CLASSIFICATION AND KINGDOMS ARCHAEBACTERIA THROUGH FUNGI

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Each major section of notes in this manual is accompanied by a slide presentation of greater detail, including explanation, photographs, and examples presented in class with opportunities for student questions and discussion.

Because notes are given in this manual does not mean that additional personal notes cannot be taken. Each student is responsible for his/her personal learning. If more notes will help, take them.

Classifying Organisms

Why Do Scientists Classify?

Classification is the process of grouping things based on their similarities. Biologists use classification to organize living things into groups so that the organisms are easier to study.

Taxonomy is the scientific study of how living things are classified.

The Naming System of Linnaeus

Carolus Linnaeus – 1750's – Swedish Naturalist who devised the basic system of naming organisms that is used today. The names of organisms are in Latin or are Latinized.

Binomial Nomenclature

Binomial means "two names", and nomenclature means "naming system". (Not only is this redundant, but it is repetitive.)

Using Binomial Nomenclature

The first name is the genus name. The first letter of the genus name is capitalized. A genus is a grouping that contains similar, closely related organisms.

The second name is the species name. The first letter of the species name is not capitalized. A species is group of similar organisms that can mate with each other and produce offspring that can also mate and reproduce.

The complete scientific name is printed in italics or underlined if handwritten.

Major Levels of Classification

The more classification levels that two organisms share, the more characteristics they have in common. Owls as an example:

[Great Horned Owl]
Domain – Eukarya
Kingdom – Animalia
Phylum – Chordata
Class – Aves
Order – Strigiformes
Family – Strigidae
Genus – Bubo
Species – virginianus

[Snowy Owl]
Domain – Eukarya
Kingdom – Animalia
Phylum – Chordata
Class – Aves
Order – Strigiformes
Family – Strigidae
Genus – Bubo
Species – scandiacus

Classification - Pine Tree Activity

Purposes

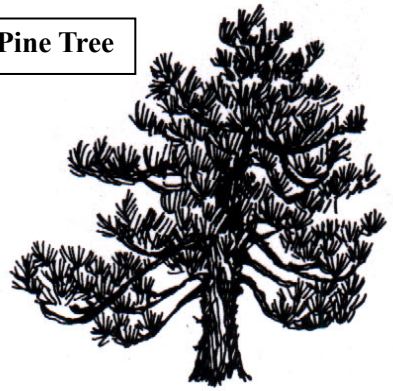
To identify pine trees using an identification key. To practice writing scientific names correctly.

Procedure

1. Look at the pine needles and cone in group A.
2. Begin at step 1 of the key and identify the tree to which these needles and cone belong.
3. On your own paper, make a chart, write Tree A, followed by its common name and scientific name. Capitalize the first letter of the genus name. Underline both words of the scientific name.
4. Use the same procedure to identify each species of pine tree whose needles and cones are pictured on the next pages.

Tree	*Common Name*	*Scientific Name*
A		
B		
C		
D		
E		
F		
G		

Pine Tree



Pine Bough

Bundle with five needles

Cone with prickles

Dichotomous Key for Idendifying Pines

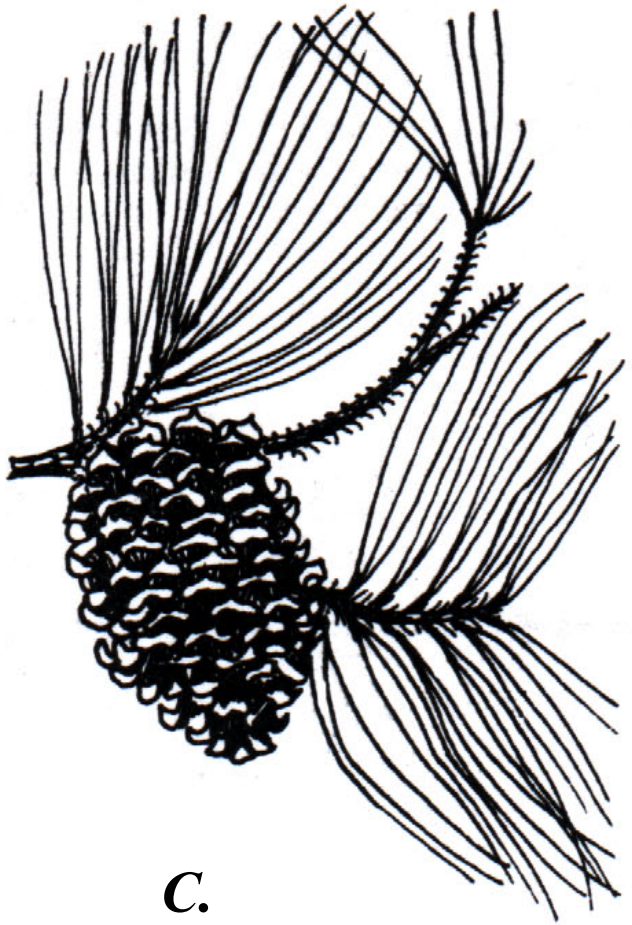
1a. If the tree has needles in bundles of 5, go to step 2.
1b. If the tree has needles in bundles of less than 5, go to step 3.
2a. If the tree has long needles and long cones, it is a white pine, ***Pinus strobus***.
2b. If the tree has short needles and short cones with prickles, it is a bristlecone pine, ***Pinus aristata***.
3a. If the tree has needles in bundles of 2, go to step 4.
3b. If the tree has needles in bundles of 3, go to step 6.

4a. If the tree has long needles and small cones without prickles, it is a red pine, ***Pinus resinosa***.
4b. If the tree has short needles, go to step 5.

5a. If the tree has small, curved cones, it is a jack pine, ***Pinus banksiana***.
5b. If the tree has small cones with prickles, it is a lodgepole pine, ***Pinus contorta***.
6a. If the tree has long needles and small cones with prickles, it is a pond pine, ***Pinus serotina***.
6b. If the tree has long needles and large cones with prickles, it is a ponderosa pine, ***Pinus ponderosa***.

A.

B.

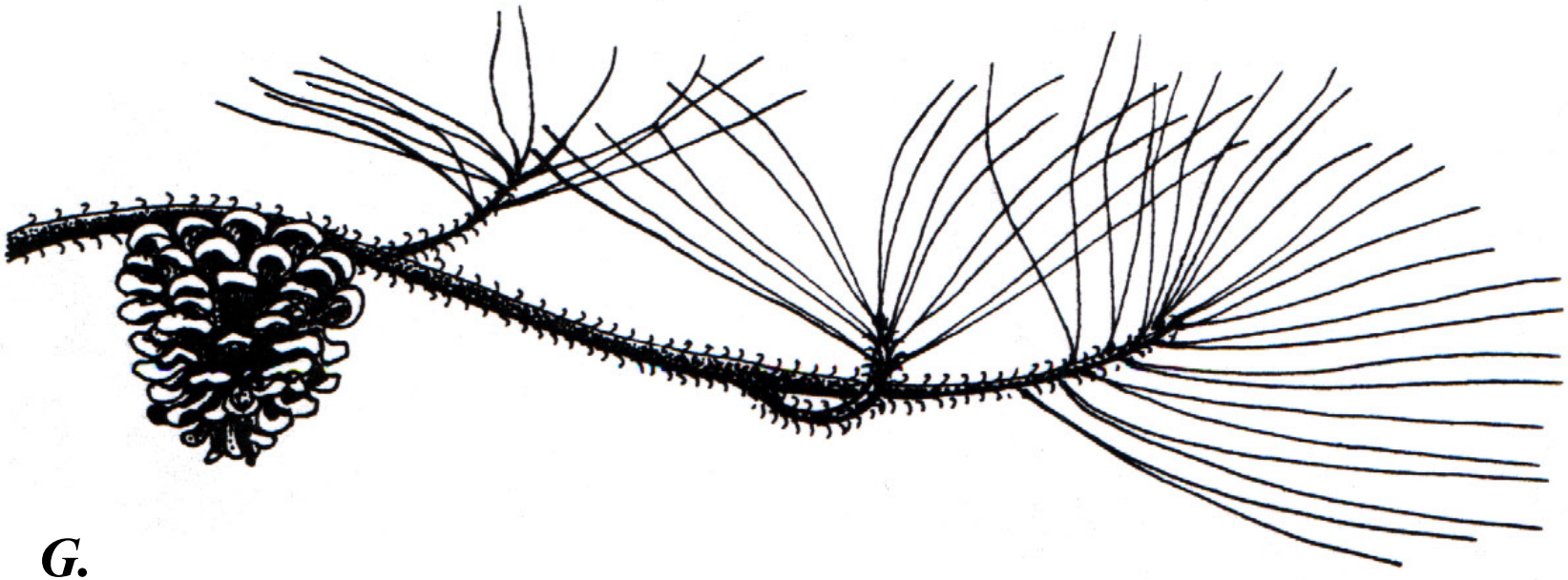


C.

D.

E.

F.



G.

Domains and Kingdoms

Organisms are placed into domains and kingdoms based on their cell type, the number of cells in their bodies, and their ability to make food.

Cells without a nucleus are called prokaryotic cells. Cells with at least one nucleus are called eukaryotic cells.

An organism made up of a single cell is a unicellular organism. An organism made up of many cells is a multicellular organism.

An autotroph is an organism that makes its own food using energy from sunlight or environmental heat and chemical energy. Autotroph means “self feeder”. A heterotroph is an organism that gets its food by consuming other organisms. Heterotroph means “other feeder”.

These terms are used together to describe the characteristics of an organism. We can say that an organism is "a unicellular, autotrophic prokaryote" instead of saying an organism "is made up of a single cell, produces its own food through the process of photosynthesis, and it's cell does not contain a nucleus." Using scientific terms properly will make your explanations more concise.

Domain Bacteria

Scientists classify organisms in the domain Bacteria into one kingdom: Eubacteria.
They are unicellular prokaryotes and may be either autotrophs or heterotrophs. They live in normal environments.

Domain Archaea

Scientists classify organisms in the domain Archaea into one kingdom: Archaebacteria.
Archaea means “ancient”. They are found in the most extreme environments on Earth - the boiling mud pots of Yellowstone or the deep ocean thermal vents, for example. They are unicellular prokaryotes and may be either autotrophs or heterotrophs. Their structure and chemical makeup differ from bacteria.

Domain Eukarya

Eukaryotes are organisms whose cells contain nuclei.
Scientists classify organisms in the domain Eukarya into one of four kingdoms:

Protista

These are eukaryotic organisms often called the “odds and ends” kingdom. They are mostly unicellular.

Fungi

They are mostly multicellular eukaryotes. Yeasts are unicellular eukaryotes. All are heterotrophs.

Plantae

These are multicellular eukaryotes. All are autotrophs. This kingdom includes a great variety of organisms in many diverse environments.

Animalia

These are multicellular eukaryotes. All are heterotrophs. Members of this kingdom are also greatly varied and live in many diverse environments.

The characteristics of these four kingdoms and their smaller divisions of classification will be discussed in greater detail in other sections of this lab manual or other manuals to follow.

Eubacteria and Archaebacteria

The Bacterial Cell

Bacterial cells were first seen by Anton van Leeuwenhoek while viewing dental scrapings through his microscopes. He could not see any details.

Cell Structure

All are prokaryotes - the genetic material in their cells is not contained in a nucleus. Untangled, the genetic material would form a circular shape. Bacterial cells lack other structures such as mitochondria and Golgi bodies. Most bacterial cells are surrounded by a cell wall. They may have a flagellum (fluh JEL um), a long whiplike structure used to move. It spins like a propeller.

Cell Sizes

Bacteria vary greatly in size. The largest is about as big as a period in regular print. An average bacterium is much smaller. The Streptococcus that causes strep throat is about 0.5 to 1 micrometer in diameter. A micrometer is one millionth of a meter. One millimeter divided into one thousand equal parts - each would be a micrometer.

Cell Shapes

Bacteria are classified by their three basic shapes.
Coccus - spherical
Bacillus - rodlike
Spirilla - spiral

The chemical makeup of the cell wall determines the shape of the cell. The names of specific bacteria often include the name of their shape. Streptococcus then are spherical.

Obtaining Food and Energy

Some bacteria are autotrophs. They make their own food either using the sun's energy (Eubacteria) or by using chemicals from their environment (Archaebacteria).
Some bacteria are heterotrophs. They can consume a variety of foods like milk, meat, and decaying leaves.
Some bacteria do not need oxygen to metabolize their food - anaerobic.

Reproduction

Asexual Reproduction

One parent divides into two separate cells identical to the parent. This process is called binary fission.

Sexual Reproduction

Sometimes bacteria use conjugation (kahn juh GAY shun) to exchange genetic material. One bacterium transfers genetic material to another bacterium through a threadlike bridge. After transfer, the cells separate. Later, when each bacterium undergoes binary fission the resulting cells will not be identical to the parent cells.

Endospore Formation

During unfavorable conditions, some bacteria form endospores - small, rounded, thick-walled, resting cells that form inside a bacterial cell. These can resist freezing, heating, and drying for many years. They are light so they can be carried easily to new places. With right conditions, the endospores open and can grow and multiply as normal bacteria.

Role of Bacteria in Nature

Oxygen Production

Autotrophic bacteria produce oxygen as a product of photosynthesis. Scientist think this is how oxygen first became part of Earth's atmosphere.

Food Production

Some bacteria help create the foods we eat. Bacteria in apple cider can change it to vinegar. Kinds of bacteria in milk produce buttermilk, yogurt, or cheese.

Some bacteria are harmful and make food poisonous. Pasteurization, named after Louis Pasteur, is the heating process used to kill most harmful bacteria in foods.

Environmental Recycling

Many heterotrophic bacteria break down dead material. They are decomposers, sometimes called "nature's recyclers." Chemicals from dead matter then become useful for other organisms.
Some bacteria convert nitrogen gas from the air into nitrogen products that plants need to grow.

Environmental Cleanup

Some bacteria use or isolate toxic substances. Bacteria have been used to "eat" oil spills changing the poisonous chemicals to harmless substances. Bacteria have also been used to extract lead poisoning from the soil.

Health and Medicine

Many bacteria live in your body and keep you healthy. Some help digest food in your intestines. Some produce vitamins that your body cannot make on its own. Scientists have used bacteria to make medicines and other substances like human insulin for diabetics.

Protista

What Is a Protist?

Protists are eukaryotes that cannot be classified as animals, plants, or fungi. They are often called the "odds and ends" kingdom. They do share some of the characteristics of organisms in other kingdoms.
They live in moist surroundings. Most are unicellular, some multicellular. Some are autotrophs, some heterotrophs, and some are both.
Some cannot move, but others do. Scientists have categorized Protists based on characteristics they share with other kingdoms.

Protozoa (pro tuh ZOH uh) are animal-like Protists.
They are heterotrophs; some are parasitic.
They move to obtain food.
They are unicellular - unlike animals.
There are four groups based on the ways they move:

Sarcodina move by forming a pseudopod (SOO duh pahd) which means "false foot." They "flow" toward their food. Example: amoeba

Ciliophora move by waving cilia, hairlike structures. Cilia help organisms "swim" and to move food into themselves. Example: paramecium

Zoomastigina are flagellates (FLAJ uh lits). They have one or more flagella which are long, whip-like structures they use to move. Example: Giardia (a parasite)

Sporozoa have no cilia or flagella; they do not move on their own. All species are parasitic; they feed on the cells and body fluids of a host. They have elaborate life cycles, often requiring more than one host. The best-known sporozoan is *Plasmodium falciparum*, the cause of malaria.

Algae are plantlike Protists.
This group is extremely diverse. They are autotrophs, using photosynthesis. Some are unicellular. Some that are unicellular live in colonies. Some are multicellular. Algae can be green, yellow, red, brown, orange, or black depending on the pigments they contain.

Diatoms (DY uh tahmz)
They are unicellular with beautiful glasslike cell walls. They live on the surface of lakes and oceans, or attach to rocks in shallow water where they are a food source for heterotrophs in the water. The cell walls from dead diatoms build up in layers of diatomaceous earth.

Dinoflagellates (dy noh FLAJ uh lits)

They are unicellular algae surrounded by stiff plates like armor. There is a great variety of colors. Two flagella held in grooves between the plates - make them twirl like tops. Many glow in the dark.

Euglenoids (yoo GLEE noydz)

They are green unicellular algae living mostly in fresh water. They have chloroplasts, but can be heterotrophs under certain conditions. When sunlight is available, they are autotrophs. Without sunlight, they are heterotrophs. Some live entirely as heterotrophs. They have a flagellum to move and an eyespot containing pigments that detect light.

Red Algae

Almost all are multicellular seaweeds. They can live deep in the ocean; the red pigments are good at absorbing small amounts of sunlight. Carrageenan and agar are product that made from red algae and are used in ice cream and hair conditioner. Some people eat red algae fresh, dried, or toasted.

Green Algae

Most are unicellular, but some form colonies, and a few are multicellular. Most live in fresh water or salt water. A few live on rocks, in crevices of tree bark, or in moist soil. They are very closely related to plants that live on land having the same type of chlorophyll. Some scientists place green algae in the plant kingdom.

Brown Algae

They are commonly called seaweeds. They contain brown, green, yellow, and orange pigments. They have plantlike structures:
Holdfasts - like roots that attach to rocks
Stalks - like branches
Blades - like leaves
They also have gas-filled sacs called bladders that float to keep the algae upright in the water. They grow in cool, rocky waters. Giant kelps can form forests. People eat brown algae. Products from seaweeds are also used as thickener in foods (algins).

Fungus-Like Protists

They are heterotrophs. Their cells have cell walls. They use spores to reproduce. They are able to move at some stage of life cycle. There are two basic types:

Slime Molds

They are often brightly colored. They live on forest floors and other moist, shady places. They ooze along the surface of decaying material, feed on bacteria and other microorganisms. Some are microscopic. Others cover several meters of area. They start out as amoeba-like cells. Some make up a very large, multicellular mass. Others are one giant cell with many nuclei.

Water Molds and Downy Mildews

They grow as tiny threads that look like fuzz. They attack food crops such as potatoes, corn, and grapes. A water mold was the cause of the Irish Potato Famine of 1845-1846.

Fungi

What Are Fungi?

Fungi are eukaryotes that have cell walls. They are heterotrophs that feed by absorbing their food. They use spores to reproduce. They need moist, warm places to grow, like on foods, damp tree bark, lawns, and bathroom tiles.

Cell Structure

There are unicellular yeasts up to large multicellular fungi. The cells are surrounded by cell walls. Most fungi cells are arranged in hyphae (HY fee), branching, threadlike tubes. Substances move quickly and freely through hyphae. Some fungi have loosely tangled hyphae; others have tightly arranged hyphae that make up the stalks and caps of mushrooms.

Obtaining Food

Fungi grow hyphae into their food source. Digestive chemicals ooze from the hyphae and break down the food. Broken down substances are absorbed by the hyphae.

Reproduction in Fungi

Usually they reproduce by making spores. Spores are surrounded by a protective covering. Spores are carried easily through the air or water. Millions of spores are produced. A few find the right conditions to grow. Spores are produced in the fruiting bodies. Mushrooms that we eat are the fruiting bodies of fungi.

Asexual Reproduction

During good conditions, some cells divide and produce spores that become fungi identical to the parent.
Yeast reproduce by budding; a new organism grows from the side of the parent.

Sexual Reproduction

During unfavorable conditions, the hyphae of two fungi may grow together. Genetic material is exchanged. A reproductive structure grows and produces spores. The spores produce fungi that are genetically different from both parents.

Classification of Fungi

There are three major groups.

Sac Fungi produce spores in structures that look like long sacs. These include yeasts, morels, and truffles.

Club Fungi produce spores in tiny club like structures. These include mushrooms, rusts, and puffballs.

Zygote Fungi produce very resistant spores. These include common fruit and bread molds.

Role of Fungi in Nature

Food and Fungi

Yeasts, molds, and mushrooms are important food sources. Yeast in bread dough makes it rise and gives it flavor. Mold creates flavor in some cheeses. *Penicillium roqueforti* in blue cheese is a common example. We eat mushrooms in salads, on pizza, and in many other foods.

Environmental Recycling

Fungi are decomposers. They break down dead matter into usable nutrients in the soil.

Disease-Fighting Fungi

Alexander Fleming, a Scottish biologist, discovered that Penicillium mold in his Petri dishes killed bacteria near it. His work led to development of the first antibiotic, penicillin. Other antibiotics have been isolated from fungi and bacteria.

Disease-Causing Fungi

Many fungi are plant parasites and cause great crop losses. Corn smut, wheat rust are examples. Athlete's foot and Ringworm are fungal diseases that affect people.

Fungus-Plant Root Associations

The hyphae of some fungi aid plants when they grow on or around plant roots. Most plants have fungal partners.

Lichens

Fungus living in close association with algae or with autotrophic bacteria benefit one another. They appear to us as irregular, flat, crusty patches on tree bark or rocks. The fungus gets food. The algae or bacteria gets water, shelter, and minerals. Lichens break down rocks into soil. They are often the first organisms to inhabit new lava flows and so they are called "pioneer" organisms.