

An Introduction to Taxonomy

Taxonomy is the branch of science that works to classify organisms on Earth. Humans seem to have an innate need to classify things around them, and taxonomy dates back to the time of Aristotle (384-322 BC). Aristotle was the first to classify all living things. He defined invertebrates as animals without blood and vertebrates as animals with blood. From there, he classified vertebrates into live-bearing and egg-bearing offspring. Invertebrates he classified into groups we still have today, such as insects, crustaceans, and mollusks.

In the 1600's, John Ray established **species** as the ultimate unit of taxonomic classification. He defined a species as a group of organisms whose parents were similar and who passed their characteristics along to their offspring. Working off this definition, Carol Linnaeus established a more formal system of naming a species. In 1758, Linnaeus published the tenth edition of *Systema Naturae*, formalizing **binomial nomenclature**, the system we use today. Every species has two names: the first name is the **genus** (plural: genera) and the second is the species. Species are categorized based on a hierarchical system based on shared characteristics. There are seven primary taxonomic categories:

Kingdom	Lion Classification:	Ball Python Classification:	Note: When writing genus and species names, each are italicized when typing; genus is always capitalized while species begins with a lowercase letter. When handwritten, genus and species are underlined with a space between, for example: <u>Panthera leo</u>
Phylum	Kingdom: Animalia	Kingdom: Animalia	
Class	Phylum: Chordata	Phylum: Chordata	
Order	Class: Mammalia	Class: Reptilia	
Family	Order: Carnivora	Order: Squamata	
Genus	Family: Felidae	Family: Pythonidae	
Species	Genus: <i>Panthera</i> Species: <i>leo</i>	Genus: <i>Python</i> Species: <i>regius</i>	

A mnemonic device, such as “**K**nights **P**our **C**offee **O**n **F**airly **G**ross **S**erpents,” can help you remember the taxonomic order.

The genus and species comprise the scientific, or Latin, name of the animal. These names are important as animals may have several common names, even within one country. For example, the puma has several other names: cougar, mountain lion, panther, and catamount. For species that are found throughout several countries, they may have their own common names in different languages. However, the puma's scientific name is *Felis concolor*. A singular scientific name allows for certainty in a discussion; no matter what language or what country a person comes from, *Felis concolor* denotes the same species.



Pumas have many common names, but are known among scientists as *Felis concolor*.

Photo credit: National Park Service (NPS). [1], Public Domain, <https://commons.wikimedia.org/w/index.php?curid=19235954>

What is a Species?

A species is the most basic unit of classifying organisms. What we define as a species is incredibly important; it influences conservation planning such as species survival plans or what animals we list as endangered. However, defining “species” in a way that works for all organisms is surprisingly difficult. As a result, there are three primary definitions of a species; each definition has its limitations, though the most common definition used is that of the biological species concept.

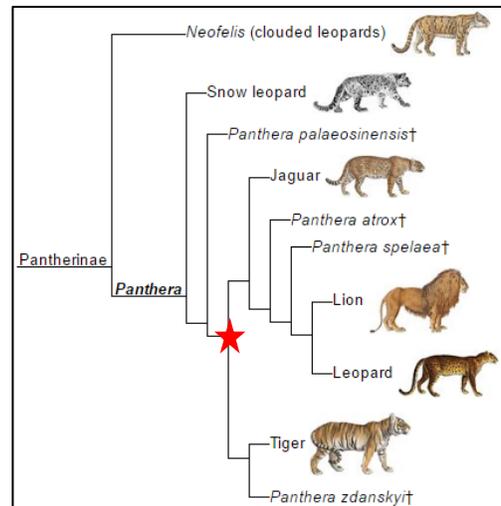


Lions and tigers are able to reproduce and bear offspring known as a liger. However, ligers are infertile; the biological species concept would define lions and tigers as separate species since the offspring produced is unable to reproduce itself.

Biological Species Concept: This concept defines a species as a population or group of populations whose members have the potential to interbreed in nature and produce *viable, fertile offspring*. These individuals would not produce viable, fertile offspring with members of other such populations. Often there is a reproductive barrier, such as a physical barrier separating the species or incompatible mating strategies.

Phylogenetic Species Concept: Using this definition, a species is defined as the smallest group of individuals with a common ancestor, forming a single branch on the “tree of life.” This definition uses multiple comparisons, such as morphology and molecular sequences among species. However, as species continue to evolve, it can be difficult to determine when one species diverges enough to become another species.

Morphological Species Concept: Historically, species were defined using morphological features (e.g. body shape). This definition is quite subjective, as scientists may disagree on which features to use to distinguish a species. Additionally, two separate species may look incredibly similar, while members of the same species may look drastically different.



Genetic sequencing and morphology suggest lions and tigers shared a common ancestor, as indicated by the red star. However, they have diverged through time to become separate species.

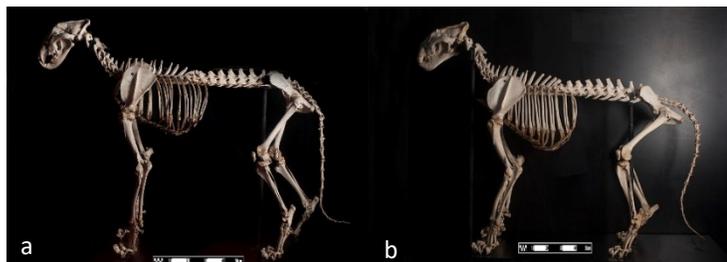


Figure a shows a lion skeleton (*Panthera leo*) while figure b shows a tiger skeleton (*Panthera tigris*). Based on similar skeletons, the morphological species concept may define them as the same species when they are in fact different.

Invertebrates

Invertebrates comprise about 95-97% of all animal species. The primary characteristic shared by all is the lack of a vertebral column and bony endoskeleton (skeleton inside the body). All invertebrates are **ectothermic**, meaning they need an outside source to regulate their body temperature. Invertebrates are classified into approximately 23 different phyla. Some examples of invertebrates include mollusks, sponges, jellyfish, flatworms, and sea stars.

The largest invertebrate phylum is **Arthropoda**, containing 750,000-1,000,000 species. One of the defining features of the phylum is the presence of **jointed legs**, which is where the name Arthropoda comes from. Arthropods have an **exoskeleton** made from chitin, which they molt as they grow. Some examples of arthropods include insects, crustaceans, spiders, scorpions, and horseshoe crabs.



Madagascar Hissing Cockroach
(*Gromphadorhina portentosa*)

Kingdom: Animalia; **Phylum:**
Arthropoda; **Class:** **Insecta**; Order:
Blattodea; Family: Blaberidae;
Genus: *Gromphadorhina*; Species:
portentosa

Photo credit: By Almabes at English Wikipedia -
<https://commons.wikimedia.org/w/index.php?curid=10542089>

related, centipedes belong to their own class, **Chilopoda**. The primary difference is centipedes only have a single pair of jointed legs per body segment. Centipedes are primarily carnivorous and have claws modified into venomous fangs.

The most diverse group of animals belong to the class **Insecta**. Common characteristics of insects include three pairs of jointed legs, compound eyes, and one pair of antennae. Insects also have a three-part body comprised of the head, thorax, and abdomen that is covered with a chitinous exoskeleton.

Our Giant African Millipedes belong to the class **Diplopoda**. The most common characteristic of this class is the presence of two pairs of jointed legs on most body segments. Most millipedes are also slow moving detritivores, though a few also eat fungi or suck on plant fluids while a small minority are predatory. Though closely



Giant African Millipede
(*Archispirostreptus gigas*)

Kingdom: Animalia; **Phylum:**
Arthropoda; **Class:** **Diplopoda**;
Order: Spirostreptida; Family:
Spirostreptidae; Genus:
Archispirostreptus; Species: *gigas*

Photo credit: By Bjørn Christian Tørrissen - Own
work by uploader,
<http://bjornfree.com/galleries.html>, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=14645188>

Vertebrates

The primary distinguishing feature of vertebrates is the presence of a **backbone**, or **vertebral/spinal column**, which evolved to protect the spinal nerve (cord). The backbone runs along the body axis from head to tail along the dorsal (top) side of the animal, serving as the core of the **endoskeleton**. The skeleton of vertebrates is made of either cartilage or bone. Cartilage is a tough tissue made of a protein called collagen; bone is a harder tissue consisting of a collagen matrix (framework) filled in with minerals, such as calcium. Bone is less flexible than cartilage, but stronger, allowing animals to grow larger and heavier while providing more protection for soft tissues and internal organs. In addition, vertebrates have other complex organ systems making them the most evolutionarily advanced group of animals.

Vertebrates are further divided into seven classes, discussed below.



Agnatha

Agnatha is a class more commonly referred to as jawless fish. As the name suggests, jaws are absent in this group; other characteristics include a cartilaginous skeleton, seven or more paired gill pouches, and a digestive system that lacks a stomach. Animals in this class include lampreys and hagfish.



Chondrichthyes

This class consists of the cartilaginous fish, such as sharks, skates, and rays. They have a skeleton composed primarily of cartilage, paired fins, and exposed gill slits. The digestive system is more complex, consisting of a U-shaped stomach. This class of fishes lacks a swim bladder, meaning they must keep moving in order to stay afloat.



Osteichthyes

This class consists of bony fishes, ranging from parrotfish to clownfish. They have a skeleton composed primarily of bone, paired fins, and a swim bladder. The swim bladder is a gas-filled sac that serves to keep the fish buoyant. As with the other fishes, respiration is through gills, but the gills are covered by a bony flap called an operculum. Many of these fishes secrete a mucus that covers the body and helps prevent infection. A lateral line is also common among these fishes; it is a sense organ used to detect movement, vibration, and pressure gradients in the surrounding water. This class of fishes is considered the most evolutionarily advanced.

Photo Credits:

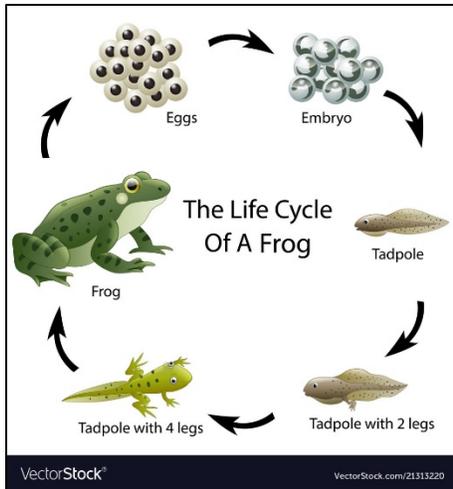
By Tiit Hunt - Own work, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=17861470>

By Elias Levy - Great White Shark, CC BY 2.0,
<https://commons.wikimedia.org/w/index.php?curid=40576970>

Copyright (c) 2005 Richard Ling

Amphibia

The word **amphibian** is derived from the Greek words “amphi” (double) and “bios” (life). This refers to the life stages of amphibians: an aquatic larval stage and a terrestrial adult stage. When in the larval stage, amphibians have gills for respiration; upon completing **metamorphosis** into their adult stage, amphibians have lungs. Amphibians have moist, smooth skin through which they absorb water and oxygen. Because of their moist skin and reproductive habits, amphibians are highly dependent on water. As ectotherms, amphibians require an outside source of heat. There are approximately 4550 species of amphibians, distributed among three orders: Anura (frogs and toads), Caudata (salamanders), and Gymnophiona (Caecilians).



African Bullfrog (*Pyxicephalus adspersus*)

Kingdom: Animalia; **Phylum: Chordata**; **Class: Amphibia**; Order: Anura; Family: Pyxicephalidae; Genus: *Pyxicephalus*; Species: *adspersus*

Photo credit: By Steven G. Johnson - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=4577846>



Common Leopard Gecko (*Eublepharis macularius*)

Kingdom: Animalia; **Phylum: Chordata**; **Class: Reptilia**; Order: Squamata; Family: Eublepharidae; Genus: *Eublepharis*; Species: *macularis*

Photo credit: By Matt Reinbold - Flickr: Eublepharis macularius, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=15137893>

Reptilia

As with amphibians, **reptiles** are ectothermic and regulate their body heat through behavior. Reptiles may often be seen basking in the sun to warm up, or burrowing to cool down. However, reptiles evolved to be less water-dependent than amphibians. A major evolutionary step was the production of **amniotic eggs**. These eggs have a leathery shell that serves to prevent rapid water loss as well as provides an internal source of nutrients. Reptiles also have dry skin covered in scales or by a shell that helps retain water. There are approximately 6550 species of reptiles, distributed among four primary orders: Crocrodilia (crocodiles and relatives), Testudines (turtles and relatives), Squamata (lizards and snakes), and Rhynchocephalia (tuataras, of which there are two species).



Tawny Frogmouth (*Podargus strigoides*)

Kingdom: Animalia; **Phylum: Chordata**; **Class: Aves**; Order: Caprimulgiformes; Family: Podargidae; Genus: *Podargus*; Species: *strigoides*

Photo credit: By Andrew Beeston from Australia - Tawny Frogmouth Uploaded by snowmanradio, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=17561485>

Aves

Unlike the classes discussed previously, **birds** are **endothermic**, meaning they are capable of physiologically regulating their body temperature. Feathers are a primary characteristic of birds that serve to regulate body temperature as well as aid in flight. In fact, birds are well adapted for flight: their forelimbs are modified into wings, their bones are light and filled with air, and the bones are well fused, serving as anchor points for strong flight muscles. Birds also reproduce via eggs, however their eggs are protected by a hard, calcified shell. There are approximately 10,000 species of birds distributed among about 30 orders. The largest order of birds is the Passeriformes, or perching birds.

Mammalia

Mammals have three unique characteristics that set them apart from other animals: three middle ear bones (malleus, incus, and stapes), hair/fur, and mammary glands. Mammals are endothermic, and as with feathers, their hair/fur helps to regulate body temperature. With a few exceptions, most mammals give birth to live young, for whom the mothers produce milk. **Monotremes** lay eggs and nurse their young after they hatch, however they lactate through mammary glands directly on their skin, rather than through nipples. **Marsupials** have incredibly short pregnancy terms and give birth to a **joey**. The joey crawls into its mother's pouch and attaches to a nipple for food; it stays in the mother's pouch until fully developed (up to a year in some species). **Placental mammals** give birth to fully developed young. They are able to carry a longer-term pregnancy due to the evolution of a **placenta**, which serves to provide the developing fetus with nutrients, water, and respiratory gases. There are approximately 5000+ species distributed among 19-26 orders (scientists do not yet agree on the number or how some orders and families are related to each other.



Striped Skunk (*Mephitis mephitis*)

Kingdom: Animalia; **Phylum: Chordata**; **Class: Mammalia**; Order: Carnivora; Family: Mephitidae; Genus: *Mephitis*; Species: *mephitis*

Photo credit: By Dan & Lin Dzurisin - originally posted to Flickr as Striped Skunk (*Mephitis mephitis*) DSC_0030, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=11414081>