The Six-Kingdom Classification

The classification used in this text combines information gathered from the systems of many different fields of biology. For example, phycollogists, biologists who study algae, have developed their own system of classification, as have mycollogists, biologists who study fungi. The naming of animals and plants is controlled by two completely different sets of rules. The six-kingdom system, although not ideal for reflecting the phylogeny of all life, is useful for showing relationships. Taxonomy is an area of biology that evolves just like the species it studies. In this Appendix, only the major phyla are listed, and at least one genus is named as an example. For more information about each taxon, refer to the chapter in the text in which the group is described.

Kingdom Eubacteria

True Bacteria

Phylum Actinobacteria
Example: Mycobacterium

Phylum Omnimbacteria
Example: Salmonella

Phylum Spirochaetae (Spirochaetes)
Example: Treponema

Phylum Chloroxybacteria
(Grass-green Bacteria)
Example: Prochloron

Phylum Cyanobacteria (Blue-green Algae)
Example: Nostoc

Kingdom Archaeabacteria

Ancient Prokaryotes

Phylum Aphragmabacteria
(Thermoacidophiles)
Example: Mycoplasma

Phylum Halobacteria (Halophiles)
Example: Halobacterium

Phylum Methanocreatrices (Methanogens)
Example: Methanobacillus

Kingdom Protista

Animal-like Protists

Phylum Rhizopoda (Amoebas)
Example: Amoeba

Phylum Ciliophora (Ciliates)
Example: Paramecium

Phylum Sporozoza (Sporozoans)
Example: Plasmodium

Phylum Zoomastigina (Flagellates)
Example: Trypanosoma

Plantlike Protists

Phylum Euglenophyta (Euglenoids)
Example: Euglena

Phylum Bacillariophyta (Diatoms)
Example: Navicula

Phylum Dinoflagellata (Dinoflagellates)
Example: Gonyaulax

Phylum Rhodophyta (Red Algae)
Example: Chondrus

Phylum Phaeophyta (Brown Algae)
Example: Laminaria

Phylum Chlorophyta (Green Algae)
Example: Ulva

Funguslike Protists

Phylum Acrasiomycota (Cellular Slime Molds)
Example: Dictyostelium

Phylum Myxomycota (Plasmodial Slime Molds)
Example: Physarum

Phylum Oomycota (Water Molds, Mildews, Rusts)
Example: Phytophthora
Kingdom Animalia

Invertebrates

Phylum Porifera (Sponges)
Example: Spongilla

Phylum Cnidaria (Corals, Jellyfishes, Hydras)
Class Hydrozoa (Hydrozoans)
Example: Hydra

Class Scyphozoa (Jellyfishes)
Example: Aurelia

Class Anthozoa (Sea Anemones, Corals)
Example: Corallium

Phylum Platyhelminthes (Flatworms)
Class Turbellaria (Free-living Flatworms)
Example: Dugesia

Class Trematoda (Flukes)
Example: Fasciola

Class Cestoda (Tapeworms)
Example: Taenia

Phylum Nematoda (Roundworms)
Example: Trichinella

Phylum Mollusca (Mollusks)
Class Gastropoda (Snails and Slugs)
Example: Helix

Class Bivalvia (Bivalves)
Example: Arca

Class Cephalopoda (Octopuses, Squid)
Example: Nautilus

Phylum Annelida (Annelids)
Class Polychaeta (Polychaetes)
Example: Nereis

Class Oligochaete (Earthworms)
Example: Lumbricus

Class Hirudinea (Leeches)
Example: Hirudo

Phylum Arthropoda (Arthropods)
Class Arachnida (Spiders, Mites, Scorpions)
Example: Latrodectus

Class Merostomata (Horseshoe Crabs)
Example: Limulus

Class Crustacea (Lobsters, Crayfishes, Crabs)
Example: Homarus

Class Chilopoda (Centipedes)
Example: Scutigerella

Appendix A

Kingdom Fungi

Division Zygomycota (Sporangium Fungi)
Example: Rhizopus

Division Ascomycota (Cap Fungi and Yeasts)
Example: Saccharomyces

Division Basidioymycota (Club Fungi)
Example: Amnaista

Division Deuteromyccota (Imperfect Fungi)
Example: Penicillium

Division Mycosphaerella (Lichens)
Example: Cladonia

Kingdom Plantae

Nonseed Plants

Division Hepatophyta (Liverworts)
Example: Pellia

Division Anthocerophyta
Example: Anthoceris

Division Bryophyta (Mosses)
Example: Polytrichum

Division Pteridophyta (Whisk Ferns)
Example: Psilotum

Division Lycophyta (Club Mosses)
Example: Lycopodium

Division Sphenophyta (Horsetails)
Example: Equisetum

Division Pterophyta (Ferns)
Example: Polypodium

Seed Plants

Division Ginkgophyta (Ginkgoes)
Example: Ginkgo

Division Cycadophyta (Cycads)
Example: Cycas

Division Coniferophyta (Conifers)
Example: Pinus

Division Gnetophyta
Example: Welwitschia

Division Anthophyta (Flowering Plants)
Class Dicotyledones (Dinots)
Family Magnoliaceae (Magnolias)
Example: Magnolia

Family Fabaceae (Beeches)
Example: Quercus

Family Cactaceae (Cacti)
Example: Opuntia

Family Malvaceae (Malows)
Example: Gossypium

Family Brassicaceae (Mustards)
Example: Brassica

Family Rosaceae (Roses)
Example: Rosa

Family Fabaceae (Peach)
Example: Arcthe

Family Aceraceae (Maples)
Example: Aesc

Family Lamiaceae (Mints)
Example: Thymus

Family Asteraceae (Daisies)
Example: Helianthus

Class Monocotyledones (Monocots)
Family Poaceae (Grasses)
Example: Triticum

Family Palmaceae (Palm)
Example: Phoenix

Family Lilaeaceae (Lilies)
Example: Asparagus

Family Orchidaceae (Orchids)
Example: Cypripedium

Appendix A

Kingdom Plantae

Nonseed Plants

Division Hepatophyta (Liverworts)
Example: Pellia

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Example: Homarus

Class Chilopoda (Centipedes)
Example: Scutigerella

Appendix A
Vertebrates
Phylum Chordata (Chordates)
Subphylum Urochordata (Tunicates)
Example: Branchiostoma
Subphylum Cephalochordata (Lancelets)
Example: Fako
Subphylum Vertebrata (Vertebrates)
Class Agnatha (Lampreys and Hagfishes)
Example: Petromyzon
Class Chondrichthyes (Sharks, Rays)
Example: Squaleus
Class Osteichthyes (Bony Fishes)
Order Primates (Primates)
Example: Gorilla
Order Carnivora (Carnivores)
Example: Ursus
Order Cetacea (Whales, Dolphins)
Example: Delphinus
Order Soriciformes (Shrews)
Example: Sorex
Order Chiroptera (Bats)
Example: Desmodus
Order Carnivora (Carnivores)
Example: Ursus
Order Rodentia (Rodents)
Example: Castor
Order Cetacea (Whales, Dolphins)
Example: Delphinus
Order Primates (Primates)
Example: Gorilla

Origins of Scientific Terms
This list of Greek and Latin roots will help you interpret the meaning of biological terms. The column headed Root gives many of the actual Greek (GK) or Latin (L) root words used in science. The letter groups that follow are forms in which the root word is most often found combined in science words. In the second column is the meaning of the root as it is used in science. The third column shows a typical science word containing the root from the first column. These root words are used throughout your textbook.

<table>
<thead>
<tr>
<th>ROOT</th>
<th>MEANING</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>next to</td>
<td>adaxial</td>
</tr>
<tr>
<td>ad (L)</td>
<td></td>
<td>aeros (GK)</td>
</tr>
<tr>
<td>ados (GK)</td>
<td>air</td>
<td>aerobic</td>
</tr>
<tr>
<td>an (GK)</td>
<td>without</td>
<td>anaerobic</td>
</tr>
<tr>
<td>anata (L)</td>
<td>away</td>
<td>anaphase</td>
</tr>
<tr>
<td>antro (GK)</td>
<td>male</td>
<td>androecium</td>
</tr>
<tr>
<td>angio (GK)</td>
<td>vessel</td>
<td>angiosperm</td>
</tr>
<tr>
<td>anthos (GK)</td>
<td>flower</td>
<td>anthophyte</td>
</tr>
<tr>
<td>anti (GK)</td>
<td>against</td>
<td>antibody</td>
</tr>
<tr>
<td>agua (L)</td>
<td>water</td>
<td>aquatic</td>
</tr>
<tr>
<td>archaeo (GK)</td>
<td>ancient</td>
<td>archaeobacteria</td>
</tr>
<tr>
<td>arthron (GK)</td>
<td>jointed</td>
<td>arthropod</td>
</tr>
<tr>
<td>artios (GK)</td>
<td>even</td>
<td>artiodactyl</td>
</tr>
<tr>
<td>askos (GK)</td>
<td>bag</td>
<td>ascospora</td>
</tr>
<tr>
<td>aster (GK)</td>
<td>star</td>
<td>Asteroida</td>
</tr>
<tr>
<td>autos (GK)</td>
<td>self</td>
<td>autoimmune</td>
</tr>
<tr>
<td>B</td>
<td>two</td>
<td>bipedal</td>
</tr>
<tr>
<td>bios (GK)</td>
<td>life</td>
<td>biology</td>
</tr>
<tr>
<td>C</td>
<td>flesh</td>
<td>carnivore</td>
</tr>
<tr>
<td>carn (L)</td>
<td>head</td>
<td>cephalopoda</td>
</tr>
<tr>
<td>cephalo (GK)</td>
<td>pale green</td>
<td>chlorophyll</td>
</tr>
<tr>
<td>chroma, (GK)</td>
<td>colored</td>
<td>chromosome</td>
</tr>
<tr>
<td>cide (L)</td>
<td>kill</td>
<td>insecticide</td>
</tr>
<tr>
<td>circia (L)</td>
<td>about</td>
<td>circadian</td>
</tr>
<tr>
<td>con (L)</td>
<td>together</td>
<td>convergent</td>
</tr>
<tr>
<td>cyte (GK)</td>
<td>cell</td>
<td>cytoplasm</td>
</tr>
<tr>
<td>D</td>
<td>remove</td>
<td>decompose</td>
</tr>
<tr>
<td>de (L)</td>
<td>tree</td>
<td>dendrite</td>
</tr>
<tr>
<td>dendron (GK)</td>
<td>tooth</td>
<td>edentate</td>
</tr>
<tr>
<td>dens (L)</td>
<td>skin</td>
<td>epidermis</td>
</tr>
<tr>
<td>derma (GK)</td>
<td>two</td>
<td>disaccharide</td>
</tr>
<tr>
<td>der (GK)</td>
<td>apart</td>
<td>diastolic</td>
</tr>
<tr>
<td>di (GK)</td>
<td>sleep</td>
<td>dormancy</td>
</tr>
<tr>
<td>dormire (L)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

APPENDIX A

APPENDIX B
### Safety in the Laboratory

These safety symbols are used in the lab activities to indicate possible hazards. Learn the meaning of each symbol.

#### SAFETY SYMBOLS

<table>
<thead>
<tr>
<th>HAZARD</th>
<th>EXAMPLES</th>
<th>PRECAUTION</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPOSAL</td>
<td>Special disposal considerations required.</td>
<td>Plan to dispose of wastes as directed by your teacher.</td>
<td>Ask your teacher how to dispose of laboratory materials.</td>
</tr>
<tr>
<td>BIOLOGICAL</td>
<td>Organisms or organic materials that can harm humans.</td>
<td>Avoid skin contact with infected material.</td>
<td>Notify your teacher if you suspect contact.</td>
</tr>
<tr>
<td>EXTREME TEMPERATURE</td>
<td>Objects that can burn skin by being too cold or too hot.</td>
<td>Use proper protection when handling.</td>
<td>Go to your teacher for first aid.</td>
</tr>
<tr>
<td>SHARP OBJECT</td>
<td>Use of tools or glassware that can easily puncture skin.</td>
<td>Practice common sense behavior and follow guidelines for use of the tool.</td>
<td>Go to your teacher for first aid.</td>
</tr>
<tr>
<td>TOXIC</td>
<td>Potential danger to olfactory tract from fumes.</td>
<td>Make sure there is good ventilation and never smell fumes directly.</td>
<td>Leave fume area and notify your teacher immediately.</td>
</tr>
<tr>
<td>IRRITANT</td>
<td>Substances that can irritate the skin or mucous membranes.</td>
<td>Dust mask or gloves are advisable.</td>
<td>Go to your teacher for first aid.</td>
</tr>
<tr>
<td>CORROSIVE</td>
<td>Substances (acids and bases) that can react with skin and destroy tissue.</td>
<td>Wear goggles and an apron.</td>
<td>Immediately begin to flush with water and notify your teacher.</td>
</tr>
<tr>
<td>FLAMMABLE</td>
<td>Flammable and combustible materials that may ignite if exposed to an open flame or spark.</td>
<td>Avoid flammable heat sources.</td>
<td>Notify your teacher immediately. Use fire safety equipment if applicable.</td>
</tr>
</tbody>
</table>

### APPENDIX B

<table>
<thead>
<tr>
<th>ROOT</th>
<th>MEANING</th>
<th>EXAMPLE</th>
<th>ROOT</th>
<th>MEANING</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>jugure (L)</td>
<td>join</td>
<td>conjugate</td>
<td>phyton (GK)</td>
<td>plant</td>
</tr>
<tr>
<td>K</td>
<td>karyon (GK)</td>
<td>seed</td>
<td>prokaryote</td>
<td>pilius (L)</td>
<td>hair</td>
</tr>
<tr>
<td>L</td>
<td>leukos (GK)</td>
<td>white</td>
<td>leukocyte</td>
<td>pinna (L)</td>
<td>feather</td>
</tr>
<tr>
<td>M</td>
<td>makros (GK)</td>
<td>large</td>
<td>macromolecule</td>
<td>post (L)</td>
<td>foot</td>
</tr>
<tr>
<td>N</td>
<td>nema (GK)</td>
<td>thread</td>
<td>nematode</td>
<td>pro (GK, L)</td>
<td>before</td>
</tr>
<tr>
<td>O</td>
<td>oligos (GK)</td>
<td>few</td>
<td>oligochaete</td>
<td>protos (GK)</td>
<td>first</td>
</tr>
<tr>
<td>P</td>
<td>paleo (GK)</td>
<td>ancient</td>
<td>paleontologist</td>
<td>rhiza (GK)</td>
<td>root</td>
</tr>
<tr>
<td>Q</td>
<td>quark (GK)</td>
<td>false</td>
<td>pseudopodium</td>
<td>ren (GK)</td>
<td>false</td>
</tr>
<tr>
<td>R</td>
<td>re (L)</td>
<td>again</td>
<td>reproduce</td>
<td>scoph (GK)</td>
<td>look</td>
</tr>
<tr>
<td>T</td>
<td>teles (GK)</td>
<td>end</td>
<td>teleophase</td>
<td>soma (GK)</td>
<td>body</td>
</tr>
<tr>
<td>U</td>
<td>uni (L)</td>
<td>one</td>
<td>unicellular</td>
<td>sperma (GK)</td>
<td>seed</td>
</tr>
<tr>
<td>V</td>
<td>vacca (L)</td>
<td>cow</td>
<td>vaccine</td>
<td>trich (GK)</td>
<td>hair</td>
</tr>
<tr>
<td>X</td>
<td>xeros (GK)</td>
<td>dry</td>
<td>xerophyte</td>
<td>trophe (GK)</td>
<td>nuture</td>
</tr>
<tr>
<td>Z</td>
<td>zoon (GK)</td>
<td>animal</td>
<td>zoology</td>
<td>stoma (GK)</td>
<td>mouth</td>
</tr>
</tbody>
</table>

### APPENDIX C

<table>
<thead>
<tr>
<th>REMEDY</th>
<th>EXAMPLES</th>
<th>PRECAUTION</th>
<th>HAZARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Safety</td>
<td>This symbol appears when there is danger to eyes exists.</td>
<td>Wearing safety glasses or goggles is applied.</td>
<td>Go to your teacher for first aid.</td>
</tr>
<tr>
<td>Clothing Protection</td>
<td>This symbol appears when there is danger to the clothing exists.</td>
<td>Wearing protective clothing is required.</td>
<td>Immediately begin to flush with water and notify your teacher.</td>
</tr>
<tr>
<td>Animal Safety</td>
<td>This symbol appears when there is danger to the animal exists.</td>
<td>Keeping animals away is recommended.</td>
<td>Immediately begin to flush with water and notify your teacher.</td>
</tr>
</tbody>
</table>
Safety in the Laboratory

The biology laboratory is a safe place to work if you are aware of important safety rules and if you are careful. You must be responsible for your own safety and for the safety of others. The safety rules given here will protect you and others from harm in the lab. While carrying out procedures in any of the BioLabs, notice the safety symbols and caution statements. The safety symbols are explained on the previous page.

The Ten Rules of Safety
1. Always obtain your teacher’s permission to begin a lab.
2. Study the procedure. If you have questions, ask your teacher. Be sure you understand all safety symbols shown.
3. Use the safety equipment provided for you. Goggles and a safety apron should be worn when any lab calls for using chemicals.
4. When you are heating a test tube, always slant it so the mouth points away from you and others.
5. Never eat or drink in the lab. Never inhale chemicals. Do not taste any substance or draw any material into your mouth.
6. If you spill any chemical, wash it off immediately with water. Report the spill immediately to your teacher.
7. Know the location and proper use of the fire extinguisher, safety shower, fire blanket, first aid kit, and fire alarm.
8. Keep all materials away from open flames. Tie back long hair.
9. If a fire should break out in the lab, or if your clothing should catch fire, smother it with the fire blanket or a coat, or get under a safety shower. NEVER RUN.
10. Report any accident or injury, no matter how small, to your teacher.

Procedures for Clean-Up Time
1. Turn off the water and gas. Disconnect electrical devices.
2. Return materials to their places.
3. Dispose of chemicals and other materials as directed by your teacher. Place broken glass and solid substances in the proper containers. Never discard materials in the sink.
4. Clean your work area.
5. Wash your hands thoroughly after working in the laboratory.

Table C-1 First aid in the laboratory

<table>
<thead>
<tr>
<th>Injury</th>
<th>Safe response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burns</td>
<td>Apply cold water. Call your teacher immediately.</td>
</tr>
<tr>
<td>Cuts and bruises</td>
<td>Stop any bleeding by applying direct pressure. Cover cuts with a clean dressing. Apply cold compresses to bruises. Call your teacher immediately.</td>
</tr>
<tr>
<td>Fainting</td>
<td>Leave the person lying down. Loosen any tight clothing and keep crowds away. Call your teacher immediately.</td>
</tr>
<tr>
<td>Foreign matter in eye</td>
<td>Flush with plenty of water. Use an eyewash bottle or fountain.</td>
</tr>
<tr>
<td>Poisoning</td>
<td>Note the suspected poisoning agent and call your teacher immediately.</td>
</tr>
<tr>
<td>Any spills on skin</td>
<td>Flush with large amounts of water or use safety shower. Call your teacher immediately.</td>
</tr>
</tbody>
</table>