Introduction to Phyla

Earth carries millions of animal species that come in a spectacular array of shapes and sizes. Some even challenge our conceptions about animals. Despite this wealth of species, the diversity of animal types is based on a limited number of fundamental blueprints called body plans.

Each body plan represents a phylum (*pl.* phyla) which can be defined as a group of organisms sharing a common ancestry and a unique assemblage of traits. While all phyla are distinct, the features characterizing them are not. In fact, some of the same features, as listed below, may be found in more than one phylum, or could be absent from a specific member of a phylum.

While there may be as many as 35 different phyla in the animal kingdom, 98 percent of all animals fall into only eight main ones. Each episode of *The Shape of Life* features one of these eight phyla.

Phylum Porifera
Sponges

Episode One of *The Shape of Life*, entitled "Origins," features the rather unassuming phylum Porifera – commonly known as the sponges. Sponges are considered the oldest of the animal phyla. The name Porifera means "pore bearer" in Latin. The surface of a sponge's body is covered by a skin, one cell thick. This is penetrated by numerous small pores and a few large openings. These are respectively the entrances and exits for a complex system of canals and chambers through which the sponge pumps a current of water. The body of the sponge between this system of canals is a loose assemblage of cells that secretes a supporting skeleton of collagen fibers and mineral spicules (glass or calcium carbonate) and carries out the process of growth, repair, nourishment, and reproduction.

Features:

- **Asymmetrical**
- **Organized as an assemblage of different kinds of specialized cells, e.g.,collar cells**
- **No tissues**
- **Skeleton lacking or made of spicules**

As the sponge pumps in water, it captures tiny food items – as small as a single micron in diameter. Specialized cells, called collar cells or choanocytes, allow sponges to pump water through their bodies at an amazing rate: Many sponges can filter their entire body volume in less than one minute! That's an important attribute, considering that some sponges must pump over a ton of water to secure just a single ounce of food!

Phylum Cnidaria
Jellyfish, Corals, Anemones, Hydra

Episode Two of *The Shape of Life*, entitled "Life on the Move," features the phylum Cnidaria, which includes such animals as jellyfish, corals, sea pens, sea anemones, and hydras. Many cnidarians alternate between two different body forms in their life: the free-swimming form, called the medusa, and the stationary form, called the polyp. Both body types follow the same basic plan. Each has a single opening that serves as both the mouth and the anus (where waste is excreted). That shared opening is typically surrounded by a ring of tentacles, allowing the animal to capture prey in all directions.

Cnidarians also have a defined top and bottom and two discernible tissue layers: an epidermis outer layer and an internal gastrodermis. Contained between these tissue layers is a layer called mesoglea. In medusa, the mesoglea is an elastic, clear jelly with fibers made of a protein called collagen. The mesoglea helps in locomotion by elastically recoiling in response to muscle contractions. Cnidarians' muscles and nerves are located at the base of the tissue layers. The internal

space, surrounded by the layers of tissue and mesoglea, is the gut or gastrovascular cavity.

Features:

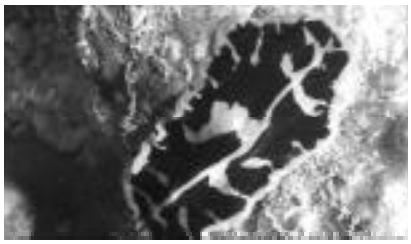
- **Two tissue layers with nerve and muscle tissues**
- **Nematocysts – structures contained in special cells called cnidocytes or cnidoblasts that can act in both offense and defense**
- **Two main life forms – free-swimming medusa (e.g.,jellyfish) or stationary polyp (e.g., anemone)**

One of the unique features of cnidarians is the stinging cells they use to capture prey. Located in their tentacles, these stinging cells, called cnidocytes, contain tiny, often toxic harpoons, called nematocysts. (The name Cnidaria comes from the Latin word meaning "nettle.") Triggered by touch or by certain chemicals, nematocysts fire out of the cnidocyte housing at lightning speed. Some hydra can fire these harpoons with an acceleration force equal to 40,000 times the acceleration of gravity. That's 10,000 times the acceleration force of a space shuttle. Often, lethal poisons are then injected into the prey once the nematocyst hits its mark.

The combination of differentiated tissues, muscles, nerves and a gut allowed ancestral cnidarians to be the first animals on the planet to show animated behavior.

Phylum Platyhelminthes
Flatworms

Episode Three of *The Shape of Life*, entitled "The First Hunter," features the phylum Platyhelminthes. This lesser-known group includes such animals as freshwater planaria, colorful marine polyclads and parasitic tapeworms and flukes. The name Platyhelminthes in Latin means *flat worm*.



Features:

- **Bilaterally symmetrical with a head and a tail**
- **Centralized nervous system**
- **Three tissue layers**
- **No coelom (body cavity),no circulatory system and no hard skeleton**

Fossilized worm tracks in the early Cambrian period (over 550 million years ago) hint at the origin of this body plan. While the actual classification of Platyhelminthes remains controversial, flatworms share distinctive features: Flatworms are bilaterally symmetrical with a defined head and tail region and a centralized nervous system containing a brain and nerve cords. Clusters of light-sensitive cells make up what are called eyespots. The head region of the flatworm also contains other sense organs, which are connected to the flatworm's simple brain. Like most animals, except sponges and cnidarians, flatworms possess three tissue layers making them triploblastic. The middle tissue layer, called the mesoderm, helps form true organs, including reproductive organs, such as ovaries, testes, and a penis.

Flatworms are hermaphroditic and capable of sexual and asexual reproduction. They are, as their name implies, flat. They have no circulatory system or body cavity (coelom), but they do have an excretory and digestive system. Passive diffusion through the skin supplies oxygen to their body parts. The highly branched gastrovascular (gut) cavity distributes nutrients to their cells.

Most species of flatworms are parasitic, having evolved protective skin coverings and elaborate attachment mechanisms to allow them to live inside their hosts. One example featured in this episode is the tapeworm.

This episode discusses sexual reproduction in terms that might not be appropriate for children and early teens.

Phylum Annelida
Polychaetes, Earthworms, Leeches & Cambrian Explosion

The Cambrian period began approximately 543 million years ago. Of the eight major phyla covered in *The Shape of Life* series, two were known from fossils of this time – Porifera and Cnidaria. Shortly thereafter, a profuse radiation of fossils representing the other animal body plans occurred over a relatively brief span of about 10 million years (by some estimates, 530 million years ago.) The rest of the animal phyla all evolved during, or shortly after, this evolutionary explosion of new life forms in the Cambrian period.

Features:

- **Elongate and bilateral with segmented true body cavity (coelom)**
- **Complete circulatory system with capillaries,arteries and veins**
- **Body wall made of circular and lengthwise muscles**
- **Continuous gut running from mouth to anus with own musculature**
- **Bristle-like structures,called setae, projecting from body (except in leeches)**

Episode Four of *The Shape of Life*, entitled "Explosion of Life," features the phylum Annelida which includes animals like earthworms, polychaetes, and leeches. The Annelida body plan is equal in complexity to that of chordates. Far from being lowly worms, these creatures are impressively powerful and capable animals.

Annelids are bilaterally symmetrical. They also contain three tissue layers and a true body cavity, or coelom. The coelom surrounds a one-way muscular digestive tract that runs from the mouth to the anus and includes a pharynx, intestine, and other structures. Annelids have a closed-circulatory system with capillaries connecting to arteries and veins, as well as a segmented central nervous system that includes a simple brain located in the head region.

One of the distinctive traits of an annelid is that it has many segments, or rings, that comprise its body. In fact, Annelida means "little ring" in Latin. Each segment has a number of bristles, called setae, which help the worm move. The evolution of segmentation is an important step for the annelids because it provides an opportunity for separate regions of the body to specialize in different tasks. The fluid-filled coelom was another important innovation for annelids, as it insulated the gut from body locomotor muscles and provided a hydrostatic fluid skeleton against which the muscle system could work quite effectively.

Phylum Arthropoda
Crustaceans, Spiders, Millipedes, Centipedes, Insects

Episode Five of *The Shape of Life*, entitled "The Conquerors," features the phylum Arthropoda – a group that includes crustaceans, like lobsters and shrimp, spiders, millipedes, centipedes, and insects. Of all the phyla in the animal kingdom, Arthropoda is by far the largest and most diverse.

Features:

- **Hard exoskeleton made of chitin and protein**
- **Possess numerous jointed appendages and a segmented body**
- **Must molt to grow**

All arthropods have segmented bodies and are covered in a hard, yet flexible, protective armor called an exoskeleton. Their body muscles attach to the inside of the exoskeleton. The name Arthropoda means "jointed foot" and refers to their jointed appendages. In order to grow, arthropods must shed their exoskeleton periodically, engaging in an activity called molting. When an arthropod passes through specific developmental stages during molting, it is said to be metamorphosing. Radical changes in body design can come from metamorphosis. For example, an arthropod like a dragonfly can start life in a pond as a swimming larva and then metamorphose into a completely different-looking, winged adult.

Arthropods, like all animals, first appeared in the sea, yet became the first animal group to invade land and even take to the skies. (Our direct ancestors, the chordates, didn't invade land for another 100 million years.) Once on land, arthropods adapted superbly to the new environment.

The incredible diversity and success of the arthropods can be attributed to their extraordinarily adaptable body plan. A key feature of this plan lies in the development of myriad types of appendages (antennae, claws, wings, shields, mouthparts) that allowed arthropods to exploit nearly every niche on Earth.

Phylum Mollusca
Clams, Snails, Slugs, Nautilus, Octopus

Episode Six of *The Shape of Life*, entitled "The Survival Game," features the phylum Mollusca. Animals in this phylum, including chitons, snails, slugs, clams, squid, and octopus, show an amazing degree of diversity. All molluscs have soft bodies. In fact, the name Mollusc means "soft" in Latin. Most molluscs are generally covered by a hard shell, which is secreted by a layer of tissue called the mantle that overlays the internal organs of the mollusc.

Molluscs also have a strong muscular foot, which is used for movement or grasping. They have gills, a mouth and an anus. One feature unique to molluscs is a file-like, rasping tool called a radula. This structure allows them to scrape algae and other food off rocks and even to drill into prey or catch fish.

Features:

- **Rasping organ called a radula – present in all groups except bivalves and *Aplacophora***
- **Muscular foot – used for locomotion and other tasks**
- **A sheath of tissue called the mantle that covers body and can secrete the shell (if there is one)**
- **A mantle cavity that houses the gills or lungs**
- **A calcium shell present in most molluscs – some molluscs have greatly reduced their shells, e.g., squid;while others have completely lost it, e.g.,slugs, nudibranchs,and octopus**

The diversity of molluscs impressively demonstrates how a basic body plan can evolve into a variety of different forms that allow survival in specific environments. For example, the hard shell in a land-dwelling snail is relatively large and serves to protect the animal. In the fast-swimming squid, however, the shell has been reduced to a small pen-shaped structure.

Phylum Echinodermata

Sea Stars, Sea Lilies, Sea Urchins, Sea Cucumbers, Brittle Stars

Episode Seven of *The Shape of Life*, entitled "Ultimate Animal," features the phylum Echinodermata. This phylum, which is exclusively marine, includes animals such as sea stars, sea lilies, urchins, sea cucumbers, and brittle stars.

Features:

- **Internal skeleton made of little calcium plates**
- **Five-part symmetry**
- **Special fluid-filled system (called a water vascular system) that operates the tube feet**

While the majority of animal body plans are bilateral with a distinct head and tail, the phylum Echinodermata does not follow this pattern. Instead, many echinoderms begin life as a bilateral larva and later in life become radial with five-part symmetry and no central brain. Echinoderms move, feed and respire with a unique water-vascular system ending in what are called tube feet. Sea stars use their tube feet to slowly pry open clams, mussels or other prey. Some sea stars can even evert their stomach between the two shells of a bivalve and digest the soft parts inside.

The bodies of echinoderms are made of tough, calcium-based plates that are often spiny and covered by a thin skin. The name, Echinodermata, means "spiny skin" in Latin. While most echinoderms are either stationary or slow-moving, methodical animals, they are nevertheless prominent members of the marine environment.

Phylum Chordata

Tunicates, Lancelets, Vertebrates, including Amphibians, Reptiles, Mammals

Episode Eight of *The Shape of Life*, entitled "Bones, Brains and Brawn," features the phylum Chordata. The Chordata includes a wide range of animals from tunicates that look superficially more like sponges, to vertebrates, including fishes, frogs, snakes, birds, and ourselves.

Despite this diversity, virtually all chordates share certain features at some point in their lives. These include a stiffening rod, called a notochord, that in many members (e.g., the vertebrates) is later replaced by a bony, vertebral column. In most adult vertebrates, the notochord only remains as a disk between the vertebrae. Another chordate feature is a hollow nerve structure called a dorsal nerve cord that in most members becomes the spinal cord and brain. Also included in the chordate body plan are structures called pharyngeal gill slits, or clefts. These skeletal elements function as jaws and jaw supports, and in some animals take on a variety of other functions.

Features:

- **Notochord – an elongate rod-like structure located above the gut and below the nerve cord**
- **Dorsal nerve cord – a hollow tube that in most differentiates into a brain anteriorly and a spinal cord posteriorly**
- **Gill clefts – structures located behind the mouth and in front of the esophagus**
- **Segmented muscles (except for tunicates)**
- **Post-anal tail**

The most conspicuous group of chordates is the subphylum Vertebrata. Vertebrates include a wide range of animals, from the jawless fishes to the more familiar mammals and birds. Unlike arthropods that wear their skeletons on the outside, chordates have their skeletons on the inside. This design, as in the echinoderms, allows chordates to grow continuously with no need for molting. Such a robust internal skeleton helps vertebrates grow to the size of an African elephant, or support the powerful movements of swimming fish.

Another major innovation in the evolution of vertebrates is the appearance of jaws and a bony skull. A quadrupling of genetic information and the appearance of a special population of migratory, cells called neural crest, are correlated with the emergence of the all-important vertebrate jaws and skulls. These new features offered a host of new opportunities.

Vertebrates fall into two main categories: fishes, and a group of animals called tetrapods. Tetrapods developed from a distinct lineage of fishes that possessed unique internal fin bones. These structures eventually aided in supporting the weight of the animals on land and laid the foundation for arms and legs and the first amphibians. The development of a shelled, water-retaining egg, the amniotic egg, enabled tetrapods to remain on land and develop into reptiles (including birds) and mammals.

From an ancient reptilian ancestor, two groups of animals, mammals and birds, independently developed the capacity to maintain a constant body temperature. Mammals evolved earlier than birds, more than 220 million years ago, and are represented today by more than 4,500 species, including humans.

Name Game—Getting to the Root of Things

"Echinoderm" is one of many examples of animal names based on Latin or Greek roots. *Echino* means "spiny." *Derm* means "skin." So... *Echinoderm* means "spiny skin." See if you can create some animal names using the word roots below. Draw a picture of the animal to match the descriptive name.

bi = two	**tri** = three	**poly** = many	**chloro** = green
endo = inside	**ecto** = outside	**peri** = around	**noto** = back
echino = spine	**ramus** = branch	**cerv** = neck	**chele** = claw
cephal = head	**som** = body	**pod** = foot	**stom** = mouth

There are many other Latin and Greek roots used for naming animals, sciences, body parts, diseases, etc. If you learn lots of those roots, you'll find that you can figure out the meanings of words you haven't even heard or seen before.

Common Names

There's a problem with common names. They don't always describe animals accurately. That's what scientific names are all about. There is only one official scientific name for each species of living thing. A specific kind of animal might have several different common names, but only one scientific name. The scientific name makes it clear what animal it really is. See if you can find out:

- What two words make up a scientific name?
- What language(s) is (are) used to develop these two words?
- How should the two words be written?