

Lecture 1.2

Human form and function

Kingdom (**animal**), superphylum (**coelomate**), phylum (**chordate**), subphylum (**vertebrate**), class (**Mammalia**), order (**primates**), family (**hominid**), genus (**homo**), and species (**homo sapiens**). The embryological development of humans reveals why they belong to these evolutionary families: **Ontogeny recapitulates phylogeny**.

Coelomates (superphylum):

- a **segmented body wall** allows independent supply systems etc.
- Coelomates have a **hollow, fluid filled, body cavity** called a **coelom**. The coelom is an enclosed tube that **suspends the gut tube and the visceral organs when they form**.
- Develop from 3 germ layers: **ectoderm** (outer layer), **mesoderm** (support structures), and **endoderm** (the inner lining). These layers are **pre-programmed to form particular structures**.
 - **Ectoderm** = forms the **epidermis, nerve cells, brain, spinal cord, and the nerve fibers of peripheral nerves**.
 - **Mesoderm** = the **supporting and connective structures** such as **muscles, connective tissue, vessels, bone, viscera, skin dermis, and fibrous sheaths** that surround nerve fibers.
 - **Endoderm** = the **surface lining within the gut cavity and the respiratory tract**. Also often known as the **epithelium** of both.

Chordates (phylum):

- characterised by a **hollow nerve cord** or **neural tube** that **forms from the ectoderm**. It **lies on the dorsal surface** of the body. It forms from an **ingrowth of the ectoderm** during development and eventually **forms into the brain and spinal cord**.
- also have a **notochord** and tail. The notochord is derived from **mesoderm** and it goes on to become a **support structure for the neural tube** in some chordates. Humans have little notochord remaining because we have other support mechanisms.
- **pharyngeal pouches** are **endoderm derived grooves at the opening of the gut tube** that turn into different things depending on the animal. They are covered by ectoderm and form their shape due to pharyngeal arches.

Both **coelomates and chordates have segmentation and polarity.**

Segmentation = early during development **segments** form called **somites**. Somites are masses of muscle that sit either side of the vertebral column then grow out laterally to give rise to muscle and support structures around sections of spinal cord.

Polarity = the segments (somites) are arranged in such a way that **cranial somites** give rise to cranial muscles and **caudal somites** give rise to caudal muscles giving polarity. The part of the skin that is innervated by a particular spinal nerve is a **dermatome**. The part of the muscle that is innervated by a particular spinal nerve is a **myotome**.

Limb development: the limbs **begin as paddles** and project outward from the body at **5-6 weeks of development**. At some point there is a **breakage** around the knee/elbow and the upper limbs rotate **laterally** to spread out and the lower limbs rotate **medially** to spread away from the body. This explains why the segmentation appears as so. Limbs each consist of 5 somites (segments). The **pre-axial border** is the **cranial** end of the limb and the **post-axial border** is the **caudal** end despite the fact that this has changed during growth.

Vertebrates (subphylum):

- vertebrates have a **spine, skull, and a skeleton** (to enclose the internal organs).
- vertebrates develop a **spinal cord from the neural tube** containing spinal nerves (peripheral nerves coming off from either side) within the spinal column.
- Vertebrates also have **2 pairs of limbs, all of which have 5 digits** (pentadactyl). All have the same pattern, **one bone in upper arm/leg, two bones in lower arm/leg, and then smaller bones for the hands/feet**. Some animals have not retained the **pentadactyl** pattern, however all primates have retained it.

Mammalia (class):

- The defining characteristic of mammals is mammary glands which are **modified sweat glands formed from the ectoderm**.
- **Skin and appendages** (hair, sweat, sebaceous glands, mammary glands)
- Many mammals such as humans are **placental mammals** that exhibit viviparity. **Marsupials and monotremes are examples of non-placental mammals**.
- Mammals are also **warm blooded with a 4 chambered heart** (differentiating venous and arterial supply - allowing warm blood) and a **large forebrain** (frontal part of the brain, that allows for greater cognitive capacity - planning, thinking etc.)

Primates (order):

- Primates have a big brain, and *binocular vision* (2 enclosed eyes that are on the front of the head allowing *overlapping vision which gives us a perception of depth*).
- Primates also have opposable thumbs (thumbs that are *at 90 degrees* to the rest of the digits) that allow grasping (*prehensile*) activity and this *allows free movement and precision*.
- Primates have *nails rather than claws* that give way to a soft pad for grasping capacity.
- Finally, primates have a *clavicle bone* (developed in vertebrates) which a lot of mammals have lost that paves the way for *independent movement by allowing free arm movement*.

Hominid (family):

A smaller group of primates including humans and the great apes; chimps, gorillas, gibbons etc.

- hominids have a *larger body size compared to other primates, the lack of a tail, and most importantly a more upright posture*. Hominids on the whole don't live in trees like their primate relatives.

Homo sapiens (species):

- *completely upright posture, non-opposable big toe* (this is *energetically more efficient for walking* because we can push off our big toe, and the entire foot moves as a single unit), and a *line of gravity between the feet*.
- a *much larger cranial* capacity.
- Tiny changes have occurred in the spine (creating a gentle "s" shape) that means *standing upright expends the minimum amount of energy with minimal stress on the spine*. Upright posture is *not exactly perfected* in terms of responding to stress e.g. L5 fractures often occur later in life
- Our *femurs are slightly more central* which means we don't have to sway when walking, and our weight is further transferred into the center.

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- *Bipedal locomotion* = *heel strike* (when you put your first foot forward) gravity is between legs, *stance phase* is when the swinging leg is moving through the medial part (gravity is over both legs), during the *swinging phase* your whole weight is on one leg so various postural adjustments are made during this time.
- **We** also have a prolonged pharynx so that the column of air can be manipulated which allows us to communicate and use speech.