Biodiversity

Invertebrates

Ocean Explorer

Module 13

Bayworld Centre for Research & Education

BCRE

Overview

1 - Phyla and body plans

2 - Tissue layers in the body

3 - Invertebrate classification

4 - Importance of invertebrates

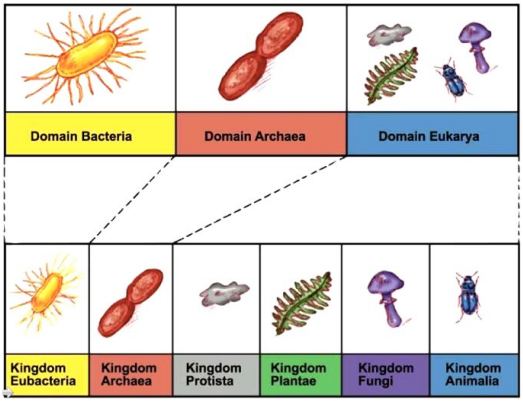
5 - Activity : Collecting Hydra

Info +

*Life is divided into **3 domains**, themselves divided into **6 kingdoms,** then into **phyla**.*

What is a phylum ?

It is the primary subdivision of a taxonomic kingdom, grouping together all classes of organisms that have the same body plan. Plural : Phyla.

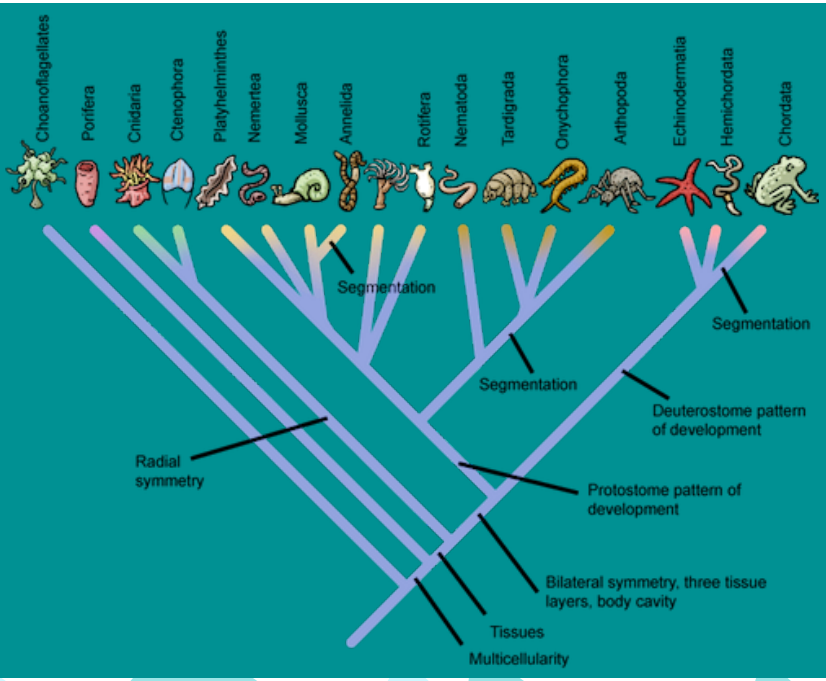


For example, the *Animalia kingdom* can be divided into *two main groups*:

- *Vertebrates* - animals with a vertebral column e.g. birds, frogs, whale, dolphins, humans etc.
- *Invertebrates* - animals without a vertebral column e.g. spiders, leeches, jellyfish, snails, worms, anemones etc.

Animal kingdom phylogeny

We won't be explaining every phylum in this module. If you would like more information on a specific phylum, we recommend the excellent book "The tree of Life" from G. Lecointre and H. Le Guyader.



What is meant by a body plan ?

A body plan is the shape and structure of an animal's body, known as the morphological characteristics, and includes the way in which it develops. A phylum consists of animals with similar body plans.

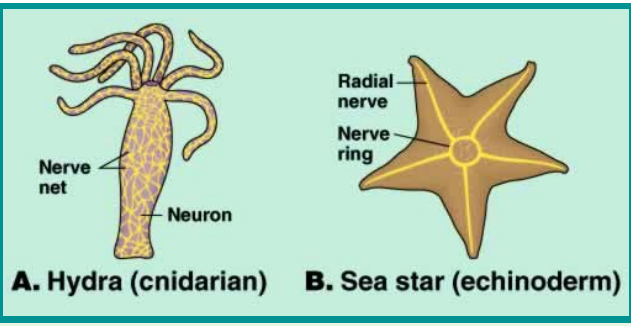
When animals are classified, 4 common features of the body plan are taken into account :

- **Cephalisation** and **symmetry**
- Number of **tissue layers**
- Presence or absence of a **coelom**
- Presence or absence of a **through gut**

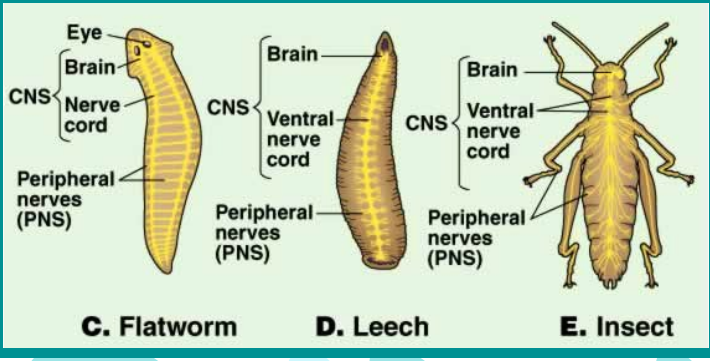
Cephalisation

Presence of a definite head region where there is a concentration of nerve cells and sensory organs that face in the direction that the animal moves in. It is also called a Central Nervous System (CNS).

Animals without a Central Nervous System



Animals with a Central Nervous System



Symmetry

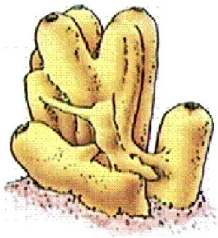
There are 3 types of symmetry :

- Asymmetry : No symmetry present, no miroir image can be obtained when the organism is cut along one or more planes. Example : sponges.
- Radial symmetry : Multiple vertical planes of symmetry, no definite sides, but ends can be distinguished. Usually sessile or free-floating. Locomotion is slow and inefficient. Example : starfish.
- Bilateral symmetry : One vertical plane of symmetry, definite sides and ends. Cephalisation, central nervous system, locomotion in one direction (crawling, running, swimming, flying and burrowing). Example : dolphin.

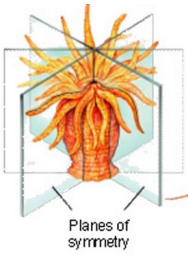
Info +

***sessile** : sedentary and attached to a substrate. No nerves or muscles so unable to move about.*

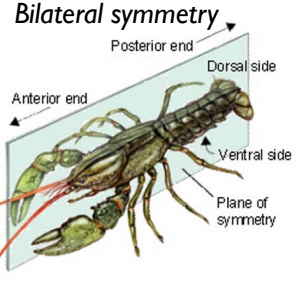
Asymmetry



Radial symmetry



Bilateral symmetry



Different types of skeleton

An **hydrostatic skeleton** consist of fluids held under pressure in a closed body. Annelids use their hydrostatic skeleton for **peristalsis**, a type of movement on land produced by rhythmic waves of muscle contractions.

2 - Tissue layers in the body

Animals are made of several tissue layers, usually developed in the embryo. These layers form a protection around the organs and keep the body together.

There are 2 types of tissue organization :

diploblastic : organisms with only 2 tissue layers, ectoderm and endoderm. Radially symmetric animals are always diploblastic

triploblastic : organisms with 3 tissue layers, ectoderm, endoderm and mesoderm

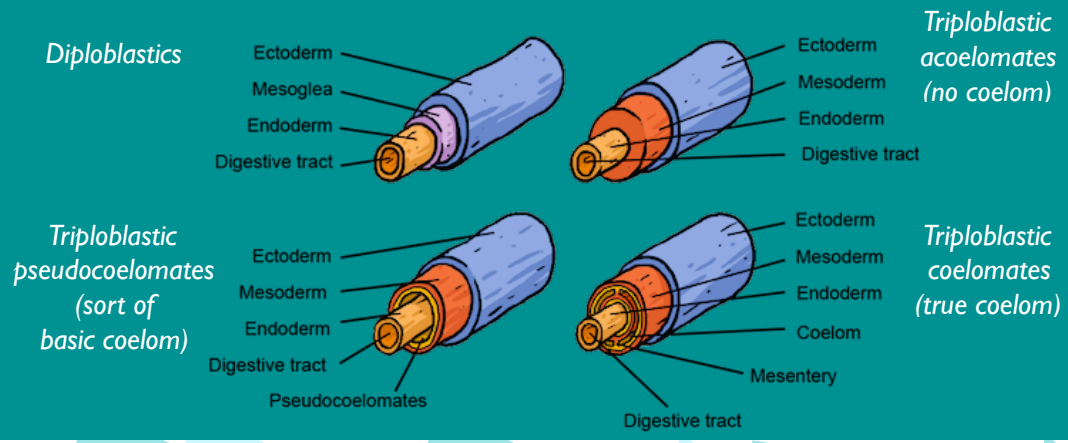
Inside the body, some animals also have a **coelom**. It is a fluid filled body cavity in the mesoderm of certain triploblastic animals. It separates the digestive tract from the body walls.

Info +

coelomic fluid *: fluid that is found within the coelom.*

Why is it advantageous to have a Coelom ?

- Animals can be larger and more complex (space for organs to develop)
- Body wall and internal organs function independently
- Coelomic fluid can act as an **hydrostatic skeleton**
- Helps the transport of gas (oxygen), nutrients (food) and waste.



The gut

During the embryology phase, another important structure is developed from the tissue layers : the gut.

Depending on the type of animal, the gut can be through (2 openings, one for the mouth and one for the anus) or blind-ending (only 1 opening for both functions).

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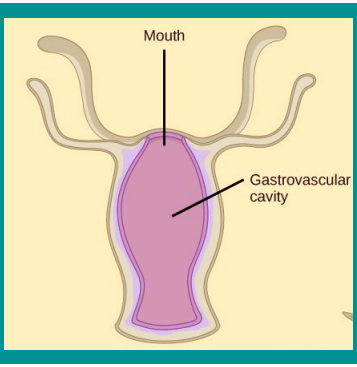
Gut movements
ingest : take food in
egest : remove undigested remains



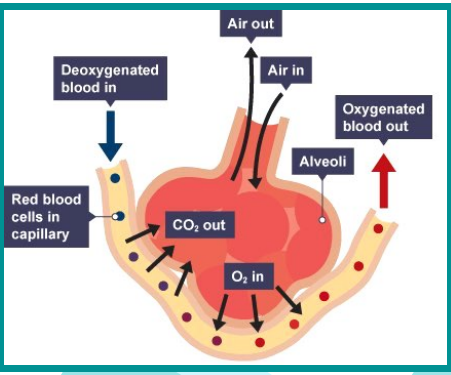
Gastrovascular cavity

Gastrovascular cavity is the name of the gut when there is only one opening for ingestion and excretion. When the 2 openings are present, it is called an **alimentary canal**.

Gas exchanges and diffusion

Land animals need to **exchange gases** between air, blood and other tissues.

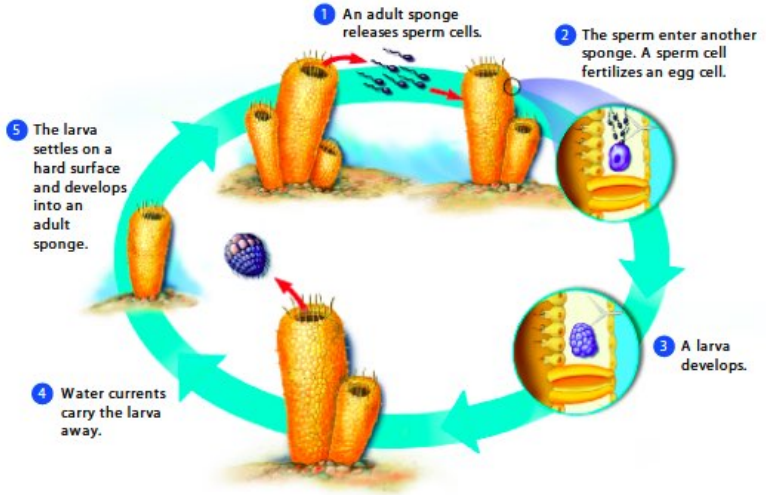
Gas exchange takes place through the process of **diffusion**. Diffusion is most effective when the surface it takes place through is thin, moist and has a large surface area relative to body volume. The greater the surface area, the more diffusion can take place.



An example of diffusion takes places in the lungs' walls, when oxygen is transferred from the air inside the lungs into the blood running around the lungs' walls. The lungs' walls, or membrane, is a very thin tissue and thus allows this transfer.

Porifera (Sponges)

- Diploblastic (2 tissue layers only) but not really true tissue structure
- No muscles or nerves, attached to rocks, corals or shells (Sessile)
- Asymmetrical (no symmetry)
- Acoelomate (no body cavity, no coelom)
- Marine

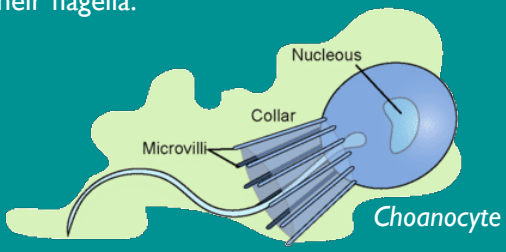


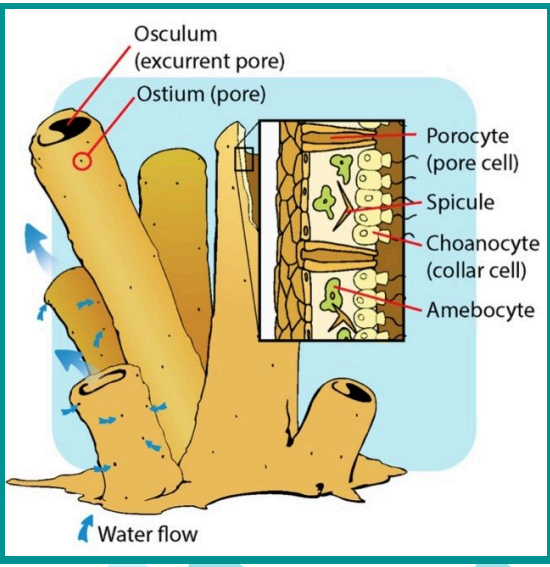
Info +

The sexual reproduction of sponges involves a larval stage that moves. Adult sponges stay in one place.

How do sponges feed ?

They have collar cells : unique flagellated cells that ingest bacterias and tiny food particules.
They create a water current to make the food particules flow to them thanks to their flagella.

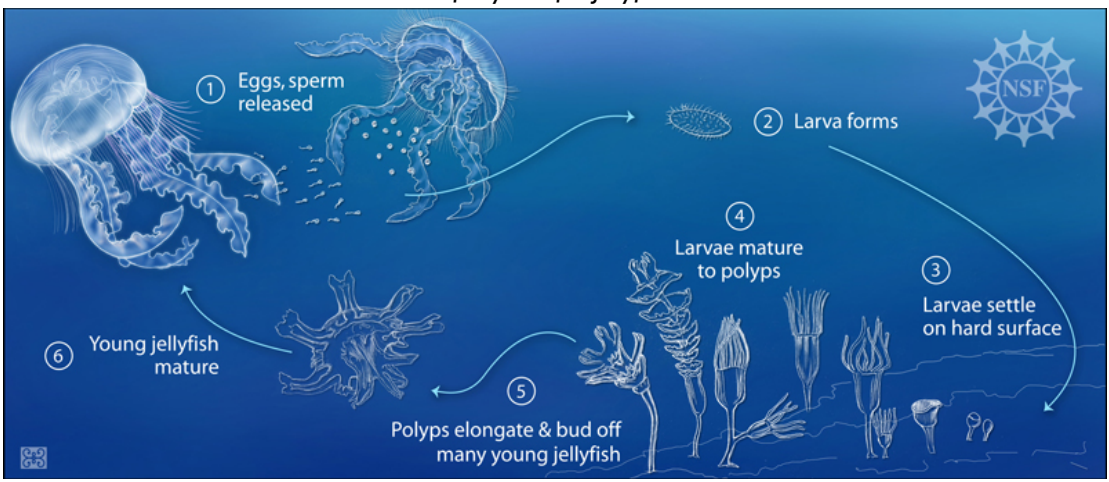




Cnidaria (Jellyfish, Hydra, Sea anemones and Coral)

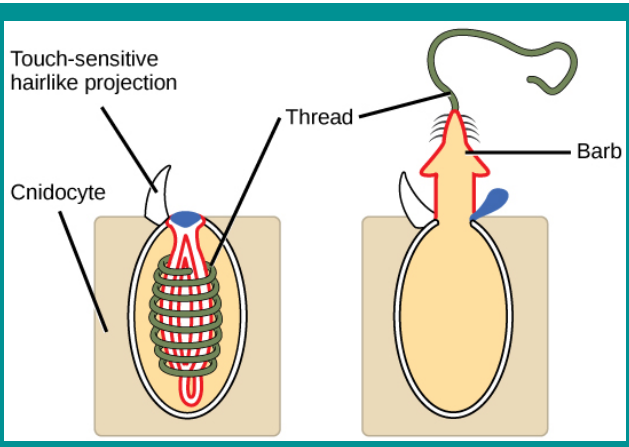
- Diploblastic
- Radially symmetrical
- Acoelomate with blind-ending gut (no body cavity)
- Aquatic (mostly marine)
- Two basic body forms – polyp and medusa
- Corals have a calcareous skeleton that forms coral reefs
- Nematocysts (stinging cells)

Life cycle of a jellyfish



Jellyfishes sting !

Like all Cnidaria, Jellyfish possess nematocysts, also called stinging cells.

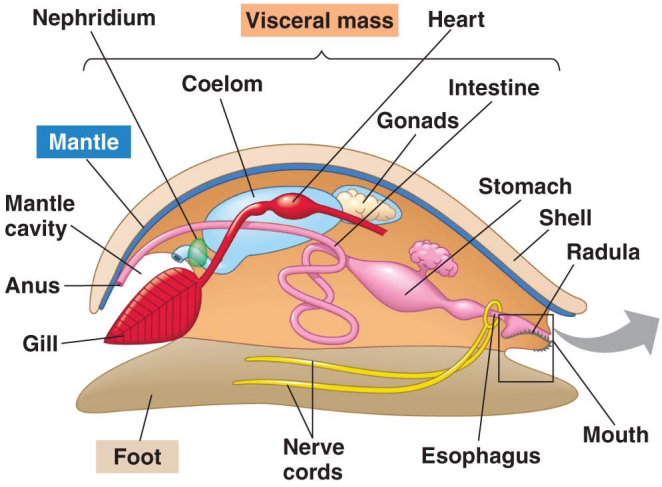


Nematocyst with stored thread and barb

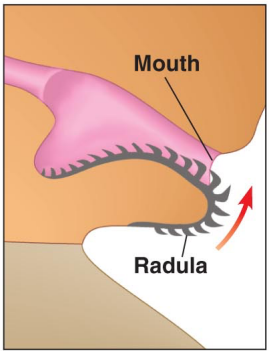
Nematocyst after firing

Mollusca (Clam, Snail, Squid)

- Coelomate (possess a coelom)
- 3 main body parts : muscular foot, visceral mass, mantle
- In most cases, hard shell made of calcium carbonate

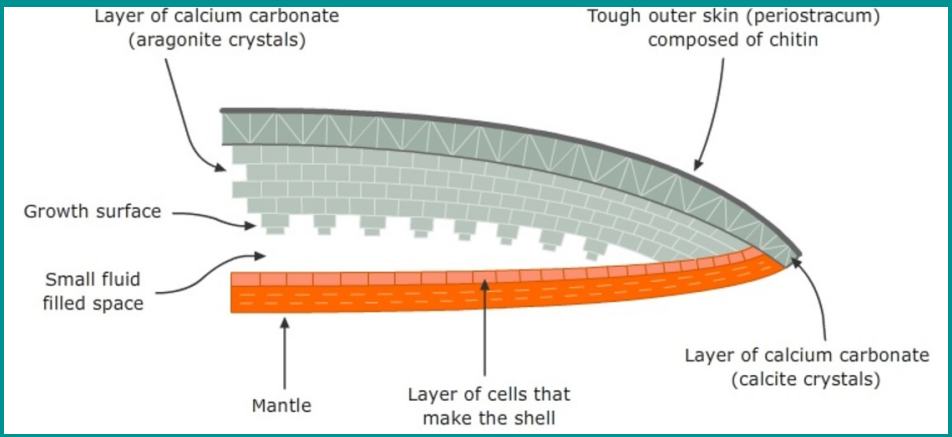


The radula is the strong and rough tongue of a mollusc



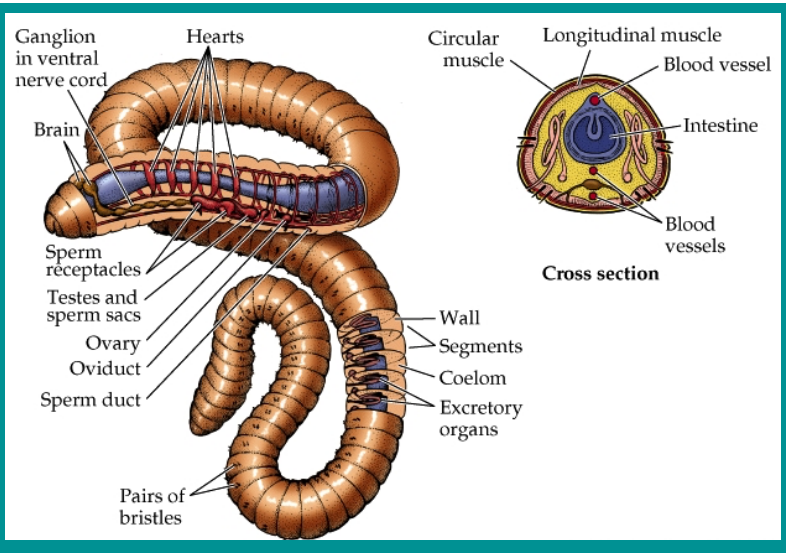
How to build a mollusc's shell

Molluscs have specialized cells on top of the mantle that produce calcite and aragonite crystals. The accumulation of these crystals form the shell.



Annelida (Segmented worms)

- Aquatic and terrestrial
- Triploblastic (3 tissue layers)
- Coelomate (possess a coelom)
- Bilateral symmetry, eyes and organs symmetrical
- Cephalisation
- Segments partitioned by septa
- Digestive tract extends throughout body (Through gut - Mouth and anus)
- Ventral nerve cord with a ganglion in each segment



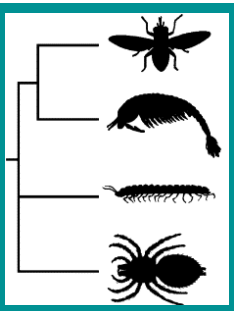
Except for the head and some more specific structures such as sexual organs, a worm is made of identical segments containing sections of muscles, blood vessels, nerve chord and intestine.

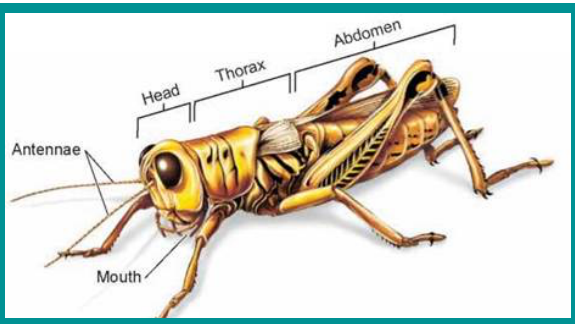
Arthropoda (Insects, Crustaceans, Spiders, Millipedes, Centipedes)

- Found in water, on land and in air
- Exoskeleton
- Waterproof cuticle
- Segmented body

- Jointed appendages
- Triploblastic (3 tissue layers)
- Coelomate (possess a coelom)
- Bilateral symmetry, eyes and organs symmetrical
- Cephalisation
- Digestive tract extends throughout body (Through gut - Mouth and anus)
- Eyes and antennae

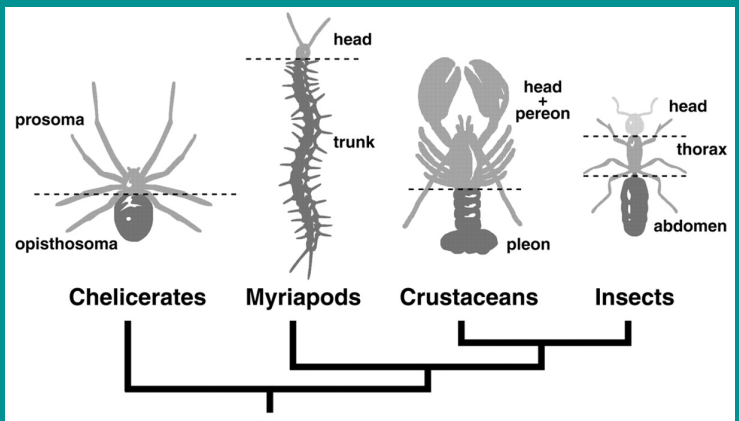
metamorphosis *: a biological process by which an animal physically develops after birth or hatching, involving a conspicuous and relatively abrupt change in the animal's body structure through cell growth and differentiation.*





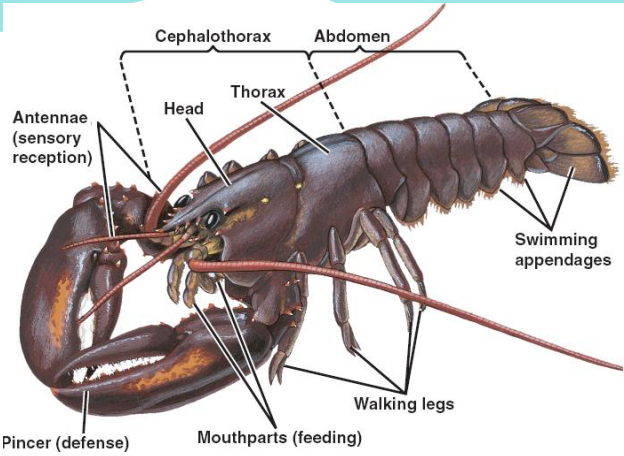
Being part of the same phylum, all arthropoda have the same body structure, even if its arrangement can slightly vary from one sub-phylum to the other.

Arthropoda are very diverse and have colonized most places on Earth. This phylum includes numerous sub-phyla which we are going to describe briefly.



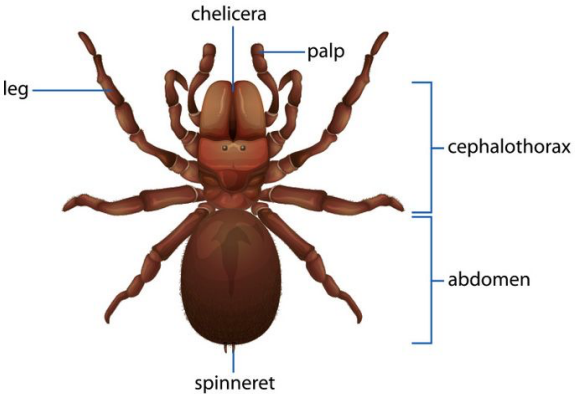
Sub-phylum : Crustacea

- Harder exoskeleton
- Live in water or on land
- 5 pairs of jointed legs
- Cephalothorax and abdomen
- Antennae and compound eyes on stalks



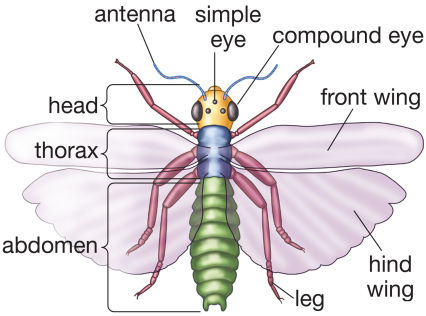
Sub-phylum : Chelicerata

- Cephalothorax and abdomen
- 4 pairs of jointed legs
- Several pairs of simple eyes
- No antennae
- Pincer-like mouthparts (modified limbs)



Sub-phylum : Hexapoda (Insects)

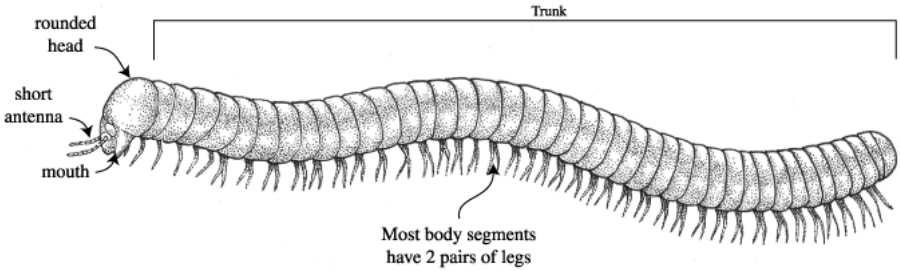
- Mostly in air or on land
- Head, thorax and abdomen
- Compound eyes, antennae and mouthparts
- 3 pairs of thoracic legs
- Some insects undergo metamorphosis during their life



Sub-phylum : Myriapoda (Millipedes, Centipedes)

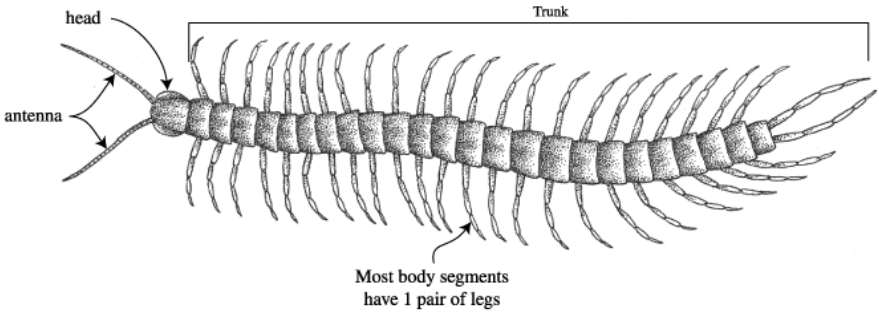
Millipedes :

- Rounded, segmented body
- 2 pairs of legs per segment
- Single pair of antenna
- Strong mouthparts



Centipedes :

- Flattened, segmented body
- 1 pair of legs per segment
- Run fast
- Single pair of antenna
- Strong mouthparts and poison claws

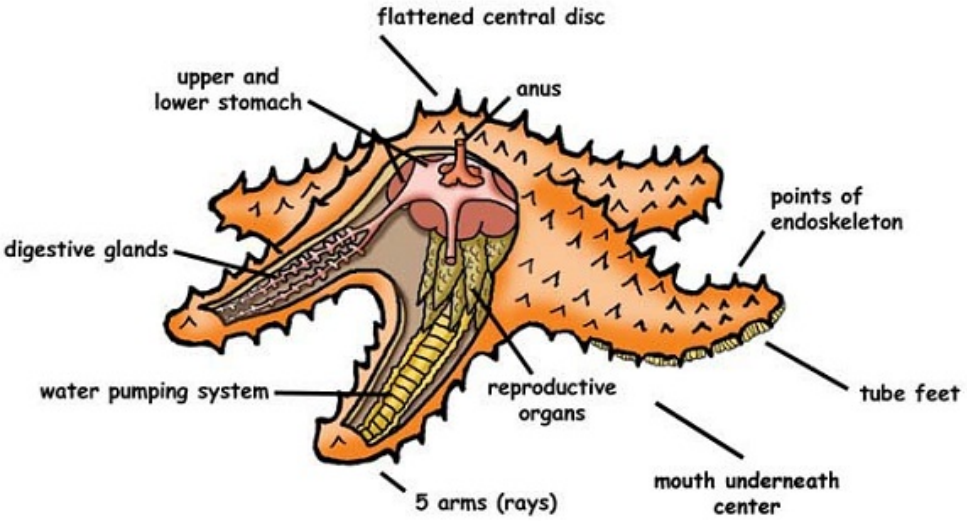


Comparative table of main features of the different arthropod classes

Characteristic	**Crustacea**	**Chelicerata**	**Myriapoda**	**Hexapoda**
Number of body sections	2 or 3	2	2	3
Pairs of legs	5 or more	4	Many	3
Pairs of antennae	2	None	1	1
Wings	None	None	None	1 or 2 pairs

Echinodermata (Sea urchins, Starfish, Sea lillies, Sea cucumbers)

- Marine
- Radial symmetry (always pentamerous - 5 axes)
- Water-vascular system used for locomotion and attachment
- Triploblastic
- No cephalisation
- Coelomate (possess a coelom)



Making up 97 percent of all animal species on earth, invertebrates are, according to acclaimed ecologist E. O. Wilson, "the little things that run the Earth." An invertebrate is any animal without a spinal column, and the word refers to insects, spiders, worms, snails, crustaceans, clams, squid, octopi, sea anemones, and coral, to name a very few. Some invertebrates are generalists and thrive almost anywhere, while others are extreme specialists, occurring in limited habitats and sometimes depending on a single plant species.

Why are they so important ?

Though invertebrates are usually small, their ecological importance is in inverse proportion to their size - if we lost invertebrates, flowering plants would lose their pollinators, water would lose much of its filtration system, the soil would lose its composters and earth-turners, and the whole ecological system would likely collapse within months.

How many invertebrate species actually live on Earth ?

We don't know ! The number of invertebrate species on Earth is unknown. Though we have described around 1,300,000 species, there remain an estimated 7 million more to be discovered. The group we call "invertebrates" is so vast that it is difficult to determine how many of them are threatened with extinction. What we do know is that 31% of invertebrate species evaluated by the IUCN in 2010 were at risk. Without swift action to halt the current extinction crisis, we may lose many invertebrates before we even knew they existed or what ecological role they played.

Material needed

Wide-necked plastic or glass jar with tight fitting lid (e.g. peanut butter jar)
Hand lenses

Method

1 - Clean the jar well inside by scrubbing and rinsing it.

2 - Find some shallow water in a pond or river and half fill the jar with water from it.

3 - Collect twigs, dead leaves and other materials from the bottom of the pond or river, and push them into the jar. Make sure to include some living water plants in the materials added to the jar.

4 - Close the lid on the jar tightly and return to the classroom. Remove the lid and place the jar where it will get plenty of light (not in direct sunlight).

5 - Leave the jar to stand for a day, undisturbed, until the water has cleared.

6 - Examine the jar using a hand lens, looking on the brightest side of the jar for hydras (thin threads that are fuzzy on one end). Hydras are usually colourless, but can be green or brick red.

Questions

1 - Observe the hydras with the hand lens to see if they move or eat.

2 - Draw a diagram of a hydra and describe any behaviour you observed.

To maintain the hydra colony, top up the jar with water from the river/pond every few days. It will give them the nutrients (food) that they need to survive and grow.