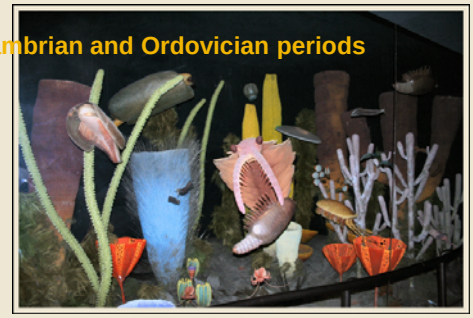
Cambrian and Ordivician



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every type of mutlicellular life will appear all the sudden. (Cambrian Explosion). over a period of 70 million years.

Geological time scale and building height

(1floor – 60Ma, 72 floors, 12 feet/floor)

- **Major Eons (Ma)**
  - **Phanerozoic**
    - (550 Ma to present time, top 9 floors')
  - **Proterozoic**
    - (2,500 – 550 Ma, 33rd -63rd)
  - **Archaean**
    - (3,800 – 2,500 Ma, 12th – 33rd)
  - **Hadean**
    - (4,500 – 3,800 Ma, 0-12th)

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Geological time scale and building height

(1floor – 60Ma, 72 floors, 12 feet/floor)

- **Major Era**
  - **Phanerozoic**
    - Cenozoic (65 Ma to present time, 72nd floor)
    - Mesozoic (245-65 Ma, 65th to 71st)
    - Paleozoic (550-245 Ma, 63th to 65th)
  - Proterozoic (2,500 – 550 Ma)
  - Archaean (3,800 – 2,500 Ma)
  - Hadean (4,500 – 3,800 Ma)

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Paleozoic periods

- Paleozoic era
  - Cambrian 550-488 Ma
  - Ordovician 488-443 Ma
  - Silurian 443-416 Ma
  - Devonian 416-359 Ma
  - Carboniferous 359-299 Ma
  - Permian 299-245 Ma

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multicellular life in oceans none on land. Ordivician ends with an extinction event that kills many multicellular species.

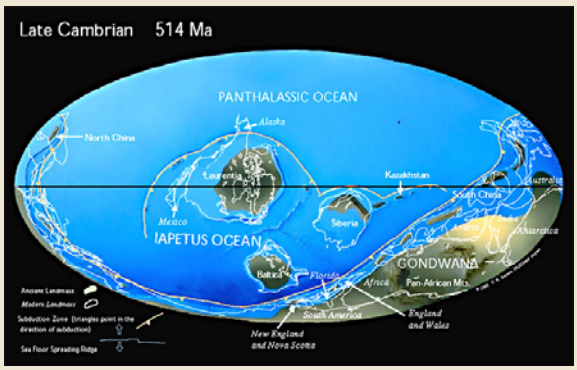

Figure 27-8

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continental shelf: lots of light, shallow waters. high primary productivity (autotrophs).

- sits on the equator (ideal location for life and fossils)
- collision on left side of continent forms rocky mountains and becomes a hot spot for fossils.

Burgess shales – Yoho National park

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soft bodied organisms fossilized in shale

The Cambrian explosion

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Burgess shales and its unusual invertebrates

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Burgess shales and its unusual invertebrates

Video 1, 2,

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organisms are one of a kind.

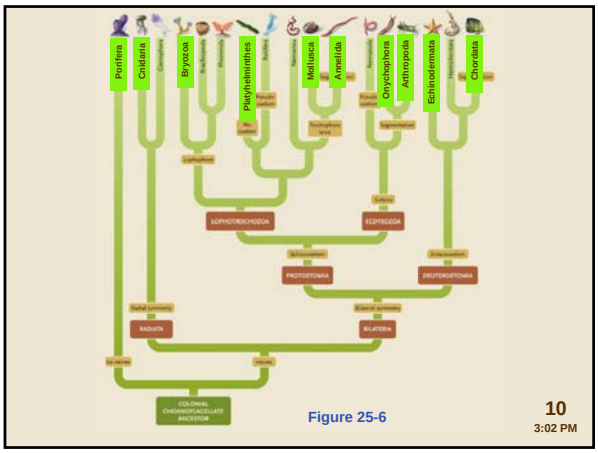

Figure 25-6

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embryology, symmetry.

Animal architecture

- Tissues
- Symmetry and cephalization
- Embryology
- Body cavities

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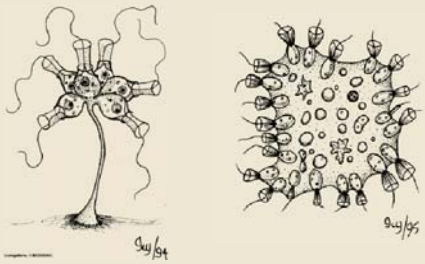
tissues: will it have cell to cell communication, different types present.

morphology to categorize organisms

Colonial choanocyte ancestor



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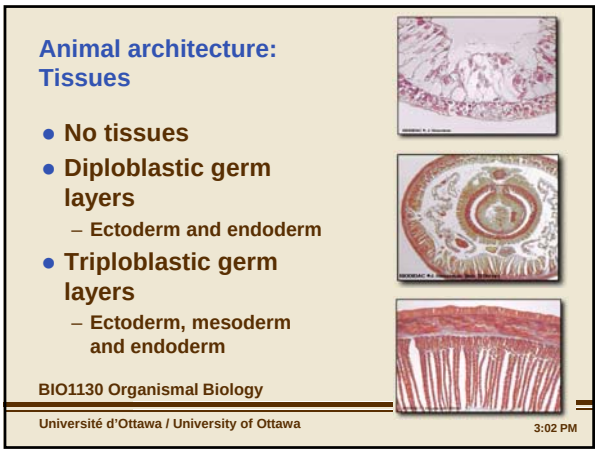
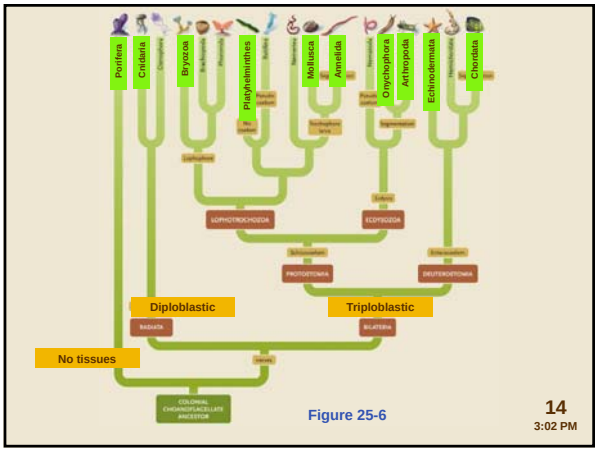
first multicellular aggregate. Unikont, had a trapping mechaninsm. use phagocytosis to pull food down to cell. microtubes on this cell is the same as microvilli on all animal cells.

they do not have tissues

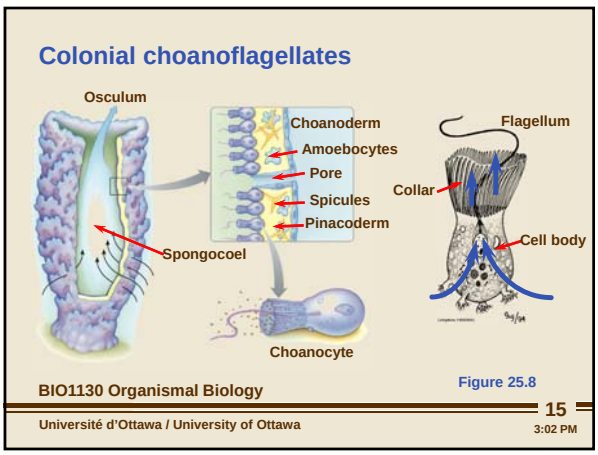


Diploblastic, 2 tissue layers.

mesodern, we have all 3 layers.



first division, tissues or no tissues. next is 2 or 3 layer of tissues.



specialist on filtering large bodies of water.

water moves in from pours in sponge and goes out through Osculum.

has no cell to cell communication- no tissues but layers.

choanoderm- outer body wall.

jelly like in between inner and outer, Amoebocytes use amoebytes to transport food to the outer cells.

spicules- bone like structure that holds the organism in shape.

no one else in the ocean that can filter large amounts of water. this is the first.

Sponge sex

- Choanoctyes become sperm
- Archeocytes (sponge stem cells) form egg

http://www.waterexplorer.com/il_cool102.htm

Figure 25.7

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go through mitotic division and turn into sperm cells.

sponge engulfs sperm but doesnt digest it. Carres it with amoebocyte to egg cell and it is fertilized in there.

Animal architecture
Symmetry and cephalization

- Assymetric
- Radial symmetry
- Bilateral symmetry and cephalization

Figure 25.3

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all animals with tissues have a mouth. Oral side= mouth Aboral= other side. cut organism from oral to aboral axis and get 2 identical halves.

sponges do not have a mouth.

Assymetric- passive to the world around it.

symmetry determines how you respond to the world.

bilateral- sense where they are going and react to the world around them. concentrate sensory at the front of the organism.

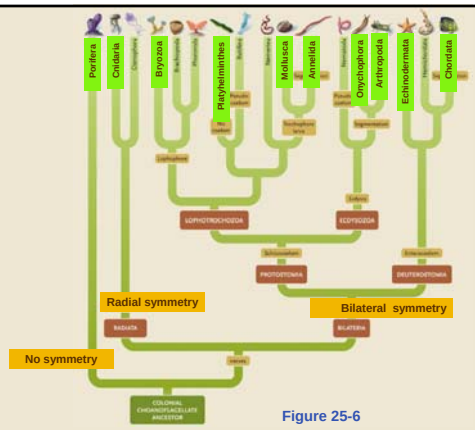

Figure 25-6

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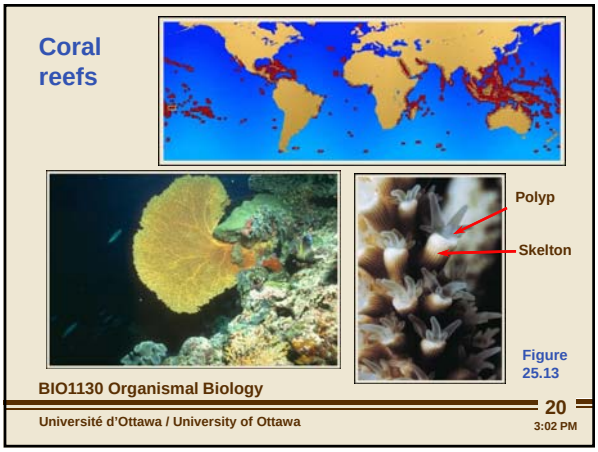
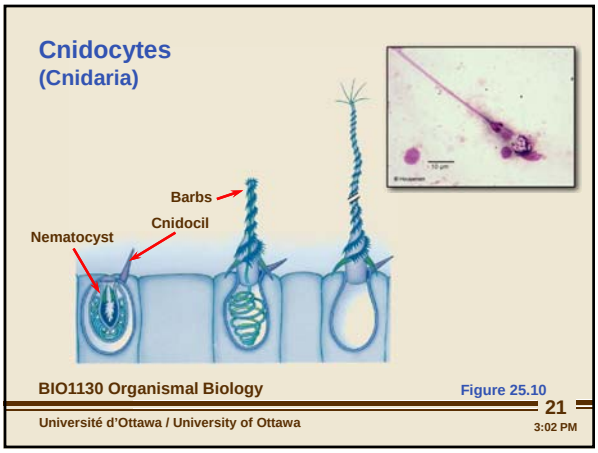
Radial- Diploblastic,

Bilateral- triploblastic

the most significant primary productivity in oceans. shallow, rich in nutrients because it is shallow.

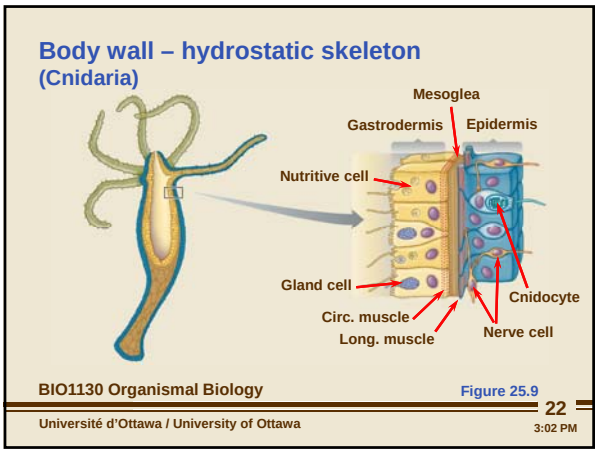
consits of polyp, sticks his head out and feeds and stick head back in.





one of the first exclusive predators.

cnidocil- stinging cell. pressure is build up in the cell, if the right stimuli it triggers the release of the barb out and zaps the organism.



mouth but no anus, not a complete digestive track.

grabs pray with tentacle and puts it in its mouth.

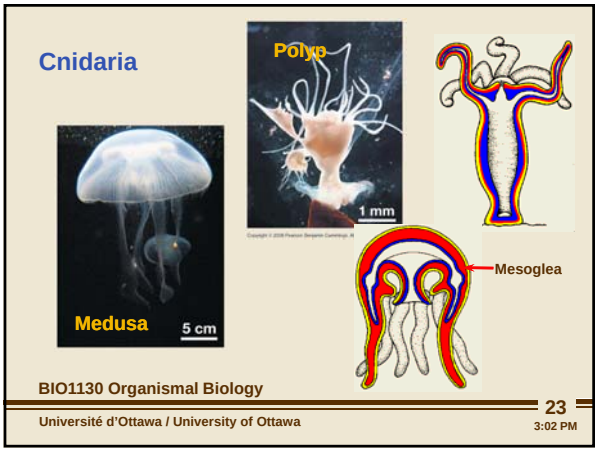
no muscle but has mesoderm. has a hydrostatic skeleton instead which is unique. gland cells- release digestive enzymes.

muscle contractile cell but NOT mesoderm.

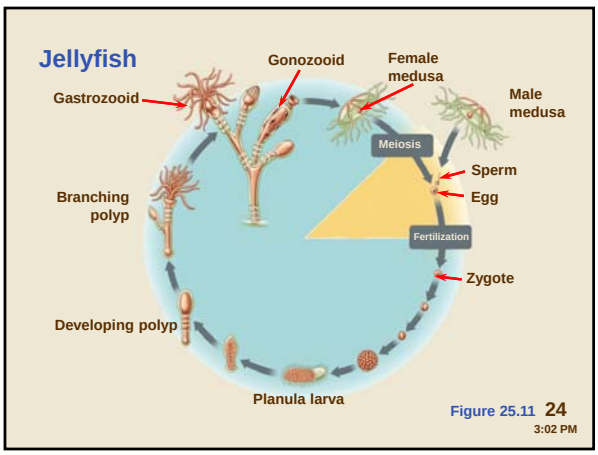
gastrodermis cells move in circles, Epidermis are running in opposite directions.

muscles act in pairs. muscles return to original length by stretching.

antagonistic muscle system.



medusa: upside down flattened polyp. ring of muscles around bell, when muscles contract, moves down, relax muscles, springs back up.



zygote divides until goes into groups (Larva)

larva has cilia

diplontic organism.

Animal architecture

- Tissues
- Symmetry and cephalization
- Embryology
- Body cavities

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Animal architecture
Embryology - cleavage

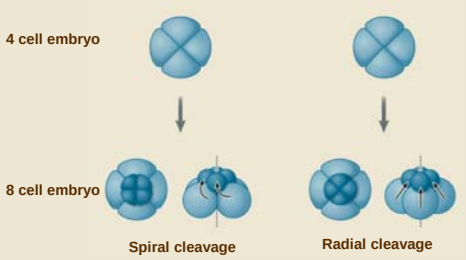

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Figure 25.5a
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All animals divided by cleavage.

Animal architecture
Embryology - gastrulation

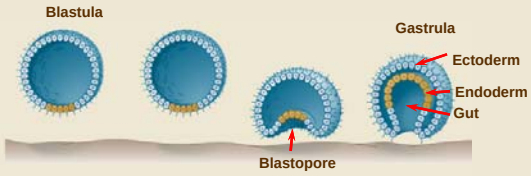

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Figure 25.2
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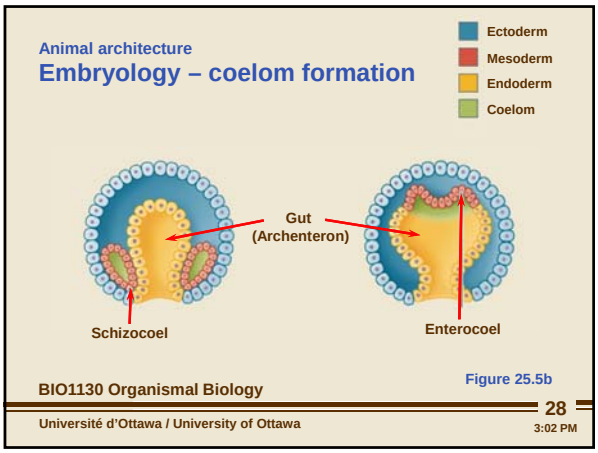
Blastula- hollow ball formed as cells divide.

all cells same until differentiate.

ball folds forming different layers.

endoderm lines digestive system, ectoderm

lies outside of the body.



endoderm will be muscle.

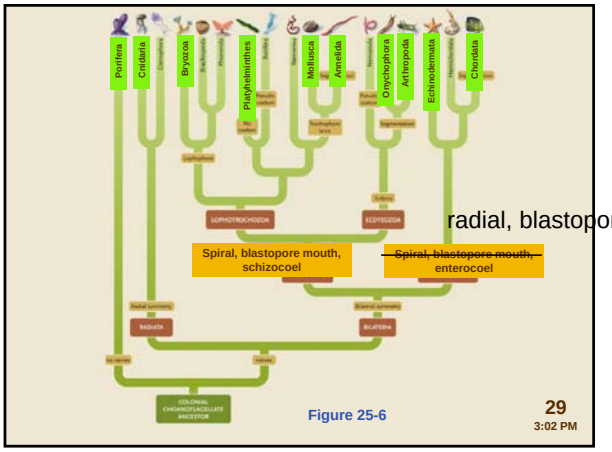
2 ways fills in space. 1) junction at opening of gut, a new cell type is made to fill the space. Mesoderm splits and there is a cavity.

Shiz meet at the top and split to make body cavity.

2. balloon like fills in the space. ceolom enteron forms from the gut.

wen the two ends (inner and outer) touch another opening is made.

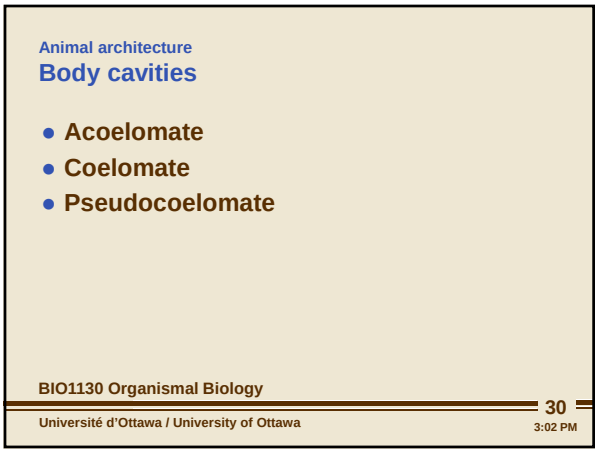
animals, anus first then mouth. nothing says the first opening has to be the mouth and the other an anus.



spiral, mouth, schizocoel -protostomes

radial, anus, anterocoel - deutostomes

radial, blastopore anus

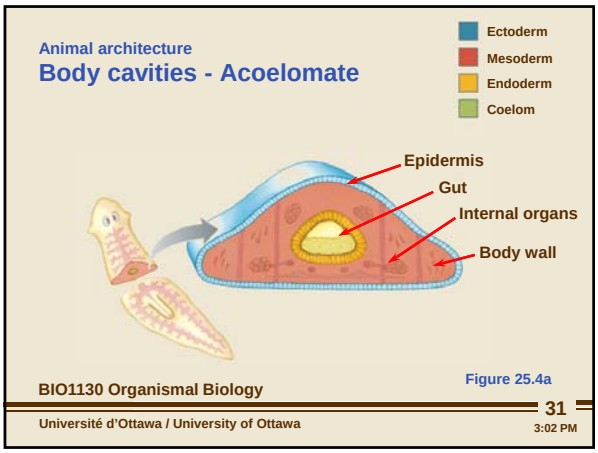


coelomate - have body cavity

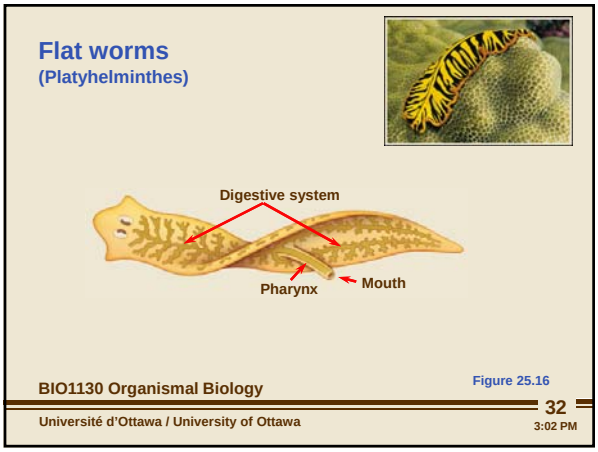
Pseudocoelomate- have a cavity partially lined with mesoderm.

Acoelomate- no cavity.

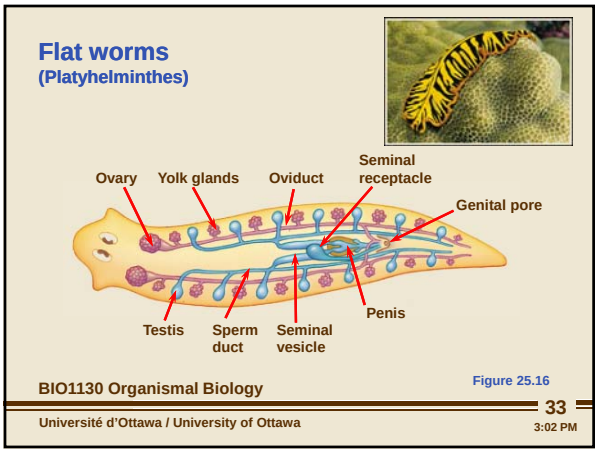
How animals feed, how they get around, how they adapt, their reproductive cycle. Nothing else matters.



Flatworms lost its body cavity, it did this because its flatness gives it a really good surface to body ratio. succesful as parasite of animals with internal ceoloms.

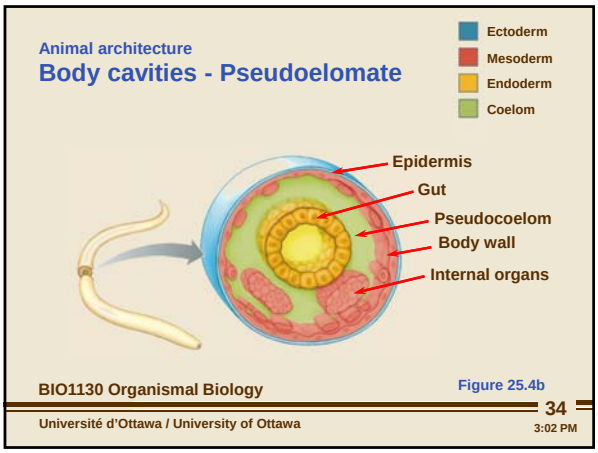


not only got rid of body cavity but the anus as well. incomplete digestive track. current curculates nutrients. all cells adjacent to food supply. it feeds with muscular pharynx. whole body is covered with Cilia. moves with cilia. thousands of cilia line bottom of body for gliding. spongeyness of tissue- accordian like movement. sensory concentration at front. moves head front, sticks it. contracts lower body. lower body is glued and he stretches his head than sticks it...

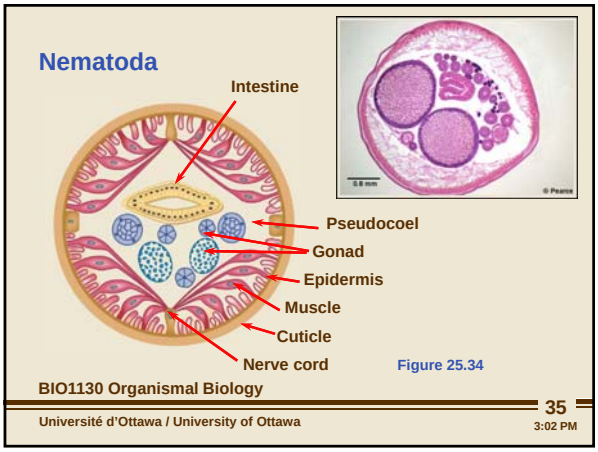


have reproductive cycle of hermaphrodite. have both sets of organs. 2 individuals fertilize each other. reproduction produces 2 pregnant individuals cant self fertilize.

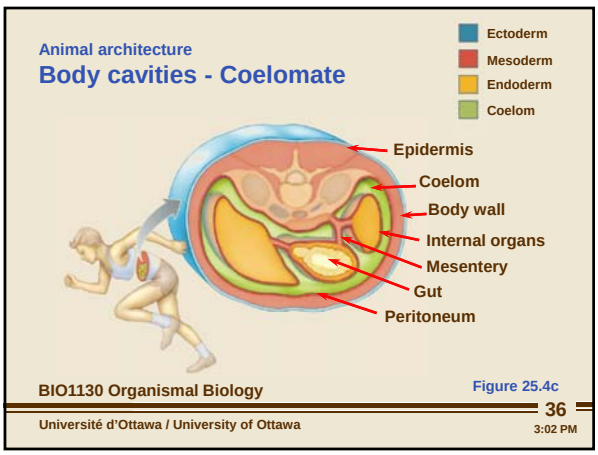
seminal vescle- holds sperm. once procreating, both individuals insert penis into one another such that once the sperm is released it goes into the seminar receptacle. after, ovary produces egg, traveles down oviduct. seminar receptacle releases sperm to fertilize egg.



round worms: mesorms doesnt complete body cavity. mesoderm only lines outer ectoderm.



have muscles only on the outside. no circular muscle, only longitudinal in its inside. hydrostatic skeleton- use antagonistic muscles on either side. they are bad at swimming, thus live on land. snake like movement. no peripheral nervous system to control muscles. males only organisms to have amoeboid sperm in animal kingdom. no flagella.



true body cavities. outer body surrounded by mesoderm.

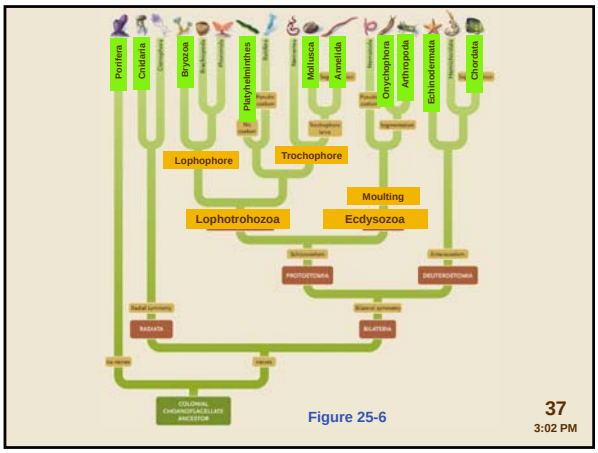


Figure 25-6

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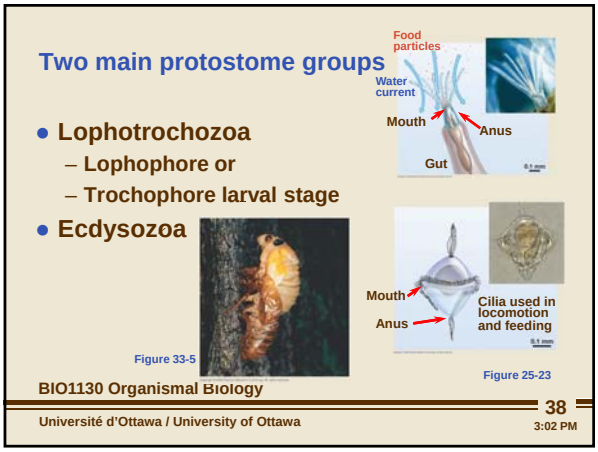
ecdysozoia- exoskeleton shed in order to grow. molting animals.

Arthropods. count for %95 of all animals on earth.

Lophotrohozoa- splits into 2 major groups. nothing physically in common.



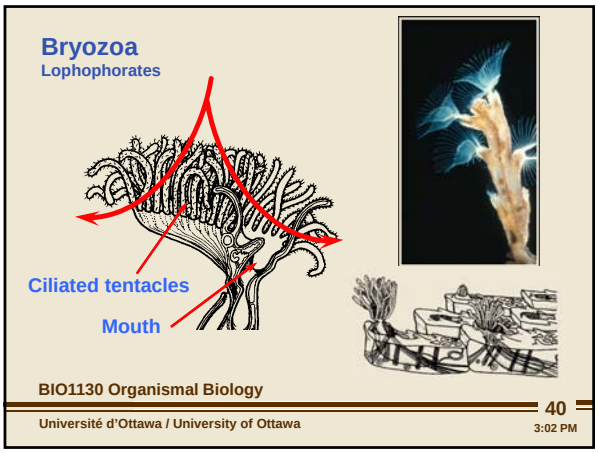
Lophophore- unique feeding structure lined with cillia, pull food out of water column.

Trochophore- begin in larval stage.

can never have both.

most important thing, Lopho and Trocho dont go together.

moss animals, live in shells that they secrete.



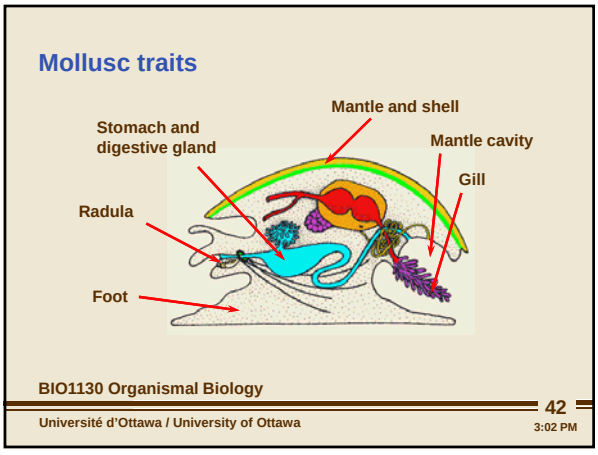
Coelomates and lophophores

tentacles holow, hydrostatic skeleton, lined with cilia

as cilia beat, moves water and particles down tentacles and toward mouth. pulls feeding structure back in when it doesnt need to feed.

removed mobility in exchange for efficieny in food and can protect itself in its shell.

2nd most abundant group. squid, snails, clams, oysters. they are all different in function. Use adaptive radiation.

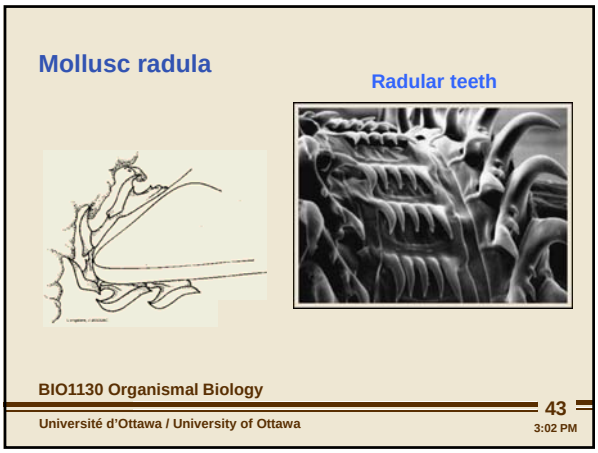


protective shell - secreted by epidermal layer (mantle).

pulls calcium from water, then excretes and solidifies it.

moves around with a muscular foot.

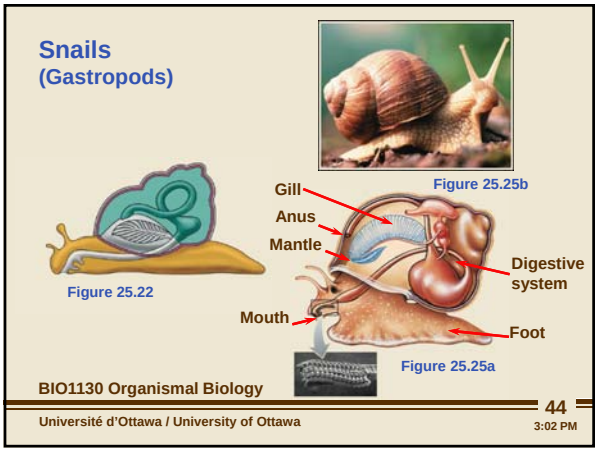
can pull shell down and tuck in all organs and tissues for protection from predators.



feeding structure. covering the surface of tongue is teeth to grind.

loosely attached so can slide it forward and back to scrape organic

debris. teeth are constantly replaced from the back.

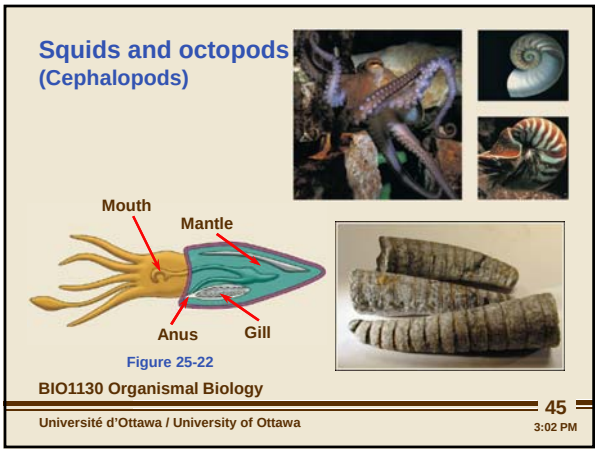


visceral mass enlarged- rolled and compacted it.

piece of shell on back on foot, when snail goes inside, it acts as a door.

can move on land.

they are also hermaphrodite.



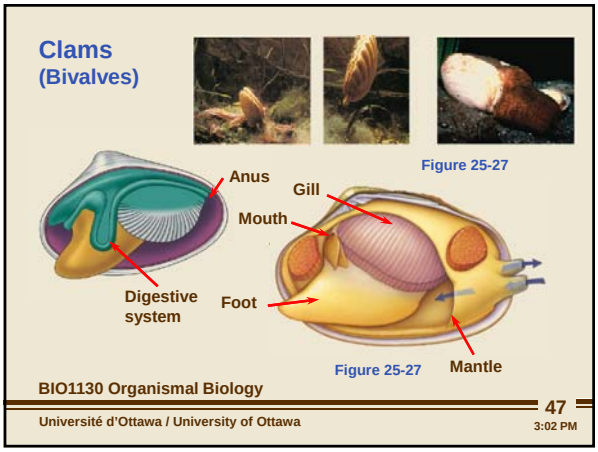
swims with its shell behind it.

its muscular foot becomes tentacles.

shell rolled inwards. opposite of a snail.

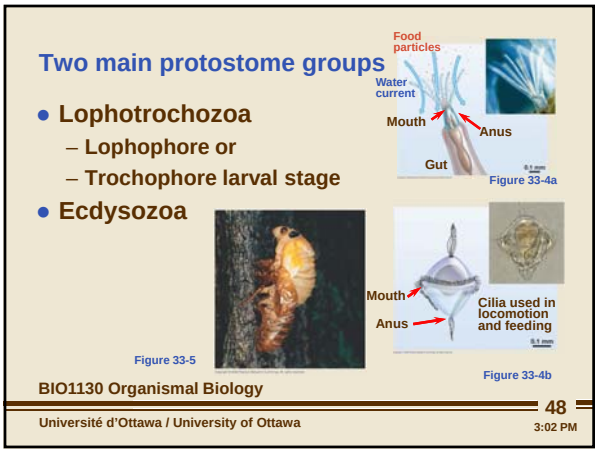
when fish come, in order to compete to become an active predator

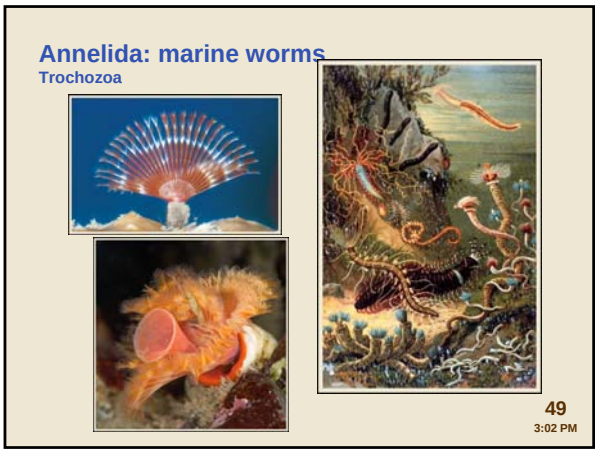
they remove their shells. all except for one organism.



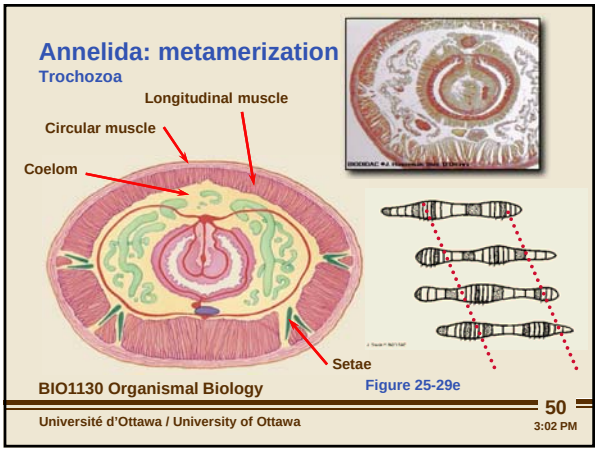
dont eat. pumps water into its digestive system as it comes along.

also dont move.





Annelids: mainly found in marine environment.



segments: bunch of fluid filled cavities arranged linearly down length of worm.

metamere- segment

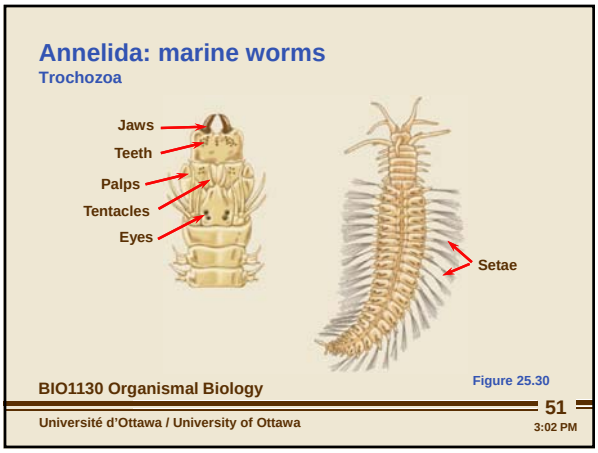
each metamere can change shape independent of its neighbor

Setae- can be retracted, bristles stuck out and retracted

- stick out when segment is at its largest to anchor in place

- small segments slide forward, enlarge and anchor.

- in order to get into sediment it opened its mouth eating all of the substrate and tunneled through.



NOT IMPORTANT.

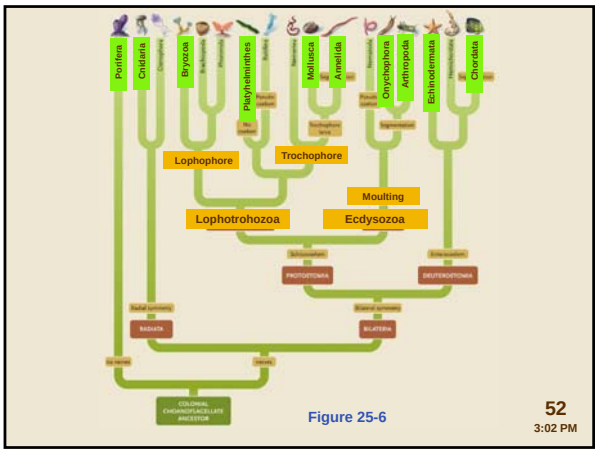


Figure 25-6

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Onychophora
Ecdysozoa

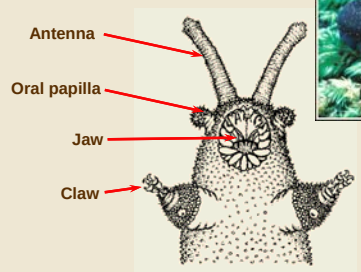

Figure 25.35

Video

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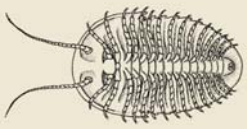
Velvet worm, it is a living fossil. In burgess shales.

Shows segmentation has occurred multiple times.

First exoskeleton - Non waterproof cuticle. moults .

Arthropods: Trilobites
Ecdysozoa

Figure 25.37



Video

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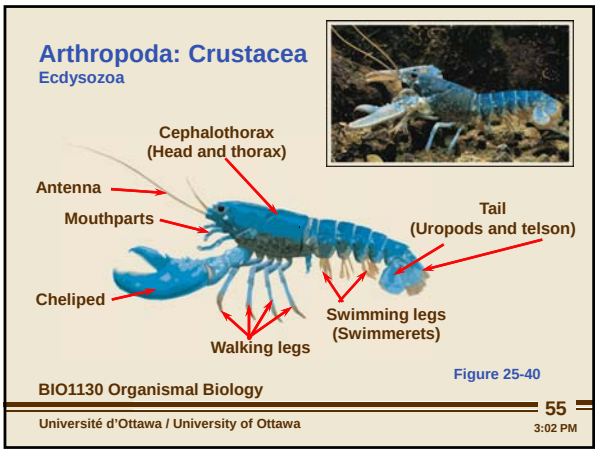
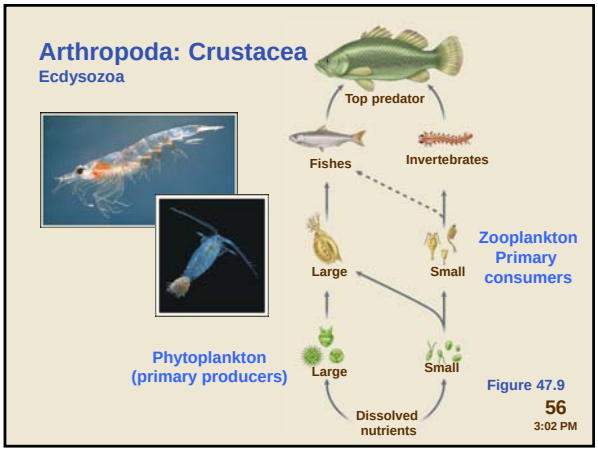
Segments fuse together to form specialized functions.



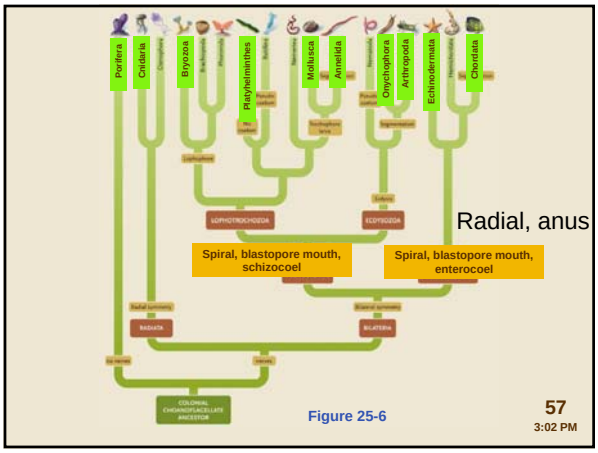
exoskeleton- cuticle toughens up

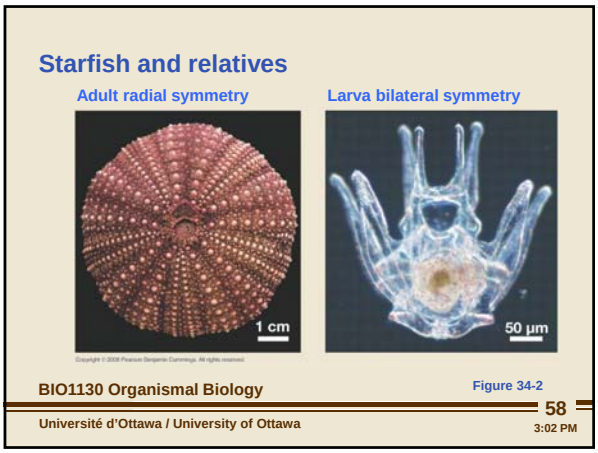
fuse segments together into functional units.

unit- tagma



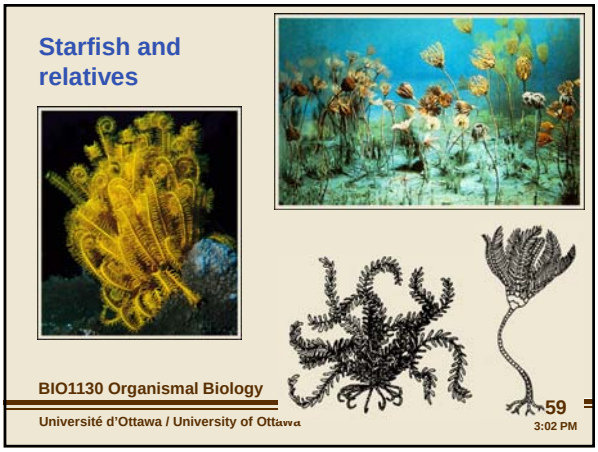
locomotion and feeding are tightly tied together.



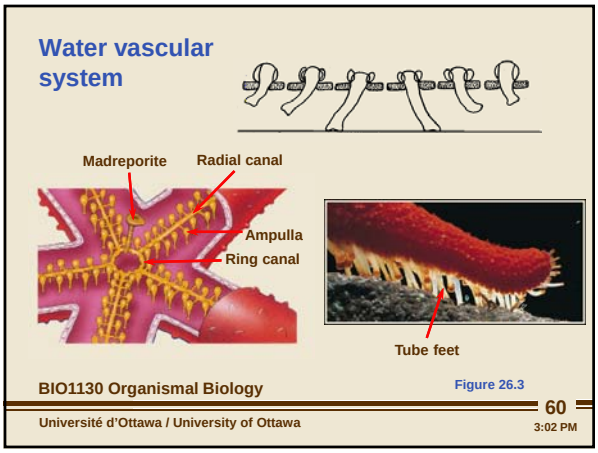


radially symmetric.

had traits of bilateral symmetric organisms but settles to become sessile, radial symmetry.



ancient echninoderms had arms to catch food faling through water column before it hit the bottom .



accidently erased...

An explanation for the Cambrian explosion

- Snowball earth
- Burrowing
- Shelled arms race
- Developmental – *hox* genes

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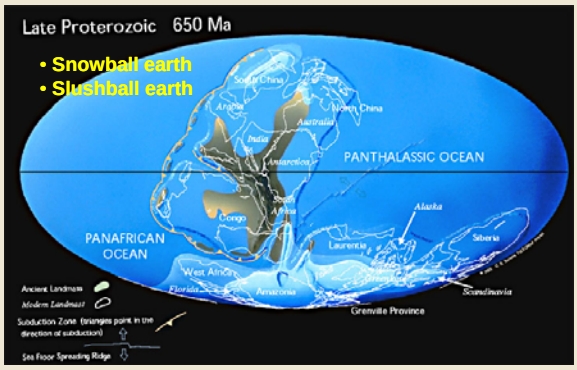

Figure 20.9

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the belt is also rainy. Most land mass was underwater.

Lots of erosion on exposed earth, debris goes into ocean.

CO2 + H20 <--> H+ + HCO3- +CO

CO2 is sucked out of atmosphere, less heat absorbed, planet cools, ice buildup at poles.

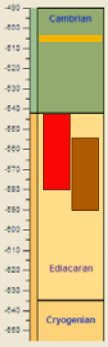
Ice -> reflective surface, even less radiant heat.

keeps becoming colder and colder building up more ice.

When ice from both sides meet, entire earth is frozen (Snowball earth)

some believe in slushball earth, life could have occurred in areas near some parts of the equator.

Early animal evolution



Burgess shale fossils
505 Ma

Ediacara fossils
580-542 Ma

Doushantou fossils
580-542 Ma

Be sure to look at Knoll VR00314 for most recent data on this period and the evidence

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Doushantuo fossils
590-565 Ma

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look like embryos at 2,4, 8 cell stage.

multicellular life must have occurred before cambrian.

Ediacaran fossils
580-542 Ma
(Mistaken point NFLD)

Protoanimals of Mistaken point
Australian footprints

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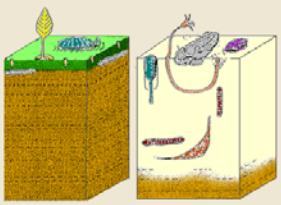
also older than cambrian. represent organisms of multicellular form.

snowball earth stop first experiments in multicellularity.

Cambrian burrowers

- **Advantages**
  - **Feeding**
  - **Anchorage**
  - **Protection**



Ediacaran benthic zone
Cambrian benthic zone

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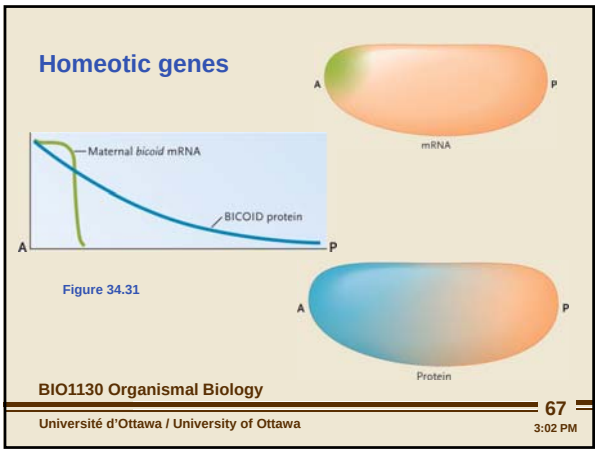
algal mats- impenetrable to organisms

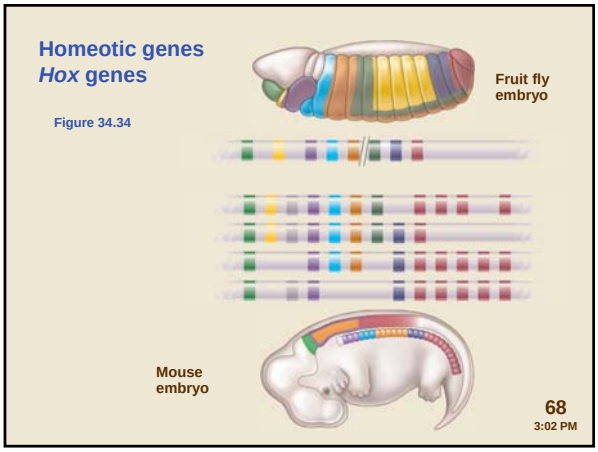
cambrian burrowers (diggers)- could go through algal mats and feed on stuff underneath, not available to any other organism.

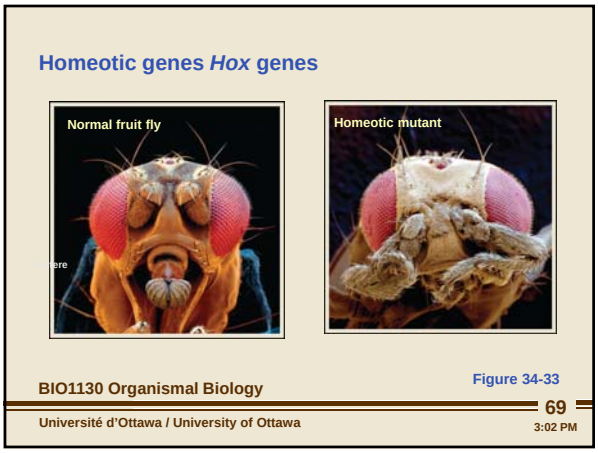
protected while under algal mats from predators.

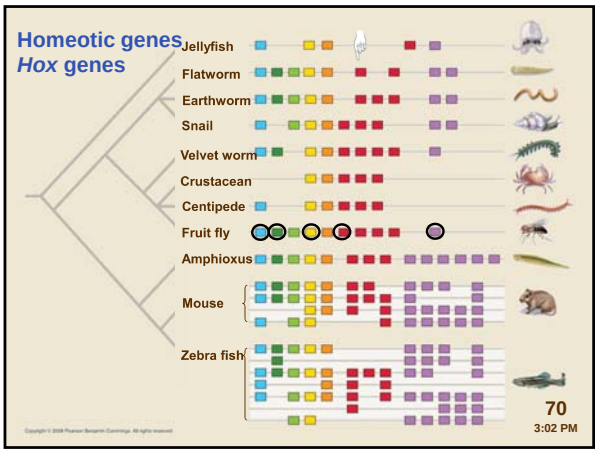
turning calcium into protective outer case. armor allows animals to become bigger to hunt bigger prey.



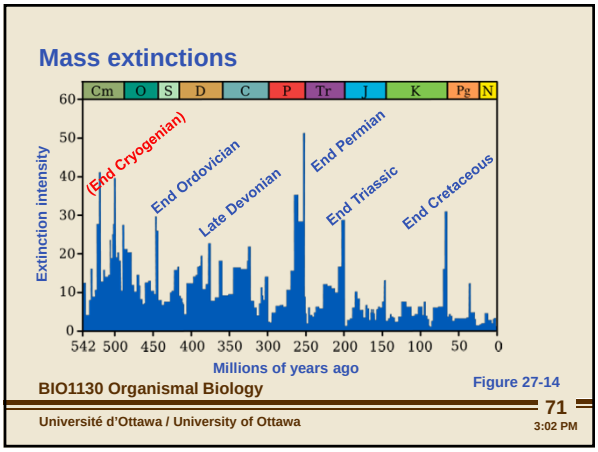
transcription factors: either placed in egg by mother or turned on produced by the egg. They are not evenly distributed in egg. used by eukaryots to turn on and off genes.

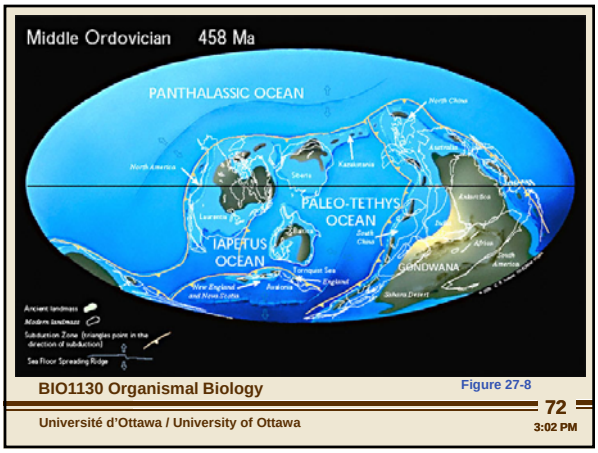






hox genes are universal





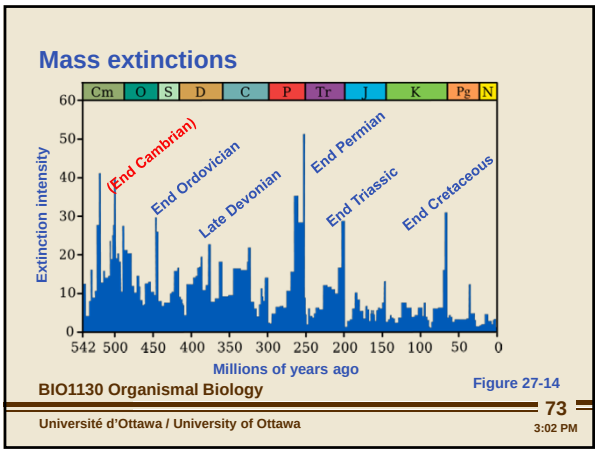

Mass extinctions
Cm
O
S
D
C
P
Tr
J
K
Pg
N
60
50
40
30
20
10
0
Extinction intensity
(End Cambrian)
End Ordovician
Late Devonian
End Permian
End Triassic
End Cretaceous
542 500 450 400 350 300 250 200 150 100 50 0
Millions of years ago
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Figure 27-14
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