flagella.

Reproduction Most reproduce by cell division; many have sexual phases to their life cycle; some exchange genetic material by conjugation.

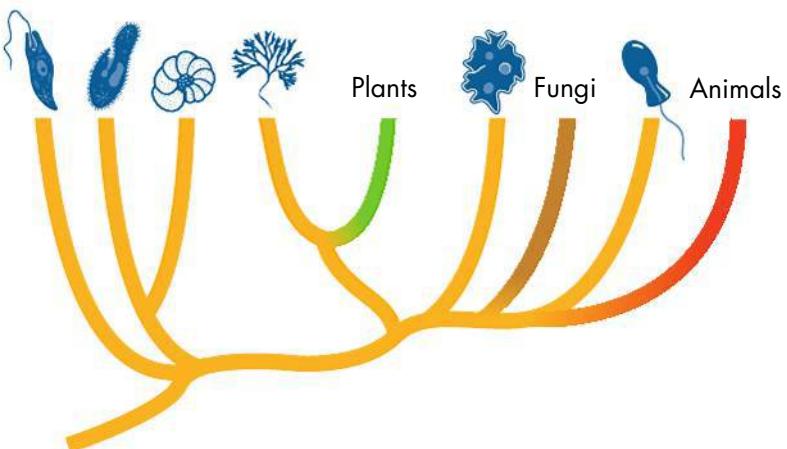
▲ Biologists are not certain how to classify *Heterophrys*, the freshwater protist shown in this micrograph. It harbors symbiotic photosynthetic algae called zoochorellae. *Heterophrys* is one of many protists called “heliozoans” (literally, “sun animals”) because of the thin pseudopods extending from its surface, giving it a sun-like appearance.

Did You Know?

The Kingdom That Isn't

The Challenges of Classifying Protists

Biologists traditionally classified protists by splitting them into funguslike, plantlike, and animal-like groups. This seemed to work for a while, but when they studied protists more carefully with new research tools, including genome-level molecular analysis, this traditional system simply fell apart.



Biologists now think that protists shouldn't be classified as a kingdom at all. In fact, when scientists look for the deepest and most fundamental divisions among eukaryotes, they find that all of those divisions are within the protists themselves, not between protists and other eukaryotes. Starting over, biologists could simply use those divisions to define newer, more accurate “kingdoms,” but that might cause new problems. For one thing, it would lump two of the traditional kingdoms (animals and fungi) together, and it would leave a handful of kingdoms that contain only unicellular organisms. There is no perfect solution to this problem. Here, “protists” are considered a kingdom for the sake of convenience, but keep in mind that their differences are really too great for any single kingdom to contain.

Excavates

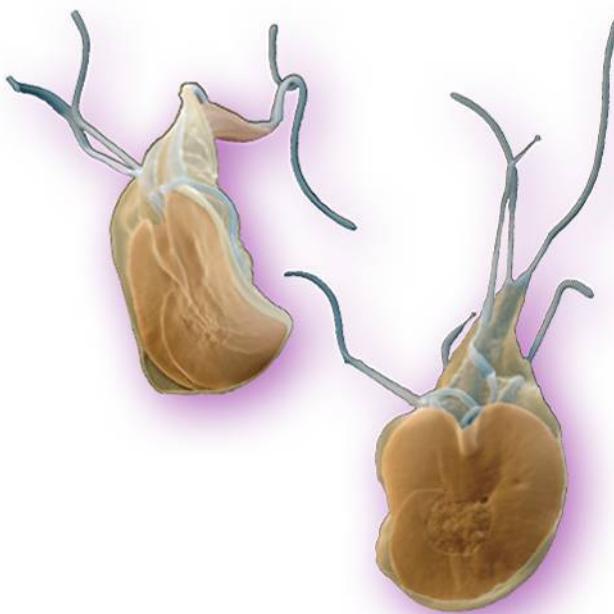


KEY CHARACTERISTICS

Excavates (EKS kuh vayts) have a characteristic feeding groove, usually supported by microtubules. Most have flagella. A few lack mitochondria and are unable to carry out oxidative phosphorylation, although they do possess remnants of the organelle.

GROUPS OF EXCAVATES

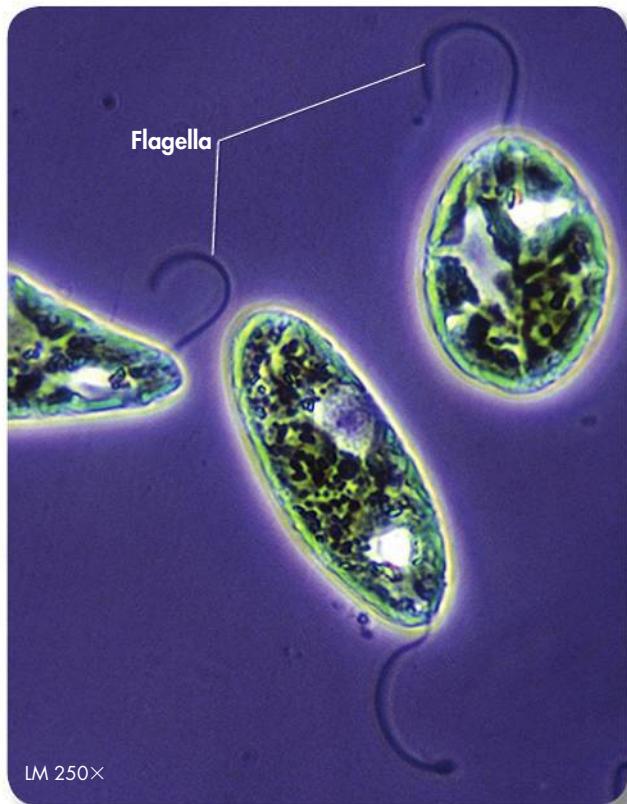
The excavates include a wide diversity of protists, from free-living photosynthesizers to some of humankind's most notorious pathogens.



▲ The diplomonad *Giardia* is a dangerous intestinal parasite that frequently contaminates freshwater streams. *Giardia* infections are common in wildlife and pet dogs and cats. (SEM 1800 \times)

DIPLOMONADS

These organisms get their name from the fact that they possess two distinct and different nuclei (from Greek, diplo = double). The double nuclei probably derived from an ancient symbiotic event in which one species was engulfed by another. Cells contain multiple flagella, usually arranged around the body of the cell. Most species of diplomonads are parasitic.

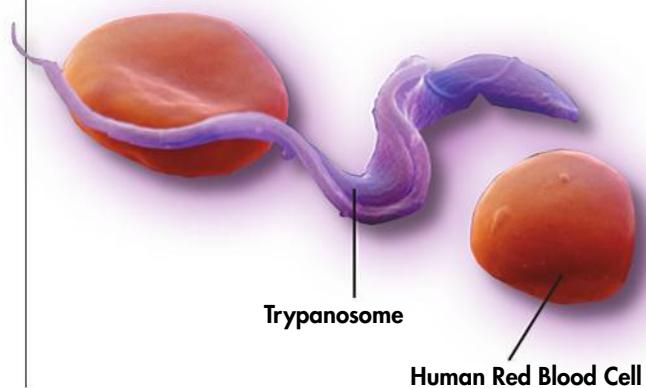


▲ Photosynthetic *Euglena gracilis* is commonly found in lakes and ponds.

DISCICRISTATES

Discicristates (disk ee KRIS tayts) are named for the disc-shaped cristae present in their mitochondria. Some species are photosynthetic and free-living, such as *Euglena*, while others are dangerous parasites.

▼ The ribbonlike cells of *Trypanosoma brucei* cause African sleeping sickness. The parasitic protist is transmitted by tsetse flies to humans, where it infects the blood, lymph, and spinal fluid. Severe nervous system damage and death are the usual result. (SEM 6700 \times)



Chromalveolates

KEY CHARACTERISTICS

Chromalveolates (*krohm AL vee uh layts*) get their name from alveoli, flattened vesicles that line the cell membrane. The prefix *chromo-*, meaning “pigment,” reflects evidence that members of this clade share a common ancestor that had accessory pigments used in photosynthesis.

GROUPS OF CHROMALVEOLATES

The chromalveolates are one of the largest and most diverse groups of eukaryotes.

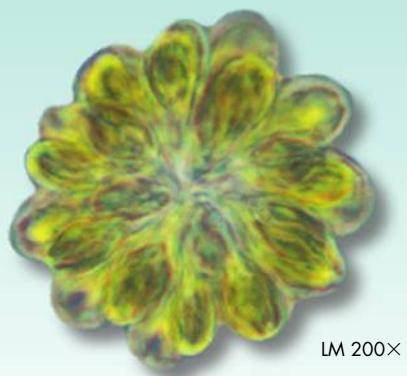
PHAEOPHYTES: Brown algae

Phaeophytes (*FAY uh fyts*) are mostly found in salt water. They are some of the most abundant and visible of the algae. Most species contain fucoxanthin, a greenish-brown pigment from which the group gets its common name. The multicellular brown alga known as giant kelp can grow as large as 60 meters in length.

▼ Brown algae in genus *Fucus* are commonly found in tidepools and on rocky shorelines of the United States.



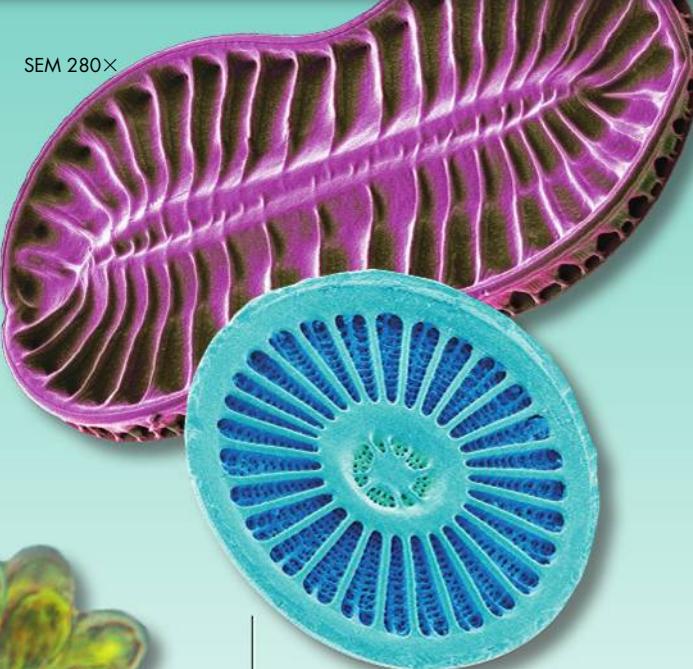
SEM 280×



▲ This species, in genus *Synura*, is a colonial alga.

CHRYSTOPHYTES: Golden algae

Chrysophytes (*KRIS oh fyts*) are known for colorful accessory pigments in their chloroplasts. Most are found in fresh water and are photosynthetic.

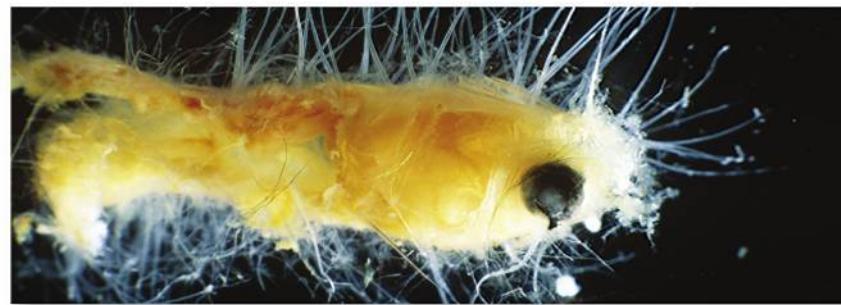


SEM 1000×

▲ Diatoms often produce intricate shells made from silicon dioxide that persist long after they die.

DIATOMS

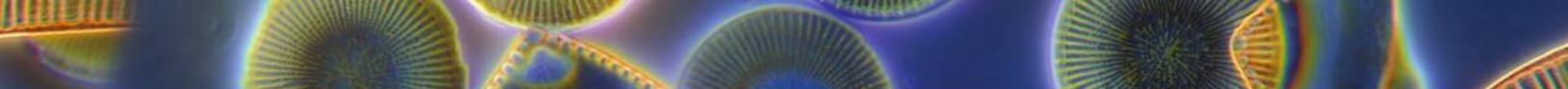
Diatoms are mostly found in salt water. When they die, they sink to the ocean floor, and their shells pile up in large deposits. Diatomaceous earth, as these deposits are known, can be used to screen out small particles, and is often used in swimming pool filters.



▲ Water molds growing on a dead goldfish

OOMYCETES: Water molds

These nonphotosynthetic organisms are often confused with fungi. Oomycetes (*oh uh MY seed eez*) typically produce fuzzy mats of material on dead or decaying animals and plants. Oomycetes are also responsible for a number of serious plant diseases, including potato blight, sudden oak death, and ink disease, which infects the American chestnut tree.



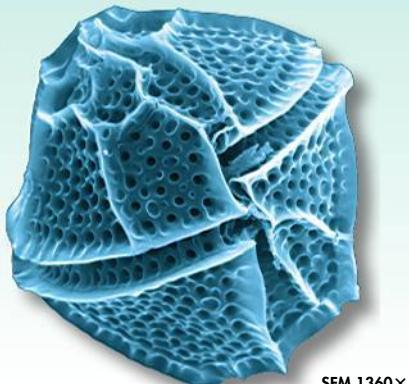
► Paramecium multimicronucleatum is the largest paramecium, with cells that are visible to the naked eye.

CILIATES

These common organisms may contain hundreds or even thousands of short cilia extending from the surface of the cell. The cilia propel the ciliate through the water, and may sweep food particles into a gullet. Ciliates are large compared to other protists, with some cells exceeding 1 mm in length.

DINOFLAGELLATES

Dinoflagellates are photosynthetic protists found in both fresh and salt water. Their name comes from their two distinct flagella, usually oriented at right angles to each other. Roughly half of dinoflagellate species are photosynthetic; the other half live as heterotrophs. Many dinoflagellate species are luminescent, and when agitated by sudden movement in the water, give off light.



▲ The two flagella of dinoflagellates originate in grooves within thick plates of cellulose that resemble a cross shape, as shown here (genus *Protoperdidinium*).

Eco • Alert

Toxic Blooms

Dangerous Dinoflagellates

Great blooms of the dinoflagellates *Gonyaulax* and *Karenia* have occurred in recent years on the East Coast of the United States, although scientists are not sure of the reason. These blooms are known as “red tides.” *Gonyaulax* and *Karenia* produce a toxin that can become amplified in the food chain when filter-feeding shellfish such as oysters concentrate it in their tissues. Eating shellfish from water affected by red tide can cause serious illness, paralysis, and even death.



Human Red Blood Cell

SEM 5000×

▲ Apicomplexans in genus *Plasmodium* are mosquito-borne parasites. Shown in green are the remnants of a red blood cell that burst when plasmodia reproduced inside.

APICOMPLEXANS

The apicomplexans (AYP ih kum plek sunz) are named for a unique organelle near one end of the cell known as the apical complex. This structure contains vesicles with enzymes that allow apicomplexans to enter other cells and take up residence as parasites.



▲ A red tide containing toxic dinoflagellates



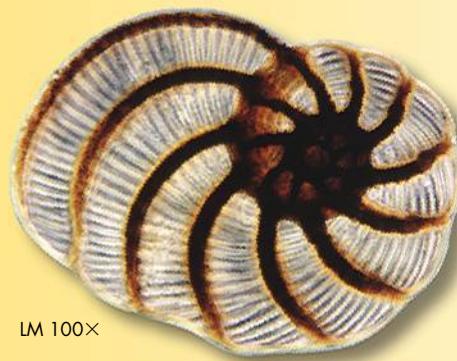


Cercozoa, Foraminiferans, and Radiolarians

There is no single morphological characteristic that unites this diverse trio, but many have extensions of cytoplasm called pseudopods and many produce protective shells. The grouping together of Cercozoa, Foraminifera, and Radiolaria is based almost entirely on molecular analyses and not on morphology.

FORAMINIFERANS

Foraminifera (fawr uh min if uh ra) produce intricate and beautiful shells that differ from species to species. Slender pseudopods that emerge through tiny holes in the shell enable them to capture food, including bacteria. As many as 4000 species exist.



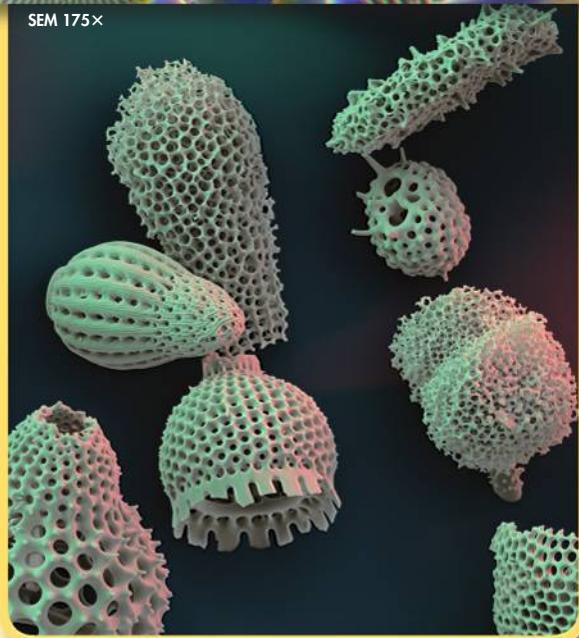
LM 100×

▼ *Peneroplis pertusus* has a spiral-shaped shell.

CERCOZOA

Members of this clade are common in soil, where they feed on bacteria as well as decaying organic matter. Many have flagella, and some produce scales made of silica that protect their surfaces.

SEM 175×



▲ Radiolarian shells are composed of silica or strontium sulfate.

RADIOLARIANS

These organisms have an intricate structure in which the nucleus is found in an inner region of the cell known as the endoplasm. The outer portion of the cell, known as the ectoplasm, contains lipid droplets and vacuoles. These organisms sometimes form symbiotic relationships with photosynthetic algae, from which they obtain food.

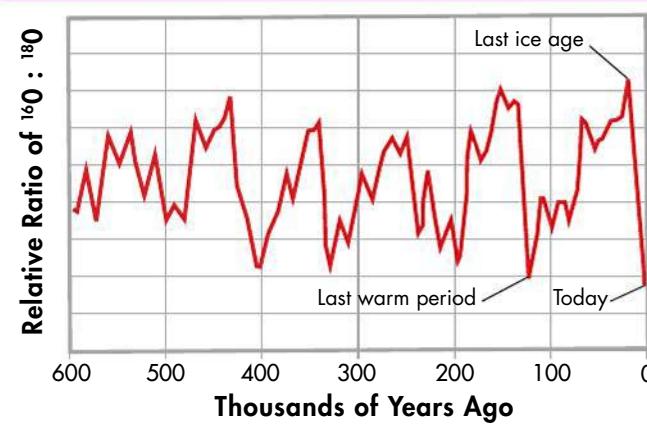
A Look Back in Time

Foraminiferan Fossils

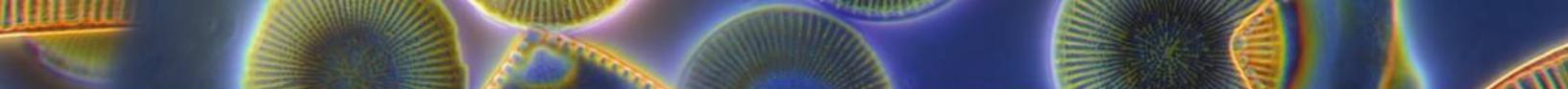
Ancient Climates Revealed

Abundant fossils of foraminiferans have been found in sediments dating to the Cambrian period (560 million years ago). For decades, oil companies have taken advantage of these ancient fossils to locate the sediments most likely to contain oil, but now there is another use for them—measuring the sea temperature of ancient Earth. Foraminiferans take dissolved oxygen from seawater to make the calcium carbonate (CaCO_3) in their shells, and when they do so, they take up two isotopes of oxygen, ^{16}O and ^{18}O . Because water made from ^{16}O is less dense, more of it evaporates into the atmosphere when the seas are warm—increasing the amount of ^{18}O in

Foraminiferan Isotope Ratios and Climate Change



the remaining seawater, and in the fossil shells. The ratio between ^{16}O and ^{18}O in these fossils allows scientists to study the history of seawater temperature, as shown in the graph above.



Rhodophytes



Also known as the red algae, these organisms get their name (from Greek, *rhodo* = red and *phyte* = plant) from reddish accessory pigments called phycobilins (fy koh BIHL inz). These highly efficient pigments enable red algae to grow anywhere from the ocean's surface to depths as great as 268 meters. Most species are multicellular. Rhodophytes are the sister group to kingdom Plantae.



▼ Some things that we call seaweeds, such as this rhodophyte, are actually protists

Amoebozoa

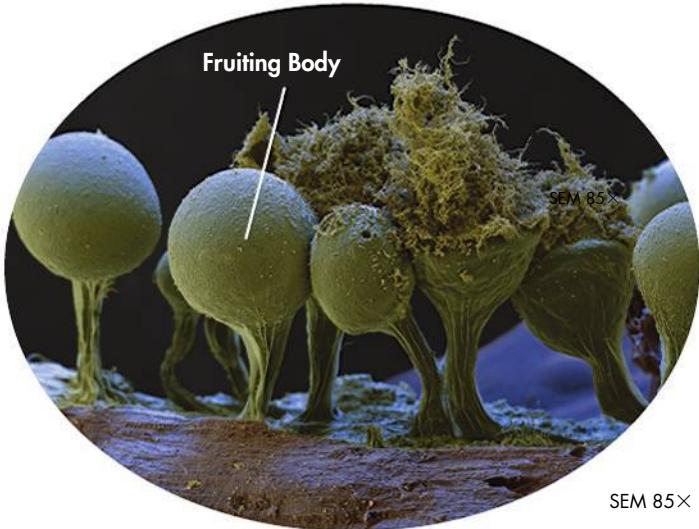


Members of the Amoebozoa (uh MEE boh zoh ah) are amoebalike organisms that move by means of cytoplasmic streaming, also called amoeboid movement, using pseudopods.

▼ This solitary amoeba, *Penardia mutabilis*, has very slender pseudopods.



▼ Slime molds live as single microscopic amoebas in the soil, but aggregate into a colony when conditions are right, forming a multicellular fruiting body. In this image, some of the fruiting bodies have burst, releasing spores.



SEM 85×

Choanozoa

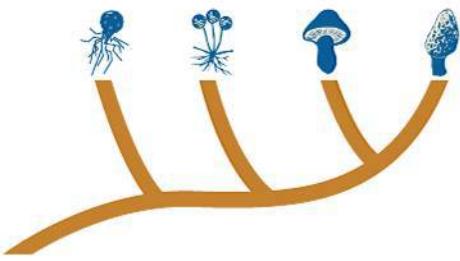


Members of the clade Choanozoa (koh AN uh zoh uh) can be solitary or colonial and are found in aquatic environments around the world. This clade is the sister group to kingdom Animalia.

Choanoflagellates are a major group in the clade Choanozoa. They get their name from a collar of cytoplasm that surrounds their single flagellum (from Greek, *choano* = collar). Many species trap food within the collar and ingest it.



Fungi



KEY CHARACTERISTICS

Fungi are heterotrophic eukaryotes with cell walls that contain chitin. Fungi were once thought to be plants that had lost their chloroplasts. It is now clear, however, that they are much more closely related to animals than to plants. More than 100,000 species of fungi are known. Distinctions among the phyla are made on the basis of DNA comparisons, cell structure, reproductive structures, and life cycles.



▲ Stinkhorn fungus (*genus Dictyophora*)

Organization Some are unicellular yeasts, but most have a multicellular body called a mycelium that consists of one or more slender, branching cells called hyphae.

Feeding and Digestion Obtain food by extracellular digestion and absorption

Reproduction Most have sexual phases to their life cycle and are haploid at most points during the cycle. Most produce tough, asexual spores, which are easily dispersed and able to endure harsh environmental conditions. Asexual reproduction by budding and splitting is also common.

• A Closer Look

Consumers Beware!

Edible and Inedible Mushrooms

Many types of fungi have long been considered delicacies, and several different species of mushrooms are cultivated for food. You may have already tasted sliced mushrooms on pizza, feasted on delicious sautéed portobello mushrooms, or eaten shiitake mushrooms. When properly cooked and prepared, domestic mushrooms are tasty and nutritious.

Wild mushrooms are a different story: Although some are edible, many are poisonous. Because many species of poisonous mushrooms look almost identical to edible mushrooms, you should never pick or eat any mushrooms found in the wild. Instead, mushroom gathering should be left to experts who can positively identify each mushroom they collect. The result of eating a poisonous mushroom can be severe illness, or even death.



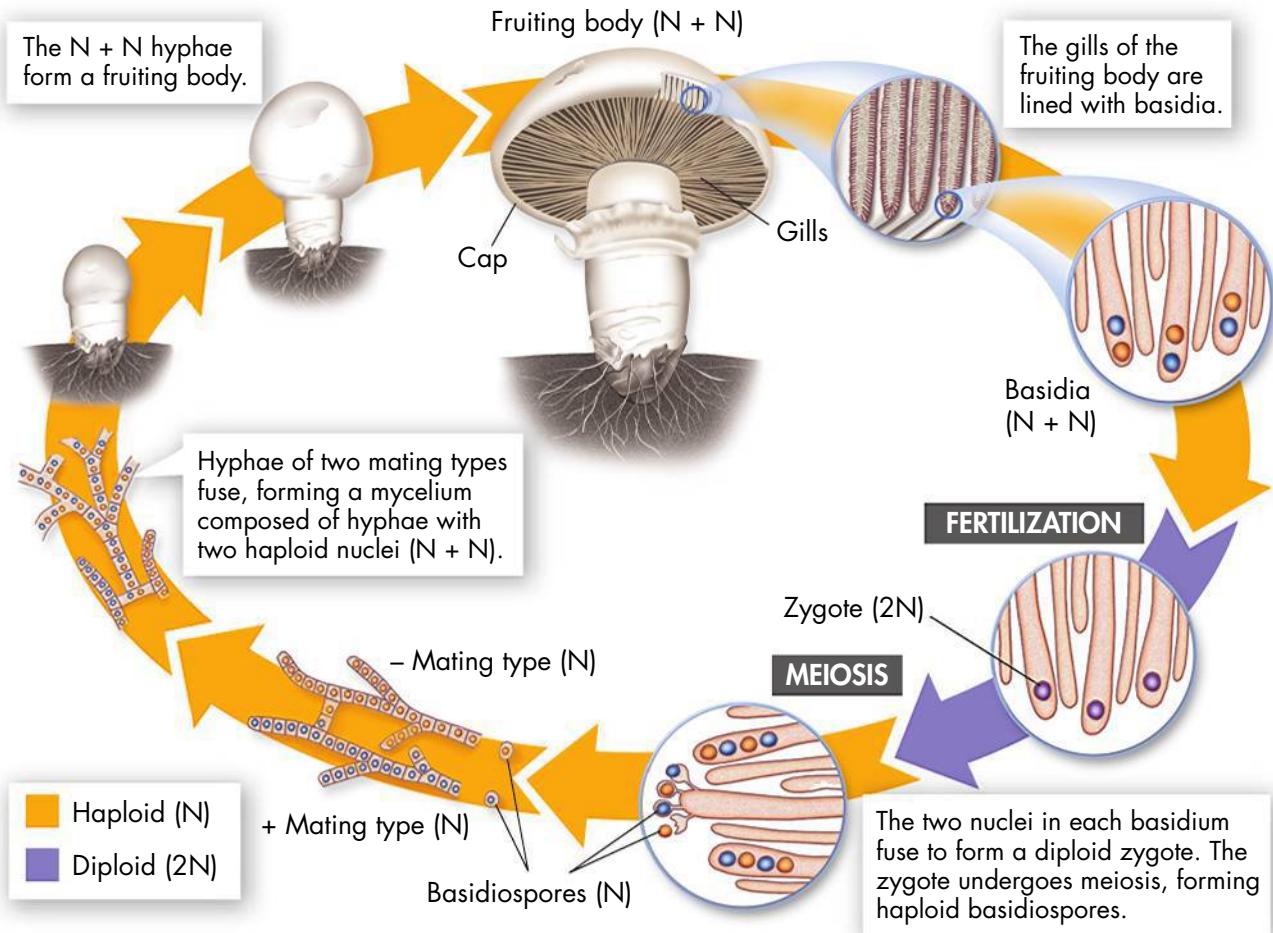
▲ Fly agaric (*Amanita muscaria*) is poisonous to humans.

Basidiomycetes

The basidiomycetes, or club fungi, are named for the basidium (buh SID ee um; plural: basidia). The basidium is a reproductive cell that resembles a club.

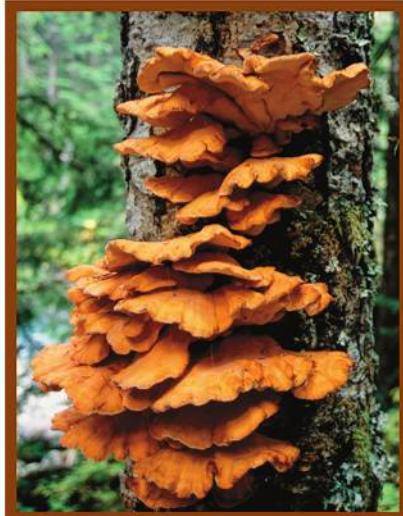


Life Cycle Basidiomycetes undergo what is probably the most elaborate life cycle of all the fungi, shown below.



Diversity More than 26,000 species of basidiomycetes have been described, roughly a quarter of all known fungal species. Examples include the stinkhorn and fly agaric mushrooms shown on the previous page, and the shelf fungus and puffball at right.

► Shelf fungi (*Polypore family*) often grow on the sides of dead or dying trees.



▼ A puffball releases its spores.



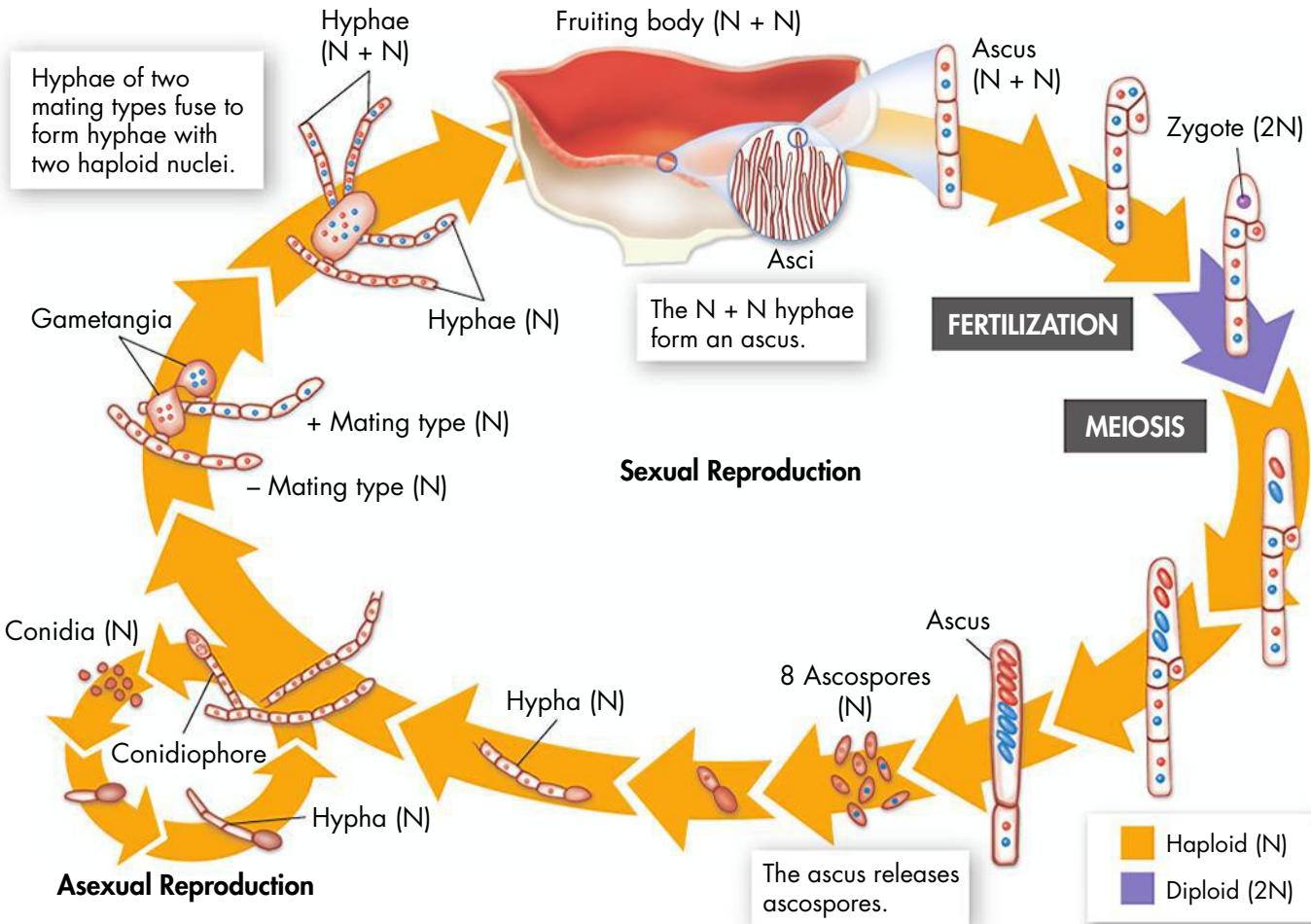
Fungi



Ascomycetes

The ascomycetes, or sac fungi, are named for the ascus (as' kus), a saclike reproductive structure that contains spores.

Life Cycle The ascomycete life cycle includes an asexual phase, in which haploid spores are released from structures called conidiophores, and a sexual phase.



▼ An edible morel in genus *Morchella*



Diversity There are more than 50,000 species of ascomycetes, making it the largest phylum of the Fungi. Some ascomycetes, such as morels and cup fungi, are large enough to be visible when they grow above ground. Others, such as the common yeasts used for baking bread, are microscopic.

▼ A cup fungus (genus *Cookeina*)



▲ *Saccharomyces cerevisiae*, the yeast used to raise bread dough, is a unicellular ascomycete that reproduces asexually by budding.

Zygomycetes



The hyphae of zygomycetes generally lack cross walls between cells. Zygomycetes get their name from the sexual phase of their reproductive cycle, which involves a structure called a zygosporangium that forms between the hyphae of two different mating types. One group within the zygomycetes, the Glomales, form symbiotic mycorrhizae (my koh RY zee) with plant roots.



► The fruiting body of the common black bread mold, *Rhizopus stolonifer* (SEM 450 \times)

► This micrograph shows mycorrhizal fungi in symbiosis with soybean roots. The soybean plant provides nutrient sugars to the fungus, while the fungus provides water and essential minerals to the plant. (SEM 200 \times)

Chytrids



Members of this phylum live in water or moist soil. Their reproductive cells have flagella, making them the only fungi known to have a motile stage to their life cycle. Chytrids are especially good at digesting cellulose, the material of plant cell walls—some live in the digestive systems of cows and deer, helping them to digest plant matter. Others are pathogens—certain chytrids have recently been associated with the decline of frog populations around the world. About 1000 species are known, many of them recently discovered.

► Spores of *Synchytrium endobioticum* in potato cells (LM 500 \times)



Eco • Alert



▲ Lichen-covered Japanese beech

Look to the Lichens

Lichens as Bio-Indicators

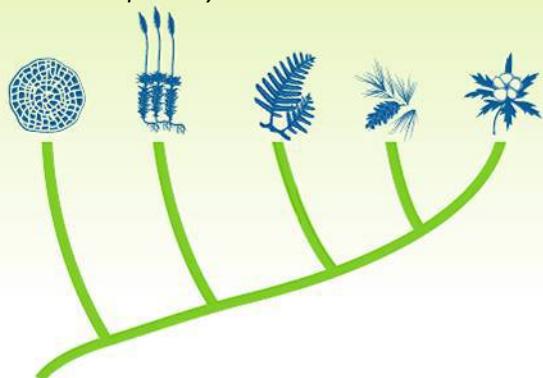
Lichens are mutualistic associations between a fungus, usually an ascomycete, and a photosynthetic organism, usually an alga. They are incredibly durable, and have even been reported to survive in the vacuum of space. However, they are also incredibly sensitive indicators of the state of the atmosphere. In particular, when sulfur dioxide is released into the atmosphere, it often reacts with water to form acids (including sulfuric acid) that pollute rainfall. Lichens can be severely damaged by acidic rainfall, although the degree of damage depends on the substrate upon which they grow. Lichens disappear first from the bark of pine and fir trees, which are themselves somewhat acidic. Lichens on elms, which have alkaline bark, are the last to go. By carefully monitoring the health of lichen populations of various trees, scientists can use these remarkable organisms as low-tech monitors for the health of the environment.



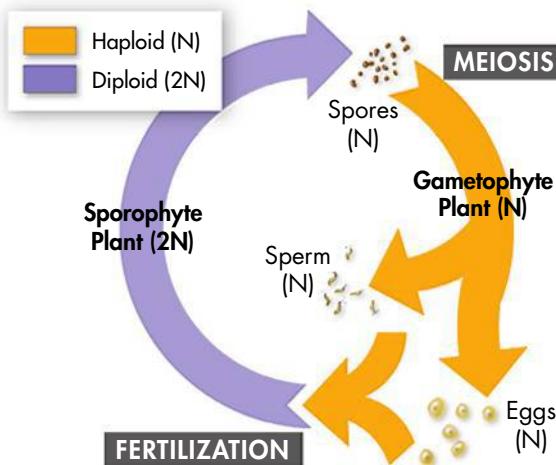
Plants

KEY CHARACTERISTICS

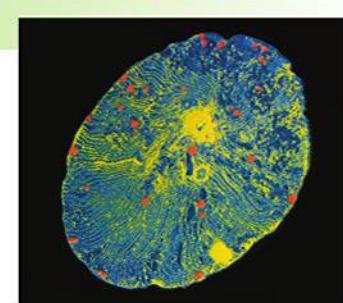
Plants are eukaryotes with cell walls composed of cellulose. Plants carry out photosynthesis using the green pigments chlorophyll a and b, and they store the products of photosynthesis as starch.



▼ A typical plant life cycle



► A banana plant in bloom



The photosynthetic membranes (shown in green) visible in this thin section of a cyanobacterium resemble the thylakoid membranes of plant cell chloroplasts. (TEM 14,000×)

• A Closer Look

Prokaryotes Within

The Origins of Chloroplasts

Chloroplasts, which contain their own DNA, are found in all green plants, but where did they come from? In 1905, the Russian botanist Konstantin Mereschkowsky, noticing the similarities between chloroplasts and cyanobacteria, proposed that these organelles originated from a symbiotic relationship formed with the ancestors of today's plants.

This hypothesis still holds up very well today. New DNA studies suggest that all chloroplasts are descended from a single photosynthetic prokaryote, closely related to today's cyanobacteria.

Green Algae

KEY CHARACTERISTICS

The green algae are plants that do not make embryos. All other plants form embryos as part of their life cycle. The green algae include both unicellular and multicellular species, and they are primarily aquatic.



Organization Single cells, colonies, and a few truly multicellular species

Movement Many swim using whiplike flagella.

Water Transport Water diffuses in from the environment.

Reproduction Asexual and sexual, with gametes and spores; some species show alternation of generations.



GROUPS OF GREEN ALGAE

The three most diverse groups of green algae are profiled below.

CHLOROPHYTES: Classic green algae

These algae usually live as single cells, like *Chlamydomonas*, or in colonies, like *Volvox*. They are found in both fresh and salt water, and some species are even known to live in arctic snowbanks.

► *Chlamydomonas* is a unicellular green alga. Each cell has two flagella, which are used in movement. (SEM 3000 \times)

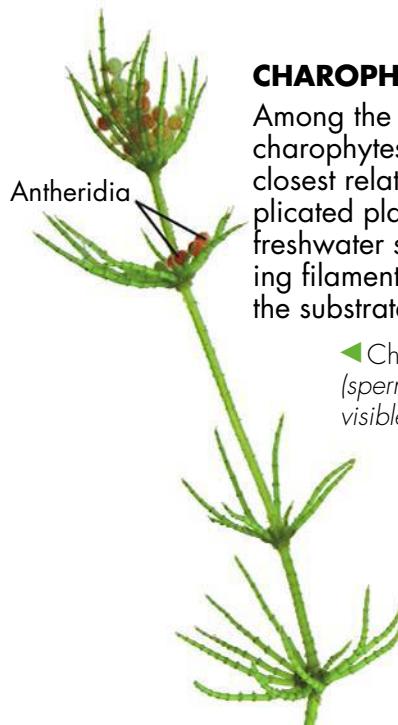


▲ Clumps of *Spirogyra*, a filamentous green alga, are commonly called water silk or mermaid's tresses.

ULVOPHYTES: Sea lettuces

The ulvophytes are large organisms composed of hundreds or thousands of cells. Most form large, flattened green sheets and are often simply called seaweed. They show both haploid and diploid phases in their life cycle, but in many species, such as the common sea lettuce, *Ulva*, it is difficult to tell the two phases apart.

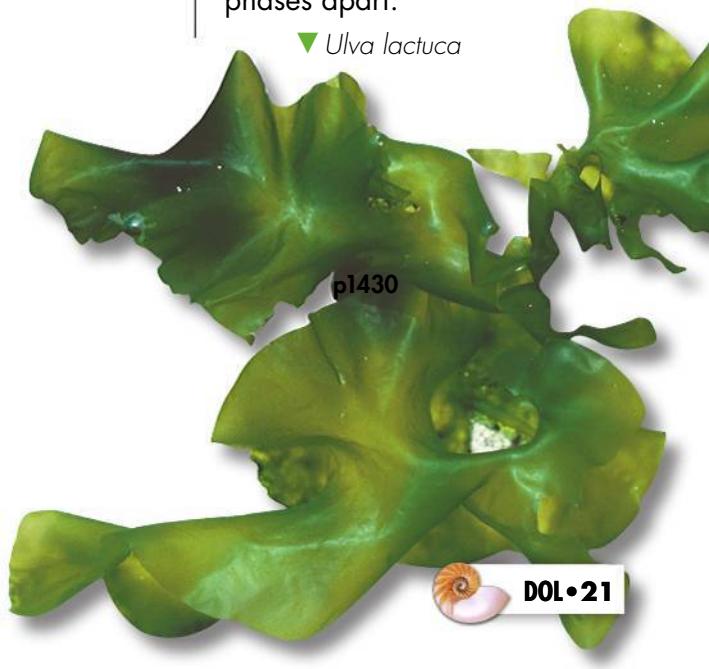
▼ *Ulva lactuca*



CHAROPHYTES: Stoneworts

Among the green algae, the charophytes (KAHR uh fyts) are the closest relatives of more complicated plants. They are mostly freshwater species. Their branching filaments may be anchored to the substrate by thin rhizoids.

► *Chara* with antheridia (sperm-producing structures) visible



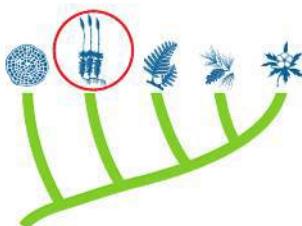
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Bryophytes

KEY CHARACTERISTICS

Bryophytes (BRY oh fyts), found mostly on land, are multicellular plants that lack true vascular tissue. This lack of vascular tissue limits their height to just a few centimeters and restricts them to moist soils.



Organization Complex and specialized tissues, including protective external layers and rhizoids

Movement Adults stationary; male gametes swim to egg cells using flagella.

Water Transport Diffusion from cell to cell; in some mosses, water flows through specialized tissue.

Reproduction All reproduce sexually with alternation of generations, producing gametes and spores. Most reproduce asexually, too. The gametophyte stage is dominant, with the sporophyte stage dependent on the gametophyte.

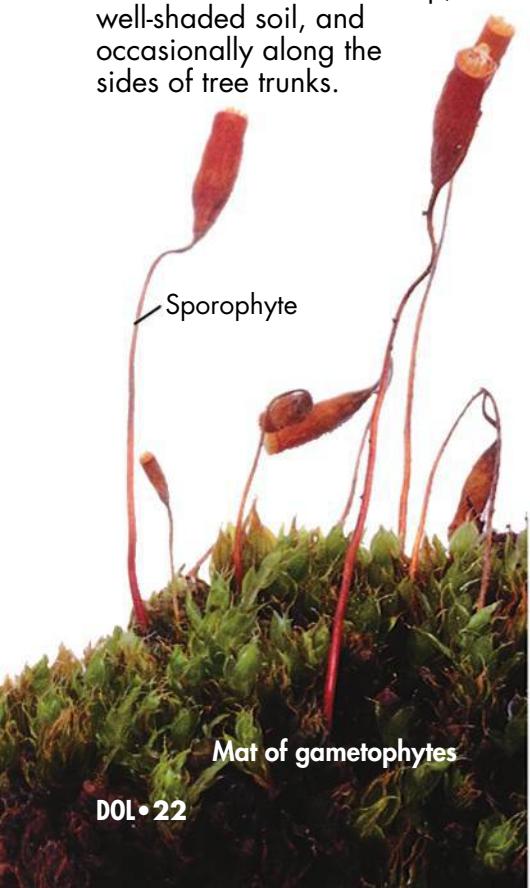
GROUPS OF BRYOPHYTES

Although they are listed together here, the three major groups of bryophytes are now considered to have evolved independently from each other.

MOSSES:

Classic bryophytes

Mosses are found on damp, well-shaded soil, and occasionally along the sides of tree trunks.



Mat of gametophytes

LIVERWORTS

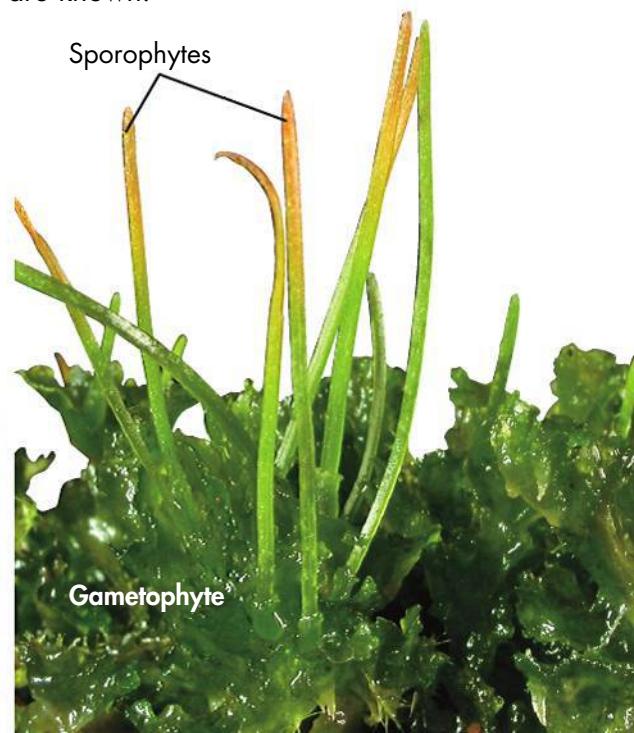
Liverworts are flat, almost leaf-like plants that grow on the damp forest floor. Sporophytes are small and grow on the underside of female gametophytes.



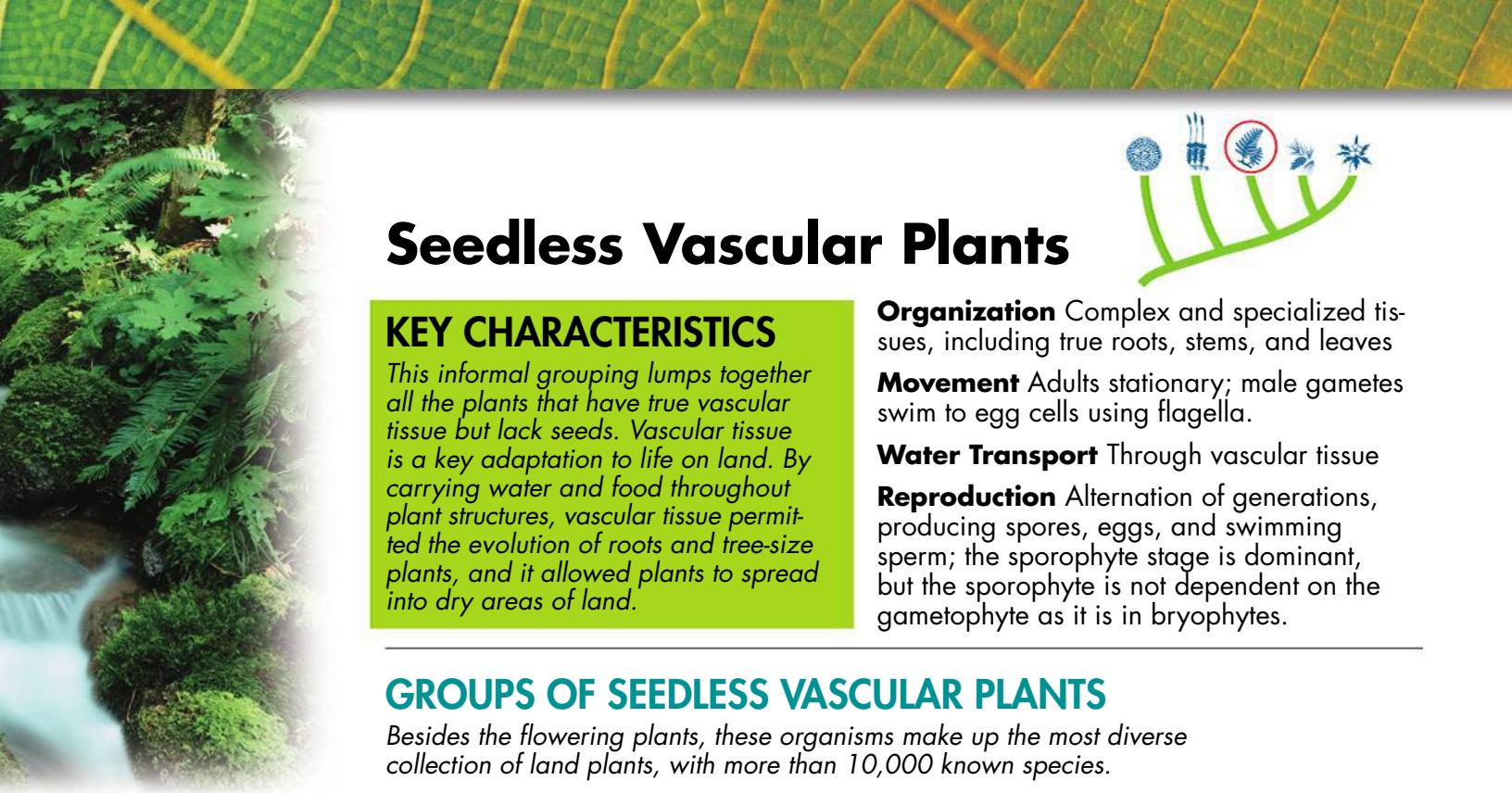
Gametophyte

HORNWORTS

Hornworts get their name from their sporophytes, tiny green structures resembling horns. Like other bryophytes, hornworts are found mostly in damp, well-shaded areas. Only about 100 species are known.



Gametophyte



Seedless Vascular Plants

KEY CHARACTERISTICS

This informal grouping lumps together all the plants that have true vascular tissue but lack seeds. Vascular tissue is a key adaptation to life on land. By carrying water and food throughout plant structures, vascular tissue permitted the evolution of roots and tree-size plants, and it allowed plants to spread into dry areas of land.

Organization Complex and specialized tissues, including true roots, stems, and leaves

Movement Adults stationary; male gametes swim to egg cells using flagella.

Water Transport Through vascular tissue

Reproduction Alternation of generations, producing spores, eggs, and swimming sperm; the sporophyte stage is dominant, but the sporophyte is not dependent on the gametophyte as it is in bryophytes.

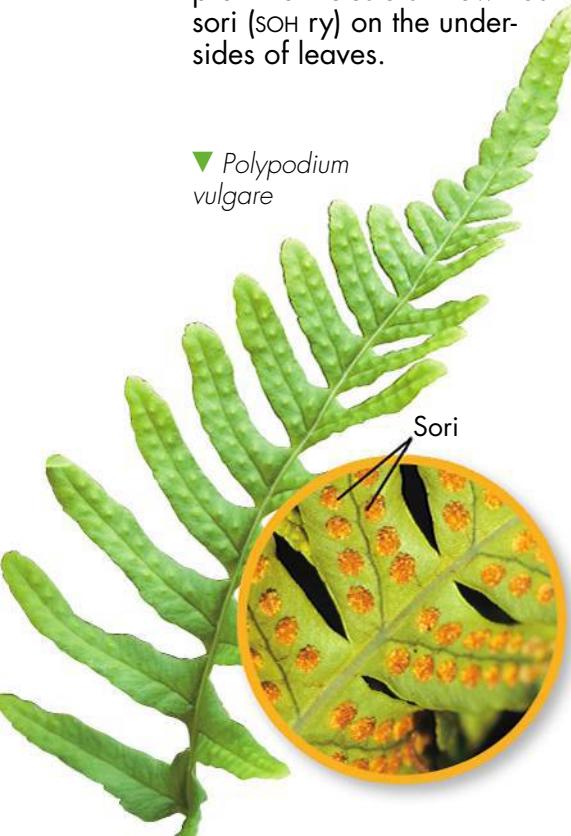
GROUPS OF SEEDLESS VASCULAR PLANTS

Besides the flowering plants, these organisms make up the most diverse collection of land plants, with more than 10,000 known species.

FERNS

Ferns are common and abundant. Because they need standing water to reproduce, ferns are generally found in areas that are damp at least part of the year. The sporophyte phase of the life cycle is dominant. Spores are produced in prominent clusters known as sori (SOH ry) on the undersides of leaves.

▼ *Polypodium vulgare*



CLUB MOSES

Not really mosses, these vascular plants are also called lycopods (LY koh pahdz). These plants were especially abundant during the Carboniferous Period 360 to 290 million years ago, when they grew as large as trees. Today, their remains make up a large part of coal deposits mined for fuel.

▼ The small club moss known as *Lycopodium* can be found growing on the forest floor throughout the temperate regions of North America. They look like tiny pine trees at first glance, but they are, in fact, small, seedless plants.



HORSETAILS

Only a single living genus of horsetails is known, *Equisetum* (ek wi SEET um). They get their name due to their resemblance to horses' tails. Today, only 25 species are known, confined to wet areas of soil. But horsetails were once much more diverse, larger in size, and abundant. Abrasive silica, found in many horsetails, was used in colonial times as a scouring powder to help clean pots and pans.

▼ *Equisetum*





Gymnosperms

KEY CHARACTERISTICS

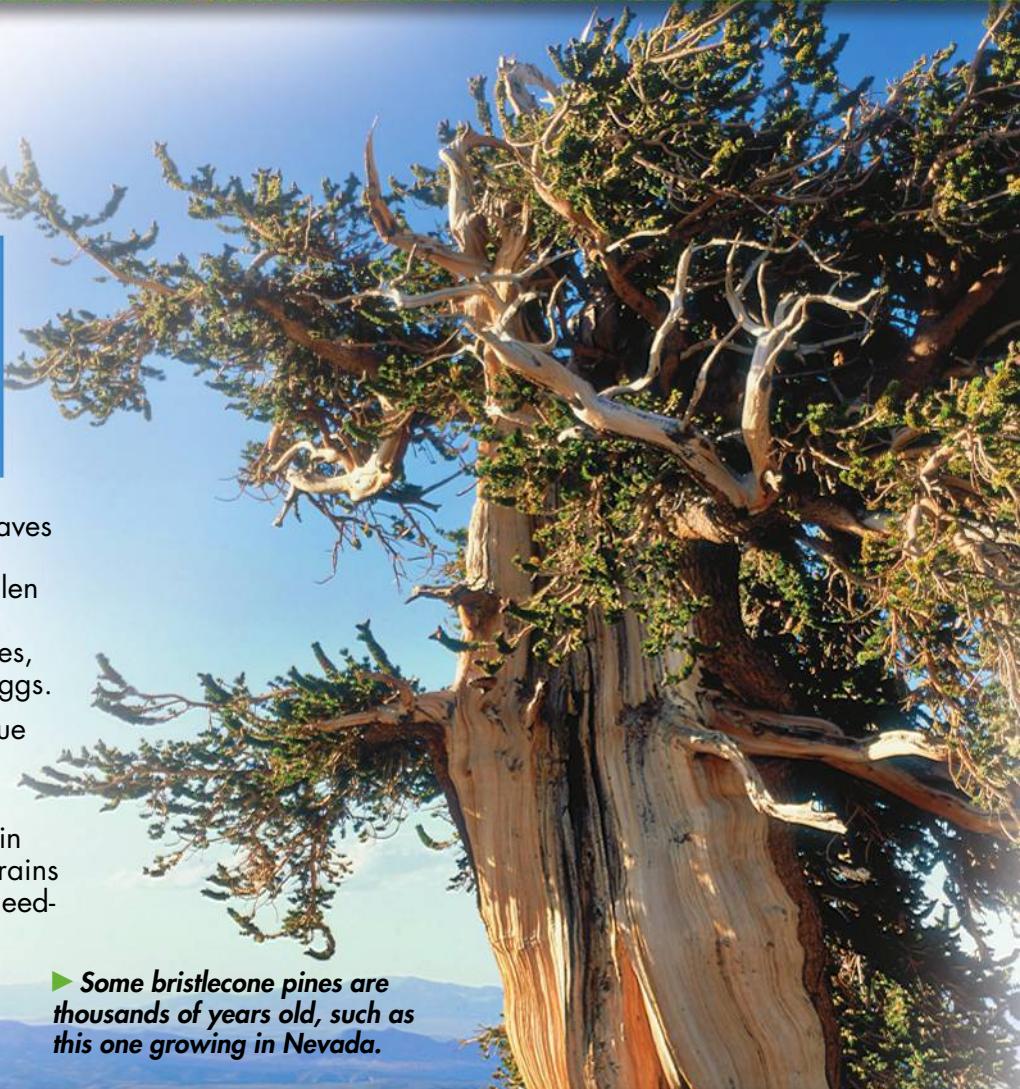
Gymnosperms are seed-bearing vascular plants whose seeds are exposed to the environment, rather than being enclosed in a fruit. The seeds are usually located on the scales of cones.

Organization True roots, stems, and leaves

Movement Adults stationary; within pollen grains, male gametophytes drift in air or are carried by animals to female structures, where they release sperm that move to eggs.

Water Transport Through vascular tissue

Reproduction Sexual; alternation of generations; the sporophyte stage is dominant. Female gametophytes live within the parent sporophyte. Because pollen grains carry sperm to eggs, open water is not needed for fertilization.



► Some bristlecone pines are thousands of years old, such as this one growing in Nevada.

Did You Know?

Rising From the Ashes

Fire's Role in Seed Germination

We generally think of forest fires as being natural disasters, and that's typically true. Some gymnosperm species, however, are so well adapted to the arid conditions of the American West that they actually depend upon such fires to spread their seeds.

The best-known example is the Jack pine, *Pinus banksiana*. Its seed cones are thick and heat resistant. When engulfed in a fire, its seeds escape damage. The fire's high heat helps to open the outer coat of the cone, enabling the seeds to pop out afterward. As a result, Jack pines are among the very first plants to repopulate a forest that has been damaged by fire.



▲ The high heat of a forest fire opens the cones of the Jack pines, releasing their seeds. In this photograph, Jack pine seedlings are growing among the charred remnants of mature trees that burned in a forest fire.

GROUPS OF GYMNOSPERMS

There are four groups of gymnosperms, representing about 800 species in total.

CONIFERS

Conifers are by far the most diverse group of living gymnosperms, represented by nearly 700 species worldwide. They include the common pine, spruce, fir, and redwood trees that make up a large share of the forests in the temperate regions of the world. Conifers have enormous economic importance. Their wood is used for residential building, to manufacture paper, and as a source of heat. Compounds from their resins are used for a variety of industrial purposes.



▲ Most conifers retain their leaves year-round.

CYCADS

Cycads (sy kads) are beautiful palmlike plants that have large cones. Cycads first appeared in the fossil record during the Triassic Period, 225 million years ago. Huge forests of cycads thrived when dinosaurs roamed Earth. Today, only nine genera of cycads exist. Cycads can be found growing naturally in tropical and subtropical places such as Mexico, the West Indies, Florida, and parts of Asia, Africa, and Australia.

► A Sago Palm,
Cycas revoluta



▲ Ginkgoes are often planted in urban settings, where their toughness and resistance to air pollution make them popular shade trees.

GINKGOES

Ginkgoes (GING kohs) were common when dinosaurs were alive, but today the group contains only one species, *Ginkgo biloba*. The living *Ginkgo* species looks similar to its fossil ancestors—in fact, *G. biloba* may be one of the oldest seed plant species alive today.

GNETOPHYTES

About 70 present-day species of gnetophytes (NET oh fytz) are known, placed in just three genera. The reproductive scales of these plants are clustered in cones.

► *Welwitschia mirabilis*, an inhabitant of the Namibian desert in southwestern Africa, is one of the most remarkable gnetophytes. Its huge leathery leaves grow continuously and spread across the ground.



Angiosperms



KEY CHARACTERISTICS

Angiosperms are plants that bear seeds in a closed ovary. The ovary is part of a reproductive organ known as a flower. Seeds are formed in a double fertilization event, which forms a diploid embryo and a triploid endosperm tissue. As seeds mature, ovaries develop into fruits that help to disperse the seeds.

Organization True roots, stems, and leaves

Movement Adults stationary; within pollen grains, male gametophytes drift in air or are carried by animals to female structures, where they release sperm that move to eggs.

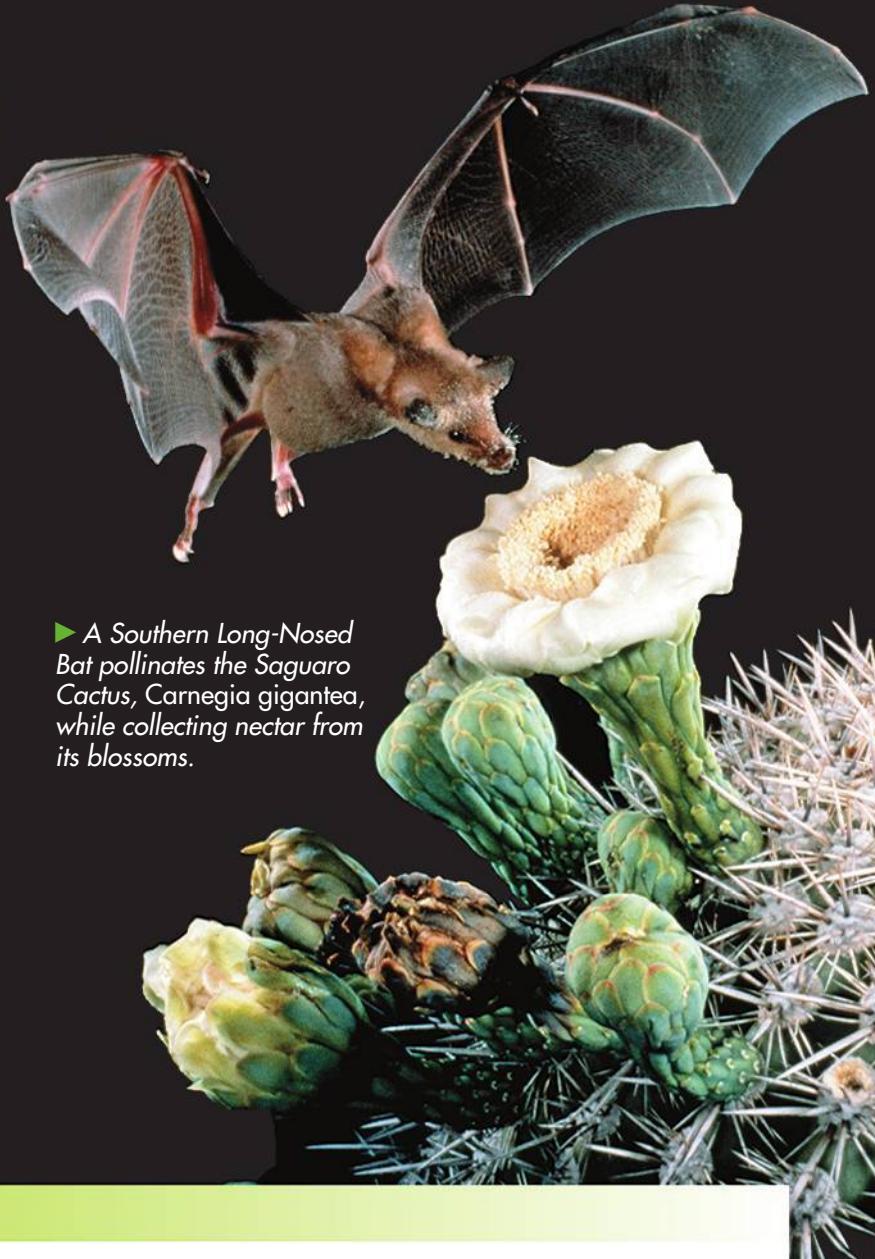
Water Transport Through vascular tissue

Reproduction Sexual, with alternation of generations; also asexual. The sporophyte stage is dominant. Female gametophytes live within the parent sporophyte. Pollen carries sperm to eggs, so open water is not needed for fertilization.

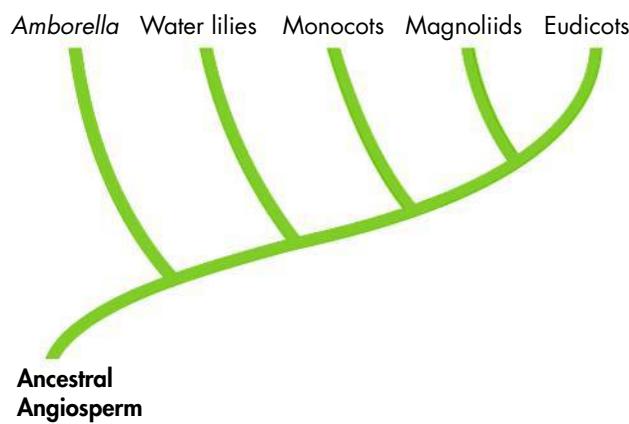
• A Closer Look

Whatever Happened to Monocots and Dicots?

Traditionally, flowering plants have been divided into just two groups, monocots and dicots, based on the number of seed leaves in their embryos. Today, however, molecular studies have shown that the dicots aren't really one group. Some of the most primitive flowering plants (like *Amborella*) are dicots, and so are some of the most advanced flowering plants, while the monocots fall right in between. So, while monocots are indeed a single group, the term *dicots* is now just an informal, though still useful, grouping.



► A Southern Long-Nosed Bat pollinates the Saguaro Cactus, *Carnegiea gigantea*, while collecting nectar from its blossoms.



GROUPS OF ANGIOSPERMS

The great majority of plant species—over 260,000—are angiosperms.



▲ Water lilies are aquatic plants that produce flowers and leaves, which float on the surface of the water.

NYMPHAEACEAE: Water lilies

About 50 species of water lilies are known, and they are of special interest to plant taxonomists. Their DNA and flower structure suggest that they are, along with *Amborella*, one of the earliest groups to have split off from the main line of flowering plant evolution. Examples of water lilies are found throughout the world.

MAGNOLIIDS:

Magnolia trees and others

The most famous genus of these plants is *Magnolia*, which includes nearly 200 species. Laurels and tulip poplars are also magnoliids (mag NOH lee ids). Because of their flower structure, magnoliids were once thought to be nearly as primitive as water lilies. Genetic studies now suggest that they split off from the rest of the angiosperm line after monocots and, therefore, do not represent the earliest flowering plants.

▼ The Tulip Poplar is a long, straight tree often used as wood for telephone poles. Its flowers are greenish and shaped like tulips.



► Magnolia trees produce conspicuous flowers, which contain multiple stamens and multiple pistils.

AMBORELLA

Amborella does not represent a group of plants but instead just a single species found only on the island of New Caledonia in the South Pacific Ocean. DNA studies show that *Amborella* is equally separated from all other flowering plants living today, suggesting that it is descended from plants that split off from the main line of flowering plant evolution as long ago as 100 million years.



▲ The flowers of *Amborella trichopoda* are simpler than those of most other plants, and the species has a number of features that place it at the very base of flowering plant evolution.



GROUPS OF ANGIOSPERMS CONTINUED...

MONOCOTS

The monocots include an estimated 65,000 species, roughly 20 percent of all flowering plants. They get their name from the single seed leaf found in monocot embryos, and they include some of the plants that are most important to human cultures. Monocots grown as crops account for a majority of the food produced by agriculture. These crops include wheat, rice, barley, corn, and sugar cane. Common grasses are monocots, as are onions, bananas, orchids, coconut palms, tulips, and irises.



▲ Onions are just one of many examples of monocot crop species.



▲ This African hillside is dotted with clumps of Wild Pampas Grass.



▲ Many orchid species are grown by enthusiasts for their rare beauty. Notice the aerial roots on this specimen, which grows as an epiphyte in its natural environment.

◀ After harvest, sugar cane regrows without being planted again for several cycles.

Eco • Alert

Coevolution: Losing the Pollinators

The successes of flowering plants are clearly due to coevolution with their insect pollinators. Common honey bees are among the most important of these, because they gather nectar from the flowers of hundreds of plant species and spread pollen from plant to plant as they go.

Unfortunately, beekeepers around the world, including the United States, are facing a serious crisis. “Colony collapse disorder,” as beekeepers describe it, causes bees to fly away from the hive and either never return, or return only to weaken and die. The disease threatens to affect scores of important crops, which depend upon bees to produce fruit and seeds. Suspicion has centered on a fungus or a virus that might spread from colony to colony, but at this point there is no definitive cause or cure.



EUDICOTS: "TRUE DICOTS"

Eudicots (yoo dy kahts) account for about 75 percent of all angiosperm species. The name means "true dicots," and these plants are the ones usually given as examples of dicot stem, leaf, and flower structure. Eudicots have distinctive pollen grains with three grooves on their surfaces, and DNA studies strongly support their classification in a single group. They include a number of important subgroups, five of which are described here.

Ranunculales

The ranunculales subgroup (ruh NUNH kyu lay les) includes, and is named after, buttercups (genus *Ranunculus*). Also included in this subgroup are a number of well-known flowers such as columbines, poppies, barberries, and moonseed.



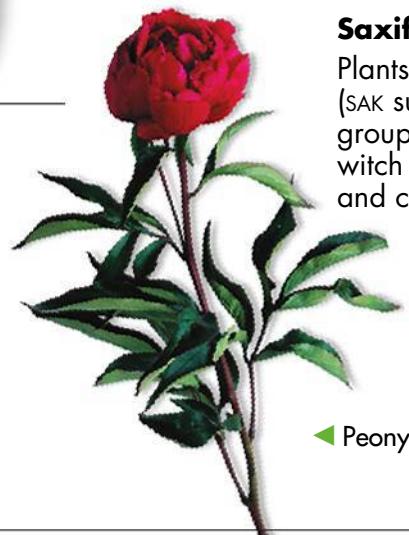
▲ Orange



▼ Rocky Mountain Columbine

Rosids

The rosids include, as you might expect, the roses. However, this subgroup also includes many popular fruits, such as oranges, raspberries, strawberries, and apples. Some of the best-known trees, including poplars, willows, and maples, are also members.



◀ Peony

Asterids

The nearly 80,000 asterid species include sunflowers, azaleas, snapdragons, blueberries, tomatoes, and potatoes.



▼ The flower heads in a field of sunflowers all track the sun as it moves across the sky; thus, they all face the same direction.



▲ Clusterhead Pinks

Caryophyllales

Cacti are probably the most well-known plants in the caryophyllales subgroup (KAR ee oh fy lay les). Pinks and carnations, spinach, rhubarb, and insect-eating plants, such as sundews and pitcher plants, are also members.

Saxifragales

Plants in the saxifragales (SAK suh frij ay les) subgroup include peonies, witch hazel, gooseberries, and coral bells.

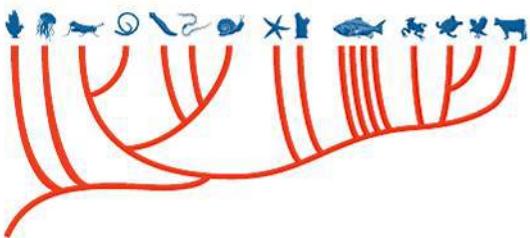
Animals

Snow Leopard



KEY CHARACTERISTICS

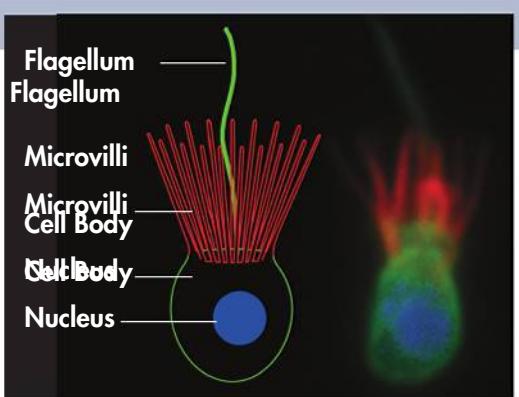
Animals are multicellular, heterotrophic, eukaryotic organisms whose cells lack cell walls.



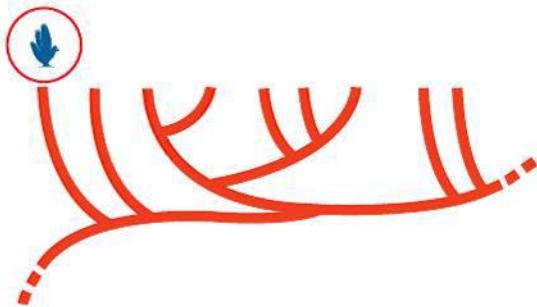
A Closer Look

A Common Ancestor

Recent molecular studies and cladistic analyses recognize the clade Choanozoa to be the true sister group to all Metazoa—multicellular animals. Choanozoa is one group of organisms formerly called “protists” and is named for choanoflagellates (art and photo right), single-celled, colonial organisms that look like certain cells of sponges and flatworms. Evidence suggests that the choanoflagellates alive today are the best living examples of what the last common ancestor of metazoans looked like.



Porifera (Sponges)



KEY CHARACTERISTICS

Sponges are the simplest animals. They are classified as animals because they are multicellular, heterotrophic, lack cell walls, and have some specialized cells. They are aquatic, lack true tissues and organs, and have internal skeletons of spongin and/or spicules of calcium carbonate or silica. Sponges have no body symmetry.

Feeding and Digestion Filter feeders; intracellular digestion.

Circulation Via flow of water through body

Respiration Oxygen diffuses from water into cells as water flows through body.

Excretion Wastes diffuse from cells into water as water flows through body.

Response No nervous system; little capacity to respond to environmental changes.

Movement Juveniles drift or swim freely; adults are stationary.

Reproduction Most—sexual with internal fertilization; water flowing out of sponge disperses sperm, which fertilizes eggs inside sponge(s); may reproduce asexually by budding or producing gemmules.

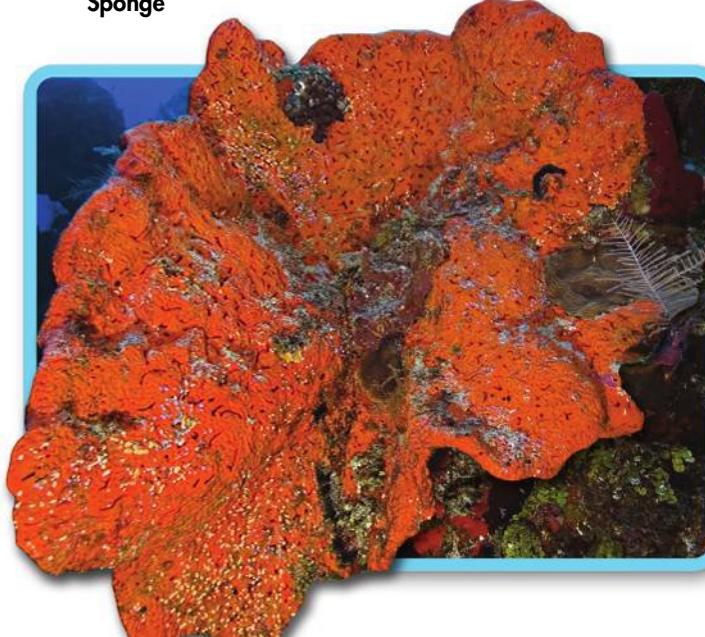
GROUPS OF SPONGES

There are more than 5000 species of sponges; most are marine. Three major groups are described below.

DEMOSPONGIAE: Typical sponges

More than 90 percent of all living sponge species are in this group, including the few freshwater species. They have skeletons made of spongin, a flexible protein. Some species have silica spicules. Examples: Yellow Sponge, bath sponges, Carnivorous Mediterranean Sponge, tube sponges

▼ Orange Elephant Ear Sponge



HEXACTINELLIDA: Glass sponges

Glass sponges live in the deep ocean and are especially abundant in the Antarctic. They are called "glass" sponges because their skeletons are made of glasslike silica spicules. Examples: Venus's Flower Basket, Cloud Sponge

◀ Glass Sponge

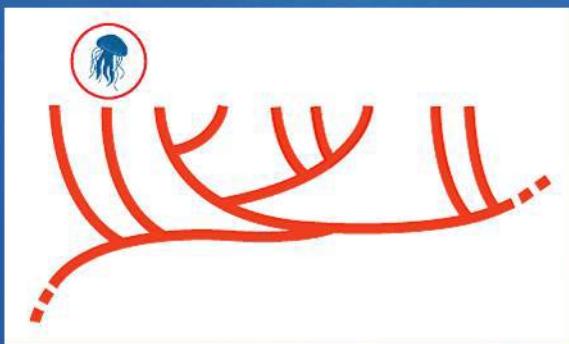
CALCAREA: Calcareous sponges

Calcareous sponges live in shallow, tropical marine waters and are the only sponges with calcium carbonate spicules. Example: *Clathrina*



Yellow Tubular Sponge ▶

Cnidarians



KEY CHARACTERISTICS

Cnidarians are aquatic, mostly carnivorous, and the simplest animals to have specialized tissues (outer skin and lining of the gastrovascular cavity) and body symmetry (radial). Their tentacles have stinging cells called nematocysts used in feeding.

Feeding and Digestion Predatory, stinging prey with nematocysts; digestion begins extracellularly in gastrovascular cavity and is completed intracellularly; indigestible materials leave body through single opening; many, especially reef-building corals, also depend on symbiotic algae, or zooxanthellae.

Circulation No internal transport system; nutrients typically diffuse through body.



Respiration Diffusion through body walls

Excretion Cellular wastes diffuse through body walls.

Response Some specialized sensory cells: nerve cells in nerve net, statocysts that help determine up and down, eyespots (ocelli) made of light-detecting cells

Movement Polyps stationary, medusas free-swimming; some, such as sea anemones, can burrow and creep very slowly; others move using muscles that work with a hydrostatic skeleton and water in gastrovascular cavity; medusas such as jellyfish move by jet propulsion generated by muscle contractions.

Reproduction Most—alternate between sexual (most species by external fertilization) and asexual (polyps produce new polyps or medusae by budding)

Eco • Alert

Coral Symbionts

Reef-building coral animals depend on symbiotic algae called zooxanthellae for certain vital nutritional needs. In many places, reef-building corals live close to the upper end of their temperature tolerance zone. If water temperatures rise too high, the coral-zooxanthellae symbiosis breaks down, and corals turn white in what is called “coral bleaching.” If corals don’t recover their algae soon, they weaken and die. This is one reason why coral reefs are in grave danger from global warming.



The color of this star coral is caused by zooxanthellae algae living within it.

GROUPS OF CNIDARIANS

There are more than 9000 species of cnidarians.



A Portuguese man-of-war is actually a colony of polyps.

HYDROZOA: Hydras and their relatives

Hydras and their relatives spend most of their time as polyps and are either colonial or solitary. They reproduce asexually (by budding), sexually, or they alternate between sexual and asexual reproduction. Examples: hydra, Portuguese man-of-war



Black
Sea
Nettle

ANTHOZOA: Corals and sea anemones

Corals and sea anemones are colonial or solitary polyps with no medusa stage. The central body is surrounded by tentacles. They reproduce sexually or asexually. Examples: reef corals, sea anemones, sea pens, sea fans



Sea Anemone

SCYPHOZOA: Jellyfishes

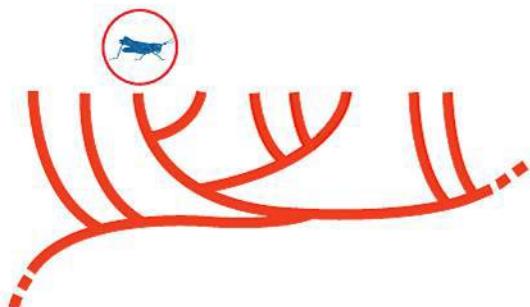
Jellyfishes spend most of their time as medusas; some species bypass the polyp stage. They reproduce sexually and sometimes asexually by budding. Examples: lion's mane jellyfish, moon jelly, sea wasp



This purple-striped jelly (*Pelagia noctiluca*) has the ability to bioluminesce, or give off light.



Arthropods



KEY CHARACTERISTICS

Arthropods are the most diverse of all multicellular organisms. They have segmented bodies and jointed appendages. They are supported by tough exoskeletons made of chitin, which they periodically shed as they grow. Arthropods are coelomate protostomes with bilateral symmetry.

Eco • Alert

Beetle Damage

You probably know that some insects can seriously damage crop plants. But insects affect plants in natural habitats, too. One example is the mountain pine beetle, which is dramatically extending its range. Global warming appears to be enabling the beetle to survive farther north, and at higher altitudes, than it used to. The new beetle infestation is causing extensive damage to northern and high-altitude forests in North America. The death of millions of acres of trees has resulted in the release of large amounts of carbon dioxide, a greenhouse gas, into the atmosphere. You can see the sort of damage the beetles cause in the photo at right.



▲ Mountain pine beetle damage to pine trees in White River National Forest, Colorado

Feeding and Digestion Extremely diverse: herbivores, carnivores, detritivores, parasites, blood-suckers, scavengers, filter feeders; digestive system with two openings; many feeding specializations in different groups

Circulation Open circulatory system with heart and arteries

Respiration Terrestrial—tracheal tubes or book lungs; aquatic—gills or book gills (horseshoe crabs)

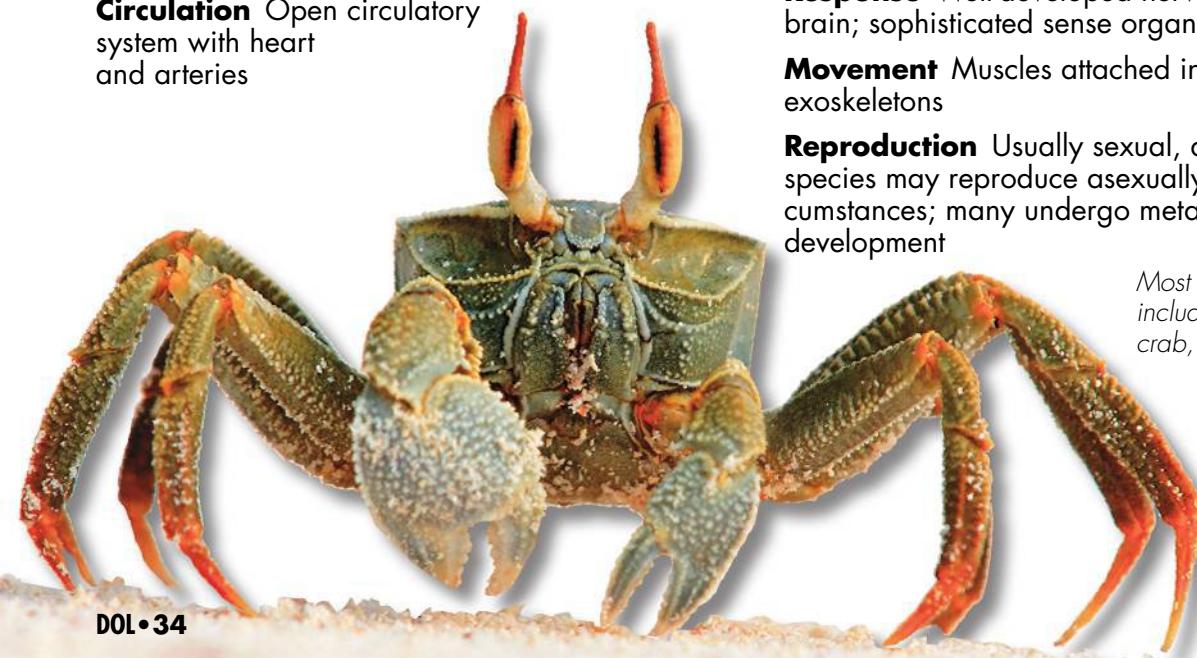
Excretion Terrestrial—Malpighian tubules; aquatic—diffusion into water

Response Well-developed nervous system with brain; sophisticated sense organs

Movement Muscles attached internally to jointed exoskeletons

Reproduction Usually sexual, although some species may reproduce asexually under certain circumstances; many undergo metamorphosis during development

Most animals, including this land crab, are arthropods.



GROUPS OF ARTHROPODS

Phylum Arthropoda contains more known species than any other phylum. Scientists have identified more than 1,000,000 arthropod species, and some scientists expect there are millions yet to be identified. Arthropods are classified based on the number and structure of body segments and appendages.



▲ Lobster

CRUSTACEA: Crustaceans

There are crustacean species in almost every habitat, but most are aquatic, and most of these are marine. They have two or three body sections, two pairs of antennae, and chewing mouthparts called mandibles. Many have a carapace, or "shell," that covers part or all of the body. Examples: crabs, lobsters, crayfish, pill bugs, water fleas, barnacles

Horseshoe crabs are actually more closely related to spiders than to crabs!



CHELICERATA: Chelicerates

Living chelicerates include horseshoe crabs and arachnids. (Their extinct relatives include trilobites and giant "sea-scorpions.") Most living chelicerates are terrestrial. The body is composed of two parts—the cephalothorax and abdomen. The first pair of appendages are specialized feeding structures called chelicerae. Chelicerates have no antennae.

Merostomata: Horseshoe crabs

The class Merostomata once included many species, but only four species of horseshoe crab survive today. All are marine. They have five pairs of walking legs and a long, spinelike tail.

Arachnida: Arachnids

The vast majority of arachnids are terrestrial. They have four pairs of walking legs and no tail. Examples: spiders, ticks, mites, scorpions, daddy longlegs



▲ Mexican Fireleg Tarantula



UNIRAMIA: Uniramians

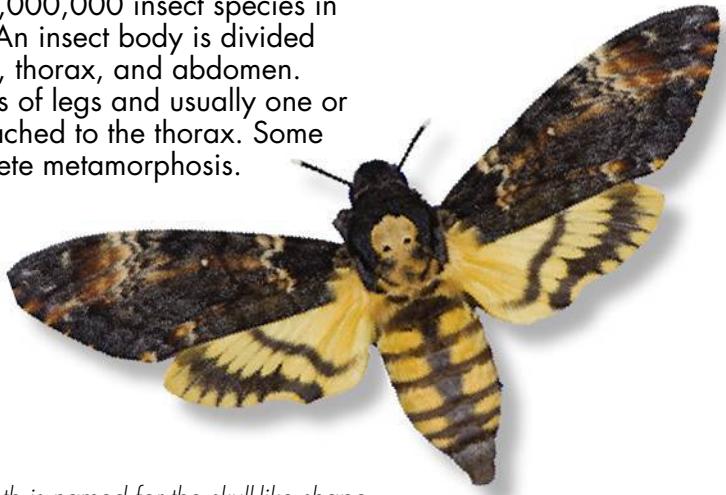
Most uniramians are terrestrial, although some are aquatic for all or part of their lives. They have one pair of antennae, mandibles, and unbranched appendages. Uniramians include at least three fourths of all known animal species!



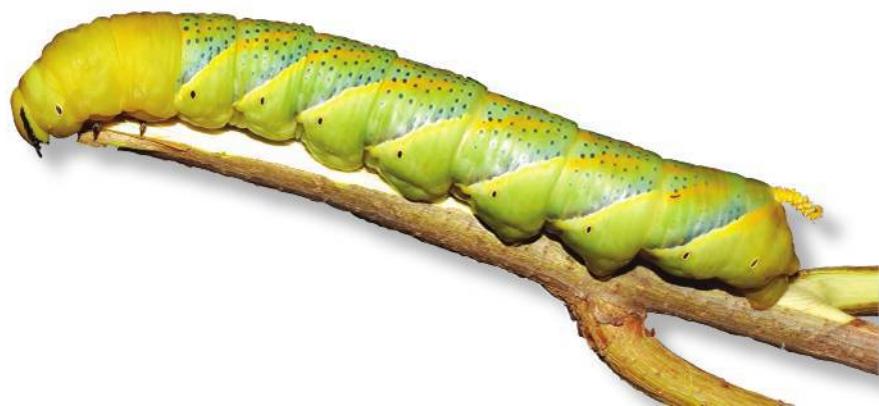
Uniramians include centipedes, millipedes, and insects—more than three fourths of all known animal species, including this green snaketail dragonfly.

Insecta: Insects

There are more than 1,000,000 insect species in more than 25 orders. An insect body is divided into three parts—head, thorax, and abdomen. Insects have three pairs of legs and usually one or two pairs of wings attached to the thorax. Some insects undergo complete metamorphosis. Examples: termites, ants, beetles, dragonflies, flies, moths, grasshoppers



The death's head hawk moth is named for the skull-like shape on the adult's head (above). Like many insects, this moth undergoes complete metamorphosis, during which the larva (below), or caterpillar, turns into a pupa, and, eventually, an adult moth.





▲ Centipede

Chilopoda: Centipedes

Centipedes have a long body composed of many segments. Each segment bears one pair of legs. They are carnivorous and have claws that release poisons to capture prey.

▼ Giant Millipede



Diplopoda: Millipedes

Millipedes have a long body composed of many segments. Each segment bears two pairs of legs. Most millipedes are herbivorous.

Insecta (continued)



▼ Leaf Beetle

Many "bugs" benefit humans. For example, ladybugs (which are not all "ladies") eat garden pests and bees pollinate plants. Insects such as praying mantises, katydids, flies, moths, beetles, and ants also have important roles in ecosystems.



Flower Beetle ▲



Blue Bottle Fly

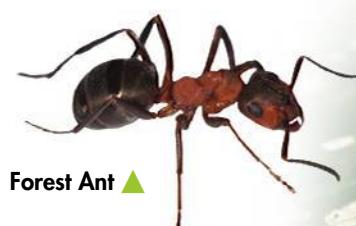


Ladybug ▲



Honeybee ▲

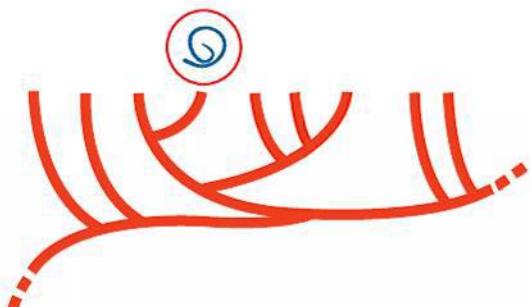
Horn Katydid



Forest Ant ▲



Nematodes (Roundworms)



Pinworms can infest the intestinal tract of humans. Although anyone can become infected with pinworms, infection is most common in children aged 5 to 10.



Pinworm ▶
(colorized SEM)

KEY CHARACTERISTICS

Nematodes, or roundworms, are unsegmented worms with a tough outer cuticle, which they shed as they grow. This “molting” is one reason that nematodes are now considered more closely related to arthropods than to other wormlike animals. Nematodes are the simplest animals to have a “one-way” digestive system through which food passes from mouth to anus. They are protostomes and have a pseudocoelom.

Feeding and Digestion Some predators, some parasites, and some decomposers; one-way digestive tract with mouth and anus

Circulation By diffusion

Respiration Gas exchange through body walls

Excretion Through body walls

Response Simple nervous system consisting of several ganglia, several nerves, and several types of sense organs

Movement Muscles work with hydrostatic skeleton, enabling aquatic species to move like water snakes and soil-dwelling species to move by thrashing around.

Reproduction Sexual with internal fertilization; separate sexes; parasitic species may lay eggs in several hosts or host organs.

GROUPS OF ROUNDWORMS

There are more than 15,000 known species of roundworms, and there may be half a million species yet to be described. Free-living species live in almost every habitat imaginable, including fresh water, salt water, hot springs, ice, and soil. Parasitic species live on or inside a wide range of organisms, including insects, humans, and many domesticated animals and plants. Examples: *Ascaris lumbricoides*, hookworms, pinworms, *Trichinella*, *C. elegans*

• A Closer Look

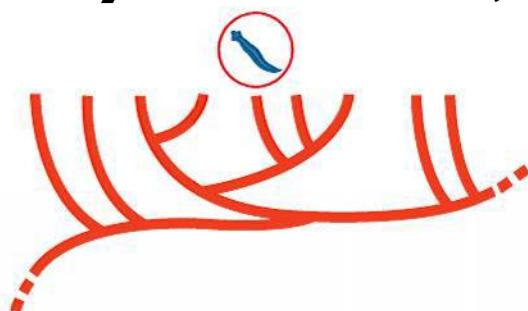


A Model Organism?

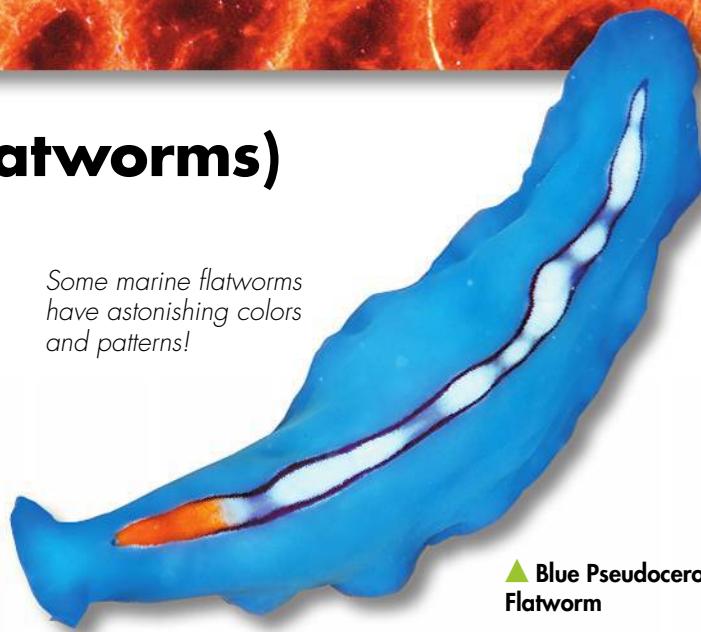
Caenorhabditis elegans is a small soil nematode. Fifty years ago, this species was selected as a “model organism” for the study of genetics and development. We can now chart the growth and development of *C. elegans*, cell by cell, from fertilization to adult. This information is invaluable in understanding the development of other species—including many other nematodes that cause serious disease.

◀ *C. elegans* (LM 64X)

Platyhelminthes (Flatworms)



Some marine flatworms have astonishing colors and patterns!



▲ Blue Pseudoceros Flatworm

KEY CHARACTERISTICS

Flatworms are soft worms with tissues and internal organ systems. They are the simplest animals to have three embryonic germ layers, bilateral symmetry, and cephalization. They are acoelomates.

Feeding and Digestion Free-living—predators or scavengers that suck food in through a pharynx and digest it in a system that has one opening. Parasitic—feed on blood, tissue fluids, or cell pieces of the host, using simpler digestive systems than free-living species have. Tapeworms, which absorb nutrients from food that the host has already digested, have no digestive system.

Circulation By diffusion

Respiration Gas exchange by diffusion

Excretion Some—flame cells remove excess water and may remove metabolic wastes such as ammonia and urea. Many flame cells are connected to tubules that release substances through pores in the skin.

Response Free-living—several ganglia connected by nerve cords that run through the body, along with eye-spots and other specialized sensory cells; parasitic—simpler nervous system than free-living forms have

Movement Free-living—using cilia and muscle cells.

Reproduction Free-living—most are hermaphrodites that reproduce sexually with internal fertilization; parasitic—commonly reproduce asexually by fission but also often reproduce sexually

GROUPS OF FLATWORMS

Flatworms are an amazingly diverse group of worms that include more than 20,000 species. They have historically been placed into three classes, but these taxa now appear not to be true clades, and will probably change.

TREMATODA: Flukes

Most flukes are parasites that infect internal organs of their hosts, but some infect external parts such as skin or gills. The life cycle typically involves more than one host or organ. Examples: *Schistosoma*, liver fluke



▲ Liver Fluke

TURBELLARIA: Turbellarians

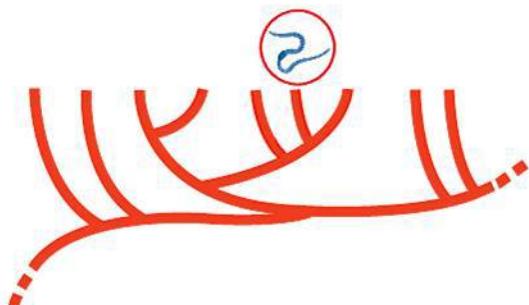
Turbellarians are free-living aquatic and terrestrial predators and scavengers. Many are colorful marine species. Examples: planarians, polyclad flatworm

CESTODA: Tapeworms

Tapeworms are very long intestinal parasites that lack a digestive system and absorb nutrients directly through their body walls. The tapeworm body is composed of many repeated sections (proglottids) that contain both male and female reproductive organs.



Annelids (Segmented Worms)



KEY CHARACTERISTICS

Annelids are coelomate protostome worms whose bodies are composed of segments separated by internal partitions. The annelid digestive system has two openings.

Feeding and Digestion Filter feeders, carnivores, or parasites; many obtain food using a muscular pharynx, often equipped with "teeth"; widely varied digestive systems—some, such as earthworms, have complex digestive tracts.

Circulation Closed circulatory system with dorsal and ventral blood vessels; dorsal vessel pumps blood like a heart.

Respiration Aquatic—gills; terrestrial—skin

Excretion Digestive waste exits through anus; nitrogenous wastes eliminated by nephridia



Peacock worms, whose feather-shaped gills look somewhat like peacock feathers, are marine annelids, or polychaetes.

Response Nervous system includes a rudimentary brain and several nerve cords; sense organs best-developed in free-living saltwater species

Movement Hydrostatic skeleton based on sealed body segments surrounded by longitudinal and circular muscles; many annelids have appendages that enable movement.

Reproduction Most—sexual, some through external fertilization with separate sexes, but others are simultaneous hermaphrodites that exchange sperm; most have a trochophore larval stage



▲ Leech (*Hirudo medicinalis*) drawing blood from a hand

• Did You Know?

Not-So-Modern Medicine

You may have heard that medieval healers used leeches to remove "excess" blood from patients and to clean wounds after surgery. But did you know that leeches—or at least compounds from leech saliva—have a place in modern medicine? Leech saliva contains the protein hirudin, which prevents blood from clotting. Some surgeons use leeches to relieve pressure caused by blood that pools in tissues after plastic surgery. Hirudin is also used to prevent unwanted blood clots.

▼ Feather-Duster Worms



GROUPS OF ANNELIDS

There are more than 15,000 species of annelids.

HIRUDINEA: Leeches

Most leeches live in fresh water. They lack appendages. Leeches may be carnivores or blood-sucking external parasites. Example: medicinal leech (*Hirudo medicinalis*)



► Earthworm

OLIGOCHAETA: Oligochaetes

Oligochaetes live in soil or fresh water. They lack appendages. Some use setae for movement but have fewer than polychaetes. Examples: *Tubifex*, earthworms

POLYCHAETA: Polychaetes

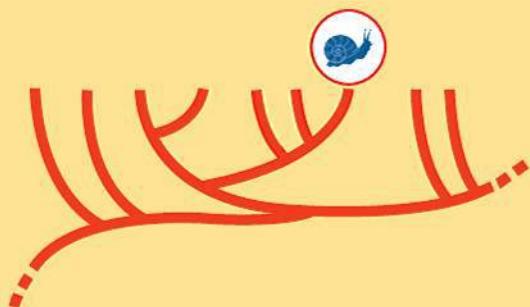
Polychaetes live in salt water; many move with paddle-like appendages called parapodia tipped with bristle-like setae. Examples: sandworms, blood-worms, fanworms, feather-duster worms



The white, bristle-like structures on the sides of this bearded fireworm are setae.



Mollusks



KEY CHARACTERISTICS

Mollusks have soft bodies that typically include a muscular foot. Body forms vary greatly. Many mollusks possess a hard shell secreted by the mantle, but in some, the only hard structure is internal. Mollusks are coelomate protostomes with bilateral symmetry.

Feeding and Digestion Digestive system with two openings; diverse feeding styles—mollusks can be herbivores, carnivores, filter feeders, detritivores, or parasites

Circulation Snails and clams—open circulatory system; octopi and squid—closed circulatory system

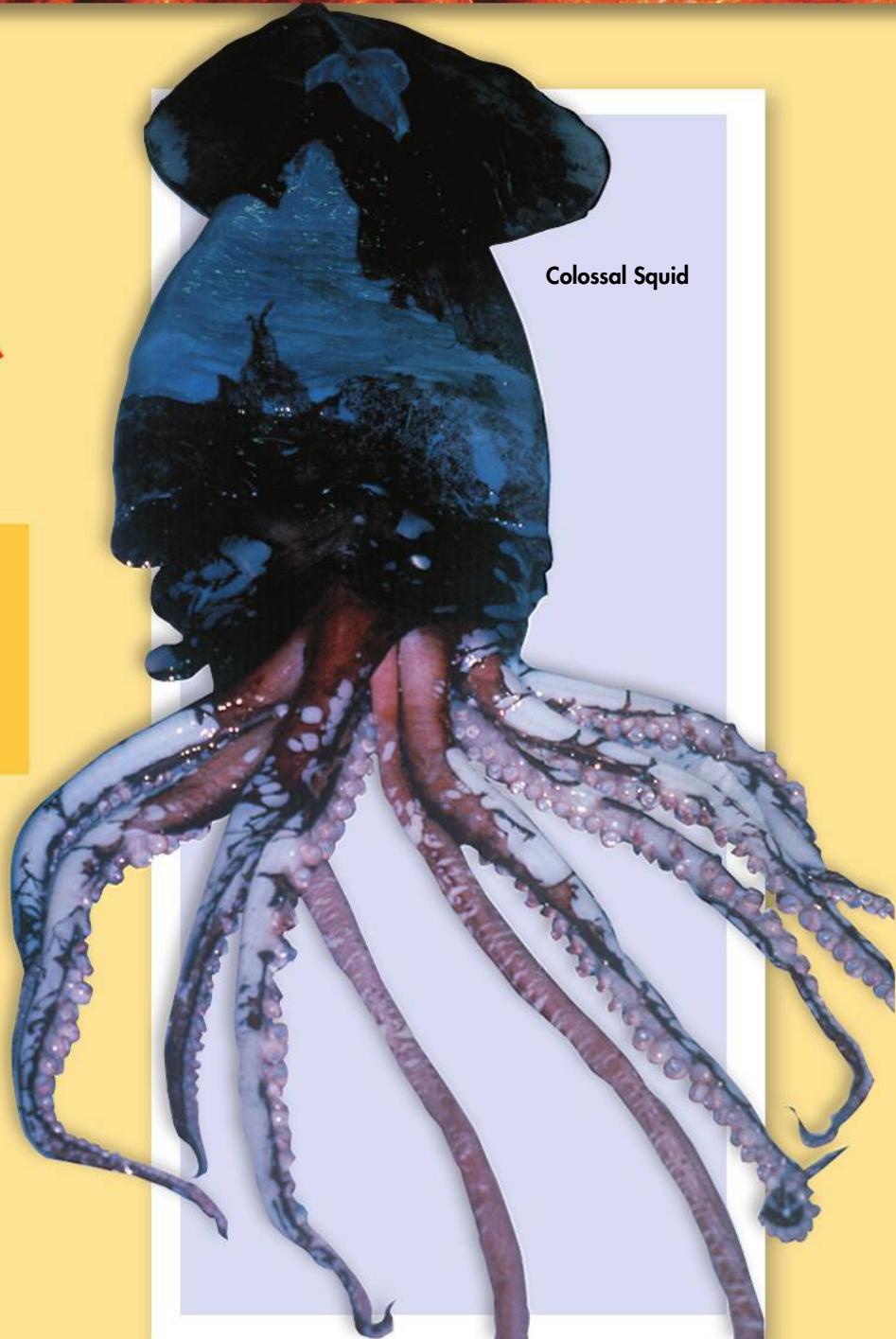
Respiration Aquatic mollusks—gills inside the mantle cavity; land mollusks—a saclike mantle cavity whose large, moist surface area is lined with blood vessels.

Excretion Body cells release ammonia into the blood, which nephridia remove and release outside the body.

Response Complexity of nervous system varies greatly; extremely simple in clams, but complex in some octopi.

Movement Varies greatly, by group. Some never move as adults, while others are very fast swimmers.

Reproduction Sexual; many aquatic species have a free-swimming trochophore larval stage.



Did You Know?

The Colossal Squid

The colossal squid, the largest of all mollusks, has the largest eyes of any known animal. One 8-meter-long, 450-kilogram specimen of the species *Mesonychoteuthis hamiltoni* had eyes 28 centimeters across—larger than most dinner plates! The lens of this huge eye was the size of an orange.

GROUPS OF MOLLUSKS

Mollusks are traditionally divided into several classes based on characteristics of the foot and the shell; specialists estimate that there are between 50,000 and 200,000 species of mollusks alive today.



▲ Giant Clam

BIVALVIA: Bivalves

Bivalves are aquatic. They have a two-part hinged shell and a wedge-shaped foot. They are mostly stationary as adults. Some burrow in mud or sand; others attach to rocks. Most are filter feeders that use gill siphons to take in water that carries food. Clams have open circulatory systems. Bivalves have the simplest nervous systems among mollusks. Examples: clams, oysters, scallops, mussels



▲ Chambered Nautilus



Garden Snail ▲

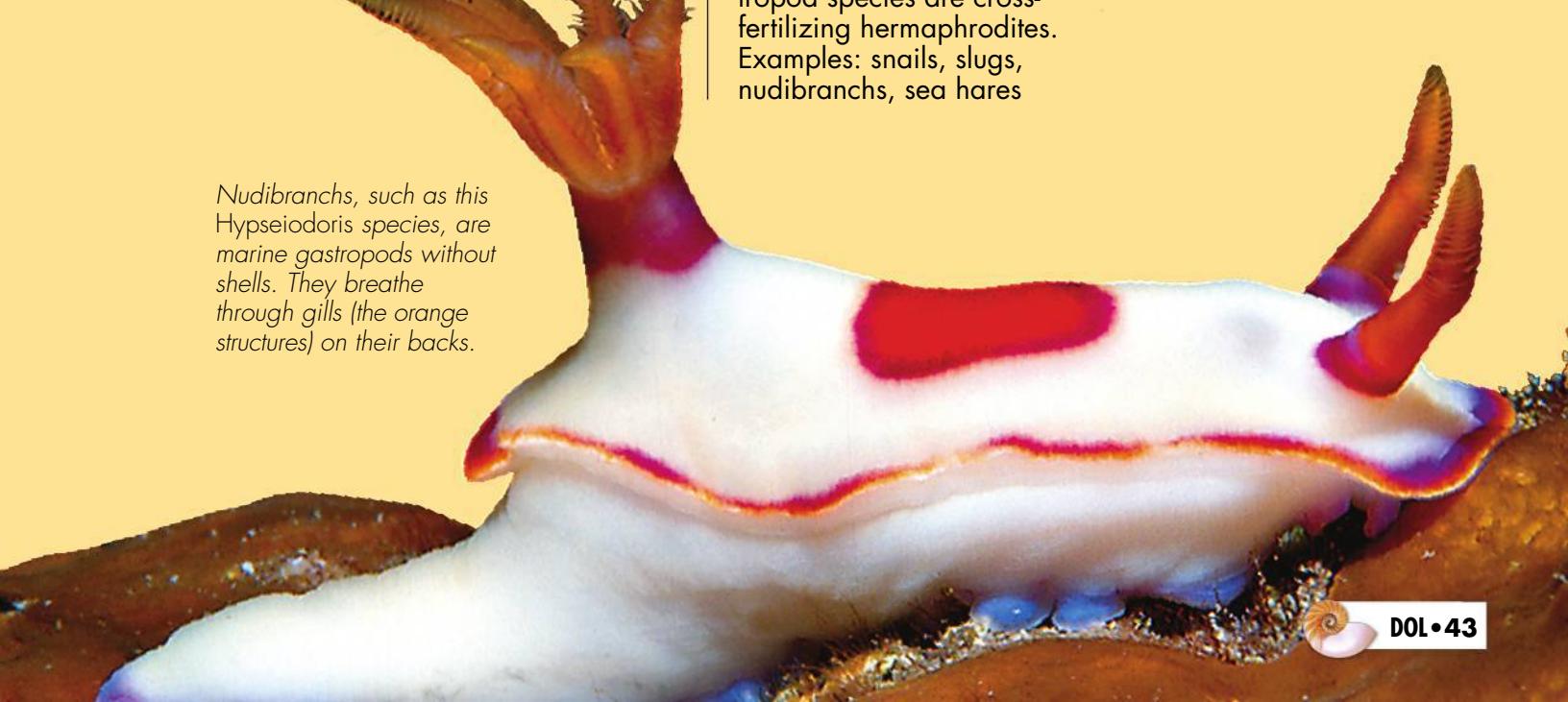
GASTROPODA: Gastropods

There are both terrestrial and aquatic gastropods. Most have a single spiral, chambered shell. Gastropods use a broad, muscular foot to move and have a distinct head region. Snails and slugs feed with a structure called a radula that usually works like sandpaper. Some species are predators whose harpoon-shaped radula carries deadly venom. They have open circulatory systems. Many gastropod species are cross-fertilizing hermaphrodites. Examples: snails, slugs, nudibranchs, sea hares

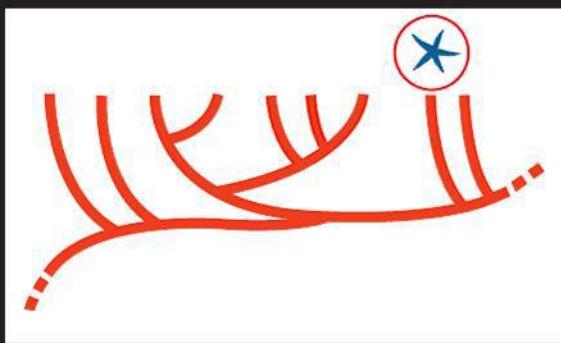
CEPHALOPODA: Cephalopods

Cephalopods live in salt water. The cephalopod has a highly developed brain and sense organs. The head is attached to a single foot, which is divided into tentacles. They have closed circulatory systems. Octopi use beaklike jaws for feeding; a few are venomous. Cephalopods have the most complex nervous systems among mollusks; octopi have complex behavior and have shown the ability to learn in laboratory settings. Examples: octopi, squids, nautilus, cuttlefish

Nudibranchs, such as this Hypselodoris species, are marine gastropods without shells. They breathe through gills (the orange structures) on their backs.



Echinoderms



KEY CHARACTERISTICS

Echinoderms are marine animals that have spiny skin surrounding an endoskeleton. Their unique water vascular system includes tube feet with suction-cuplike ends used in moving and feeding. The water vascular system also plays a role in respiration, circulation, and excretion. Echinoderms are coelomate deuterostomes. Adults exhibit 5-part radial symmetry.

Feeding and Digestion Method varies by group—echinoderms can be filter feeders, detritivores, herbivores, or carnivores.

Circulation Via fluid in the coelom, a rudimentary system of vessels, and the water vascular system

Respiration Gas exchange is carried out by surfaces of tube feet, and, in many species, by skin gills.



Crinoid fossil, about 400 million years old



Living modern crinoid (feather star)

• A Look Back in Time

Crinoids Then and Now

Echinoderms have a long fossil record that dates all the way back to the Cambrian Period. Although these animals have been evolving for millions of years, some fossil crinoids look a great deal like living crinoids.

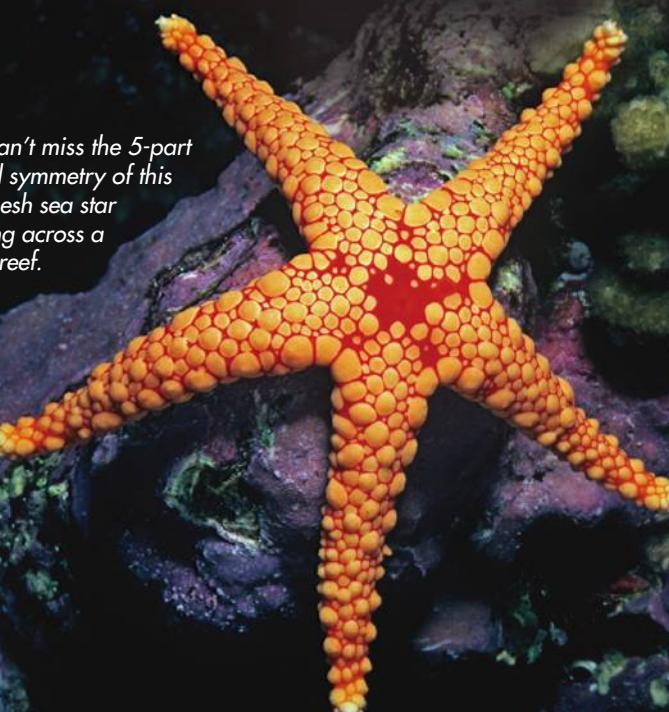
Excretion Digestive wastes released through anus; nitrogenous cellular wastes excreted as ammonia through tube feet and skin gills.

Response Minimal nervous system; nerve ring is connected to body sections by radial nerves; most have scattered sensory cells that detect light, gravity, and chemicals secreted by prey.

Movement In most, tube feet work with endoskeleton to enable locomotion.

Reproduction Sexual, with external fertilization; larvae have bilateral symmetry, unlike adults.

You can't miss the 5-part radial symmetry of this red mesh sea star moving across a coral reef.



GROUPS OF ECHINODERMS

There are more than 7000 species of echinoderms.

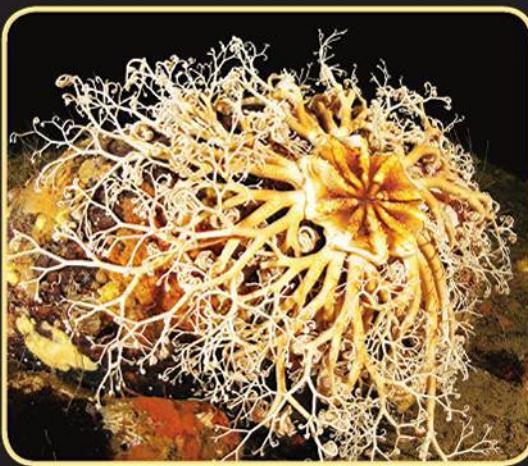
CRINOIDEA: Crinoids

Crinoids are filter feeders; some use tube feet along feathery arms to capture plankton. The mouth and anus are on the upper surface of the body disk. Some are stationary as adults while others can "walk" using short "arms" on the lower body surface. Examples: sea lily, feather star

► Feeding Crinoid



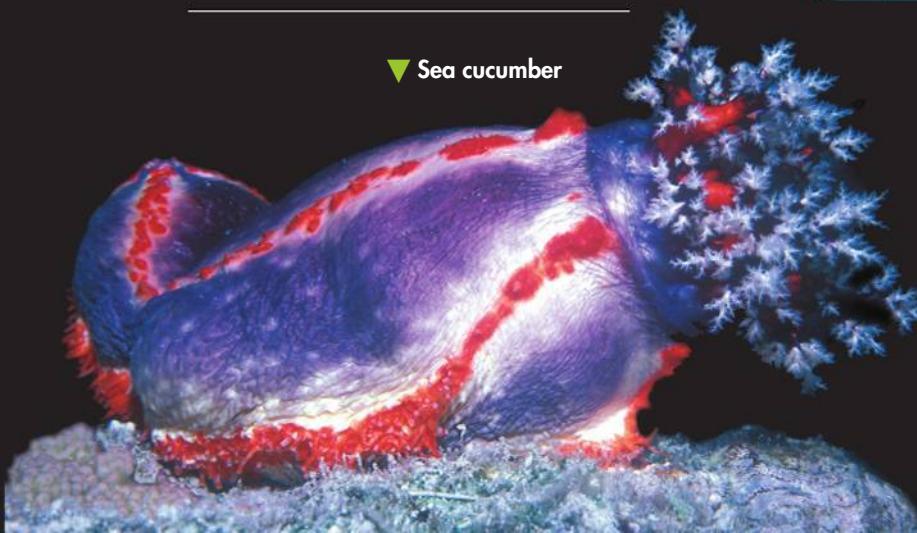
▼ Basket Star



OPHIUROIDEA: Ophiuroids

Ophiuroids have small body disks, long, armored arms, and flexible joints. Most are filter feeders or detritivores. Examples: brittle star, basket star

▼ Sea cucumber



► Sea Star

ASTEROIDEA: Sea stars

Sea stars are bottom dwellers whose star-shaped bodies have flexible joints. They are carnivorous—the stomach pushes through the mouth onto the body tissues of prey and pours out digestive enzymes. The stomach then retracts with the partially digested prey; digestion is completed inside the body. Examples: crown-of-thorns sea star, sunstar

ECHINOIDEA: Echinoids

Echinoids lack arms. Their endoskeletons are rigid and boxlike and covered with movable spines. Most echinoids are herbivores or detritivores that use five-part jawlike structures to scrape algae from rocks. Examples: sea urchin, sand dollar, sea biscuit

▼ Sea urchins grazing on kelp



HOLOTHUROIDEA: Sea cucumbers

Sea cucumbers have a cylindrical, rubbery body with a reduced endoskeleton and no arms. They typically lie on their side and move along the ocean floor by the combined action of tube feet and body-wall muscles. These filter feeders or detritivores use a set of retractable feeding tentacles on one end to take in sand and detritus, from which they glean food.

Nonvertebrate Chordates



Tunicates are chordates named for the colorful tunic-like covering the adults have. As larvae, tunicates have all the characteristics of chordates, as well as bilateral symmetry, but as adults, they look very, very different.

KEY CHARACTERISTICS

The nonvertebrate chordates are the only chordates that lack a backbone. Like other chordates, they have a nerve cord, notochord, pharyngeal pouches, and a tail at some point during development. They are coelomate deuterostomes. The two subphyla, tunicates and lancelets, differ significantly.

Feeding and Digestion Filter feeders; tunicates—in most, water carrying food particles enters through an incurrent siphon; food is strained out in the pharynx and passed to the digestive system; lancelets—mucus in the pharynx catches food particles carried in by water, which are then carried into digestive tract

Circulation Closed; tunicates—heart pumps blood by “wringing out,” and flow periodically reverses direction; lancelets—no heart, but blood vessels pump blood through body in one direction

Respiration Tunicates—gas exchange occurs in the gills and across other body surfaces; lancelets—through pharynx and body surfaces

Excretion Tunicates—most through excurrent siphon; lancelets—flame cells in nephridia release water and nitrogenous wastes into the atrium and out through an opening called an atriorepore

Response Cerebral ganglion, few specialized sensory organs; tunicates—sensory cells in and on the siphons and other internal surfaces help control the amount of water passing through the pharynx; lancelets—a pair of eyespots detect light

Movement Tunicates—free-swimming larvae, but most are stationary as adults; lancelets—no appendages: they move by contracting muscles paired on either side of the body

Reproduction Tunicates—most sexual and hermaphroditic with external fertilization, but some reproduce by budding; most have free-swimming tadpole-like larvae that metamorphose into adults; lancelets—sexual with external fertilization



Eco • Alert



Asian
Stalked
Tunicate

Out-of-Control Tunicates

You've never heard of them, but Asian stalked tunicates are disrupting marine ecosystems in Washington State; Prince Edward Island, Canada; and elsewhere. Tunicate larvae are carried in the ballast water of freight ships and discharged wherever the ships make port. There, away from their usual predators, the tunicates grow out of control, smothering shellfish beds and covering boats, docks, and underwater equipment. Researchers are still trying to figure out how to control them.

GROUPS OF NONVERTEBRATE CHORDATES

There are two major groups of nonvertebrate chordates: tunicates and lancelets (sometimes called amphioxus).

CEPHALOCHORDATA: Lancelets

Lancelets are fishlike animals that have bilateral symmetry and live in salt water. They are filter feeders and have no internal skeleton. Example: *Branchiostoma*

Two lancelets, *Branchiostoma lanceolatum*, poking out of sand.



▼ Pastel Sea Squirt



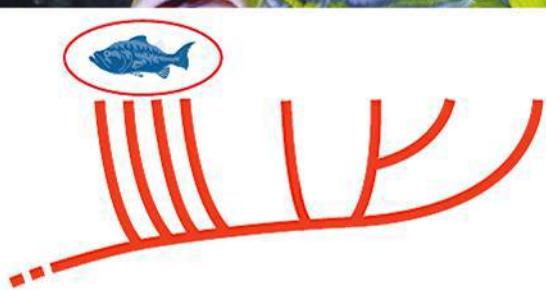
UROCHORDATA: Tunicates

Tunicates are filter feeders that live in salt water. Most adults have a tough outer covering ("tunic") and no body symmetry; most display chordate features and bilateral symmetry only during larval stages. Many adults are stationary; some are free-swimming. Examples: sea squirts, sea peaches, salps

▼ Sea Squirts



Fishes



KEY CHARACTERISTICS

The word fish is used informally to describe aquatic vertebrates that look similar even though they belong to several different clades, because all are adapted to life in water. Most vertebrates we call fishes have paired fins, scales, and gills.

Feeding and Digestion Varies widely, both within and between groups: herbivores, carnivores, parasites, filter feeders, detritivores; digestive organs often include specialized teeth and jaws, crop, esophagus, stomach, liver, pancreas

Circulation Closed, single-loop circulatory system; two-chambered heart

Respiration Gills; some have specialized lungs or other adaptations that enable them to obtain oxygen from air.

Excretion Diffusion across gill membranes; kidneys

Response Brain with many parts; highly developed sense organs, including lateral line system

Movement Paired muscles on either side of backbone; many have highly maneuverable fins; the largest groups have two sets of paired fins; some have a gas-filled swim bladder that regulates buoyancy.

Reproduction Methods vary within and between groups: external or internal fertilization; oviparous, ovoviviparous, or viviparous

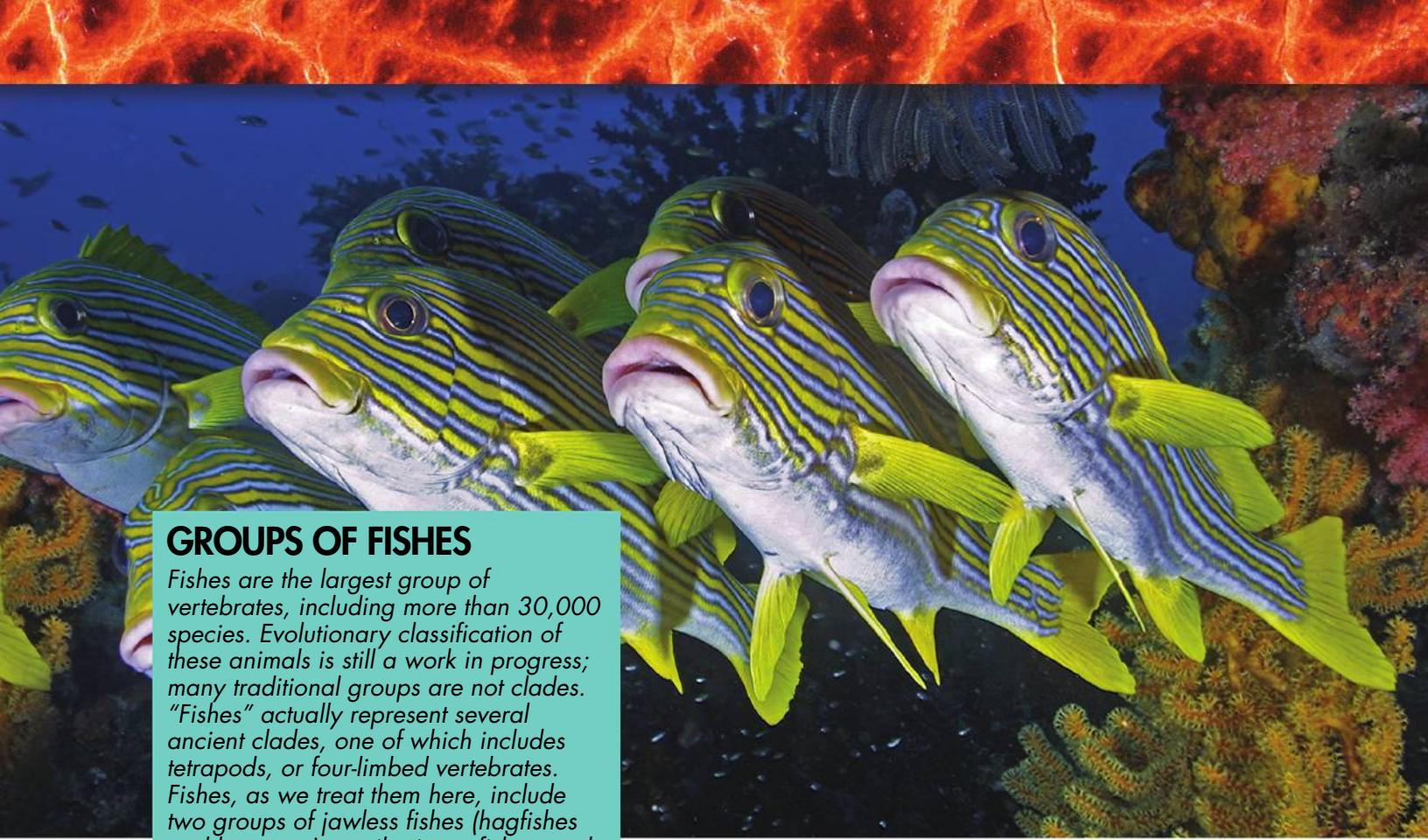


▲ Artist's conception of *Materpiscis* giving birth

• A Look Back in Time

Live Birth in Devonian Seas

You might think that live birth is a recent addition to chordate diversity. Guess again. Recent fossil finds of fishes from the Devonian Period show that at least one group of fishes was already bearing live young 380 million years ago. Two incredibly well preserved fossils, including that of the fish *Materpiscis*, show the remains of young with umbilical cords still attached to their mother's bodies. This is the earliest fossil evidence of viviparity in vertebrates.



GROUPS OF FISHES

Fishes are the largest group of vertebrates, including more than 30,000 species. Evolutionary classification of these animals is still a work in progress; many traditional groups are not clades. "Fishes" actually represent several ancient clades, one of which includes tetrapods, or four-limbed vertebrates. Fishes, as we treat them here, include two groups of jawless fishes (hagfishes and lampreys), cartilaginous fishes, and bony fishes.

Sweetlips are, despite their funny faces, easily recognizable as fish.

"JAWLESS FISHES"

Hagfishes and lampreys make up separate clades, but their bodies share common features that distinguish them from other fishes. They have no jaws, lack vertebrae, and their skeletons are made of fiber and cartilage.

PETROMYZONTIDA: Lampreys

Lampreys are mostly filter feeders as larvae and parasites as adults. The head of an adult lamprey is taken up almost completely by a circular, tooth-bearing, sucking disk with a round mouth. Adult lampreys typically attach themselves to fishes. They hold on to their hosts using the teeth in their sucking disk and then scrape away at the skin with a rasping tongue. Lampreys then suck up their host's tissues and body fluids. Because lampreys feed mostly on blood, they are called "vampires of the sea."



▲ Lamprey



Lamprey mouth



▲ Atlantic Hagfish

MYXINI: Hagfishes

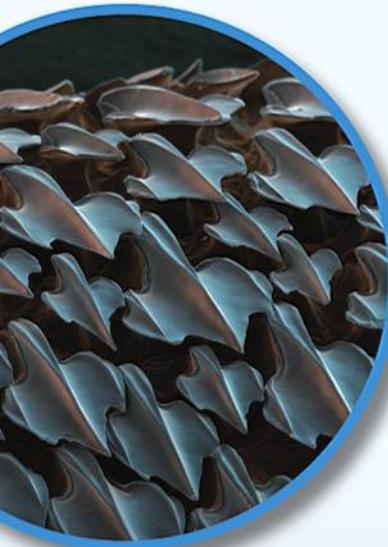
Hagfishes have pinkish gray wormlike bodies and four or six short tentacles around their mouths. They retain notochords as adults. Hagfishes lack image-forming eyes, but have light-detecting sensors scattered around their bodies. They feed on dead and dying animals using a rasping tongue that scrapes away layers of flesh.



Animals



Tiger Shark



Dermal denticles on shark skin reduce drag, helping the shark to swim faster.
(SEM 40 \times)



Hammerhead
Shark

CHONDRICHTHYES: Cartilaginous Fishes

Members of this clade are considered “cartilaginous” because they lack true bone; their skeletons are built entirely of cartilage. Most cartilaginous fishes also have tough scales, which make their skin as rough as sandpaper.



Elephant Fish

Holocephalans: Chimaeras

Chimaeras have smooth skin that lacks scales. Most have just a few platelike, grinding teeth and a venomous spine located in front of the dorsal fin. Examples: ghostfish, ratfish, rabbitfish

Elasmobranchii: Sharks, skates, and rays

Sharks, skates, and rays are very diverse, but all have skin covered with toothlike scales known as dermal denticles. Elasmobranchii make up the vast majority of living cartilaginous fish species.

Galeomorphi: Sharks

Most of the 350 or so shark species have large, curved asymmetrical tails, torpedo-shaped bodies, and pointed snouts with a mouth underneath. Predatory sharks, such as the great white, have many teeth arranged in rows. As teeth in the front rows are worn out or lost, new teeth replace them. Some sharks go through 20,000 teeth in their lifetime! Other sharks are filter feeders, and some species have flat teeth for crushing mollusk and crustacean shells. Examples: great white shark, whale shark, hammerhead shark

Squalomorphi: Skates and rays

Skates and rays have diverse feeding habits. Some feed on bottom-dwelling invertebrates by using their mouths as powerful vacuums. Others filter-feed on plankton. When not feeding or swimming, many skates and rays cover themselves with a thin layer of sand and rest on the ocean floor. Example: stingray



Blue-Spotted Stingray

OSTEICHTHYES: BONY FISHES

The skeletons of these vertebrates are made of true bone. This clade includes the ancestors and living members of all "higher" vertebrate groups—including tetrapods.



Rainbow Trout

Actinopterygii: Ray-finned fishes

Almost all living bony fishes, such as these rainbow trout, belong to a huge group called ray-finned fishes. The name *ray-finned* refers to the slender bony rays that are connected to one another by a layer of skin to form fins.



Coelacanth

Sarcopterygii: Lobe-finned fishes

Seven living species of bony fishes, including lungfishes and coelacanths, are classified as lobe-finned fishes. Lungfishes live in fresh water; coelacanths live in salt water. The fleshy fins of lobe-finned fishes are supported by strong bones rather than rays. Some of these bones are homologous to the limb bones of land vertebrates. Examples: lungfish, coelacanths

This clade includes the ancestors of tetrapods, which means, that all living tetrapods (including us!) are Sarcopterygians. As a result, the bony-fish clade includes almost half of all chordate species.



Amphibians



KEY CHARACTERISTICS

The word *amphibian* means “double life,” an apt name for these vertebrates, most of which live in water as larvae and on land as adults. Most adult amphibians breathe with lungs, lack scales and claws, and have moist skin that contains mucous glands.

Feeding and Digestion Tadpoles—usually filter feeders or herbivores with long, coiled intestines to digest plant material; adults—carnivores with shorter intestines for processing meat

Circulation Double-loop system with three-chambered heart

Respiration Larvae breathe through skin and gills; most adult species have lungs, though a few use gills; lungless salamanders breathe through their mouth-cavity lining and skin.

Excretion Kidneys produce urine.

Response Well-developed nervous and sensory systems; organs include protective nictitating membrane over moveable eyes, tympanic membranes, lateral line system

Movement Larvae have tails; adults have limbs (except caecilians); some have specialized toes for climbing.

Reproduction Most lay eggs without shells that are fertilized externally; most undergo metamorphosis from aquatic tadpole larvae that breathe with gills to land-dwelling adults, which usually have lungs and limbs.

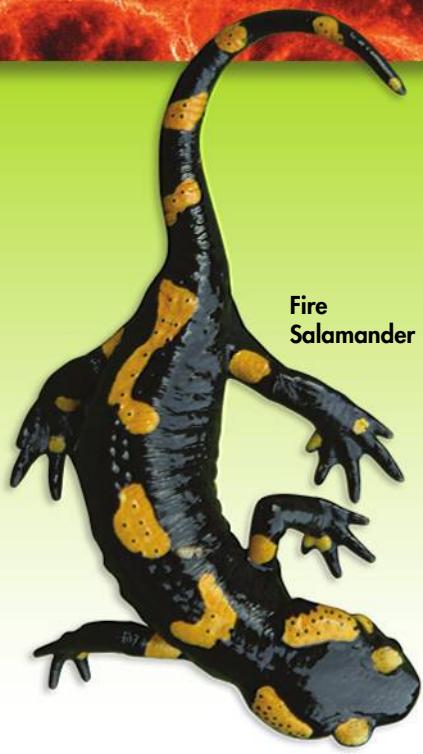
Eco • Alert



The Frogs Are Disappearing!

For several decades, scientists have noticed that amphibian populations worldwide have been decreasing, and a number of species have become extinct. Scientists have not yet pinpointed a single cause for this problem. It is, however, becoming clear that amphibians are susceptible to a variety of environmental threats, including habitat loss, ozone depletion, acid rain, water pollution, fungal infections, and introduced aquatic predators.

To better understand this decline, biologists worldwide have been focusing their efforts and sharing data about amphibian populations. One amphibian-monitoring program covers all of North America.



Fire
Salamander

GROUPS OF AMPHIBIANS

The three orders of amphibians include more than 6000 species, roughly 5000 of which are frogs and toads.

URODELA: Salamanders and newts

Salamanders and newts have long bodies and tails. Most also have four legs. All are carnivores. Adults usually live in moist woods, where they tunnel under rocks and rotting logs. Some salamanders, such as the mud puppy, keep their gills as adults and live in water all their lives. Examples: barred tiger salamander, red eft



American Toad

APODA: Caecilians

The least-known and most unusual amphibians are the legless caecilians. They have tentacles, and many have fishlike scales embedded in their skin—which shows that not all amphibians fit the general definition. Caecilians live in water or burrow in moist soil or sediment, feeding on small invertebrates such as termites. Examples: ringed caecilian, yellow-striped caecilian

Ringed Caecilian



ANURA: Frogs and toads

Adult frogs and toads are amphibians without tails that can jump. Frogs tend to have long legs and make long jumps, whereas toads have shorter legs that limit them to shorter hops. Frogs are generally more dependent on bodies of fresh water than toads, which may live in moist woods or even deserts. Examples: treefrogs, leopard frog, American toad, spadefoot toad

► Because amphibian eggs must develop in water, most amphibians live in moist climates. Some, such as this alpine newt, live on cool, rainy mountain slopes.



Reptiles



Saltwater crocodiles, such as this young one, are the largest living reptiles and sometimes reach 6 meters long. This is about the same length as a giraffe!

KEY CHARACTERISTICS OF REPTILES

Living reptiles, traditionally classified in the class Reptilia, are ectothermic vertebrates with dry, scaly skin; lungs; and amniotic eggs. Modern evolutionary classification now recognizes a larger clade Reptilia that includes living reptiles, extinct dinosaurs, and birds—the living descendants of one dinosaur group.

Feeding and Digestion Feeding methods vary by group; digestive systems—herbivores have long digestive systems to break down plant materials; carnivores may swallow prey whole

Circulation Two loops; heart with two atria and one or two ventricles

Respiration Spongy lungs provide large surface area for gas exchange; lungs operated by muscles and moveable ribs

Excretion Kidneys; urine contains ammonia or uric acid

Response Brain; well-developed senses including, in some species, infrared detectors that can spot warm-bodied prey in the dark

Movement Strong limbs (except snakes)

Reproduction Internal fertilization via cloaca; amniotic egg with leathery shell

Eco • Alert

Calling Doctor 'Gator'!

You might think of alligators mostly as killing machines, but their blood may soon provide medicines that can save lives. An alligator's immune system works quite differently from our own. Proteins in their white blood cells can kill multidrug resistant bacteria, disease-causing yeasts, and even HIV. Remarkably, these proteins work against pathogens to which the animals have never been exposed. Researchers are currently sequencing the genes for these proteins and hope to develop them into human medicines in the near future.

GROUPS OF REPTILES

There are nearly 9000 species of reptiles (not including birds).



SQUAMATA: Lizards, snakes, and relatives

There are more than 8000 species of lizards and snakes. Most lizards have legs, clawed toes, and external ears. Some lizards have evolved highly specialized structures, such as glands in the lower jaw that produce venom. Snakes are legless; they have lost both pairs of legs through evolution. Examples: iguanas, milk snake, coral snake



Leopard Gecko



Leopard Tortoise

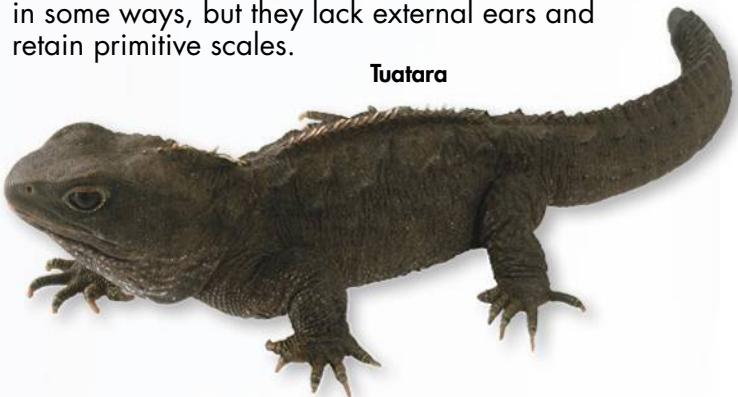
TESTUDINE: Turtles and tortoises

Turtles and tortoises have a shell built into their skeleton. Most can pull their heads and legs into the shell for protection. Instead of teeth, these reptiles have hornlike ridges covering their jaws equipped with sharp beaklike tips. Strong limbs can lift their body off the ground when walking or, in the case of sea turtles, can drag their body across a sandy shore to lay eggs. Examples: snapping turtles, green sea turtles, Galápagos tortoise

SPHENODONTA: Tuataras

The tuatara, found only on a few small islands off the coast of New Zealand, is the only living member of this group. Tuataras resemble lizards in some ways, but they lack external ears and retain primitive scales.

Tuatara



ARCHOSAURS: Crocodilians; pterosaurs and dinosaurs (extinct); and birds

This clade includes some of the most spectacular animals that have ever lived. The extinct dinosaurs and pterosaurs (flying reptiles), whose adaptive radiations produced some of the largest animals ever to walk Earth or fly above it, are the closest relatives of birds. Living crocodilians are short-legged and have long and typically broad snouts. They are fierce carnivorous predators, but the females are attentive mothers. Crocodilians live only in regions where the climate remains warm year-round. We discuss birds separately. Examples: extinct types: *Tyrannosaurus*, *Pteranodon*; living types: alligators, crocodiles, caimans, and birds (see following pages)



Spectacled Caiman



Birds



Common Kingfisher

Today, only birds have feathers. These delicate, intricately interlocking and beautiful structures keep birds warm and cool and enable most to fly.



KEY CHARACTERISTICS OF BIRDS

Birds, once placed in a class of their own, are now recognized as endothermic reptiles with feathers and hard-shelled, amniotic eggs that are descended from dinosaurs. Birds have two scaly legs and front limbs modified into wings, which enable most species to fly.

Feeding and Digestion No teeth; bills adapted to widely varied foods, including insects, seeds, fruits, nectar, fish, meat; organs of the digestive system include crop, gizzard, cloaca

Circulation Two loops with four-chambered heart; separation of oxygen-rich and oxygen-poor blood

Respiration Constant, one-way flow of air through lungs and air sacs increases the efficiency of gas exchange and supports high metabolic rate

Excretion Kidneys remove nitrogenous wastes from blood, converting them to uric acid, which is excreted through cloaca

Response Brain with large optic lobes and enlarged cerebellum; highly evolved sense organs including, in some species, eyes that can see ultraviolet light

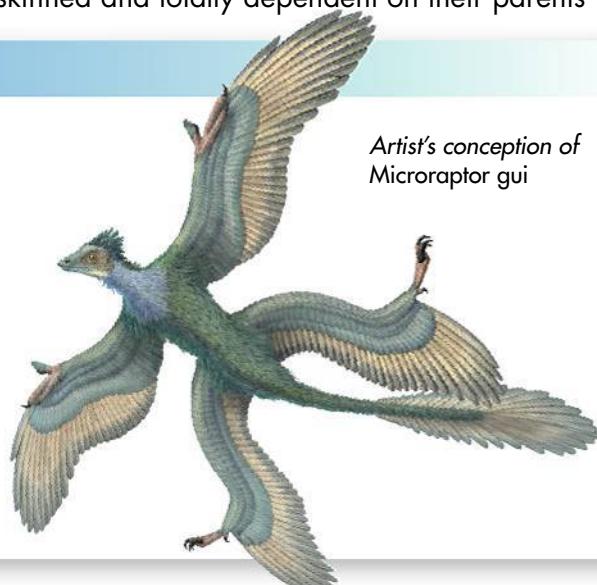
Movement Skeleton made up of lightweight, hollow bones with internal struts for strength; powerful muscles; most fly

Reproduction Internal fertilization via cloaca; amniotic egg with hard, brittle shell; depending on species, newly hatched young may be precocial—downy-feathered chicks able to move around and feed themselves, or altricial—bare-skinned and totally dependent on their parents

A Look Back in Time

Birds of a Feather

Fossils recently discovered in lake beds in China have greatly expanded our understanding of bird evolution. One exciting discovery was that of a four-winged dinosaur named *Microraptor gui* from about 125 million years ago. *Microraptor gui*, which was related to *Tyrannosaurus rex*, had feathers on both its wings and its legs, so some researchers hypothesize that it flew like a biplane! This and other fossils show that several lineages of dinosaurs and ancient birds evolved various kinds of feathers over millions of years.



Artist's conception of
Microraptor gui

GROUPS OF BIRDS

Evolutionary classification of living birds is still a work in progress, as different techniques and analyses produce different results. There are about 10,000 species. The groups described below illustrate some of the diversity of birds.



Ostrich

PALEOGNATHAE: Ostriches, emus, kiwis, and relatives

This group represents an early branch of the bird family tree that is separate from all other living birds. This clade includes the largest birds alive today. Ostriches can be 2.5 meters tall and weigh 130 kilograms! Kiwis, however, are only about the size of chickens. Roughly a dozen living species are scattered throughout the Southern Hemisphere. All are flightless, but the larger species can run very fast. They generally eat a variety of plant material, insects, and other small invertebrates. Examples: ostrich, emu, brown kiwi, greater rhea, dwarf cassowary

SPHENISCIDAE: Penguins

These flightless birds of the Southern Hemisphere are adapted to extreme cold and hunting in water. Though they cannot fly, they use their wings as flippers when they swim. Penguins have more feathers per square centimeter than any other bird; this density allows them to repel water and conserve heat effectively. Some species form large colonies. Examples: emperor penguin, chinstrap penguin, king penguin



King
Penguins



Redhead

ANATIDAE: Ducks, geese, and swans

These birds spend much of their time feeding in bodies of water. Webbed feet enable them to paddle efficiently across the surface of the water. Most fly well, however, and many species migrate thousands of kilometers between breeding and resting locations. Examples: redhead, Ross's goose, trumpeter swan



**Ferruginous Hawk****FALCONIDAE AND ACCIPITRIDAE:
Falcons, eagles, and hawks**

These fierce predators, often called raptors, typically have powerful hooked bills, large wingspans, and sharp talons. Raptors have powerful flight muscles and keen eyesight, enabling them to see prey at a distance. Examples: Eurasian kestrel, golden eagle, Galápagos hawk

**Great-Spotted
Woodpecker****PICIDAE AND RAMPHASTIDAE:
Woodpeckers and toucans**

Woodpeckers are tree-dwelling birds with two toes in front and two in back. (Most birds have three in front and one in back; the two-and-two arrangement makes moving up and down tree trunks easier.) Woodpeckers are typically carnivores that eat insects and their larvae. Toucans usually use their huge, often colorful bills to eat fruit. Examples: black woodpecker, keel-billed toucan

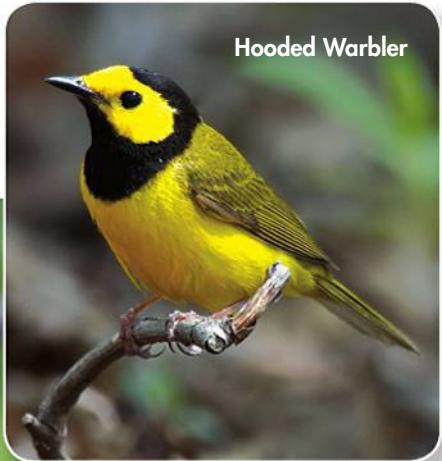
**Keel-Billed Toucan**

PASSERIFORMES: Passerines

Also called perching birds, this is by far the largest and most diverse group of birds, with about 5000 species. Most are songbirds. Examples: flycatchers, mockingbirds, cardinals, crows, chickadees, and finches.



Scarlet Tanager



Hooded Warbler



Blue Grosbeak

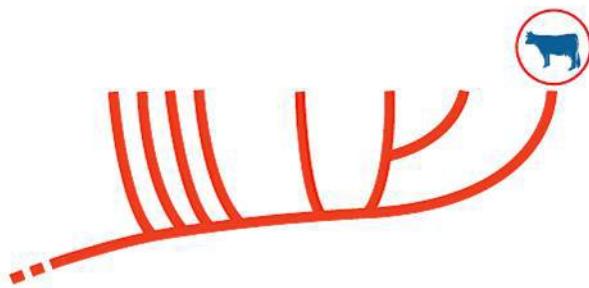


Lark Sparrow



Great
Crested
Flycatcher

Mammals



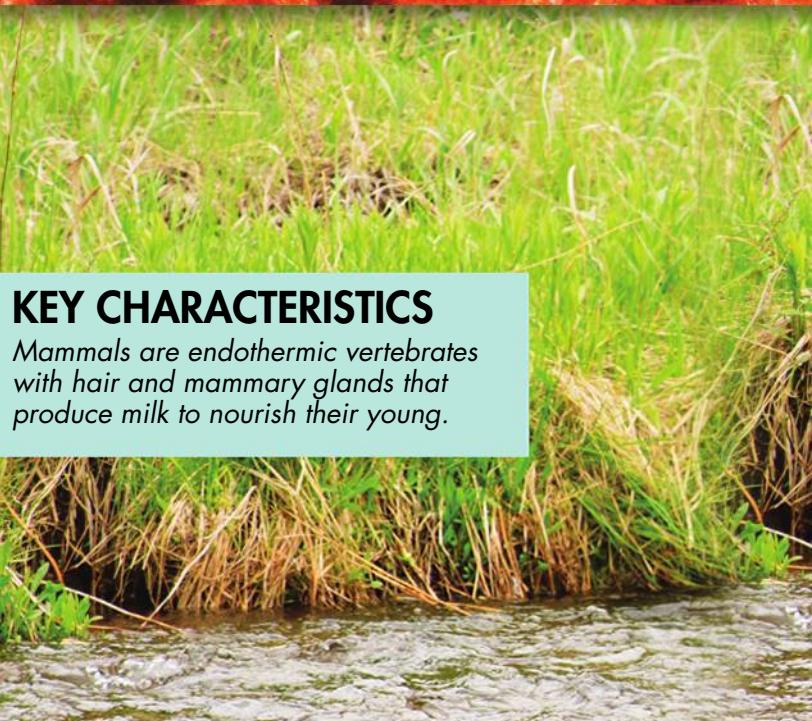
Feeding and Digestion Diet varies with group; foods range from seeds, fruits, and leaves to insects, fish, meat, and even blood; teeth, jaws, and digestive organs are adapted to diet

Circulation Two loops; four-chambered heart; separation of oxygen-rich and oxygen-poor blood

Respiration Lungs controlled by two sets of muscles.

Excretion Highly evolved kidneys filter urea from blood and produce urine.

Response Most highly evolved brain of all animals; keen senses



KEY CHARACTERISTICS

Mammals are endothermic vertebrates with hair and mammary glands that produce milk to nourish their young.

Movement Flexible backbone; variations in limb bones and muscles enable wide range of movement across groups: from burrowing and crawling to walking, running, hopping, and flying

Reproduction Internal fertilization; developmental process varies with group (monotreme, marsupial, placental)

Did You Know?

Platypus: Mix-and-Match Genome

The duckbill platypus has such an odd mix of reptile and mammal features that some scientists thought the first specimens were hoaxes produced by sticking parts of different animals together! Recent genome studies have revealed an equally odd mix of reptilian and mammalian genes. Genes for reptile-like vision, the production of egg yolk, and the production of venom link the platypus to reptiles. Genes for the production of milk link it to other mammals. The evidence provides confirmation that this monotreme represents a truly ancient lineage, one from the time close to that at which mammals branched off from reptiles.





GROUPS OF MAMMALS

The three living groups of mammals are the monotremes, the marsupials, and the placentals. There are about 5000 species of mammals, usually divided into about 26 orders, most of which are placentals. There is only one order of monotremes.

This young moose is enjoying a moment of independence from its mother. Mammals provide intensive parental care to their young.



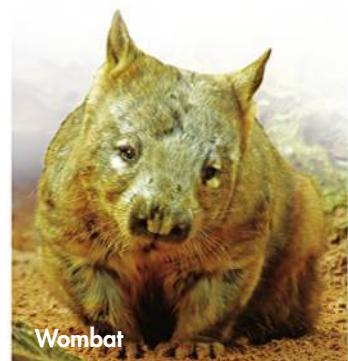
Short-Beaked Echidna

MONOTREMATA: Monotremes

Monotremes—egg-laying mammals—share two important characteristics with reptiles. First, the digestive, reproductive, and urinary systems of monotremes all open into a cloaca similar to that of reptiles. Second, monotreme development is similar to that of reptiles. Like a reptile, a female monotreme lays soft-shelled eggs incubated outside her body. The eggs hatch in about ten days. Unlike reptiles, however, young monotremes are nourished by mother's milk, which they lick from pores on the surface of her abdomen. Only five monotreme species exist today, all in Australia and New Guinea. Examples: duckbill platypus, echidnas

MARSUPIALIA: Marsupials

Marsupials bear live young at an extremely early stage of development. A fertilized egg develops into an embryo inside the mother's reproductive tract. The embryo is then "born" in what would be an embryonic stage for most other mammals. It crawls across its mother's fur and attaches to a nipple that, in most species, is located in a pouch called the marsupium. The embryo spends several months attached to the nipple. It continues to nurse until it can survive on its own. Examples: kangaroos, wallabies, wombats, opossums



Wombat



PLACENTALIA: Placental Mammals

Placental mammals are the mammals with which you are most familiar. This group gets its name from a structure called the placenta, which is formed when the embryo's tissues join with tissues within the mother's body. Nutrients, gases, and wastes are exchanged between embryo and mother through the placenta. Development may take as little as a few weeks (mice), to as long as two years (elephants). After birth, most placental mammals care for their young and provide them with nourishment by nursing. Examples: mice, cats, dogs, seals, whales, elephants, humans

Chiroptera: Bats

These are the only mammals capable of true flight. There are more than 900 species of bats! They eat mostly insects or fruit and nectar, although a few species feed on the blood of other vertebrates. Examples: fruit bats, little brown myotis, vampire bat



Epauletted Bat,
roosting



Lioness attacking
Greater Kudu

Carnivora: Carnivores

Many members of this group, such as tigers and hyenas, chase or stalk prey by running or pouncing, then kill with sharp teeth and claws. Dogs, bears, and other members of this group may eat plants as well as meat. Examples: dogs, cats, skunks, seals, bears

Sirenia: Sirenians

Sirenians are herbivores that live in rivers, bays, and warm coastal waters scattered throughout the world. These large, slow-moving mammals lead fully aquatic lives. Examples: manatees, dugongs



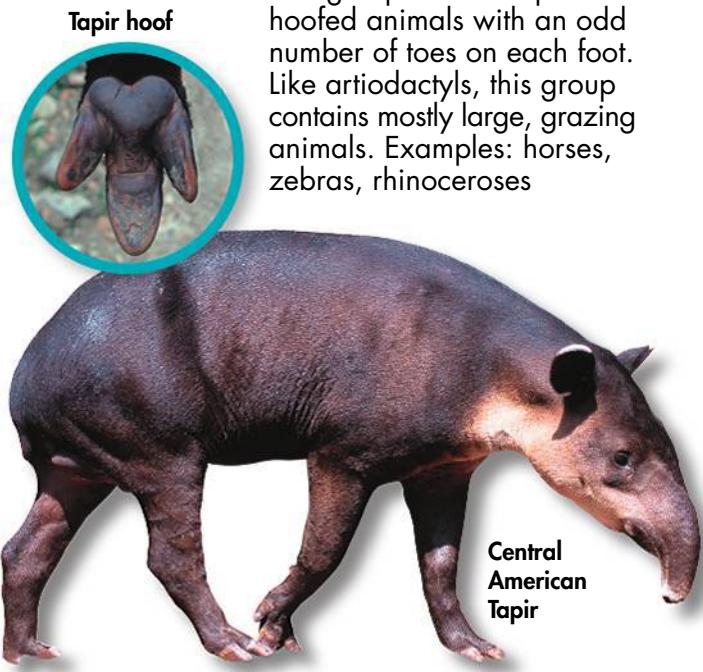
Manatee mother
and nursing calf

**Four-Toed Hedgehog
mother and baby****Insectivora: Insectivores**

These insect eaters have long, narrow snouts and sharp claws that are well suited for digging. Examples: shrews, moles, hedgehogs

Perissodactyla: Hoofed, odd-toed mammals

This group is made up of hoofed animals with an odd number of toes on each foot. Like artiodactyls, this group contains mostly large, grazing animals. Examples: horses, zebras, rhinoceroses

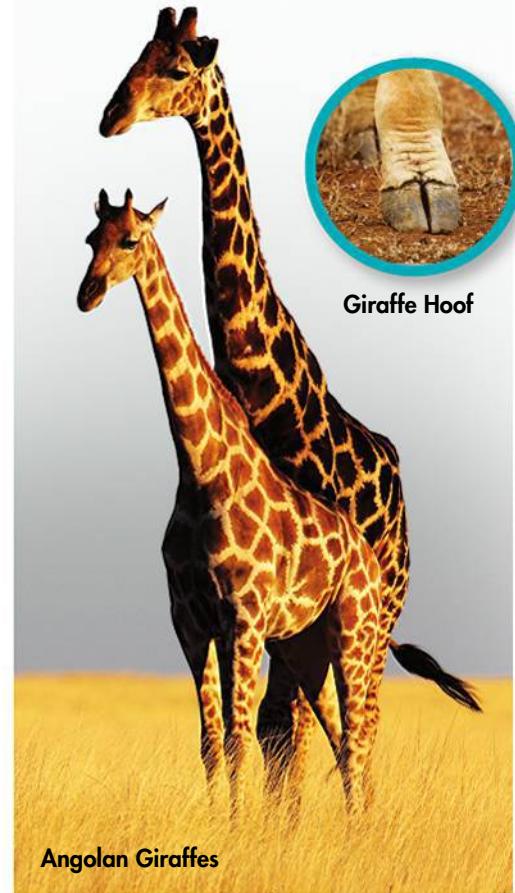


Rodentia: Rodents

Rodents have a single pair of long, curved incisor teeth in both their upper and lower jaws, used for gnawing wood and other tough plant material. Examples: rats, squirrels, porcupines

Artiodactyla: Hoofed, even-toed mammals

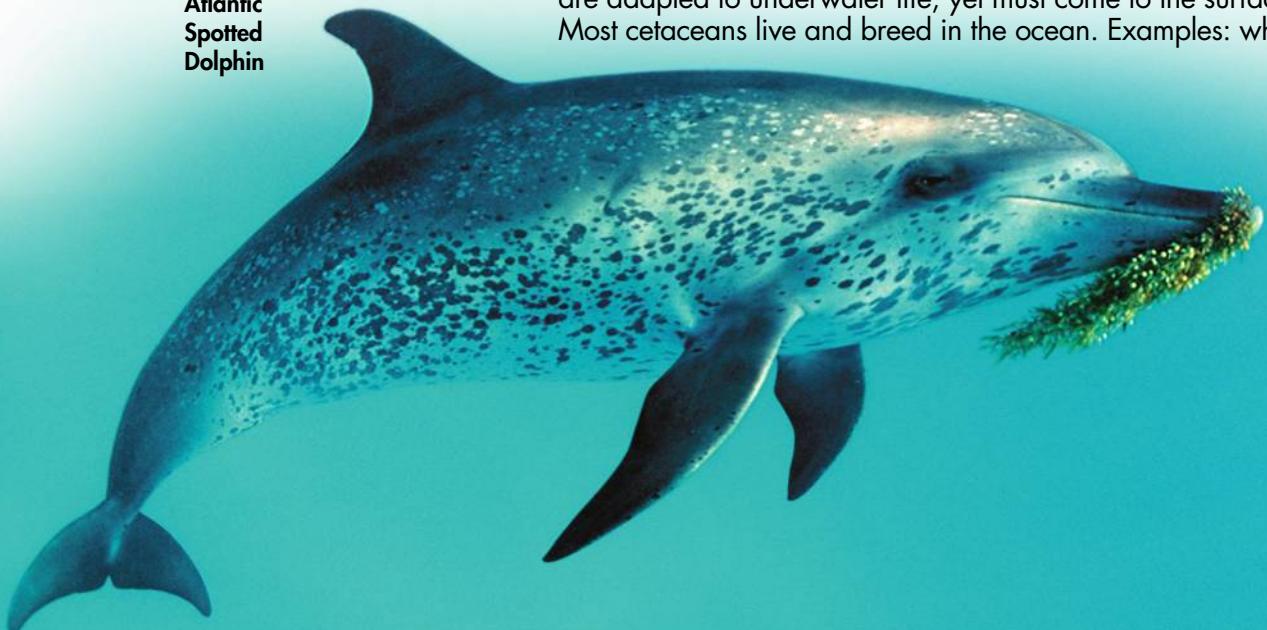
These large, grazing, hoofed mammals have an even number of toes on each foot. Examples: cattle, sheep, pigs, hippopotami



Atlantic
Spotted
Dolphin

Cetacea: Cetaceans

Like sirenians, cetaceans—the group that includes whales and dolphins—are adapted to underwater life, yet must come to the surface to breathe. Most cetaceans live and breed in the ocean. Examples: whales, dolphins



Animals



European Hare

Lagomorpha: Rabbit, hares, and pikas

Lagomorphs are entirely herbivorous. They differ from rodents by having two pairs of incisors in the upper jaw. Most lagomorphs have hind legs that are adapted for leaping.



Tamandua

Xenarthra: Edentates

The word *edentate* means "toothless," which refers to the fact that some members of this group (sloths and anteaters) have simple teeth without enamel or no teeth at all. Armadillos, however, have more teeth than most other mammals! Examples: sloths, anteaters, armadillos



Asian Elephant and calf

Primates: Lemurs, monkeys, apes, humans, and relatives

Members of this group are closely related to ancient insectivores but have a highly developed cerebrum and complex behaviors.



Sifaka



Tarsier



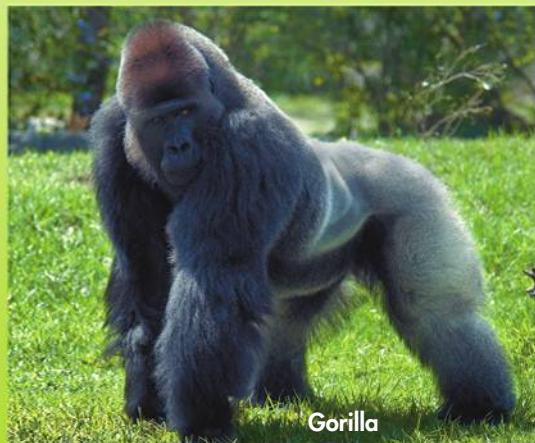
Langur



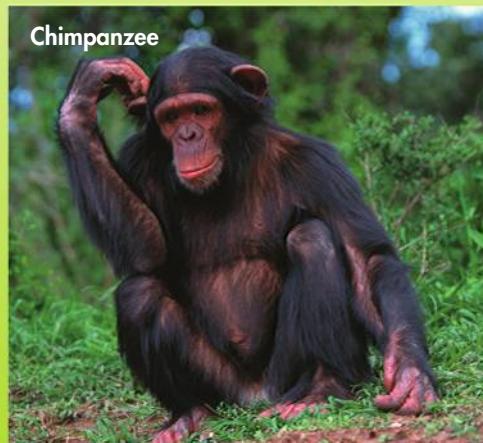
Baboon and baby



Orangutan



Gorilla



Chimpanzee

Appendix A Science Skills

Data Tables and Graphs

How can you make sense of the data from a science experiment? The first step is to organize the data. You can organize data in data tables and graphs to help you interpret them.

Data Tables

You have gathered your materials and set up your experiment. But before you start, you need to plan a way to record what happens during the experiment. By creating a data table, you can record your observations and measurements in an orderly way.

Suppose, for example, that a scientist conducted an experiment to find out how many kilocalories people of different body masses burned while performing various activities for 30 minutes. The data table below shows the results.

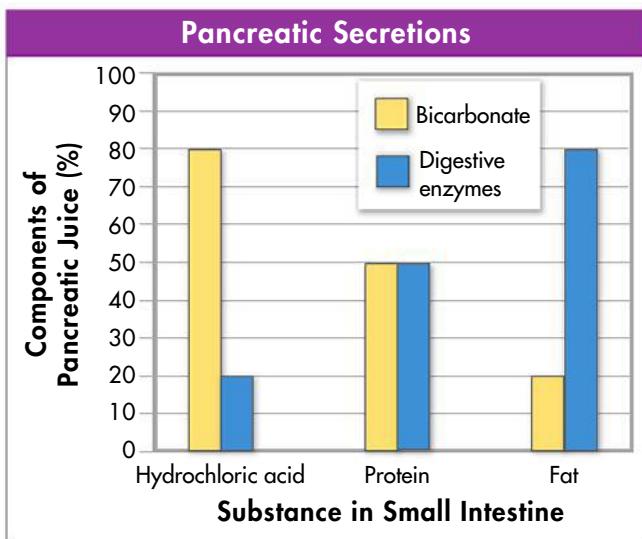
Notice in this data table that the independent variable (body mass) is the heading of the first column. The dependent variable (for Experiment 1, the number of kilocalories burned while bicycling for 30 minutes) is the heading of the next column. Additional columns were added for related experiments.

Calories Burned in 30 Minutes			
Body Mass	Experiment 1: Bicycling	Experiment 2: Playing Basketball	Experiment 3: Watching Television
30 kg	60 Calories	120 Calories	21 Calories
40 kg	77 Calories	164 Calories	27 Calories
50 kg	95 Calories	206 Calories	33 Calories
60 kg	114 Calories	248 Calories	38 Calories

Bar Graphs

A bar graph is useful for comparing data from two or more distinct categories. In this example, pancreatic secretions in the small intestine are shown. To create a bar graph, follow these steps.

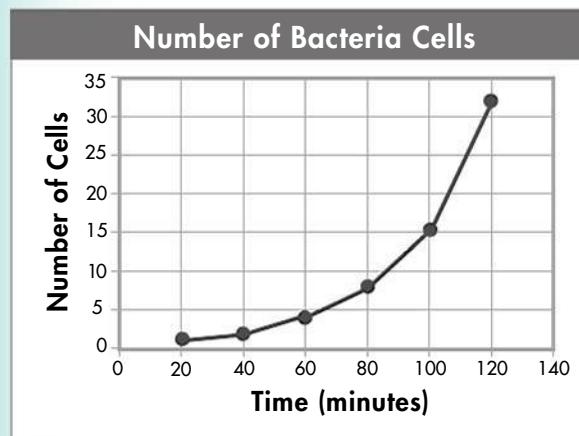
1. On graph paper, draw a horizontal, or *x*-axis, and a vertical, or *y*-axis.
2. Write the names of the categories (the independent variable) along one axis, usually the horizontal axis. You may put the categories on the vertical axis if that graph shape better fits on your page. Label the axis.
3. Label the other axis with the name of the dependent variable and the unit of measurement. Then, create a scale along that axis by marking off equally spaced numbers that cover the range of the data values.
4. For each category, draw a solid bar at the appropriate value. Then, fill in the space from the bar to the axis representing the independent variable. Make all the bars the same width.
5. Add a title that describes the graph.



Appendix A Science Skills *continued*

Line Graphs

A line graph is used to display data that show how the dependent variable changes in response to manipulations of the independent variable. You can use a line graph when your independent variable is continuous, that is, when there are other points between the ones that you tested. For example, the graph below shows how the growth of a bacterial population is related to time. The graph shows that the number of bacteria approximately doubles every 20 minutes. Line graphs are powerful tools because they also allow you to estimate values for conditions that you did not test in the experiment.



To construct a line graph, follow these steps.

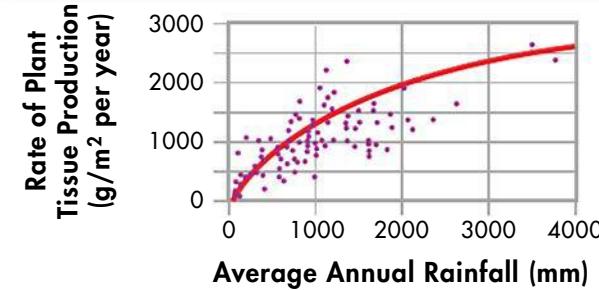
1. On graph paper, draw a horizontal, or x -axis, and a vertical, or y -axis.
2. Label the horizontal axis with the name of the independent variable. Label the vertical axis with the name of the dependent variable. Include the units of measurement on both axes.
3. Create a scale on each axis by marking off equally spaced numbers that cover the range of the data values collected.

4. Plot a point on the graph for each data value. To do this, follow an imaginary vertical line extending up from the horizontal axis for an independent variable value. Then, follow an imaginary horizontal line extending across from the vertical axis at the value of the associated dependent variable. Plot a point where the two lines intersect. Repeat until all your data values are plotted.

5. Connect the plotted points with a solid line. Not all graphs are linear, so you may discover that it is more appropriate to draw a curve to connect the points.

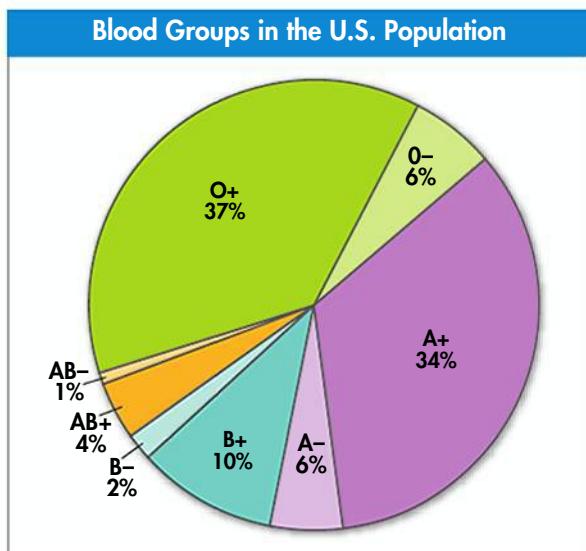
The data in the graph at the left fit neatly on a smooth curve. But if you were to connect each data point on the graph below, you would have a mess that yielded little useful information. In some cases, it may be most useful to draw a line that shows the general trend of the plotted points. This type of line is often called a line of best fit. Such a line runs as closely as possible to all the points and allows you to make generalizations or predictions based on the data. Some points will fall above or below a line of best fit.

The Effect of Rainfall on Plant Productivity



Circle Graphs

Circle graphs, or pie charts, display data as parts of a whole. Like bar graphs, circle graphs can be used to display data that fall into separate categories. Unlike bar graphs, however, circle graphs can only be used when you have data for all the categories that make up a given group. The circle, or “pie,” represents 100 percent of a group, while the sectors, or slices, represent the percentages of each category that make up that group. The example below compares the different blood groups found in the U.S. population.



To construct a circle graph, follow these steps.

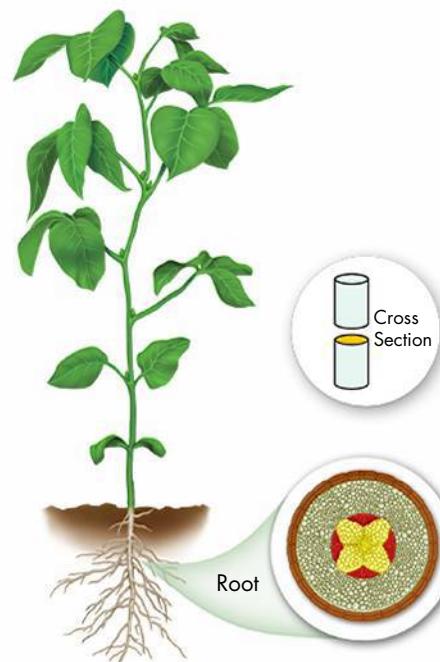
1. Draw a circle and mark the center. Then, draw a radius line from the center to the circle's edge.
2. Determine the size of a sector of the graph by calculating the number of degrees that correspond to a percentage you wish to represent. For example, in the graph shown, B⁺ makes up 10 percent of all blood groups; $360 \text{ degrees} \times 0.10 = 36 \text{ degrees}$.
3. With a protractor fixed at the center of the circle, measure the angle—in this example, 36 degrees—from the existing radius, and draw a second radius at that point. Label the sector with its category and the percentage of the whole it represents. Repeat for each of the other categories, measuring each sector from the previous radius so the sectors don't overlap.
4. For easier reading, shade each sector differently.
5. Add a title that describes the graph.

Reading Diagrams

In scientific figures showing a cut-away of a structure, the diagram or photograph is showing the structure from a particular angle. Look for clues throughout this book that will help you interpret the view being shown.

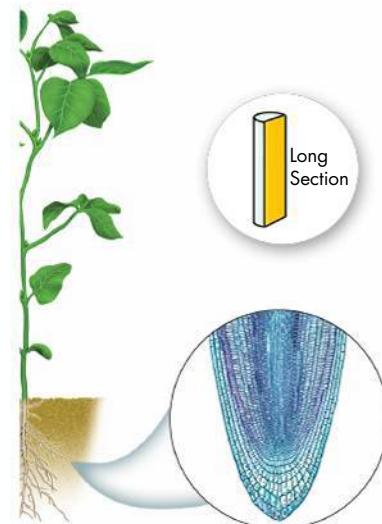
Cross Sections

A cross section shows a horizontal cut through the middle of a structure. This icon will help you locate cross sections.



Longitudinal Sections

A longitudinal section shows a vertical cut through the middle of a structure. This icon will help you locate longitudinal sections.



Appendix A Science Skills

Basic Process Skills

During a biology course, you often carry out short lab activities as well as lengthier experiments. Here are some skills that you will use.

Observing

In every science activity, you make a variety of observations. Observing is using one or more of the five senses to gather information. Many observations involve the senses of sight, hearing, touch, and smell. On rare occasions in a lab—but only when explicitly directed by your teacher—you may use the sense of taste to make an observation.

Sometimes you will use tools that increase the power of your senses or make observations more precise. For example, hand lenses and microscopes enable you to see things in greater detail. Rulers, balances, and thermometers help you measure key variables. Besides expanding the senses or making observations more accurate, tools may help eliminate personal opinions or preferences.

In science, it is customary to record your observations at the time they are made, usually by writing or drawing in a notebook. You may also make records by using computers, cameras, videotapes, and other tools. As a rule, scientists keep complete accounts of their observations, often using tables to organize their observations.



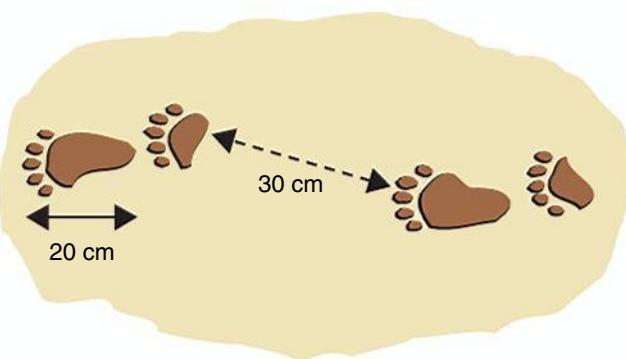
A-4 Appendix A

Inferring

In science, as in daily life, observations are usually followed by inferences. Inferring is interpreting an observation or statement based on prior knowledge.

For example, suppose you're on a mountain hike and you see footprints like the ones illustrated below. Based on their size and shape, you might infer that a large mammal had passed by. In making that inference, you would use your knowledge about the shape of animals' feet. Someone who knew much more about mammals might infer that a bear left the footprints. You can compare examples of observations and inferences in the table.

Notice that an inference is an act of reasoning, not a fact. An inference may be logical but not true. It is often necessary to gather further information before you can be confident that an inference is correct. For scientists, that information may come from further observations or from research done by others.



Comparing Observations and Inferences

Sample Observations	Sample Inferences
The footprints in the soil each have five toes.	An animal made the footprints.
The larger footprints are about 20 cm long.	A bear made the footprints.
The space between each pair of footprints is about 30 cm.	The animal was walking, not running.

As you study biology, you may make different types of inferences. For example, you may generalize about all cases based on information about some cases: *All the plant roots I've observed grow downward, so I infer that all roots grow downward.* You may determine that one factor or event was caused by another factor or event: *The bacteria died after I applied bleach, so I infer that bleach kills bacteria.* Predictions may be another type of inference.

Predicting

People often make predictions, but their statements about the future could be either guesses or inferences. In science, a prediction is an inference about a future event based on evidence, experience, or knowledge. For example, you can say, *On the first day of next month, it will be sunny.* If your statement is based on evidence of weather patterns in the area, then the prediction is scientific. If the statement was made without considering any evidence, it's just a guess.

Predictions play a major role in science because they provide a way to test ideas. If scientists understand an event or the properties of a particular object, they should be able to make accurate predictions about that event or object. Some predictions can be tested simply by making observations. At other times, carefully designed experiments are needed.

Classifying

If you have ever heard people debate whether a tomato is a fruit or a vegetable, you've heard an argument about classification. Classifying is the process of grouping items that are alike according to some organizing idea or system. Classifying occurs in every branch of science, but it is especially important in biology because living things are so numerous and diverse.

You may have the chance to practice classifying in different ways. Sometimes you will place objects into groups using an established system. At other times, you may create a system of your own by examining a variety of objects and identifying their properties.

Classification can have different purposes. Sometimes it's done just to keep things organized, to make lab supplies easy to find, for example.

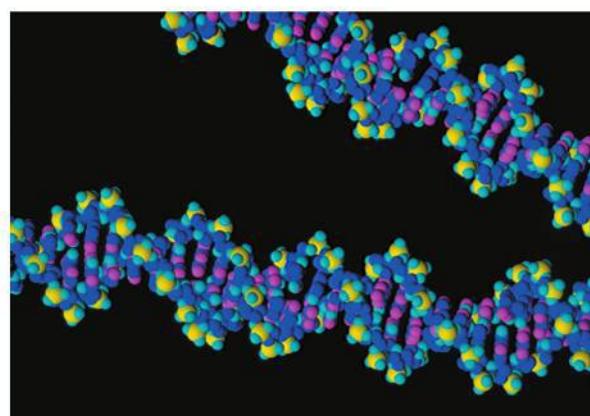
More often, though, classification helps scientists understand living things better and discover relationships among them. For example, one way biologists determine how groups of vertebrates are related is to compare their bones. Biologists classify certain animal parts as bone or muscle and then investigate how they work together.

Using Models

Some cities refuse to approve any new buildings that could cast shadows on a popular park. As architects plan buildings in such locations, they use models that can show where a proposed building's shadow will fall at any time of day in any season of the year. A model is a mental or physical representation of an object, process, or event. In science, models are usually made to help people understand natural objects and processes.

Models can be varied. Mental models, such as mathematical equations, can represent some kinds of ideas or processes. For example, the equation for the surface area of a sphere can model the surface of Earth, enabling scientists to determine its size. Physical models can be made of a huge variety of materials; they can be two dimensional (flat) or three dimensional (having depth). In biology, a drawing of a molecule or a cell is a typical two-dimensional model. Common three-dimensional models include a representation of a DNA molecule and a plastic skeleton of an animal.

Physical models can also be made "to scale," which means they are in proportion to the actual object. Something very large, such as an area of land being studied, can be shown at 1/100 of its actual size. A tiny organism can be shown at 100 times its size.



Appendix A Science Skills

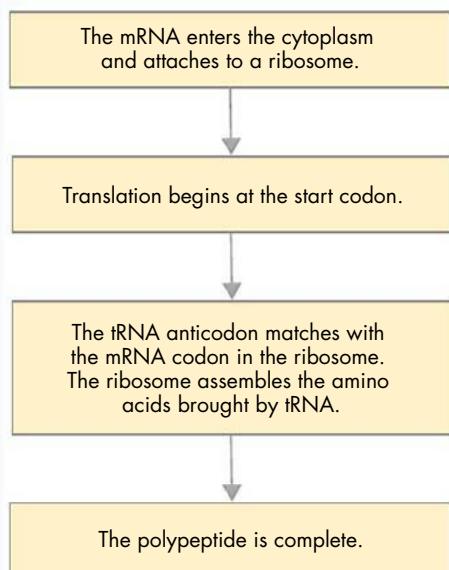
Organizing Information

When you study or want to communicate facts and ideas, you may find it helpful to organize information visually. Here are some common graphic organizers you can use. Notice that each type of organizer is useful for specific types of information.

Flowcharts

A flowchart can help you represent the order in which a set of events has occurred or should occur. Flowcharts are useful for outlining the steps in a procedure or stages in a process with a definite beginning and end.

To make a flowchart, list the steps in the process you want to represent and count the steps. Then, create the appropriate number of boxes, starting at the top of a page or on the left. Write a brief description of the first event in the first box, and then fill in the other steps, box by box. Link each box to the next event in the process with an arrow.

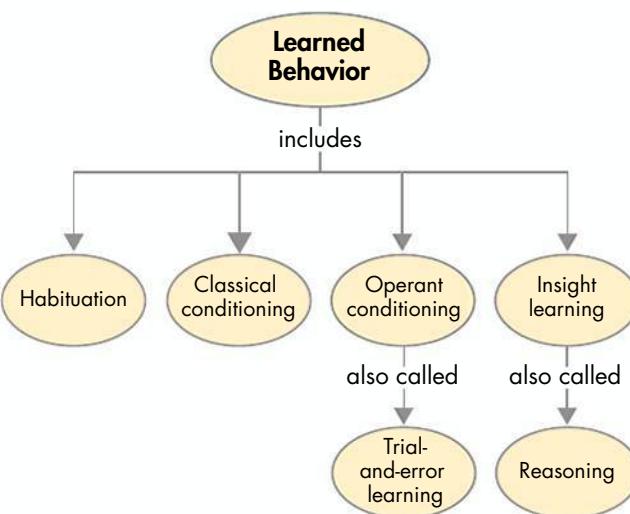


Concept Maps

Concept maps can help you organize a topic that has many subtopics. A concept map begins with a main idea and shows how it can be broken down into specific topics. It makes the ideas easier to understand by presenting their relationships visually.

You construct a concept map by placing the concept words (usually nouns) in ovals and connecting the ovals with linking words. The most general concept usually is placed at the top of the map or in the center. The content of the other ovals becomes more specific as you move away from the main concept. The linking words, which describe the relationship between the linked concepts, are written on a line between two ovals. If you follow any string of concepts and linking words down through a map, they should sound almost like a sentence.

Some concept maps may also include linking words that connect a concept in one branch to another branch. Such connections, called cross-linkages, show more complex interrelationships.



Compare/Contrast Tables

Compare/contrast tables are useful for showing the similarities and differences between two or more objects or processes. The table provides an organized framework for making comparisons based on specific characteristics.

To create a compare/contrast table, list the items to be compared across the top of the table. List the characteristics that will form the basis of your comparison in the column on the left. Complete the table by filling in information for each item.

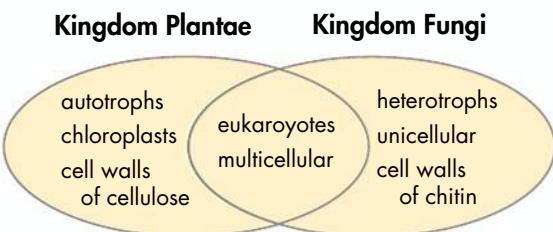
Comparing Cellular Respiration and Fermentation

Characteristic	Cellular Respiration	Fermentation
Starting reactants	Glucose	Glucose, oxygen
Pathways involved	Glycolysis, several others	Glycolysis, Krebs cycle, electron transport
End products	CO ₂ and alcohol or CO ₂ and lactic acid	CO ₂ , H ₂ O
Number of ATP molecules produced	2	36

Venn Diagrams

Another way to show similarities and differences between items is with a Venn diagram. A Venn diagram consists of two or more ovals that partially overlap. Each oval represents a particular object or idea. Characteristics that the objects share are written in the area of overlap. Differences or unique characteristics are written in the areas that do not overlap.

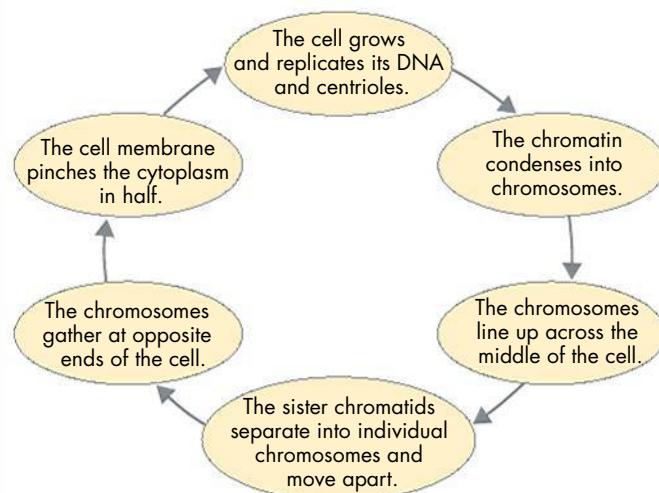
To create a Venn diagram, draw two overlapping ovals. Label them with the names of the objects or the ideas they represent. Write the unique characteristics in the part of each oval that does not overlap. Write the shared characteristics within the area of overlap.



Cycle Diagrams

A cycle diagram shows a sequence of events that is continuous, or cyclical. A continuous sequence does not have a beginning or an end; instead, each event in the process leads to another event. The diagram shows the order of the events.

To create a cycle diagram, list the events in the process and count them. Draw one box for each event, placing the boxes around an imaginary circle. Write one of the events in an oval, and then draw an arrow to the next oval, moving clockwise. Continue to fill in the boxes and link them with arrows until the descriptions form a continuous circle.



Conducting an Experiment

A science experiment is a procedure designed to test a prediction. Some types of experiments are fairly simple to design. Others may require ingenious problem solving.

Starting With Questions or Problems

A gardener collected seeds from a favorite plant at the end of the summer, stored them indoors for the winter, and then planted them the following spring. None of the stored seeds developed into plants, yet uncollected seeds from the original plant germinated in the normal way. The gardener wondered: *Why didn't the collected seeds germinate?*

An experiment may have its beginning when someone asks a specific question or wants to solve a particular problem. Sometimes the original question leads directly to an experiment, but often researchers must restate the problem before they can design an appropriate experiment. The gardener's question about the seeds, for example, is too broad to be tested by an experiment, because there are so many possible answers. To narrow the topic, the gardener might think about related questions: *Were the seeds I collected different from the uncollected seeds? Did I try to germinate them in poor soil or with insufficient light or water? Did storing the seeds indoors ruin them in some way?*

Developing a Hypothesis

In science, a question about an object or event is answered by developing a possible explanation called a hypothesis. The hypothesis may be developed after long thought and research, or it may come to a scientist "in a flash." How a hypothesis is formed doesn't matter; it can be useful as long as it leads to predictions that can be tested.

The gardener decided to focus on the fact that the nongerminating seeds were stored in the warm conditions of a heated house. That premise led the person to propose this hypothesis: *Seeds require a period of low temperatures in order to germinate.*

The next step is to make a prediction based on the hypothesis, for example: *If seeds are stored indoors in cold conditions, they will germinate in the same way as seeds left outdoors during the winter.* Notice that the prediction suggests the basic idea for an experiment.

Designing an Experiment

A carefully designed experiment can test a prediction in a reliable way, ruling out other possible explanations. As scientists plan their experimental procedures, they pay particular attention to the factors that must be controlled.

The gardener decided to study three groups of seeds: (1) some that would be left outdoors throughout the winter, (2) some that would be brought indoors and kept at room temperature, and (3) some that would be brought indoors and kept cold.

Controlling Variables

As researchers design an experiment, they identify the variables, factors that can change. Some common variables include mass, volume, time, temperature, light, and the presence or absence of specific materials. An experiment involves three categories of variables. The factor that scientists purposely change is called the independent variable. An independent variable is also known as a manipulated variable. The factor that may change because of the independent variable and that scientists want to observe is called the dependent variable. A dependent variable is also known as a responding variable. Factors that scientists purposely keep the same are called controlled variables. Controlling variables enables researchers to conclude that the changes in the independent variable are due exclusively to changes in the dependent variable.

For the gardener, the independent variable is whether the seeds were exposed to cold conditions. The dependent variable is whether or not the seeds germinate. Among the variables that must be controlled are whether the seeds remain dry during storage, when the seeds are planted, the amount of water the seeds receive, and the type of soil used.

Interpreting Data

The observations and measurements that are made in an experiment are called data. Scientists usually record data in an orderly way. When an experiment is finished, the researcher analyzes the data for trends or patterns, often by doing calculations or making graphs, to determine whether the results support the hypothesis.

For example, after planting the seeds in the spring, the gardener counted the seeds that germinated and found these results: None of the seeds kept at room temperature germinated, 80 percent of the seeds kept in the freezer germinated, and 85 percent of the seeds left outdoors during the winter germinated. The trend was clear: The gardener's prediction appeared to be correct.

To be sure that the results of an experiment are correct, scientists review their data critically, looking for possible sources of error. Here, *error* refers to differences between the observed results and the true values. Experimental error can result from human mistakes or problems with equipment. It can also occur when the small group of objects studied does not accurately represent the whole group. For example, if some of the gardener's seeds had been exposed to an herbicide, the data might not reflect the true seed germination pattern.

Drawing Conclusions

If researchers are confident that their data are reliable, they make a final statement summarizing their results. That statement, called the conclusion, indicates whether the data support or refute the hypothesis. The gardener's conclusion was this: *Some seeds must undergo a period of freezing in order to germinate.* A conclusion is considered valid if it is a logical interpretation of reliable data.

Following Up an Experiment

When an experiment has been completed, one or more events often follow. Researchers may repeat the experiment to verify the results. They may publish the experiment so that others can evaluate and replicate their procedures. They may compare their conclusion with the discoveries made by other scientists. And they may raise new questions that lead to new experiments. For example, *Are the spores of fungi affected by temperature as these seeds were?*

Researching other discoveries about seeds would show that some other types of plants in temperate zones require periods of freezing before they germinate. Biologists infer that this pattern makes it less likely the seeds will germinate before winter, thus increasing the chances that the young plants will survive.



Appendix B Lab Skills

The Metric System

The standard system of measurement used by scientists throughout the world is known as the International System of Units, abbreviated as SI (Système International d'Unités, in French). It is based on units of 10. Each unit is 10 times larger or 10 times smaller than the next unit. The table lists the prefixes used to name the most common SI units.

Common SI Prefixes		
Prefix	Symbol	Meaning
kilo-	k	1000
hecto-	h	100
deka-	da	10
deci-	d	0.1 (one tenth)
centi-	c	0.01 (one hundredth)
milli-	m	0.001 (one thousandth)

Commonly Used Metric Units

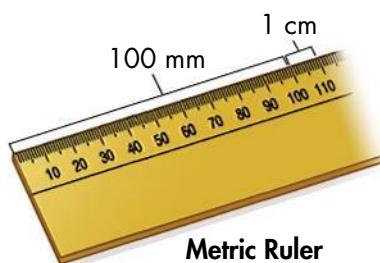
Length To measure length, or distance from one point to another, the unit of measure is a meter (m). A meter is slightly longer than a yard.

Useful equivalents:

1 meter = 1000 millimeters (mm)

1 meter = 100 centimeters (cm)

1000 meters = 1 kilometer (km)



Volume To measure the volume of a liquid, or the amount of space an object takes up, the unit of measure is a liter (L). A liter is slightly more than a quart.

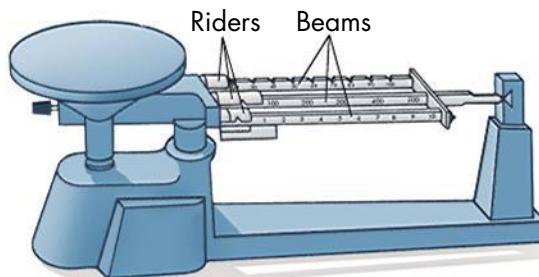
Useful equivalents:

1 liter = 1000 milliliters (mL)

Mass To measure the mass, or the amount of matter in an object, the unit of measure is the gram (g). A paper clip has a mass equal to about one gram.

Useful equivalents:

1000 grams = 1 kilogram (kg)



Triple-Beam Balance

Temperature To measure the hotness or coldness of an item, or its temperature, you use the unit degrees. The freezing point of water is 0°C (Celsius). The boiling point of water is 100°C.

Metric-English Equivalents

2.54 centimeters (cm) = 1 inch (in.)

1 meter (m) = 39.37 inches (in.)

1 kilometer (km) = 0.62 miles (mi)

1 liter (L) = 1.06 quarts (qt)

236 milliliters (mL) = 1 cup (c)

1 kilogram (kg) = 2.2 pounds (lb)

28.3 grams (g) = 1 ounce (oz)

$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$

Safety Symbols

These symbols appear in laboratory activities to alert you to possible dangers and to remind you to work carefully.

 **Safety Goggles** Always wear safety goggles to protect your eyes during any activity involving chemicals, flames or heating, or the possibility of flying objects, particles, or substances.

 **Lab Apron** Wear a laboratory apron to protect your skin and clothing from injury.

 **Plastic Gloves** Wear disposable plastic gloves to protect yourself from contact with chemicals or organisms that could be harmful. Keep your hands away from your face, and dispose of the gloves according to your teacher's instructions at the end of the activity.

 **Breakage** Handle breakable materials such as thermometers and glassware with care. Do not touch broken glass.

 **Heat-Resistant Gloves** Use an oven mitt or other hand protection when handling hot materials. Heating plates, hot water, and glassware can cause burns. Never touch hot objects with your bare hands.

 **Heating** Use a clamp or tongs to hold hot objects. Do not touch hot objects with your bare hands.

 **Sharp Object** Scissors, scalpels, pins, and knives are sharp. They can cut or puncture your skin. Always direct sharp edges and points away from yourself and others. Use sharp instruments only as directed.

 **Electric Shock** Avoid the possibility of electric shock. Never use electrical equipment around water or when the equipment or your hands are wet. Be sure cords are untangled and cannot trip anyone. Disconnect equipment when it is not in use.

 **Corrosive Chemical** This symbol indicates the presence of an acid or other corrosive chemical. Avoid getting the chemical on your skin or clothing, or in your eyes. Do not inhale the vapors. Wash your hands when you are finished with the activity.

 **Poison** Do not let any poisonous chemical get on your skin, and do not inhale its vapor. Wash your hands when you are finished with the activity.

 **Flames** Tie back loose hair and clothing, and put on safety goggles before working with fire. Follow instructions from your teacher about lighting and extinguishing flames.

 **No Flames** Flammable materials may be present. Make sure there are no flames, sparks, or exposed sources of heat present.

 **Fumes** Poisonous or unpleasant vapors may be produced. Work in a ventilated area or, if available, in a fume hood. Avoid inhaling a vapor directly. Test an odor only when directed to do so by your teacher, using a wafting motion to direct the vapor toward your nose.

 **Physical Safety** This activity involves physical movement. Use caution to avoid injuring yourself or others. Follow instructions from your teacher. Alert your teacher if there is any reason that you should not participate in the activity.

 **Animal Safety** Treat live animals with care to avoid injuring the animals or yourself. Working with animal parts or preserved animals may also require caution. Wash your hands when you are finished with the activity.

 **Plant Safety** Handle plants only as your teacher directs. If you are allergic to any plants used in an activity, tell your teacher before the activity begins. Avoid touching poisonous plants and plants with thorns.

 **Disposal** Chemicals and other materials used in the activity must be disposed of safely. Follow the instructions from your teacher.

 **Hand Washing** Wash your hands thoroughly when finished with the activity. Use soap and warm water. Lather both sides of your hands and between your fingers. Rinse well.

 **General Safety Awareness** You may see this symbol when none of the symbols described earlier applies. In this case, follow the specific instructions provided. You may also see this symbol when you are asked to design your own experiment. Do not start your experiment until your teacher has approved your plan.

Appendix **B** Lab Skills

Science Safety Rules

Working in the laboratory can be an exciting experience, but it can also be dangerous if proper safety rules are not followed at all times. To prepare yourself for a safe year in the laboratory, read the following safety rules. Make sure that you understand each rule. Ask your teacher to explain any rules you don't understand.

Dress Code

1. Many materials in the laboratory can cause eye injury. To protect yourself from possible injury, wear safety goggles whenever you are working with chemicals, burners, or any substance that might get into your eyes. Avoid wearing contact lenses in the laboratory. Tell your teacher if you need to wear contact lenses to see clearly, and ask if there are any safety precautions you should observe.
2. Wear a laboratory apron or coat whenever you are working with chemicals or heated substances.
3. Tie back long hair to keep it away from any chemicals, burners, candles, or other laboratory equipment.
4. Before working in the laboratory, remove or tie back any article of clothing or jewelry that can hang down and touch chemicals and flames.



General Safety Rules and First Aid

5. Read all directions for an experiment several times. Follow the directions exactly as they are written. If you are in doubt about any part of the experiment, ask your teacher for assistance.
6. Never perform investigations your teacher has not authorized. Do not use any equipment unless your teacher is in the lab.
7. Never handle equipment unless you have specific permission.
8. Take care not to spill any material in the laboratory. If spills occur, ask your teacher immediately about the proper cleanup procedure. Never pour chemicals or other substances into the sink or trash container.
9. Never eat or drink in, or bring food into, the laboratory.
10. Immediately report all accidents, no matter how minor, to your teacher.
11. Learn what to do in case of specific accidents, such as getting acid in your eyes or on your skin. (Rinse acids off your body with lots of water.)
12. Be aware of the location of the first-aid kit. Your teacher should administer any required first aid due to injury. Your teacher may send you to the school nurse or call a physician.
13. Know where and how to report an accident or fire. Find out the location of the fire extinguisher, fire alarm, and phone. Report any fires to your teacher at once.

Heating and Fire Safety

14. Never use a heat source such as a candle or burner without wearing safety goggles.
15. Never heat a chemical you are not instructed to heat. A chemical that is harmless when cool can be dangerous when heated.
16. Maintain a clean work area and keep all materials away from flames. Be sure that there are no open containers of flammable liquids in the laboratory when flames are being used.
17. Never reach across a flame.

18. Make sure you know how to light a Bunsen burner. (Your teacher will demonstrate the proper procedure for lighting a burner.) If the flame leaps out of a burner toward you, turn the gas off immediately. Do not touch the burner. It may be hot. Never leave a lighted burner unattended!
19. When you are heating a test tube or bottle, point the opening away from yourself and others. Chemicals can splash or boil out of a heated test tube.
20. Never heat a closed container. The expanding hot air, vapors, or other gases inside may blow the container apart, causing it to injure you or others.
21. Never pick up a container that has been heated without first holding the back of your hand near it. If you can feel the heat on the back of your hand, the container may be too hot to handle. Use a clamp or tongs when handling hot containers or wear heat-resistant gloves if appropriate.

Using Chemicals Safely

22. Never mix chemicals for “the fun of it.” You might produce a dangerous, possibly explosive substance.
23. Many chemicals are poisonous. Never touch, taste, or smell a chemical that you do not know for certain is harmless. If you are instructed to smell fumes in an experiment, gently wave your hand over the opening of the container and direct the fumes toward your nose. Do not inhale the fumes directly from the container.
24. Use only those chemicals needed in the investigation. Keep all container lids closed when a chemical is not being used. Notify your teacher whenever chemicals are spilled.
25. Dispose of all chemicals as instructed by your teacher. To avoid contamination, never return chemicals to their original containers.
26. Be extra careful when working with acids or bases. Pour such chemicals from one container to another over the sink, not over your work area.
27. When diluting an acid, pour the acid into water. Never pour water into the acid.
28. If any acids or bases get on your skin or clothing, rinse them with water. Immediately notify your teacher of any acid or base spill.

Using Glassware Safely

29. Never heat glassware that is not thoroughly dry. Use a wire screen to protect glassware from any flame.
30. Keep in mind that hot glassware will not appear hot. Never pick up glassware without first checking to see if it is hot.
31. Never use broken or chipped glassware. If glassware breaks, notify your teacher and dispose of the glassware in the proper trash container.
32. Never eat or drink from laboratory glassware. Thoroughly clean glassware before putting it away.

Using Sharp Instruments

33. Handle scalpels or razor blades with extreme care. Never cut material toward you; cut away from you.
34. Notify your teacher immediately if you cut yourself when in the laboratory.

Working With Live Organisms

35. No experiments that will cause pain, discomfort, or harm to animals should be done in the classroom or at home.
36. Your teacher will instruct you how to handle each species that is brought into the classroom. Animals should be handled only if necessary. Special handling is required if an animal is excited or frightened, pregnant, feeding, or with its young.
37. Clean your hands thoroughly after handling any organisms or materials, including animals or cages containing animals.

End-of-Experiment Rules

38. When an experiment is completed, clean up your work area and return all equipment to its proper place.
39. Wash your hands with soap and warm water before and after every experiment.
40. Turn off all burners before leaving the laboratory. Check that the gas line leading to the burner is off as well.

Appendix B Lab Skills

Use of the Microscope

The microscope used in most biology classes, the compound microscope, contains a combination of lenses. The eyepiece lens is located in the top portion of the microscope. This lens usually has a magnification of $10\times$. Other lenses, called objective lenses, are at the bottom of the body tube on the revolving nosepiece. By rotating the nosepiece, you can select the objective through which you will view your specimen.

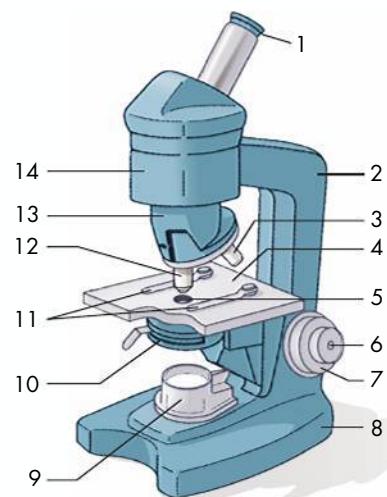
The shortest objective is a low-power magnifier, usually $10\times$. The longer ones are of high power, usually up to $40\times$ or $43\times$. The magnification is marked on the objective. To determine the total magnification, multiply the magnifying power of the eyepiece by the magnifying power of the objective. For example, with a $10\times$ eyepiece and a $40\times$ objective, the total magnification is $10 \times 40 = 400\times$.

Learning the name, function, and location of each of the microscope's parts is necessary for proper use. Use the following procedures when working with the microscope.

1. Carry the microscope by placing one hand beneath the base and grasping the arm of the microscope with the other hand.
2. Gently place the microscope on the lab table with the arm facing you. The microscope's base should be resting evenly on the table, approximately 10 cm from the table's edge.
3. Raise the body tube by turning the coarse adjustment knob until the objective lens is about 2 cm above the opening of the stage.

1. **Eyepiece:** Contains a magnifying lens.
2. **Arm:** Supports the body tube.
3. **Low-power objective:** Provides a magnification of $10\times$.
4. **Stage:** Supports the slide being observed.
5. **Opening of the stage:** Permits light to pass up to the eyepiece.
6. **Fine adjustment knob:** Moves the body tube slightly to adjust the image.
7. **Coarse adjustment knob:** Moves the body tube to focus the image.
8. **Base:** Supports the microscope.
9. **Illuminator:** Produces light or reflects light up toward the eyepiece.
10. **Diaphragm:** Regulates the amount of light passing up toward the eyepiece.
11. **Stageclips:** Hold the slide in place.
12. **High-power objective:** Provides a magnification of $40\times$.
13. **Nosepiece:** Holds the objectives and can be rotated to change the magnification.
14. **Body tube:** Maintains the proper distance between the eyepiece and the objectives.

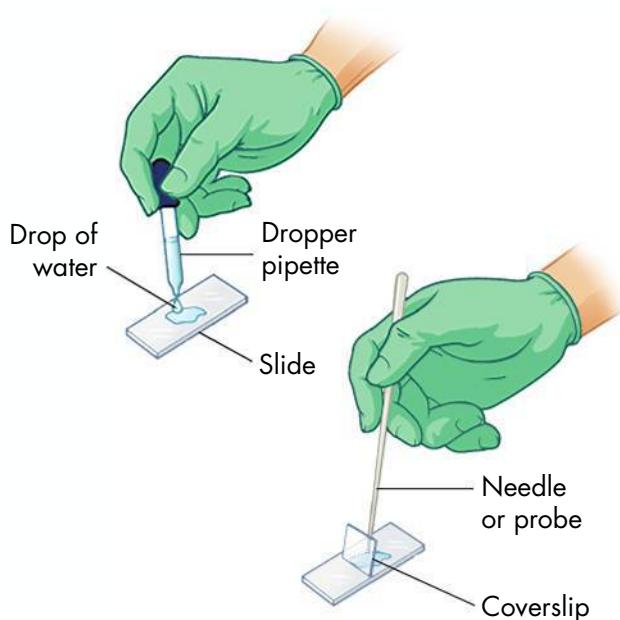
4. Rotate the nosepiece so that the low-power objective ($10\times$) is directly in line with the body tube. A click indicates that the lens is in line with the opening of the stage.
5. Look through the eyepiece and switch on the lamp or adjust the mirror so that a circle of light can be seen. This is the field of view. Moving the lever of the diaphragm permits a greater or smaller amount of light to come through the opening of the stage.
6. Place a prepared slide on the stage so that the specimen is over the center of the opening. Use the stage clips to hold the slide in place.
7. Look at the microscope from the side. Carefully turn the coarse adjustment knob to lower the body tube until the low-power objective almost touches the slide or until the body tube can no longer be moved. Do not allow the objective to touch the slide.
8. Look through the eyepiece and observe the specimen. If the field of view is out of focus, use the coarse adjustment knob to raise the body tube while looking through the eyepiece. **CAUTION:** *To prevent damage to the slide and the objective, do not lower the body tube using the coarse adjustment while looking through the eyepiece.* Focus the image as best you can with the coarse adjustment knob. Then, use the fine adjustment knob to focus the image more sharply. Keep both eyes open when viewing a specimen. This helps prevent eyestrain.



- Adjust the lever of the diaphragm to allow the right amount of light to enter.
- To change the magnification, rotate the nosepiece until the desired objective is in line with the body tube and clicks into place.
- Look through the eyepiece and use the fine adjustment knob to bring the image into focus.
- After every use, remove the slide. Return the low-power objective into place in line with the body tube. Clean the stage of the microscope and the lenses with lens paper. Do not use other types of paper to clean the lenses; they may scratch the lenses.
- Lower one edge of the coverslip so that it touches the side of the drop of water at about a 45° angle. The water will spread evenly along the edge of the coverslip. Using a dissecting needle or probe, slowly lower the coverslip over the specimen and water as shown in the drawing. Try not to trap any air bubbles under the coverslip. If air bubbles are present, gently tap the surface of the coverslip over the air bubble with a pencil eraser.
- Remove any excess water around the edge of the coverslip with a paper towel. If the specimen begins to dry out, add a drop of water at the edge of the coverslip.

Preparing a Wet-Mount Slide

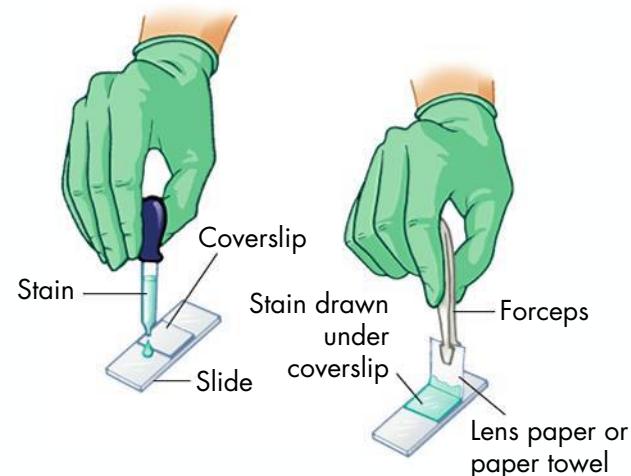
- Obtain a clean microscope slide and a coverslip. A coverslip is very thin, permitting the objective lens to be lowered very close to the specimen.
- Place the specimen in the middle of the microscope slide. The specimen must be thin enough for light to pass through it.
- Using a dropper pipette, place a drop of water on the specimen.



- Using a dropper pipette, place a drop of water on the specimen. Place the coverslip so that its edge touches the drop of water at a 45° angle. After the water spreads along the edge of the coverslip, use a dissecting needle or probe to lower the coverslip over the specimen.
- Add a drop of stain at the edge of the coverslip. Using forceps, touch a small piece of lens paper or paper towel to the opposite edge of the coverslip, as shown in the drawing. The paper causes the stain to be drawn under the coverslip and to stain the cells in the specimen.

Staining Techniques

- Obtain a clean microscope slide and coverslip.
- Place the specimen in the middle of the microscope slide.
- Using a dropper pipette, place a drop of water on the specimen. Place the coverslip so that its edge touches the drop of water at a 45° angle. After the water spreads along the edge of the coverslip, use a dissecting needle or probe to lower the coverslip over the specimen.
- Add a drop of stain at the edge of the coverslip. Using forceps, touch a small piece of lens paper or paper towel to the opposite edge of the coverslip, as shown in the drawing. The paper causes the stain to be drawn under the coverslip and to stain the cells in the specimen.



Appendix

C Technology & Design

Engineers are people who use scientific and technological knowledge to solve practical problems. To design new products, engineers usually follow the process described here, even though they may not follow these steps in the exact order.

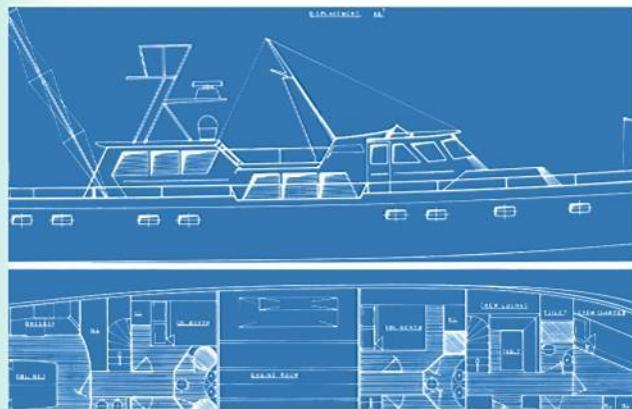
Identify a Need

Before engineers begin designing a new product, they must first identify the need they are trying to meet. For example, suppose you are a member of a design team in a company that makes toys. Your team has identified a need: a toy boat that is inexpensive and easy to assemble.

Research the Problem

Engineers often begin by gathering information that will help them with their new design. This research may include finding articles in books, in magazines, or on the Internet. It may also include talking to other engineers who have solved similar problems. Engineers also often perform experiments related to the product they want to design.

For your toy boat, you could look at toys that are similar to the one you want to design. You might do research on the Internet. You could also test some materials to see whether they would work well in a toy boat.



Design a Solution

Research gives engineers information that helps them design a product. When engineers design new products, they usually work in teams.

Generating Ideas Often, design teams hold brainstorming meetings in which any team member can contribute ideas. Brainstorming is a creative process in which one team member's suggestions can spark ideas in other group members. Brainstorming can lead to new approaches to solving a design problem.

Evaluating Constraints During brainstorming, a design team will often come up with several possible designs. The team must then evaluate each one.

As part of their evaluation, engineers consider constraints. Constraints are factors that limit or restrict a product design. Physical characteristics, such as the properties of materials used to make your toy boat, are constraints. Cost and time are also constraints. If the materials in a design cost a lot, or if the design takes a long time to make, it may be impractical.

Making Trade-offs Design teams usually need to make trade-offs. A trade-off is the acceptance of the benefits of one design aspect at the cost of another. In designing your toy boat, you will have to make trade-offs. For example, suppose one material is sturdy but not fully waterproof. Another material is more waterproof, but breakable. You may decide to give up the benefit of sturdiness in order to obtain the benefit of waterproofing.

Build and Evaluate a Prototype

Once the team has chosen a design plan, the engineers build a prototype of the product. A prototype is a working model used to test a design. Engineers evaluate the prototype to see whether it works well, is easy to operate, is safe to use, and holds up to repeated use.

Think of your toy boat. What would the prototype be like? Of what materials would it be made? How would you test it?

Troubleshoot and Redesign

Few prototypes work perfectly, which is why they need to be tested. Once a design team has tested a prototype, the members analyze the results and identify any problems. The team then tries to troubleshoot, or fix the weaknesses in the design. For example, if your toy boat leaks or wobbles, the boat should be redesigned to eliminate those problems.

Communicate the Solution

A team needs to communicate the final design to the people who will manufacture the product. To do this, teams may use sketches, detailed drawings, computer simulations, and written descriptions.



Activity

You can use the technology design process to design and build a toy boat.

Research and Investigate

1. Visit the library or go online to research toy boats.
2. Investigate how a toy boat can be powered, including wind, rubber bands, or baking soda and vinegar.
3. Brainstorm materials, shapes, and steering methods for your boat.

Design and Build

4. Based on your research, design a toy boat that
 - is made of readily available materials
 - is no larger than 15 cm long and 10 cm wide
 - includes a power system, a rudder, and a cargo area
 - travels 2 meters in a straight line while carrying a load of 20 pennies
5. Sketch your design and write a step-by-step plan for building your boat. After your teacher approves your plan, build your boat.

Evaluate and Redesign

6. Test your boat, evaluate the results, and identify any technological design problems in your boat.
7. Based on your evaluation, redesign your toy boat so it performs better.
8. As a class, compare the test results for each boat. Choose the model which best meets the needs of the toy company.

Appendix D Math Skills

Scientists use math to organize, analyze, and present data. This appendix will help you review some basic math skills.

Formulas and Equations

Formulas and equations are used in many areas of science. Both formulas and equations show the relationships between quantities. Any numerical sentence that contains at least one variable and at least one mathematical operator is called an equation. A formula is a type of equation that states the relationship between unknown quantities represented by variables.

For example, Speed = Distance ÷ Time is a formula, because no matter what values are inserted, speed is always equal to distance divided by time. The relationship between the variables does not change.

Example

Follow these steps to convert a temperature measurement of 50°F to Celsius.

1. Determine the formula that shows the relationship between these quantities.

$$^{\circ}\text{F} = (9/5 \times ^{\circ}\text{C}) + 32^{\circ}\text{F}$$

2. Insert values you know into the formula.

$$50^{\circ}\text{F} = (9/5 \times ^{\circ}\text{C}) + 32^{\circ}\text{F}$$

3. Solve the resulting equation.

$$50^{\circ}\text{F} - 32^{\circ}\text{F} = (9/5 \times ^{\circ}\text{C})$$

$$18^{\circ}\text{F} = 9/5 \times ^{\circ}\text{C}$$

$$18^{\circ}\text{F} \times 5/9 = 10^{\circ}\text{C}$$

Applying Formulas and Equations

There are many applications of formulas in science. The example described below uses a formula to calculate density.

Example

Follow these steps to calculate the density of an object that has a mass of 45 g and a volume of 30 cm³.

1. Determine the formula that shows the relationship between these quantities.

$$\text{Density} = \text{Mass}/\text{Volume}$$

2. Insert values you know into the formula.

$$\text{Density} = \text{Mass}/\text{Volume} = 45 \text{ g}/30 \text{ cm}^3$$

3. Solve the resulting equation.

$$45 \text{ g} = 1.5 \text{ g/cm}^3/30 \text{ cm}^3$$

Mean, Median, and Mode

The mean is the average, or the sum of the data divided by the number of data items. The middle number in a set of ordered data is called the median. The mode is the number that appears most often in a set of data.

Example

A scientist counted the number of distinct songs sung by seven different male birds and collected the data shown below.

Male Bird Songs							
Bird	A	B	C	D	E	F	G
Number of Songs	36	29	40	35	28	36	27

To determine the mean number of songs, find the sum of the songs sung by all the male birds and divide by the number of male birds.

$$\text{Mean} = 231/7 = 33 \text{ songs}$$

To find the median number of songs, arrange the data items in numerical order and identify the number in the middle.

27 28 29 35 36 36 40

The number in the middle is 35, so the median number of songs is 35.

The mode is the value that appears most frequently. In the data, 36 appears twice, while every other item appears only once. Therefore, 36 is the mode.

Estimation

An estimate is a reasonable approximation of a numerical value. Estimates are made based on careful assumptions and known information.

Scientists use estimates in biology for two primary reasons: when an exact count or calculation cannot be made or is impractical to make, and to make reasonable approximations of answers that will be calculated or measured later.

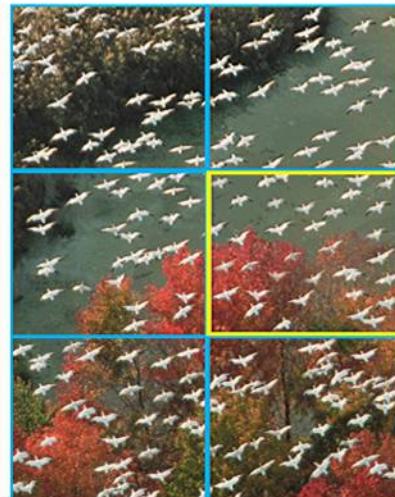
One method for estimation used in biology is sampling. In sampling, the number of organisms in a small area (a sample) is multiplied to estimate the number of organisms in a larger area.

Example

Follow these steps to use sampling to estimate the total number of birds in the photo.

1. Count the birds in the highlighted area of the photo. In the highlighted area of the photo, there are 36 birds.
2. Determine the portion of the entire photo represented by the highlighted area. In this case, the highlighted area is $1/6$ of the total area.
3. Calculate your estimate by multiplying the number of birds in the sample area by 6 (because the entire photo is 6 times as large as the sample area). A reasonable estimate of the total number of birds is 36×6 , or 216 birds.

HINT: Estimates and calculated answers are rarely exactly the same. However, a large difference between an estimated answer and a calculated answer indicates there may be a problem with the estimate or calculation.



Using Measurements in Calculations

Density is an example of a value that is calculated using two measurements. Density represents the amount of mass in a particular volume of a substance. The units used for density are grams per milliliter (g/mL) or grams per cubic centimeter (g/cm³). Density is calculated by dividing an object's mass by its volume.

Example

Follow these steps to calculate the density of an object.

1. Measure and record the mass of an object in grams.
2. Measure and record the volume of an object in mL or cm³.
3. Use the following formula to calculate density:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Effects of Measurement Errors

Density is calculated using two measured values. An error in the measurement of either mass or volume will result in the calculation of an incorrect density.

Example

A student measured the mass of an object as 2.5 g and its volume as 2.0 cm³. The actual mass of the object is 3.5 g; the actual volume is 2.0 cm³. What is the effect of the measurement error on the calculation of density?

Follow these steps to determine the effect of a measurement error on calculation.

1. Determine the density using the student's measurements.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Density} = \frac{2.5 \text{ g}}{2.0 \text{ cm}^3}$$

$$\text{Density} = 1.25 \text{ g/cm}^3$$

2. Determine the density using the actual values.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Density} = \frac{3.5 \text{ g}}{2.0 \text{ cm}^3}$$

$$\text{Density} = 1.75 \text{ g/cm}^3$$

3. Compare the calculated and the actual values.

In this case, a measurement of mass that was less than the actual value resulted in a calculated value for the density that was less than the actual density.

Accuracy

The accuracy of a measurement is its closeness to the actual value. Measurements that are accurate are close to the actual value.

Both clocks on this page show a time of 3:00. Suppose, though, that these clocks had not been changed to reflect daylight savings time. The time shown on the clocks would be inaccurate. On the other hand, if the actual time is 3:00, these clocks would be accurate.

Precision

Precision describes the exactness of a measurement. The clocks shown on this page differ in precision. The analog clock measures time to the nearest minute. The digital clock measures time to the nearest second. Time is measured more precisely by the digital clock than by the analog clock.



Comparing Accuracy and Precision

There is a difference between accuracy and precision. Measurements can be accurate (close to the actual value) but not precise. Measurements can also be precise but not accurate. When making scientific measurements, both accuracy and precision are important. Accurate and precise measurements result from the careful use of high-quality measuring tools.

Significant Figures

Significant figures are all of the digits that are known in a measurement, plus one additional digit, which is an estimate. In the figure below, the length of a turtle's shell is being measured using a centimeter ruler. The ruler has unnumbered divisions representing millimeters. In this case, two numbers can be determined exactly: the number of centimeters and the number of millimeters. One additional digit can be estimated. So, the measurement of this turtle's shell can be recorded with three significant figures as 8.80 centimeters.

Rules for Significant Digits

Follow these rules to determine the number of significant figures in a number.

All nonzero numbers are significant.

Example: 3217 has four significant digits.

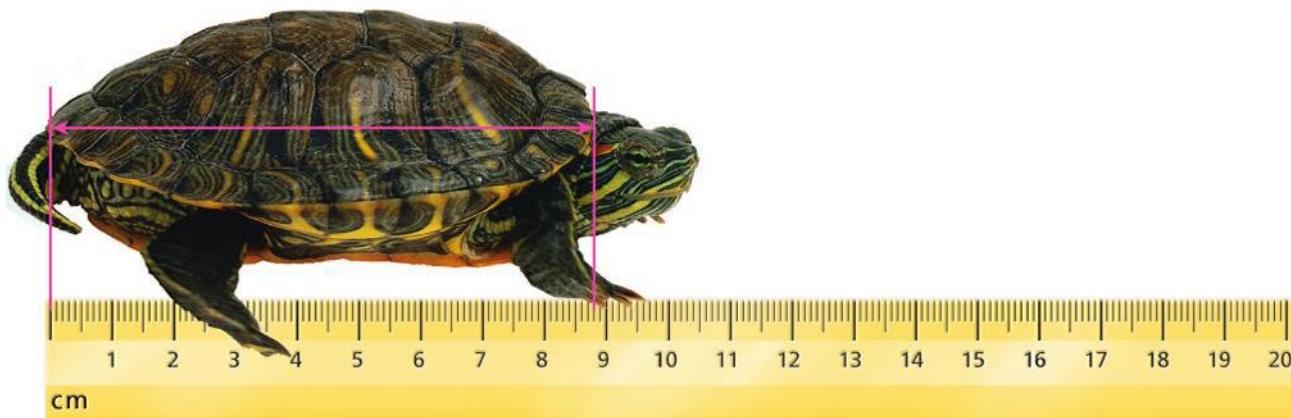
Zeros are significant if

- They are between nonzero digits. Example: 509
- They follow a decimal point and a nonzero digit.

Example: 7.00

Zeros are not significant if

- They follow nonzero digits in a number without a decimal. Example: 7000
- They precede nonzero digits in a number with a decimal. Example: 0.0098



Calculating With Significant Figures

When measurements are added or subtracted, the precision of the result is determined by the precision of the least-precise measurement. The result may need to be rounded so the number of digits after the decimal is the same as the least-precise measurement.

Example

Follow these steps to determine the correct number of significant figures when adding 4.51 g, 3.27 g, and 6.0 g.

1. Determine which measurement is reported with the least degree of precision. In this case, the least-precise measurement, 6.0 g, has one digit after the decimal point.
2. The result must be rounded so that it also has one digit after the decimal point. After rounding, the result of this calculation is 13.8 g.

When measurements are multiplied or divided, the answer must have the same number of significant figures as the measurement with the fewest number of significant figures.

Example

Follow these steps to determine the correct number of significant figures when multiplying 120 g by 6.32 g.

1. Determine the number of significant figures in each of the measurements. In this case, the measurement 120 g has two significant figures; the measurement 6.32 g has three significant figures.
2. The result must be rounded to have only two significant figures. After rounding, the result of this calculation is 760 g.

Scientific Notation

In science, measurements are often very large or very small. Using scientific notation makes these large and small numbers easier to work with.

Using scientific notation requires an understanding of exponents and bases. When a number is expressed as a base and an exponent, the base is the number that is used as a factor. The exponent tells how many times the base is multiplied by itself. For example, the number 25 can be expressed as a base and an exponent in the following way:

$$25 = 5 \times 5 = 5^2$$

In the example above, 5 is the base and 2 is the exponent. In scientific notation, the base is always the number 10. The exponent tells how many times the number 10 is multiplied by itself.

A number written in scientific notation is expressed as the product of two factors, a number between 1 and 10 and the number 10 with an exponent. For example, the number 51,000 can be expressed in scientific notation. To find the first factor, move the decimal to obtain a number between 1 and 10. In this case, the number is 5.1. The exponent can be determined by counting the number of places the decimal point was moved. The decimal point was moved four places to the left. So, 51,000 expressed in scientific notation is 5.1×10^4 .

Numbers that are less than zero can also be expressed in scientific notation. In the case of numbers less than zero, the decimal point must be moved to the right to obtain a number between 1 and 10. For example, in the number 0.000098, the decimal point must move five places to the right to obtain the number 9.8. When the decimal point is moved to the right, the exponent is negative. So, 0.000098 expressed in scientific notation is 9.8×10^{-5} .

Calculating With Scientific Notation

Numbers expressed in scientific notation can be used in calculations. When adding or subtracting numbers expressed in scientific notation, the first factors must be rewritten so the exponents are the same.

Example

Follow these steps to add $(4.30 \times 10^4) + (2.1 \times 10^3)$.

1. Move the decimal point in one of the expressions so the exponents are the same.
 $(4.30 \times 10^3) + (2.1 \times 10^3)$
2. Add the first factors, keeping the value of the exponents the same.
 $(4.30 \times 10^3) + (2.1 \times 10^3) = 45.1 \times 10^3$
3. Move the decimal point so the first factor is expressed as the product of a number between 1 and 10 and an exponent with base 10.
 $45.1 \times 10^3 = 4.51 \times 10^4$

When numbers expressed in scientific notation are multiplied, the exponents are added. When numbers expressed in scientific notation are divided, the exponents are subtracted.

Example

Use the following steps to determine the area of a rectangular field that has a length of 1.5×10^3 meters and a width of 3.2×10^2 meters.

1. Write down the expressions to be multiplied.
 $(1.5 \times 10^3 \text{ m})(3.2 \times 10^2 \text{ m})$
2. Multiply the first factors, add the exponents, and multiply any units.
 $= (1.5 \times 3.2)(10^{3+2}) \text{ m} \times \text{m}$
 $= 4.8 \times 10^5 \text{ m}^2$

Dimensional Analysis

Scientific problems and calculations often involve unit conversions, or changes from one unit to another. Dimensional analysis is a method of unit conversion.

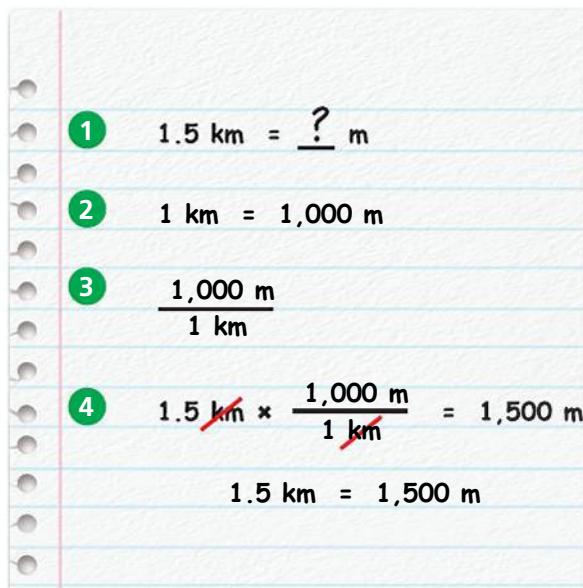
Suppose you were counting a pile of pennies. If there were 197 pennies in the pile, how many dollars would the pennies be worth? To determine the answer, you need to know the conversion factor between pennies and dollars. A conversion factor simply shows how two units are related. In this case, the conversion factor is 100 pennies = 1 dollar. Determining that 197 pennies is equal to \$1.97 is an example of a unit conversion.

In dimensional analysis, the conversion factor is usually expressed as a fraction. Remember that the two values in any conversion factor are equal to one another. So, the two values form a fraction with the value of 1. Look at the example below to see how dimensional analysis can be applied to an everyday problem.

Example

A student walked 1.5 kilometers as part of a school fitness program. How many meters did the student walk?

1. $1.5 \text{ km} = ? \text{ m}$
2. $1 \text{ km} = 1000 \text{ m}$
3. $1000 \text{ m}/1 \text{ km}$
4. $1.5 \text{ km} \times 1000 \text{ m}/1 \text{ km} = 1500 \text{ m}$ (cross out “km” in two places); $1.5 \text{ km} = 1500 \text{ m}$



Applying Dimensional Analysis

There are many applications of dimensional analysis in science. The example below demonstrates the use of dimensional analysis to convert units.

Example

The average teenage girl needs about 2200 kilocalories of energy from food each day. How many calories is this equivalent to?

Use the following steps to convert kilocalories to calories.

1. Determine the conversion factor that relates the two units.
1 kilocalorie = 1000 calories
2. Write the conversion factor in the form of a fraction.
 $1000 \text{ calories}/1 \text{ kilocalorie}$
3. Multiply the measurement by the conversion factor.
 $2200 \text{ kilocalories} \times 1000 \text{ calories}/1 \text{ kilocalorie} = 2,200,000 \text{ calories}$

Appendix E Periodic Table

1	1	H	Hydrogen 1.0079	1A	Representative Elements	Transition Elements	Transition Metals	Inner transition metals	C Solid	B Liquid	He Gas	2 2
3	1	Li	Lithium 6.941	2	Alkali Metals	Sc	Ti	V	Cr	Mn	Ni	He
11	2	Mg	Magnesium 24.305	2	Alkaline Earth Metals	Scandium	Titanium	Vanadium	Chromium	Manganese	Copper	Neon
19	8	K	Potassium 39.098	2	Other Metals	Nb	Zr	Ta	Ru	Rh	Nickel	Neon
37	8	Rb	Rubidium 85.468	2	Metalloids	Mo	Ta	Ta	Re	Os	Pd	Neon
55	2	Cs	Ceasium 137.35	2	Nonmetals	Nb	Hf	Ta	W	Re	Pt	Neon
87	8	Fr	Francium (223)	2	Noble Gases	Db	Rf	Ta	Ta	Ir	Pt	Neon
89	2	Ac	Actinium (227)	2		Sg	Bh	Bh	Os	Os	Pt	Neon
1	1	H	Hydrogen 1.0079	2		Dubnium	Bohrium	Bohrium	Hs	Hs	Pt	Neon
3	1	Li	Lithium 6.941	2		Seaborgium	Seaborgium	Seaborgium	Mt	Ir	Pt	Neon
11	2	Mg	Magnesium 24.305	2		Dubnium	Dubnium	Dubnium	Mc	Mc	Pt	Neon
19	8	K	Potassium 39.098	2		Lawrencium	Lawrencium	Lawrencium	Db	Mc	Pt	Neon
37	8	Rb	Rubidium 85.468	2		Rutherfordium	Rutherfordium	Rutherfordium	Db	Mc	Pt	Neon
55	2	Cs	Ceasium 137.35	2		Curium	Curium	Curium	Mc	Mc	Pt	Neon
87	8	Fr	Francium (223)	2		Plutonium	Plutonium	Plutonium	Mc	Mc	Pt	Neon
89	2	Ac	Actinium (227)	2		Americium	Americium	Americium	Mc	Mc	Pt	Neon
1	1	H	Hydrogen 1.0079	2		Curium	Curium	Curium	Mc	Mc	Pt	Neon
3	1	Li	Lithium 6.941	2		Neptunium	Neptunium	Neptunium	Mc	Mc	Pt	Neon
11	2	Mg	Magnesium 24.305	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
19	8	K	Potassium 39.098	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
37	8	Rb	Rubidium 85.468	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
55	2	Cs	Ceasium 137.35	2		Rutherfordium	Rutherfordium	Rutherfordium	Mc	Mc	Pt	Neon
87	8	Fr	Francium (223)	2		Curium	Curium	Curium	Mc	Mc	Pt	Neon
89	2	Ac	Actinium (227)	2		Neptunium	Neptunium	Neptunium	Mc	Mc	Pt	Neon
1	1	H	Hydrogen 1.0079	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
3	1	Li	Lithium 6.941	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
11	2	Mg	Magnesium 24.305	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
19	8	K	Potassium 39.098	2		Rutherfordium	Rutherfordium	Rutherfordium	Mc	Mc	Pt	Neon
37	8	Rb	Rubidium 85.468	2		Curium	Curium	Curium	Mc	Mc	Pt	Neon
55	2	Cs	Ceasium 137.35	2		Neptunium	Neptunium	Neptunium	Mc	Mc	Pt	Neon
87	8	Fr	Francium (223)	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
89	2	Ac	Actinium (227)	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
1	1	H	Hydrogen 1.0079	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
3	1	Li	Lithium 6.941	2		Rutherfordium	Rutherfordium	Rutherfordium	Mc	Mc	Pt	Neon
11	2	Mg	Magnesium 24.305	2		Curium	Curium	Curium	Mc	Mc	Pt	Neon
19	8	K	Potassium 39.098	2		Neptunium	Neptunium	Neptunium	Mc	Mc	Pt	Neon
37	8	Rb	Rubidium 85.468	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
55	2	Cs	Ceasium 137.35	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
87	8	Fr	Francium (223)	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
89	2	Ac	Actinium (227)	2		Rutherfordium	Rutherfordium	Rutherfordium	Mc	Mc	Pt	Neon
1	1	H	Hydrogen 1.0079	2		Curium	Curium	Curium	Mc	Mc	Pt	Neon
3	1	Li	Lithium 6.941	2		Neptunium	Neptunium	Neptunium	Mc	Mc	Pt	Neon
11	2	Mg	Magnesium 24.305	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
19	8	K	Potassium 39.098	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
37	8	Rb	Rubidium 85.468	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
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11	2	Mg	Magnesium 24.305	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
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19	8	K	Potassium 39.098	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
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1	1	H	Hydrogen 1.0079	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
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11	2	Mg	Magnesium 24.305	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
19	8	K	Potassium 39.098	2		Rutherfordium	Rutherfordium	Rutherfordium	Mc	Mc	Pt	Neon
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87	8	Fr	Francium (223)	2		Uranium	Uranium	Uranium	Mc	Mc	Pt	Neon
89	2	Ac	Actinium (227)	2		Thorium	Thorium	Thorium	Mc	Mc	Pt	Neon
1	1	H	Hydrogen 1.0079	2		Protactinium	Protactinium	Protactinium	Mc	Mc	Pt	Neon
3	1	Li	Lithium 6.941	2	</							

Glossary

A

abiotic factor: physical, or nonliving, factor that shapes an ecosystem (58)

factor abiótico: factor físico, o inanimado, que da forma a un ecosistema

abscisic acid: plant hormone that inhibits cell division and, therefore, growth (589)

ácido abscísico: hormona vegetal que inhibe la división celular y, por ende, el crecimiento

acetylcholine: neurotransmitter that produces an impulse in a muscle cell (772)

acetilcolina: neurotransmisor que produce un impulso en una célula muscular

acid: compound that forms hydrogen ions (H^+) in solution; a solution with a pH of less than 7 (36)

ácido: compuesto que en una solución produce iones hidrógeno (H^+); una solución con un pH inferior a 7

acid rain: rain containing nitric and sulfuric acids (136)

lluvia ácida: lluvia que contiene ácido nítrico y ácido sulfúrico

actin: thin filament of protein found in muscles (771)

actina: microfilamento de proteína que se halla en los músculos

action potential: reversal of charges across the cell membrane of a neuron; also called a nerve impulse (744)

potencial de acción: inversión de las cargas a través de la membrana de una neurona; también llamado impulso nervioso

activation energy: energy that is needed to get a reaction started (43)

energía de activación: energía necesaria para que comience una reacción

active immunity: immunity that develops as a result of natural or deliberate exposure to an antigen (846)

inmunidad activa: inmunidad que se desarrolla a consecuencia de la exposición natural o deliberada a un antígeno

adaptation: heritable characteristic that increases an organism's ability to survive and reproduce in an environment (388)

adaptación: característica heredable que aumenta la capacidad de un organismo de sobrevivir y reproducirse en un medio ambiente

adaptive radiation: process by which a single species or a small group of species evolves into several different forms that live in different ways (459)

radiación adaptativa: proceso mediante el cual una sola especie o un grupo pequeño de especies evoluciona y da lugar a diferentes seres que viven de diversas maneras

adenosine triphosphate (ATP): compound used by cells to store and release energy (192)

trifosfato de adenosina (ATP): compuesto utilizado por las células para almacenar y liberar energía

adhesion: force of attraction between different kinds of molecules (34, 568)

adhesión: fuerza de atracción entre diferentes tipos de moléculas

aerobic: process that requires oxygen (214)

aeróbico: proceso que requiere oxígeno

age structure: number of males and females of each age in a population (109)

estructura etaria: número de machos y de hembras de cada edad en una población

aggression: threatening behavior that one animal uses to exert dominance over another animal (702)

agresión: comportamiento amenazador que emplea un animal para ejercer control sobre otro animal

algal bloom: increase in the amount of algae and other producers that results from a large input of a limiting nutrient (510)

florecimiento de algas: aumento de la cantidad de algas y otros productores debido a una gran entrada de un nutriente limitante

allele: one of a number of different forms of a gene (263)

alelo: cada una de las diversas formas de un gen

allele frequency: number of times that an allele occurs in a gene pool compared with the number of alleles in that pool for the same gene (406)

frecuencia alélica: número de veces que aparece un alelo en un caudal genético, comparado con la cantidad de alelos en ese caudal para el mismo gen

allergy: overreaction of the immune system to an antigen (849)

alergia: reacción exagerada del sistema inmune ante un antígeno

alternation of generations: life cycle that has two alternating phases—a haploid (N) phase and diploid (2N) phase (507, 530)

alternancia de generaciones: ciclo vital con dos fases que se alternan, una fase haploide (N) y una fase diploide (2N)

alveolus (pl. alveoli): one of many tiny air sacs at the end of a bronchiole in the lungs that provides surface area for gas exchange to occur (652, 797)

alvéolos: pequeños sacos, ubicados en las terminaciones de los bronquiolos pulmonares, que proporcionan una superficie en la que tiene lugar el intercambio gaseoso

amino acid: compound with an amino group on one end and a carboxyl group on the other end (40)

aminoácido: compuesto que contiene un grupo amino en un extremo y un grupo carboxilo en el otro extremo

Glossary (continued)

amniotic egg: egg composed of shell and membranes that creates a protected environment in which the embryo can develop out of water (682)

huevo amniota: huevo formado por una cáscara y membranas que crea un ambiente protegido en el cual el embrión puede desarrollarse en un medio seco

amylase: enzyme in saliva that breaks the chemical bonds in starches (724)

amilasa: enzima de la saliva que fragmenta los enlaces químicos de los almidones

anaerobic: process that does not require oxygen (214)

anaeróbico: proceso que no requiere oxígeno

analogous structures: body parts that share a common function, but not structure (393)

estructuras análogas: partes del cuerpo que tienen la misma función, mas no la misma estructura

anaphase: phase of mitosis in which the chromosomes separate and move to opposite ends of the cell (242)

anafase: fase de la mitosis en la cual los cromosomas se separan y se desplazan hacia los extremos opuestos de la célula

angiosperm: group of seed plants that bear their seeds within a layer of tissue that protects the seed; also called flowering plant (536)

angiospermas: grupo de plantas con semillas, que están protegidas con una capa de tejido. Se conocen también como plantas que florecen.

anther: flower structure in which pollen grains are produced (579)

antera: estructura de la flor en la cual se generan los granos de polen

anthropoid: primate group made up of monkeys, apes, and humans (634)

antropoide: grupo de primates constituido por monos, simios y humanos

antibiotic: group of drugs used to block the growth and reproduction of bacterial pathogens (490)

antibiótico: grupo de drogas utilizadas para bloquear el desarrollo y la reproducción de organismos patógenos bacterianos

antibody: protein that either attacks antigens directly or produces antigen-binding proteins (842)

anticuerpo: proteína que ataca directamente a los antígenos o produce proteínas que se unen a los antígenos

anticodon: group of three bases on a tRNA molecule that are complementary to the three bases of a codon of mRNA (313)

anticodón: grupo de tres bases en una molécula de ARN de transferencia que son complementarias a las tres bases de un codón de ARN mensajero

antigen: any substance that triggers an immune response (842)

antígeno: cualquier sustancia que provoca una respuesta inmune

aphotic zone: dark layer of the oceans below the photic zone where sunlight does not penetrate (96)

zona afótica: sección oscura de los océanos donde no penetra la luz solar, situada debajo de la zona fótica

apical dominance: phenomenon in which the closer a bud is to the stem's tip, the more its growth is inhibited (588)

dominancia apical: fenómeno por el cual cuanto más cerca de la punta del tallo está un brote, más se inhibe su crecimiento

apical meristem: group of unspecialized cells that divide to produce increased length of stems and roots (555)

meristemo apical: grupo de células no especializadas que se dividen para producir un aumento en la longitud de tallos y raíces

apoptosis: process of programmed cell death (246)

apoptosis: proceso de muerte celular programada

appendage: structure, such as a leg or antenna, that extends from the body wall (625)

áplice: estructura, como una pierna o una antena, que se proyecta desde la superficie corporal

appendicular skeleton: the bones of the arms and legs along with the bones of the pelvis and shoulder area (766)

esqueleto apendicular: los huesos de los brazos y de las piernas junto con los huesos de la pelvis y del área de los hombros

aquaculture: raising of aquatic organisms for human consumption (146)

acuicultura: cría de organismos acuáticos para el consumo humano

aquaporin: water channel protein in a cell (177)

acuaporina: proteína que canaliza el agua en una célula

Archaea: domain consisting of unicellular prokaryotes that have cell walls that do not contain peptidoglycan; corresponds to the kingdom Archaeabacteria (439)

Arqueas: dominio formado por procariotas unicelulares cuyas paredes celulares no contienen peptidoglicano; corresponden al reino de las Arqueabacterias

artery: large blood vessel that carries blood away from the heart to the tissues of the body (789)

arteria: vaso sanguíneo grande que transporta la sangre desde el corazón a los tejidos del cuerpo

artificial selection: selective breeding of plants and animals to promote the occurrence of desirable traits in offspring (387)

selección artificial: cría selectiva de plantas y animales para fomentar la ocurrencia de rasgos deseados en la progenie

asexual reproduction: process of reproduction involving a single parent that results in offspring that are genetically identical to the parent (15, 236)

reproducción asexual: proceso de reproducción que involucra a un único progenitor y da por resultado descendencia genéticamente idéntica a ese progenitor

asthma: chronic respiratory disease in which air passages narrow, causing wheezing, coughing, and difficulty breathing (849)

asma: enfermedad respiratoria crónica en la cual las vías respiratorias se estrechan, provocando jadeos, tos y dificultad para respirar

atherosclerosis: condition in which fatty deposits called plaque build up inside artery walls and eventually cause the arteries to stiffen (793)

arteriosclerosis o aterosclerosis: enfermedad en la cual se acumulan depósitos de grasa llamados placas en el interior de las paredes arteriales que, con el tiempo, causan un endurecimiento de las arterias

atom: the basic unit of matter (28)

átomo: unidad básica de la materia

ATP synthase: cluster of proteins that span the cell membrane and allow hydrogen ions (H^+) to pass through it (199)

ATP sintasa: complejo de proteínas unidas a la membrana celular que permiten el paso de los iones de hidrógeno (H^+) a través de ella

atrium (pl. atria): upper chamber of the heart that receives blood from the rest of the body (654, 787)

aurícula: cavidad superior del corazón que recibe sangre del resto del cuerpo

autonomic nervous system: part of the peripheral nervous system that regulates activities that are involuntary, or not under conscious control; made up of the sympathetic and parasympathetic subdivisions (753)

sistema nervioso autónomo: parte del sistema nervioso periférico que regula las actividades involuntarias, o que son independientes de la conciencia; está compuesto por las subdivisiones simpática y parasympática

autosome: chromosome that is not a sex chromosome; also called autosomal chromosome (335)

autosoma: cromosoma que no es un cromosoma sexual; también llamado cromosoma autosómico

autotroph: organism that is able to capture energy from sunlight or chemicals and use it to produce its own food from inorganic compounds; also called a producer (60, 194)

autótrofo: organismo capaz de atrapar la energía de la luz solar o de las sustancias químicas y utilizarla para producir su propio alimento a partir de compuestos inorgánicos; también llamado productor

auxin: regulatory substance produced in the tip of a growing plant that stimulates cell elongation and the growth of new roots (588)

auxina: sustancia reguladora producida en la punta de una planta en crecimiento que estimula el alargamiento celular y el crecimiento de raíces nuevas

axial skeleton: skeleton that supports the central axis of the body; consists of the skull, vertebral column, and the rib cage (766)

esqueleto axial: esqueleto que sostiene al eje central del cuerpo; consiste en el cráneo, la columna vertebral y la caja torácica

axon: long fiber that carries impulses away from the cell body of a neuron (743)

axón: fibra larga que lleva los impulsos desde el cuerpo celular de una neurona

B

bacillus (pl. bacilli): rod-shaped prokaryote (486)

bacilo: procariota con forma de bastón

background extinction: extinction caused by slow and steady process of natural selection (457)

extinción de fondo: extinción causada por un proceso lento y continuo de selección natural

Bacteria: domain of unicellular prokaryotes that have cell walls containing peptidoglycan; corresponds to the kingdom eubacteria (439)

Bacteria: pertenece al dominio de los unicelulares procariota cuyas paredes celulares contienen peptidoglicano; corresponde al reino de las Eubacterias

bacteriophage: kind of virus that infects bacteria (289, 481)

bacteriófago: clase de virus que infecta a las bacterias

bark: tissues that are found outside the vascular cambium, including the phloem, cork cambium, and cork (563)

corteza: tejidos que se hallan fuera del cámbrío vascular, incluidos el floema, el cámbrío suberoso y el corcho

base: compound that produces hydroxide ions (OH^-) in solution; solution with a pH of more than 7 (36)

base: compuesto que en una solución produce iones hidróxido (OH^-); una solución con un pH superior a 7

Glossary (continued)

base pairing: principle that bonds in DNA can form only between adenine and thymine and between guanine and cytosine (295)

apareamiento de bases: principio que establece que los enlaces en el ADN sólo pueden formarse entre adenina y timina y entre guanina y citosina

behavior: manner in which an organism reacts to changes in its internal condition or external environment (696)

comportamiento: manera en que un organismo reacciona a los cambios que ocurren en su condición interna o en el medio ambiente externo

behavioral isolation: form of reproductive isolation in which two populations develop differences in courtship rituals or other behaviors that prevent them from breeding (415)

aislamiento conductual: forma de aislamiento reproductivo en la cual dos poblaciones desarrollan diferencias en sus rituales de cortejo o en otros comportamientos que evitan que se aparen

benthos: organisms that live attached to or near the bottom of lakes, streams, or oceans (96)

bentos: organismos que viven adheridos al fondo, o cerca del fondo, de lagos, arroyos u océanos

bias: particular preference or point of view that is personal, rather than scientific (12)

parcialidad: preferencia especial o punto de vista que es personal en lugar de ser científico

bilateral symmetry: body plan in which a single imaginary line can divide the body into left and right sides that are mirror images of each other (611)

simetría bilateral: diseño corporal en el cual una línea imaginaria divide al cuerpo en dos lados, izquierdo y derecho, que son imágenes reflejas una del otra

binary fission: type of asexual reproduction in which an organism replicates its DNA and divides in half, producing two identical daughter cells (487)

fisión binaria: tipo de reproducción asexual en la cual un organismo replica su ADN, se divide por la mitad y produce dos células hijas idénticas

binocular vision: ability to merge visual images from both eyes, providing depth perception and a three-dimensional view of the world (634)

visión binocular: capacidad de fusionar las imágenes visuales provenientes de ambos ojos, lo cual proporciona una percepción profunda y una visión tridimensional del mundo

binomial nomenclature: classification system in which each species is assigned a two-part scientific name (428)

nomenclatura binaria: sistema de clasificación en el cual a cada especie se le asigna un nombre científico que consta de dos partes

biodiversity: total of the variety of organisms in the biosphere; also called biological diversity (138)

biodiversidad: totalidad de los distintos organismos que se hallan en la biosfera; también denominada diversidad biológica

biogeochemical cycle: process in which elements, chemical compounds, and other forms of matter are passed from one organism to another and from one part of the biosphere to another (68)

ciclo biogeoquímico: proceso en el cual los elementos, los compuestos químicos y otras formas de materia pasan de un organismo a otro y de una parte de la biosfera a otra

biogeography: study of past and present distribution of organisms (392)

biogeografía: estudio de la distribución pasada y presente de los organismos

bioinformatics: application of mathematics and computer science to store, retrieve, and analyze biological data (344)

bioinformática: aplicación de las matemáticas y de la informática para almacenar, recuperar y analizar información biológica

biological magnification: increasing concentration of a harmful substance in organisms at higher trophic levels in a food chain or food web (134)

bioacumulación: concentración creciente de sustancias perjudiciales en los organismos de los niveles tróficos más elevados de una cadena o red alimentaria

biology: scientific study of life (13)

biología: estudio científico de la vida

biomass: total amount of living tissue within a given trophic level (67)

biomasa: cantidad total de tejido vivo dentro de un nivel trófico dado

biome: a group of ecosystems that share similar climates and typical organisms (57)

bioma: un grupo de ecosistemas que comparten climas similares y organismos típicos

biosphere: part of Earth in which life exists including land, water, and air or atmosphere (17, 56)

biósfera: parte de la Tierra en la cual existe vida, y que incluye el suelo, el agua y el aire o atmósfera

biotechnology: process of manipulating organisms, cells, or molecules, to produce specific products (355)

biotecnología: proceso de manipular organismos, células o moléculas con el fin de obtener productos específicos

biotic factor: any living part of the environment with which an organism might interact (57)

factor biótico: cualquier parte viva del medio ambiente con la cual un organismo podría interaccionar

bipedal: term used to refer to two-foot locomotion (635)

bípedo: término utilizado para referirse a la locomoción sobre dos pies

blastocyst: stage of early development in mammals that consists of a hollow ball of cells (249, 825)

blastocisto: etapa temprana del desarrollo de los mamíferos que consiste en una bola hueca formada por una capa de células

blastula: hollow ball of cells that develops when a zygote undergoes a series of cell divisions (612)

blástula: esfera hueca de células que se desarrolla cuando un cigoto atraviesa una serie de divisiones celulares

bone marrow: soft tissue found in bone cavities (767)

médula ósea: tejido blando que se halla en las cavidades de los huesos

bottleneck effect: a change in allele frequency following a dramatic reduction in the size of a population (411)

efecto cuello de botella: un cambio en la frecuencia alélica que resulta cuando el tamaño de una población reduce drásticamente

Bowman's capsule: cuplike structure that encases the glomerulus; collects filtrate from the blood (731)

cápsula de Bowman: estructura en forma de taza que encierra al glomérulo; recoge los filtrados provenientes de la sangre

brain stem: structure that connects the brain and spinal cord; includes the medulla oblongata and the pons (749)

tronco cerebral: estructura que conecta al cerebro con la médula espinal; incluye el bulbo raquídeo y el puente de Varolio

bronchus (pl. bronchi): one of two large tubes in the chest cavity that leads from the trachea to the lungs (797)

bronquio: cada uno de los dos conductos largos ubicados en la cavidad torácica que parten desde la tráquea y llegan a los pulmones

bryophyte: group of plants that have specialized reproductive organs but lack vascular tissue; includes mosses and their relatives (533)

briofitas: grupo de plantas que tienen órganos reproductores especializados pero carecen de tejido vascular; incluyen a los musgos y sus congéneres

bud: plant structure containing apical meristem tissue that can produce new stems and leaves (560)

yema o gema: estructura de las plantas que contiene tejido del meristemo apical y puede producir nuevos tallos y hojas

buffer: compound that prevents sharp, sudden changes in pH (36)

solución amortiguadora: compuesto que evita cambios bruscos y repentinos en el pH

C

calcitonin: hormone produced by the thyroid that reduces blood calcium levels (815)

calcitonina: hormona producida por la tiroides que reduce los niveles de calcio en la sangre

Calorie: measure of heat energy in food; equivalent to 1000 calories (719)

Caloría: medida de la energía térmica de los alimentos, equivalente a 1000 calorías

calorie: amount of energy needed to raise the temperature of 1 gram of water by 1 degree Celsius (212)

caloría: cantidad de energía necesaria para elevar la temperatura de 1 gramo de agua en 1 grado Celsius

Calvin cycle: light-independent reactions of photosynthesis in which energy from ATP and NADPH is used to build high-energy compounds such as sugar (201)

ciclo de Calvin: reacciones de la fotosíntesis independientes de la luz en las cuales se utiliza la energía del ATP y del NADPH para elaborar compuestos con alto contenido energético, como el azúcar

cancer: disorder in which some of the body's cells lose the ability to control growth (247)

cáncer: enfermedad en la cual algunas de las células del cuerpo pierden la capacidad de controlar su crecimiento

canopy: dense covering formed by the leafy tops of tall rain-forest trees (92)

dosel forestal: cubierta densa formada por las copas de los árboles altos del bosque tropical

capillary: smallest blood vessel; brings nutrients and oxygen to the tissues and absorbs carbon dioxide and waste products (789)

capilar: más pequeño de los vasos sanguíneos más pequeños; lleva nutrientes y oxígeno a los tejidos y absorbe dióxido de carbono y productos de desecho

capillary action: tendency of water to rise in a thin tube (568)

capilaridad: tendencia del agua a ascender en un tubo delgado

capsid: protein coat surrounding a virus (481)

cápsida: cobertura de proteínas que rodea a un virus

carbohydrate: compound made up of carbon, hydrogen, and oxygen atoms; type of nutrient that is the major source of energy for the body (38, 720)

hidrato de carbono: compuesto formado por átomos de carbono, hidrógeno y oxígeno; tipo de nutriente que es la fuente principal de energía para el cuerpo

carnivore: organism that obtains energy by eating animals (62)

carnívoro: organismo que obtiene energía al comer otros animales

Glossary (continued)

carpel: innermost part of a flower that produces and shelters the female gametophytes (579)

carpelo: parte interna de una flor que produce y alberga los gametofitos femeninos

carrying capacity: largest number of individuals of a particular species that a particular environment can support (111)

capacidad de carga: mayor cantidad de individuos de una especie en particular que un medio ambiente específico puede mantener

cartilage: type of connective tissue that supports the body and is softer and more flexible than bone (628, 767)

cartílago: tipo de tejido conectivo que sostiene al cuerpo y es más blando y flexible que el hueso

Casparian strip: waterproof strip that surrounds plant endodermal cells and is involved in the one-way passage of materials into the vascular cylinder in plant roots (558)

banda de Caspary: banda impermeable que rodea a las células endodérmicas de las plantas y participa en el transporte unidireccional de las sustancias hacia el interior del cilindro vascular de las raíces de las plantas

catalyst: substance that speeds up the rate of a chemical reaction (44)

catalizador: sustancia que acelera la velocidad de una reacción química

cell: basic unit of all forms of life (160)

célula: unidad básica de todas las formas de vida

cell body: largest part of a typical neuron; contains the nucleus and much of the cytoplasm (743)

cuerpo celular: parte más grande de una neurona típica; que contiene el núcleo y gran parte del citoplasma

cell cycle: series of events in which a cell grows, prepares for division, and divides to form two daughter cells (240)

ciclo celular: serie de sucesos en los cuales una célula crece, se prepara para dividirse y se divide para formar dos células hijas

cell division: process by which a cell divides into two new daughter cells (236)

división celular: proceso por el cual una célula se divide en dos células hijas nuevas

cell membrane: thin, flexible barrier that surrounds all cells; regulates what enters and leaves the cell (162)

membrana celular: barrera flexible y delgada que rodea a todas las células; regula lo que entra y sale de la célula

cell theory: fundamental concept of biology that states that all living things are composed of cells; that cells are the basic units of structure and function in living things; and that new cells are produced from existing cells (160)

teoría celular: concepto fundamental de la Biología que establece que todos los seres vivos están compuestos por células; que las células son las unidades básicas estructurales y funcionales de los seres vivos; y que las células nuevas se producen a partir de células existentes

cell wall: strong, supporting layer around the cell membrane in some cells (171)

pared celular: capa resistente que sirve de sostén y está situada alrededor de la membrana celular de algunas células

cell-mediated immunity: immune response that defends the body against viruses, fungi, and abnormal cancer cells inside living cells (843)

inmunidad celular: respuesta inmune que desde las células defiende al cuerpo contra virus, hongos y células anormales cancerígenas

cellular respiration: process that releases energy by breaking down glucose and other food molecules in the presence of oxygen (213)

respiración celular: proceso que libera energía al descomponer la glucosa y otras moléculas de los alimentos en presencia de oxígeno

central nervous system: includes the brain and spinal cord; processes information and creates a response that it delivers to the body (742)

sistema nervioso central: incluye el cerebro y la médula espinal; procesa información y genera una respuesta que es enviada al cuerpo

centriole: structure in an animal cell that helps to organize cell division (167, 242)

centríolo: estructura de una célula animal que contribuye a organizar la división celular

centromere: region of a chromosome where the two sister chromatids attach (242)

centrómero: región de un cromosoma donde se unen las dos cromátidas hermanas

cephalization: concentration of sense organs and nerve cells at the anterior end of an animal (613)

cefalización: concentración de órganos sensoriales y células nerviosas en el extremo anterior de un animal

cerebellum: part of the brain that coordinates movement and controls balance (671, 749)

cerebelo: parte del encéfalo que coordina el movimiento y controla el equilibrio

cerebral cortex: outer layer of the cerebrum of a mammal's brain; center of thinking and other complex behaviors (748)

corteza cerebral: capa externa del cerebro de un mamífero; centro del raciocinio y otros comportamientos complejos

cerebrum: part of the brain responsible for voluntary activities of the body; “thinking” region of the brain (671, 748)

cerebro: parte del encéfalo responsable de las actividades voluntarias del cuerpo; región “pensante” del encéfalo

chemical digestion: process by which enzymes break down food into small molecules that the body can use (723)

digestión química: proceso por el cual las enzimas descomponen los alimentos en moléculas pequeñas que el cuerpo puede utilizar

chemical reaction: process that changes, or transforms, one set of chemicals into another set of chemicals (42)

reacción química: proceso que cambia, o transforma, un grupo de sustancias químicas en otro grupo de sustancias químicas

chemosynthesis: process in which chemical energy is used to produce carbohydrates (61)

quimiosíntesis: proceso en el cual la energía química se utiliza para producir hidratos de carbono

chitin: complex carbohydrate that makes up the cell walls of fungi; also found in the external skeletons of arthropods (514)

quitina: hidrato de carbono complejo que forma las paredes celulares de los hongos; también se halla en los esqueletos externos de los artrópodos

chlorophyll: principal pigment of plants and other photosynthetic organisms (195)

clorofila: pigmento fundamental de las plantas y de otros organismos fotosintéticos

chloroplast: organelle found in cells of plants and some other organisms that captures the energy from sunlight and converts it into chemical energy (170)

cloroplasto: orgánulo de las células de las plantas y de otros organismos que captura la energía de la luz solar y la convierte en energía química

chordate: animal that has, for at least one stage of its life, a dorsal, hollow nerve cord, a notochord, a tail that extends beyond the anus, and pharyngeal pouches (606)

cordado: animal que, al menos durante una etapa de su vida, tiene un cordón nervioso hueco y dorsal, un noto-cordio, una cola que se prolonga más allá del ano y bolsas faríngeas

chromatid: one of two identical “sister” parts of a duplicated chromosome (242)

cromátida: una de las dos partes “hermanas” idénticas de un cromosoma duplicado

chromatin: substance found in eukaryotic chromosomes that consists of DNA tightly coiled around histones (239)

cromatina: sustancia que se halla en los cromosomas eucarióticos y que consiste en ADN enrollado apretadamente alrededor de las histonas

chromosome: threadlike structure within the nucleus that contains genetic information that is passed from one generation to the next (239)

cromosoma: estructura filiforme situada dentro del núcleo que contiene la información genética que se transmite de una generación a la siguiente

chyme: mixture of enzymes and partially digested food (725)

quimo: mezcla de enzimas y alimentos parcialmente digeridos

cilium (pl. cilia): short hairlike projection that produces movement (506)

cilio: pequeña prolongación parecida a un pelo que produce movimiento

circadian rhythm: behavioral cycles that occur daily (701)

ritmo circadiano: ciclos conductuales que ocurren diariamente

clade: evolutionary branch of a cladogram that includes a single ancestor and all its descendants (433)

clado: rama evolutiva de un cladograma que incluye a un único ancestro y a todos sus descendientes

cladogram: diagram depicting patterns of shared characteristics among species (433)

cladograma: diagrama que representa patrones de características compartidas entre especies

class: in classification, a group of closely related orders (430)

clase: en la clasificación, un grupo de varios órdenes relacionados estrechamente

classical conditioning: type of learning that occurs when an animal makes a mental connection between a stimulus and some kind of reward or punishment (698)

condicionamiento clásico: tipo de aprendizaje que ocurre cuando un animal realiza una conexión mental entre un estímulo y algún tipo de recompensa o castigo

climate: average year-to-year conditions of temperature and precipitation in an area over a long period of time (82)

clima: promedio anual de las condiciones de temperatura y precipitación en un área durante un largo período de tiempo

clone: member of a population of genetically identical cells produced from a single cell (361)

clon: miembro de una población de células genéticamente idénticas producidas a partir de una célula única

closed circulatory system: type of circulatory system in which blood circulates entirely within blood vessels that extend throughout the body (653)

sistema circulatorio cerrado: tipo de sistema circulatorio en el cual la sangre circula completamente dentro de los vasos sanguíneos que se extienden por todo el cuerpo

coccus (pl. cocci): spherical prokaryote (486)

coco: procariota de forma esférica

cochlea: fluid-filled part of inner ear; contains nerve cells that detect sound (755)

cóclea: parte del oído interno llena de fluidos; contiene las células nerviosas que detectan el sonido

codominance: situation in which the phenotypes produced by both alleles are completely expressed (271)

codominancia: situación en la cual los fenotipos producidos por ambos alelos están expresados completamente

Glossary (continued)

codon: group of three nucleotide bases in mRNA that specify a particular amino acid to be incorporated into a protein (311)

codón: grupo de tres bases de nucleótidos en el RNA mensajero que especifican la incorporación de un aminoácido en particular en una proteína

coelom: body cavity lined with mesoderm (612)

celoma: cavidad corporal revestida de mesodermo

coevolution: process by which two species evolve in response to changes in each other over time (460)

coevolución: proceso por el cual dos especies evolucionan en respuesta a cambios mutuos en el transcurso del tiempo

cohesion: attraction between molecules of the same substance (34)

cohesión: atracción entre moléculas de la misma sustancia

collenchyma: in plants, type of ground tissue that has strong, flexible cell walls; helps support larger plants (553)

colénquima: en las plantas, tipo de tejido fundamental que tiene paredes celulares fuertes y flexibles; contribuye a sostener las plantas más grandes

commensalism: symbiotic relationship in which one organism benefits and the other is neither helped nor harmed (87)

comensalismo: relación simbiótica en la cual un organismo se beneficia y el otro ni se beneficia ni sufre daño

communication: passing of information from one organism to another (703)

comunicación: traspaso de información desde un organismo a otro

community: assemblage of different populations that live together in a defined area (56)

comunidad: conjunto de varias poblaciones que viven juntas en un área definida

companion cell: in plants, phloem cell that surrounds sieve tube elements (554)

célula anexa: en las plantas, célula del floema que rodea a los vasos cribosos

competitive exclusion principle: principle that states that no two species can occupy the same niche in the same habitat at the same time (86)

principio de exclusión competitiva: principio que afirma que dos especies no pueden ocupar el mismo nicho en el mismo hábitat al mismo tiempo

compound: substance formed by the chemical combination of two or more elements in definite proportions (30)

compuesto: sustancia formada por la combinación química de dos o más elementos en proporciones definidas

cone: in the eye, photoreceptor that responds to light of different colors, producing color vision (757)

cono: en el ojo, receptor de luz que responde a la luz de diferentes colores, produciendo la visión a color

coniferous: term used to refer to trees that produce seed-bearing cones and have thin leaves shaped like needles (93)

coníferas: término utilizado para referirse a los árboles que producen conos portadores de semillas y que tienen hojas delgadas con forma de aguja

conjugation: process in which paramecia and some prokaryotes exchange genetic information (487, 507)

conjugación: proceso mediante el cual los paramecios y algunos procariotas intercambian información genética

connective tissue: type of tissue that provides support for the body and connects its parts (714)

tejido conectivo: tipo de tejido que proporciona sostén al cuerpo y conecta sus partes

consumer: organism that relies on other organisms for its energy and food supply; also called a heterotroph (61)

consumidor: organismo que depende de otros organismos para obtener su energía y su provisión de alimentos; también llamado heterótrofo

control group: group in an experiment that is exposed to the same conditions as the experimental group except for one independent variable (6)

grupo de control: en un experimento, grupo que está expuesto a las mismas condiciones que el grupo experimental, excepto por una variable independiente

controlled experiment: experiment in which only one variable is changed (6)

experimento controlado: experimento en el cual sólo se cambia una variable

convergent evolution: process by which unrelated organisms independently evolve similarities when adapting to similar environments (460)

evolución convergente: proceso mediante el cual organismos no relacionados evolucionan independientemente hacia caracteres similares cuando se adaptan a ambientes parecidos

cork cambium: meristematic tissue that produces the outer covering of stems during secondary growth of a plant (562)

cámbium suberoso: tejido del meristemo que produce la cubierta exterior de los tallos durante el crecimiento secundario de una planta

cornea: tough transparent layer of the eye through which light enters (756)

córnea: membrana dura y transparente del ojo a través de la cual entra la luz

corpus luteum: name given to a follicle after ovulation because of its yellow color (821)

cuero lúteo: nombre dado a un folículo después de la ovulación debido a su color amarillo

cortex: in plants, region of ground tissue just inside the root through which water and minerals move (557)

corteza radicular: en las plantas, región de tejido fundamental situada en el interior de la raíz a través de la cual pasan el agua y los minerales

corticosteroid: steroid hormone produced by the adrenal cortex (814)

corticosteroide o corticoide: hormona esteroídica producida por la corteza de las glándulas adrenales

cotyledon: first leaf or first pair of leaves produced by the embryo of a seed plant (542)

cotiledón: primera hoja o primer par de hojas producidas por el embrión de una planta fanerógama

courtship: type of behavior in which an animal sends out stimuli in order to attract a member of the opposite sex (702)

cortejo: tipo de comportamiento en el cual un animal emite estímulos para atraer a un miembro del sexo opuesto

covalent bond: type of bond between atoms in which the electrons are shared (31)

enlace covalente: tipo de enlace entre átomos en el cual se comparten los electrones

crossing-over: process in which homologous chromosomes exchange portions of their chromatids during meiosis (276)

entrecruzamiento: proceso por el cual los cromosomas homólogos intercambian partes de sus cromátidas durante la meiosis

cyclin: one of a family of proteins that regulates the cell cycle in eukaryotic cells (246)

ciclina: un componente de la familia de proteínas que regulan el ciclo celular de las células eucariotas

cytokinesis: division of the cytoplasm to form two separate daughter cells (241)

citocinesis: división del citoplasma para formar dos células hijas separadas

cytokinin: plant hormone produced in growing roots and in developing fruits and seeds (589)

citoquinina: hormona vegetal que se genera en las raíces en crecimiento y en los frutos y semillas en desarrollo

cytoplasm: fluid portion of the cell outside the nucleus (164)

citoplasma: parte fluida de la célula externa al núcleo

cytoskeleton: network of protein filaments in a eukaryotic cell that gives the cell its shape and internal organization and is involved in movement (167)

citoesqueleto: en una célula eucariota, red de filamentos proteínicos que otorga a la célula su forma y su organización interna y participa en el movimiento

D

data: evidence; information gathered from observations (6)

datos: evidencia; información reunida a partir de observaciones

deciduous: term used to refer to a type of tree that sheds its leaves during a particular season each year (92)

caduco: término utilizado para referirse a un tipo de árbol que pierde sus hojas cada año durante una estación en particular

decomposer: organism that breaks down and obtains energy from dead organic matter (62)

descomponedor: organismo que descompone y obtiene energía de la materia orgánica muerta

deforestation: destruction of forests (133)

deforestación: destrucción de los bosques

demographic transition: change in a population from high birth and death rates to low birth and death rates (118)

transición demográfica: en una población, cambio de índices de nacimiento y mortalidad altos a índices de nacimiento y mortalidad bajos

demography: scientific study of human populations (118)

demografía: estudio científico de las poblaciones humanas

dendrite: extension of the cell body of a neuron that carries impulses from the environment or from other neurons toward the cell body (743)

dendrita: prolongación del cuerpo celular de una neurona que transporta impulsos desde el medio ambiente o desde otras neuronas hacia el cuerpo celular

denitrification: process by which bacteria convert nitrates into nitrogen gas (71)

desnitritificación: proceso por el cual las bacterias del suelo convierten los nitratos en gas nitrógeno

density-dependent limiting factor: limiting factor that depends on population density (112)

factor limitante dependiente de la densidad: factor limitante que depende de la densidad de la población

density-independent limiting factor: limiting factor that affects all populations in similar ways, regardless of the population density (114)

factor limitante independiente de la densidad: factor limitante que afecta a todas las poblaciones de manera similar, sin importar la densidad de la población

deoxyribonucleic acid (DNA): genetic material that organisms inherit from their parents (14)

ácido desoxirribonucleico (ADN): material genético que los organismos heredan de sus padres

dependent variable: variable that is observed and that changes in response to the independent variable; also called the responding variable (6)

variable dependiente: variable que está siendo observada y cambia en respuesta a la variable independiente; también llamada variable de respuesta

Glossary (continued)

derived character: trait that appears in recent parts of a lineage, but not in its older members (434)

carácter derivado: rasgo que aparece en los descendientes recientes de un linaje, pero no en sus miembros más viejos

dermis: layer of skin found beneath the epidermis (778)

dermis: capa de la piel situada debajo de la epidermis

desertification: lower land productivity caused by over-farming, overgrazing, seasonal drought, and climate change (132)

desertificación: disminución de la productividad de la tierra debido al cultivo y al pastoreo excesivo, a la sequía estacional y al cambio climático

detrivore: organism that feeds on plant and animal remains and other dead matter (62)

detrívoro: organismo que se alimenta de restos animales y vegetales y demás materia orgánica muerta

deuterostome: group of animals in which the blastopore becomes an anus, and the mouth is formed from the second opening that develops (613)

deuteróstomos: grupo de animales en los cuales el blastoporo se convierte en ano y la boca se forma a partir del desarrollo de una segunda abertura

diaphragm: large flat muscle at the bottom of the chest cavity that helps with breathing (799)

diafragma: músculo plano y grande ubicado en la parte inferior de la cavidad torácica que participa en la respiración

dicot: angiosperm with two seed leaves in its ovary (542)

dicotiledónea: angiosperma con dos cotiledones (hojas embrionarias) en su ovario

differentiation: process in which cells become specialized in structure and function (248, 323)

diferenciación: proceso en el cual las células se especializan en estructura y función

diffusion: process by which particles tend to move from an area where they are more concentrated to an area where they are less concentrated (176)

difusión: proceso por el cual las partículas tienden a desplazarse desde un área donde están más concentradas hacia un área donde están menos concentradas

digestive tract: tube that begins at the mouth and ends at the anus (648)

tracto digestivo: tubo que comienza en la boca y termina en el ano

diploid: term used to refer to a cell that contains two sets of homologous chromosomes (275)

diploide: término utilizado para referirse a una célula que contiene dos series de cromosomas homólogos

directional selection: form of natural selection in which individuals at one end of a distribution curve have higher fitness than individuals in the middle or at the other end of the curve (410)

selección direccional: forma de selección natural en la cual los individuos que se hallan en un extremo de la curva de distribución poseen una mayor capacidad de adaptación que los individuos que se hallan en el centro o en el otro extremo de la curva

disruptive selection: natural selection in which individuals at the upper and lower ends of the curve have higher fitness than individuals near the middle of the curve (410)

selección disruptiva: forma de selección natural en la cual los individuos que se hallan en los extremos superior e inferior de la curva poseen una mayor capacidad de adaptación que los individuos que se hallan cerca del centro de la curva

DNA fingerprinting: tool used by biologists that analyzes an individual's unique collection of DNA restriction fragments; used to determine whether two samples of genetic material are from the same person (365)

prueba de ADN: herramienta utilizada por los biólogos mediante la cual se analiza el conjunto de los fragmentos de restricción de ADN exclusivo de cada individuo; utilizada para determinar si dos muestras de material genético pertenecen a la misma persona; también llamada huella genética o análisis de ADN

DNA microarray: glass slide or silicon chip that carries thousands of different kinds of single-stranded DNA fragments arranged in a grid. A DNA microarray is used to detect and measure the expression of thousands of genes at one time (364)

chip de ADN: superficie de vidrio o chip de silicona que contiene miles de diferentes tipos de fragmentos de ADN de una sola cadena dispuestos en una cuadrícula. Un chip de ADN se utiliza para detectar y medir la expresión de miles de genes a la vez

DNA polymerase: principal enzyme involved in DNA replication (297)

ADN polimerasa: enzima fundamental involucrada en la replicación del ADN

domain: larger, more inclusive taxonomic category than a kingdom (438)

dominio: categoría taxonómica más amplia e inclusiva que un reino

dopamine: neurotransmitter that is associated with the brain's pleasure and reward centers (750)

dopamina: neurotransmisor que está asociado con los centros de placer y de recompensa del cerebro

dormancy: period of time during which a plant embryo is alive but not growing (586)

latencia: período de tiempo durante el cual un embrión vegetal está vivo pero no crece

double fertilization: process of fertilization in angiosperms in which the first event produces the zygote, and the second, the endosperm within the seed (581)

doble fertilización: proceso de fecundación de las angiospermas en el cual se produce, en el primer suceso el cigoto y en el segundo, el endospermo dentro de la semilla

E

ecological footprint: total amount of functioning ecosystem needed both to provide the resources a human population uses and to absorb the wastes that population generates (143)

huella ecológica: cantidad total de ecosistema en funcionamiento necesaria para proporcionar los recursos que utiliza una población humana y para absorber los residuos que genera esa población

ecological hot spot: small geographic area where significant numbers of habitats and species are in immediate danger of extinction (142)

zona de conflicto ecológico: área geográfica pequeña donde cantidades importantes de hábitats y especies se hallan en peligro de extinción inmediato

ecological pyramid: illustration of the relative amounts of energy or matter contained within each trophic level in a given food chain or food web (66)

pirámide ecológica: ilustración de las cantidades relativas de energía o materia contenidas dentro de cada nivel trófico en una cadena o red alimenticia dada

ecological succession: series of gradual changes that occur in a community following a disturbance (88)

sucesión ecológica: serie de cambios graduales que ocurren en una comunidad después de una alteración

ecology: scientific study of interactions among organisms and between organisms and their environment (56)

ecología: estudio científico de las interacciones entre organismos y entre los organismos y su medio ambiente

ecosystem: all the organisms that live in a place, together with their nonliving environment (57)

ecosistema: todos los organismos que viven en un lugar, junto con su medio ambiente inanimado

ecosystem diversity: variety of habitats, communities, and ecological processes in the biosphere (138)

diversidad de ecosistemas: variedad de hábitats, comunidades y procesos ecológicos que existen en la biosfera

ectoderm: outermost germ layer; produces sense organs, nerves, and outer layer of skin (612)

ectodermo: capa embrionaria más externa; desarrolla órganos sensoriales, nervios y la capa exterior de la piel

ectotherm: animal whose body temperature is determined by the temperature of its environment (685)

animal de sangre fría: animal cuya temperatura corporal está determinada por la temperatura de su medio ambiente

electron: negatively charged particle; located in the space surrounding the nucleus (28)

electrón: partícula con carga negativa; ubicada en el espacio que rodea al núcleo

electron transport chain: series of electron carrier proteins that shuttle high-energy electrons during ATP-generating reactions (199)

cadena de transporte de electrones: serie de proteínas transportadoras que llevan electrones de alta energía, durante las reacciones generadoras de ATP

element: pure substance that consists entirely of one type of atom (29)

elemento: sustancia pura que consiste íntegramente en un tipo de átomo

embryo: developing stage of a multicellular organism (248)

embríon: una de las etapas de desarrollo de un organismo multicelular

embryo sac: female gametophyte within the ovule of a flowering plant (580)

saco embrionario: gametofito femenino dentro del óvulo de una planta que produce flores

emerging disease: disease that appears in the population for the first time, or an old disease that suddenly becomes harder to control (492)

enfermedad emergente: enfermedad que aparece en una población por primera vez o una enfermedad antigua que de pronto se vuelve más difícil de controlar

emigration: movement of individuals out of an area (109)

emigración: desplazamiento de individuos fuera de un área

endocrine gland: gland that releases its secretions (hormones) directly into the blood, which transports the secretions to other areas of the body (685, 810)

glándula endocrina: glándula que vierte sus secreciones (hormonas) directamente en la sangre, para ser transportadas a otras áreas del cuerpo

endoderm: innermost germ layer; develops into the linings of the digestive tract and much of the respiratory system (612)

endodermo: capa embrionaria más interna, a partir de la cual se desarrollan los revestimientos del tracto digestivo y gran parte del sistema respiratorio

endodermis: in plants, layer of ground tissue that completely encloses the vascular cylinder (557)

endodermis: en las plantas, un capa de tejido fundamental que envuelve completamente al cilindro vascular

endoplasmic reticulum: internal membrane system found in eukaryotic cells; place where lipid components of the cell membrane are assembled (168)

retículo endoplasmático: sistema de membranas internas de las células eucariotas; lugar donde se reúnen los componentes lipídicos de la membrana celular

endoskeleton: internal skeleton; structural support system within the body of an animal (675)

endoesqueleto: esqueleto interno; sistema estructural de sostén dentro del cuerpo de un animal

Glossary (continued)

endosperm: food-rich tissue that nourishes a seedling as it grows (581)

endospermo: tejido nutritivo que alimenta a una plántula a medida que crece

endospore: structure produced by prokaryotes in unfavorable conditions; a thick internal wall that encloses the DNA and a portion of the cytoplasm (487)

endospora: estructura producida por los procariotas en condiciones desfavorables; una gruesa pared interna que encierra al ADN y a una parte del citoplasma

endosymbiotic theory: theory that proposes that eukaryotic cells formed from a symbiotic relationship among several different prokaryotic cells (464)

teoría endosimbiótica: teoría que propone que las células eucariotas se formaron a partir de una relación simbiótica entre varias células procariotas distintas

endotherm: animal whose body temperature is regulated, at least in part, using heat generated within its body (686)

endotermo: animal cuya temperatura corporal se regula, al menos en parte, utilizando el calor generado dentro de su cuerpo

enzyme: protein catalyst that speeds up the rate of specific biological reactions (44)

enzima: proteína catalizadora que acelera la velocidad de reacciones biológicas específicas

epidermis: in plants, single layer of cells that makes up dermal tissue (553); in humans, the outer layer of the skin (778)

epidermis: en las plantas, única capa de células que forma el tejido dérmico; en los seres humanos, la capa exterior de la piel

epididymis: organ in the male reproductive system in which sperm mature and are stored (818)

epidídimo: órgano del sistema reproductor masculino en el cual el esperma madura y se almacena

epinephrine: hormone released by the adrenal glands that increases heart rate and blood pressure and prepares the body for intense physical activity; also called adrenaline (814)

epinefrina: hormona liberada por las glándulas adrenales que aumenta la frecuencia cardíaca y la presión sanguínea y prepara al cuerpo para una actividad física intensa; también llamada adrenalina

epithelial tissue: type of tissue that lines the interior and exterior body surfaces (714)

tejido epitelial: tipo de tejido que reviste el interior y el exterior de las superficies del cuerpo

era: major division of geologic time; usually divided into two or more periods (454)

era: división principal del tiempo geológico; usualmente dividida en dos o más períodos

esophagus: tube connecting the mouth to the stomach (724)

esófago: tubo que conecta la boca con el estómago

estuary: kind of wetland formed where a river meets the ocean (98)

estuario: tipo de humedal que se forma donde un río se une al océano

ethylene: plant hormone that stimulates fruits to ripen (589)

etileno: hormona vegetal que estimula la maduración de los frutos

Eukarya: domain consisting of all organisms that have a nucleus; includes protists, plants, fungi, and animals (440)

Eukarya (eucariontes): dominio compuesto por todos los organismos que tienen un núcleo; incluye a los protistas, las plantas, los hongos y los animales

eukaryote: organism whose cells contain a nucleus (162)

eucariota: organismo cuyas células contienen un núcleo

evolution: change over time; the process by which modern organisms have descended from ancient organisms (380)

evolución: cambio en el transcurso del tiempo; el proceso por el cual los organismos actuales se derivaron de los organismos antiguos

excretion: process by which metabolic wastes are eliminated from the body (656, 729)

excreción: proceso por el cual se eliminan del cuerpo los residuos metabólicos

exocrine gland: gland that releases its secretions, through tubelike structures called ducts, directly into an organ or out of the body (810)

glándula exocrina: glándula que vierte sus secreciones directamente a un órgano o al exterior del cuerpo a través de estructuras tubulares denominadas conductos

exon: expressed sequence of DNA; codes for a protein (310)

exón: secuencia expresada de ADN; codifica una porción específica de una proteína

exoskeleton: external skeleton; tough external covering that protects and supports the body of many invertebrates (674)

exoesqueleto: esqueleto externo; cubierta externa dura que protege y sostiene el cuerpo de muchos invertebrados

exponential growth: growth pattern in which the individuals in a population reproduce at a constant rate (109)

crecimiento exponencial: patrón de crecimiento en el cual los individuos de una población se reproducen a una tasa constante

extinct: term used to refer to a species that has died out and has no living members (450)

extinto: término utilizado para referirse a una especie que ha desaparecido y de la que ninguno de sus miembros está vivo

extracellular digestion: type of digestion in which food is broken down outside the cells in a digestive system and then absorbed (647)

digestión extracelular: tipo de digestión en la cual el alimento es degradado fuera de las células dentro de un sistema digestivo y luego se absorbe

F

facilitated diffusion: process of diffusion in which molecules pass across the membrane through cell membrane channels (177)

difusión facilitada: proceso de difusión en el cual las moléculas atraviesan la membrana a través de los canales de la membrana celular

family: in classification, group of similar genera (430)

familia: en la clasificación, grupo de géneros similares

fat: lipid; made up of fatty acids and glycerol; type of nutrient that protects body organs, insulates the body, and stores energy (721)

grasa: lípido; compuesto de ácidos grasos y glicerina; tipo de nutriente que protege a los órganos del cuerpo, actúa como aislante térmico y almacena energía

feedback inhibition: process in which a stimulus produces a response that opposes the original stimulus; also called negative feedback (608, 717)

inhibición de la retroalimentación: proceso en el cual un estímulo produce una respuesta que se opone al estímulo original; también llamada retroalimentación negativa

fermentation: process by which cells release energy in the absence of oxygen (223)

fermentación: proceso por el cual las células liberan energía en ausencia de oxígeno

fertilization: process in sexual reproduction in which male and female reproductive cells join to form a new cell (262)

fecundación: proceso de la reproducción sexual en el cual las células reproductoras masculinas y femeninas se unen para formar una célula nueva

fetus: a human embryo after eight weeks of development (827)

feto: un embrión humano después de ocho semanas de desarrollo

fever: increased body temperature that occurs in response to infection (842)

fiebre: temperatura corporal elevada que se produce como respuesta a una infección

filtration: process of passing a liquid or gas through a filter to remove wastes (731)

filtración: proceso de hacer pasar un líquido o un gas a través de un filtro para quitar los residuos

fitness: how well an organism can survive and reproduce in its environment (388)

aptitud: capacidad de un organismo para sobrevivir y reproducirse en su medio ambiente

flagellum (pl. flagella): structure used by protists for movement; produces movement in a wavelike motion (506)

flagelo: estructura utilizada por los protistas para desplazarse; produce un desplazamiento con un movimiento semejante al de una onda

food chain: series of steps in an ecosystem in which organisms transfer energy by eating and being eaten (63)

cadena alimenticia: serie de pasos en un ecosistema, en que los organismos transfieren energía al alimentarse y al servir de alimento

food vacuole: small cavity in the cytoplasm of a protist that temporarily stores food (510)

vacuola alimenticia: pequeña cavidad situada en el citoplasma de los protistas que almacena alimentos por algún tiempo

food web: network of complex interactions formed by the feeding relationships among the various organisms in an ecosystem (63)

red alimenticia: red de interacciones complejas constituida por las relaciones alimenticias entre los varios organismos de un ecosistema

forensics: scientific study of crime scene evidence (365)

ciencias forenses: estudio científico de las pruebas en la escena del crimen

fossil: preserved remains or traces of ancient organisms (382)

fósil: restos conservados o vestigios de organismos antiguos

founder effect: change in allele frequencies as a result of the migration of a small subgroup of a population (411)

efecto fundador: cambio en las frecuencias alélicas como consecuencia de la migración de un subgrupo pequeño de una población

frameshift mutation: mutation that shifts the “reading frame” of the genetic message by inserting or deleting a nucleotide (317)

mutación de corrimiento de estructura: mutación que cambia el “marco de lectura” del mensaje genético insertando o eliminando un nucleótido

fruit: structure in angiosperms that contains one or more matured ovaries (541)

fruto: estructura de las Angiospermas que contiene uno o más ovarios maduros

fruiting body: reproductive structure of a fungus that grows from the mycelium (515)

cuerpo fructífero: estructura reproductora de los hongos que se desarrolla a partir del micelio

Glossary (continued)

G

gamete: sex cell (264)

gameto: célula sexual

gametophyte: gamete-producing plant; multicellular haploid phase of a plant life cycle (530)

gametofito: planta que produce gametos; fase haploide multicelular del ciclo vital de una planta

ganglion (pl. ganglia): group of interneurons (670)

ganglio nervioso: grupo de interneuronas

gastrovascular cavity: digestive chamber with a single opening (647)

cavidad gastrovascular: cámara digestiva con una sola apertura

gastrulation: process of cell migration that results in the formation of the three cell layers—the ectoderm, the mesoderm, and the endoderm (826)

gastrulación: proceso de migración celular que da por resultado la formación de las tres capas celulares—el ectodermo, el mesodermo y el endodermo

gel electrophoresis: procedure used to separate and analyze DNA fragments by placing a mixture of DNA fragments at one end of a porous gel and applying an electrical voltage to the gel (342)

electroforesis en gel: procedimiento utilizado para separar y analizar fragmentos de ADN colocando una mezcla de fragmentos de ADN en un extremo de un gel poroso y aplicando al gel un voltaje eléctrico

gene: sequence of DNA that codes for a protein and thus determines a trait; factor that is passed from parent to offspring (263)

gen: secuencia de ADN que contiene el código de una proteína y por lo tanto determina un rasgo; factor que se transmite de un progenitor a su descendencia

gene expression: process by which a gene produces its product and the product carries out its function (314)

expresión génica: proceso por el cual un gen produce su producto y el producto lleva a cabo su función

gene pool: all the genes, including all the different alleles for each gene, that are present in a population at any one time (406)

caudal de genes: todos los genes, incluidos todos los alelos diferentes para cada gen, que están presentes en una población en un momento dado

gene therapy: process of changing a gene to treat a medical disease or disorder. An absent or faulty gene is replaced by a normal working gene. (364)

terapia genética o génica: proceso en el cual se cambia un gen para tratar una enfermedad o una afección médica. Se reemplaza un gen ausente o defectuoso con un gen de funcionamiento normal.

genetic code: collection of codons of mRNA, each of which directs the incorporation of a particular amino acid into a protein during protein synthesis (311)

código genético: conjunto de codones del ARN mensajero, cada uno de los cuales dirige la incorporación de un aminoácido en particular a una proteína durante la síntesis proteica

genetic diversity: sum total of all the different forms of genetic information carried by a particular species, or by all organisms on Earth (138)

diversidad genética: suma de todas las distintas formas de información genética portadas por una especie en particular, o por todos los organismos de la Tierra

genetic drift: random change in allele frequency caused by a series of chance occurrences that cause an allele to become more or less common in a population (411)

tendencia genética: alteración al azar de la frecuencia alélica causada por una serie de acontecimientos aleatorios que hacen que un alelo se vuelva más o menos común en una población

genetic equilibrium: situation in which allele frequencies in a population remain the same (412)

equilibrio genético: situación en la cual las frecuencias alélicas de una población se mantienen iguales

genetic marker: alleles that produce detectable phenotypic differences useful in genetic analysis (360)

marcador genético: alelos que producen diferencias fenotípicas detectables, útiles en el análisis genético

genetics: scientific study of heredity (262)

genética: estudio científico de la herencia

genome: entire set of genetic information that an organism carries in its DNA (334)

genoma: todo el conjunto de información genética que un organismo transporta en su ADN

genomics: study of whole genomes, including genes and their functions (344)

genómica: estudio integral de los genomas, incluyendo los genes y sus funciones

genotype: genetic makeup of an organism (267)

genotipo: composición genética de un organismo

genus: group of closely related species; the first part of the scientific name in binomial nomenclature (428)

género: grupo de especies relacionadas estrechamente; la primera parte del nombre científico en la nomenclatura binaria

geographic isolation: form of reproductive isolation in which two populations are separated by geographic barriers such as rivers, mountains, or bodies of water, leading to the formation of two separate subspecies (414)

aislamiento geográfico: forma de aislamiento reproductivo en el cual dos poblaciones están separadas por barreras geográficas como ríos, montañas o masas de agua, dando lugar a la formación de dos subespecies distintas

geologic time scale: time line used to represent Earth's history (453)

escala de tiempo geológico: línea cronológica utilizada para representar la historia de la Tierra

germ theory of disease: idea that infectious diseases are caused by microorganisms (838)

teoría microbiana de la enfermedad: idea de que las enfermedades infecciosas son causadas por microorganismos

germination: resumption of growth of the plant embryo following dormancy (586)

germinación: reanudación del crecimiento del embrión de la planta después de la latencia

giberellin: plant hormone that stimulates growth and may cause dramatic increases in size (589)

giberelina: hormona de las plantas que estimula el crecimiento y puede causar aumentos significativos de tamaño

gill: feathery structure specialized for the exchange of gases with water (651)

branquia: estructura tegumentaria especializada en el intercambio de los gases con el agua

global warming: increase in the average temperatures on Earth (147)

calentamiento global: aumento del promedio de temperatura en la tierra

glomerulus: small network of capillaries encased in the upper end of the nephron; where filtration of the blood takes place (731)

glomérulo: pequeña red de capilares encerrados en el extremo superior del nefrón; donde tiene lugar la filtración de la sangre

glycolysis: first set of reactions in cellular respiration in which a molecule of glucose is broken into two molecules of pyruvic acid (216)

glicólisis: primer conjunto de reacciones en la respiración celular, en las cuales una molécula de glucosa se descompone en dos moléculas de ácido pirúvico

Golgi apparatus: organelle in cells that modifies, sorts, and packages proteins and other materials from the endoplasmic reticulum for storage in the cell or release outside the cell (169)

aparato de Golgi: orgánulo de las células que modifica, clasifica y agrupa las proteínas y otras sustancias provenientes del retículo endoplasmático para almacenarlas en la célula o enviarlas fuera de la célula

gradualism: the evolution of a species by gradual accumulation of small genetic changes over long periods of time (458)

gradualismo: evolución de una especie por la acumulación gradual de pequeños cambios genéticos ocurridos en el transcurso de largos períodos de tiempo

grafting: method of propagation used to reproduce seedless plants and varieties of woody plants that cannot be propagated from cuttings (584)

injerto: método de propagación utilizado para reproducir plantas sin semillas y algunas variedades de plantas leñosas que no pueden propagarse a partir de esquejes

gravitropism: response of a plant to the force of gravity (590)

geotropismo: respuesta de una planta a la fuerza de la gravedad

green revolution: development of highly productive crop strains and use of modern agriculture techniques to increase yields of food crops (594)

revolución verde: el desarrollo de variedades de cultivos altamente productivos y el uso de técnicas agrícolas modernas para aumentar el rendimiento de los cultivos

greenhouse effect: process in which certain gases (carbon dioxide, methane, and water vapor) trap sunlight energy in Earth's atmosphere as heat (83)

efecto invernadero: proceso mediante el cual ciertos gases (dióxido de carbono, metano y vapor de agua) atrapan la energía de la luz solar en la atmósfera terrestre en forma de calor

growth factor: one of a group of external regulatory proteins that stimulate the growth and division of cells (246)

factor de crecimiento: una de las proteínas del grupo de proteínas reguladoras externas que estimulan el crecimiento y la división de las células

guard cell: specialized cell in the epidermis of plants that controls the opening and closing of stomata (565)

célula de guarda (o célula oclusiva): célula especializada de la epidermis vegetal que controla la apertura y el cierre de los estomas

gullet: indentation in one side of a ciliate that allows food to enter the cell (510)

citofaringe: hendidura a un costado de un ciliado que permite que los alimentos entren a la célula

gymnosperm: group of seed plants that bear their seeds directly on the scales of cones (536)

Gimnospermas: grupo de plantas fanerógamas que tienen sus semillas directamente sobre las escamas de los conos

H

habitat: area where an organism lives, including the biotic and abiotic factors that affect it (85)

hábitat: área donde vive un organismo, incluidos los factores bióticos y abióticos que lo afectan

Glossary (continued)

habitat fragmentation: splitting of ecosystems into pieces (140)

fragmentación del hábitat: la ruptura, o separación en partes, de los ecosistemas

habituation: type of learning in which an animal decreases or stops its response to a repetitive stimulus that neither rewards nor harms the animal (697)

habitación: tipo de aprendizaje en el cual un animal disminuye o cancela su respuesta ante un estímulo repetido que no recompensa ni castiga al animal

hair follicle: tubelike pockets of epidermal cells that extend into the dermis; cells at the base of hair follicles produce hair (776)

folículo piloso: sacos tubulares de las células epidérmicas que se prolongan hacia el interior de la dermis; las células situadas en la base de los folículos pilosos, producen pelo

half-life: length of time required for half of the radioactive atoms in a sample to decay (452)

vida media: período de tiempo requerido para que se desintegre la mitad de los átomos radiactivos de una muestra

haploid: term used to refer to a cell that contains only a single set of genes (275)

haploide: tipo de célula que posee un solo juego de cromosomas

Hardy-Weinberg principle: principle that states that allele frequencies in a population remain constant unless one or more factors cause those frequencies to change (412)

principio de Hardy-Weinberg: el principio que afirma que las frecuencias alélicas de una población permanecen constantes a menos que uno o más factores ocasionen que esas frecuencias cambien

Haversian canal: one of a network of tubes running through compact bone that contains blood vessels and nerves (767)

conducto de Havers: uno de los tubos de una red que recorre longitudinalmente el hueso compacto y contiene vasos sanguíneos y nervios

heart: hollow muscular organ that pumps blood throughout the body (653)

corazón: órgano muscular hueco que bombea la sangre a todo el cuerpo

heartwood: in a woody stem, the older xylem near the center of the stem that no longer conducts water (562)

duramen: en un tallo leñoso, el xilema más viejo situado cerca del centro del tallo que ya no conduce agua

hemoglobin: iron-containing protein in red blood cells that binds oxygen and transports it to the body (790)

hemoglobina: proteína de los glóbulos rojos que contiene hierro, fija el oxígeno y lo transporta al organismo

herbaceous plant: type of plant that has smooth and non-woody stems; includes dandelions, zinnias, petunias, and sunflowers (542)

planta herbácea: tipo de planta que tiene tallos blandos y no leñosos; incluye dientes de león, cinias, petunias y girasoles

herbivore: organism that obtains energy by eating only plants (62)

herbívoro: organismo que obtiene energía alimentándose solo de plantas

herbivory: interaction in which one animal (the herbivore) feeds on producers (such as plants) (86)

herbivorismo: interacción en la cual un animal (el herbívoro) se alimenta de productores (como las plantas)

heterotroph: organism that obtains food by consuming other living things; also called a consumer (61, 194)

heterótrofo: organismo que obtiene su alimento consumiendo otros seres vivos; también llamado consumidor

heterozygous: having two different alleles for a particular gene (267)

heterocigota: que tiene dos alelos diferentes para un gen dado

histamine: chemical released by mast cells that increases the flow of blood and fluids to the infected area during an inflammatory response (841)

histamina: sustancia química liberada por los mastocitos que aumenta el flujo de la sangre y los fluidos hacia el área infectada durante una respuesta inflamatoria

homeobox gene: The homeobox is a DNA sequence of approximately 130 base pairs, found in many homeotic genes that regulate development. Genes containing this sequence are known as homeobox genes, and they code for transcription factors, proteins that bind to DNA, and they also regulate the expression of other genes. (324)

gen homeobox: el homeobox es una secuencia de ADN de aproximadamente 130 pares de bases, presente en muchos genes homeóticos que regulan el desarrollo. Los genes que contienen esta secuencia se denominan genes homeobox y codifican los factores de transcripción, las proteínas que se adhieren al ADN y regulan la expresión de otros genes

homeostasis: relatively constant internal physical and chemical conditions that organisms maintain (15, 181, 717)

homeostasis: las condiciones internas, químicas y físicas, que los organismos mantienen relativamente constantes

homeotic gene: a class of regulatory genes that determine the identity of body parts and regions in an animal embryo. Mutations in these genes can transform one body part into another (324)

gen homeótico: tipo de genes reguladores que determinan la identidad de las partes y regiones del cuerpo en un embrión animal. Las mutaciones de estos genes pueden transformar una parte del cuerpo en otra

hominine: hominoid lineage that led to humans (635)

homínino: linaje hominoide que dio lugar a los seres humanos

hominoid: group of anthropoids that includes gibbons, orangutans, gorillas, chimpanzees, and humans (635)

homínido: grupo de antropoides que incluye a los gibones, orangutanes, gorilas, chimpacés y seres humanos

homologous: term used to refer to chromosomes in which one set comes from the male parent and one set comes from the female parent (275)

homólogos: término utilizado para referirse a los cromosomas en los que un juego proviene del progenitor masculino y un juego proviene del progenitor femenino

homologous structures: structures that are similar in different species of common ancestry (393)

estructuras homólogas: estructuras que son similares en distintas especies que tienen un ancestro común

homozygous: having two identical alleles for a particular gene (267)

homocigota: que tiene dos alelos idénticos para un gen dado

hormone: chemical produced in one part of an organism that affects another part of the same organism (588, 810)

hormona: sustancia química producida en una parte de un organismo que afecta a otra parte del mismo organismo

Hox gene: a group of homeotic genes clustered together that determine the head to tail identity of body parts in animals. All hox genes contain the homeobox DNA sequence. (324)

gen Hox: grupo de genes homeóticos agrupados en un conjunto que determinan la identidad posicional de las partes del cuerpo de los animales. Todos los genes Hox contienen la secuencia de ADN homeobox

humoral immunity: immunity against antigens in body fluids, such as blood and lymph (843)

inmunidad humoral: inmunidad contra los抗ígenos presentes en los fluidos corporales, como la sangre y la linfa

humus: material formed from decaying leaves and other organic matter (93)

humus: material formado a partir de hojas en descomposición y otros materiales orgánicos

hybrid: offspring of crosses between parents with different traits (263)

híbrido: descendencia del cruce entre progenitores que tienen rasgos diferentes

hybridization: breeding technique that involves crossing dissimilar individuals to bring together the best traits of both organisms (355)

hibridación: técnica de cría que consiste en cruzar individuos diferentes para reunir los mejores rasgos de ambos organismos

hydrogen bond: weak attraction between a hydrogen atom and another atom (33)

enlace de hidrógeno: atracción débil entre un átomo de hidrógeno y otro átomo

hydrostatic skeleton: skeleton made of fluid-filled body segments that work with muscles to allow the animal to move (674)

esqueleto hidrostático: esqueleto constituido por segmentos corporales llenos de fluido que trabajan con los músculos para permitir el movimiento del animal

hypertonic: when comparing two solutions, the solution with the greater concentration of solutes (178)

hipertónica: al comparar dos soluciones, la solución que tiene la mayor concentración de solutos

hypha (pl. hyphae): one of many long, slender filaments that makes up the body of a fungus (515)

hifa: uno de muchos filamentos largos y delgados que componen el cuerpo de un hongo

hypothalamus: structure of the brain that acts as a control center for recognition and analysis of hunger, thirst, fatigue, anger, and body temperature (749)

hipotálamo: estructura del cerebro que funciona como un centro de control para el reconocimiento y el análisis del hambre, la sed, la fatiga, el enojo y la temperatura corporal

hypothesis: possible explanation for a set of observations or possible answer to a scientific question (5)

hipótesis: explicación posible para un conjunto de observaciones o respuesta posible a una pregunta científica

hypotonic: when comparing two solutions, the solution with the lesser concentration of solutes (178)

hipotónica: al comparar dos soluciones, la solución que tiene la menor concentración de solutos

immigration: movement of individuals into an area occupied by an existing population (109)

inmigración: desplazamiento de individuos a un área ocupada por una población ya existente

immune response: the body's specific recognition, response, and memory to a pathogen attack (842)

respuesta inmune: reconocimiento, respuesta y memoria específicos que tiene el cuerpo respecto al ataque de un organismo patógeno

implantation: process in which the blastocyst attaches to the wall of the uterus (825)

implantación: proceso en el cual la blástula se adhiere a la pared del útero

Glossary (continued)

imprinting: type of behavior based on early experience; once imprinting has occurred, the behavior cannot be changed (699)

impronta: tipo de comportamiento basado en las primeras experiencias; una vez que ocurre la impronta, el comportamiento no puede cambiarse

inbreeding: continued breeding of individuals with similar characteristics to maintain the derived characteristics of a kind of organism (355)

endogamia: la cría continua de individuos con características semejantes para mantener las características derivadas de un tipo de organismo

incomplete dominance: situation in which one allele is not completely dominant over another allele (271)

dominancia incompleta: situación en la cual un alelo no es completamente dominante sobre otro alelo

independent assortment: one of Mendel's principles that states that genes for different traits can segregate independently during the formation of gametes (269)

distribución independiente: uno de los principios de Mendel que establece que los genes para rasgos diferentes pueden segregarse independientemente durante la formación de los gametos

independent variable: factor in a controlled experiment that is deliberately changed; also called manipulated variable (6)

variable independiente: en un experimento controlado, el factor que se modifica a propósito; también llamada variable manipulada

index fossil: distinctive fossil that is used to compare the relative ages of fossils (451)

fósil guía: fósil distintivo usado para comparar las edades relativas de los fósiles

infectious disease: disease caused by microorganism that disrupts normal body functions (838)

enfermedad infecciosa: enfermedad causada por un microorganismo que altera las funciones normales del cuerpo

inference: a logical interpretation based on prior knowledge and experience (5)

inferencia: interpretación lógica basada en la experiencia y en conocimientos previos

inflammatory response: nonspecific defense reaction to tissue damage caused by injury or infection (841)

respuesta inflamatoria: reacción defensiva no específica al daño causado a los tejidos por una herida o una infección

innate behavior: type of behavior in which the behavior appears in fully functional form the first time it is performed even though the animal has had no previous experience with the stimuli to which it responds; also called instinct (697)

comportamiento innato: tipo de comportamiento en el cual la conducta aparece en forma completamente funcional la primera vez que se lleva a cabo, aunque el animal no tenga ninguna experiencia previa con los estímulos a los que responde; también llamado instinto

insight learning: type of behavior in which an animal applies something it has already learned to a new situation, without a period of trial and error; also called reasoning (698)

aprendizaje por discernimiento: tipo de comportamiento en el cual un animal aplica algo que ya ha aprendido a una situación nueva, sin un período de ensayo y error; también llamado razonamiento

interferon: one of a group of proteins that help cells resist viral infection (842)

interferón: un tipo de proteína que ayuda a las células a combatir las infecciones virales

interneuron: type of neuron that processes information and may relay information to motor neurons (669)

interneurona: tipo de neurona que procesa información y la puede transmitir para estimular las neuronas

interphase: period of the cell cycle between cell divisions (241)

interfase: período del ciclo celular entre las divisiones celulares

intracellular digestion: type of digestion in which food is digested inside specialized cells that pass nutrients to other cells by diffusion (647)

digestión intracelular: tipo de digestión en la cual los alimentos se digieren dentro de células especializadas que pasan los nutrientes a otras células mediante difusión

intron: sequence of DNA that is not involved in coding for a protein (310)

intrón: secuencia de ADN que no participa en la codificación de una proteína

invertebrate: animal that lacks a backbone, or vertebral column (606)

invertebrado: animal que carece de columna vertebral

ion: atom that has a positive or negative charge (30)

ión: átomo que tiene una carga positiva o negativa

ionic bond: chemical bond formed when one or more electrons are transferred from one atom to another (30)

enlace iónico: enlace químico que se forma cuando uno o más electrones se transfieren de un átomo a otro

iris: colored part of the eye (756)

iris: parte coloreada del ojo

isotonic: when the concentration of two solutions is the same (178)

isotónica: cuando la concentración de dos soluciones es la misma

isotope: one of several forms of a single element that contains the same number of protons but different numbers of neutrons (29)

isótopo: cada una de las diferentes formas de un único elemento, que contiene la misma cantidad de protones pero cantidades distintas de neutrones

J

joint: place where one bone attaches to another bone (675, 768)

articulación: sitio donde un hueso se une a otro hueso

K

karyotype: micrograph of the complete diploid set of chromosomes grouped together in pairs, arranged in order of decreasing size (334)

cariotipo: micrografía de la totalidad del conjunto diploide de cromosomas agrupados en pares, ordenados por tamaño decreciente

keratin: tough fibrous protein found in skin (776)

queratina: proteína fibrosa y resistente que se halla en la piel

keystone species: single species that is not usually abundant in a community yet exerts strong control on the structure of a community (86)

especie clave: especie que habitualmente no es abundante en una comunidad y sin embargo ejerce un fuerte control sobre la estructura de esa comunidad

kidney: an organ of excretion that separates wastes and excess water from the blood (656)

riñón: órgano excretor que separa los residuos y el exceso de agua de la sangre

kingdom: largest and most inclusive group in classification (431)

reino: en la clasificación, el grupo mayor y más inclusivo

Koch's postulates: set of guidelines developed by Koch that help identify the microorganism that causes a specific disease (839)

postulados de Koch: conjunto de pautas desarrollado por Koch que ayuda a identificar al microorganismo que causa una enfermedad específica

Krebs cycle: second stage of cellular respiration in which pyruvic acid is broken down into carbon dioxide in a series of energy-extracting reactions (218)

ciclo de Krebs: segunda fase de la respiración celular en la cual el ácido pirúvico se descompone en dióxido de carbono en una serie de reacciones que liberan energía

L

language: system of communication that combines sounds, symbols, and gestures according to a set of rules about sequence and meaning, such as grammar and syntax (704)

lenguaje: sistema de comunicación que combina sonidos, símbolos y gestos según un conjunto de reglas sobre la secuencia y el significado, como la gramática y la sintaxis

large intestine: organ in the digestive system that removes water from the undigested material that passes through it; also called the colon (728)

intestino grueso: órgano del sistema digestivo que extrae el agua del material no digerido que pasa por él; también llamado colon

larva: (pl. larvae): immature stage of an organism (627)

larva: etapa inmadura de un organismo

larynx: structure in the throat that contains the vocal cords (796)

laringe: órgano situado en la garganta que contiene las cuerdas vocales

learning: changes in behavior as a result of experience (697)

aprendizaje: cambios en el comportamiento a consecuencia de la experiencia

lens: structure in the eye that focuses light rays on the retina (757)

crystalino: estructura del ojo que enfoca los rayos luminosos en la retina

lichen: symbiotic association between a fungus and a photosynthetic organism (518)

liquen: asociación simbiótica entre un hongo y un organismo fotosintético

ligament: tough connective tissue that holds bones together in a joint (675, 769)

ligamento: tejido conectivo resistente que mantiene unidos a los huesos en una articulación

light-dependent reactions: set of reactions in photosynthesis that use energy from light to produce ATP and NADPH (197)

reacciones dependientes de la luz: en la fotosíntesis, conjunto de reacciones que emplean la energía proveniente de la luz para producir ATP y NADPH

Glossary (continued)

light-independent reactions: set of reactions in photosynthesis that do not require light; energy from ATP and NADPH is used to build high-energy compounds such as sugar; also called the Calvin cycle (197)

reacciones independientes de la luz: en la fotosíntesis, conjunto de reacciones que no necesitan luz; la energía proveniente del ATP y del NADPH se emplea para construir compuestos con gran contenido energético, como el azúcar; también llamado ciclo de Calvin

lignin: substance in vascular plants that makes cell walls rigid (554)

lignina: sustancia de las plantas vasculares que hace rígidas a las paredes celulares

limiting factor: factor that causes population growth to decrease (112)

factor limitante: un factor que hace disminuir el crecimiento de la población

limiting nutrient: single essential nutrient that limits productivity in an ecosystem (72)

nutriente limitante: un solo nutriente esencial que limita la productividad de un ecosistema

lipid: macromolecule made mostly from carbon and hydrogen atoms; includes fats, oils, and waxes (39)

lípido: macromolécula compuesta principalmente por átomos de carbono e hidrógeno; incluye las grasas, los aceites y las ceras

lipid bilayer: flexible double-layered sheet that makes up the cell membrane and forms a barrier between the cell and its surroundings (171)

bicapa lipídica: lámina flexible de dos capas que constituye la membrana celular y forma una barrera entre la célula y su entorno

logistic growth: growth pattern in which a population's growth slows and then stops following a period of exponential growth (111)

crecimiento logístico: patrón de crecimiento en el cual el desarrollo de una población se reduce y luego se detiene después de un período de crecimiento exponencial

loop of Henle: section of the nephron tubule that is responsible for conserving water and minimizing the volume of the filtrate (731)

asa de Henle: una sección del túbulo de nefrón responsable de conservar el agua y minimizar el volumen del material filtrado

lung: respiratory organ; place where gases are exchanged between the blood and inhaled air (651)

pulmón: órgano respiratorio; lugar donde se intercambian los gases entre la sangre y el aire inhalado

lymph: fluid that is filtered out of the blood (792)

linfa: fluido procedente de la sangre

lysogenic infection: type of infection in which a virus embeds its DNA into the DNA of the host cell and is replicated along with the host cell's DNA (482)

infección lisogénica: tipo de infección en la cual un virus inserta su ADN en el ADN de la célula huésped y se replica junto con el ADN de dicha célula huésped

lysosome: cell organelle that breaks down lipids, carbohydrates, and proteins into small molecules that can be used by the rest of the cell (166)

lisosoma: orgánulo celular que descompone los lípidos, los hidratos de carbono y las proteínas en moléculas pequeñas que pueden ser utilizadas por el resto de la célula

lytic infection: type of infection in which a virus enters a cell, makes copies of itself, and causes the cell to burst (482)

infección lítica: tipo de infección en la cual un virus penetra una célula, hace copias de sí mismo y provoca la ruptura o muerte celular

M

macroevolutionary patterns: changes in anatomy, phylogeny, ecology, and behavior that take place in clades larger than a single species (456)

patrones de macroevolución: cambios que ocurren en la anatomía, filogenia, ecología y comportamiento de clados que abarcan a más de una especie

Malpighian tubule: structure in most terrestrial arthropods that concentrates the uric acid and adds it to digestive wastes (658)

túbulo de Malpighi: estructura de la mayoría de los artrópodos terrestres que concentra el ácido úrico y lo incorpora a los residuos digestivos

mammary gland: gland in female mammals that produces milk to nourish the young (682)

glándula mamaria: glándula de las hembras de los mamíferos que produce leche para alimentar a las crías

mass extinction: event during which many species become extinct during a relatively short period of time (457)

extinción masiva: suceso durante el cual se extinguen muchas especies durante un período de tiempo relativamente corto

matrix: innermost compartment of the mitochondrion (218)

matriz: compartimento más interno de la mitocondria

mechanical digestion: physical breakdown of large pieces of food into smaller pieces (723)

digestión mecánica: descomposición física de grandes pedazos de comida en pedazos más pequeños

meiosis: process in which the number of chromosomes per cell is cut in half through the separation of homologous chromosomes in a diploid cell (276)

meiosis: proceso por el cual el número de cromosomas por célula se reduce a la mitad mediante la separación de los cromosomas homólogos de una célula diploide

melanin: dark brown pigment in the skin that helps protect the skin by absorbing ultraviolet rays (776)

melanina: pigmento marrón oscuro de la piel que contribuye a protegerla al absorber los rayos ultravioletas

melanocyte: cell in the skin that produces a dark brown pigment called melanin (776)

melanocito: célula de la piel que produce un pigmento marrón oscuro llamado melanina

menstrual cycle: regular sequence of events in which an egg develops and is released from the body (820)

ciclo menstrual: secuencia regular de sucesos en la cual un huevo se desarrolla y se elimina del cuerpo

menstruation: discharge of blood and the unfertilized egg from the body (821)

menstruación: descarga de sangre y del huevo no fertilizado del cuerpo

meristem: regions of unspecialized cells responsible for continuing growth throughout a plant's lifetime (554)

meristemos: regiones de células no especializadas responsables del crecimiento continuo de una planta durante su vida

mesoderm: middle germ layer; develops into muscles, and much of the circulatory, reproductive, and excretory systems (612)

mesodermo: capa embrionaria media; se desarrolla para dar lugar a los músculos y gran parte de los sistemas circulatorio, reproductor y excretor

mesophyll: specialized ground tissue found in leaves; performs most of a plant's photosynthesis (564)

mesófilo: tejido fundamental especializado que se halla en las hojas; realiza la mayor parte de la fotosíntesis de una planta

messenger RNA (mRNA): type of RNA that carries copies of instructions for the assembly of amino acids into proteins from DNA to the rest of the cell (309)

ARN mensajero: tipo de ARN que transporta copias de las instrucciones para el ensamblaje de los aminoácidos en proteínas, desde el ADN al resto de la célula

metabolism: the combination of chemical reactions through which an organism builds up or breaks down materials (15)

metabolismo: la combinación de reacciones químicas a través de las cuales un organismo acumula o desintegra materiales

metamorphosis: process of changes in shape and form of a larva into an adult (681)

metamorfosis: proceso de cambios en la estructura y forma de una larva hasta que se convierte en adulto

metaphase: phase of mitosis in which the chromosomes line up across the center of the cell (242)

metafase: fase de la mitosis en la cual los cromosomas se alinean a través del centro de la célula

microclimate: environmental conditions within a small area that differs significantly from the climate of the surrounding area (82)

microclima: condiciones medioambientales de un área pequeña que difieren significativamente del clima del área circundante

migration: seasonal behavior resulting in the movement from one environment to another (701)

migración: comportamiento estacional que da por resultado el desplazamiento desde un medio ambiente a otro

mineral: inorganic nutrient the body needs, usually in small amounts (721)

mineral: nutriente inorgánico que el cuerpo necesita, usualmente en pequeñas cantidades

mitochondrion: cell organelle that converts the chemical energy stored in food into compounds that are more convenient for the cell to use (170)

mitocondria: orgánulo celular que convierte la energía química almacenada en los alimentos en compuestos más apropiados para que la célula los use

mitosis: part of eukaryotic cell division during which the cell nucleus divides (241)

mitosis: fase de la división de las células eucariotas durante la cual se divide el núcleo celular

mixture: material composed of two or more elements or compounds that are physically mixed together but not chemically combined (34)

mezcla: material compuesto por dos o más elementos o compuestos que están mezclados físicamente pero no están combinados químicamente

molecular clock: method used by researchers that uses mutation rates in DNA to estimate the length of time that two species have been evolving independently (417)

reloj molecular: método de investigación que emplea las tasas de mutación del ADN para estimar el lapso de tiempo en que dos especies han evolucionado independientemente

molecule: smallest unit of most compounds that displays all the properties of that compound (31)

molécula: la unidad más pequeña de la mayoría de los compuestos que exhibe todas las propiedades de ese compuesto

molting: process of shedding an exoskeleton and growing a new one (675)

muda: proceso de desprendimiento de un exoesqueleto y el crecimiento de uno nuevo

monocot: angiosperm with one seed leaf in its ovary (542)

monocotiledónea: angiosperma con un cotiledón (hoja embrionaria) en su ovario

Glossary (continued)

monoculture: farming strategy of planting a single, highly productive crop year after year (129)

monocultivo: estrategia agrícola que consiste en plantar año tras año un único cultivo altamente productivo

monomer: small chemical unit that makes up a polymer (38)

monómero: pequeña unidad química que forma un polímero

monophyletic group: group that consists of a single ancestral species and all its descendants and excludes any organisms that are not descended from that common ancestor (433)

grupo monofilético: grupo que consiste en una especie con un único ancestro y todos sus descendientes y excluye a todos los organismos que no descienden de ese ancestro común

monosaccharide: simple sugar molecule (38)

monosacárido: molécula de azúcar simple

motor neuron: type of nerve cell that carries directions from interneurons to either muscle cells or glands (669)

neurona motora: tipo de célula nerviosa que lleva las instrucciones provenientes de las interneuronas a las células musculares o las glándulas

multiple alleles: a gene that has more than two alleles (272)

alelos múltiples: un gen que tiene más de dos alelos

multipotent: cell with limited potential to develop into many types of differentiated cells (250)

multipotentes: células con potencial limitado para generar muchos tipos de células diferenciadas

muscle fiber: long slender skeletal muscle cells (770)

fibra muscular: células largas y delgadas de los músculos esqueléticos

muscle tissue: type of tissue that makes movements of the body possible (715)

tejido muscular: tipo de tejido que hace posibles los movimientos del cuerpo

mutagen: chemical or physical agents in the environment that interact with DNA and may cause a mutation (318)

mutágeno: agentes físicos o químicos del medioambiente que interaccionan con el ADN y pueden causar una mutación

mutation: change in the genetic material of a cell (316)

mutación: cambio en el material genético de una célula

mutualism: symbiotic relationship in which both species benefit from the relationship (87)

mutualismo: relación simbiótica en la cual ambas especies se benefician

mycelium (pl. mycelia): densely branched network of the hyphae of a fungus (515)

micelio: la red de filamentos muy ramificados de las hifas de un hongo

mycorrhiza (pl. mycorrhizae): symbiotic association of plant roots and fungi (519)

micorriza: asociación simbiótica entre las raíces de las plantas y los hongos

myelin sheath: insulating membrane surrounding the axon in some neurons (743)

vaina de mielina: membrana aislante que rodea al axón de algunas neuronas

myocardium: thick middle muscle layer of the heart (787)

miocardio: capa media, gruesa y musculara del corazón

myofibril: tightly packed filament bundles found within skeletal muscle fibers (771)

miofibrilla: manojos de filamentos muy apretados que se hallan dentro de las fibras de los músculos esqueléticos

myosin: thick filament of protein found in skeletal muscle cells (771)

miosina: filamento grueso de proteína que se halla en las células de los músculos esqueléticos

N

NAD⁺ (nicotinamide adenine dinucleotide): electron carrier involved in glycolysis (216)

NAD⁺ (dinucleótido de nicotinamida adenina): transportador de electrones que participa en la glucólisis

NADP⁺ (nicotinamide adenine dinucleotide phosphate): carrier molecule that transfers high-energy electrons from chlorophyll to other molecules (196)

NADP⁺ (fosfato de dinucleótido de nicotinamida adenina): molécula transportadora de electrones que transfiere electrones de alta energía desde la clorofila a otras moléculas

natural selection: process by which organisms that are most suited to their environment survive and reproduce most successfully; also called survival of the fittest (389)

selección natural: proceso por el cual los organismos más adaptados a su medioambiente sobreviven y se reproducen más exitosamente; también llamada supervivencia del más apto

nephridium (pl. nephridia): excretory structure of an annelid that filters body fluid (658)

nefridio: estructura excretora de los anélidos que filtra el fluido corporal

nephron: blood-filtering structure in the kidneys in which impurities are filtered out, wastes are collected, and purified blood is returned to the circulation (729)

nefrón: estructura filtradora de la sangre en los riñones, en la cual se filtran las impurezas, se recogen los desechos y la sangre purificada se devuelve a la circulación

nervous tissue: type of tissue that transmits nerve impulses throughout the body (715)

tejido nervioso: tipo de tejido que transmite los impulsos nerviosos por el cuerpo

neuromuscular junction: the point of contact between a motor neuron and a skeletal muscle cell (772)

unión neuromuscular: el punto de contacto entre una neurona motora y una célula de un músculo esquelético

neuron: nerve cell; specialized for carrying messages throughout the nervous system (668)

neurona: célula nerviosa; especializada en conducir mensajes a través del sistema nervioso

neurotransmitter: chemical used by a neuron to transmit an impulse across a synapse to another cell (746)

neurotransmisor: sustancia química utilizada por una neurona para transmitir un impulso a otra célula a través de una sinapsis

neurulation: the first step in the development of the nervous system (826)

neurulación: primer paso en el desarrollo del sistema nervioso

niche: full range of physical and biological conditions in which an organism lives and the way in which the organism uses those conditions (85)

nicho: toda la variedad de condiciones biológicas y físicas en las que vive un organismo y la manera en la que dicho organismo utiliza esas condiciones

nitrogen fixation: process of converting nitrogen gas into nitrogen compounds that plants can absorb and use (71)

fijación de nitrógeno: el proceso por el cual el gas nitrógeno se convierte en los compuestos nitrogenados que las plantas pueden absorber y utilizar

node: part on a growing stem where a leaf is attached (560)

nudo: parte de un tallo en crecimiento donde está adherida una hoja

nondisjunction: error in meiosis in which the homologous chromosomes fail to separate properly (341)

no disyunción: error que ocurre durante la meiosis, en el que cromosomas homólogos no logran separarse adecuadamente

nonrenewable resource: resource that cannot be replenished by a natural process within a reasonable amount of time (131)

recurso no renovable: recurso que no se puede reponer mediante un proceso natural dentro de un período de tiempo razonable

norepinephrine: hormone released by the adrenal glands that increases heart rate and blood pressure and prepares the body for intense physical activity (814)

norepinefrina o noradrenalina: hormona liberada por las glándulas adrenales que aumenta la frecuencia cardíaca y la presión sanguínea y prepara al cuerpo para realizar actividad física intensa

notochord: long supporting rod that runs through a chordate's body just below the nerve cord (606)

notocordio: extenso bastón de apoyo que se extiende a lo largo del cuerpo de los cordados, justo por debajo del cordón nervioso

nucleic acid: macromolecules containing hydrogen, oxygen, nitrogen, carbon, and phosphorus (40)

ácido nucleico: macromoléculas que contienen hidrógeno, oxígeno, nitrógeno, carbono y fósforo

nucleotide: subunit of which nucleic acids are composed; made up of a 5-carbon sugar, a phosphate group, and a nitrogenous base (40)

nucleótido: subunidad que constituye los ácidos nucleicos; compuesta de un azúcar de 5 carbonos, un grupo fosfato y una base nitrogenada

nucleus: the center of an atom, which contains the protons and neutrons (28); in cells, structure that contains the cell's genetic material in the form of DNA (162)

núcleo: el centro de un átomo, contiene los protones y los neutrones; en las células, la estructura que contiene el material genético de la célula en forma de ADN

nutrient: chemical substance that an organism needs to sustain life (70)

nutriente: sustancia química que un organismo necesita para continuar con vida

nymph: immature form of an animal that resembles the adult form but lacks functional sexual organs (681)

ninfa: forma inmadura de un animal que se parece a la forma adulta, pero carece de órganos sexuales funcionales



observation: process of noticing and describing events or processes in a careful, orderly way (5)

observación: el método de percibir y describir sucesos o procesos de manera atenta y ordenada

omnivore: organism that obtains energy by eating both plants and animals (62)

omnívoro: organismo que obtiene energía alimentándose de plantas y animales

open circulatory system: type of circulatory system in which blood is only partially contained within a system of blood vessels as it travels through the body (653)

sistema circulatorio abierto: tipo de sistema circulatorio en el cual la sangre, cuando fluye por el cuerpo, está solo parcialmente contenida dentro de un sistema de vasos sanguíneos

operant conditioning: type of learning in which an animal learns to behave in a certain way through repeated practice, to receive a reward or avoid punishment (698)

acondicionamiento operante: tipo de aprendizaje en el cual un animal aprende a comportarse de cierta manera mediante una práctica repetida, para recibir una recompensa o evitar un castigo

Glossary (continued)

operator: short DNA region, adjacent to the promoter of a prokaryotic operon, that binds repressor proteins responsible for controlling the rate of transcription of the operon (321)

operador: pequeña región de ADN, adyacente al promotor del operón de una procariota, que une las proteínas represoras responsables de controlar la tasa de transcripción del operón

operon: in prokaryotes, a group of adjacent genes that share a common operator and promoter and are transcribed into a single mRNA (320)

operón: en las procariotas, grupo de genes adyacentes que comparten un operador y un promotor en común y que son transcritas a un solo ARN mensajero

opposable thumb: thumb that enables grasping objects and using tools (635)

pulgar oponible o prensible: un pulgar que permite aferrar objetos y utilizar herramientas

order: in classification, a group of closely related families (430)

orden: en la clasificación, un grupo de familias relacionadas estrechamente

organ: group of tissues that work together to perform closely related functions (182)

órgano: grupo de tejidos que trabajan juntos para realizar funciones estrechamente relacionadas

organ system: group of organs that work together to perform a specific function (182)

sistema de órganos: grupo de órganos que trabajan juntos para realizar una función específica

organelle: specialized structure that performs important cellular functions within a eukaryotic cell (164)

orgánulo: estructura especializada que realiza funciones celulares importantes dentro de una célula eucariota

osmosis: diffusion of water through a selectively permeable membrane (177)

ósmosis: la difusión de agua a través de una membrana de permeabilidad selectiva

osmotic pressure: pressure that must be applied to prevent osmotic movement across a selectively permeable membrane (178)

presión osmótica: la presión que debe aplicarse para evitar el movimiento osmótico a través de una membrana de permeabilidad selectiva

ossification: process of bone formation during which cartilage is replaced by bone (767)

osificación: el proceso de formación de hueso durante el cual el cartílago es reemplazado por hueso

osteoblast: bone cell that secretes mineral deposits that replace the cartilage in developing bones (767)

osteoblasto: célula ósea que secreta depósitos minerales que reemplazan al cartílago de los huesos en desarrollo

osteoclast: bone cell that breaks down bone minerals (767)

osteoclasto: célula ósea que degrada los minerales óseos

osteocyte: bone cell that helps maintain the minerals in bone tissue and continue to strengthen the growing bone (767)

osteocito: célula ósea que ayuda a conservar los minerales en el tejido óseo y continúa fortaleciendo al hueso en crecimiento

ovary: in plants, the structure that surrounds and protects seeds (540); in animals, the primary female reproductive organ; produces eggs (819)

ovario: en las plantas, la estructura que rodea a las semillas y las protege; órgano reproductor femenino fundamental en los animales; produce huevos

oviparous: species in which embryos develop in eggs outside a parent's body (680)

ovíparo: especie animal en la cual los embriones se desarrollan en huevos fuera del cuerpo del progenitor

ovoviviparous: species in which the embryos develop within the mother's body but depend entirely on the yolk sac of their eggs (680)

ovovíparo: especie animal en la cual los embriones se desarrollan dentro del cuerpo de la madre, pero dependen completamente del saco vitelino de sus huevos

ovulation: the release of a mature egg from the ovary into one of the Fallopian tubes (820)

ovulación: liberación de un huevo maduro desde el ovario a una de las trompas de Falopio

ovule: structure in seed cones in which the female gamophytes develop (538)

óvulo: estructura de las semillas coníferas donde se desarrollan los gametos femeninos

ozone layer: atmospheric layer in which ozone gas is relatively concentrated; protects life on Earth from harmful ultraviolet rays in sunlight (145)

capa de ozono: capa atmosférica en la cual el gas ozono se encuentra relativamente concentrado; protege a los seres vivos de la Tierra de los perjudiciales rayos ultravioletas de la luz solar

P

pacemaker: small group of cardiac muscle fibers that maintains the heart's pumping rhythm by setting the rate at which the heart contracts; the sinoatrial (SA) node (788)

marcapasos: grupo pequeño de fibras musculares cardíacas que mantiene el ritmo de bombeo del corazón estableciendo la frecuencia a la que se contrae el corazón; el nodo sinusal

paleontologist: scientist who studies fossils (450)

paleontólogo: científico que estudia los fósiles

palisade mesophyll: layer of cells under the upper epidermis of a leaf (564)

mesófilo en empalizada: capa de células situada bajo la epidermis superior de una hoja

parasitism: symbiotic relationship in which one organism lives on or inside another organism and harms it (87)

parasitismo: relación simbiótica en la cual un organismo vive sobre otro organismo o en su interior y lo perjudica

parathyroid hormone (PTH): hormone produced by parathyroid gland that increases calcium levels in the blood (815)

hormona de la paratiroides: hormona producida por la glándula paratiroides que aumenta los niveles de calcio en la sangre

parenchyma: main type of ground tissue in plants that contains cells with thin cell walls and large central vacuoles (553)

parénquima: tipo principal de tejido fundamental de las plantas que contiene células con paredes celulares delgadas y vacuolas centrales grandes

passive immunity: temporary immunity that develops as a result of natural or deliberate exposure to an antibody (846)

inmunidad pasiva: inmunidad transitoria que se desarrolla a consecuencia de una exposición natural o deliberada a un anticuerpo

pathogen: disease-causing agent (489)

patógeno: agente que causa una enfermedad

pedigree: chart that shows the presence or absence of a trait according to the relationships within a family across several generations (336)

árbol genealógico: diagrama que muestra la presencia o ausencia de un rasgo de acuerdo con las relaciones intrafamiliares a través de varias generaciones

pepsin: enzyme that breaks down proteins into smaller polypeptide fragments (725)

pepsina: enzima que descompone las proteínas en fragmentos de polipéptidos más pequeños

period: division of geologic time into which eras are subdivided (454)

período: división del tiempo geológico en la que se subdividen las eras

peripheral nervous system: network of nerves and supporting cells that carries signals into and out of the central nervous system (742)

sistema nervioso periférico: red de nervios y células de apoyo que transporta señales hacia y desde el sistema nervioso central

peristalsis: contractions of smooth muscles that provide the force that moves food through the esophagus toward the stomach (724)

peristalsis: contracciones de los músculos lisos que proporcionan la fuerza que hace avanzar los alimentos a través del esófago hacia el estómago

permafrost: layer of permanently frozen subsoil found in the tundra (94)

permacongelamiento: capa de subsuelo congelado en forma permanente que se halla en la tundra

pH scale: scale with values from 0 to 14, used to measure the concentration of H⁺ ions in a solution; a pH of 0 to 7 is acidic, a pH of 7 is neutral, and a pH of 7 to 14 is basic (35)

escala del pH: escala con valores de 0 a 14, utilizada para medir la concentración de iones H⁺ en una solución; un pH de 0 a 7 es ácido, un pH de 7 es neutro y un pH de 7 a 14 es básico

pharyngeal pouch: one of a pair of structures in the throat region of a chordate (607)

bolsa faríngea: cada una de las dos estructuras situadas en la región de la garganta de los cordados

pharynx: tube at the back of the mouth that serves as a passageway for both air and food; also called the throat (796)

faringe: tubo situado a continuación de la boca que sirve de conducto para que pasen el aire y los alimentos; también llamada garganta

phenotype: physical characteristics of an organism (267)

fenotipo: características físicas de un organismo

phloem: vascular tissue that transports solutions of nutrients and carbohydrates produced by photosynthesis through the plant (534)

floema: tejido vascular que transporta por toda la planta las soluciones de nutrientes e hidratos de carbono producidos en la fotosíntesis

photic zone: sunlight region near the surface of water (96)

zona fótica: región cerca de la superficie del mar en la que penetra la luz solar

photoperiod: plant response to the relative lengths of light and darkness (591)

fotoperíodo: la respuesta de una planta a los tiempos relativos de luz y oscuridad

photosynthesis: process used by plants and other autotrophs to capture light energy and use it to power chemical reactions that convert carbon dioxide and water into oxygen and energy-rich carbohydrates such as sugars and starches (60, 194)

fotosíntesis: proceso empleado por las plantas y otros organismos autótrofos para atrapar la energía lumínosa y utilizarla para impulsar reacciones químicas que convierten el dióxido de carbono y el agua en oxígeno e hidratos de carbono de gran contenido energético, como azúcares y almidones

photosystem: cluster of chlorophyll and proteins found in thylakoids (199)

fotosistema: conjunto de clorofila y proteínas que se hallan en los tilacoides

phototropism: tendency of a plant to grow toward a light source (590)

fototropismo: la tendencia de una planta a crecer hacia una fuente de luz

Glossary (continued)

phylogeny: study of evolutionary relationships among organisms (433)

filogenia: estudio de las relaciones evolutivas entre los organismos

phylum (pl. phyla): in classification, a group of closely related classes (431)

filo: en la clasificación, un grupo de clases estrechamente relacionadas

phytoplankton: photosynthetic algae found near the surface of the ocean (63)

fitoplancton: algas fotosintéticas que se hallan cerca de la superficie del océano

pigment: light-absorbing molecule used by plants to gather the sun's energy (195)

pigmento: moléculas que absorben la luz, empleadas por las plantas para recolectar la energía solar

pioneer species: first species to populate an area during succession (88)

especies pioneras: las primeras especies en poblar un área durante la sucesión ecológica

pistil: single carpel or several fused carpels; contains the ovary, style, and stigma (579)

pistilo: un único carpelo o varios carpelos unidos; contiene el ovario, el estilo y el estigma

pituitary gland: small gland found near the base of the skull that secretes hormones that directly regulate many body functions and controls the actions of several other endocrine glands (813)

glándula pituitaria: pequeña glándula situada cerca de la base del cráneo que secreta hormonas que regulan directamente muchas funciones corporales y controla las acciones de varias otras glándulas endocrinas

placenta: specialized organ in placental mammals through which respiratory gases, nutrients, and wastes are exchanged between the mother and her developing young (683, 827)

placenta: órgano especializado de los mamíferos placentarios a través del cual se intercambian los gases respiratorios, los nutrientes y los residuos entre la madre y su cría en desarrollo

plankton: microscopic organisms that live in aquatic environments; includes both phytoplankton and zooplankton (97)

plancton: organismos microscópicos que viven en medios ambientes acuáticos; incluye el fitoplancton y el zooplancton

plasma: straw-colored liquid portion of the blood (790)

plasma: parte líquida de la sangre de color amarillento

plasmid: small, circular piece of DNA located in the cytoplasm of many bacteria (359)

plásmido: pequeña porción circular de ADN ubicada en el citoplasma de muchas bacterias

plasmodium: amoeboid feeding stage in the life cycle of a plasmodial slime mold (511)

plasmodio: etapa de alimentación ameboide del ciclo vital de los mohos mucilaginosos

plate tectonics: geologic processes, such as continental drift, volcanoes, and earthquakes, resulting from plate movement (454)

tectónica de placas: procesos geológicos, como la deriva continental, los volcanes y los terremotos, que son consecuencia de los movimientos de las placas

platelet: cell fragment released by bone marrow that helps in blood clotting (791)

plaqueta: fragmento celular liberado por la médula espinal que interviene en la coagulación de la sangre

pluripotent: cells that are capable of developing into most, but not all, of the body's cell types (249)

pluripotentes: células capaces de convertirse en la mayoría de células del cuerpo, pero no en todas

point mutation: gene mutation in which a single base pair in DNA has been changed (317)

mutación puntual: mutación genética en la cual se ha modificado un único par de bases en el ADN

pollen grain: structure that contains the entire male gametophyte in seed plants (536)

grano de polen: la estructura que contiene a todo el gametofito masculino en las plantas fanerógamas

pollen tube: structure in a plant that contains two haploid sperm nuclei (538)

tubo polínico: en una planta, estructura que contiene dos núcleos espermáticos haploides

pollination: transfer of pollen from the male reproductive structure to the female reproductive structure (536)

polinización: transferencia de polen desde la estructura reproductora masculina hacia la estructura reproductora femenina

pollutant: harmful material that can enter the biosphere through the land, air, or water (134)

contaminante: material nocivo que puede ingresar en la biosfera a través de la tierra, el aire o el agua

polygenic trait: trait controlled by two or more genes (272, 408)

rasgo poligénico: rasgo controlado por dos o más genes

polymer: molecules composed of many monomers; makes up macromolecules (38)

polímero: molécula compuesta por muchos monómeros; forma macromoléculas

polymerase chain reaction (PCR): the technique used by biologists to make many copies of a particular gene (358)

reacción en cadena de la polimerasa (PCR): técnica usada por los biólogos para hacer muchas copias de un gen específico

polypeptide: long chain of amino acids that makes proteins (311)

polipéptido: cadena larga de aminoácidos que constituye las proteínas

polyploidy: condition in which an organism has extra sets of chromosomes (319)

poliploidía: condición en la cual un organismo tiene grupos adicionales de cromosomas

population: group of individuals of the same species that live in the same area (56)

población: grupo de individuos de la misma especie que viven en la misma área

population density: number of individuals per unit area (108)

densidad de población: número de individuos que viven por unidad de superficie

predation: interaction in which one organism (the predator) captures and feeds on another organism (the prey) (86)

depredación: interacción en la cual un organismo (el predador) captura y come a otro organismo (la presa)

prehensile tail: long tail that can coil tightly enough around a branch (635)

cola prensil: cola larga que puede enrollarse apretadamente alrededor de una rama

pressure-flow hypothesis: hypothesis that explains the method by which phloem sap is transported through the plant from a sugar “source” to a sugar “sink” (568)

teoría de flujo por presión: teoría que explica el método por el cual la savia del floema recorre la planta desde una “fuente” de azúcar hacia un “vertedero” de azúcar

primary growth: pattern of growth that takes place at the tips and shoots of a plant (561)

crecimiento primario: patrón de crecimiento que tiene lugar en las puntas y en los brotes de una planta

primary producer: first producer of energy-rich compounds that are later used by other organisms (60)

productor primario: los primeros productores de compuestos ricos en energía que luego son utilizados por otros organismos

primary succession: succession that occurs in an area in which no trace of a previous community is present (88)

sucesión primaria: sucesión que ocurre en un área en la cual no hay rastros de la presencia de una comunidad anterior

principle of dominance: Mendel’s second conclusion, which states that some alleles are dominant and others are recessive (263)

principio de dominancia: segunda conclusión de Mendel, que establece que algunos alelos son dominantes y otros son recesivos

prion: protein particles that cause disease (493)

prión: partículas de proteína que causan enfermedades

probability: likelihood that a particular event will occur (266)

probabilidad: la posibilidad de que ocurra un suceso dado

product: elements or compounds produced by a chemical reaction (42)

producto: elemento o compuesto producido por una reacción química

prokaryote: unicellular organism that lacks a nucleus (162, 485)

procariota: organismo unicelular que carece de núcleo

promoter: specific region of a gene where RNA polymerase can bind and begin transcription (310)

promotor: región específica de un gen en donde la ARN polimerasa puede unirse e iniciar la transcripción

prophage: bacteriophage DNA that is embedded in the bacterial host’s DNA (482)

profago: ADN del bacteriófago que está alojado en el interior del ADN del huésped bacteriano

prophase: first and longest phase of mitosis in which the genetic material inside the nucleus condenses and the chromosomes become visible (242)

profase: primera y más prolongada fase de la mitosis, en la cual el material genético dentro del interior del núcleo se condensa y los cromosomas se hacen visibles

prostaglandin: modified fatty acids that are produced by a wide range of cells; generally affect only nearby cells and tissues (811)

prostaglandina: ácidos grasos modificados que son producidos por una amplia gama de células; generalmente afectan solo a las células y tejidos cercanos

protein: macromolecule that contains carbon, hydrogen, oxygen, and nitrogen; needed by the body for growth and repair (40, 721)

proteína: macromolécula que contiene carbono, hidrógeno, oxígeno y nitrógeno; necesaria para el crecimiento y reparación del cuerpo

protostome: animal whose mouth is formed from the blastopore (613)

protóstomo: animal cuya boca se desarrolla a partir del blastoporo

pseudocoelom: body cavity that is only partially lined with mesoderm (612)

pseudoceloma o falso celoma: cavidad corporal que está revestida sólo parcialmente con mesodermo

Glossary (continued)

pseudopod: temporary cytoplasmic projection used by some protists for movement (505)

seudópodo: prolongación citoplasmática transitoria utilizada por algunos protistas para moverse

puberty: period of rapid growth and sexual maturation during which the reproductive system becomes fully functional (817)

pubertad: período de crecimiento rápido y de maduración sexual durante el cual el sistema reproductor se vuelve completamente funcional

pulmonary circulation: path of circulation between the heart and lungs (788)

circulación pulmonar: recorrido de la circulación entre el corazón y los pulmones

punctuated equilibrium: pattern of evolution in which long stable periods are interrupted by brief periods of more rapid change (458)

equilibrio interrumpido: patrón de evolución en el cual los largos períodos de estabilidad se ven interrumpidos por breves períodos de cambio más rápido

Punnett square: diagram that can be used to predict the genotype and phenotype combinations of a genetic cross (267)

cuadro de Punnett: un diagrama que puede utilizarse para predecir las combinaciones de genotipos y fenotipos en un cruce genético

pupa: stage in complete metamorphosis in which the larva develops into an adult (681)

pupa: etapa de la metamorfosis completa en la cual la larva se convierte en un adulto

pupil: small opening in the iris that admits light into the eye (757)

pupila: pequeña abertura en el iris que deja pasar la luz al ojo

Q, R

radial symmetry: body plan in which any number of imaginary planes drawn through the center of the body could divide it into equal halves (611)

simetría radial: diseño corporal en el cual cualquier número de ejes imaginarios dibujados a través del centro del cuerpo lo dividirá en mitades iguales

radiometric dating: method for determining the age of a sample from the amount of a radioactive isotope to the non-radioactive isotope of the same element in a sample (452)

datación radiométrica: método para determinar la edad de una muestra a partir de la cantidad de isótopo radioactivo en relación a la de isótopo no radiactivo del mismo elemento en dicha muestra

reabsorption: process by which water and dissolved substances are taken back into the blood (731)

reabsorción: proceso por el cual el agua y las sustancias disueltas regresan a la sangre

reactant: elements or compounds that enter into a chemical reaction (42)

reactante: elemento o compuesto que participa en una reacción química

receptor: on or in a cell, a specific protein to whose shape fits that of a specific molecular messenger, such as a hormone (183, 588)

receptor: proteína específica que puede encontrarse en la membrana celular o dentro de la célula, cuya forma se corresponde con la de un mensajero molecular específico, por ejemplo una hormona

recombinant DNA: DNA produced by combining DNA from different sources (359)

ADN recombinante: ADN producido por la combinación de ADN de orígenes diferentes

red blood cell: blood cell containing hemoglobin that carries oxygen (790)

glóbulo rojo: célula sanguínea que contiene hemoglobina y transporta oxígeno

reflex: quick, automatic response to a stimulus (747)

reflejo: respuesta rápida y automática a un estímulo

reflex arc: the sensory receptor, sensory neuron, motor neuron, and effector that are involved in a quick response to a stimulus (752)

arco reflejo: el receptor sensorial, la neurona sensorial, la neurona motora y el efector que participan en una respuesta rápida a un estímulo

relative dating: method of determining the age of a fossil by comparing its placement with that of fossils in other rock layers (451)

datación relativa: método para determinar la edad de un fósil comparando su ubicación con la de los fósiles hallados en otras capas de roca

releasing hormone: hormone produced by the hypothalamus that makes the anterior pituitary secrete hormones (813)

hormona liberadora: hormona producida por el hipotálamo que hace que la glándula pituitaria anterior secrete hormonas

renewable resource: resource that can be produced or replaced by healthy ecosystem functions (131)

recurso renovable: recurso que se puede producir o reemplazar mediante el funcionamiento saludable del ecosistema

replication: process of copying DNA prior to cell division (296)

replicación: proceso de copia de ADN previo a la división celular

reproductive isolation: separation of a species or population so that they no longer interbreed and evolve into two separate species (414)

aislamiento reproductor: separación de una especie o de una población de tal manera que ya no pueden aparearse y evolucionan hasta formar dos especies separadas

resource: any necessity of life, such as water, nutrients, light, food, or space (85)

recuso: todo lo necesario para la vida, como agua, nutrientes, luz, alimento o espacio

response: specific reaction to a stimulus (669)

respuesta: reacción específica a un estímulo

resting potential: electrical charge across the cell membrane of a resting neuron (744)

potencial de reposo: carga eléctrica que pasa a través de la membrana celular de una neurona en reposo

restriction enzyme: enzyme that cuts DNA at a sequence of nucleotides (342)

enzima restrictiva: enzima que corta el ADN en una secuencia de nucleótidos

retina: innermost layer of the eye; contains photoreceptors (757)

retina: membrana más interna del ojo; contiene receptores susceptibles a la luz

retrovirus: RNA virus that contains RNA as its genetic information (483)

retrovirus: ARN viral cuya información genética está contenida en el ARN

ribonucleic acid (RNA): single-stranded nucleic acid that contains the sugar ribose (308)

ácido ribonucleico (ARN): hebra única de ácido nucleico que contiene el azúcar ribosa

ribosomal RNA (rRNA): type of RNA that combines with proteins to form ribosomes (309)

ARN ribosomal: tipo de ARN que se combina con proteínas para formar los ribosomas

ribosome: cell organelle consisting of RNA and protein found throughout the cytoplasm in a cell; the site of protein synthesis (168)

ribosoma: orgánulo celular formado por ARN y proteína que se halla en el citoplasma de una célula; lugar donde se sintetizan las proteínas

RNA interference (RNAi): introduction of double-stranded RNA into a cell to inhibit gene expression (323)

ARN de interferencia: introducción de un ARN de doble hebra en una célula para inhibir la expresión de genes específicos

RNA polymerase: enzyme that links together the growing chain of RNA nucleotides during transcription using a DNA strand as a template (309)

ARN polimerasa: enzima que enlaza los nucleótidos de la cadena de ARN en crecimiento durante la transcripción, usando una secuencia de ADN como patrón o molde

rod: photoreceptor in the eyes that is sensitive to light but can't distinguish color (757)

bastoncillo: receptor ubicado en los ojos que es susceptible a la luz, pero que no puede distinguir el color

root cap: tough covering of the root tip that protects the meristem (557)

cofa: cubierta dura de la punta de las raíces que protege al meristemo

root hair: small hairs on a root that produce a large surface area through which water and minerals can enter (557)

pelo radicular: pelos pequeños sobre una raíz que producen una superficie extensa a través de la cual pueden penetrar el agua y los minerales

rumen: stomach chamber in cows and related animals in which symbiotic bacteria digest cellulose (648)

panza: cavidad del estómago de las vacas y otros rumiantes en la cual las bacterias simbióticas digieren la celulosa

S

sapwood: in a woody stem, the layer of secondary phloem that surrounds the heartwood; usually active in fluid transport (562)

albura: en un tallo leñoso, la capa de floema secundario que rodea al duramen; participa usualmente en el transporte de fluidos

sarcomere: unit of muscle contraction; composed of two z-lines and the filaments between them (771)

sarcómero: unidad de contracción muscular; compuesto por dos líneas "z" y los filamentos que hay entre ellas

scavenger: animal that consumes the carcasses of other animals (62)

carroñero: animal que consume los cadáveres de otros animales

science: organized way of gathering and analyzing evidence about the natural world (4)

ciencia: manera organizada de reunir y analizar la información sobre el mundo natural

sclerenchyma: type of ground tissue with extremely thick, rigid cell walls that make ground tissue tough and strong (553)

esclerénquima: tipo de tejido fundamental con células extremadamente rígidas y gruesas que lo hacen fuerte y resistente

scrotum: external sac that houses the testes (818)

escroto: bolsa externa que contiene a los testículos

sebaceous gland: gland in the skin that secretes sebum (oily secretion) (776)

glándula sebácea: glándula de la piel que secreta sebo (secreción oleosa)

Glossary (continued)

secondary growth: type of growth in dicots in which the stems increase in thickness (562)

crecimiento secundario: tipo de crecimiento de las dicotiledóneas en el cual los tallos aumentan su grosor

secondary succession: type of succession that occurs in an area that was only partially destroyed by disturbances (88)

sucesión secundaria: tipo de sucesión que ocurre en un área destruida sólo parcialmente por alteraciones

seed: plant embryo and a food supply encased in a protective covering (536)

semilla: embrión vegetal y fuente de alimento encerrada en una cubierta protectora

seed coat: tough covering that surrounds and protects the plant embryo and keeps the contents of the seed from drying out (537)

envoltura de la semilla: cubierta dura que rodea y protege al embrión de la planta y evita que el contenido de la semilla se seque

segregation: separation of alleles during gamete formation (264)

segregación: separación de los alelos durante la formación de gametos

selective breeding: method of breeding that allows only those organisms with desired characteristics to produce the next generation (354)

reproducción selectiva o selección artificial: método de reproducción que sólo permite la producción de una nueva generación a aquellos organismos con características deseadas

selectively permeable: property of biological membranes that allows some substances to pass across while others cannot; also called semipermeable membrane (173)

permeabilidad selectiva: propiedad de las membranas biológicas que permite que algunas sustancias pasen a través de ellas mientras que otras no pueden hacerlo; también llamada membrana semipermeable

semen: the combination of sperm and seminal fluid (818)

semen: combinación de esperma y de fluido seminal

semicircular canal: one of three structures in the inner ear that monitor the position of the body in relation to gravity (756)

canal semicircular: una de las tres estructuras ubicadas en el oído interno que controlan la posición del cuerpo en relación con la fuerza de la gravedad

seminiferous tubule: one of hundreds of tubules in each testis in which sperm develop (818)

túbulo seminífero: uno de los cientos de túbulos situados en cada testículo, en los cuales se produce el esperma

sensory neuron: type of nerve cell that receives information from sensory receptors and conveys signals to central nervous system (668)

neurona sensorial: tipo de célula nerviosa que recibe información de los receptores sensoriales y transmite señales al sistema nervioso central

sex chromosome: one of two chromosomes that determines an individual's sex (334)

cromosoma sexual: uno de los pares de cromosomas que determina el sexo de un individuo

sex-linked gene: gene located on a sex chromosome (336)

gen ligado al sexo: gen situado en un cromosoma sexual

sexual reproduction: type of reproduction in which cells from two parents unite to form the first cell of a new organism (15, 236)

reproducción sexual: tipo de reproducción en la cual las células de dos progenitores se unen para formar la primera célula de un nuevo organismo

sexual selection: when individuals select mates based on heritable traits (412)

selección sexual: cuando un individuo elige a su pareja sexual atraído por sus rasgos heredables

sexually transmitted disease (STD): disease that is spread from person to person by sexual contact (823)

enfermedad de transmisión sexual (ETS): enfermedad que se transmite de una persona a otra por contacto sexual

sieve tube element: continuous tube through the plant phloem cells, which are arranged end to end (554)

tubo crivoso: tubo continuo que atraviesa las células del floema vegetal, que están puestas una junto a otra

single-gene trait: trait controlled by one gene that has two alleles (408)

rasgo de un único gen (monogénico): rasgo controlado por un gen que tiene dos alelos

small intestine: digestive organ in which most chemical digestion and absorption of food takes place (725)

intestino delgado: órgano digestivo en el cual tiene lugar la mayor parte de la digestión química y la absorción de los alimentos

smog: gray-brown haze formed by a mixture of chemicals (136)

esmog: neblina marrón grisácea formada por una mezcla de compuestos químicos

society: group of closely related animals of the same species that work together for the benefit of the group (702)

sociedad: grupo de animales de la misma especie, estrechamente relacionados, que trabajan juntos para el beneficio del grupo

solute: substance that is dissolved in a solution (34)

sóluto: sustancia que está disuelta en una solución

solution: type of mixture in which all the components are evenly distributed (34)

solución: tipo de mezcla en la cual todos los compuestos están distribuidos de forma homogénea

solvent: dissolving substance in a solution (34)

disolvente: sustancia que disuelve una solución

somatic nervous system: part of the peripheral nervous system that carries signals to and from skeletal muscles (752)

sistema nervioso somático: parte del sistema nervioso periférico que conduce señales hacia y desde los músculos esqueléticos

speciation: formation of a new species (414)

especiación: formación de una nueva especie

species: a group of similar organisms that can breed and produce fertile offspring (414)

especie: un grupo de organismos similares que pueden reproducirse y producir una descendencia fértil

species diversity: number of different species that make up a particular area (138)

diversidad de especies: número de especies diferentes que forman un área determinada

spirillum (pl. spirilla): spiral or corkscrew-shaped prokaryote (486)

espirilo: procariota con forma helicoidal o espiral

spongy mesophyll: layer of loose tissue found beneath the palisade mesophyll in a leaf (564)

mesófilo esponjoso: capa de tejido suelto situado debajo del mesófilo en empalizada de una hoja

sporangium (pl. sporangia): spore capsule in which haploid spores are produced by meiosis (507)

esporangio: cápsula en la cual se producen las esporas haploides mediante meiosis

spore: in prokaryotes, protists, and fungi, any of a variety of thick-walled life cycle stages capable of surviving unfavorable conditions (506)

espora: en los procariotas, los protistas y los hongos, cada una de las células que, en un momento de su ciclo de vida, produce una membrana gruesa y resistente capaz de sobrevivir en condiciones desfavorables

sporophyte: spore-producing plant; the multicellular diploid phase of a plant life cycle (530)

esporofito: planta productora de esporas; la fase diploide multicelular del ciclo vital de una planta

stabilizing selection: form of natural selection in which individuals near the center of a distribution curve have higher fitness than individuals at either end of the curve (410)

selección estabilizadora: forma de selección natural en la cual los individuos situados cerca del centro de una curva de distribución tienen mayor aptitud que los individuos que se hallan en cualquiera de los extremos de la curva

stamen: male part of a flower; contains the anther and filament (579)

estambre: parte masculina de una flor; contiene la antera y el filamento

stem cell: unspecialized cell that can give rise to one or more types of specialized cells (249)

célula troncal: célula no especializada que puede originar uno o más tipos de células especializadas

stigma: sticky part at the top of style; specialized to capture pollen (579)

estigma: parte pegajosa situada en la parte superior del estilo; especializado en atrapar el polen

stimulus (pl. stimuli): signal to which an organism responds (14, 668)

estímulo: señal a la cual responde un organismo

stoma (pl. stomata): small opening in the epidermis of a plant that allows carbon dioxide, water, and oxygen to diffuse into and out of the leaf (564)

estoma: pequeña abertura en la epidermis de una planta que permite que el dióxido de carbono, el agua y el oxígeno entren y salgan de la hoja

stomach: large muscular sac that continues the mechanical and chemical digestion of food (725)

estómago: gran bolsa muscular que continúa la digestión mecánica y química de los alimentos

stroma: fluid portion of the chloroplast; outside of the thylakoids (195)

estroma: parte fluida del cloroplasto; en el exterior de los tilacoides

substrate: reactant of an enzyme-catalyzed reaction (44)

sustrato: reactante de una reacción catalizada por enzimas

suspension: mixture of water and nondissolved material (35)

suspensión: mezcla de agua y material no disuelto

sustainable development: strategy for using natural resources without depleting them and for providing human needs without causing long-term environmental harm (131)

desarrollo sostenible: estrategia para utilizar los recursos naturales sin agotarlos y para satisfacer las necesidades humanas sin causar daños ambientales a largo plazo

symbiosis: relationship in which two species live close together (87)

simbiosis: relación en la cual dos especies viven en estrecha asociación

synapse: point at which a neuron can transfer an impulse to another cell (746)

sinapsis: punto en el cual una neurona puede transferir un impulso a otra célula

systematics: study of the diversity of life and the evolutionary relationships between organisms (430)

sistemática: estudio de la diversidad de la vida y de las relaciones evolutivas entre los organismos

systemic circulation: path of circulation between the heart and the rest of the body (788)

circulación sistémica: recorrido de la circulación entre el corazón y el resto del cuerpo

Glossary (continued)

T

taiga: biome with long cold winters and a few months of warm weather; dominated by coniferous evergreens; also called boreal forest (94)

taiga: bioma con inviernos largos y fríos y pocos meses de tiempo cálido; dominado por coníferas de hojas perennes; también llamada bosque boreal

target cell: cell that has a receptor for a particular hormone (588, 810)

célula diana o célula blanco: célula que posee un receptor para una hormona determinada

taste bud: sense organs that detect taste (754)

papila gustativa: órgano sensorial que percibe los sabores

taxon (pl. taxa): group or level of organization into which organisms are classified (430)

taxón: grupo o nivel de organización en que se clasifican los organismos

telomere: repetitive DNA at the end of a eukaryotic chromosome (297)

telómero: ADN repetitivo situado en el extremo de un cromosoma eucariota

telophase: phase of mitosis in which the distinct individual chromosomes begin to spread out into a tangle of chromatin (242)

telofase: fase de la mitosis en la cual los distintos cromosomas individuales comienzan a separarse y a formar hebras de cromatina

temporal isolation: form of reproductive isolation in which two or more species reproduces at different times (415)

aislamiento temporal: forma de aislamiento reproductivo en la cual dos o más especies se reproducen en épocas diferentes

tendon: tough connective tissue that connects skeletal muscles to bones (676, 773)

tendón: tejido conectivo resistente que une los músculos esqueléticos a los huesos

territory: a specific area occupied and protected by an animal or group of animals (702)

territorio: área específica ocupada y protegida por un animal o un grupo de animales

testis (pl. testes): primary male reproductive organ; produces sperm (818)

testículo: órgano reproductor masculino fundamental; produce esperma

tetrad: structure containing four chromatids that forms during meiosis (276)

tétrada: estructura con cuatro cromátidas que se forma durante la meiosis

tetrapod: vertebrate with four limbs (630)

tetrápode: vertebrado con cuatro miembros

thalamus: brain structure that receives messages from the sense organs and relays the information to the proper region of the cerebrum for further processing (749)

tálamo: estructura cerebral que recibe mensajes de los órganos sensoriales y transmite la información a la región adecuada del cerebro para su procesamiento ulterior

theory: well-tested explanation that unifies a broad range of observations and hypotheses, and enables scientists to make accurate predictions about new situations (11)

teoría: explicación basada en pruebas que unifica una amplia gama de observaciones e hipótesis; permite que los científicos hagan predicciones exactas ante situaciones nuevas

thigmotropism: response of a plant to touch (590)

tigmotropismo: respuesta de una planta al tacto

threshold: minimum level of a stimulus that is required to cause an impulse (745)

umbral: nivel mínimo que debe tener un estímulo para causar un impulso

thylakoid: saclike photosynthetic membranes found in chloroplasts (195)

tilacoid: membranas fotosintéticas con forma de bolsa situadas en los cloroplastos

thyroxine: hormone produced by the thyroid gland, which increases the metabolic rate of cells throughout the body (815)

tiroxina: hormona producida por la glándula tiroides que aumenta el metabolismo de las células de todo el cuerpo

tissue: group of similar cells that perform a particular function (182)

tejido: grupo de células similares que realizan una función en particular

tolerance: ability of an organism to survive and reproduce under circumstances that differ from their optimal conditions (85)

tolerancia: capacidad de un organismo de sobrevivir y reproducirse en circunstancias que difieren de sus condiciones óptimas

totipotent: cells that are able to develop into any type of cell found in the body (including the cells that make up the extraembryonic membranes and placenta) (249)

totipotentes: células capaces de convertirse en cualquier tipo de célula del cuerpo (incluidas las células que forman las membranas situadas fuera del embrión y la placenta)

trachea: tube that connects the larynx to the bronchi; also called the windpipe (796)

tráquea: tubo que conecta a la laringe con los bronquios

tracheid: hollow plant cell in xylem with thick cell walls strengthened by lignin (534)

traqueida: célula vegetal ahuecada del xilema con paredes celulares gruesas, fortalecida por la lignina

trait: specific characteristic of an individual (262)

rasgo: característica específica de un individuo

transcription: synthesis of an RNA molecule from a DNA template (309)

transcripción: síntesis de una molécula de ARN a partir de una secuencia de ADN

transfer RNA (tRNA): type of RNA that carries each amino acid to a ribosome during protein synthesis (309)

ARN de transferencia: tipo de ARN que transporta a cada aminoácido hasta un ribosoma durante la síntesis de proteínas

transformation: process in which one strain of bacteria is changed by a gene or genes from another strain of bacteria (288)

transformación: proceso en el cual una cepa de bacterias es transformada por uno o más genes provenientes de otra cepa de bacterias

transgenic: term used to refer to an organism that contains genes from other organisms (360)

transgénico: término utilizado para referirse a un organismo que contiene genes provenientes de otros organismos

translation: process by which the sequence of bases of an mRNA is converted into the sequence of amino acids of a protein (312)

traducción (genética): proceso por el cual la secuencia de bases de un ARN mensajero se convierte en la secuencia de aminoácidos de una proteína

transpiration: loss of water from a plant through its leaves (565)

transpiración: pérdida del agua de una planta a través de sus hojas

trochophore: free-swimming larval stage of an aquatic mollusk (627)

trocófora: estado larvario de un molusco acuático durante el cual puede nadar libremente

trophic level: each step in a food chain or food web (66)

nivel trófico: cada paso en una cadena o red alimenticia

tropism: movement of a plant toward or away from stimuli (590)

tropismo: movimiento de una planta hacia los estímulos o en dirección opuesta a ellos

tumor: mass of rapidly dividing cells that can damage surrounding tissue (247)

tumor: masa de células que se dividen rápidamente y pueden dañar al tejido circundante

ureter: tube that carries urine from a kidney to the urinary bladder (731)

uréter: conducto que transporta la orina del riñón a la vejiga urinaria

urethra: tube through which urine leaves the body (731)

uretra: conducto por donde la orina sale del cuerpo

urinary bladder: saclike organ in which urine is stored before being excreted (731)

vejiga urinaria: órgano en forma de bolsa en el cual se almacena la orina antes de ser excretada

V

vaccination: injection of a weakened, or a similar but less dangerous, pathogen to produce immunity (846)

vacunación: inyección de un patógeno debilitado o similar al original, pero menos peligroso, para producir inmunidad

vaccine: preparation of weakened or killed pathogens used to produce immunity to a disease (490)

vacuna: preparación hecha con organismos patógenos debilitados o muertos que se utiliza para producir inmunidad a una enfermedad

vacuole: cell organelle that stores materials such as water, salts, proteins, and carbohydrates (166)

vacuola: orgánulo celular que almacena sustancias como agua, sales, proteínas e hidratos de carbono

valve: flap of connective tissue located between an atrium and a ventricle, or in a vein, that prevents backflow of blood (787)

válvula: pliegue de tejido conectivo ubicado entre una aurícula y un ventrículo, o en una vena, que impide el retroceso de la sangre

vas deferens: tube that carries sperm from the epididymis to the urethra (818)

conducto deferente: tubo que transporta el esperma desde el epidídimo a la uretra

vascular bundle: clusters of xylem and phloem tissue in stems (561)

hacecillo vascular: manojo de tejidos del xilema y del floema en los tallos

vascular cambium: meristem that produces vascular tissues and increases the thickness of stems (562)

cámbium vascular: meristemo que produce tejidos vasculares y aumenta el grosor de los tallos

U

understory: layer in a rain forest found underneath the canopy formed by shorter trees and vines (92)

sotobosque: en un bosque tropical, la capa de vegetación que se halla bajo el dosel forestal, formada por árboles más bajos y enredaderas

Glossary (continued)

vascular cylinder: central region of a root that includes the vascular tissues—xylem and phloem (557)

cilindro vascular: región central de una raíz que incluye a los tejidos vasculares xilema y floema

vascular tissue: specialized tissue in plants that carries water and nutrients (533)

tejido vascular: tejido especializado de las plantas que transporta agua y nutrientes

vector: animal that transports a pathogen to a human (840)

vector: animal que transmite un patógeno a un ser humano

vegetative reproduction: method of asexual reproduction in plants, which enables a single plant to produce offspring that are genetically identical to itself (583)

reproducción vegetativa: método de reproducción asexual de las plantas que permite que una única planta produzca descendencia genéticamente idéntica a sí misma

vein: blood vessel that carries blood from the body back to the heart (789)

vena: vaso sanguíneo que transporta la sangre del cuerpo de regreso al corazón

ventricle: lower chamber of the heart that pumps blood out of heart to the rest of the body (654, 787)

ventrículo: cavidad inferior del corazón que bombea la sangre fuera del corazón hacia el resto del cuerpo

vertebrate: animal that has a backbone (607)

vertebrado: animal que posee una columna vertebral

vessel element: type of xylem cell that forms part of a continuous tube through which water can move (554)

elemento vascular (o vaso): tipo de célula del xilema que forma parte de un tubo continuo a través del cual el agua puede desplazarse

vestigial structure: structure that is inherited from ancestors but has lost much or all of its original function (393)

estructura vestigial: estructura heredada de los ancestros que ha perdido su función original en gran parte o por completo

villus (pl. villi): fingerlike projection in the small intestine that aids in the absorption of nutrient molecules (727)

vellosidad: proyección en forma de dedo en el intestino delgado que contribuye a la absorción de las moléculas nutrientes

virus: particle made of proteins, nucleic acids, and sometimes lipids that can replicate only by infecting living cells (480)

virus: partícula compuesta por proteínas, ácidos nucleicos y, a veces, lípidos, que puede replicarse sólo infectando células vivas

vitamin: organic molecule that helps regulate body processes (721)

vitamina: molécula orgánica que ayuda a regular los procesos corporales

viviparous: animals that bear live young that are nourished directly by the mother's body as they develop (680)

vivíparo: animal que da a luz crías vivas que se nutren directamente dentro del cuerpo de la madre mientras se desarrollan

W

weather: day-to-day conditions of the atmosphere, including temperature, precipitation, and other factors (82)

tiempo: condiciones diarias de la atmósfera, entre las que se incluyen la temperatura, la precipitación y otros factores

wetland: ecosystem in which water either covers the soil or is present at or near the surface for at least part of the year (97)

humedal: ecosistema en el cual el agua cubre el suelo o está presente en la superficie durante al menos una parte del año

white blood cell: type of blood cell that guards against infection, fights parasites, and attacks bacteria (791)

glóbulo blanco: tipo de célula sanguínea que protege de las infecciones, combate a los parásitos y ataca a las bacterias

woody plant: type of plant made primarily of cells with thick cell walls that support the plant body; includes trees, shrubs, and vines (542)

planta leñosa: tipo de planta constituida fundamentalmente por células con paredes celulares gruesas que sostienen el cuerpo de la planta; en este tipo se incluyen los árboles, arbustos y vides

X, Y, Z

xylem: vascular tissue that carries water upward from the roots to every part of a plant (534)

xilema: tejido vascular que transporta el agua hacia arriba, desde las raíces a cada parte de una planta

zoonosis (pl. zoonoses): disease transmitted from animal to human (840)

zoonosis: enfermedad transmitida por un animal a un ser humano

zygote: fertilized egg (277, 612, 824)

cigoto: huevo fertilizado

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