The Villablanca Connection

UNIT 7:

ANIMALS I. INVERTEBRATES

“When you have seen one ant, one bird, one tree, you have not seen them all.”
Edward O. Wilson.

Unit 7: Animals I. Invertebrates.
Biology and Geology 1º ESO
Villablanca Connection

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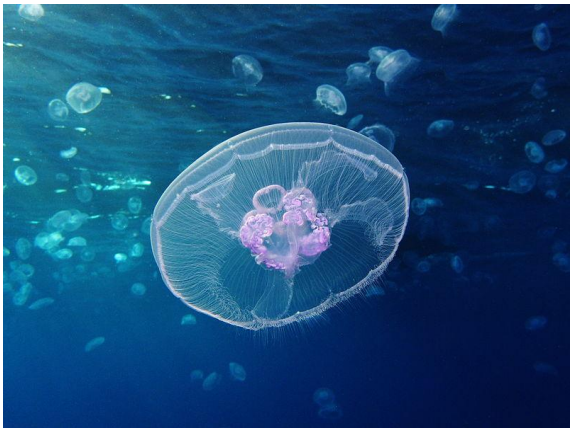
Unit 7: ANIMALS I: INVERTEBRATES.

1. What is an animal?

Usually, the students of 1º ESO consider the animals as the most interesting of the organisms. It is easy for humans to develop such an interest because they are more similar to us that any other living being. In the natural world we are just another type of animal and we all belong to the animal kingdom.
Animals are basically **eukaryotic**, **multicellular** and **heterotrophic** organisms, without a cell wall and, with a few exceptions, with real **tissues**, **organs** and **systems**.
Animals have also other common characteristics:

- Although some of them are **sessile** organisms, most of them **can move** very quickly compared to plants or fungi.
- They are very **sensitive organisms** and react quickly to the changes in the environment.
- Animals stop their growth when they reach to an adult age with reproductive capacity.
- The high metabolic rate of the animals depends on their **breathing**, taking oxygen from the atmosphere and returning carbon dioxide.
- All the animals get the organic matter they need from other organisms: they are **heterotrophs**. Some of them can feed on plants or algae and are **herbivores**, while others feed on other animals and are considered **carnivores**. But some of them can feed on both plants and animals and are called **omnivores**.
- Depending on the relationship with the living beings they eat, animals can be **predators**, **parasites** or **saprotrophs**.
- Although some animals can also reproduce **asexually** through budding or through fragmentation, all of them have **sexual reproduction** by means of **spermatozoa** (=male gametes) and **ova** (=female gametes) that fuse together to form the **zygote**. When this happens inside the body of the female it is called **internal fertilization** and when this happens outside the body of the female, directly in the water, it is called **external fertilization**.
- In most of the animals we find **separate sexes** (=some individuals are male and the rest are female) but in some groups of animals we can find species that are **hermaphrodites** with both male and female organs in the same individual.
- In the **oviparous** animals the embryo develops inside of an egg that is laid by the female. If the egg is not laid and it remains inside of the female until the egg hatches we talk of **ovoviviparous** animals. And if the embryo develops directly inside of the mother's body, and it is actively fed by the female until the birth, we have **viviparous** animals.
- The offspring of some species of animals present an aspect that is similar to that of the adults, and they become gradually even more similar as they grow. These species have a **direct development**. But in other species the offspring are very different to the adults (they are **larvae**) and become adults only after a complex process called **metamorphosis**. These species have an **indirect development**.
- Most animals have a **bilateral symmetry** because their body presents right and left halves. Some of them have a **radial symmetry** because their body looks like the wheel of a bicycle, with many radiuses, and can be divided into equal halves by any of the diameters. And only a few are **asymmetrical**.
- Most animals have hard parts in their body that form a **skeleton**. The conch of the snails or the shell of the mussels are examples of an **exoskeleton** (= external skeleton). The bones of a human or the fishbone of a trout are examples of an **endoskeleton** (= internal skeleton). Some other animals, like the worms, have not a skeleton at all.

Some animals like this bat *Eptesicus fuscus* have bilateral symmetry.



Some animals like this moon jellyfish *Aurelia aurita* have radial symmetry.

2. Classification of the animals.

For didactical purposes, animals are classified into the following groups:

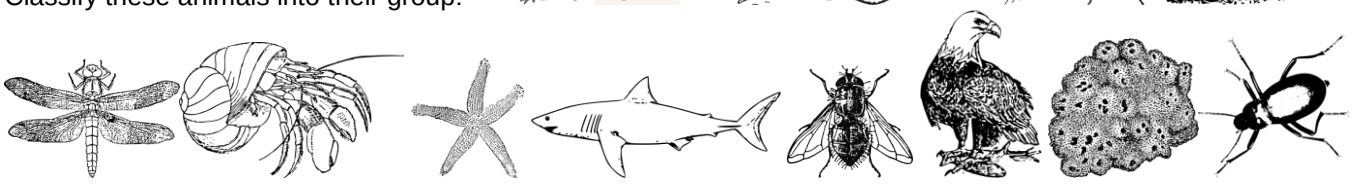
- **Invertebrates** (animals without a backbone)
  - Porifera (=Sponges)
  - Cnidaria
  - Platyhelminthes (=Flatworms)
  - Nematoda (=Nematodes or Roundworms)
  - Annelida (=Segmented worms)
  - Mullusca (=Molluscs or Mollusks)
  - Arthropoda (= Arthropods)
  - Echinodermata (=Echinoderms)
- **Vertebrates** (animals with a backbone)
  - Fish
  - Amphibians
  - Reptiles
  - Birds
  - Mammals

Activity 109.
Write the meaning of:
a) eukaryotic organism
b) multicellular organism
c) heterotrophic organism
d) tissue
e) organ
f) sessile organism

Activity 110.
Decide if the following statements are true or false and correct the false ones:
a) Some unicellular animals are herbivores.
b) Animals have cells with the cell wall made of chitin.
c) Mosquitoes are sessile organisms.
d) Some animals are hermaphrodites.
e) The male gamete is called spermatozoon
f) When the development of the embryo occurs inside of an egg the species is viviparous.
g) Spiders are vertebrates because they have a backbone.
h) In oviparous animals the egg develops inside the body of the female.
i) Budding is a type of asexual reproduction.
j) The domestic fly has bilateral symmetry.
k) When the zygote is formed outside of the body of the female it is called internal fertilization.
l) Animals with direct development undergo metamorphosis.

Activity 111.

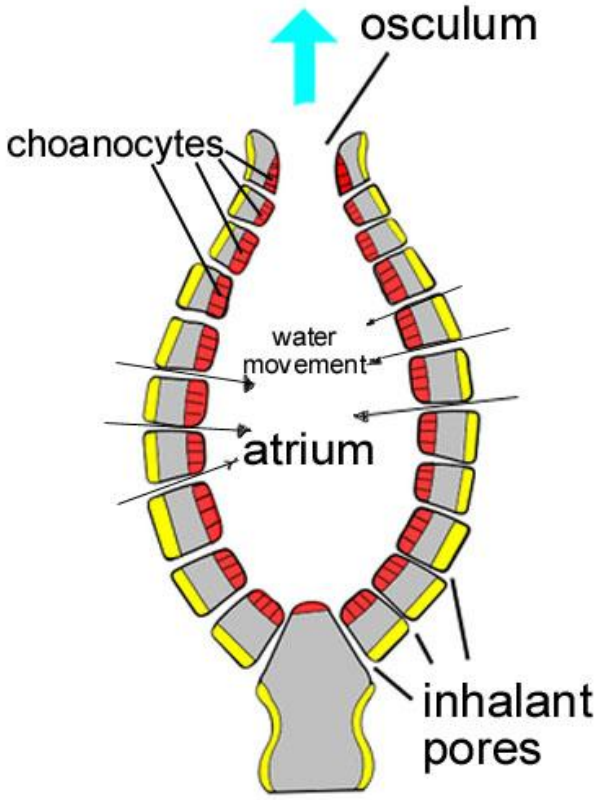
Classify these animals into their group: 

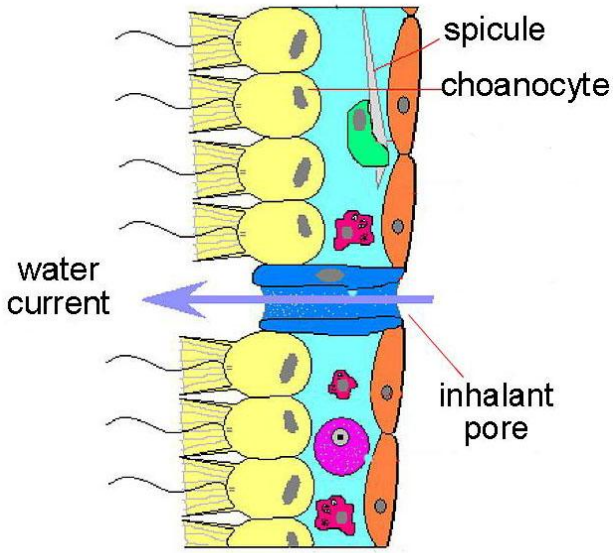


Activity 112.
Copy in your notebook the classification of the animals.

3. Porifera.

Porifera means “animals with the body perforated by pores”. They are also known as “sponges”.
Porifera are **aquatic sessile** animals that live attached to the sand or the rocks in oceans and seas all over the word. Only a few species live in freshwater.
They are considered the simplest organisms in the animal kingdom. In fact it took some time to realize that they were not a weird type of algae or fungi, and it was not until 1825 when the studies of their structure under the microscope and the nature and characteristics of their cells convinced the scientists that they were animals.
Sponges present a great variety of shapes and colors and most of them are **asymmetrical**; but many of them look like a “cup” or “chimney” with a big internal cavity called **atrium** and a big hole in the top called **osculum**.
Sponges have an internal skeleton formed by microscopic needles called **spicules**. The chemical composition of these spicules is used as a criterion to classify these animals. Most of the times the spicules are made of calcium carbonate or silicon dioxide but sometimes they are made by a fibrous substance called **spongin**. The sponges with spongin can be used as a hygienic instrument for humans.
Sponges are **filtering animals**. They have specialized cells called **choanocytes** with a flagellum that is used to pump water through the **inhalant pores** into the atrial cavity. The small particles of food enter with the water and are captured by the cells that digest them and distribute the nutrients to the rest of the cells of the body of the sponge. The waste materials are discarded to the atrium where the current of water will take them out by the osculum.





Sponges have both types of reproduction **sexual** and **asexual**. They can reproduce asexually by **budding** and/or **fragmentation**. Most of the species are **hermaphrodites** and during the reproductive season can produce both **spermatozoa** and **ova** that are released to the surrounding water. When one **spermatozoon** finds an **ovum** the **zygote** is formed and it develops as a **larva** that can swim until it finds a new place to attach to and becomes a new adult sponge.

Activity 113.
When a recipient with alimentary colorant is opened near the inhalant pores of the body surface of a sponge a column of colorant can be seen flowing from the osculum of the sponge a minute or two afterwards. Explain why.

Activity 114.
Draw a choanocyte in your notebook.

4. Cnidaria.

This phylum includes medusas, corals, polyps, hydras and anemones. All of them are aquatic and most are marine organisms. We can find here some of the most beautiful invertebrates and also some of the most dangerous. The animals in this group have stinging tentacles with a characteristic type of cells called **cnidocytes** or **nematocysts**. All the members of this phylum can be classified into two different kinds of body shape: the polyp-shaped members and the medusa-shaped members.

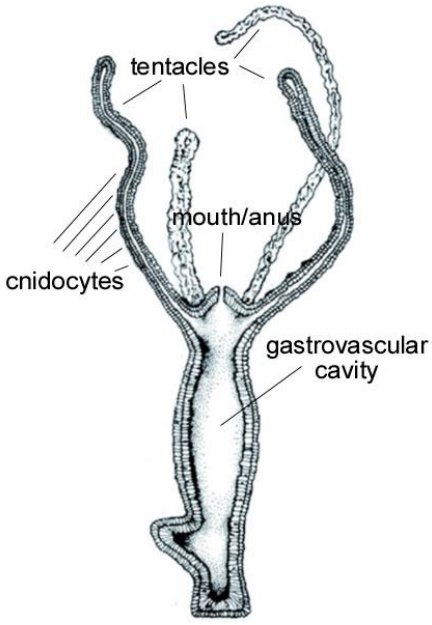
Polyps are sessile animals that live attached to a surface and have a body with the shape of a bag. Some species live individually, like the anemones or the hydras, but others, like corals, live in **colonies** of many individuals that remain together when reproduce by budding. Sometimes they cover themselves with a skeleton made of limestone that remains when the animal dies and constitutes the **coral reefs**, some of them, like The Great Reef Barrier at the East of Australia, are so big that can be seen as far as from the Moon.

Medusas, commonly known as jellyfish, look like gelatinous, delicate and transparent animals that swim elegantly by regular contractions of their umbrella-shaped body.

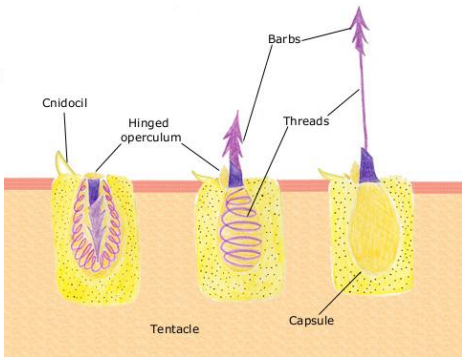
Both polyps and jellyfish have **radial symmetry** and they are **carnivores**. They capture their preys by means of the tentacles that have **cnidocytes**. When something gets in contact with a cnidocyte it fires a microscopic structure similar to a harpoon that injects a toxin that immobilizes or kills the prey. Then the tentacles take the prey to the mouth and it is swallowed into a **gastrovascular cavity** where digestion takes place. The residues are eliminated also by the mouth as these animals have not an anus.

Polyps can reproduce asexually by budding or fragmentation and sexually by male and female gametes that swim to produce a zygote and then a larva that eventually will attach to a new surface to develop a new polyp.

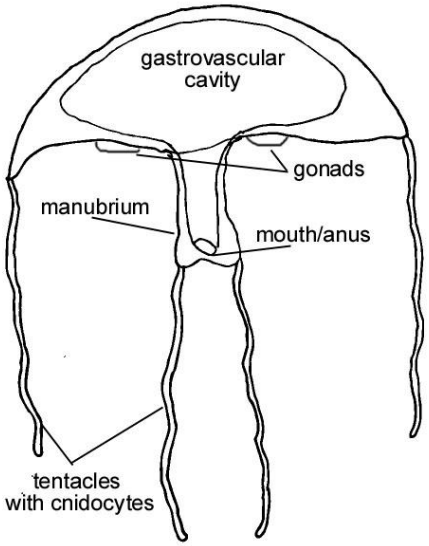
Jellyfish only reproduce sexually.



A polyp-shaped cnidarian: Hydra



Phases in the cnidocyte discharge



A medusa-shaped cnidarian: Jellyfish

Activity 115.

Decide if these sentences are true or false and correct the false ones.

a) A bag-shaped cnidarian is a polyp.
b) Corals are porifera with limestone skeleton.
c) Jellyfish reproduce sexually.
d) The atrium is the internal cavity of the cnidaria.
e) The Portuguese man o' war (*Physalia physalis*) is a vertebrate animal:
f) Porifera and cnidaria are sessile invertebrates.
g) Spicules are present in sponges but not in polips.
h) Choanocytes are poisonous cells.

Activity 116.

Copy in your notebook the drawings with the anatomy of the polyps and the medusas.

5. Platyhelminthes, flatworms or tapeworms.

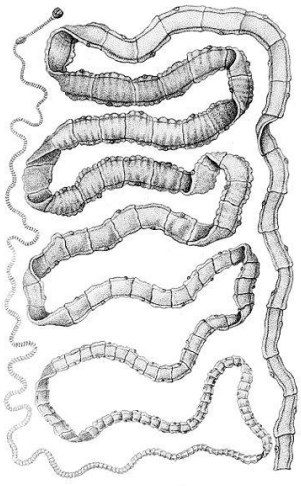
They are very simple invertebrates with **bilateral symmetry**. They look like worms that have been top down squished and their appearance is like a tape more or less long. Platyhelminthes have a simple head with a nervous ganglion that can be considered a **primitive brain** and, sometimes, one pair (or more) of **pigment spot ocelli** (sing. “occellus”). Platyhelminthes have not a respiratory system and take the oxygen directly by their body surface. They are **hermaphrodites** and reproduce by eggs, although some of them can also reproduce asexually by budding or fragmentation. There are three main groups of platyhelminthes: **planarians**, **taenias** and **flukes**.

Planarians live in the oceans, in freshwater and in very wet soils. They have a free life moving by small cilia and leaving a mucous trail similar to the one of the snails. The mouth is in the middle of their body and can be projected outside to catch their food. Their digestive system has not an anus and the food is digested in a gastrovascular cavity and then the residues are eliminated by the mouth. Planarians can reproduce by fragmentation detaching their tails and each half re-grows the lost parts by regeneration. Planarians can also reproduce sexually by producing both types of gametes (they are hermaphrodites) that they exchange with another individual to produce eggs.

Taenias are tape shaped parasites that can reach more then 10 meters long. They live inside the small intestine of the humans or other vertebrate animals. Their body is divided into **segments** and the first one (the head) is called the **scolex** that usually has a set of hooks, spines and suckers to fix to the wall of the intestine of their host.

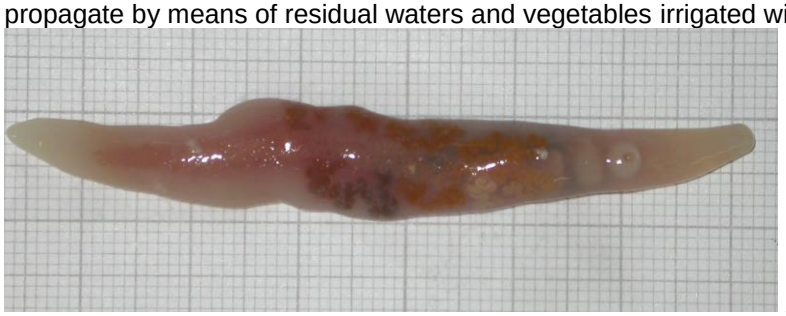
Taenia has not a digestive system and feeds on the nutrients digested by its host through its body surface.

They are hermaphrodites and can fertilize themselves producing eggs that accumulate in the last segments of their body.



These segments detach from their body and are eliminated with the excrements of their host. When they are eaten by an animal (pig, horse, rodent…) they hatch and the larvae remain in the muscles of this intermediate host until it is eaten by a human. Then they develop a scolex that fixes to the small intestine wall and new segments are produced beginning the cycle once more.

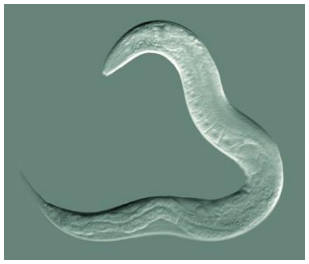
Flukes are parasites with suction cups that infest the blood, the liver, the intestine or other organs of animals or humans. They can produce very important illnesses and propagate by means of residual waters and vegetables irrigated with these waters.



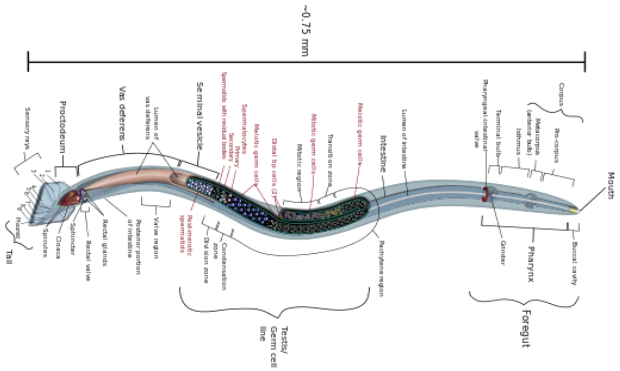
Botulus microporus

6. Nematodes or roundworms.

Nematodes are cylindrical worms with sharpened ends. They have tubular digestive systems with a mouth in one end and an anus in the other. Some species can live freely in the water (marine or fresh water) while other species are parasitic. There are also many species that can live in the soil and it has been said that they represent the 80% of the animal individuals present in the Earth.
Among the free-living species we can find *Caenorhabditis elegans*, a nematode that is commonly used in the laboratory in studies of genetics and development.



Caenorhabditis elegans



Among the parasitic species we can find the hookworms and the trichina.

Hookworm

Trichina

Activity 117.
Explain the difference in the symmetry of worms, cnidarians and sponges.

Activity 118.
Define parasite.

Activity 119.
Platyhelminthes and nematodes are both worms. Make a table to summarize their similarities and their differences.

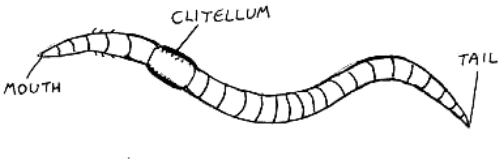
Activity 120.
Draw in your notebook a flatworm and a nematode.

Activity 121.
Decide if these sentences are true or false and correct the false ones.
a) Nematodes have a digestive system with mouth and anus.
b) Platyhelmintes are always parasites.
c) Nematodes and flatworms have radial symmetry.
d) Like most of the invertebrates, platyhelminthes and nematodes are autotrophic organisms.
e) *Taenia solium* is a parasitic nematode.
f) *Caenorhabditis elegans* is a parasitic nematode.
g) Nematodes are cylindrical worms with sharpened ends.
h) Platyhelminthes can often reproduce asexually.
i) Flatworms and roundworms can be considered oviparous animals.

7. Annelids or segmented worms.

Annelids are worms whose body is divided into a series of **segments** that look like rings. Each segment has a set of organs that is repeated in any other segment of their body. They have a head with the mouth and sometimes a pair of ocelli to detect light. In the last segment they have the anus. They usually breath through the skin and their blood is always inside the blood vessels (They have an enclosed circulation).
Annelids live both in marine and fresh water, and some very common species, like the earthworms, live in the soil. There are some parasitic annelids (like the leech) but most of them feed on decomposing organic matter. They can reproduce asexually by fragmentation and can regenerate the part of the body that has been lost when a predator attacks them, but most of the times they reproduce sexually, producing gametes in specialized sexual organs. Most of them are **hermaphrodites**.
Earthworms and **leeches** are very common species inside this group.

Earthworms excavate galleries in the soil feeding on the remains of animals and plants that are decomposing in the sand of the soil. They advance when they eat the soil in front of their mouth and eliminate the sand and the indigestible parts by their anus, aerating the soil as they build the galleries and enriching the soil, producing great benefits to agriculture. The gonads (=sexual organs) of the earthworm are in a group of specialized segments that form the **clitellum**. Although they are hermaphrodites they look for a partner during the reproductive season and they **copulate**.



Leeches usually live in the water. They have the head adapted like a suction cup with three sharp teeth that they use to attach to other animals to suck their blood. They are temporary parasites.
Leeches have been used by humans with medical purposes in the treatment of varicose veins and other illnesses. Their saliva has a potent anesthetic substance and several components that prevent the coagulation of the blood.

Hirudo medicinalis

Detail of the mouth

Activity 122.
Explain why earthworms and leeches can be considered beneficial organisms.

Activity 123.
What is the “clitellum”?

Activity 124.
a) What is the difference between species with separate sexes and hermaphrodite species?
b) What is the difference between self fertilization and cross fertilization?

8. Molluscs or mollusks.

This phylum groups together animals apparently very different but all of them have a **soft** body with **highly developed organs**. Other general characteristics of molluscs are:

- Their body can be divided into **head**, **visceral mass** and **muscular foot**.
  - In the **head** we can find the sense organs and the mouth
  - The **visceral mass** is formed by the internal organs like heart, stomach, digestive glands, etc. It is covered by the **mantle**.
  - The **muscular foot** is a part of the body of the molluscs that can perform different functions depending on the group we are talking about. It can be used to excavate, to move around or to catch their prey.
- In many cases the mantle secretes a protective calcareous **shell**. This shell can be made of one piece or can be made of two pieces called **valves**. Shells made of only one piece are often spiral in shape, while valves are joined by a hinge that makes possible that the animal can open or close them. The interior part of the shell is made of nacre.
- Most of the species of molluscs live in aquatic environments (marine or fresh water) and only a group of very common species are terrestrial (slugs and snails).
- Between the mantle and the visceral mass there are the respiratory organs: gills in the case of aquatic species and lungs in the terrestrial ones.
- Molluscs reproduce sexually with separate sexes most of the times and hermaphrodites in other cases. They are oviparous and some of them present a direct development while others produce a larva that eventually will become an adult.

Molluscs are classified into **bivalves**, **gastropods** and **cephalopods**.

Bivalves

They have a shell with two valves that the animal closes at any sign of danger. Their muscular foot has the shape of an axe and can be use to move around, excavate in the sand so the animal can hide from the predators or attach to the rocks secreting a substance that will become like threads.
The head of the bivalves is not differentiated from the rest of the body and they feed on plankton that they filter using their gills. Mussels, clams and oysters belong to this group.

Anatomy of a mussel

Tridacna gigas. (The giant clam).

Gastropods

They have a wide ventral foot that they use to move around slowly. Most of the species have a single spiral shell although there are also species without shell. The head is clearly differentiated and has two or four retractile tentacles that have tactile, olfactory and visual receptors. In the head is also the mouth with a rasping tongue called **radula**. Gastropods are usually herbivorous and can be found both in terrestrial and aquatic ecosystems. Snails and slugs belong to this group.

Slug

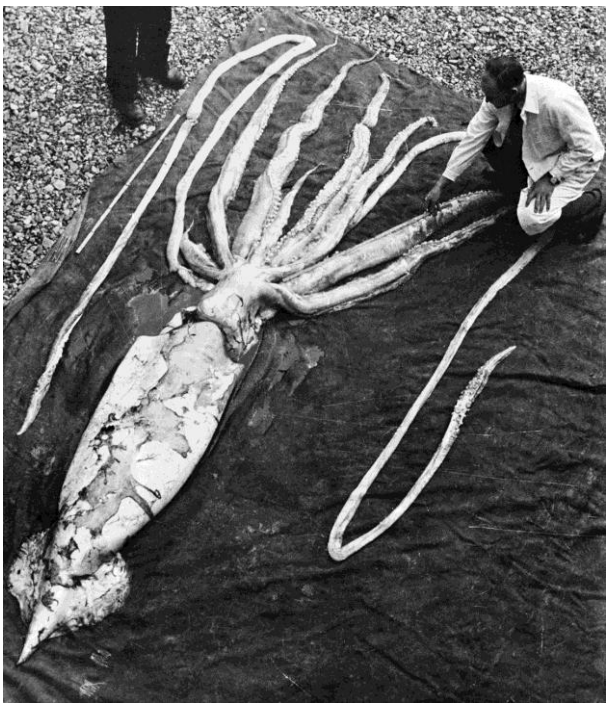
Snail

Mitra stictica

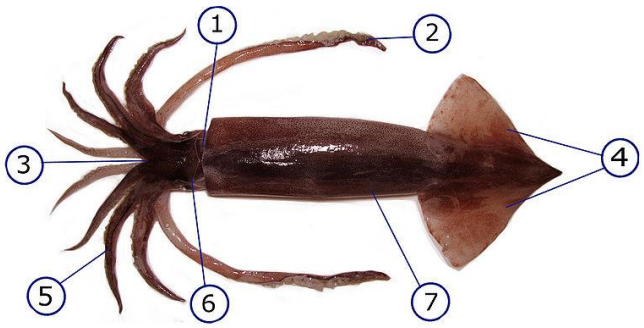
Cephalopods

The foot of the cephalopods has been transformed into tentacles with suckers to capture their preys. These tentacles surround the mouth that has two hard mandibles with the aspect of the beak of a parrot. In the head they also have two very complex eyes. Their shell is usually internal and has been transformed into a structure (the **cuttlebone**) that helps the animal to float; but some very old species like *Nautilus sp.* have a beautiful external spiral shell.
Cephalopods are carnivorous. Many species move by swimming and by jet propulsion, expelling streams of water by a tube called **siphon**. They also can expel clouds of dark ink to confuse their predators. Squids, octopuses, cuttlefish and nautilus are classified into this group of molluscs.

Common octopus



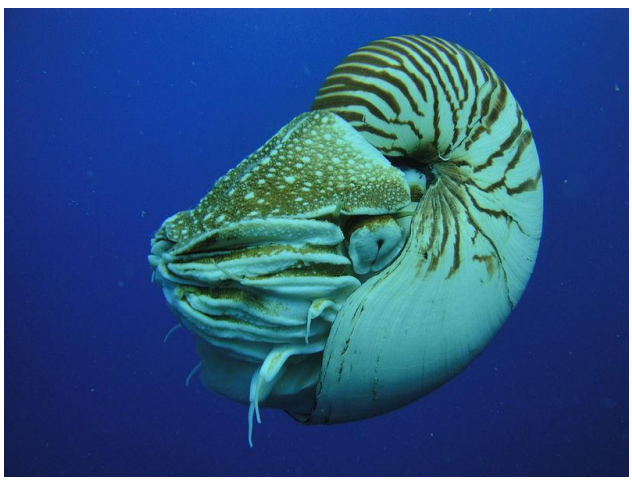
Giant squid captured in Trodheim (Norway)



External anatomy of a squid

1. Siphon
2. Tentacles
3. Mouth
4. Fins
5. Arms
6. Head
7. Mantle

Sepia officinalis



Nautilus belauensis

Activity 125.
List the body parts of a mollusk.

Activity 126.
Draw the body of a squid and label its parts.

Activity 127.
Draw the body of a snail.

Activity 128.
What part of the body of the molluscs produces the shell?

Activity 129.
What is the function of the radula?

Activity 130.
What is the meaning, in Greek, of “cephalopod”?

Activity 130.
Write what type of molluscs are we talking about in each of these sentences:
a) They have tentacles and two complex eyes.
b) The shell of this group is made of two valves joint by a hinge.
c) Their foot has the shape of an axe.
d) They do not have a defined head.
e) Most of the species in this group have a spiral shell.
f) They can confuse their predators expelling clouds of ink.
g) Many of them have very simple eyes (ocelli) at the end of the tentacles.
h) They have a flat, large and ventral foot that they use to move around.
i) They are filtering animals.
j) They present suckers in the tentacles to catch a prey because they are carnivorous.
k) They feed on vegetables using the rádula.

Activity 131.
Decide if these sentences are true or false and correct the false ones.
a) Terrestrial snails breathe through lungs while aquatic ones breathe through gills.
b) Molluscs have bilateral symmetry.
c) Bivalves are filtering animals.
d) Pearls are made of nacre and are obtained from the shells of the cephalopods.
e) Gastropods have a beak that looks like the one of the parrots.
f) Snails and slugs are classified into the cephalopods.
g) Cuttlefish are cephalopods with a spiral shell.
h) The ink of the gastropods is used to catch their prey.

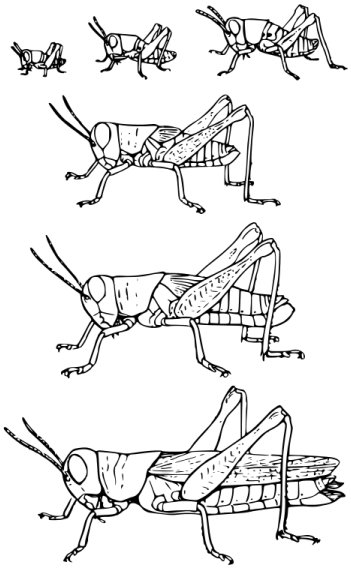
Activity 132.
Imagine that you are in the supermarket. Make a list of the different molluscs that can be found there and group them into bivalves, gastropods and cephalopods.

9. Arthropods.

The phylum of the arthropods has more individuals than the sum of all the other phyla of the animal kingdom. There are arthropods in all the ecosystems of the planet both aquatic and terrestrial. Their name “arthropods” comes from the Greek and it means “animals with articulated extremities”. Their general characteristics are:

- Their body is covered with a hard **exoskeleton** made of **chitin** and composed of different pieces that fit together in an articulated way that lets them to move very efficiently.
- Their body is divided into **segments** that often are assembled into several body regions (like head, thorax and abdomen or other dispositions depending of the different groups). They have bilateral symmetry.
- Hard and articulated appendages appear from the segments fulfilling different functions (legs, antennae, wings, palps…)
- Arthropods have a complete tubular digestive system with the mouth in the head and the anus at the end of the abdomen.
- Arthropods breathe through **tracheas** (systems of thin tunnels that distribute oxygen to all the cells of the body) or **lungs** if they are terrestrial or through **gills** if they are aquatic.
- They have very complex sense organs.
- Their exoskeleton is hard and rigid so they have to replace it periodically in order to grow in a process called **molting** (=”moulting” in British English).
- They reproduce **sexually** with **internal fertilization** and are **oviparous** or **ovoviviparous**. The embryo can present **direct** development or **indirect** development with **metamorphosis**. There are two types of metamorphosis: direct or incomplete metamorphosis and indirect or complete metamorphosis.

Incomplete metamorphosis of the grasshopper



Stages:

1. Eggs
2. Nymph
3. Adult animal

Complete metamorphosis of the butterfly

Stages:

1. Eggs
2. Larva
3. Pupa
4. Adult animal

The phylum of the arthropods is classified into four main classes:

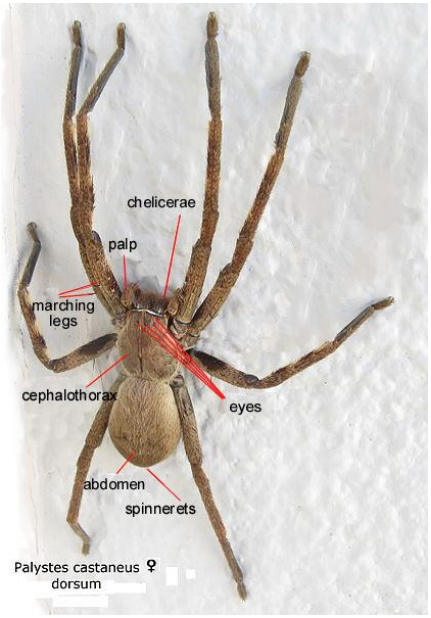
Arachnids: mostly terrestrial with cephalothorax and abdomen. They have chelicerae.
Crustaceans: mostly aquatic with cephalothorax and abdomen. They have antennae.
Insects: mostly terrestrial with head, thorax and abdomen. They have antennae.
Myriapods: terrestrial with head and segments. They have antennae.

9.1. Arachnids.

Arachnids are terrestrial arthropods with their body divided into two main parts: the **cephalothorax** and the **abdomen**. In the cephalothorax they have a pair of **chelicerae** (one at each side of the mouth) that in many cases are connected to glands that produce venom. They are used to inject this venom to their prey. They usually also have a pair of sense appendages called **pedipalps** and four pairs of **marching legs**. In the cephalothorax they also have several ocelli and, in many species, several pairs of compound eyes.
Arachnids are classified into spiders, scorpions, mites and ticks.

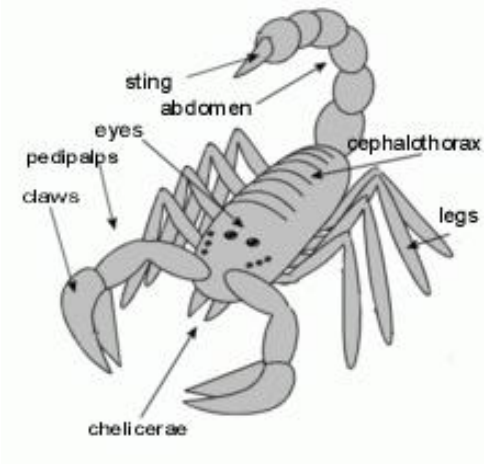
Spiders

In the abdomen they have glands that produce a liquid that solidifies in contact with the air and becomes the silk. These glands are called **spinnerets**. Most of spiders are carnivorous and catch their prey spinning a spider web. They usually inject in the captured prey enzymes that digest it and then they suck the nutrients.
Spiders are oviparous and the females take care of the eggs until they hatch and then the little spiders use a thread of silk as a “paraglider” to get dispersed by the wind.



Scorpions

The scorpions have the end of the abdomen transformed into a dangerous sting that they use to capture their prey and defend themselves from the predators. Their pedipalps are transformed into a pair of claws. They are ovoviviparous and they care of their offspring until the little scorpions are able to feed themselves.

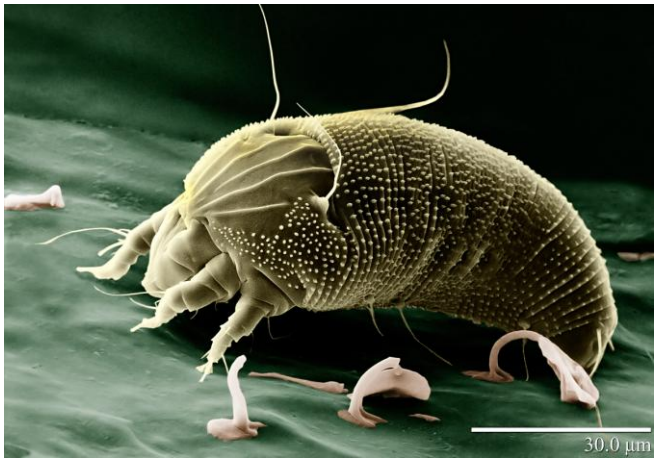


External anatomy of a scorpion

Pandinus imperator

Mites and ticks (*Acari*)

They are very abundant in the soil and the water where they are decomposers animals. Most of them are microscopic. Some species are external parasites and can propagate illnesses or cause allergy.



Aceria anthocoptes (very common in the dust)


Sarcoptes scabei (a parasite in human skin)


Ixodus ricinus (a tick very common in European mammals)


An adult tick compared to a ballpoint pen

Activity 133.
What are the advantages of having an exoskeleton?

Activity 134.
What are the disadvantages of having an exoskeleton?

Activity 135.
How many antennae can be found in an arachnid?

Activity 136.
What are the chelicerae and what are they used for?

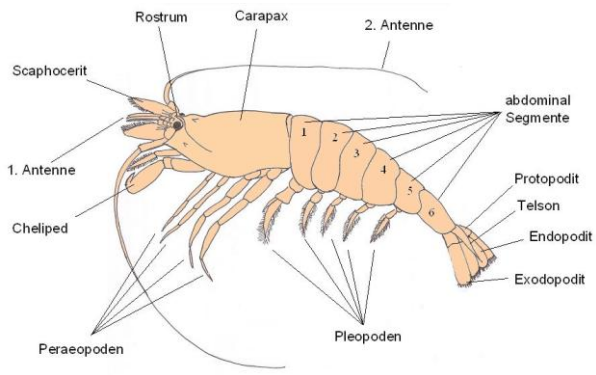
Activity 137.
Make a grid with the main characteristics of the different kinds of arachnids.

Activity 138.
Draw in your notebook a spider and label the structures of its external anatomy.

Activity 139.
Draw in your notebook a scorpion and label the structures of its external anatomy.

9.2. Crustaceans.

With the exception of a few species, crustaceans are **aquatic** arthropods. Their body is divided into **cephalothorax** and **abdomen**. They have two pairs of **antennae** with tactile and olfactory functions. Lobsters, crabs, shrimps, barnacles, krill and prawns are very known marine crustaceans; crayfish are freshwater crustaceans; pill-bugs are terrestrial crustaceans. There are also many different species of microscopic crustaceans in the **zoo-plankton** of both marine and fresh water and they are very important in the food web of aquatic ecosystems.
Most of the crustaceans that are interesting from the economic point of view belong to the group of the **decapods** that in Greek means “ten legs”.



Main external anatomy characteristics of a shrimp.


A ghost crab


Daphnia pulex. A microscopic crustacean.


Balanus improvisus. A sessile crustacean living on a shell.

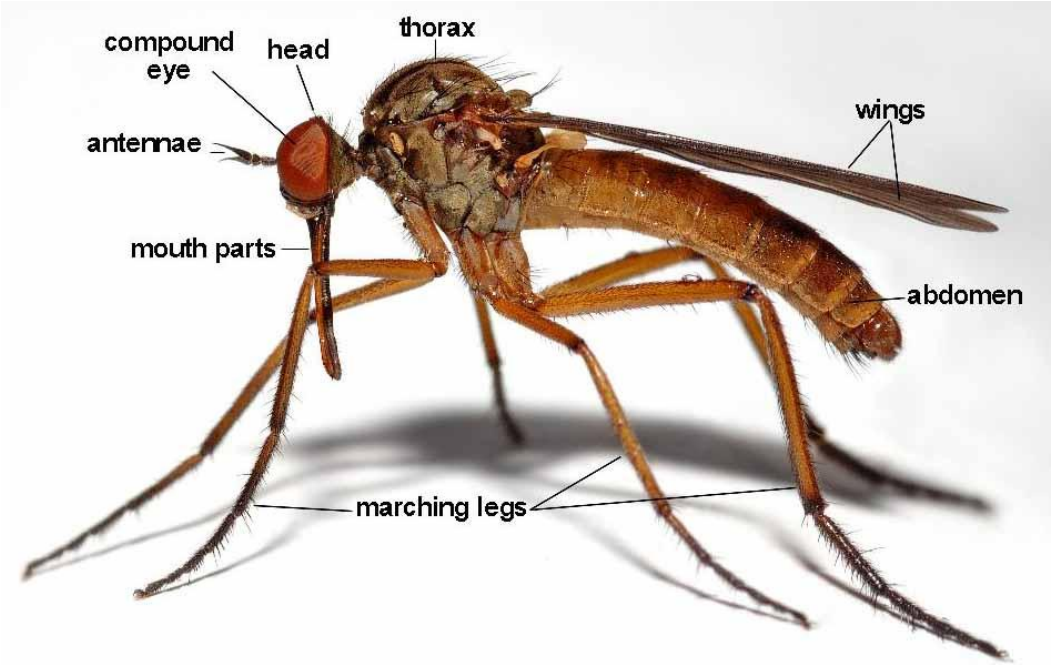
Activity 140.
What are the functions of the antennae in the crustaceans?

Activity 141.
What is the meaning of “decapods”?

9.3. Insects.

Insects are among the **most succeeding organisms** of the planet Earth. There are a huge number of individuals living in every habitat, there is also an extraordinary variety of life forms in this group and they are adapted in the most incredible ways to live in the most extreme conditions.
The body of the insects is divided into **head**, **thorax** and **abdomen**.

- In the **head** the insects have one pair of **antennae** with olfactory and tactile functions, several **ocelli**, one pair of **compound eyes** and a **complex mouth** composed by many different parts depending on the type of food it is adapted to. There are insects that feed on blood while others feed on paper, on nectar, on other insects, on wood… It is difficult to find something that an insect cannot eat.
- In the **thorax** the insects have three pairs of **marching legs** and one or two pairs of **wings**. Insects are the only invertebrates that can fly.
- In the **abdomen** insects have the **spiracles**, the respiratory openings by which the oxygen enters the tracheae and is distributed to all the cells of the animal. There are no appendages in the abdomen of the insects.



Insects have sexual reproduction and are **oviparous**. When the eggs hatch the newborns can be similar to adults (direct development), slightly different (incomplete metamorphosis) or totally different (complete metamorphosis).

Insects are classified in many different orders. The most important are:

- **Coleoptera** → beetles.
- **Lepidoptera** → butterflies and moths.
- **Diptera** → flies.
- **Ortoptera** → grasshoppers and locusts.
- **Hymenoptera** → bees, wasps and ants.
- **Odonata** → dragonflies.
- **Hemiptera** → bedbugs.
- **Blattodea** → cockroach.

Some insects are **herbivorous** while others are **carnivorous** or **omnivorous**. Some of them are parasites but many others are beneficial.
Some insects live by their own but others present a complex social behavior like ants, honeybees and termites.

Benefits and damages of the insects	
Benefits	Damages
Insects pollinate many plants, including some of the most important crops.	Some insects eat plants and crops of human interest.
They are food for birds and other living beings.	Some insects can transmit illnesses to humans or other organisms of human interest.
Some insects are decomposers returning inorganic matter to the producers of the ecosystems.	Some insects attack the wood of buildings, furniture or eat the clothes.
They produce honey, silk, wax, colorants and other products of industrial interest.	
Some insects are used to fight plagues and contribute to protect human food sources.	

Activity 142.
In what part of the body of an insect can we find the following elements?
Wings, spiracles, compound eyes, legs, antennae and mouth

Activity 143.
What is the main difference between incomplete and complete metamorphosis?

Activity 144.
Summarize the benefits that insects produce to humans.

Activity 145.
Classify these insects:

9.4. Myriapods: millipedes and centipedes.

They are terrestrial arthropods with the body divided into segments. The first segments form a well defined **head** and the rest articulate in a way that gives the animal the aspect of a long train.
In the **head**, myriapods have a pair of **antennae**, several **ocelli** and the mouth. The rest of the body has between 15 and 200 segments with one (centipedes) or two (millipedes) pairs of legs each.
Myriapods are **oviparous** with **direct** development. They are classified into two main groups: **centipedes** and **millipedes**.
Centipedes have a flat body and only one pair of legs on each segment. They are carnivorous and the first segment of the body (the one that is near the head) has the legs transformed into **forcipules** that are appendages with the shape of a claw. These forcipules are connected to glands with venom and the animal uses them to catch their prey and defend from their predators.

In this photograph of the ventral head of a centipede can be distinguished clearly the antennae, the powerful mandibles and the poisonous forcipules.

Man holding *Scolopendra gigantean*

Millipedes have a cylindrical body, their first segment has no appendages and the following four have only one pair of legs each but the rest of the segments have two pairs of legs. They are herbivores and some of them can curl into a spiral shape when disturbed.

A female *Illacme plenipes* with 618 legs (309 pairs)

Activity 146.
Explain the main differences between insects and myriapods.

Activity 147.
Decide if these sentences are true or false and correct the false ones.
a) Forcipules are appendages specialized in movement.
b) A species of myriapod with two legs for segment is a millipede.
c) Insects, arachnids and myriapods have antennae while crustaceans have chelicerae.
d) Centipedes are herbivorous.
e) Butterflies and moths are classified as ortoptera.

Activity 148.
Draw a centipede and a millipede.

10. Echinoderms.

In Greek “echinoderms” means “skin with spines”. They are **marine** animals with a hard **dermal skeleton** (usually with spines) and **penta-radial symmetry**. The skeleton is under the skin and it is made of calcareous plates; it can grow with the animal so echinoderms do not need to molt (=”moult” in British English).
The main exclusive characteristic of the echinoderms is their **ambulacral system**. The ambulacral system is composed of a set of tubes or channels filled with water that spread for the whole body of the animal. This system regulates movement, breathing and circulation. The tubes of the ambulacral system have a lot of extensions called **ambulacral feet** that project themselves out of the body and end in suction cups that are used to move around or to attach to the sea floor.
The mouth is placed in the underside to look for the food in the sand and the anus is placed on top of the animal.
Echinoderms reproduce sexually with external fertilization but some species can regenerate great parts of their body and can reproduce asexually by fragmentation.
Echinoderms are divided into four groups: sea urchins, starfish, brittle stars and sea cucumbers.

Sea urchins

Sea urchins have a round shaped body with long spines that come off it. They usually eat algae or decomposing matter from the coral or the rocks.

Starfish

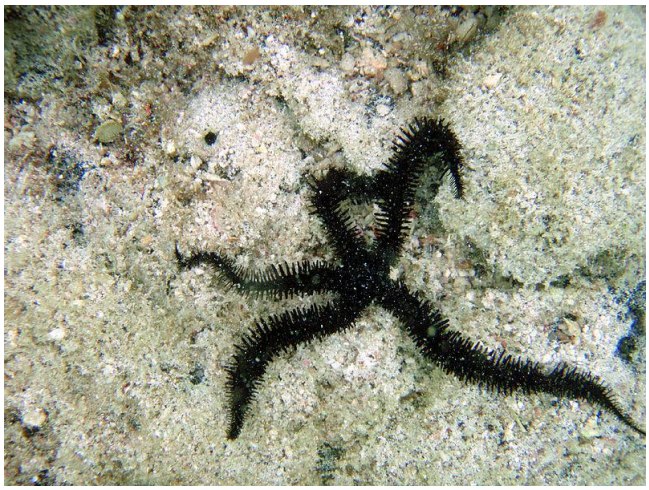
Most starfish have five arms that radiate from a central disc. The mouth is in the lower surface. Most species are carnivorous and some of them prey on bivalves. The starfish pulls with its ambulacral feet to separate the two valves and inserts a section of its stomach, which releases enzymes to digest the bivalve. The stomach and the partially digested prey are later retracted inside of the body. They reproduce sexually, but some species can also reproduce asexually by fission of their central disc or by detaching one of the arms.

A starfish regenerating from one arm.


Ambulacral feet of a starfish.

Brittle stars

Brittle stars are closely related to starfish but they have more flexible arms so they can crawl across the sea floor using them for locomotion. They live at almost any depth down the sea and their ambulacral feet have a sensory function. They reproduce sexually and most species have separate sexes but, as it happens in starfish, some species can reproduce asexually by fission. A handful of species have been found to be bioluminescent and they emit a green light that they use to deter predators.

Sea cucumbers

Sea cucumbers or holothurians are detritivorous animals that live on the sea floor and have a soft cylindrical body. Some species are appreciated as delicious food for humans.


Holothuria fuscopunctata


Actinopyga echinites

Activity 149.
Draw a sea urchin, a starfish, a brittle star and a sea cucumber.

Activity 150.
What is the ambulacral system?

Activity 151.
Decide if these sentences are true or false and correct the false ones.
a) The body of many echinoderms is covered with spines.
b) Ambulacral feet are used for reproduction.
c) Sea cucumbers can swim with its long arms.
d) Starfish breathe by lungs.
e) Starfish are carnivores.
f) All the invertebrates have an exoskeleton.

Activity 152.
Write the group of animal we are talking about in each sentence:
a) They have claws and a dangerous sting at the end of the abdomen.
b) Their beautiful four wings and their spiral proboscides make them unique.
c) Parasites that live in the human small intestine.
d) Animals with the body divided in rings.
e) They have a spiral shell.
f) Their name means “legs in the head”.
g) They have eight marching legs and sometimes they inject venom.
h) Their other name is “hexapoda”
i) Their soft body is protected by a shell with two hinged parts.
j) Animals without a backbone.
k) This group is divided into insects, arachnids, crustaceans and myriapods.
l) Their shell often helps them to float.
m) The only invertebrates that can fly.
n) They can digest their prey putting their stomach on them.
ñ) They are insects that can jump very high.
o) These animals can form colonies and reproduce by budding.
p) Their specialized cells pump the water moving a flagellum.
q) They look like an umbrella and have poisonous cells.
r) Their body is covered with spines and their mouth is in their underside.
s) These worms can suck your blood.

Activity 153.
Make a chart with the classification of all the invertebrates.

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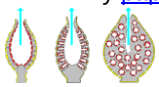 By Philcha. From http://commons.wikimedia.org/wiki/File:Porifera_body_structures_01.png. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

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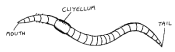 By Jim Thomas, modifying work done by Wikipedian Neckro. Este archivo se encuentra bajo la licencia Creative Commons Genérica de Atribución/Compartir-Igual 3.0.

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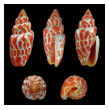 "Mitra stictica 01" by H. Zell - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Mitra_stictica_01.JPG#mediaviewer/File:Mitra_stictica_01.JPG

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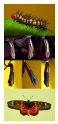 "Acraea zetes caterpillar to pupae to butterfly metamorphosis by Nick Hobgood" by Nick Hobgood - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Acraea_zetes_caterpillar_to_pupae_to_butterfly_metamorphosis_by_Nick_Hobgood.jpg#mediaviewer/File:Acraea_zetes_caterpillar_to_pupae_to_butterfly_metamorphosis_by_Nick_Hobgood.jpg

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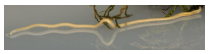 "Female Illacme plenipes (MIL0020) with 618 legs - ZooKeys-241-077-SP-6-top" by Marek, P.; Shear, W.; Bond, J. (2012) - Marek, P.; Shear, W.; Bond, J. (2012). "A redescription of the leggiest animal, the millipede Illacme plenipes, with notes on its natural history and biogeography (Diplopoda, Siphonophorida, Siphonorhinidae)". ZooKeys 241: 77. doi:10.3897/zookeys.241.3831.. Licensed under CC BY 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Female_Illacme_plenipes_(MIL0020)_with_618_legs_-_ZooKeys-241-077-SP-6-top.jpg#mediaviewer/File:Female_Illacme_plenipes_(MIL0020)_with_618_legs_-_ZooKeys-241-077-SP-6-top.jpg

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