What makes a human and an ape the same? What makes them different? With the help of this article, you'll become more aware of how biologists organize, classify, and relate different living beings.

An Introduction to Biological Diversity.

Living in an archipelago, we have different local names for the same life forms or variations on the name thereof. Consider that languages in the Philippines are part of the larger Austronesian group of languages according to linguists. This can be seen when looking at the name for chicken, fowl, or flying creatures in general in our region. An example is that we call chicken *manok* while in the Indo and Malayan peninsula it is called *manuk*, going towards Oceania they are called *manu* with language experts tracing its origins to *manuk* (Blust, 2002).

How does this relate to the study of life?

Life manifests in different shapes, forms, and sizes. These features are then sculpted or formed as a response to the environment these organisms live in.

For different organisms, it is better to "recall" or "identify" which substances can be used and which should be avoided. In our case, as different human societies and communities develop, we acquire knowledge by being able to identify objects in our environment. This has led, for

example, to knowledge ranging from as simple as identifying which plants or animals can be eaten safely to greater developments such as domestication in agriculture and folk and herbal medicine, just to name a few.

The relationship between the environment, form, and function is what biologists use in order to categorize the different organisms that live on Earth. By categorizing these organisms, we gain a better understanding of them.

Taxonomy & Binomial Nomenclature: *What's in a Name?*

The branch of biology concerned with identifying, naming, and classifying organisms is called **Taxonomy**.

The basis of taxonomy is a system introduced by naturalist **Carolus Linnaeus**, who devised a means of naming organisms and a hierarchical scheme of classifying these organisms into groups within broader groups.

Why do scientists do this?

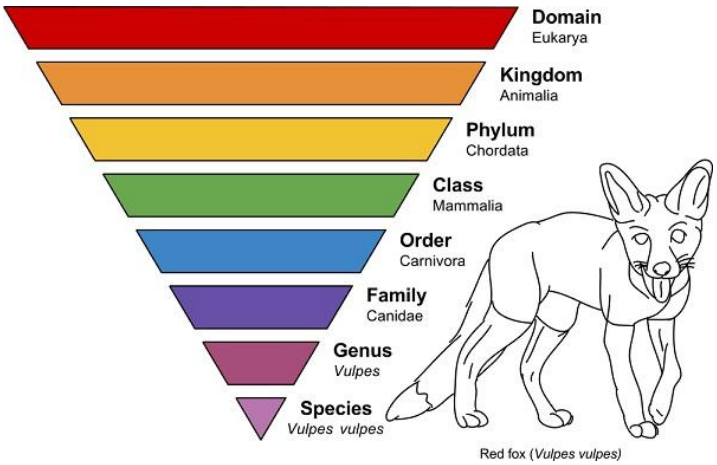
As shown earlier, common names can vary between communities. They may be useful for everyday conversations but can be ambiguous because there are many different organisms that fall into these common names. Take for instance a chef looking for ingredients. If he or she only asks market vendors for "fish," vendors may offer the chef a fish that his/her recipe may not look for.

Some common names are downright misleading in the biological context. Using the case of a fish: starfish (preferably called "sea stars", an echinoderm), crayfish (a crustacean), and jellyfish (a cnidarian) are not fish in the taxonomic sense of the word.

As such, Linnaeus' system of naming organisms is the standard for naming organisms and is called a "**scientific name**".

In his naming system, an organism is assigned a two-part name. Hence, this system is referred to as the **binomial nomenclature system**. The first part of the scientific name is the **genus** (plural, genera) which is a larger group. This is then followed by the species name (or specific epithet in the more technical use of the term) of the organism. Note that in biology, species is both singular and plural so be careful when using the term around biology-trained individuals because they might hiss the missing “s” on you.

When we refer to a specific organism, we usually mean it at the species level. The image below shows an example of the red fox. As seen at the genus level, it is part of the genus of *Vulpes*. Look further down into the species name and it is the same but is not capitalized as the genus name. Hence the red fox’s scientific name is *Vulpes vulpes*.



The species name is not always the same as the genus name. For example, our scientific name is *Homo sapiens*.

Cases like those of the red fox are called **tautonymy** and may signify that the species is representative of the characteristics of the genus. Another case of tautonymy is that of milkfish, the *bangus*, which has *Chanos chanos* for its scientific name.

Always remember that a scientific name is a standard and so, rules must be followed when writing it in whatever media. The main things to remember are usually:

- The genus name always starts with a capital letter.
- Both genus and species names must be italicized when typewritten and underlined when handwritten. For example, if I handwrite the scientific name for humans it would appear as Homo sapiens. Take note that you underline the genus and species name separately.
- Once the full scientific name has been mentioned, it is possible to refer to it on succeeding use of the name through a contraction. That is, we simply put the first letter of the genus name, followed by a period then proceed to the species name. Example: *H. sapiens* or H. sapiens is the contracted form for *Homo sapiens*.

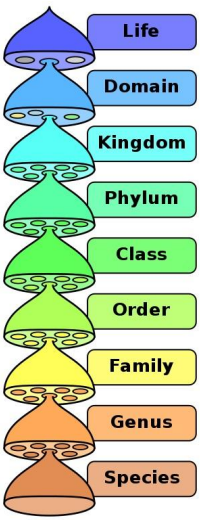
Consider the genus as the surname of a family; it is shared by your relatives. Meanwhile, the species name is your first name, which only refers to you but may also be the same name of others unrelated to you.

Naming a species can be based on any language, inspired by the organism's unique characteristics, the place it is located, or a person you admire (there were also scientific names made as an insult to people, mostly rivals); but it is an arduous process requiring you to justify the validity of your proposed name and if no records on the species have already been created in the past.

However, once validated and accepted, it is usually harder for any future proposed names on similar-looking organisms to replace older names.

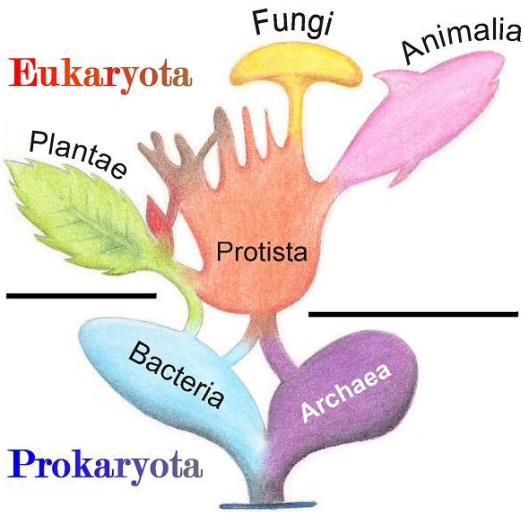
Next, let's take a closer look at how life is identified, classified, and structured in the eyes of Biology.

Hierarchies of Classification.



As mentioned earlier, Linnaeus also introduced a system for grouping species into hierarchies of increasingly inclusive categories. The illustration on the red fox already showed these hierarchies starting from the broadest, the domain, to the most specific, the species level.

Each level is considered a unit, and in taxonomic terms, this unit is called a taxon (plural taxa) and refers to any of the taxonomic levels the species inquired belongs to. The next image shows the three large domains of life: two are prokaryotes (Bacteria and Archaea) and the rest are eukaryotes (taxonomically referred to as the Eukarya).

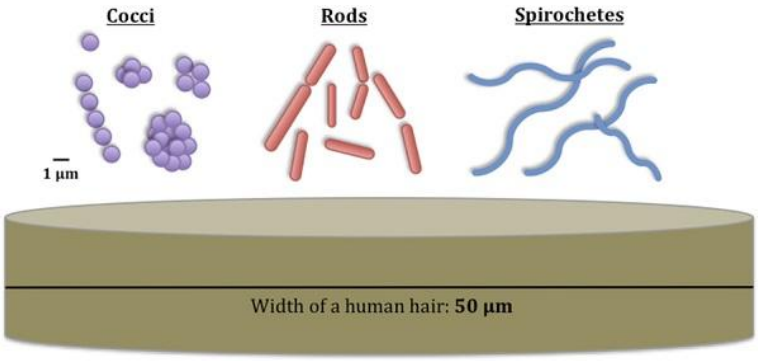


Despite their microscopic size, prokaryotes have an immense impact on our world. These microorganisms are present wherever there is life, this includes ourselves. In fact, communities of microorganisms live in and on our bodies. This community is referred to as the **microbiota**.

Some of these microorganisms are beneficial to us, as long as our body is able to regulate them. These include the gut bacteria that help us feed on otherwise indigestible food.

On the opposite ends are microorganisms that feed on our sweat and in turn cause body odor and more dangerous microorganisms (disease-causing pathogens). There are two different kinds of Prokaryotes, classified into the domains **Archaea** and **Bacteria**. Including the Eukarya, the differences across the domains involve the cellular machinery involving the genes.

The Prokaryotic Domains.



Our basic understanding of prokaryotes is based on their shapes as we perceive them under the microscope. Here are the most common prokaryotic cell shapes:

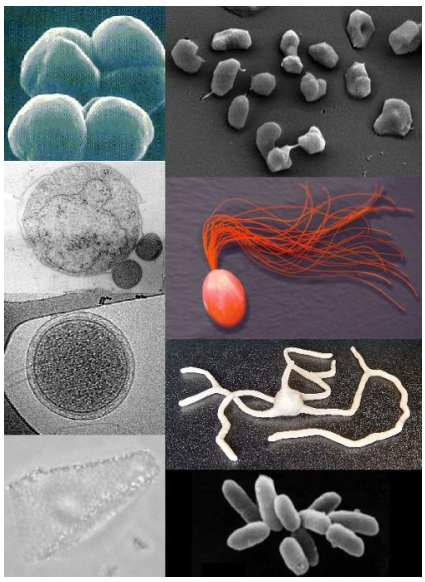
- Spherical cells are called **cocci** (singular coccus)and when they appear as chains, they are called **streptococci**. Others may appear as clusters and are referred to as **staphylococci**.
- Rod-shaped prokaryotes are called **bacilli** (singular bacillus). Bacilli may also be threadlike or filamentous.
- The third is spiral prokaryotes. Short and rigid prokaryotes are called **spirilla** while longer cells are called **spirochetes**.

1. Domain Archaea: *Those Who Live on Extremes*.

Members of this domain thrive in many habitats, including places where few other organisms survive. This is because they have molecular features that enable them to survive such extreme conditions.

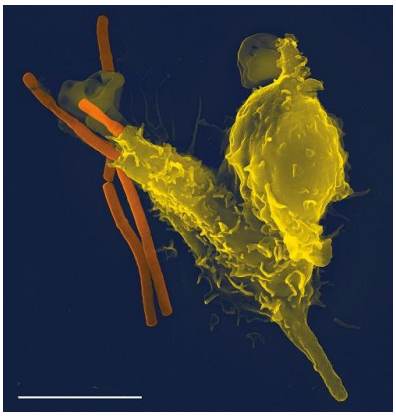
Archaea can be classified based on the conditions in which they thrive. Here are some of those classifications:

- **Extreme Halophiles** or “Salt Lovers” thrive in conditions where the salt concentration is extremely high. Remember, osmoregulation is an important feature of life, and so archaea must take extreme measures with regards to this.
- **Extreme Thermophiles** or “Heat Lovers” thrive in areas with high temperatures. They can also be present in areas of high acidity.
- **Methanogens** are archaea that thrive in oxygen-lacking environments and, as the name suggests, live on other gases in the area such as methane.



2. Domain Bacteria: *A Numerous Bunch*.

Compared with Archaea, our understanding of **Bacteria** is better. Again, Archaea thrive in places where we would normally think life would not thrive and so, our means of accessing them have only been developed relatively recently. Whereas with Bacteria, microscope work on them began earlier and had allowed us to view them through staining methods. In this regard, bacteria can be stained as **Gram-negative** or **Gram-positive**.



There are also more special stains for specific bacteria and our understanding of the domain has increased alongside our technological advancements. The domain is divided into five groups based on their genetic differences:

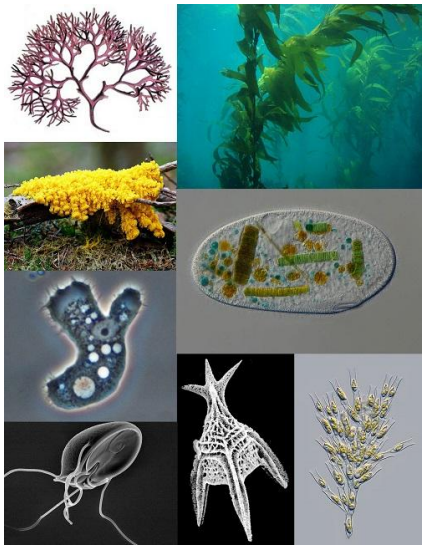
- **Proteobacteria** are Gram-negative bacteria and share a common rRNA sequence. Examples include pathogenic bacteria such as *Vibrio cholerae* that causes cholera and those that are residents of the body like *Escherichia coli* (*E. coli*).
- **Gram-positive bacteria** rival the proteobacteria in terms of diversity. Soil-dwelling *Streptomyces* are bacteria of this group that are cultured by pharmaceutical companies to create antibiotics (Streptomycin). There are also pathogens in this group.
- The **cyanobacteria** are the only ones that are plant-like and are able to photosynthesize. It is believed that the origins of chloroplasts in plants are linked to cyanobacteria.
- **Chlamydias** are parasites of eukaryotic hosts. Chlamydia is one of the most common sexually transmitted infections because of this group.
- **Spirochetes** are helical bacteria that rotate to move through their environment. Some spirochetes are notorious for causing syphilis (*Treponema pallidum)* and Lyme disease (*Borrelia burgdorferi)*.

As we have discussed previously, cells can either be prokaryotic and eukaryotic. The latter group of cells also form a kingdom of their own with its own hierarchy. Let's take a closer look at the eukaryotes next.

The Eukaryotic Domains.

The domain Eukarya is a diverse, complicated group of organisms. Under it are the main kingdoms composed of fungi, plants, animals, and a plethora of unicellular eukaryotes. These unicellular eukaryotes previously belonged to a kingdom of their own, but are now better understood as also constituting other kingdoms of the domain.

1. Protists: *An Assortment of Eukaryotes*.



Protist is the term used on these unicellular eukaryotes. They once belonged to their Kingdom, Protista, but due to their extreme diversity, it is difficult to categorize these organisms into a

specific group. Hence, protists are conveniently referred to as eukaryotes that are not plants, animals, or fungi.

Because it isn't clear yet how the organization of this group is to be resolved, intuitive groupings have been established to describe protists.

One of the groupings is for protists that are plant-like and can photosynthesize: the algae. Others are heterotrophs and parasitic in nature; these protists are informally called **protozoans**. Still, other protists can be both.

Because of these diverse modes of living, it has been proposed that protists be classified into supergroups. We will focus more on some groups of protists that may be familiar to most of us. These include the following:

- **Diatoms** and **Algae** – photosynthetic protists.
- **Dinoflagellates** – common components of marine and freshwater plankton (organisms that drift in aquatic environments). Some cause red tides but there are also beneficial ones like those that provide food for corals.
- **Ciliates** – have cilia to move and sweep food into their mouth. This includes *Paramecium*.
- **Amoebas** – move and feed by means of pseudopodia, temporary extensions of the cell.

2. Kingdom Fungi: *Fantastic Yeasts & Where to Find Them*.

You may have seen mushrooms sprout on damp surfaces, bracket fungi on trees that stack upon each other like shelves, and patches of mold on leftover food. Though their forms differ, they acquire their nutrients in the same manner. All fungi are heterotrophs and nourish themselves through **absorption**. They secrete powerful enzymes that are able to break macromolecules into monomers and absorb the broken-down nutrient molecules into their cells.

Because they secrete powerful enzymes, most feed on decaying matter, and fungi are essential **decomposers** in most ecosystems. However, not all fungi are decomposers. Some form a beneficial relationship with other organisms, termed **symbiosis**, an example of which is the

mycorrhiza (plural *mycorrhizae*) where the fungi associate itself with plant roots. Acting as extensions of the plant root, they provide nutrients otherwise unreachable to the plant and the plant is able to nourish them by providing products of photosynthesis.

There are also parasitic fungi, an example of which is used as a plot element in the videogame “The Last of Us” where the fungi *Cordyceps*, which normally are parasites of insect larvae, are hypothesized in a what-if scenario as being able to take humans as hosts. Other fungi form symbiotic relationships with green algae or cyanobacteria forming **lichens**.

The feeding structures of fungi are composed of threadlike filaments called **hyphae**. These hyphae branch repeatedly as they grow, forming a mass called **mycelium** (plural mycelia). Since fungi are immobile, the mycelium acts like hands that extend, without enlarging, at a phenomenal rate to scour for food. This allows the fungi to cover more area and since the mycelium does not enlarge, more surface area can be utilized for absorption.

The umbrella-like structure that we recognize as fungi are reproductive structures made of tightly packed hyphae. The hyphae are surrounded by a cell wall composed of **chitin**, the same as those found in external skeletons of insects.

The reproduction of fungi typically involves the release of a vast number of spores that are easily transported over great distances by wind or water. A spore that lands in a moist place is able to germinate and become a fungus by means of mitosis.

Spores can be produced sexually or asexually. Those that solely rely on spore production asexually are called imperfect fungi and these include the **molds** and **yeasts**, the latter pertaining to a single-celled fungus that reproduces by **budding** or pinching small buds from the original parent cell.

There are different groups of fungi but the one we are most familiar with falls into the **club fungi** group. Technically called **basidiomycetes** because of the club-shaped, spore-producing structure called a basidium. Many basidiomycete species specialize in breaking down **lignin,** which is found in wood and thus plays a key role as decomposers.

3. Kingdom Plantae: *From the Creeping Moss to the Tallest Pines*.

Plants are a diverse group of photosynthetic eukaryotes. We have previously mentioned the characteristics of plant cells. In this section, we will focus more on the different groups of plants based on how botanists arrange them in terms of complexity and evolutionary history.

Since our understanding of plant groups is more comprehensive, we have a clearer distinction between the groups and have classified them into different **phylum** (plural phyla).

The first are plants that are seedless and nonvascular, that is to say, they do not have vascular systems composed of the **xylem** and **phloem** (more on this in Plant Forms and Functions). These include plants such as mosses, liverworts, and hornworts. Collectively, they are called **bryophytes** (Phylum Bryophyta). Bryophytes lack true roots and leaves.

Then there are **vascular plants**. The first vascular plants are seedless. These seedless vascular plants are composed of two phyla: the **lycophytes** (which include club mosses, spike mosses, and quillworts) and the **monilophytes** (the ferns, horsetails, and whisk ferns).

Later on, vascular plants with seeds appeared. A seed contains the plant's embryo packed with food supply and with a protected covering.

Seed plants are classified into non-flowering or flowering plants. The non-flowering seed plants are called **gymnosperms** and they include phyla where conifers as well as the ginkgo tree, and some palm-like cycads belong to. Flowering vascular plants are called **angiosperms** belonging to a single phylum, the **anthophytes**. Flowers are complex reproductive structures that develop seeds in protective chambers.

We have examined some three eukaryotic groups and in the next article, we will focus on the diversity of the animal kingdom.

4. Kingdom Animalia: *Where We Belong*.

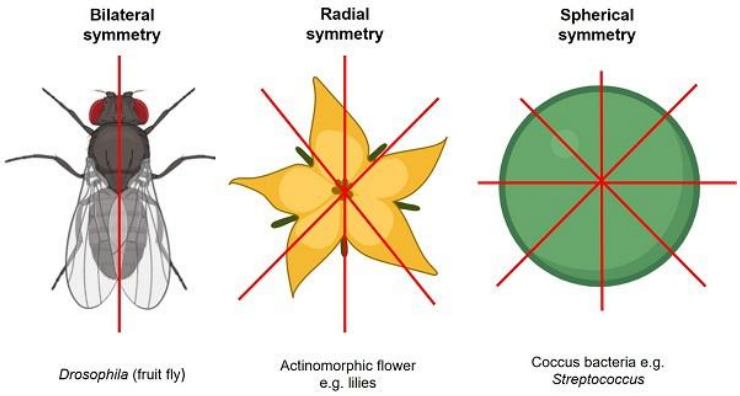
Animals are multicellular, heterotrophs (few exceptions exist) that obtain nutrients through **ingestion**.

Animals generally fall into two categories: **invertebrates** and **vertebrates**, referring to the lack or presence of a backbone respectively. The large majority of animals are invertebrates while we humans belong to the vertebrates.

Animals can be characterized by basic features of the body called “body plan”. Distinctions of the body plan allow biologists to categorize animals into different groups.

One feature of a body plan is symmetry. Two types of symmetry are present in animals: **radial symmetry** and **bilateral symmetry**. Radially symmetric animals have body parts that radiate

from a center; imagine how a bicycle tire has a center with spokes that go to the wheel. Bilaterally symmetric animals have mirror images of left and right sides. In addition, these animals have a distinct head or **anterior**; tail, or **posterior**; a back, or **dorsal** side; and a bottom, or **ventral**, surface.



The other feature is based on how the animal embryo develops in a process called **gastrulation** (more on this in Animal Form and Function).

Animals can be considered **protostomes** if the first opening that forms during gastrulation becomes the mouth. The other group, the **deuterostomes**, have this opening that becomes the anus and develops a second opening that becomes the mouth. These two features have allowed biologists to categorize the animals. We will now look into them in greater detail.

Sponges (Phylum Porifera) are considered the most basic of animals having no tissues. Animals with tissues form a bigger group called **Eumetazoa**. This group is split based on the symmetry of the body. Those with radial symmetry developed into the **Phylum Cnidaria** which includes corals and jellyfish. The other group, with bilateral symmetry called **Bilateria**, diversified even further into three large groups: **Lophotrochozoa**, **Ecdysozoa**, and **Deuterostomia**.

The first group includes many phyla such as those of flatworms, mollusks, and annelids and is based on a feeding apparatus called the **lophophore** in some phyla and a **trochophore** type of larva in mollusks and annelids.

Ecdysozoans include the nematodes and arthropods. The group got its name from the process of ecdysis, where the external skeleton of the organism must be shed first before the animal could grow. Think butterflies and lobsters. The two groups usually have a protostome type of embryonic development while the last group pertains to the deuterostome type of development.

a. Diversity of Invertebrates.

We will now look at the different phyla that comprise the invertebrates, starting with the simplest:

Phylum Porifera (Sponges) are the simplest animals, usually marine organisms, due to having no tissues. But they have cells that sense and react to changes in the environment. The body of a sponge is composed of two layers: the inner layer is composed of cells called **choanocytes** that help move water through the sponge's body. The other layer is composed of **amoebocytes** that produce supportive skeletal fibers called **spongin** or mineralized particles called **spicules**. The sponges used in baths are those that contain only spongin. Adult sponges are **sessile** in that they are anchored in place. Their mode of feeding is called **suspension feeding** as they collect food from the water that passes through their porous bodies.

- **Phylum Cnidaria** encompasses animals with radial symmetry and bodies that arise from only two layers of tissue. Cnidarians have two body forms: The first is a **polyp** and is exemplified by hydras and sea anemones which have a cylindrical body with tentacles projecting from one end; the other is the **medusa**, umbrella-shaped with a fringe of tentacles around the lower edge, as shown by the jellyfish. This phylum is named after its stinging cells called **cnidocytes**.

Lophotrochozoan Phyla:

- **Phylum Platyhelminthes** (Flatworms) are deuterostomes that lack a body cavity. There are three major groups of flatworms: The first are **planarians**, free-living flatworms; the second are the **flukes**, which are parasites of other animals; the last group, the tapeworms, are also parasites of other animals.
- **Phylum Mollusca** includes soft-bodied animals with variations on a common body plan. A mollusk consists of three main parts: A muscular **foot**, for locomotion; a **visceral mass** containing the internal organs; and a **mantle**, a fold of tissue that drapes over the visceral mass. Another feature of mollusks is a unique rasping organ called a **radula**. The three most diverse groups under the phyla include **gastropods**, **bivalves**, and **cephalopods**.
- **Phylum Annelida** (Segmented Worms) are characterized by **segmentation** (i.e., their body has begun to be divided into a series of repeated parts). An example is the earthworm and marine worms such as polychaetes. Annelids can be grouped based on their lifestyle: **Errantia** are mobile annelids; the others are **Sedentarians** which tend to be less mobile.

Ecdysozoan Phyla:

- **Phylum Nematoda** (Roundworms) have a complete digestive tract, that is to say, they have a mouth and anus for ingestion and egestion respectively. Nematodes are cylindrical and are covered in a layer called a **cuticle** that helps them prevent drying out. Nematodes can be free-living or parasitic.
- **Phylum Arthropoda** is a group composed of segmented animals with a hard exoskeleton and jointed appendages. Arthropods grow through molting or **ecdysis**

where they shed their exoskeleton and grow a new one. The arthropods consist of groups called **chelicerates**, **myriapods**, and **pancrustaceans**. Chelicerates have clawlike, feeding appendages. The horseshoe crab and arachnids (scorpions, spiders, ticks, and mites) belong in this group. Myriapods resemble annelids but have jointed legs. The millipedes and centipedes belong to this group. The anatomical distinction between the two is that the former has two pairs of short legs per body segment while the latter has one pair of legs per segment. Pancrustaceans include the crustaceans and the insects, the latter considered the most successful invertebrate.

Deuterostome Phyla:

- **Phylum Echinodermata** refers to the animals' prickly bumps or spines as in the case of sea stars or sea urchins. These extensions of the animal's internal skeleton are called **endoskeletons**. These animals are bilaterally symmetrical as larvae but develop into radially symmetric adults. Sea stars, sea urchins, sand dollars, and brittle stars belong in this group.
- **Phylum Chordata** which includes us. But wait, aren't we vertebrates? Well, the earliest chordates developed a backbone, technically the **vertebra**, from invertebrate ancestors. Four features identify members of the phylum: (1) a **dorsal**, **hollow nerve cord**; (2) a **notochord**, a rod located between the digestive tract and the nerve cord; (3) **pharyngeal slits** located in the pharynx; and (4) a muscular **post-anal tail**. The chordates which retained invertebrate features are the lancelets and the tunicates.

In the next section, we will look at the group where we humans belong to and we will also tackle the different means by which biologists establish diversity--and how species become diverse in the first place.

b. Vertebrate Diversity: *Growing a Backbone*.

As mentioned earlier, the notochord is a feature that unites chordates. This structure serves as the only skeletal support for the lancelets and tunicates but the development of the vertebral column and a skull allowed the vast majority of vertebrates to enclose and protect the nerve

cord while taking on a structural support function. As we survey the vertebrates, we will highlight transitions that occurred along with the groups.

Among the vertebrates, fish are the first to have developed a vertebral column. The earliest fish are composed of hagfish and lampreys. Thereafter, the development of a jaw made vertebrates more diverse.

Fish with jaws began with cartilaginous fishes, called **chondrichthyans**. These fish are made primarily of cartilage. This group includes sharks and rays. **Ray-finned** fishes such as tuna, trout, and goldfish developed skeletons made of bone. **Lobe-finned** fish have a series of rod-shaped bones on their muscular pectoral and pelvic fins. This group includes the coelacanth and lungfish, the latter showing a transition phase since they are able to gulp air and have lung structures. This group is thought to have given rise to the **tetrapods**, which are adapted to live on land, and the terrestrial vertebrates we are more familiar with.

Tetrapods are jawed vertebrates with two pairs of limbs and we are familiar with them in the form of **classes**. The first class of tetrapods is the Amphibians, which include frogs, salamanders, and caecilians. Amphibians have a larval stage that lives in aquatic environments and upon growing and maturing, through the process of **metamorphosis**, are able to live outside of an aquatic environment. However, they must still keep themselves moist.

The succeeding classes are called **amniotes** because of the development of an amniotic egg where a fluid-filled sac surrounds the embryo and the egg itself is protected by a waterproof

layer. The first is the reptiles which include lizards, snakes, turtles, crocodilians, and birds, and also the dinosaurs. The first four groups of reptiles are said to be “cold-blooded” animals, known as **ectotherms**, as they do not use their metabolism to produce body heat and are dependent on the environment to regulate their temperature. This is why you see sunbathing reptiles.

The birds (Class **Aves**) are believed to be descendants of dinosaurs. They developed feathers which allowed some of them to fly while also becoming **endotherms**, animals that generate their own body heat to maintain a steady body temperature.

The last of the amniotes is the **Class Mammalia**, endotherms with the distinguishing feature of having hair and mammary glands that produce milk. Some mammals called **monotremes** retained egg-laying and include spiny anteaters and platypus.

All other mammals are born rather than hatch from an egg. These mammals develop as embryos nourished by a **placenta**, a structure that allows nutrients from the mother’s blood to diffuse into the embryo’s blood.

Placental mammals can further be distinguished based on the young**. Marsupials** are mammals where the offspring still completes development while being breastfed. They are usually housed in an external pouch. This includes kangaroos and opossums. **Eutherians** are mammals with the more complex placenta and bear fully-developed live young.

Humans are categorized as belonging to the group known as **primates**. The primates are composed of three main groups: The first includes the lorises, bushbabies, and lemurs; the next is formed by tarsiers; and the last, the **anthropoids**, include monkeys and apes. The group composed of different species of humans is collectively called the **hominins**.

What is a “Species”?

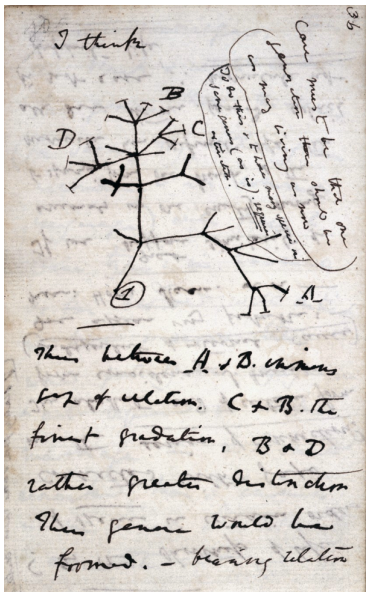
“Both in space and time, we seem to be brought somewhat near to that great fact – that mystery of mysteries- the first appearance of new beings on this Earth.” -Charles Darwin

Charles Darwin is a renowned naturalist who tried to find a means to explain why life on Earth is so diverse.

The “mystery of mysteries” that fascinated Darwin refers to **speciation**, the process by which a species splits into two or more species. He envisioned how life on Earth developed as a tree; with multiple branches arising from a common trunk, with young twigs representing more present-day species.

Species came from the Latin for “kind” or “appearance.” Sometimes it is easy to distinguish one species from one another, but there are times that different species will look the same. As such biologists devised ways to define a species:

- **Biological species concept** - a **species** is a group of populations whose members can interbreed and produce fertile offspring. Conversely, barriers that stop members of two species from producing fertile offspring are in place which refers to **reproductive isolation**. However, this could be hard as you may have been aware that there are offspring that are **hybrids** of two different species. Also, this definition is useless for organisms that reproduce asexually and for organisms that we only know through fossils, the latter due to our uncertainty if they were able to breed.
- **Morphological species concept** – species are categorized based on similarity or differences in their physical traits, such as size, shape, and other features of their morphology or body form. This would allow us to categorize prokaryotes and fossilized organisms but it relies on subjective criteria, with researchers disagreeing which features distinguish a species.
- **Ecological species concept** – identifies species based on their unique adaptations to their particular roles in their habitat. For example, two river fish may appear similar but one feeds on shallow depths and the other prefers to feed on deeper parts of the river.
- **Phylogenetic species concept** – defines species based on a shared common ancestor and this would be the closest to Darwin’s view of the history of life on Earth.



Each definition is useful depending on the situation or questions asked but the **biological species concept** helps us focus on the differences among the groups of organisms and how they are reproductively isolated from one another. There are two mechanisms by which speciation occur because of this reproductive isolation:

1. **Allopatric speciation** – where species arise because groups from an original population become isolated geographically from each other. Imagine a mountain suddenly rises and divides a large population into two and isolated them on either side of that mountain for example.
2. **Sympatric speciation** – a new species arises within the same area as its parent species. This may be due to errors during cell division or other factors such as when organisms become more selective to specific traits in choosing their mates.