Animal Diversity — I
Characteristics used in Classification and Preparing a Taxonomic Key

The classification of organisms into groups is known as BIOLOGICAL TAXONOMY. The value of a classification system is that it allows biologists to discern relationships between different organisms. Classification of organisms is a pursuit that has preoccupied naturalists and biologists for millennia. Herbalists were among the first persons to employ a system of classification and names to facilitate the identification of medicinally useful plants. Today, biologists place organisms within a system of groupings, or TAXA (kingdom, phylum, class, order, family, genus and species), which reflect their perceived evolutionary (or PHYLOGENETIC) relationships. An outgrowth of a classification system is a TAXONOMIC KEY, which is a tool used to identify organisms. Taxonomic keys can commonly be found in "field guide" books used widely by amateur and professional naturalists to identify plants, birds, reptiles, insects, and other organisms. In this lab exercise you will employ the mental skills that biologists use when they classify organisms and produce your own classification system and taxonomic key for a variety of organisms.

OBJECTIVES

1. To learn how organisms are classified according to their physical characteristics and evolutionary relationships.

2. To learn how a taxonomic key is made and used to identify different types of organisms.

3. To learn some of the distinguishing characteristics of common invertebrate and vertebrate animals.

SYNOPSIS OF LAB EXERCISE

In this exercise, you will:

1) carefully examine a selection of different animals and list the fundamental characteristics of each organism, and then
2) classify these organisms into groups based upon perceived homologous characteristics.
3) use your classification system to develop a taxonomic key.

HOW SCIENTISTS CLASSIFY ORGANISMS

Modern biological taxonomy strives to discern evolutionary, or PHYLOGENETIC, relationships between different organisms. Biological classification is usually based upon anatomical characteristics of modern (and sometimes extinct) organisms. Characteristics of organisms that reflect evolutionary relationships are most useful for biological classification. However, similar appearances is not always a reliable indicator of evolutionary relationships. Consider the platypus, the semiaquatic creature from Downunder. It has hair and milk glands like a mammal, a rubbery bill and webbed feet like a bird, and lays leathery eggs in burrows like a reptile. Within which group should the platypus be grouped? Which traits are most "important"? During the 1800's, the platypus was alternately placed in different groups as taxonomists argued these points. Today it is generally agreed that the presence of hair and milk glands indicate that the platypus is a primitive type of mammal.

Why is the presence of hair and milk glands deemed to be more important to the classification of the platypus than the other features described above? The answer lies in the way in which traits arise during evolution. When two organisms share a body structure that was passed down from a common ancestor, the traits are referred to as HOMOLOGOUS. An example of a homologous structure is the thumb on the hands of chimpanzees and humans, both were inherited from a common primate ancestor. Likewise, the milk glands in the platypus and other mammals are believed to have arisen from a common ancestor.

A similarity in structure can also evolve independently in unrelated organisms. When different organisms possess body structures that serve similar functions, but which arise independently during evolution, the structures are referred to as ANALOGOUS. The wings of a bat and a bird are analogous because these organisms did not arise from a common ancestor that possessed wings. Similarly, the webbed feet of the platypus and a duck are now believed to be analogies, having evolved independently to facilitate swimming in water.

Taxonomists are most interested in homologous traits when classifying organisms. Discerning whether traits are homologous or analogous can be a formidable task. (Many taxonomists now study the genetic code carried in the DNA of organisms to better understand their phylogenetic relationships.) For your classification system you will employ the classical method of comparing anatomical traits of organisms, and seeking to identify homologous similarities.

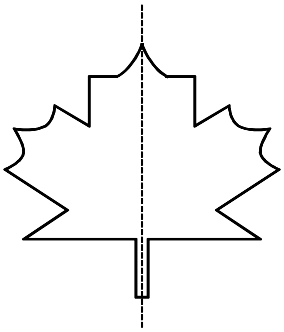
Some anatomical traits often reflect homologous similarities

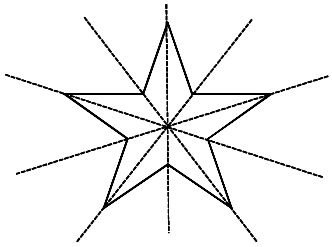
To provide some guidance, some of the anatomical traits that often, but not always, reflect homologous similarities are described below. As you prepare your classification system use judgement in deciding which traits most likely reflect homologous or analogous similarities. For example, which similarity most likely reflects a homology: segmentation shared by a worm and a caterpillar, or the "hairy" covering shared by the caterpillar and a mouse? Feel free to ask your instructor for assistance.

1. Body symmetry

The shape of most animals is either BILATERALLY or RADIALLY symmetrical, although a few primitive organisms are ASYMMETRICAL. An object that is said to possess bilateral symmetry if only a single plane will divide the object into two identical halves. For example, the leaf shown below possesses bilateral symmetry, and can only be cut by a single line that will produce two mirror-image halves.

In contrast, an object that possesses radial symmetry can be divided by more than two planes that yield identical halves. Note that many straight lines could be drawn through the star, all of which will produce identical halves.





2. Type of body skeleton

Animals such as a worm or sea anemone do not possess a rigid skeleton. The bodies of these organisms are supported by the pressure exerted by internal fluids, referred to as a **hydroskeleton**. However, other animals have evolved various types of rigid body skeletons. The skeleton provides a framework that supports the internal organs, and to which are attached the muscles and ligaments that make possible body movements.

Some organisms, such as insects and spiders evolved a hard outer casing, called an **exoskeleton**. An exoskeleton also provides protection from predators and a waterproof covering that is crucial in an arid environment. Unfortunately exoskeletons cannot enlarge, and thus, as the organism grows its exoskeleton must be periodically shed and replaced with a new larger exoskeleton.

Animals such as humans evolved an internal framework called an **endoskeleton**. Composed of a calcified bony matrix, the endoskeleton of vertebrates is capable of enlarging with the organism as growth and development progress. If you are unsure if an organism possesses an endoskeleton, ask your instructor.

3. Segmentation; multiple body units

The bodies of many organisms are composed of distinct units, and are said to be segmented. In more primitive organisms, such as earthworms, most of the segments are identical. However, in more advanced organisms certain segments evolved specialized functions and structures, such as the head, thorax and abdomen of an insect. As you prepare your classification system consider if the organisms possess no segments, many identical segments, or segments with specialized functions?

4. Body covering

The presence of fur, feathers or scales are other useful characteristics. However, be sure to make careful observations. You should avoid using subjective descriptions such as "fuzzy" to describe body coverings, and remember that some body coverings that look outwardly similar may be structurally very different, and therefore be analogous. Color is rarely a homologous similarity.

Some animals possess a **shell** along with other body coverings, which is different than an exoskeleton. Whereas an exoskeleton completely encases all of the appendages of an animal, an animal living in a shell can extend part of its body out from under the shell. Thus, a clam can extend its "foot" out from between its protective shell. Do you think the shell of a turtle and a clam are analogous or homologous structures? What about the shells of an oyster and a snail?

5. Presence of body appendages

Legs, tentacles and antennae are examples of some of the various appendages that animals possess. These appendages serve many different functions; some facilitate movement or manipulation of objects in the environment, while others are sensory in nature, such as the antennae of insects. You should take note whether these appendages are arranged with bilateral or radial symmetry. When grouping your organisms, consider carefully whether the appendages are homologous or analogous. Is it likely that the legs of a mouse are analogous with the tentacles of a squid? Also, you should decide whether the appendages are **jointed**— consisting of subunits that can be independently manipulated.

A TAXONOMIC KEY

A taxonomic key is a tool that is used to identify different types of organisms. An example of a key that could be used to identify different types of microorganisms is provided below. A taxonomic key contains a series of statements that describe the traits of the organisms, as shown in the sample key presented below. The statements are grouped into 2 or 3 alternative descriptions (such as 1a and 1b) for each trait. NOTICE THAT EACH GROUP OF STATEMENTS REFERS TO ONLY A SINGLE TRAIT. To use the key, appropriate traits of the unknown organism are identified while following the steps of the key. When the description in the key and trait of the organism match, you are instructed to proceed to another set of descriptions or given an identification. Correctly following the steps of the key eventually leads to identification of the unknown organism.

Step number	Description of trait	Instruction	Classification
1a.	Organism is green	Go to 2	
1b.	Organism is not green	Go to 3	
2a.	Cells contain internal organelles		Algae
2b.	Cells do not contain organelles		Cyanobacteria
3a.	Cells are not filamentous	Go to 4	
3b.	Cells of organism are filamentous, round spores may be present		Fungi
4a.	Organism is multicellular		Animal
4b.	Organism is unicellular		Protozoa

Prelab assignment

Complete the assignment given at the end of the lab exercise (pp. 13-14) before coming to lab.

LAB ACTIVITIES

Students working in groups will turn in a ONE classification and taxonomic key, NEATLY and CLEARLY written, at the end of the lab period.

Part I. Prepare Your Classification System

There are 20 organisms on display throughout the laboratory. There are many acceptable ways of classifying the organism. You will be graded on the carefulness of your observations and the logic and consistency that you use in classifying the organisms.

1. Make careful observations of these organisms and list the fundamental characteristics in the tables provided. Identify only those traits that you believe will be useful criteria for classification--you should not prepare an exhaustive list of all traits for each organism. DO NOT USE HABITATS AS TRAITS.

2. You will then use this information to classify the organisms into 6 to 8 groups that you believe to contain organisms with common ancestors. List for each group those traits that are shared by all organisms in that group. Write out the final classification system in the Table provided.

Part II. Prepare Your Taxonomic Key

After you have completed your classification system, prepare a taxonomic key that could be used to place any of the 20 organisms into its correct group. Thus, your key will not list the names of each organism, but rather the 6 to 8 group names. You should only use those characteristics that you have identified as distinguishing characteristics of each group. Use the key presented in this chapter as a model for formatting your key.

Your grade will reflect how well your key actually "works" and whether the traits used are consistent with the traits listed for each group and the individual organisms.

Animal Classification Exercise Name:_____

Descriptions of the Display Animals

Animal #1 -- Name:	Animal #5 -- Name:
Animal #2 -- Name:	Animal #6 -- Name:
Animal #3 -- Name:	Animal #7 -- Name:
Animal #4 -- Name:	Animal #8 -- Name:

Descriptions of the Display Animals

Animal #9 -- Name:	Animal #13 -- Name:
Animal #10 -- Name:	Animal #14 -- Name:
Animal #11 -- Name:	Animal #15 -- Name:
Animal #12 -- Name:	Animal #16 -- Name:

Descriptions of the Display Animals

Animal #17 -- Name:	Animal #19 -- Name:
Animal #18 -- Name:	Animal #20 -- Name:

After you have completed the descriptions, return to your bench and begin to devise your classification system on the following pages. Your classification system should comprise 6 - 8 different groups.

Your Animal Classification System

Group #1 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:
Group #2 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:
Group #3 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:
Group #4 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:

Group #5 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:
Group #6 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:
Group #7 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:
Group #8 Name of Group: _____ Characteristics that distinguish this group from all other groups:	Organisms classified in this group:

Taxonomic key to animal groups you described above

Remember, the traits that you use for the taxonomic key should be those listed for the groups in your classification system.

★★★Use the example on page 5 as a model ★★★

Step number	Description of trait	Instruction	Name of group
1a			
1b			

Name _____

Prelab Assignment: You should answer the following questions before coming to lab.

1. What is a "phylogenetic" relationship?

2. Define a homologous and analogous trait.

3. Are the shell of a turtle and that of a snail homologous or analogous? Explain why.

4. Are the legs of a cat and the fins of a whale homologous or analogous? Explain why.

5. What is the difference in purpose between a classification system and a taxonomic key?

6. Create a taxonomic key for the groups of organisms listed on the next page; follow the model shown on page 5.

Name of Group	Characteristics of the group
Alphas	bilateral symmetry, not segmented, hydroskeleton, no appendages
Betas	bilateral symmetry, segmented, exoskeleton, appendages
Gammas	radial symmetry, no segmentation, hydroskeleton, no appendages
Deltas	bilateral symmetry, segmented, no appendages, hydroskeleton,
Epsilons	bilateral symmetry, no segmentation, endoskeleton, appendages

Step number	Description of trait	Instruction	Classification
1a.			
1b.			