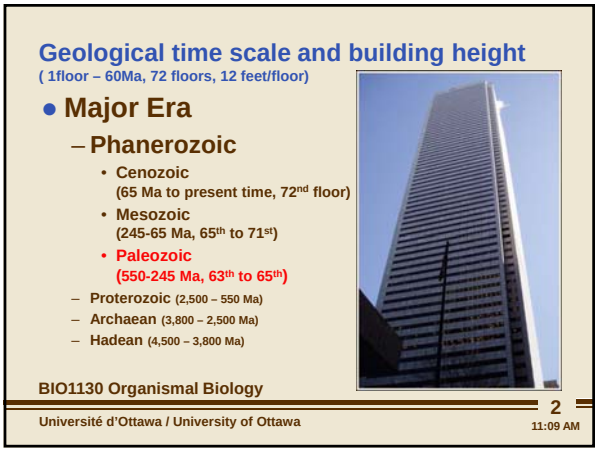

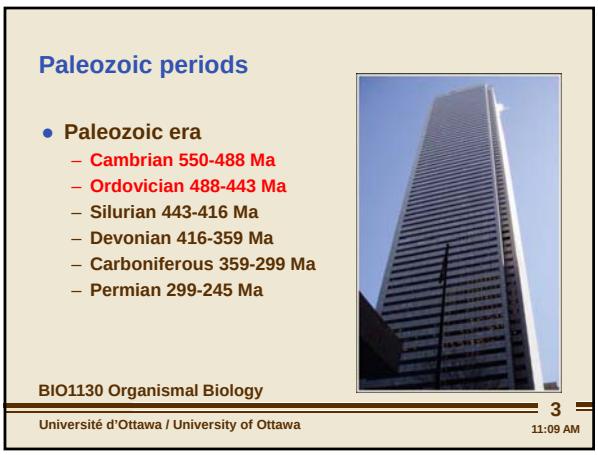

the cambrian explosion all of the sudden created all of the initial ancestors of all animals. The oceans went from nothing to full of multicellular organisms.

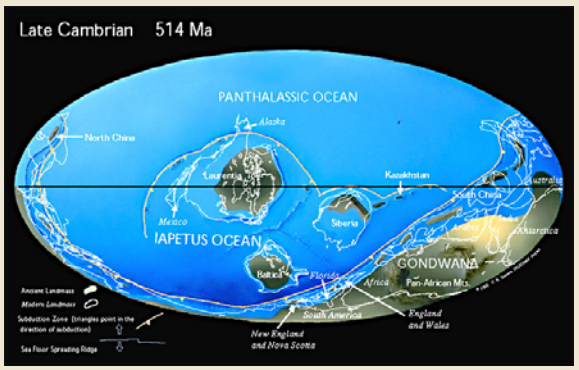

Figure 27-8

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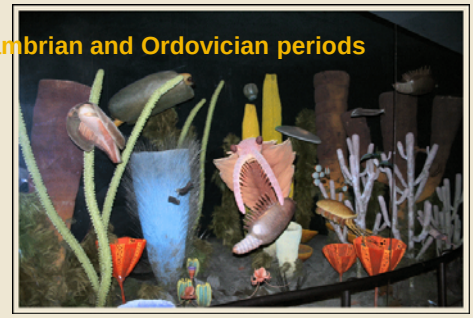
Laurentia is surrounded by an extremely large continental shelf. The ocean is more shallow here causing the growth of algae due to the sun being able to penetrate the water. This area is a great source of biodiversity. This area along the coast line is actually the canadian rockies.
In this area we find many different kinds of fossils.

Cambrian and Ordovician periods



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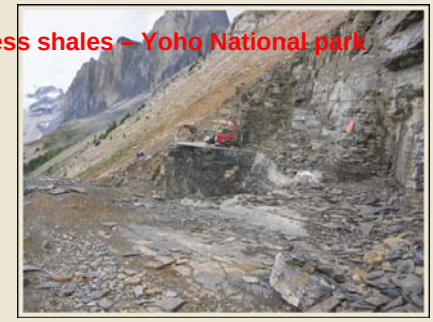
Burgess shales – Yoho National park



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There was a cliff at the end of the continental shelf. Organisms would fall off this cliff into the anaerobic environment below and die. Sediments would then wash off the cliff and fossilize the organisms below.These are called shales

The Cambrian explosion

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Burgess shales and its unusual invertebrates

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Burgess shales and its unusual invertebrates

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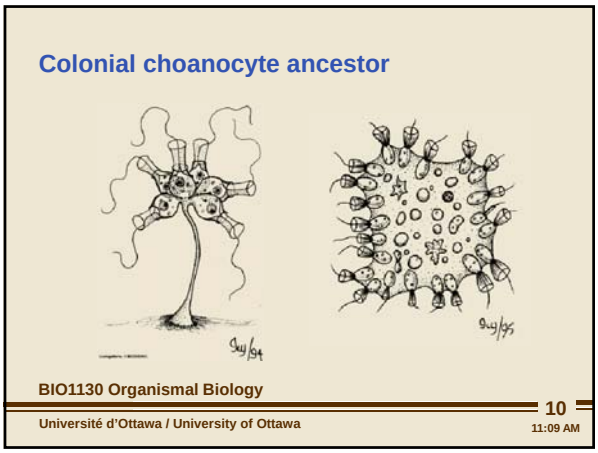
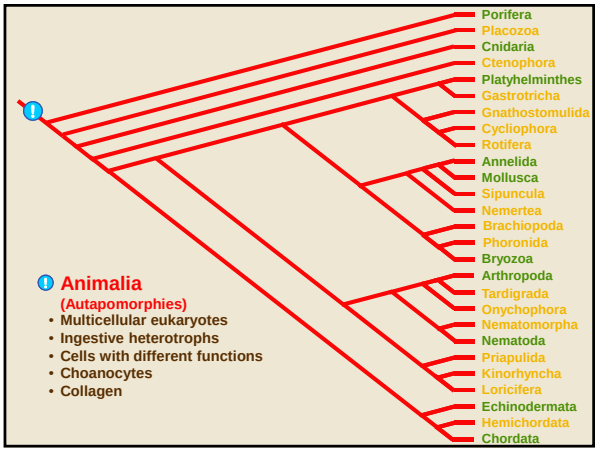
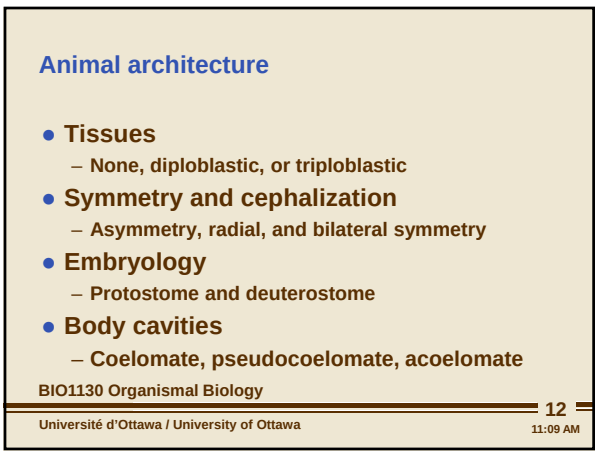
At this time, it was still all about morphology. The scientist classified them all as arthropoda and that there was nothing really important about them. The late 80's and 90's was the excitement about the bergess shales happened again because 2 scientists took a second look.



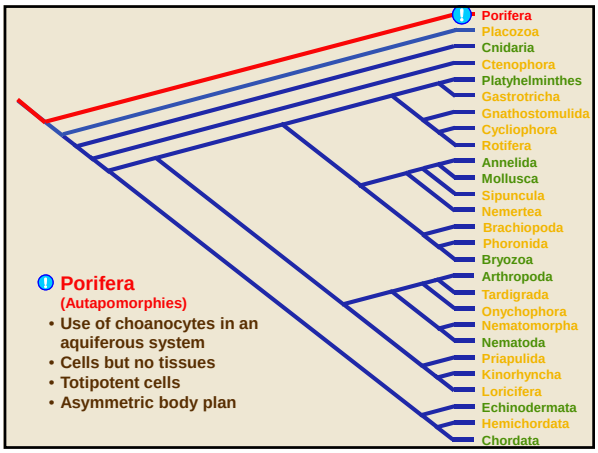
One of the first heterotrophic things. Food gets consumed by phagocytosis. As a group they can pump more water than individually so they would group together. From this cell we get the fungi and the animal cells. We nknow this is the original ancestor because the arrangements of the microvilli of the surface. The arrangement of microtubuluals around the collar is identical to that of animal cells.
- Autapomorphy for the kingdom animalia.



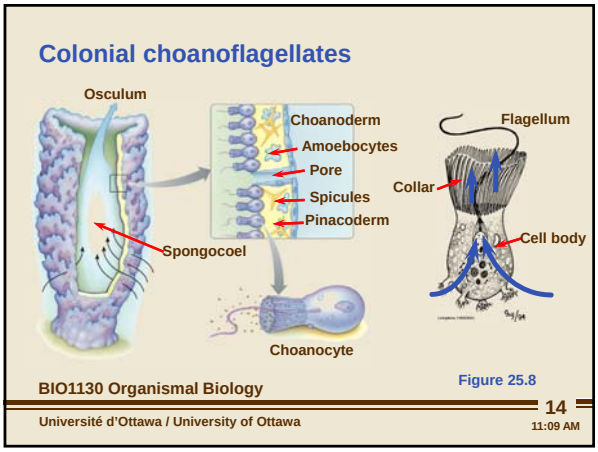
We've stepped away from being a colony of cells to a multicellular organism.
When we get into the kingdom of animal we get more specialized cells for specific functions.



Divide the living world:
-When cells begin to communicate with each other they are called tissues.
2 types:
Diplobasltic (2 layers: inner ectoderm, outer endoderm)
Triploblastic (3 layers: Inner ectoderm, mesoderm, outer endoderm)
- Animal groups end up starting to orient with bilateral symmetry (only one axis to cut an organism perfectly in half). Cephalization: Animals start to orient and move in one direction. They then concentrate the sensory materials to the end where they are going.
- Radial symmetry: When you are responding to the world on all axis around you, allowing you to slice an organism in half anywhere and get identical halves. These are usually still organisms, like at the bottom of the ocean
- Protostome and deuterostome are about the digestive tract.

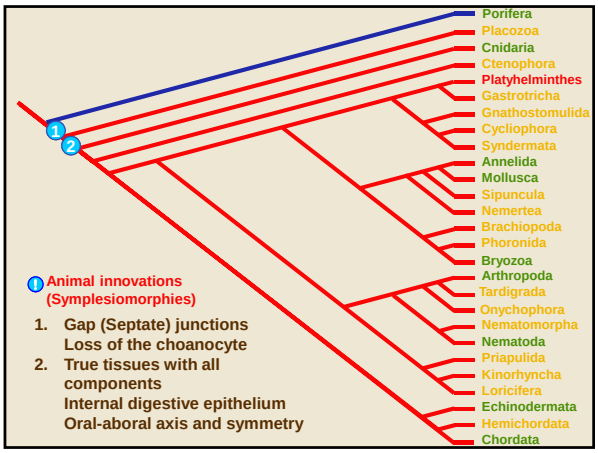


Inherit all of the etapomorphies of the kingdom animalia and add some of their own.
These are the sponges. They pump huge amounts of water through their bodies and capture any food within their body.
There is no cell to cell communication. This group was organized prior to the tissue grade



Sponges basically just sit and pump water. The flagella are constantly beating forcing water out of the opening in the top. They consume their food through phagocytosis and move it to food vacuoles.I Pinacoderm cells cannot eat but need to get nutrients from something. the amoebocytes basically walk around and carry things to each of the cells. The cells are not committed to their function, not specialized. If you blend a sponge all of the cells will go back to amoeba cells and then dedifferentiate back into new cells. Capable of breaking off and generate new pieces, reproduce asexually. Assymetric.

Releasing sperm and eggs into the water around the organisms so that fertilization can occur. Certain proportions of the choanicites in the wall, will differentiate and turn into sperm. When it becomes time to mate the sponges synchronize. They burst simultaneously.
Some of the archeocytes (amoebacites), have dedifferentiated and turned themselves into eggs. A female sponge will be pumping water and trapping the particles in the water and being engulfed through phagocytosis. It can identify sperm from its own species, and will then be transferred into a vacuole and transported to be fertilized.



Gap Junction allows cytoplasmic communication between the cells.

Animal architecture

- **Tissues**
  - None, diploblastic, or triploblastic
- **Symmetry and cephalization**
  - Asymmetry, radial, and bilateral symmetry
- **Embryology**
  - Protostome and deuterostome
- **Body cavities**
  - Coelomate, pseudocoelomate, acoelomate

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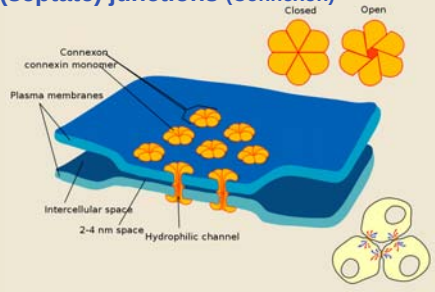
Gap (septate) junctions (Connexon)



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Moderates the cellular communication between one cell to the next using a very specific protein sac that will open and close.

Animal architecture: Tissues

- No tissues
- Diploblastic germ layers
  - Ectoderm and endoderm
- Triploblastic germ layers
  - Ectoderm, mesoderm and endoderm

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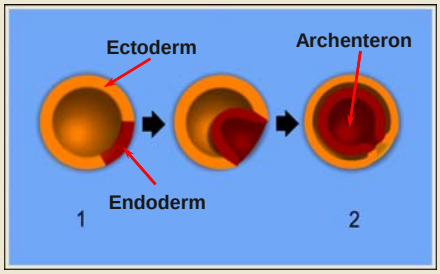
mesoderm - muscle
Endoderm - digestive tract
Ectoderm - nerve cells
At the diploblastic level, organisms do not have muscles

Gastrulation - digestive epithelium



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Blastula caused the primitive gut. All animals have an embryology that consists of a hollow ball of cells with invaginates, pushing inwards, causing it to meet up with the cell layers on the other sire, creating a lining of ectoderm.

Animal architecture Symmetry and cephalization

- Assymetric
- Radial symmetry
- Bilateral symmetry and cephalization

Figure 25.3

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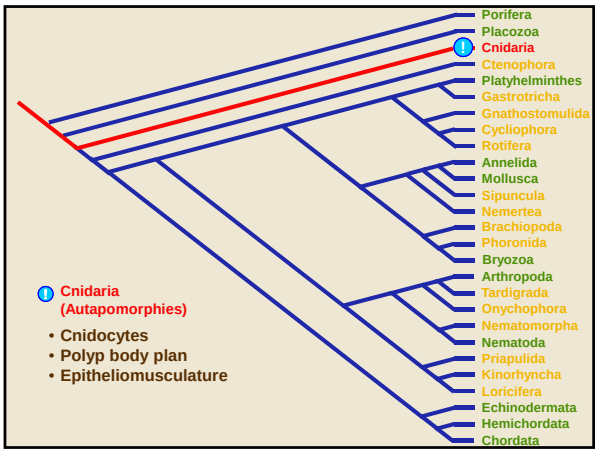
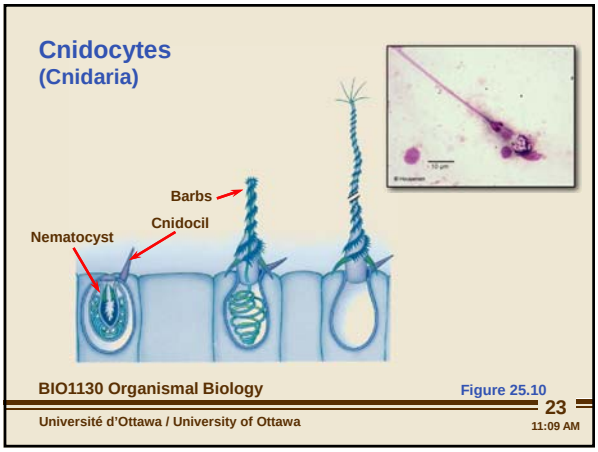
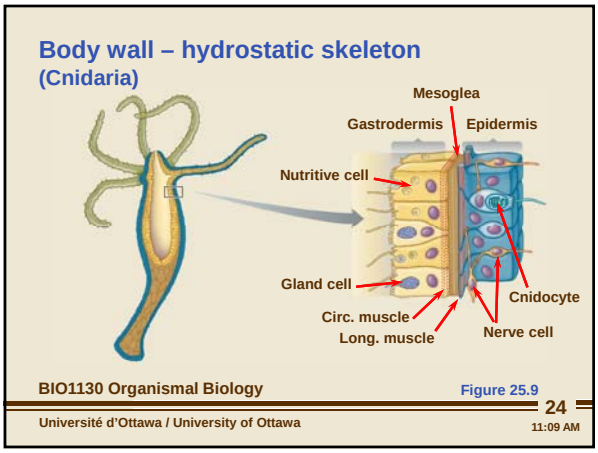
Radial symmetry is the first form of symmetry. This type of organism is either going to be cecile, or a swimmer (jelly fish).



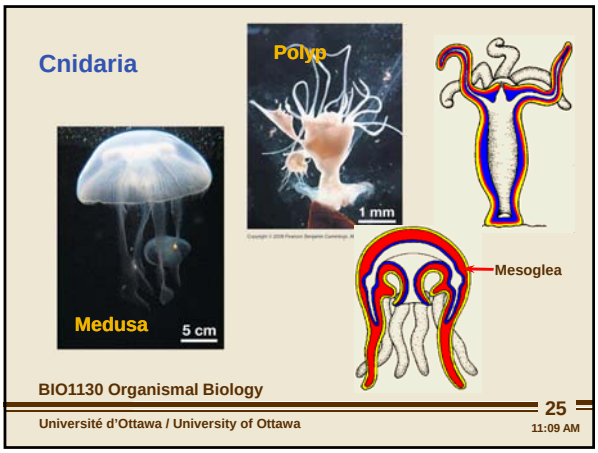
Jelly fish, Sea Annenomies
Also predators. They have a very distinct body architecture and specific cells.



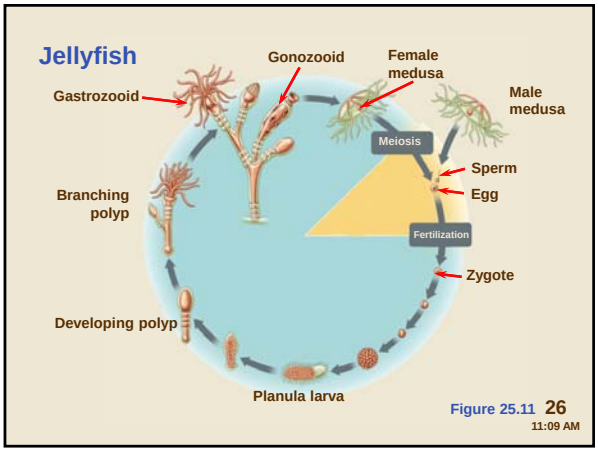
The cnidocyte is the part of a jelly fish that stings the person. As the cell matures, a barbed hook is coiled under pressure inside the organelle. If a stimulus is recognized, it turns inside out and soots out at very high speeds. It pierces through their outer tissue. It also has poisons on it which will knock out the nervous system of the animal they were attaching. There is one group (box jelly fish) have become specialists at using these to actually kill prey. If stung by even one, it can kill a human. They know when one jelly fish has released its barb and will swarm to attack.



The mouth in the centre leads to a digestive tract inside.
Able to bend over and attach its nitocytes to the substrate and do a summersault to walk.
This is basically a giant u shaped organism with an inner digestive tract and extra tentacles on the outside.
The inner surface have cells that consume things by phagocytosis and glandular cells that release digestive enzymes. These enzyme will break down the food small enough to be consumed by phagocytosis, once the mouth is closed.
- Epidermis has epidermal cells that are important for creating the integrity of the wall, theres some that are cnidocytes, and also has nerve cells.
Also epithelial muscular cells. At the base there are active strands of actin and meiosin. The ones found at the base of the nutritive cells are arranged circular around the cavity. The ones found at the base of the epidermis are arranged longitudinally. These cells that can be nutrient and contractive cells are called nutritive muscular cells. The cells on the outside are these cells as well. This creates the first skeleton. A skeletal element is involved in returning the contracted muscle back to its original place.
In this organism, the water filled middle, when contracted then contract the circular ones to give a tall skinny hydra. When it contracts all of the things along its height, it will get shorter and stretch the diameter out.

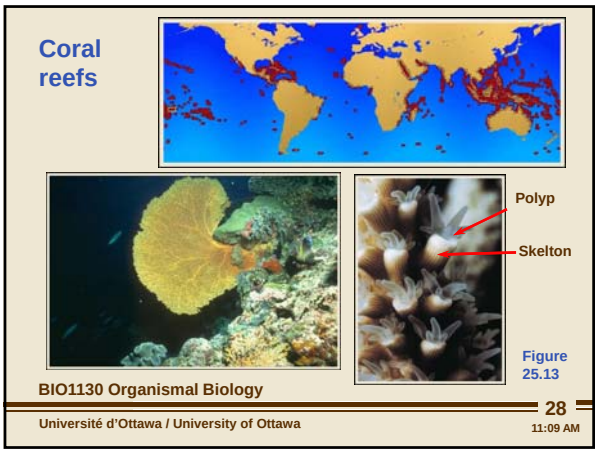


The medusa is the same organism just flipped upside down. Circular muscle lining the endoderm and a mass of a jelly like structure - a very thin layer between the tissue. The bell can be contracted and with a spring like structure the bell pops back open, squirting out any water inside, and that allows for movement. The medusa is then able to move up in the water column to feed rather than just sitting in the substrate.
We have a very rare freshwater jelly fish in ottawa, something to do with the salt used to clean roads. they dont sting

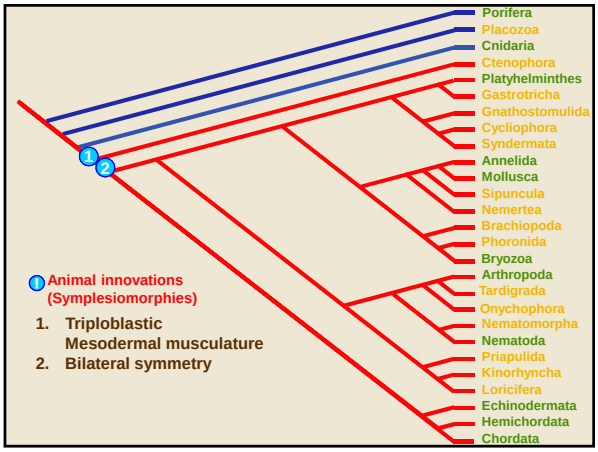


Swimming medusa stage: They release their gametes into the water column and rely on pure chance that the right sperm finds the right egg. It undergoes cell divisions and eventually settles on the ground as the planula larva. It then creeps around on the substrate and is radial symmetrical. It then stops and projects itself upward, growing tentacles and becomes a polyp. Completes all of the requirements of a diplonic life cycle.
This example developed 2 types of polyps, feeding and reproductive. On the surface of these, little baby medusa form and then are released.

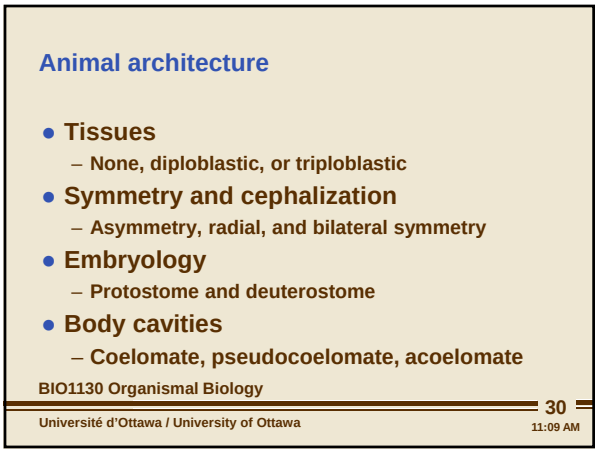
Corals are all connected to eachother. Many can secrete minerals to form a base. There is a huge variety of organisms.
This follis predates the cambrian explosion. It is branching polyp type structures. Gives an indication in its most primitive form maybe didn't start in the cambrian.

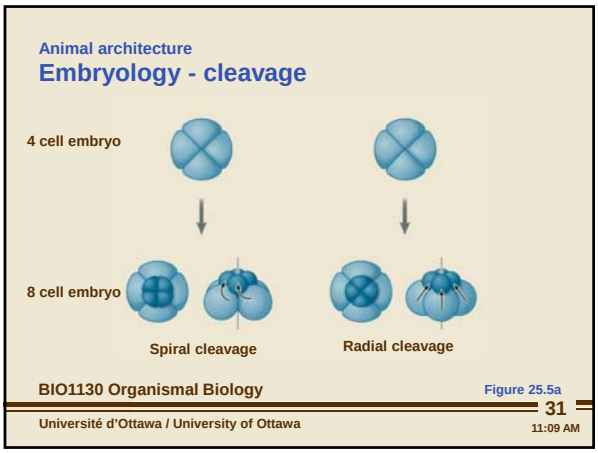


Coral reefs are distributed only in tropical locations reaching the most extreme temperature zones. the polyps are built on layer by layer each year. Some of these reefs get huge (great barrier reef). They become geological features. They can modify the ocean environment bringing the level of the substrate up into the photic zone. They are some of the most bio diverse zones on the planet even comparing to the rain forests.
Reef building on the continental shelf is a major changer of the environment. There is a period of time where is disappeared completely. This had a huge effect on the ocean environments. An area of concern right now because these corals live symbiotically with green algae and we're seeing as climate change occurs the relationship between the green algae and the coral is ending and the green algae leaves the coral (bleached corals) the coral cannot survive. Within the next 10 years more than half of the great barrier reef will be dead and the habitat will be destroyed. The biodiversity in this are will also be destroyed, possibly being a major game changer in the marine environment.

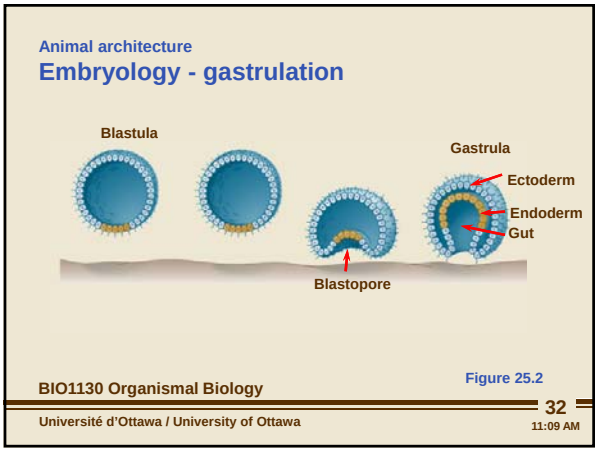


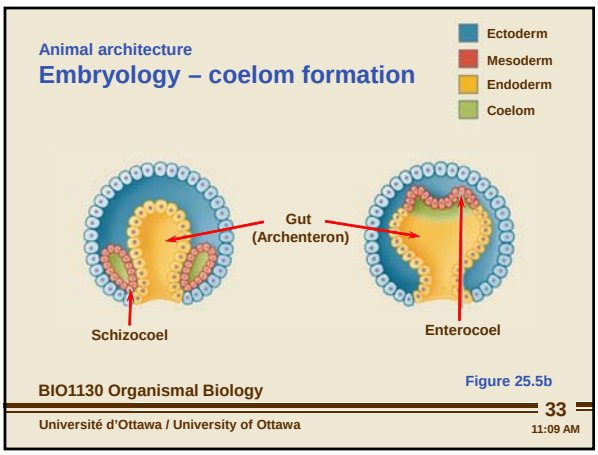
We now have organisms that have directed movement. This creates an antirior end. This limits our symmetry and we now have bilateral symmetry.





at the 4 to 8 cell stage you can divide all animals up into 2 groups depending on how they orient themselves during the next division. spiral cleavage is a very stable structure. This is the origins of spiral cleavage and radial cleavage.





The mesoderm can form in 2 different ways. at the blastopore (opening), a mass of cells start to fill the space in and then a split develops on each of the 2 sides.

The second way for this to happen is as the cells invaginate, when they make an association with the cells on the opposite side it causes the cells in the gut to start to form mesoderm. They fill backwards and we get mesoderm with a cavity in it.

In both of these, when all of this is said and done and the mesoderm is in place, the archenteron fuses and causes an opening to the blastopore (second opening). This brings it from an incomplete digestive tract to a complete one. The blastopore is on one side, mouth and the other the anus. Since just in early embryology theres 2 possibilities - mouth or anus.

Protostomes vs deuterostomes

- **Protostomes**
  - Blastopore mouth
  - Spiral cleavage
  - Schizocoely
- **Deuterostomes**
  - Blastopore anus
  - Radial cleavage
  - Enterocoley

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Protostone - First mouth (the blastopore became the mouth)
Deuterostomes - Second opening (The blastopore became the anus).
This description is wrong and yet still persists in the textbooks. Spiral cleavage and schizocely came later.

Animal architecture

Body cavities

- Acoelomate
- Pseudocoelomate
- Coelomate

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Acoelomate - absence of the body cavity (solid mesoderm) *flat worm*
Which of these is the primitive condition.
- Acelomate happened first happened on its own. pseudocoelomates are at the top of the Protostone linage. They are highly specialized organisms.
-Pseudocelomate is when animals are miniatures. There are animals that are the size of protists. They get rid of things they don't need because they are trying to get smaller. This causes a reduction in the size of the body cavity.

Animal architecture

Body cavities - Acoelomate

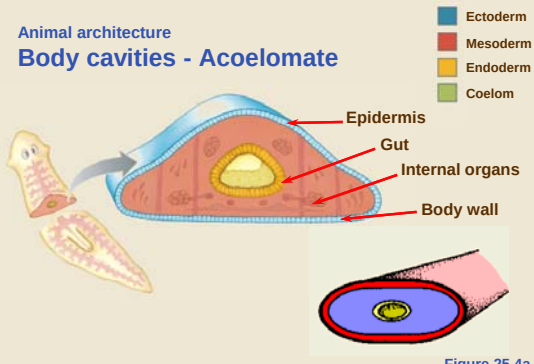

Figure 25.4a

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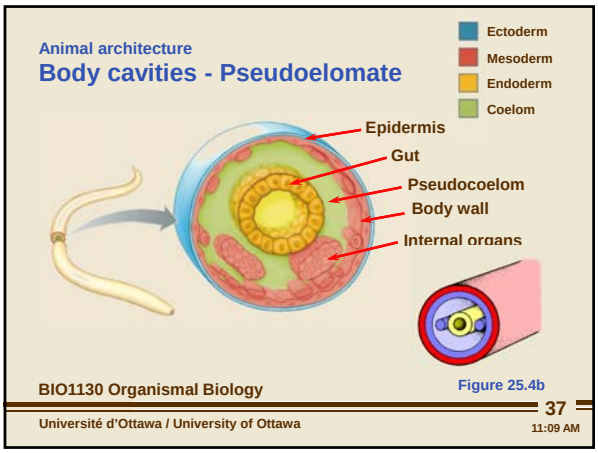
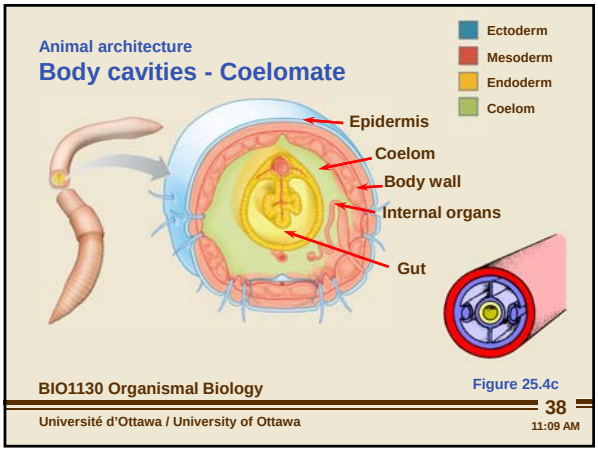
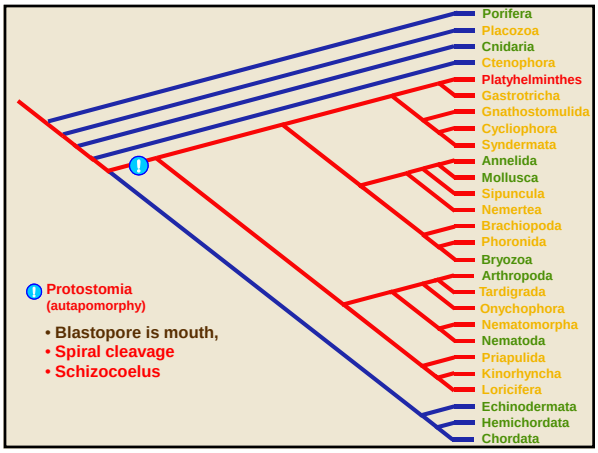
Filled with fluid but is not completely lined in mesoderm. There is no mesoderm in the digestive tract, only their outer wall. These animals cant move food through their body without moving. Their organs are then not suspended.

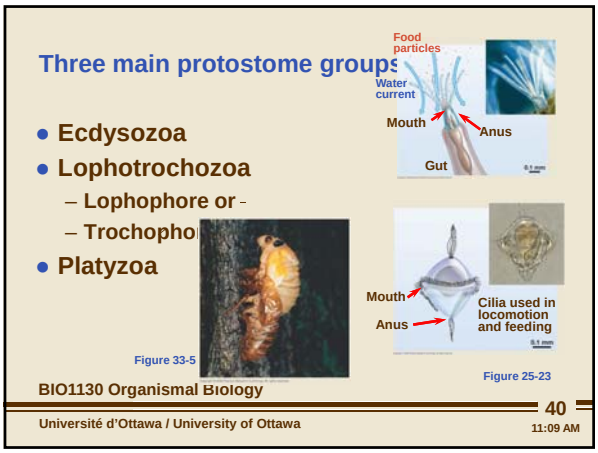


Filled with fluid but is not completely lined with mesoderm. There is no mesoderm associated with the digestive tract, only the outer body wall. This is a problem because they cannot propel food through their digestive tract without moving their body and there is nothing to suspend the organs in their bodies.

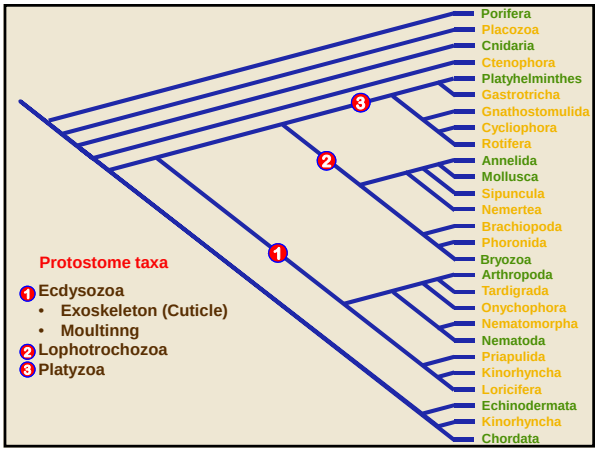


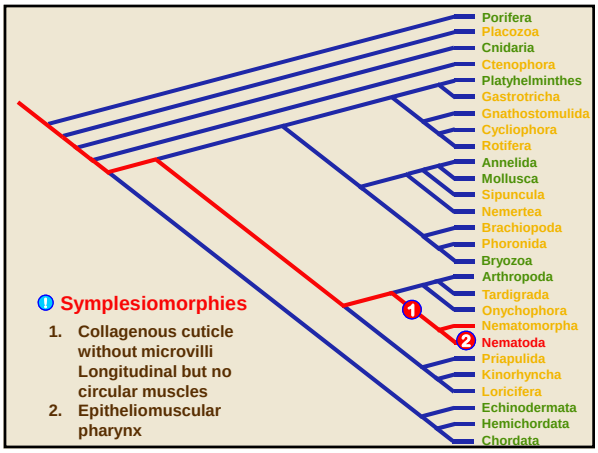
Coelomate - Endoderm lining both side of the body cavity. A innovation is that theres always a strand of mesoderm that connect between the gut and wall. This is what holds all of the organelles in place (suspended inside body cavity). Huge innovation because we can now move foot in the digestive tract without moving its body.





1st: Ecdysozoa - Moulting (outer skeleton)
2nd: When everything got reorganized, we noticed that there was a groups of animals thats had either a trochophore larva or lophophore that they fed with.
3rd: Lost their selomes. Lost the disadvantages very a very different lifestyle





Cuticle - Non living and on the outside
2 organisms that have to moult because they live inside an exoskeleton that will either be reinforced with either collagen or kyten
To be able to do things with a minimal number of cells, they've gone back to the ancient condition of combining the epithlio and muscular pharynx.

Animal architecture

- **Tissues**
  - None, diploblastic, or triploblastic
- **Symmetry and cephalization**
  - Asymmetry, radial, and bilateral symmetry
- **Embryology**
  - Protostome and deuterostome
- **Body cavities**
  - Coelomate, pseudocoelomate, acoelomate

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Animal architecture

Body cavities - Pseudoelomate

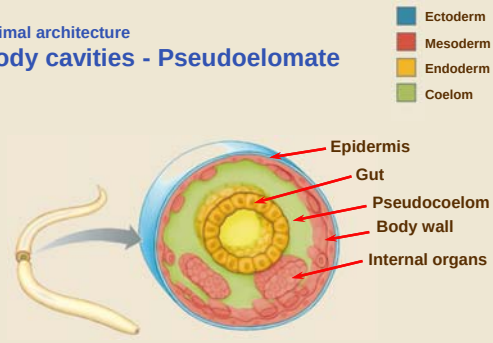

Figure 25.4b

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Nematoda

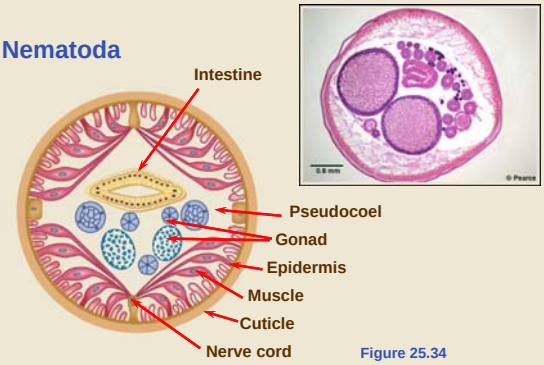

Figure 25.34

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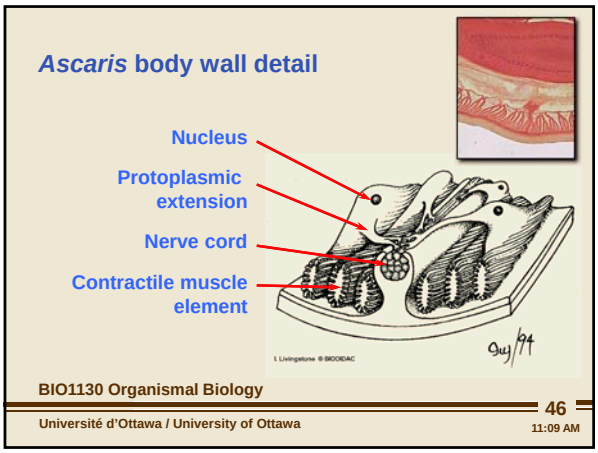
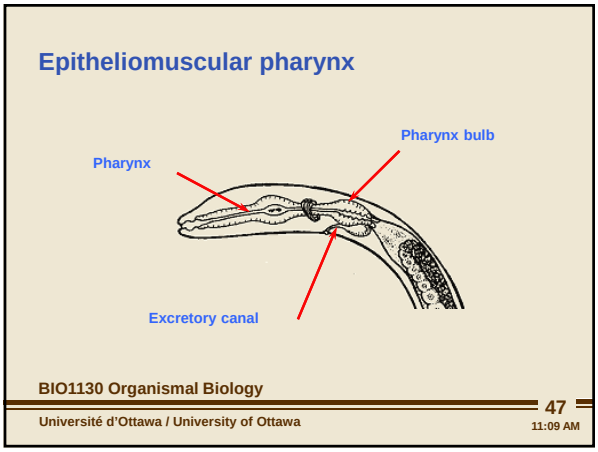
11:09 AM

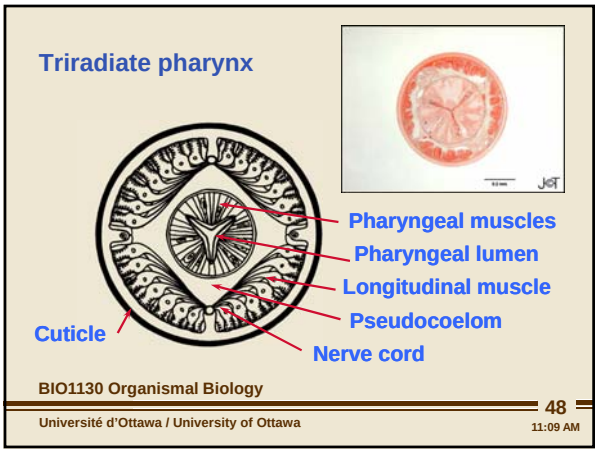
Nothing holding anything in place. This is female. You slit up the side and everything falls outside. Theres a longitudinal muscle on the outside that makes a cylindrical animal and animal will bend when the muscles are contracted. The shape of the whole organism will change. "Whip like motion". Nematodes aren't supposed to swim. They live in substrate and that movement is perfect for a solid environment. By reducing the circular muscle for swimming, they are very effective in the environment they live in.



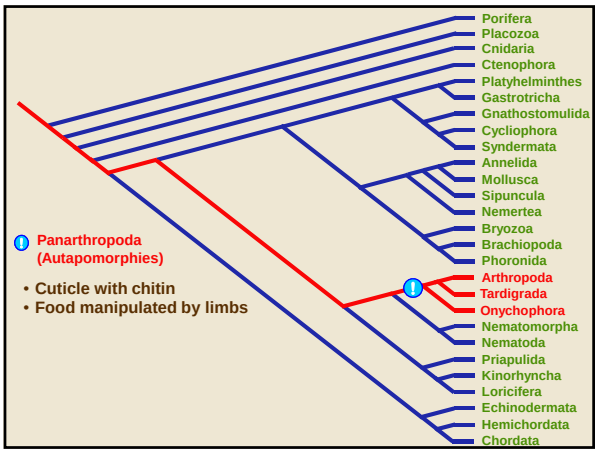
Instead of having a normal nervous system, their muscle cell sends an arm directly to the muscle cells to stimulate them.
When they replicate they use amoebic sperm.

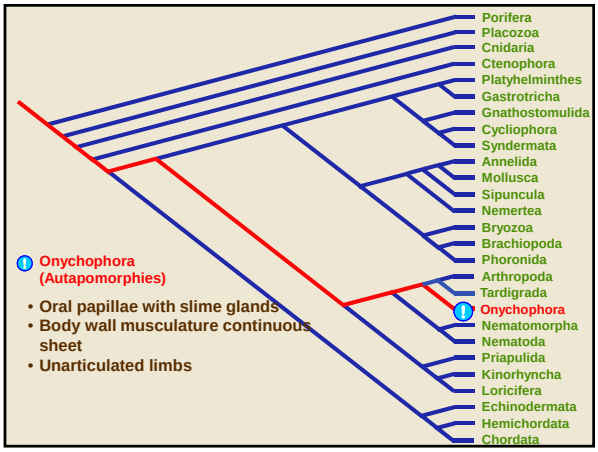


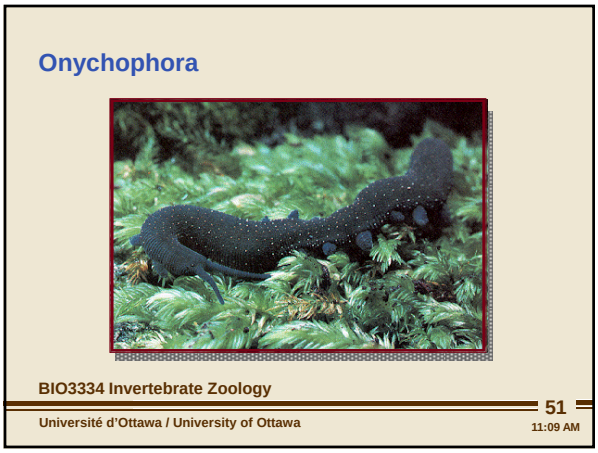
Everything is kept rigid for armour. There is pressure on the gut tissue, meaning they would puke every time they opened their mouth. Because they were miniaturizing they take a step back and have a gut with 2 valveles. Shut the back valve and fill the pharynx, and close the front valve to open the back and squeeze down pushing the food into the digestive tract.



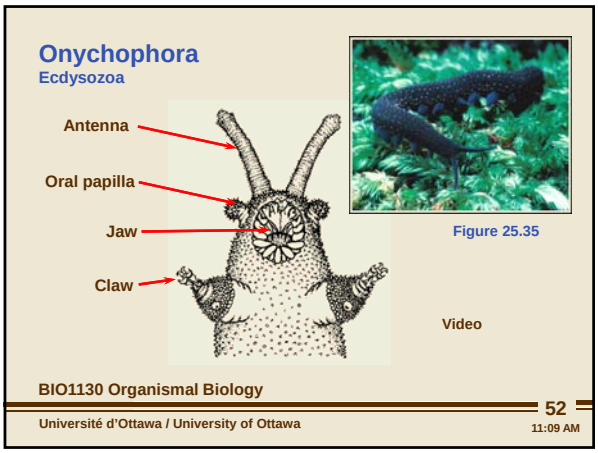
The fastest way to open a circle is using 3 lips. They all pull at the same time and open it as far as possible with limited muscles. We dont know how many there are because they are so morphologically the same. We know the ones that are associated with disease. If you go and sample they may out number arthropods. They re predators of small microinvertibrates. They can cause agricultural diseases and infections.



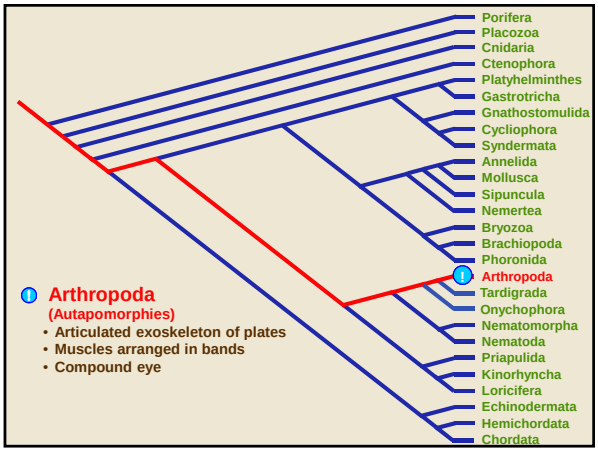




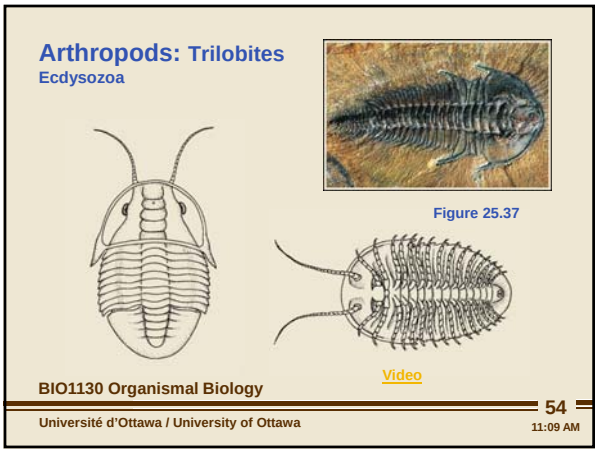
~~"velvet worm" - There is a marine version of this~~ found in the bergess shales, proving that they literally just came up onto ~~land and didn't change from its original form.~~



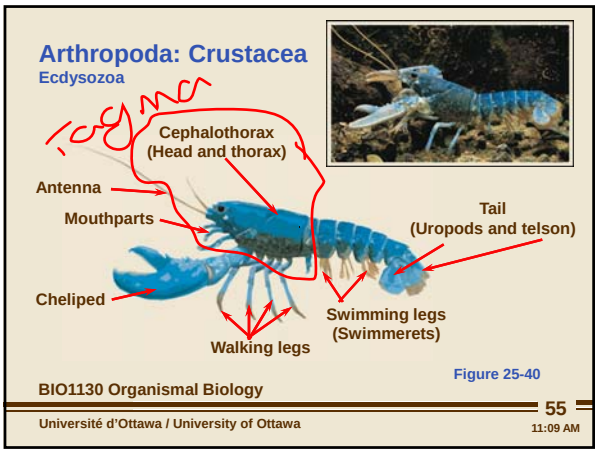
The antenna is used to prob the environment. The feet are extendable with a claw for grip. Their oral opening is large with 2 great big jaws in the middle. It captures pray and pushed pray into the jaw to rip it apart. This changes the food before eating it. It also shows the beginnings of segmentation that can be modified. This is a key characteristic of arthropods.



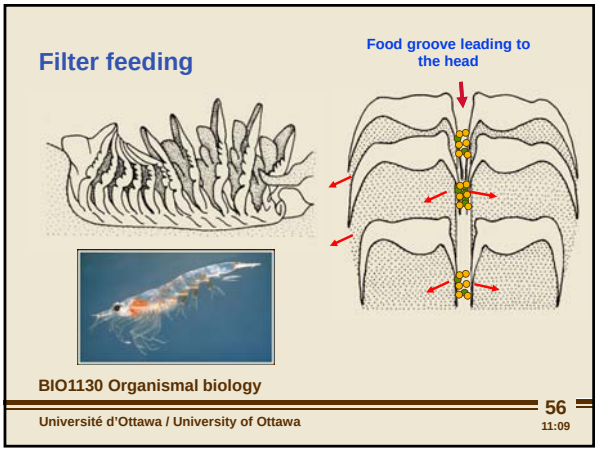
Arthropods: 90-95% of the planet
Huge reason is insects up on land but this hasnt happened yet. For now just marine arthropods.



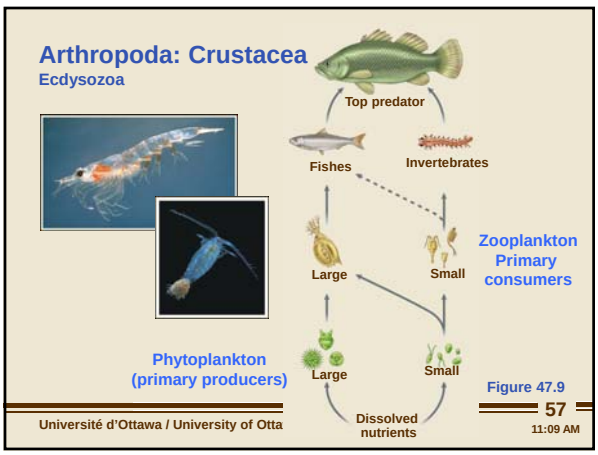
Have gone extinct in the permian. They were at one time one of the major arthropods in the cambrian oceans. They had a lot of variation and were really common. They were a major predator until they were eliminated by another predator.



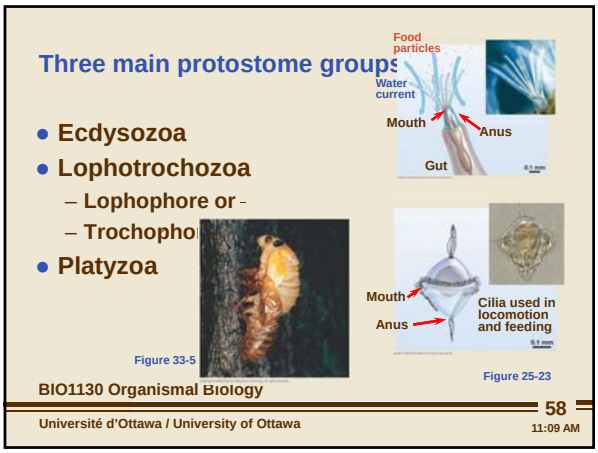
Still alive today but are not the ones from the cambrian. They do show a sequence of appendages and each on is all different in shape and appearance for different functions.



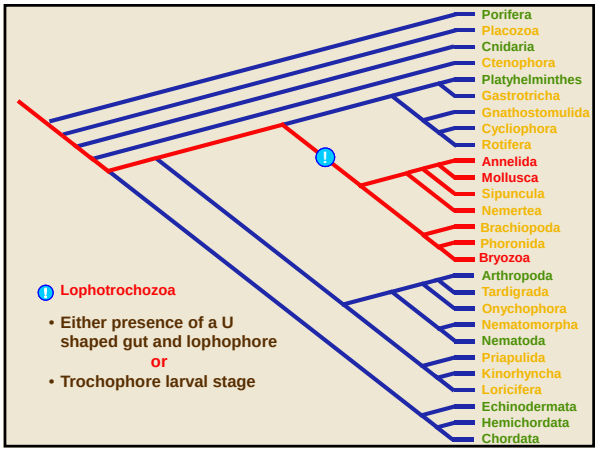
The first crustations had a unique set of legs that were very similar down the length of the animal. They are going to become the most adept filter feeders in the oceans while being capable of efficient movement (swimming).
To swim they move away to pull water in. The hairs overlap at all times, causing the water to go through them so it cant escape. The water then gets forced out the side. As the water comes in the midline and gets squeezed out using a metachronal wave down the organism.
This water contains algae, as this water is passed through the hairs, it gets trapped. As those limbs are moving, part of how the water flow does what it =does is that the bases squeeze and move forward, taking the trapped food and slowly pushes it up the groove to the mouth. That motion is happening while they swim. Locomotion is also a constant feeding motion. Primary herbivores. We will not see at this stage in evolution anyone who can filter out the primary productivity of the marine environment like them. They can still do this to this day because it is so successful.



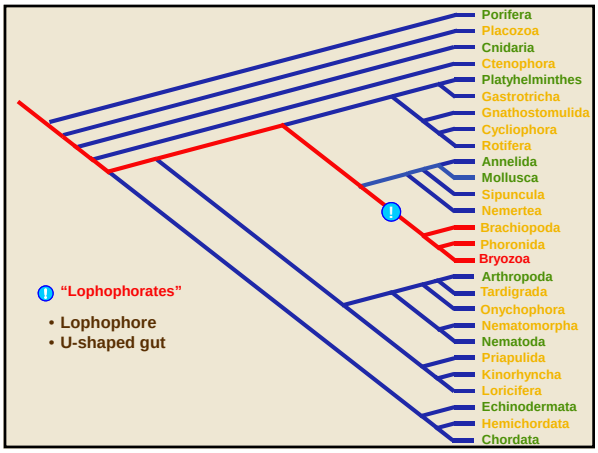
This sets the stage for the trophic oceans.

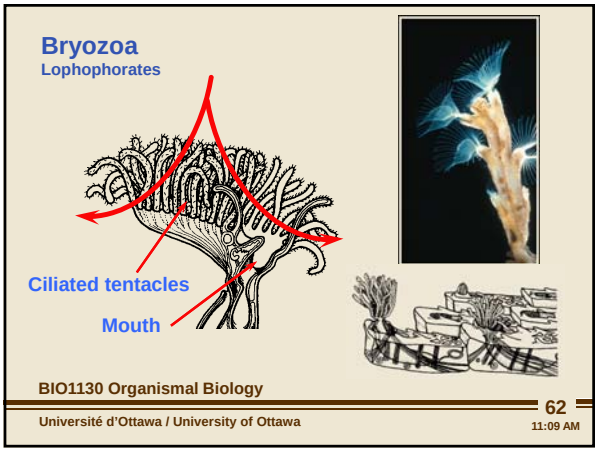


2) No single morphological character that defines them. The molecular data told us that they had 2 very different groups. They had to come up with a name. They simply combined the names. LOPH - lophophore OR** trophophore

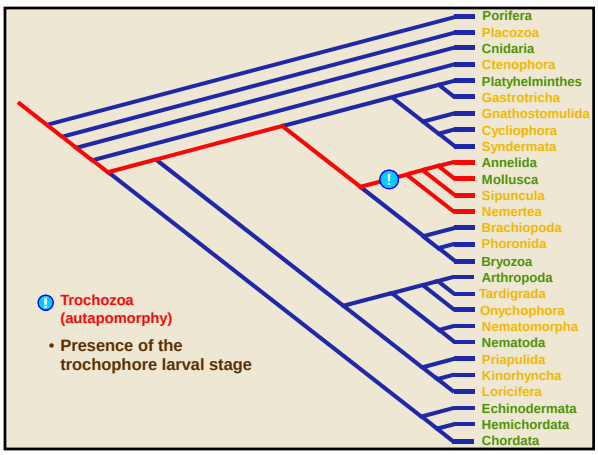


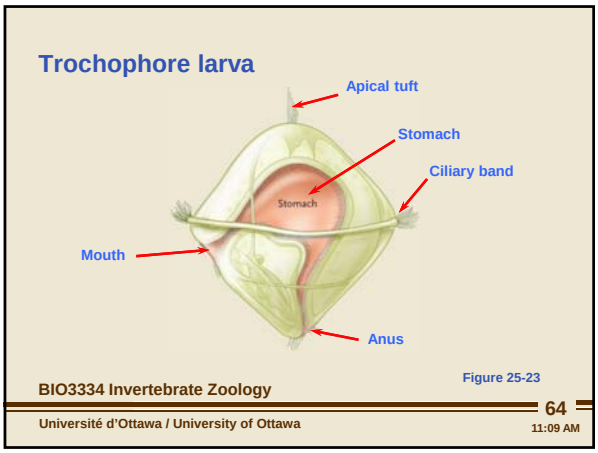
Briozoins are another example of greate reef building. Whats unusual about them is that they have settles back down onto the ground. This causes a problem because if you have a mouth and an anus and become a non moving organism and keep feeding. This group then creates a U-shaped gut.



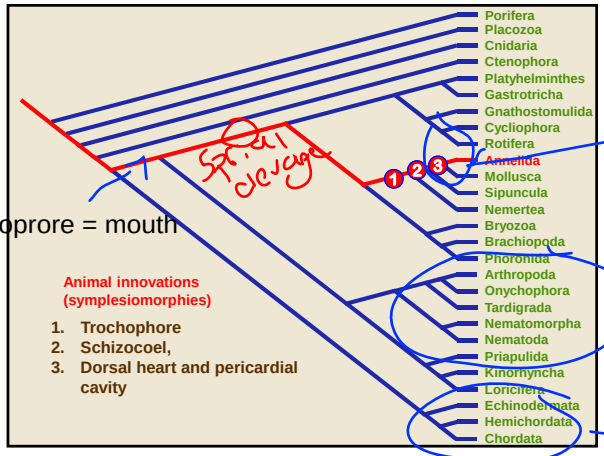


They sit on the substrate and has a U-shaped gut. It has bent itself and created a casing to pump water and create a current. This current comes into the centre and cilia grab hold of food. They pass the food down cilium's into the mouth. Convergance**** If a predator comes around they can come down inside and protect themselves. The position of the anus will cause the water to be filtered before it comes in so it is not contaminated.





Band of cilia around the middle is the locomotionary mechanism. Their currents pass food into a mouth to a stomach to an anus and out. Tuft of cilia at top and bottom to keep it stable. It then undergoes metamorphoses into one of the 3 next groups.



Mollusks are the second largest of the animal phyla out there. As it moves up they actually are schizocel.

Heart is on the outer surface

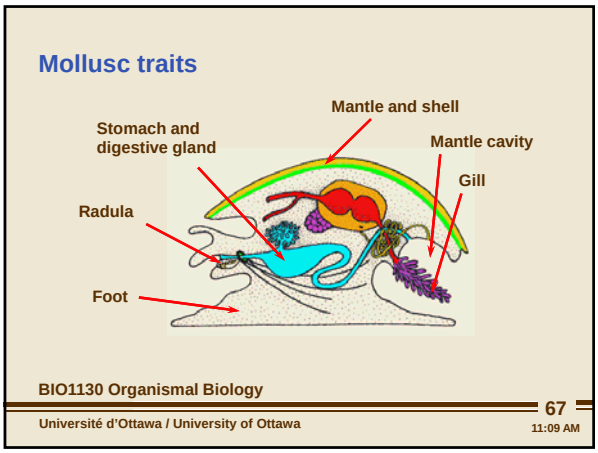
THESE ARE SYMPLEASEOMORPHIES BECAUSE THEY DONT DEFINE A GROUP. THEY DONT DEFINE THE GROUP. BOTH OF THESE WILL INHERENT THE SE IN THEIR LINEAGE AND AS A CONSEQUENCE THEY ARE SISTER GROUPS TO EACH OTHER****

Ventral heart

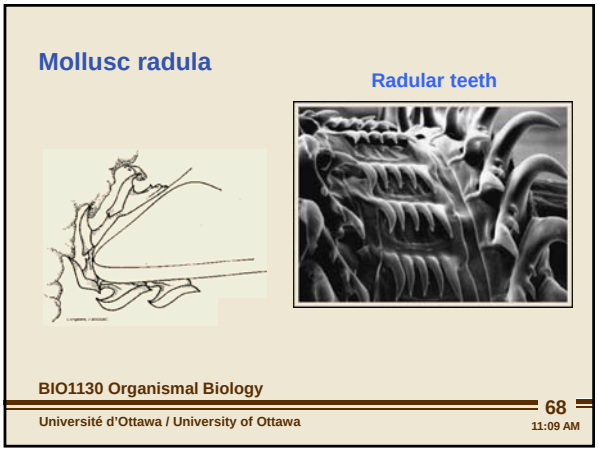
Blastoprore = mouth

Yolky eggs. Embryos develops on the surface of yolk and don't fit classic rules. Recognize 13 ways the get the first cleavages.

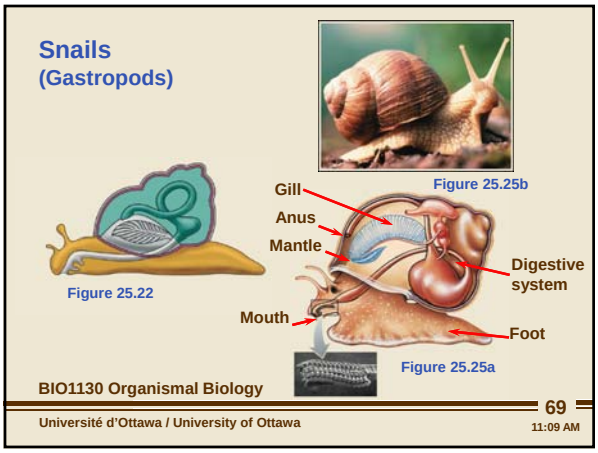
Molluscs are a very diverse group
(Muscles, claims, squids, snails)
Huge amounts of fossils showing that this is extremely biologically diverse. The characteristics that are apomorphies (Defining traits) - all mollusks have a shell which is secreted by an epithelial layer to protect themselves; They have also been found to mineralize calcium to make the shell. Aswell as armour, they also fed with a uniqure structure called a radula.



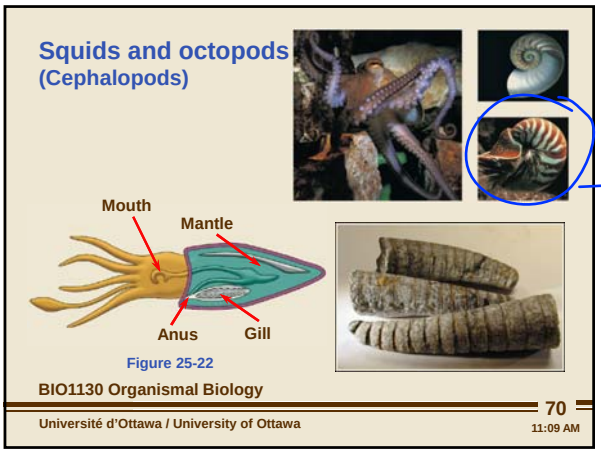
They also have a cavity for their respiratory structures. It has gills covered in cilia which pump the water into the water cavity. Even when it pulls its shell down it leaves a small opening at the back to breath. It can also grind an feed while the shell is down aswell. The anus is located in the outgoing water because the ingested water will never be contaminated. It can hide still, while eating, perspiring, moving, and removing waste.



They are able to stick their tongue out and move barbs or teeth on the surface of the tongue to grate and scrape food off of things like rocks for a food source. No one else was doing this yet.

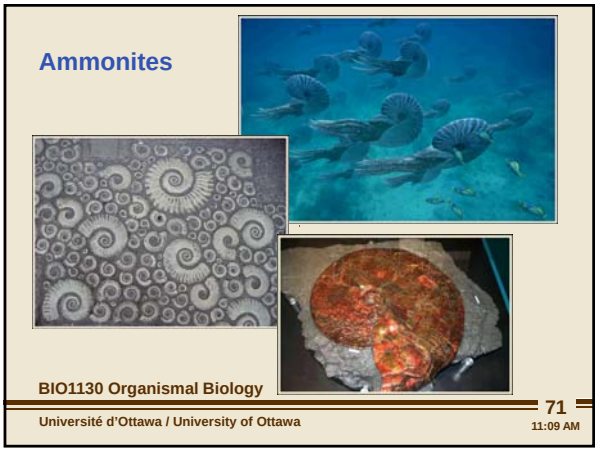


A snail is a mollusk that came on land. They are able to lock themselves inside they shell so they dont dry out while they are eating on land. Many snails have a piece of shell over their tail that clamps completely shut tight. In the desert they can shut down and hibernate for 8 months at a time during the summer. Because they were some of the first animals on the terrestrial environment they are one of the most abundance.

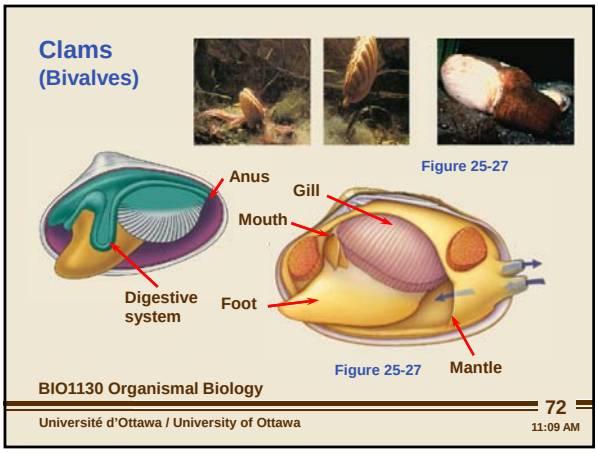


Take the mollusk body plan, and elongated itself along the dorsal axis. The foot has modified itself into tenticles to capture prey., the cavity is still there, but they developed a mechanism to pump water in the cavity and shoot it out a funnel. It is a predator in the cambrian period.

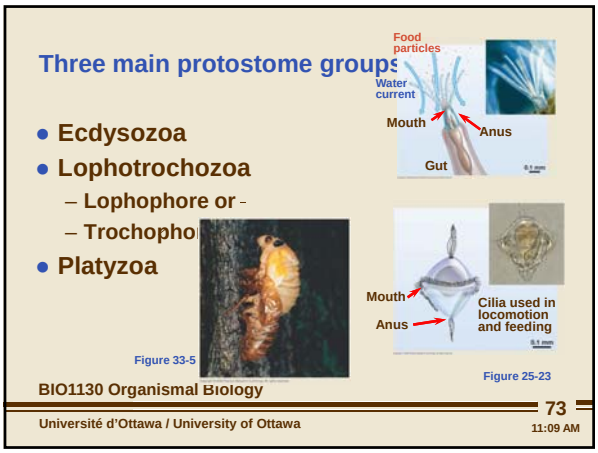
Only one still alive today with a shell in the ocean. When freshwater came into the oceans do to the mass extinction of ocean fish, they were dominant predators. This cause the shell to become a less effective trait due to its weight. As it got lighter and lighter to compete it eventually just went away and created the squid: a very agile organism.

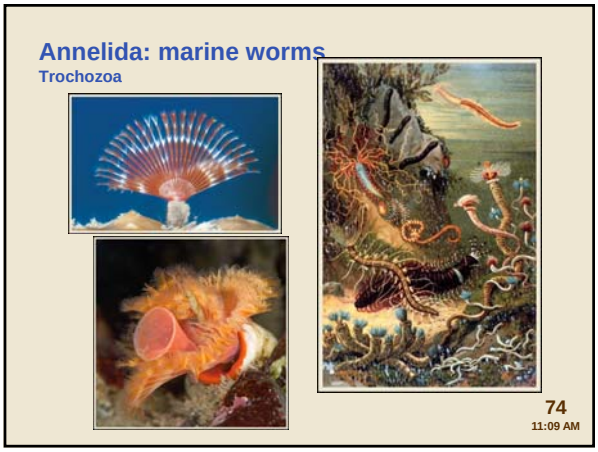


They were one of they key predators in the oceans.

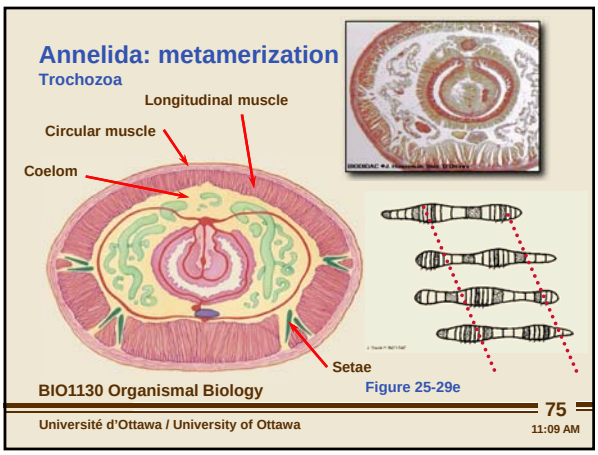


No one has completly tapped the floating material in the environment. Theres larvae, and small organisms floating around. It has taken its shell and folded it around itself. It leaves 2 openings to pump water into and over the gills and out. As the food is trapped in the gills it is moved towards the digestive system. the water moves out taking the waste with it. They also burrow in the ground to hide. It uses its muscular foot to dig into the ground for protection. When its in position all you will see are 2 little openings to pump water. The mantal cavity is part of the respirstory organs. They ahev 2 very large muscles used to close their mouths. When you steam clams you never eat the ones that stay closed because the clam that doesnt pop open has died and got tetnis and the muscles have ceased. The

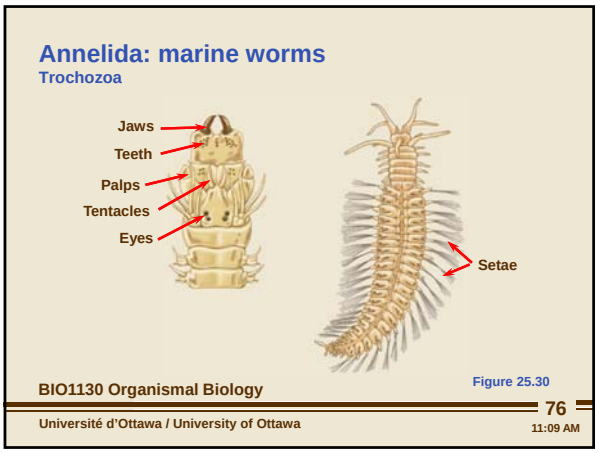


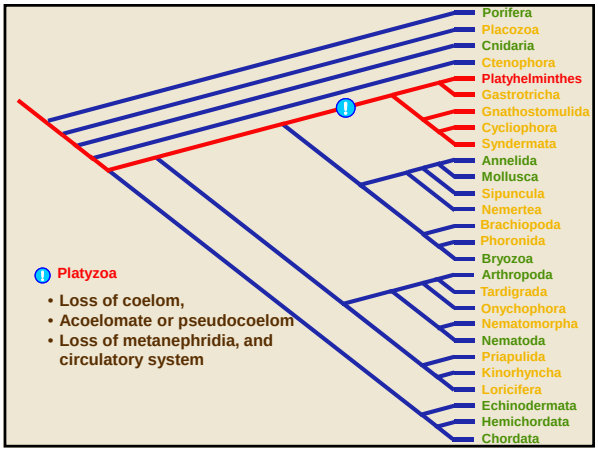


Most of the annelid diversity is in the ocean. One of the things that they did is found a new way to feed.

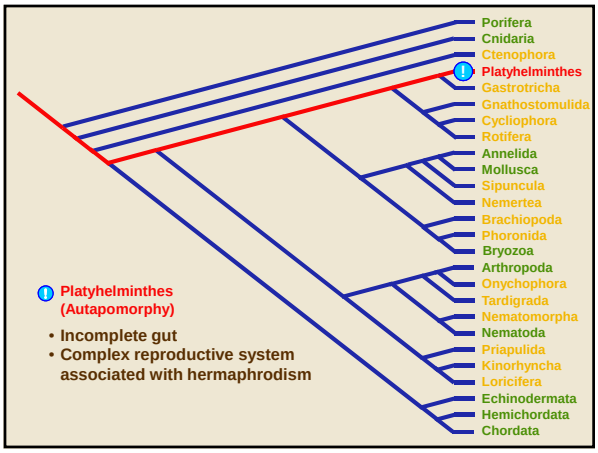


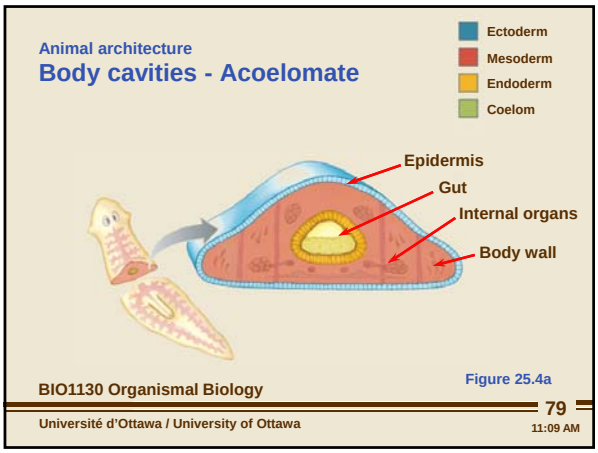
The earthworm is an example of how they all have a segmented body. Each ring is hydrostatically independent. They each have their own longitudinal and circular muscles. they also have hairs made out of kytin that stick out the sides creating anchors in the substrate. By contracting the longitudinal muscles and lengthen the circular ones and the fornt end will move. "Accordion-like movement" new and only possible in the segmented body plan of these animals.
With that locomotion, as they pointed their anterior end forward and push it into the substrate. Earth worms swallow their substrate, process and leave waste creating their burrow. They did this on the bottoms of the ocean.



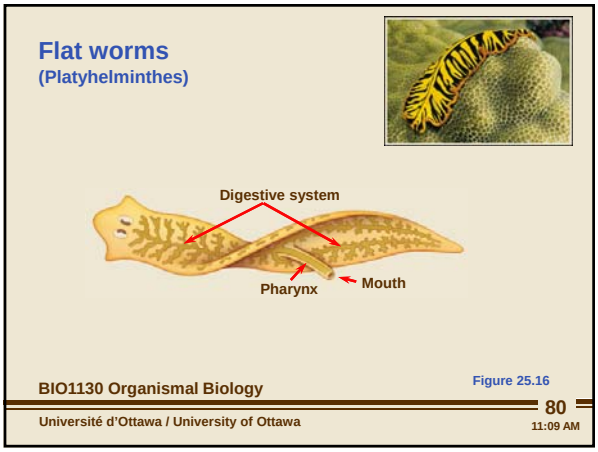


That celomic loss results in acelomates and pseudoceilomates.

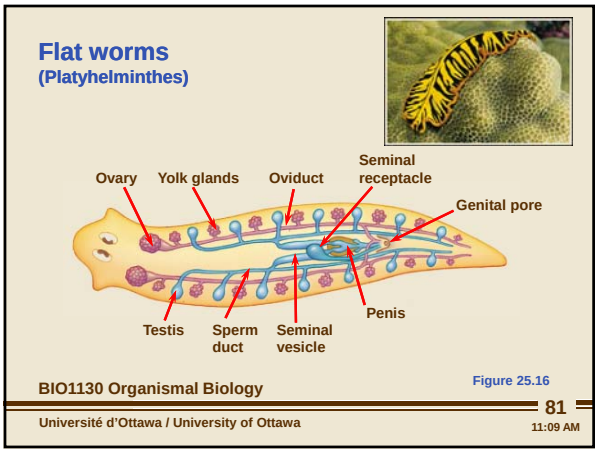




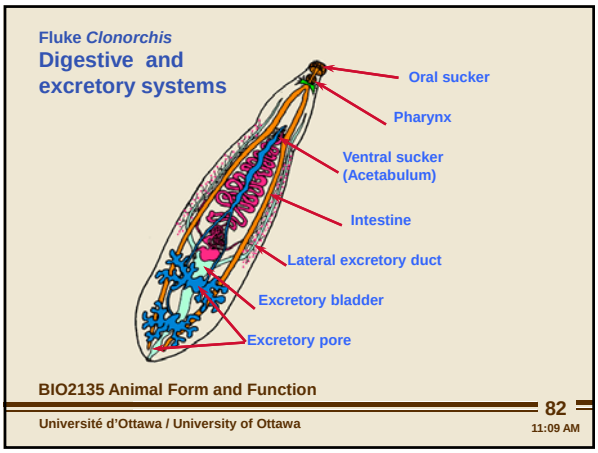
Genomics has told us that this is a derived condition. In addition to being acoelomate, they have an incomplete gut. This is unusual because there is a great advantage to the other digestrive tract. This is a group that has gone backwards. They also all exhibit hemaphriditism
There are outer circular muscles. Mesodermal muscles fill the space in between. This animal is able to stay flat. Every single tissue is either really close to the gut for nutrients or the outside for oxygen. The whole underside of the animal is covered with cilia which allow it to glide across the substrate in a smooth swimming movement. These ~~shit into a second form of locomotion by contracting~~ the dorsal ventral without widening the diameter. This is similar to the earth word but it doesn't use independent compartments. The flatworm protects its self with the nitocites that they consumed.

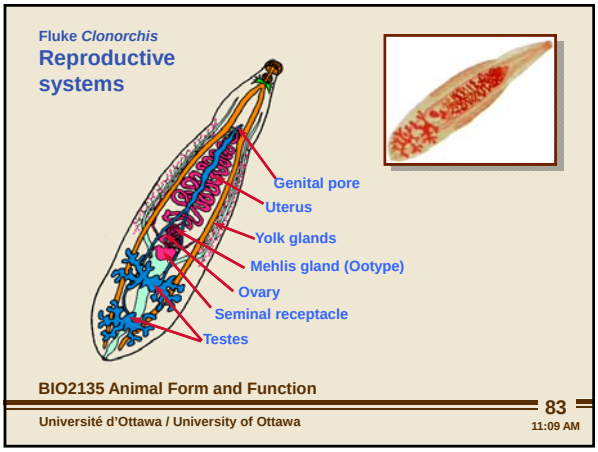


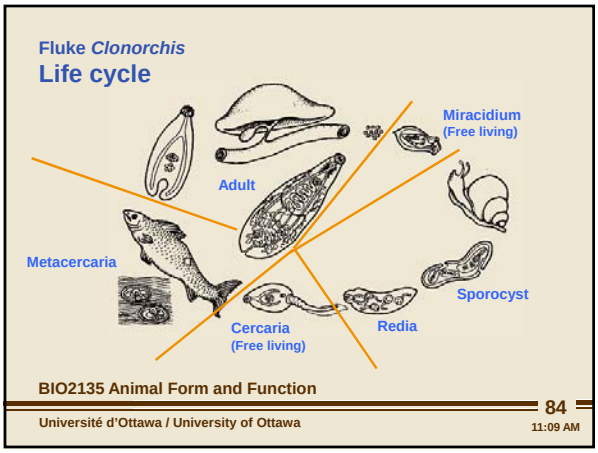
Not only do they have an incomplete gut, but the mouth is no longer towards the front of the animal. It is not in the middle of the animal on the underside.



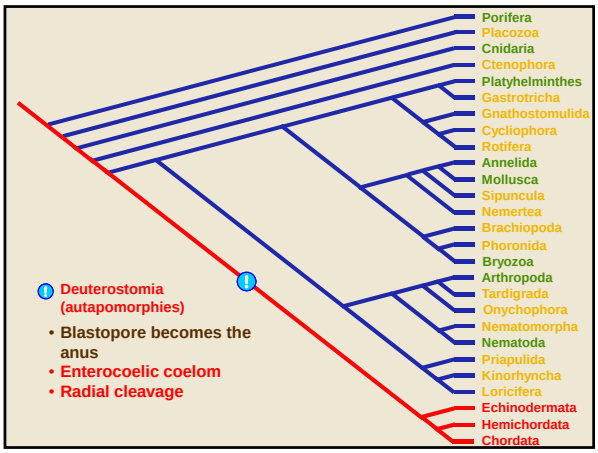
~~This animal is a hermaphridite. It is not really that~~ mobile and there is a distinct advantage to this is (in a mating event ~~between animals that have separate sexes only on~~e becomes pregnant. In hermaphridites both become pregnant ~~and produce offspring. This increasing the number~~ of organisms because they really meet each other. They are also capeable of preventing self-fertilization. During mating, when they meet, they insert their organ into each other to transfer sperm. The sperm goes through into the seminal receptacle. They then separate and only later do they produce they eggs which pass in front of the seminal receptacle which releases the sperm and fertilizes the egg.



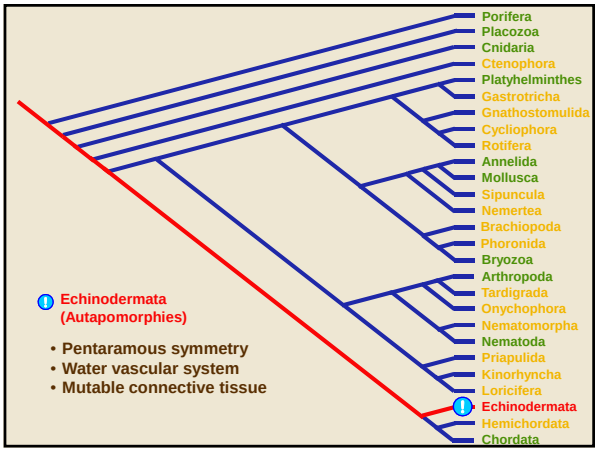




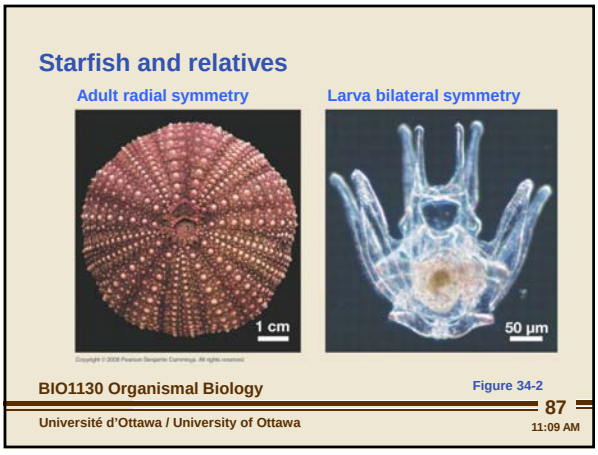
Flat worms have very complex life cycles. This a fish fluke that lives in the liver. When it produces eggs they are passed out into the fecal material. The rain then washes the eggs away. the eggs then hatch into a free-living, swimming, larval stage which always looks for a snail. When they get into the snail wall they develop into a sporocyst which increases the numbers in the snail, then it becomes full of little organisms that have tails and are capable of swimming. When the time is right they burrow back out of the snail into the waTER TO DWIM. IN THYE OTHER LIFE CYCLE THEY WILL DIG INTO THE SKIN OF THE FISH AND WAIT FOR THE FISH TO BE CONSUMED. This is why there is so much control on the raw fish industry. That little fluke that gets into the fishs skin can be very dangerous.
In all of these the free swimming larval stage leaves the host and seaks out what is appropriate for its life cycle and increases its numbers.



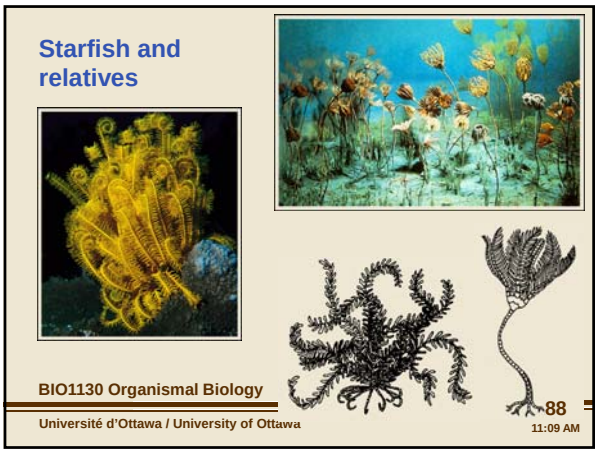
Deuterostomia: radial cleavage is associated with this line as an atapomorphy. In the cambrian seas, we will get the starfish



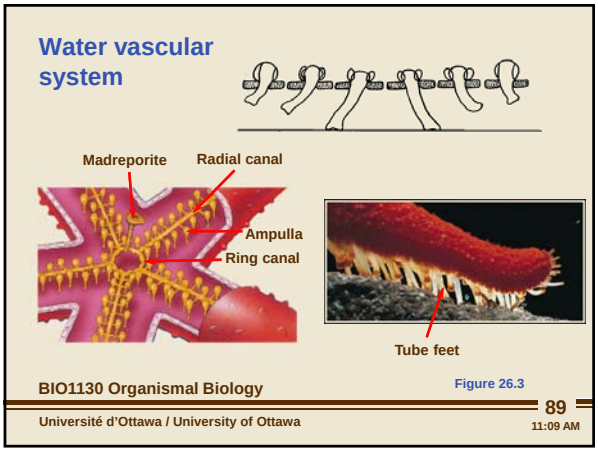
The starfish returned to radial symmetry. Theirs is always based on five as well as using a water vascular system for movement. They have a very unusual connevtive tissue. The cynoderms have a outer skelton arranged in plates surrounded by tissue. It is unusual because it is under nerve control to determine weather the connective tissue is flexible or rigid. When is becomes rigid the starfish becomes solid.



Bilateral symmetry was supposed to be the best advantage. For some reason they have returned to radial symmetry although only as adults. At maturity they undergo metamorphosis back into radial symmetry.



When we look at the environment they came in we see that they used to sit on the bottom with long stalks. These were formed the same as starfish. At the very top of these stalks had a set of small arms. The arms anchored on the bottom and the mouth was on top so it could catch all of the organic matter that fell through the water column before it hit the bottom. This group tested the sediments before it was sediments.



On the surface of the arm there were little hydrostatic skeletons, as the foot particles fell onto the arms of the starfish the feet would move the food down the arm towards the mouth. This is the water vascular system of these organisms. Sea water fills it and its canals, basically carrying the sea water to the feet. The feet have an ampulla at the top which connects it the the rest of the system. It them blocks off its connection to the rest of the system, when you put the fluid in and contract the muscles the foot will move. This is all supplemented by a suction cup on the bottom of the foot to hold on to the substrate. There are millions of these providing a nice soft and slow movement across the substrate.
Starfish are predators. they feed on muscles and clam. They also eats coral when it spreads its digestive enzymes and aeats them