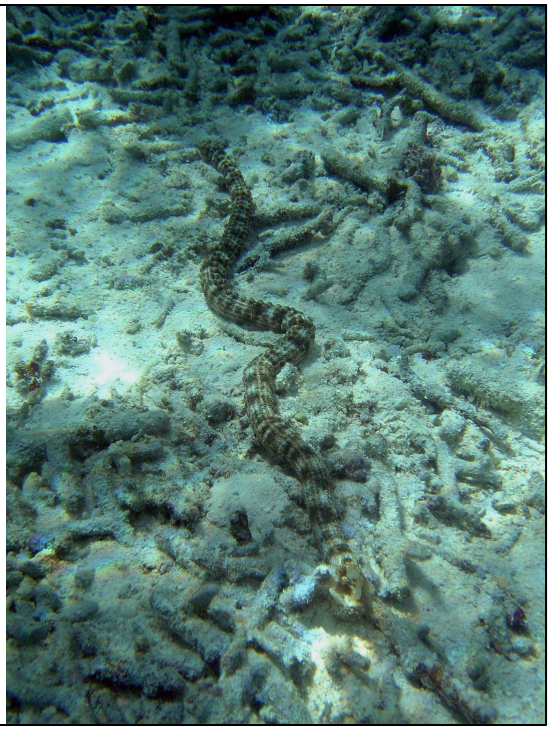
Reproduction of Holothurians

Kaylyn Flanigan

Echinoderm Introduction

François Michonneau, 2008



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  - This means that, during reproduction, the anus forms first
- All chordates (*humans are chordates*) are deuterostomes!
  - Echinoderms are close relatives to humans!

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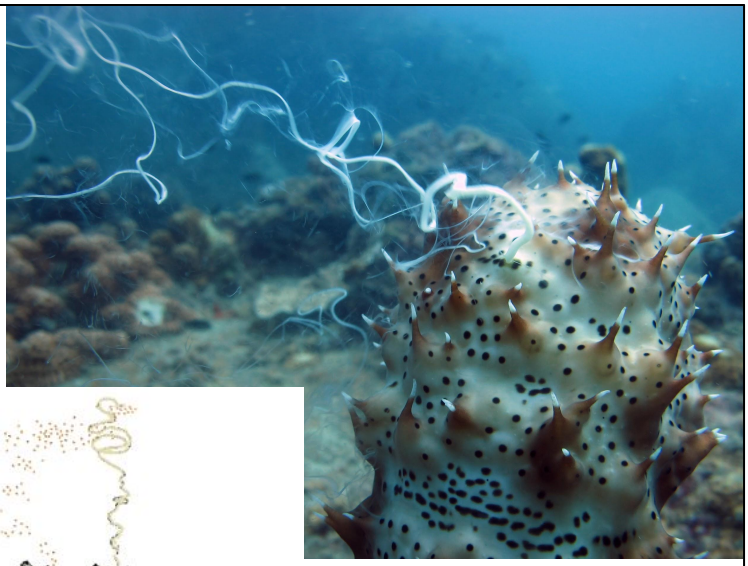
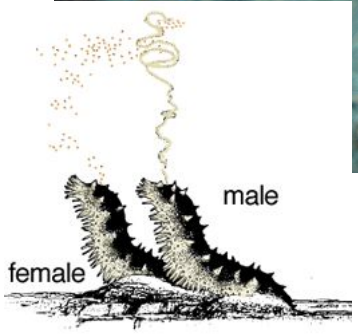
Sexual Reproduction

- Dioecious[1]
  - Sexes are separate



Conserve Marine, 2014

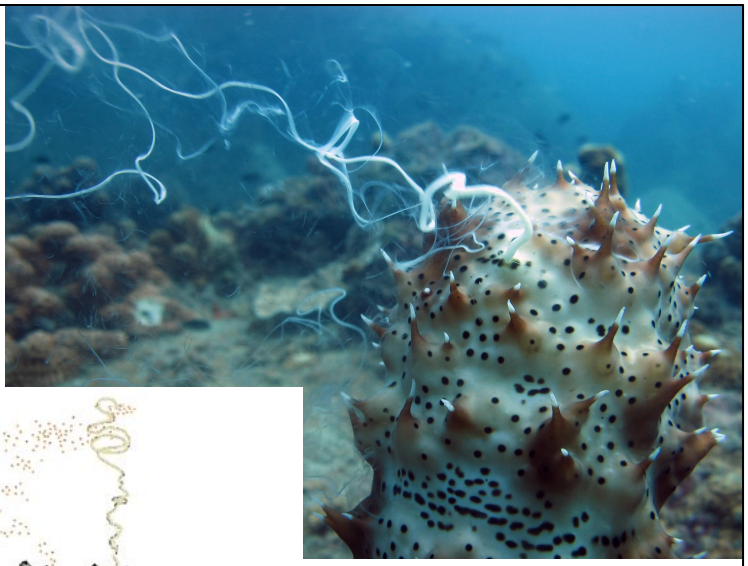


Tom Carefoot

Similar to other echinoderms, holothurians are broadcast spawners[1,2]. This means that they release their gametes into the water where ~hopefully~ sperm and egg will find each other, form a planktonic larvae, and eventually become a sea cucumber[2].

Sexual Reproduction

- Dioecious[1]
  - Sexes are separate
- Externally indistinguishable[1,2]
  - Internal sexual dimorphism



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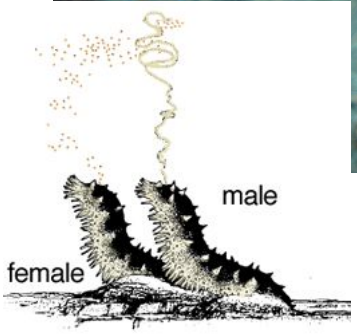

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- Dioecious[1]
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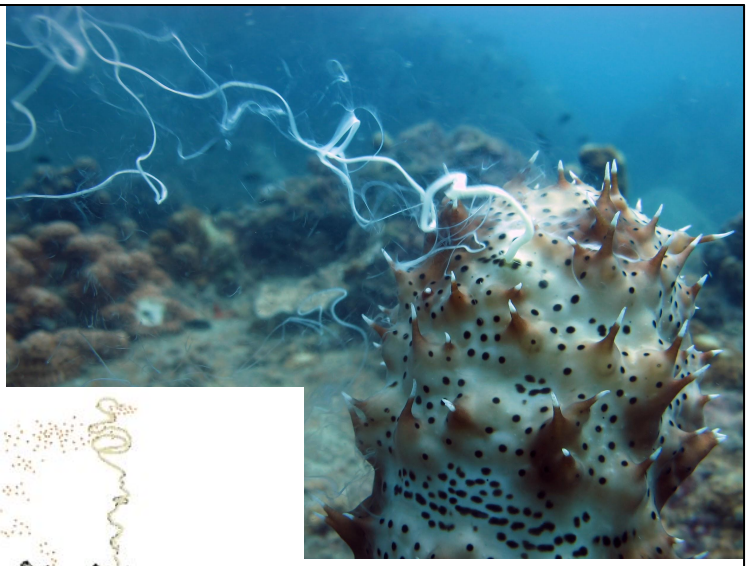
  - Internal sexual dimorphism
- Broadcast spawners[2]
  - External fertilization



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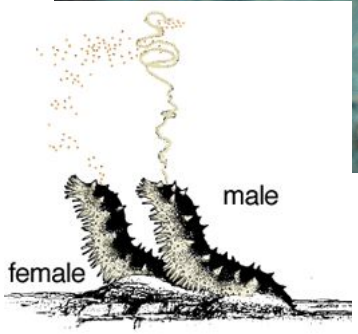

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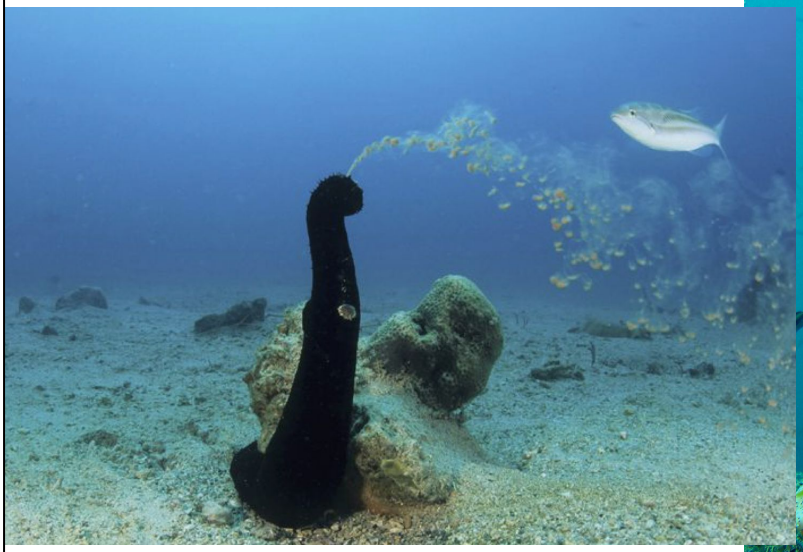
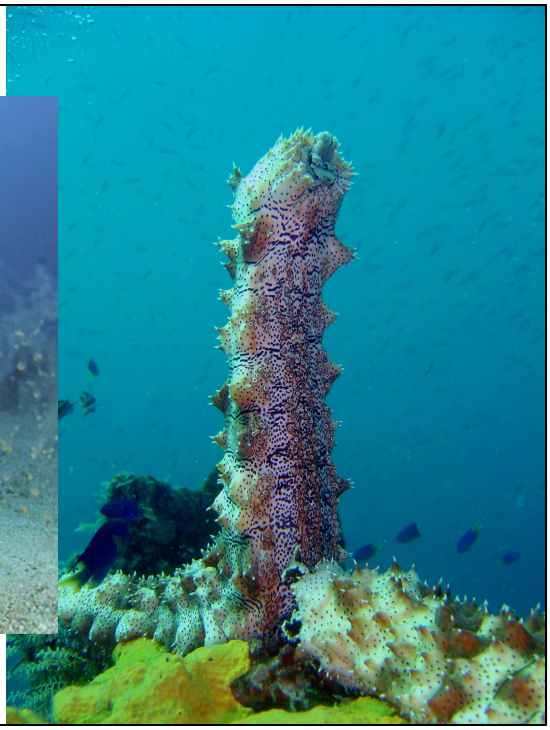
To increase the likelihood that sperm meets egg, it has been hypothesized that sea cucumbers for aggregates and all spawn in a domino effect. *H. grisea* defies this stereotype and aggregates during gametogenesis (the formation of gametes) while exchanging chemical cues between one another; however, once they are ready to spawn they aren't terribly far away from one another and fertilization can still occur[2].

H. scabra in the Solomon Islands, however, forms aggregates immediately before spawning[2].

Sexual Reproduction



Franco Banfi



David Burdick

During the release of gametes, holothurians will stand erect, with their tube feet as their holdfast, in order to stand tall above the substrate[3]. This behavior increases the likelihood that gametes will float through the water column instead being delivered right to the substrate.

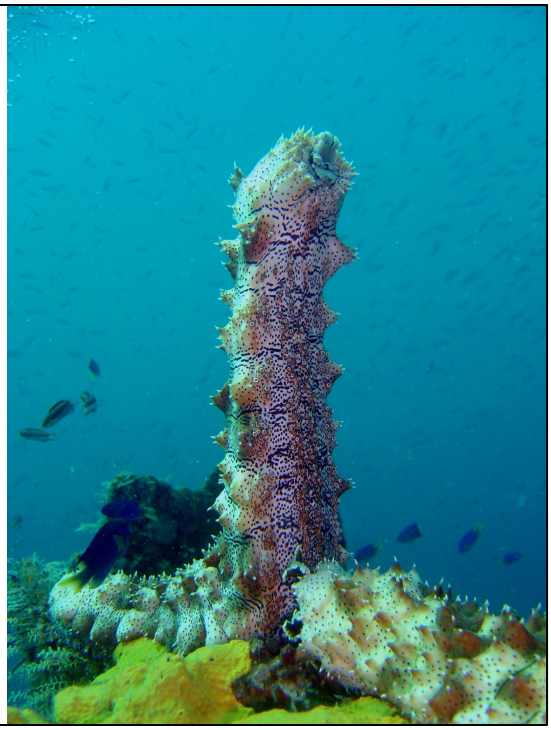
These spawning events are typically cyclical; temperate species spawn during the warmer months and have a shorter spawning period compared to the more equatorial species who have a longer, more continuous spawning period[2,4,5.]

Sea cucumbers take cues from the environment and from one another during spawning events[2].

These environmental cues include water temperature, chlorophyll a levels (plankton activity), and the lunar cycle[2]. Typically it is observed that in cooler temperatures, sea cucumbers are less likely to spawn. Some species tend to spawn when there are high levels of primary production (hypothesized to be for the survival of their offspring)[2].

Sexual Reproduction

1. *Holothuria scabra*
    a. Biannual or continuous[6]



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In *Holothuria scabra* in the Solomon Islands exhibits continuous breeding with heightened breeding from September - December; however, this species in the oceans surrounding India, New Caledonia, and Indonesia are biannual breeders[6].

In the cases of *H. whitmaei* and *H. fuscogilvia* which live in the same geographic location, *H. whitmaei* spawns during the winter while *H. fuscogilvia* spawns in the summer[7]. This is hypothesized to happen to avoid cross-fertilization[7].

In the case of *H. grisea*, a tropical intertidal sea cucumber, their breeding period is relatively short to that of other tropical (equatorial) species[2]. This is thought to be because their habitat is extremely variable and these changes trigger seasonality providing a restricted number of months during which water level and temperature is

optimal for larval survival[2].

Sexual Reproduction

1. *Holothuria scabra*
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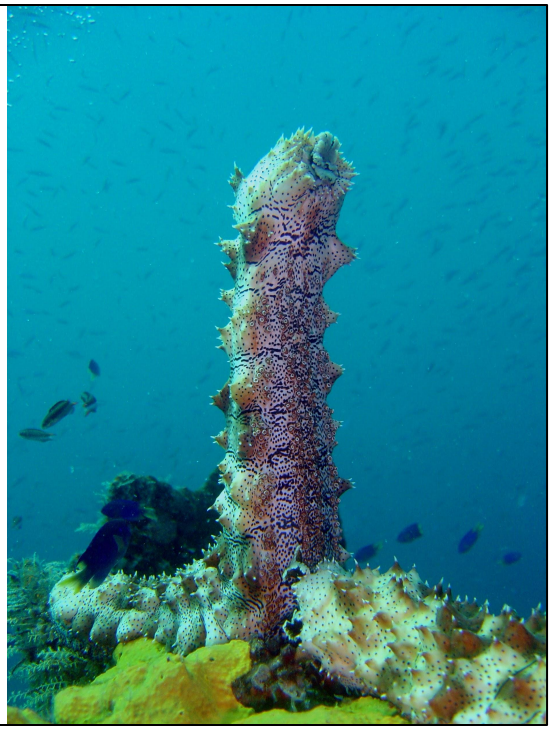

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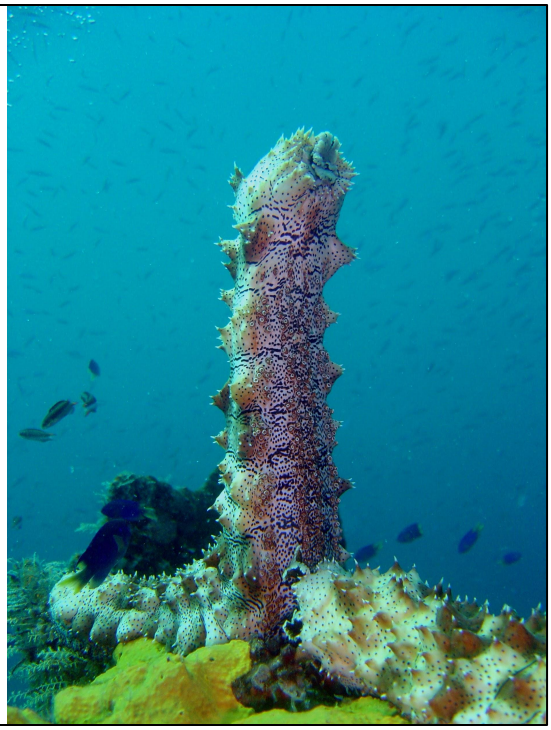
3. *H. grisea*
    a. Tropical intertidal species
    b. Relatively short spawn period



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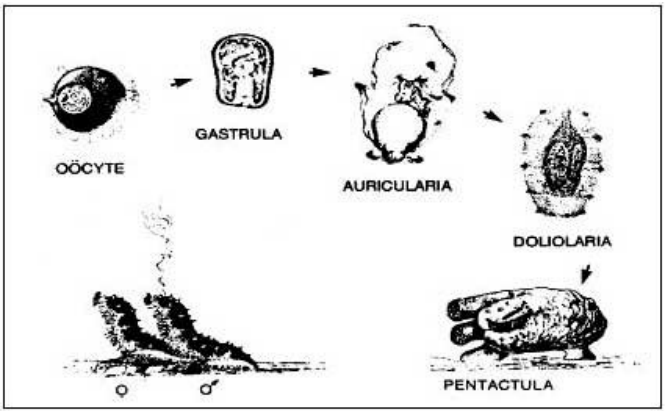
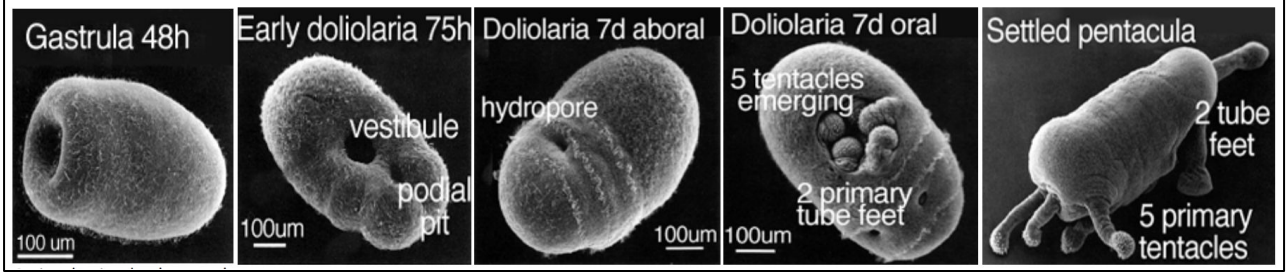
Holothurian larvae

- Oocyte: egg
- Gastrula: ~ 24 hours after fertilization[9]
- Auricularia: ciliated intermediate
- Dolioaria: swimming larvae[3]
- Pentactula: five tentacled, 2 tube footed “walking” larvae[3]





Within one month of their pentactula stage, they will develop into juveniles[9]

Holothurian larvae actually walk about the sediment on two tube feet and 5 tentacles.

Asexual Reproduction

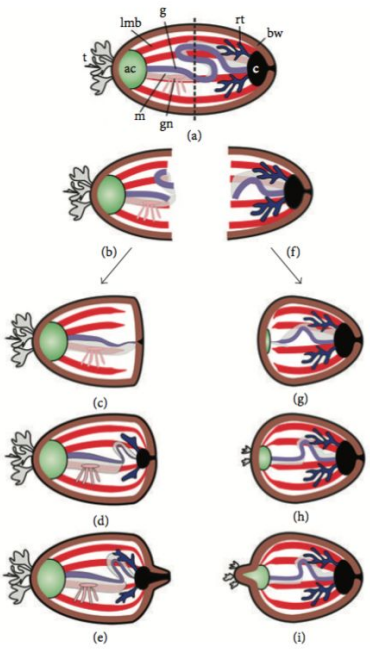
FIGURE 1: Twisting of *Cladolabes schmeltzii* during fission. a: anterior part; p: posterior part. Scale bar 2 cm.

- Fissiparous (reproduction by fission)
- Constriction site or twisting
- Process can last a few minutes or days[8].

Igor Dolmatov, 2014.

There are 16 known species of holothurians that reproduce asexually[8]. The term for this kind of reproduction is called fissiparous (reproducing by fission).

Pros and cons of asexual reproduction



Igor Dolmatov, 2014.

Pros:

- Reach high population sizes when conditions are favorable
- Ability to reproduce without finding mate (if one is not available)

Cons:

- Low genetic diversity
- The daughter half will have to regrow gonad which can take several months
    - Retards sexual maturity of the population
- Requires much energy

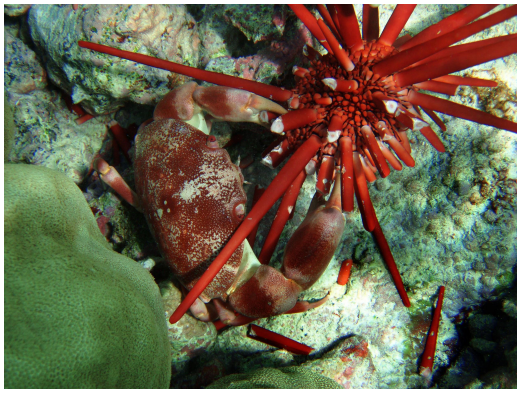
Similarities between Holothurians and Echinoderms

- Capability of asexual reproduction (asteroidea and ophiuroidea)

One arm regenerating

Entire sea star regenrating from one arm

NCSU



Philippe Bourjon

- Similar to subclasses asteroidea and ophiuroidea in that they reproduce asexually by separating into two pieces and then regenerating the missing pieces[1]
- Similar to most echinoderm species in that they reproduce sexually; are dioecious (sexes are separate)[1]
- Similar to most echinoderm species - ophiuroids excluded - in that their sexes are indistinguishable externally [1]
- Similar to sea star species Henricia lisa (Canada) and the brittle star Ophiodaphine formata (Japan) in that they form aggregates prior to spawning[2]
- Similar to sea star Leptasterias polaris in that they form aggregates during gametogenesis[2]

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- Reproduce sexually and are dioecious[1]
- Sexes are externally indistinguishable[1]
- Aggregations

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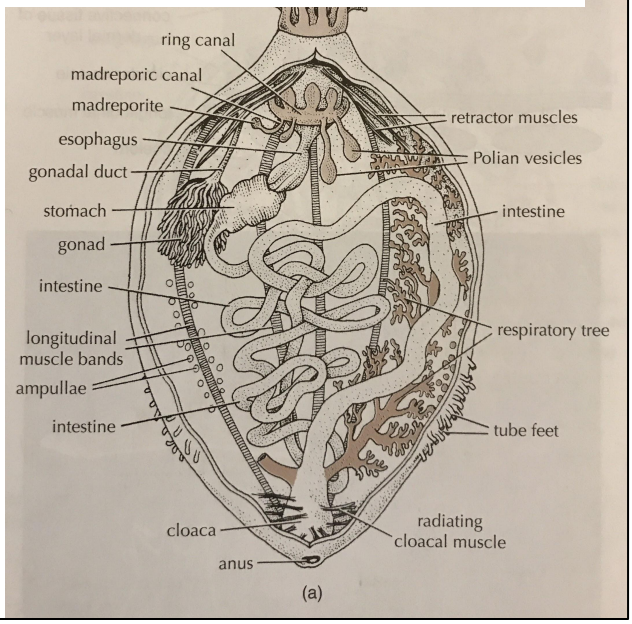
Differences between Holothurians and Echinoderms

- Holothurians only possess one gonad



Pechenik, 2015

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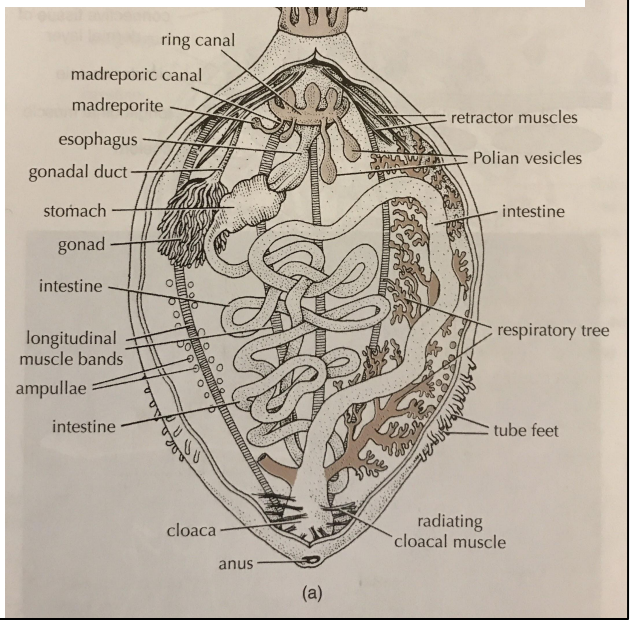
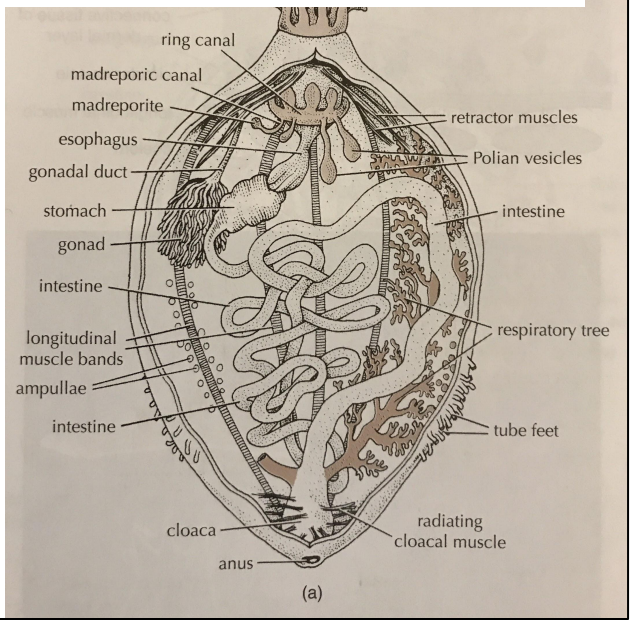


Pechenik, 2015

Differences between Holothurians and Echinoderms

- Holothurians only possess one gonad
- Not *all* species of echinodermata can reproduce asexually
- Typically external fertilization



Pechenik, 2015

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