

Vertebrate origins

1) Chordates

- a) Chordates are a classification of organisms that includes all vertebrates and a few other groups as well
- b) The first chordates evolved about 540 million years ago in the late Cambrian with the first vertebrates following not long after in the early parts of the Ordovician
- c) Chordates all share the same 5 characteristics at some point during their development
 - i) **Notochord**
 - (1) The notochord is a flexible rod extending the length of the body.
 - (2) Muscles attach to the notochord allowing for more refined movements
 - (3) Most modern chordates replace the notochord with a cartilage or bone vertebrae during development (the ones who do not are **amphioxus** and **jawless vertebrates**)
 - ii) **Dorsal hollow nerve cord**
 - (1) Unlike most invertebrates chordates nerve cord is located dorsally and is hollow
 - (2) In vertebrates the anterior end enlarges to become a brain
 - iii) **Pharyngeal slits**
 - (1) Openings from the pharyngeal cavity (throat area) to the outside
 - (2) In early chordates this was used for filter feeding
 - (3) More modern aquatic vertebrates use some of these slits as gills and others have developed into other organs
 - (4) In terrestrial vertebrates many of these slits become structures such as the middle ear cavity, tonsils, parathyroid glands.
 - iv) **Endostyle or thyroid gland**
 - (1) Endostyles secrete mucus in the pharynx for more efficient filter feeding
 - (2) In juvenile lamprey (jawless fish) they secrete mucus and an iodinated protein. However when the lamprey matures this endostyle turns into a thyroid gland.
 - v) **Postanal tail**
 - (1) Evolved specifically for swimming and propulsion
 - (2) Only evident in humans during development and as the coccyx bone (tail bone)
- d) Chordates include the protochordates as well as the vertebrates.
 - i) **protochordates** are represented primarily by two groups, the tunicats and the cephalochordates
 - (1) tunicates
 - (a) these odd creatures only show the characteristics of chordates as a larvae
 - (b) as adults they are highly specialized and their chordate traits have been greatly reduced or absent all together
 - (c) the notochord and tail disappear and the nerve cord is reduced to just a single set of ganglions. The pharyngeal slits are ever present as well as an endostyle.
 - (2) Cephalochordates (amphioxus)
 - (a) These are slender animals that show a pristine example of the characteristics that make up chordates.

- (b) Most of these species filter feed and use their pharyngeal slits/ endostyle to help collect food particles.
- (c) The notochord stretches the full length of the body allowing for muscle attachments and swimming when needed
 - (i) Swimming ability are very limited due to lack of other fins

2) Vertebrates

- a) Vertebrates were larger and incredibly more active than the chordates of early seas. However to sustain this life style there came great modification in the skeleton, muscles, ability to capture nutrients, and abilities to digest those nutrients.
- b) **Endoskeleton** of vertebrates allows for almost unlimited body size. These endoskeletons are made of cartilage or bone. Most likely early vertebrates had cartilage skeleton because its easier to repair, lighter, and flexible.
- c) bone endoskeletons probably formed for mineral storage of calcium and phosphorous (both very important for muscle contraction and nervous system function). It also is stronger and better support for muscles to act on.
- d) However, vertebrates also have an exoskeleton (skeleton that develops from the skin). They typically are very specialized in modern vertebrates (scales in fish, hair on mammals, feathers on birds) but in early fish they were bony dermal armor.
- e) To incorporate better movement nutrient intake and absorption had to get better
 - i) The pharynx with its pharyngeal slits became muscular to help circulate water
 - (1) This also lead to increased vascularity forming gills
 - ii) Movement of food in the intestines is made by muscles instead of cilia
 - iii) Accessory digestive glands
 - (1) Liver (for filtering blood and bile production)
 - (2) Pancreas (enzymes and digestion)
 - iv) Multi chambered heart for better blood flow
- f) With greater movement come better sensory organs
 - i) The anterior end of the nerve chord divided into the forebrain, midbrain, and hindbrain
 - (1) this was all protected by a hard cranium
 - ii) paired eyes for depth perception
 - iii) inner ear for equilibrium
 - iv) lateral-line for detecting water pressure
 - v) electroreceptors for detecting electrical currents
- g) with new development of structures there also came specialized cells
 - i) **neural crest cells** these are present in developing embryos that then go on to help create the skull, brain, and endocrine glands.
 - ii) **Hox genes** are specialized regions of DNA that control body plans
 - (1) the combination of hox genes that are activated or not activated control major changes in body form. For example, if a particular hox gene is activated in chickens they will develop teeth similar to ancient reptiles (their relatives).

3) Major vertebrate groups

- a) Fishes

- i) Jawless
- ii) Cartilaginous
- iii) Bony
- iv) Lobefin
- v) Lung fish
- b) Amphibians
 - i) Frogs/Toads
 - ii) Salamanders
- c) Reptiles
 - i) Snakes/ lizards
 - ii) Crocodiles
 - iii) Turtles
 - iv) Dinosaurs
 - v) birds
- d) mammals
 - i) monotremes (egg layers)
 - ii) marsupials (pouched)
 - iii) eutherians (placental)