**Diversity of Life Lab**
**Pre-Lab Exercise** **Name _____**

1. a. What are the three taxonomic domains currently used to categorize living organisms?

   b. Which domain is *not* represented by our list of specimens?

2. Define the following terms:

   a. Protist:

   b. Cilia:

   c. Bryophyte:

   d. Sorus:

   e. Pistil:

   f. Gill:

   h. Metamorphosis:

   i. Mammal:

# Diversity of Life Lab
**Work in groups of two**

All living organisms have a cellular basis. Some types of organisms are unicellular and some are multicellular. Some cells have a very simple shape, while other cells are more complex. All cells have certain common characteristics that define them as cells. Cells with different functions, however, can look very different, both as individual cells and in the way they are organized together into a tissue. There are many other structural and biochemical characteristics that are used to differentiate and classify organisms. The field of taxonomy is all about grouping together organisms based on their similarities and separating them based on their differences. Today's lab offers a look at a very small sampling of a broad range of organisms.

Cells can be loosely classified based on the presence or absence of internal membrane structures called organelles. Organisms lacking organelles, and in particular the nucleus, are called prokaryotes. Organisms that contain a nucleus are eukaryotes. They are much larger than prokaryotes, so they separate different functions within the cell for efficiency, sort of like rooms in a large house. Organelles may be seen as bubble-like structures within the cytoplasm.

Categorizing living organisms into groups is called taxonomy. The current system of organization has three domains: Eubacteria, Archaea, and Eukarya. Eubacteria and Archaea are prokaryotes. The common bacterial organisms you are the most familiar with all belong to the domain Eubacteria. The Archaea are differentiated from Eubacteria based on differences in ribosomal RNA genes. The Eukarya include protists, fungi, plants, and animals.

**Lab Reports:** Use separate pieces of paper to make your drawings and to answer the questions. Identify and draw clearly and in as much detail as possible each organism you are able to see. Make your drawings large and colorful! If a microscope was used, record the magnification at which the drawing was made. Include labels of the described structures, using your textbook and any information provided in lab as reference. This lab exercise contains questions to answer as you work your way through each specimen, rather than a series of follow-up questions at the end.

**Summary of Activities**

Bacteria: Bacillus, Spirillum, Coccus, *Anabaena*
Protists: Paramecium, Physarum, Volvox, Marine Algae
Fungi: Yeast, Mushroom
Plants: Liverworts, Ferns, Cactus & Succulents, Flowers
Animals: Rotifers, Skeletons of Perch, Frog, Turtle, Cat

**A. Bacteria**

Even though bacteria are tiny and appear to be simple, this group of organisms is still quite variable. The following are examples of the three main types of morphologies, or cell shapes. Also included is an example of photosynthesizing bacteria called Cyanobacteria.

1. **Bacillus** - rod shaped. This is a very diverse group. Some of these bacteria cause food poisoning, like botulism, *E. coli*, or *Salmonella*, while other bacillus bacteria are harmless. One specific species is used as a biological pesticide, called *Bacillus thuringiensis*, or BT, and is used to kill gypsy moth larvae.

2. **Spirillum** - spiral shaped. These are commonly found in aquatic environments and generally do not cause disease in humans. However, a related type of bacteria called a spirochete causes syphilis.

3. **Coccus** - round shaped. Two genera from this group, *Streptococcus* and *Staphylococcus*, are the most common bacterial pathogens found in hospitals. They can cause sore throats, skin infections, and many other diseases.

    a. To see these cells, you must use 1000X magnification and immersion oil. Ask for assistance if you do not remember the procedure for using oil.

    b. Make a sketch of a 5 or 6 cells. Label any cellular structures you can recognize.

*Q1. Can you see a nucleus or other internal compartments? How do you explain this?*

**Making a wet mount:** To view living organisms, place a single drop of specimen on a clean slide. Gently lower the coverslip onto the drop. Use any bubbles that form to focus at the lowest power first. Scan the field of view for a moving organism. If it is not moving too quickly, place it in the middle of your field of view and increase your magnification.

4. ***Anabaena*** – This is a nitrogen-fixing, photosynthetic Cyanobacteria. *Anabaena* live in fresh water habitats and are not disease-causing. This species of bacteria is interesting because some of its cells differentiate into specialized structures. One is the **heterocyst**, which is used for nitrogen-fixation and appears as a dark bead-like structure along a chain of lighter **vegetative cells**. The other specialized structure is the **akinete**, which is a spore-like structure that is resistant to heat and drought and allows the cyanobacterium to survive unfavorable environmental conditions. These form large oval bodies that look like an "accent" bead on a necklace.

    Draw a string of *Anabaena* cells, labeling a vegetative cell, a heterocyst, and an akinete.

Nitrogen fixation is a chemical process of converting atmospheric nitrogen gas ($N_2$) and into nitrite, nitrate, or ammonia ($NO_2^-$, $NO_3^-$, or $NH_3^+$), biologically useable forms of nitrogen.

**B. Protists**

**Protists** are single celled eukaryotes. Some can ingest their food through a process called phagocytosis (cell eating) and may have an extremely primitive digestive system called a gullet. Some of these organisms get their energy from photosynthesis and contain green chloroplast organelles.

Draw each organism you are able to see in as much detail as possible. Label as many structures as possible, using your textbook and any information provided in lab as reference. If the organisms are

moving too quickly for you to see well, use a drop of methylcellulose on top of a drop of the culture, then cover with a cover slip.

1. ***Paramecium*** – This is a ciliated protozoan. Ciliates are so-called because they are covered with tiny hair-like structures called **cilia**, which rhythmically beat for motility. *Paramecium* consumes food through an oral groove using phagocytosis and eats primarily bacteria. These organisms contain many organelles, including food vacuoles, and a bladder-like contractile vacuole used to help maintain osmotic balance.

After observing these organisms while swimming (as best as you can – they move pretty fast), make a new slide by placing a drop of methyl cellulose on top of the drop of *Paramecium* culture. The methyl cellulose is a long carbohydrate that forms a thick viscose solution. This gooey solution will slow down the motility of the organism, but you will still be able to see the cilia beating.

2. ***Physarum*** – Slime molds are protists that can exist as both single cells and multi-cellular "plasmodium" during different stages of its life cycle. When food is plentiful, they exist in the fan-like plasmodial stage, a giant single cell with many diploid nuclei. Within the fan-like mass, vein-like strands allow cytoplasm to stream or flow in different directions. Cytoplasmic streaming probably helps distribute nutrients and oxygen as the plasmodium feeds on bacteria, yeast, and bits of dead organic matter. When food and water are scarce, the organism will differentiate into reproductive structures called sporangia. These stalked structures can release spores over a large area, hopefully to where more food is available.

3. ***Volvox*** – This is a motile green algae whose individual cells aggregate to form spherical colonies. This species may be an evolutionary precursor to multi-celled organisms.

4. **Marine Algae** – The marine algae are most closely related to the protistans. They are multicellular and live in the ocean. Most marine algae live just offshore or in the intertidal zone. They need to be close to the surface of the water so they can capture sunlight for photosynthesis. But because they live in nearshore areas, most marine algae are subject to wave action (which can be rough!) and to being dried out at low tide.

*Q2. Why do eukaryotic cells need organelles and prokaryotic cells do not?*

**C. Fungus**

Fungi are an unusual group of organisms. They have cell wall like plants, but not made of cellulose. In fact the cell walls contain chitin — the same material a crab uses to construct its shell. They are not photosynthetic, but obtain food by secreting digestive enzymes upon their surroundings and then absorbing the nutrients. Most fungi are constructed of thin, threadlike filaments called **hyphae**, although in many species the will weave into a macroscopic structure called a **mycelium**.

**1. Yeast –** Yeast are unicellular fungi that are capable of reproducing sexually and asexually. The yeast you are viewing reproduce asexually by a process called **budding**. You will notice many cells with small protrusions; these are the buds. Yeast prefer to draw energy from fermentation. Byproducts of fermentation are ethanol and carbon dioxide, compounds that make our wine alcoholic and our bread rise.

Prepare a wet mount of yeast. You may use a stain such as methylene blue to help in visualization. Draw a sketch of a few cells.

*Q3. What do yeast have in common with protists?*

2. **Mushroom** — A mushroom is the reproductive mycelium formed by certain types of fungi. Most of the time the fungus grows as a network of hyphae spreading through the soil. But when conditions are good, the mycelium grows rapidly sometimes forming the mushroom overnight to spread the fungus' spores.

   Draw the mushroom. Note the **gills** on the underside of the mushroom cap. These hold the club-like basidia that form the spores. It has been estimated that a single 3–4" mushroom may produce as many as 40 million spores per hour!

**D. Plants**

**Cell walls**, **plastids**, and **vacuoles** are cell structures found in plant cells. Cell walls help maintain cell shape and are composed primarily of the polysaccharide **cellulose**. Plastids and vacuoles store pigments or other substances and may be involved in energy converting chemical reactions.

1. **Liverworts** – Liverworts belong to a group of plants called **bryophytes**, which are considered to be the most primitive members of the plant kingdom. Bryophytes lack any type of vascular system, or conducting cells that would allow fluids to flow from one part of a plant to another. Instead, these plants must live in very moist environments. These organisms reproduce most commonly by asexual reproduction. The asexual reproductive structures are called **gemmae cups**. These structures are haploid, and in fact, a bryophyte spends the majority of its life cycle as a haploid organism.

   Draw a liverwort and label the gemmae cups.

2. **Ferns** – Ferns are seedless plants that are adapted to dry land, as opposed to a more primitive aquatic environment. Although they do not produce seeds, they do produce spores that the plants nourish and protect until environmental conditions are favorable enough to support the growth of a new generation. The stems of most ferns grow underground - it is the featherlike leaves, or fronds, that you see above ground. On the undersides of some of the fronds are rust-colored patches. Each patch is called a **sorus** (plural = sori), and each sorus is made up of many **sporangia**, or the protective tissues that contain the spores. When the sporangia dry out, they crack open and release many spores into the air. Each spore grow into a small **gametophyte**, which produces the sperm and egg for sexual reproduction.

   Draw a fern frond and label the sori.

3. **Cactus and Succulents** - Succulents live in areas where there is little rainfall and high temperatures. Because water is difficult to come by, the succulents have adaptations to reduce water loss. One of the ways to do this is to reduce surface area. For example, which would evaporate quicker: a small amount of water a small deep cup or big flat plate? The plate has a larger surface area from which water would evaporate very quickly. Consequently, succulents do not have large, flat, thin leaves. Some do not have leaves at all or have reduced their leave to spines and use enlarged stems for photosynthesis instead.

   Make a sketch of one of these plants. Label the structures that allow it to survive in harsh climates.

4. **Flowers** – Flowers are the reproductive structures of angiosperms, or seed-bearing plants. They contain both male and female organs (hermaphrodites). Seed-bearing plants have the advantage of producing embryos (seeds) that can remain dormant for long periods of time in the absence of favorable environmental conditions, like drought or hot temperatures. The seeds can then sprout when conditions change and become more favorable. The **stamen** is the male organ and is made of two parts: the **anther** and the **filament**. The anther produces the pollen grains, or sperm. The

filament supports the anther. The **pistil** is the female organ and is made of three parts: the **stigma**, the **style**, and the **ovary**. The stigma traps pollen grains that are shed from the anther. A pollen tube will develop and extend down the style and deliver the pollen grain to the ovary. The egg in the ovary is then fertilized and develops into an embryo, or seed.

a. Dissect a flower by removing all the petals, then carefully cut what is left in cross-section (see demonstration).

b. Make a sketch of the reproductive structures in the flower, labeling as many parts as you can identify.

*Q4. How do cacti survive in very dry conditions?*

**E. Animals**

Animals represent the most diverse kingdom of life on earth. They are most conspicuously typified by motility and ingestion of their food. For each draw a simple sketch.

1. **Rotifers** – These organisms are among the smallest of true animals — about the size of many protists — yet these are multicellular creatures with tissue layers and organ systems. Rotifers are zooplankton, using a crown of cilia for motility and for catching prey. Many species are parthenogenic, meaning the females can produce viable eggs and offspring without requiring fertilization by a male.

2. Skeletons – These skeletons are of four vertebrate animals that represent the movement of these animals from water to land. Observe the skeletal structures and think about how they have evolved to allow the animal to adapt to life in the water or on land.

   a. **Perch**: this is a representative of the bony fish. Their bones contain a hard matrix of calcium phosphate for strength. Bones in the fins are flattened for swimming.

   b. **Frog**: frogs are amphibians, the first vertebrates to adapt to land. Frogs live the beginning of their lives exclusively in water as tadpoles. In fact, tadpoles resemble fish in structure and appearance. In development into a frog, the tadpole undergoes radical changes called **metamorphosis**. For example, gills and the tail are lost, while lungs and limbs develop.

   c. **Turtle**: despite its appearances, this reptile representative is very well adapted to land. It has well developed lungs, four powerful limbs, and is covered by scales to prevent drying out. Reptiles lay eggs on land. These eggs are very resistant to drying out. Unlike other reptiles, the turtle has an added bonus of a hard protective shell into which it can retreat in case of danger.

   d. **Cat**: the cat is our mammal representative. Mammals are warm-blooded animals with hair and **mammary glands**. Hair provides insulation so that the animal can maintain constant body temperature. Mammary glands in females have the ability to secrete milk. This represents the evolutionary advancement caring for the young. Mammals produce less numbers of offspring, but nurse them for a long period of time. This has increased the survival rate of the young.

*Q5. What do humans and cats have in common?*