Chapter 6

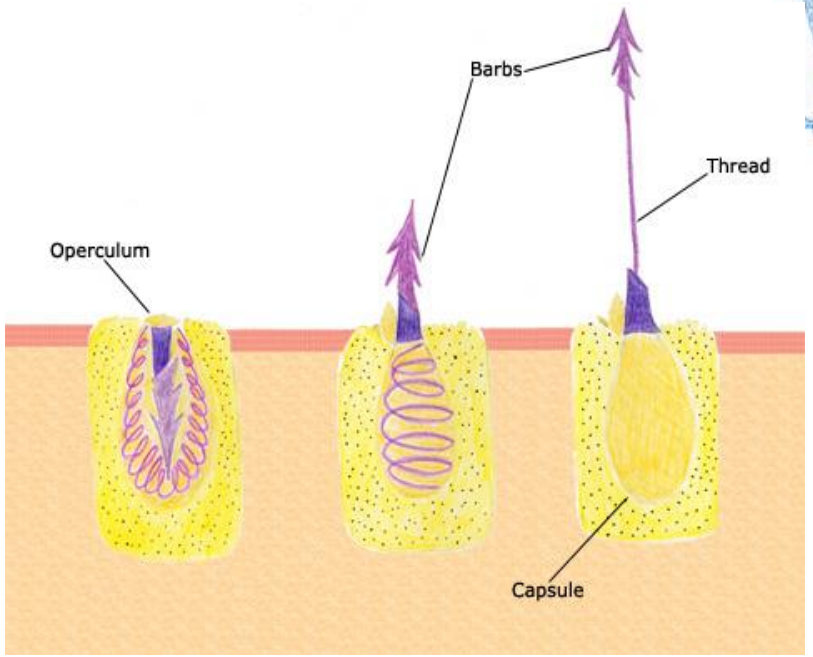
Phylum Cnidaria

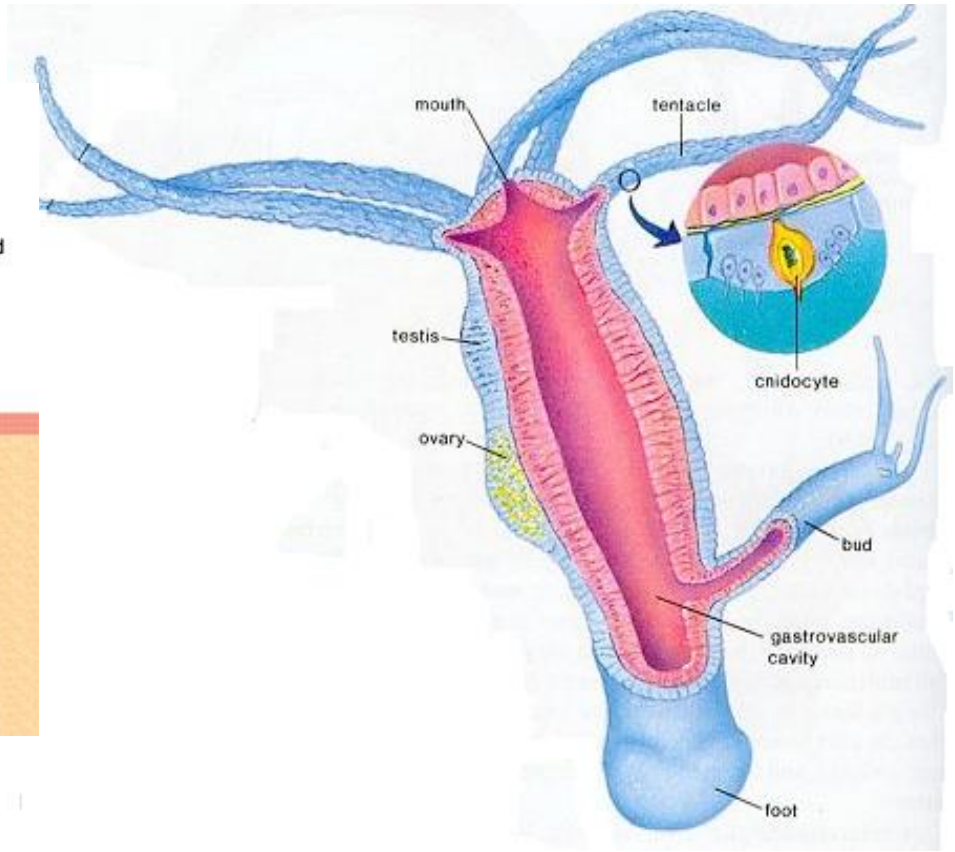
"Coeleterata"

Kingdom Animalia

Phylum Cnidaria = Coelenterata

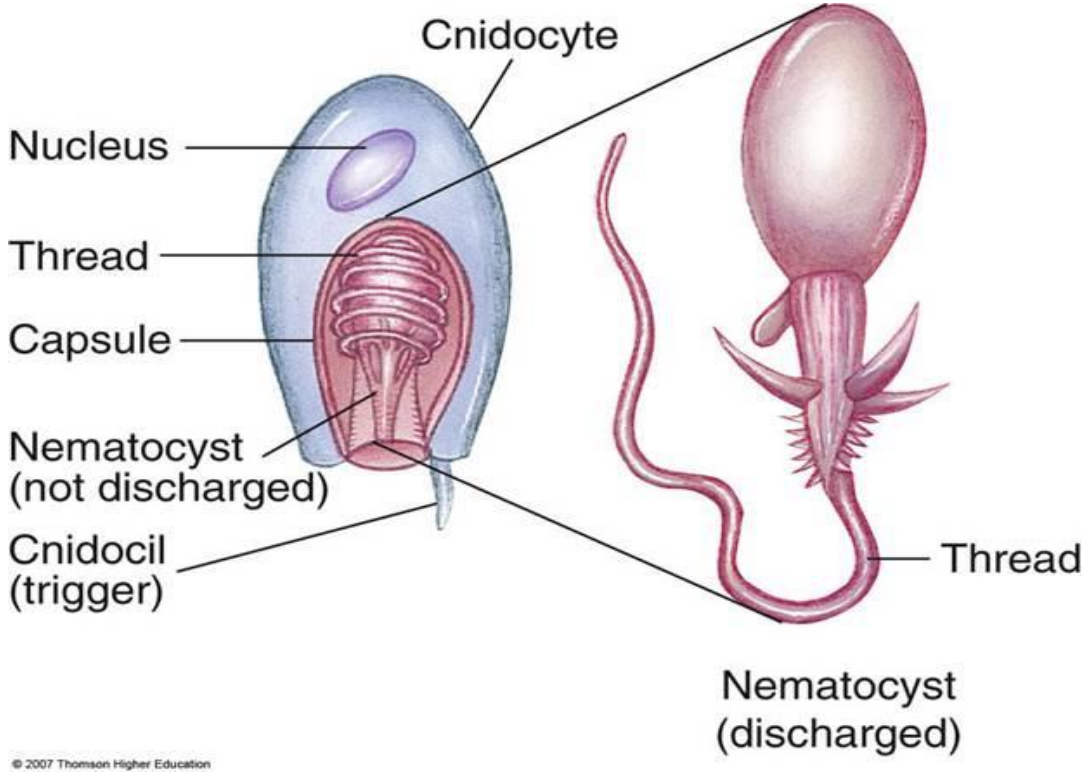
- Cnidaria: G= a stinging thread
- Coelenterata G= hollow gut

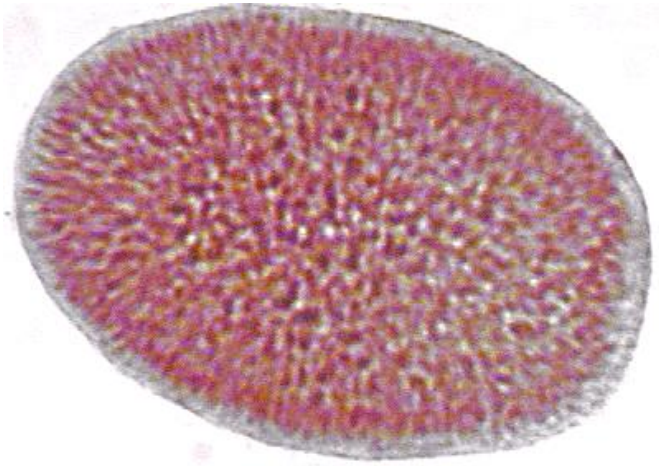




Defining Characteristic:

- Secretion of complex intracellular organelles called **cnidae.**
- **Planula larvae** in the life cycle.



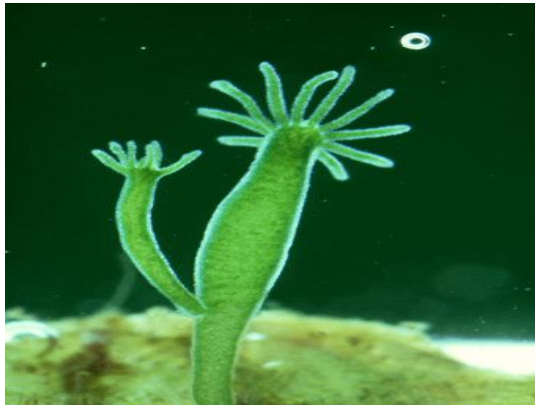


Nematocyst **Planula**

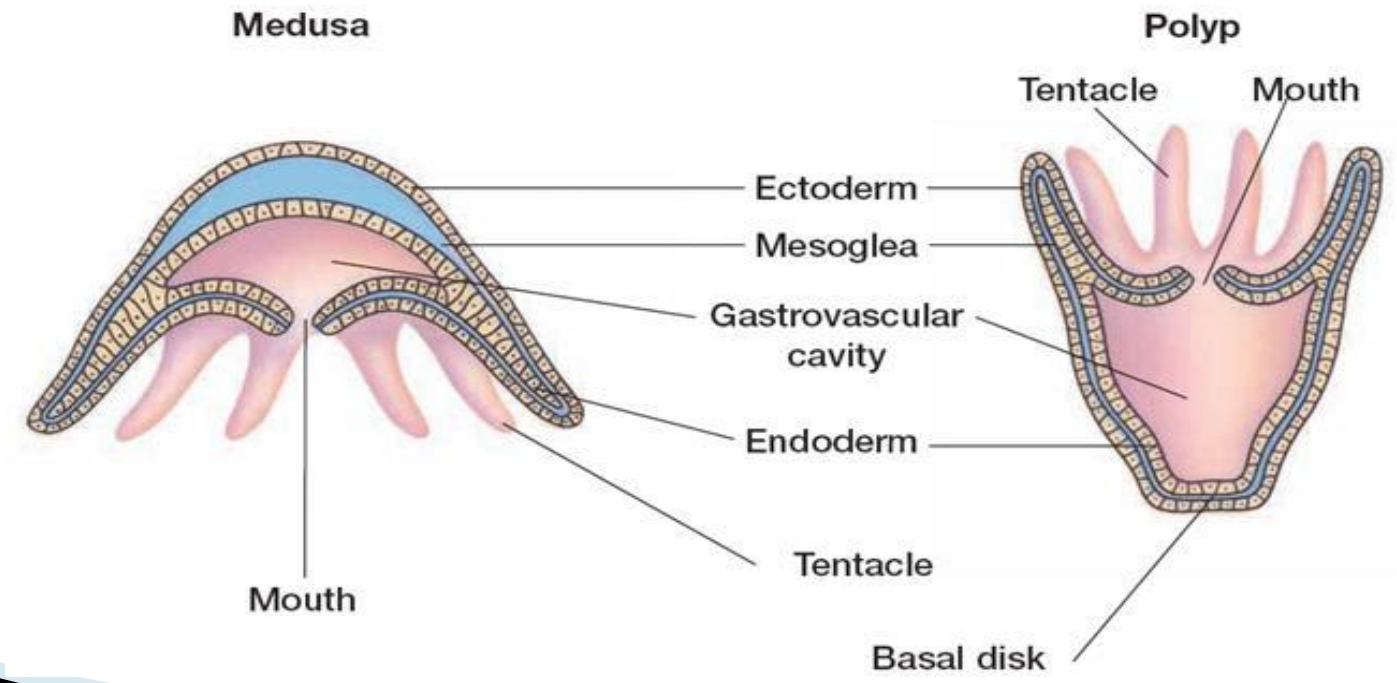
General Characteristics:

- This phylum includes some **11,000 species** like: **Sea anemones, corals, jellyfish, *Hydra***



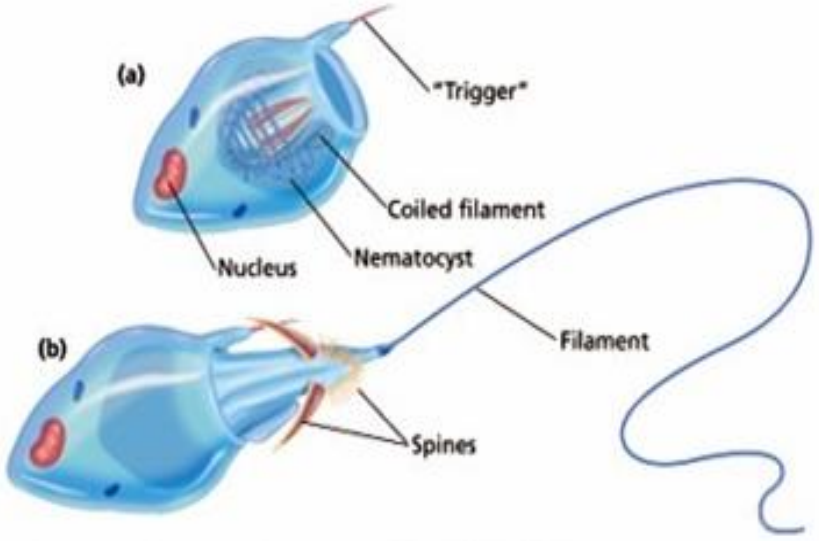
- **0.2% are freshwater the remaining are marine.**
- Cnidarians have two different **body plans:**
  - **Medusa** :resembles an upside-down cup and generally swims).
  - **Polyp**: has a tubular body and generally sessile.



Cnidarians are characterized by:

- A basic **radial symmetry**.
- Having only **2 layers of living tissues**: the **epidermis** and the **gastrodermis.**
- A gelatinous dead layer between the epidermis and the gastrodermis called the **Mesoglea:**
  - Mesoglea might contain some living cells **"amoebocytes"** that function is digestion, transport and storage of nutrients, wound repair and antibacterial defense.

- **Tentacles** that surround the mouth.
- A single opening of the digestive system.
- **Having Cnidae** that are unique to this phylum. They are secreted by cells called **Cnidoblasts** or **nematoblasts**. One major category of Cnidae is the **nematocysts** (Thread bags). It includes more than 30 types.

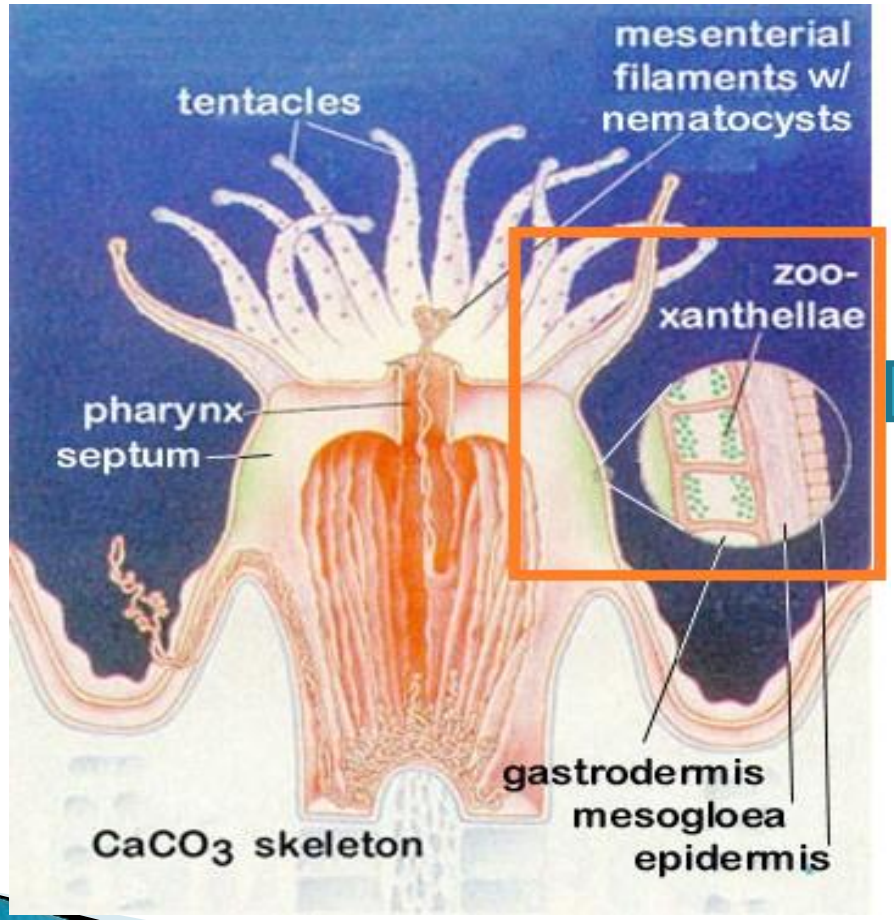


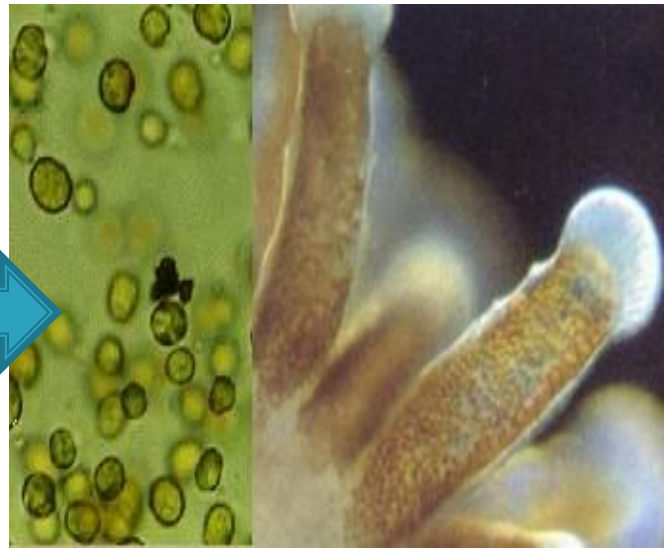
- Discharge of cnidae is stimulated **chemically** and **mechanically** by stimuli that are perceived through the **Cnidocil** (trigger) (a cluster of modified cilia).
- Cnidae can be **discharged only once** (discharge time=3ms).
- Cnidae may be specialized for **wrapping** around small objects, **sticking** to surfaces, **penetrating** surfaces or **secreting toxins** (deadly to humans)
- **Functions of cnidae include**: **food collection, defense, & locomotion.**

Feeding of Cnidarians:

- Cnidarians have a **mouth** but **no anus**.
- Cnidarians are primarily **carnivorous.**
- Some soft corals feed also on **phytoplankton**.

- Some species obtain food from their **endosymbiotic algae** (especially the reef-building corals=hermatypic corals).

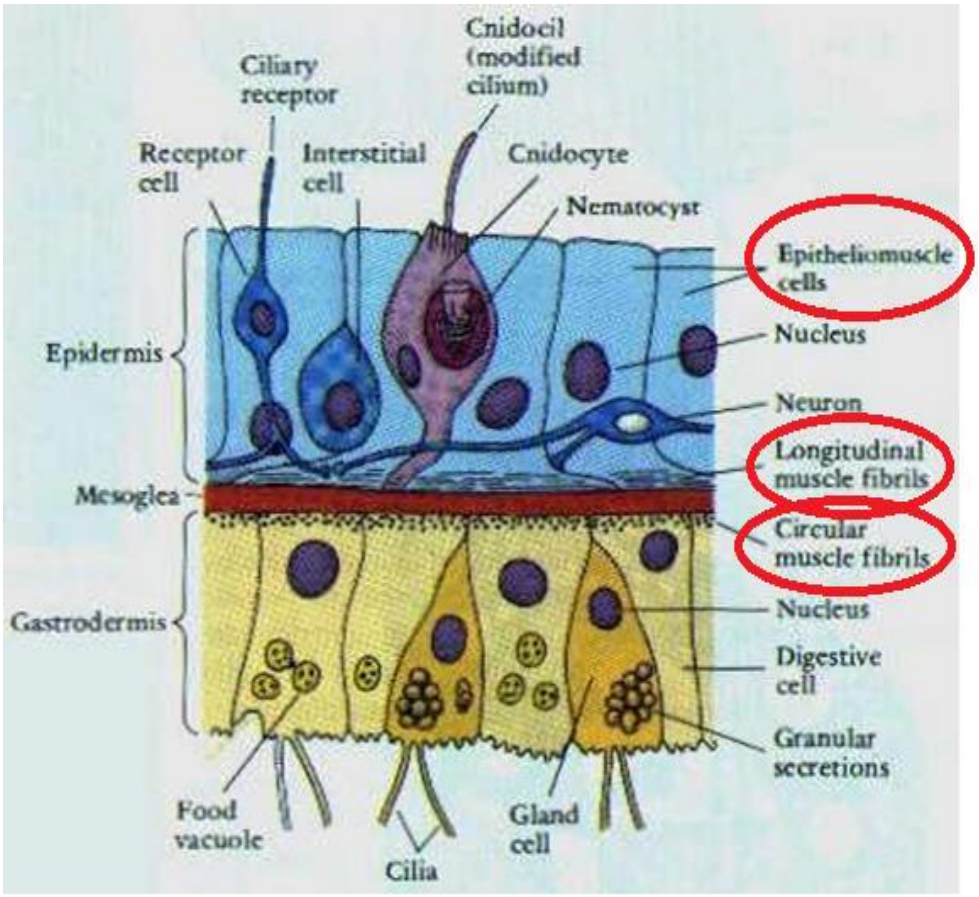




Cnidarian Muscles and Nerves:

- In contrast to Poriferans, **cnidarians have nerve and muscles** but **lack a central nervous system.**
- Their nerves take the form of a **network of nerve cells** (neurons).
- Cnidarians **have muscles** that originate from ectodermal and endodermal cells (not mesodermal like true muscle).
- These cells are termed **epitheliomuscular cells (or nutritive-muscular cells).** They function in **digestion** in addition to **contraction**.

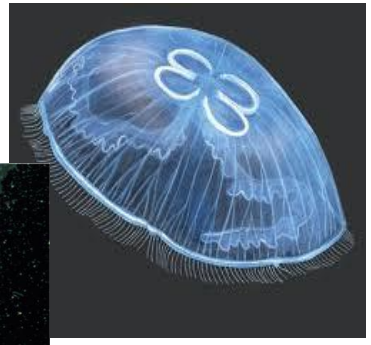
- Cnidarians have **longitudinal muscles** (running from body base to the tip of a tentacle) and **circular ones** (running around the circumference of the animal).
- Cnidarians **respirations** is by simple diffusion (like Poriferans).



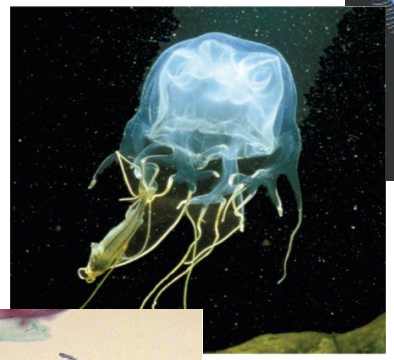
Classification of Cnidrians

Subphylum Medusozoa

Class Scyphozoa



Class Cubozoa



Class Hydrozoa

Cubozoa)

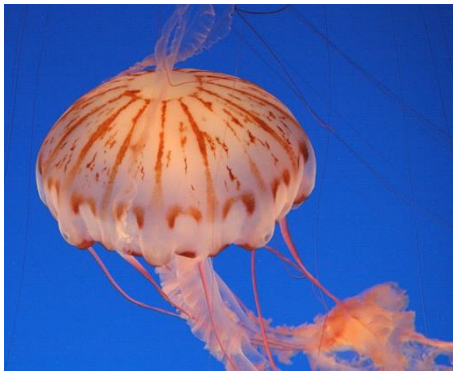
Non-Medusozoan Group

Class Anthozoa

Class Scyphozoa

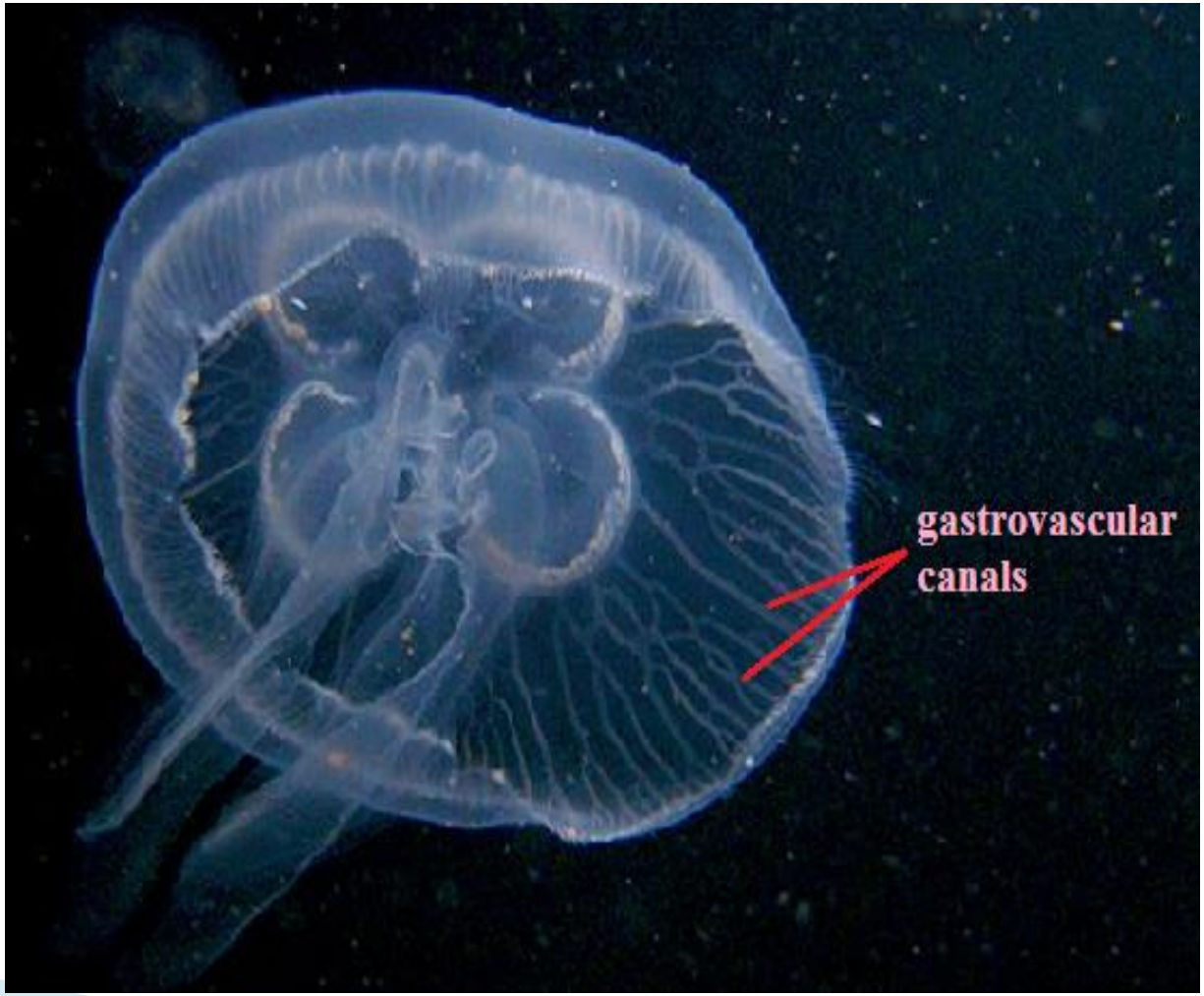
- Scyphzoa: G. *Scypho: Cup*; *Zoa*: *animals*
- *Defining Characteristic*: Asexual reproduction by strobilation.
- This class contains **few hundred species** that are known as **Jellyfish.**
- All are marine; some are large (2 m across).



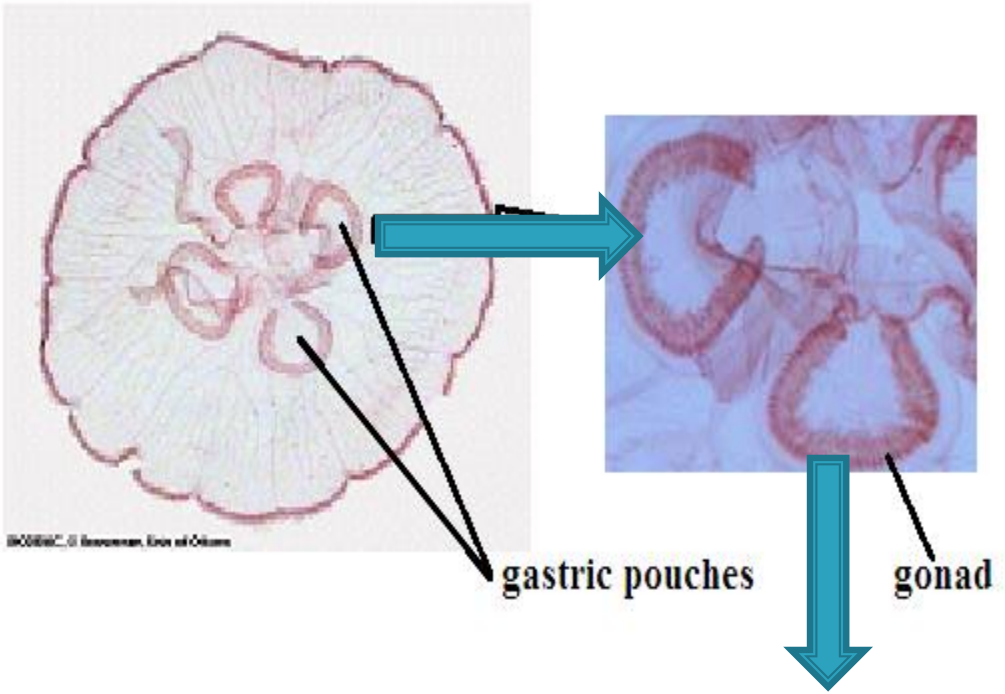


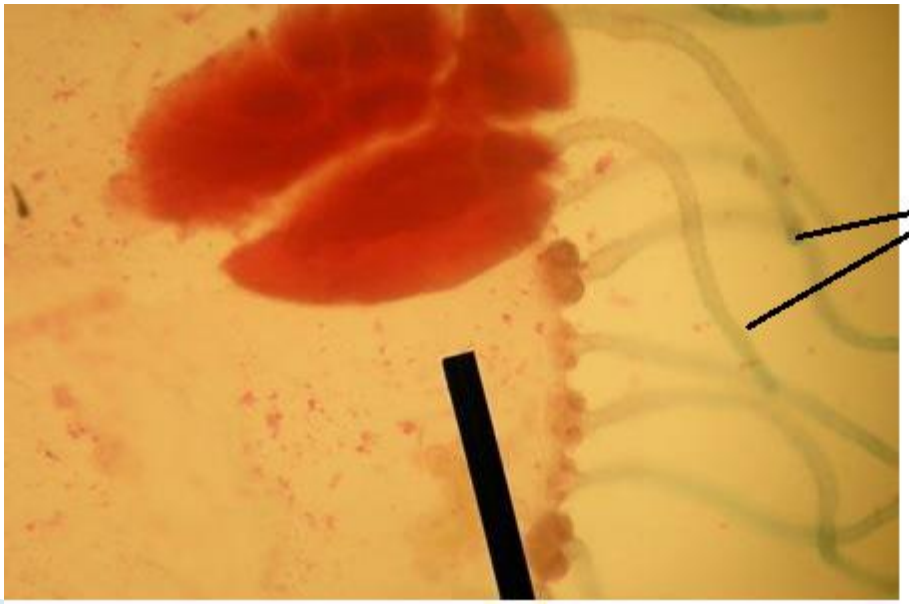
- Their **mesoglea is thick** and gelatinous; this is why they are called Jellyfish.
- The body of jellyfish is **medosoid.**
- The mouth is found at the end of a muscular cylinder called **Manubrium.**
- Most scyphozoans are **active swimmers**. They use bell-contraction to achieve movement.
- Scyphozoans are characterized by a well-developed, fluid-filled system of **gastrovascular canals.**

- **Gastrovascular canals function in:-**
  - Circulation of O_2 and CO_2.
  - Distribution of nutrients.



- **Feeding**:
  - Food is captured by nematocysts found on tentacles and/or oral arms, transferred to the **4 gastric pouches** through the mouth and manubrium.
  - Gastric pouches contain short, nematocyst-bearing tentacles called **Gastric tentacles** that secrete digestive enzymes.
  - Partially digested food is **phagocytized** and digestion is completed intracellularly.


gastric pouches
gonad

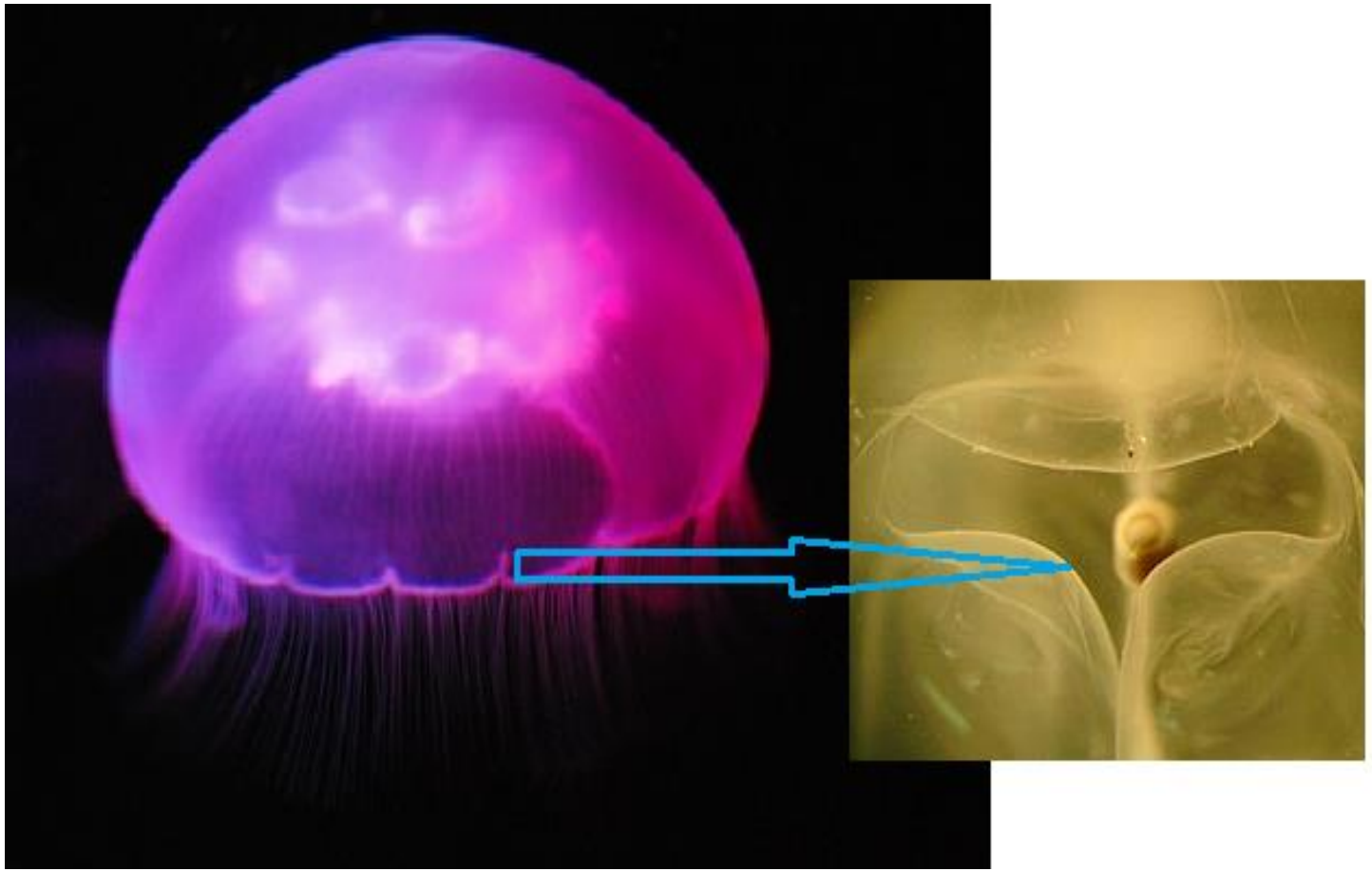

Gastric
filaments

- Some scyphozoans also obtain nutrients from certain unicellular, endosymbiotic algae called **Zooxanthellae**.

Scyphozoan Receptors:

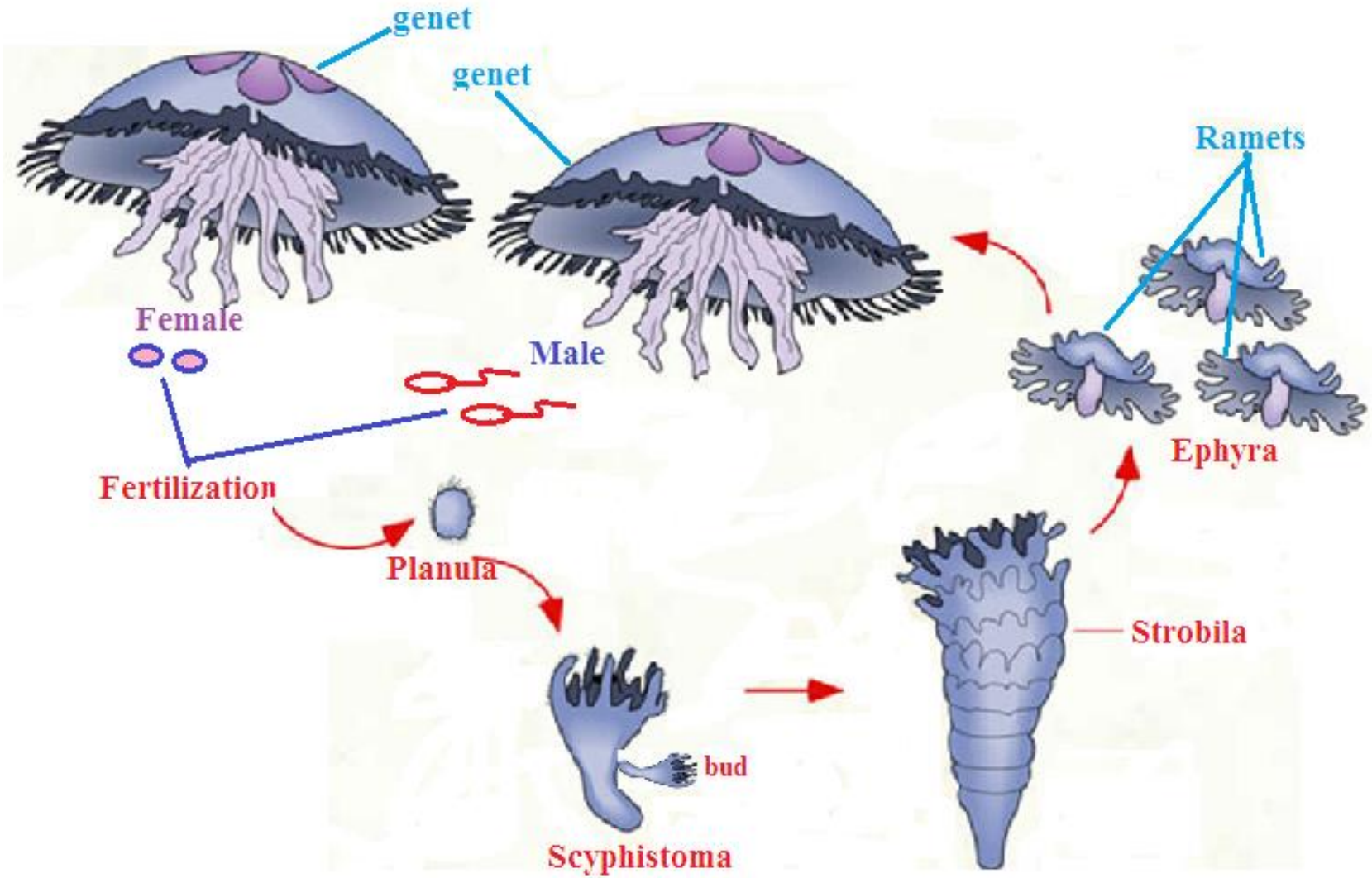
- Scyphozoans are provided with sophisticated **sensory receptors** like:
  - **Statocysts**: balance organs
  - **Ocelli**: simple light receptors
  - **Sensory lappets**: touch receptors
- Statocysts and Ocelli are found within structures that are distributed along the margins of the bell called **Rhopalia.**

Rhopalia



Reproduction and Life Cycle:

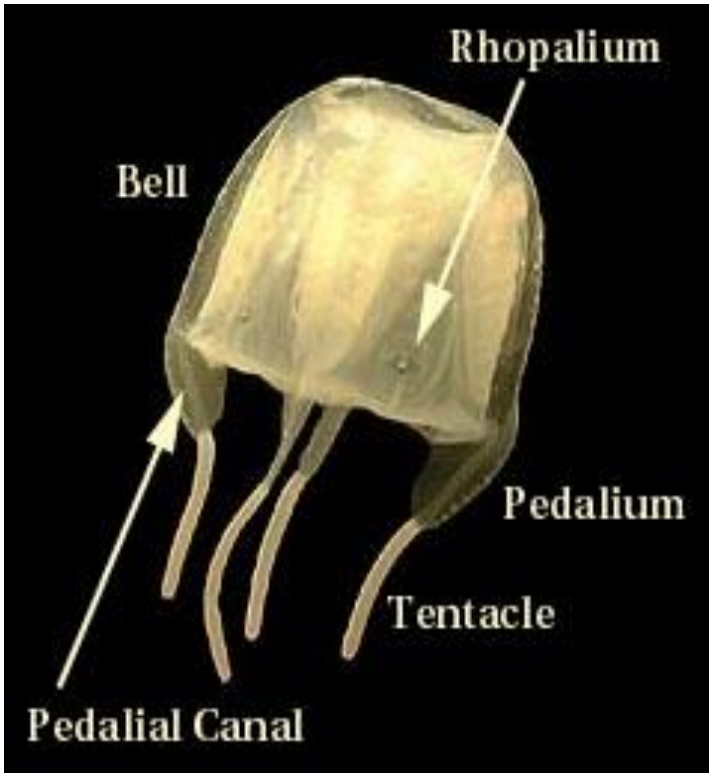
- Gonads develop within the **gastrodermal tissue** and closely associated with the **gastric pouches**.
- Most scyphozoans are **gonochoristic (or dioecious)**, which means **separate sexes**. ***(gono: gonad, chorist: separate).***
- *(When one organism carries both male and female gonads at the same time or in sequence, then it is described as being **hermaphroditic** **or** **monoecious** =single house)*.

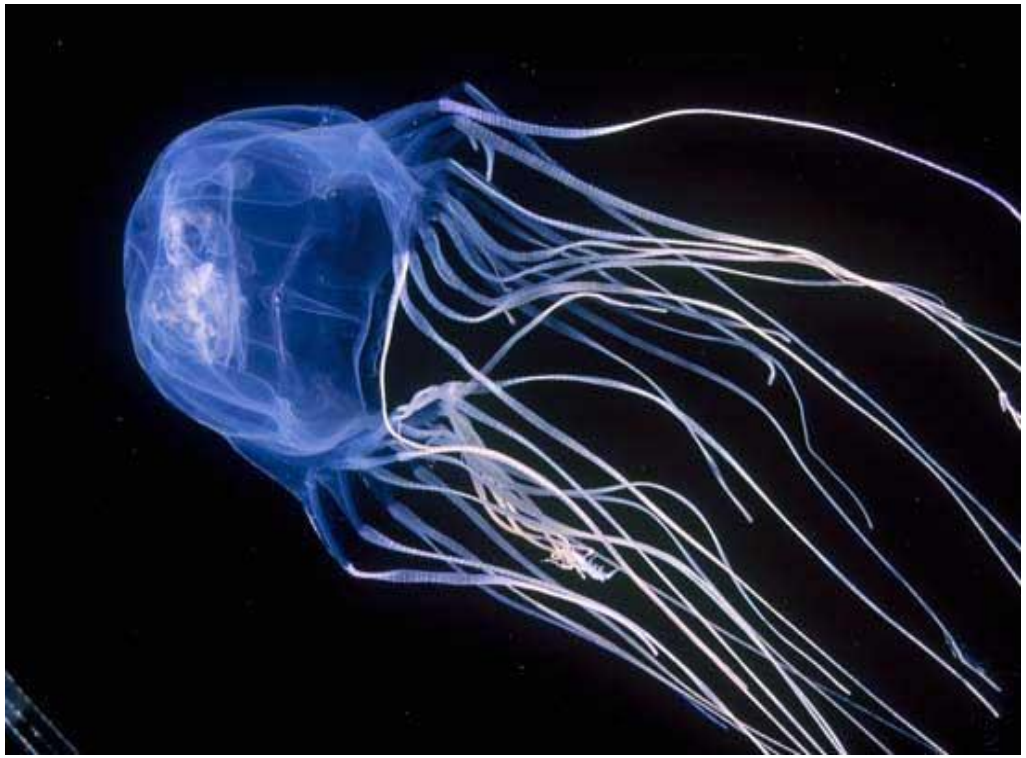


Jellyfish life cycle

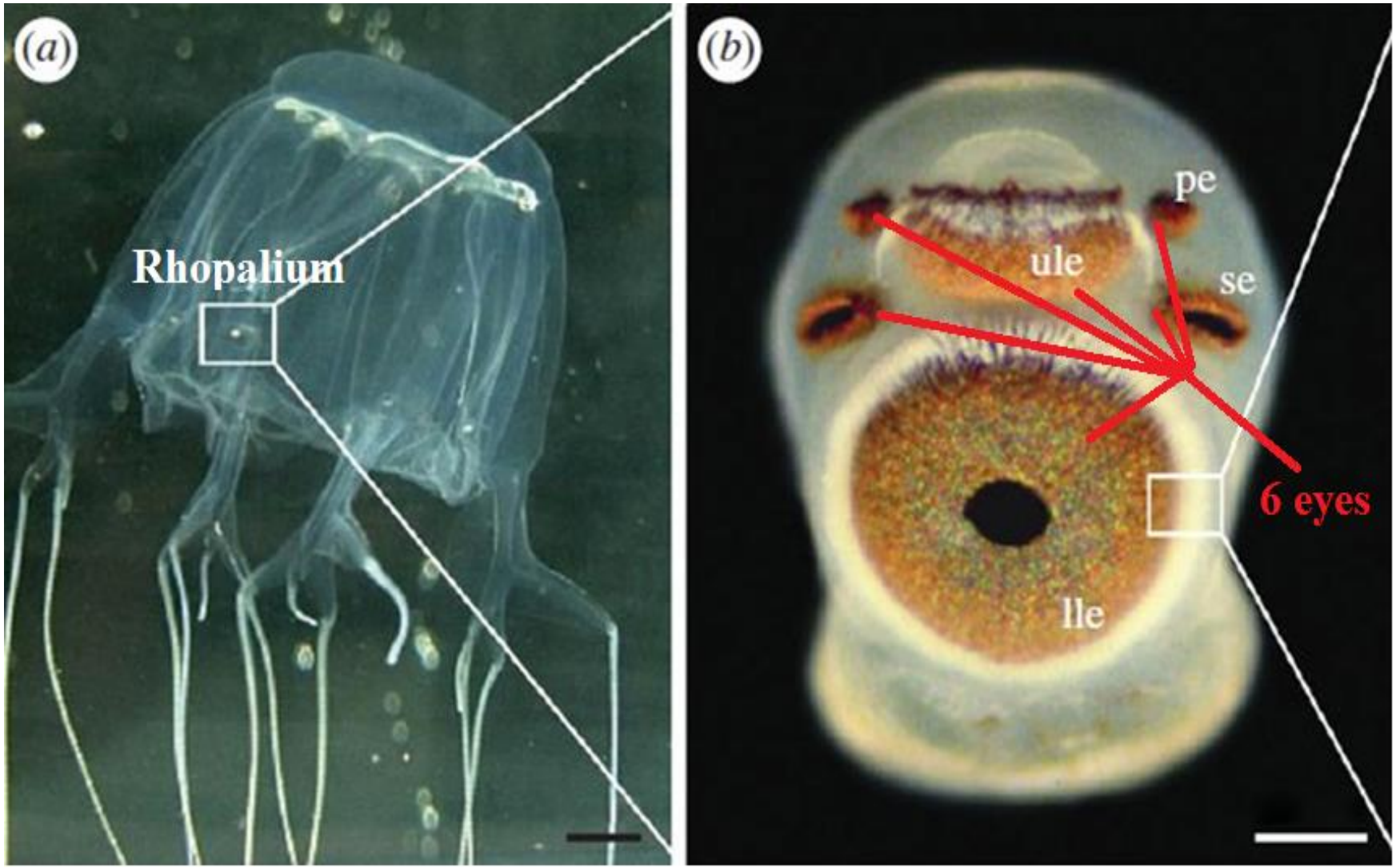
Class Cubozoa

- *Cubozoa*: G. *Cubo*: Cube (box-like)
- *Zoa* : Animals
- This class contains a small group of organisms (20 species) called Cubomedusae (box-jellyfish).
- Like scyphozoans, **medusa form dominates** the life cycle.
- **Body is small** (few cm in max. dimensions) and transparent.
- The bell is cube-like and **bears 4 tentacles** (or 4 clusters of tentacles) emerging at the 4 corners of the cube body

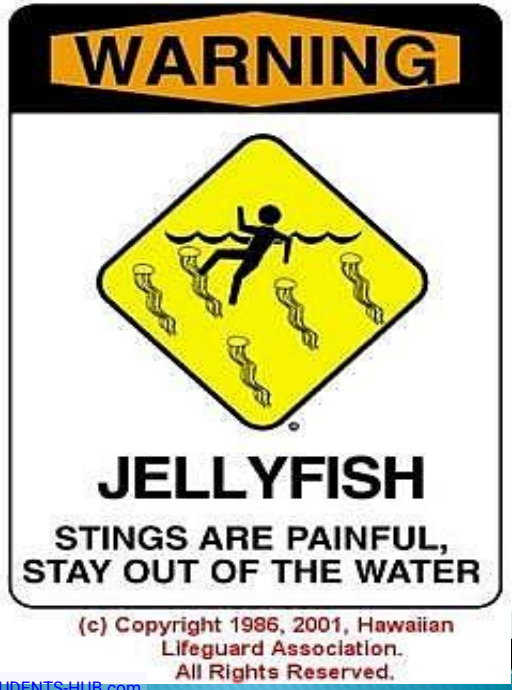

Rhopalium
Bell
Pedalium
Tentacle
Pedalial Canal



- Can bear **very long tentacles** (over 30 cm), that carry **highly toxic nematocysts** (this is why cubozoans are described as **Sea Wasps**).
- Some cubomedusans can kill humans.
- Cubozoans kill and feed on small fish usually larger than themselves.
- The bell bears **4 rhopalia** emerging at the corners. These have lensed eyes, ocellei and statocysts.
- The lensed eyes are complex and probably can form images. (6 eyes X 4 Rhopalia=24 eyes).


(a)
Rhopalium
(b)
pe
ule
se
6 eyes
lle

- Cubuzoans are active swimmers that move by **jet propulsion**.
- During life cycle, **polyps do not strobilate**. Instead **they form buds** and each bud gives a medusa.
- Cubozoans live in **tropical and subtropical** waters.



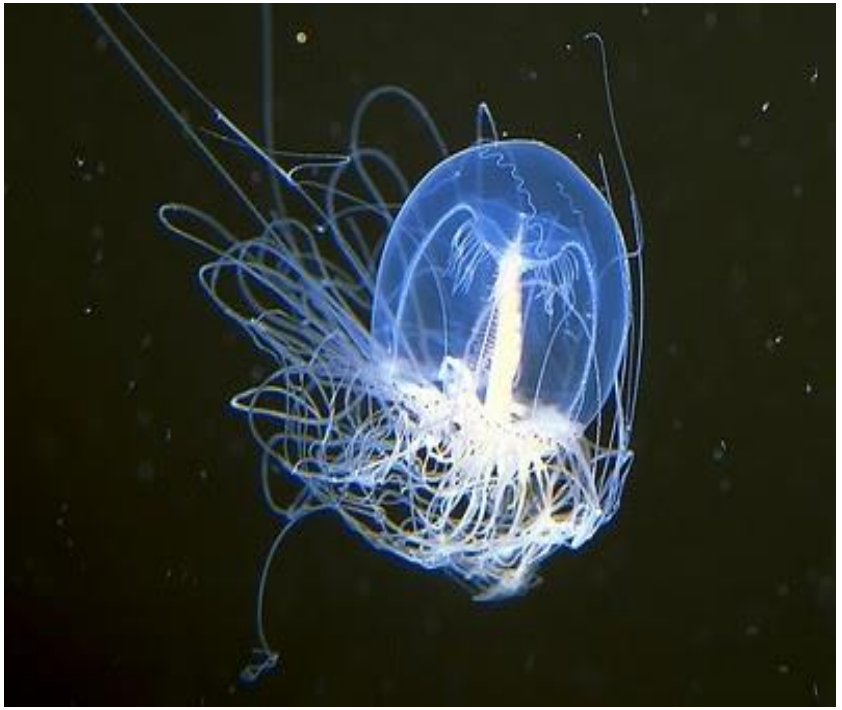
Class Hydrozoa

- **Hydrozoa**: G. **Hydro**: **water**
- **Zoa** : **animals**
- **Gastrodermal** tissue **lacks nematocysts** (Nematocysts are restricted to the epidermis).
- **No cells** in the **mesoglea layer**.
- The **polyp form** is more represented in the life cycle.
- This class comprises **3 major orders** that contain about 3000 species. (in addition to several smaller ones).

I) Order Hydroida:

- **Most species are marine** although few are freshwater species exist (example ***Hydra***).
- Generally **medosoid as adults**. Mesoglea is thick and manubrium is found (like scyphozoans).
- Hydrozoan medusae are smaller than scyphozoans and they usually have **a shelf of tissues** called **velum** (help in faster movement).
- Have **Ocelli** and **Statocysts.**
- All are **gonochoristic** (dioecious=separate sexes).

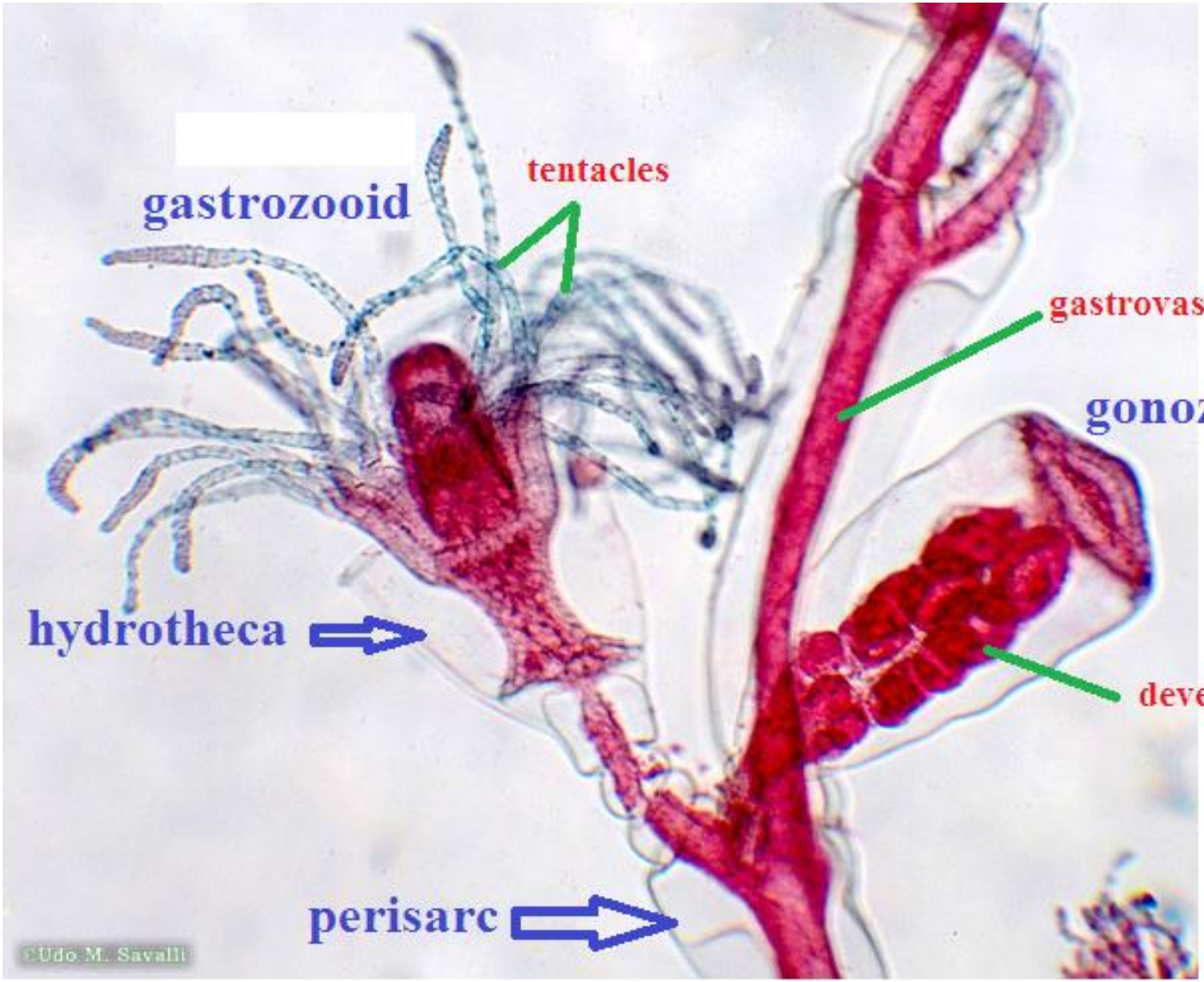

SCIENCEphotoLIBRARY



- Some species of the freshwater, *Hydra* have **endosymbiotic green algae** called **Zoochlorella.**
- *Note: **Hydra** is **not** a good example that represents the characteristics of this order).* ⇒ *It is freshwater, solitary and polyp.*

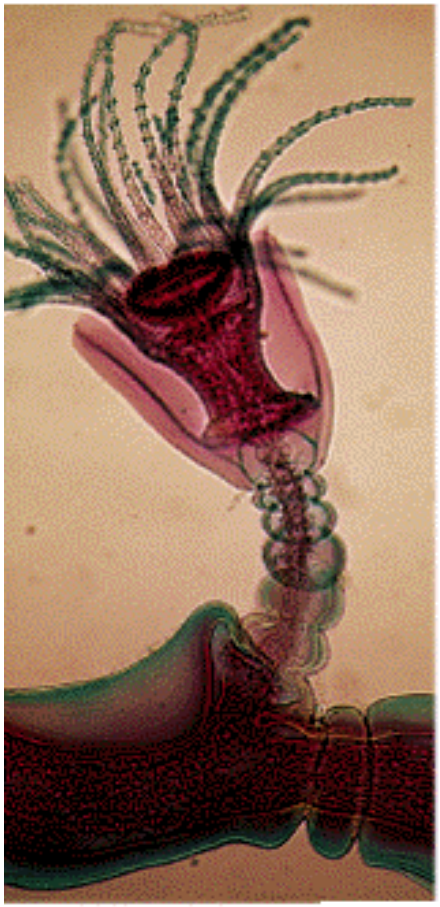
- Mostly, hydrozoans **in the polyp stage** are **colonial.** This means that **one planula** gives rise to **a large number of polyps** (**Zooids** or **modules** of the colony) that are all *interconnected and share the same gastrovascular cavity*.
- The colony has **a root-like structure** called **stolon.**
- The **oral end** of the polyp is called the **hydranth**.
- The stolon and stalk of the colony are usually encased in a **transparent protective tube** called **perisarc** (made up of polysaccharides, proteins and chitin). Example: ***Obelia*** colony.

- Zooids of a colony could be of **two types** (**dimorphic colony**) or **more than two** (**polymorphic colony**).
- **Zooid (Module) types are:**
  - **Gastrozooids:** specialized for feeding.
  - **Gonozooids:** specialized for reproduction (production of medusae).
  - **Dactylozooids:** specialized for defense (finger-like).
- **Examples**: *Hydra & Obelia*

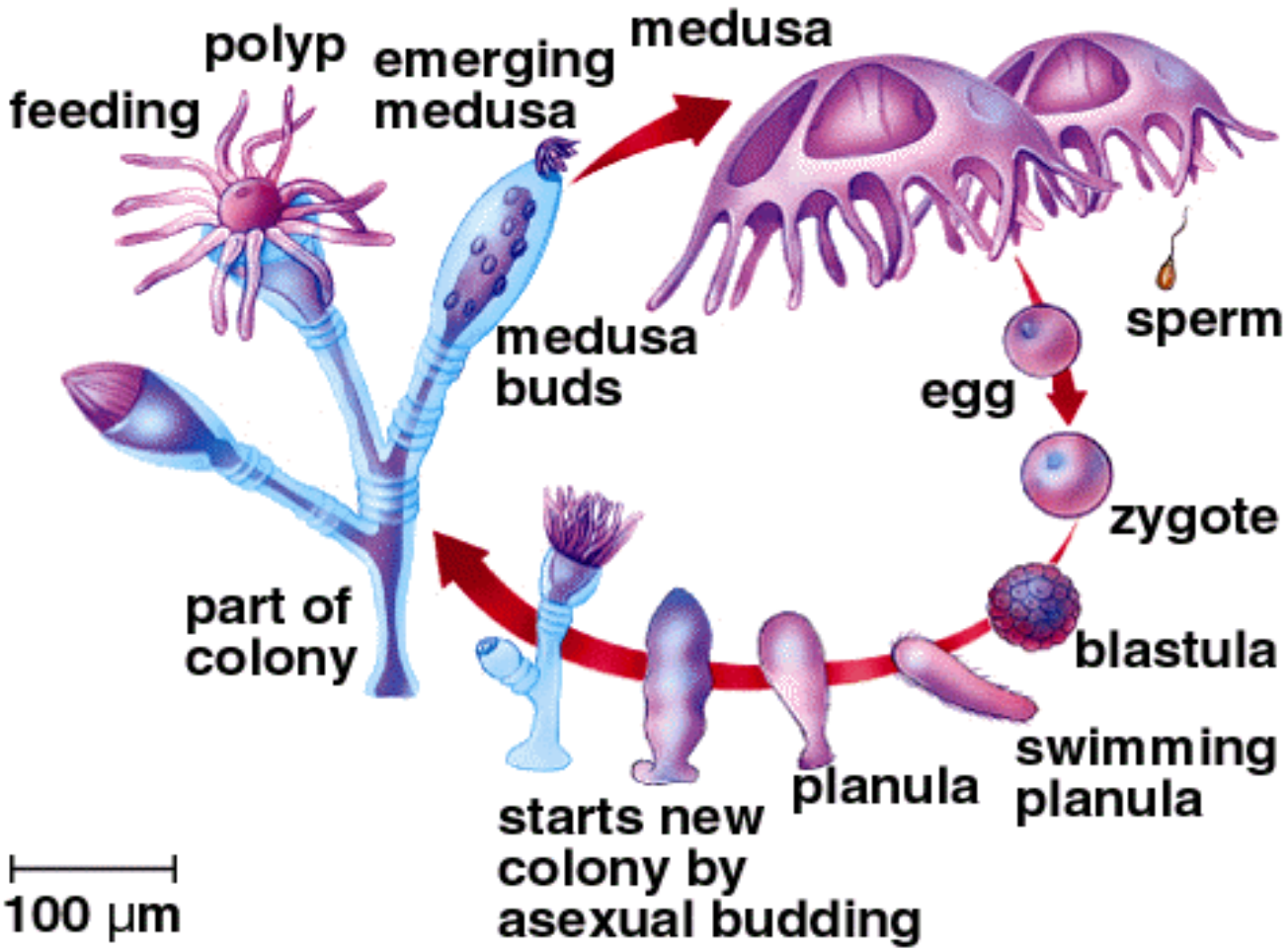


Obelia colony

Obelia structure and life cycle



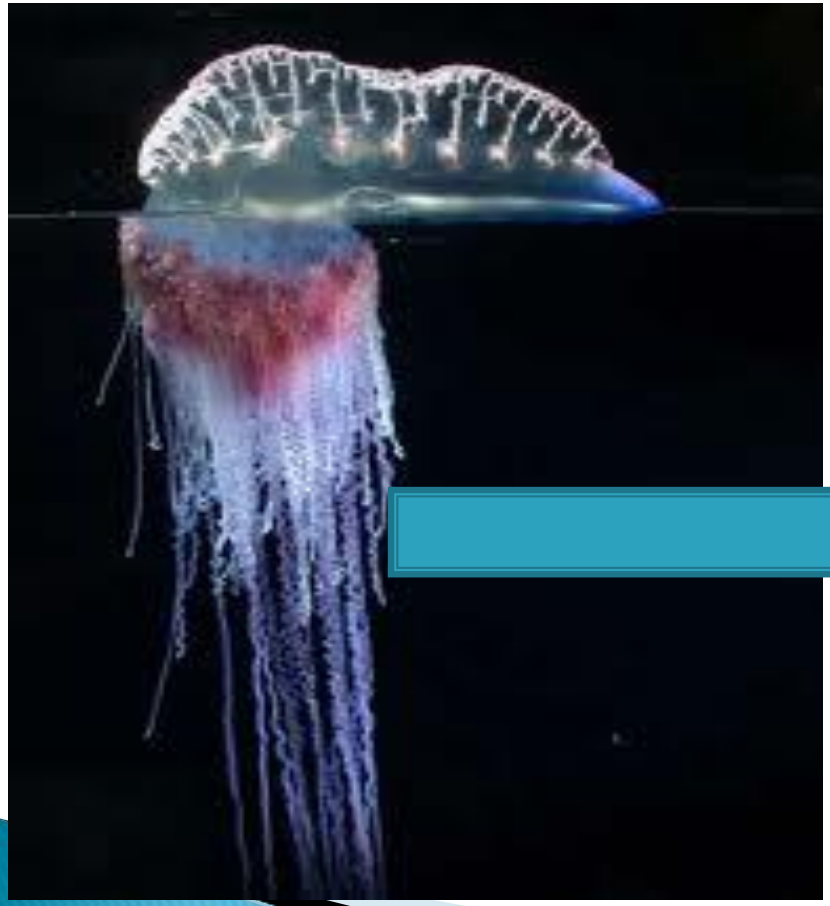
© Runk/Schoenberger/
Grant Heilman Photography

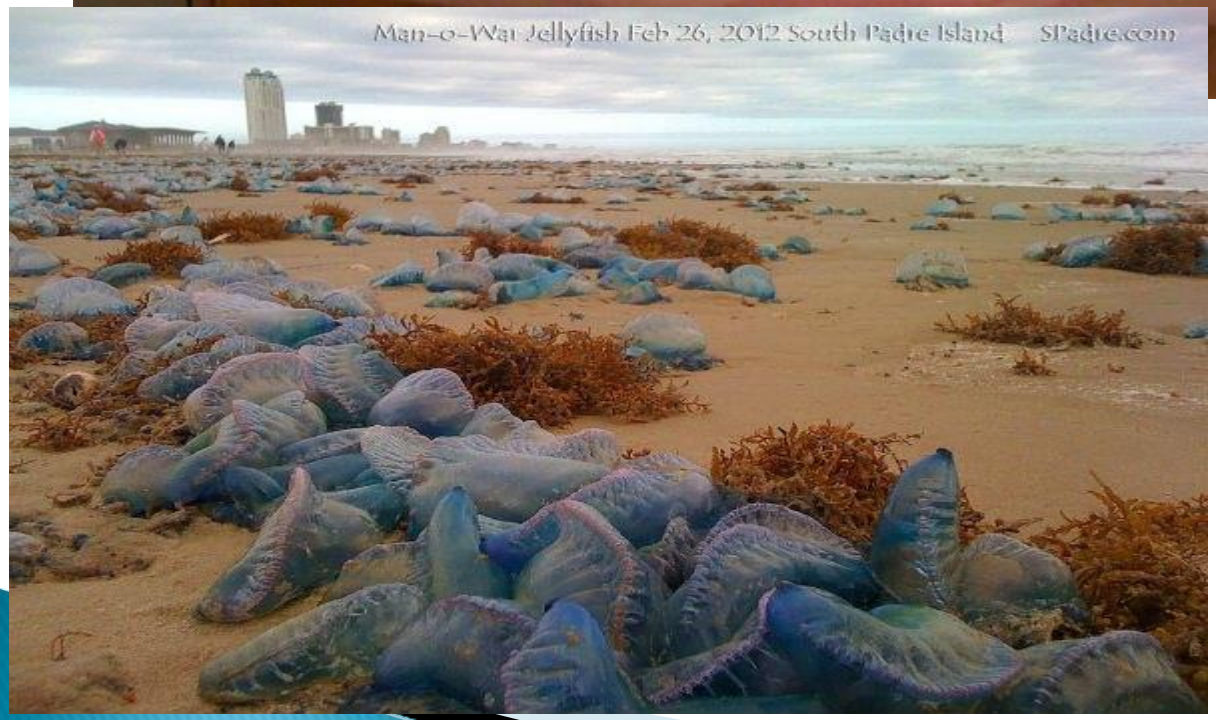


II) Order Siphonophora

- **Colonies are free floating** and contain **polyp and medusa forms at the same time**.
- Example: the **Portuguese man-of-war (*Physalia*)**
- **Modified medusae** serve as modules modified to propel the colony through water by jet propulsion (**nectophores**), or as leaf-like defensive modules (**bracts** or **phyllozooids**).
- Other modified medusae serve as gas-filled floats (**pneumatophores**).
- Mesoglea is reduced or absent as in pneumatophores.

- The **polyp form** is represented by gastrozooids, gonozooids and dactylozooids.
- All are **carnivorous.**




Man-o-War Jellyfish Feb 26, 2012 South Padre Island SPadre.com

II) Order Hydrocorallina:

- **A small group of organisms** that are **all colonial** and **secrete $CaCO_3$ skeleton**.
- Restricted to *warm waters*.
- Commonly known as "**fire corals**" because of their powerful and abundant dactylozooids (**These are NOT TRUE corals**).
- **Examples**: *Millepora*.

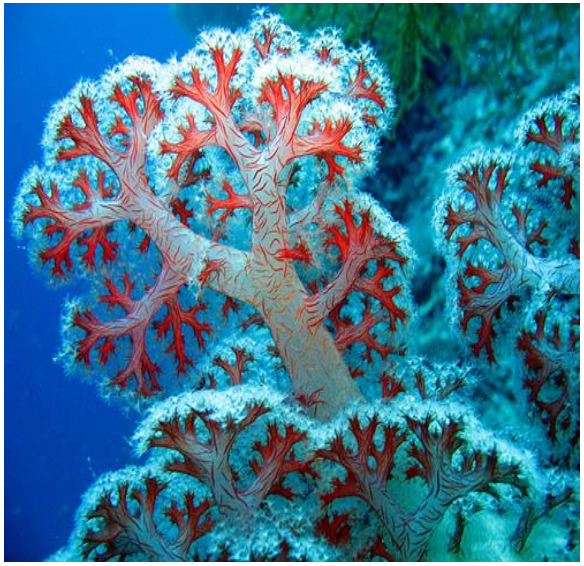
Class Anthozoa

- **Anthozoa** G. **Antho**: **flower**
- **Zoa** : **animals**
- **Defining Characteristics:**
  - **Absence** (or loss?) of any **medusa** stage, **operculum** or **cnidocil.**
  - **Mitochondrial DNA is circular** (as in most eukaryotes) rather than linear (as in other cnidarians).
  - Presence of **ciliated groove** (**siphonoglyph**) in the pharyngeal wall leading from the mouth.
  - Coelenteron is partitioned by sheets of tissue called **mesenteris** or **septa.**

- This class is **the largest** (contains 70%)=6000 species.
- It includes the **sea anemones** and **corals**.

- Sea anemones:



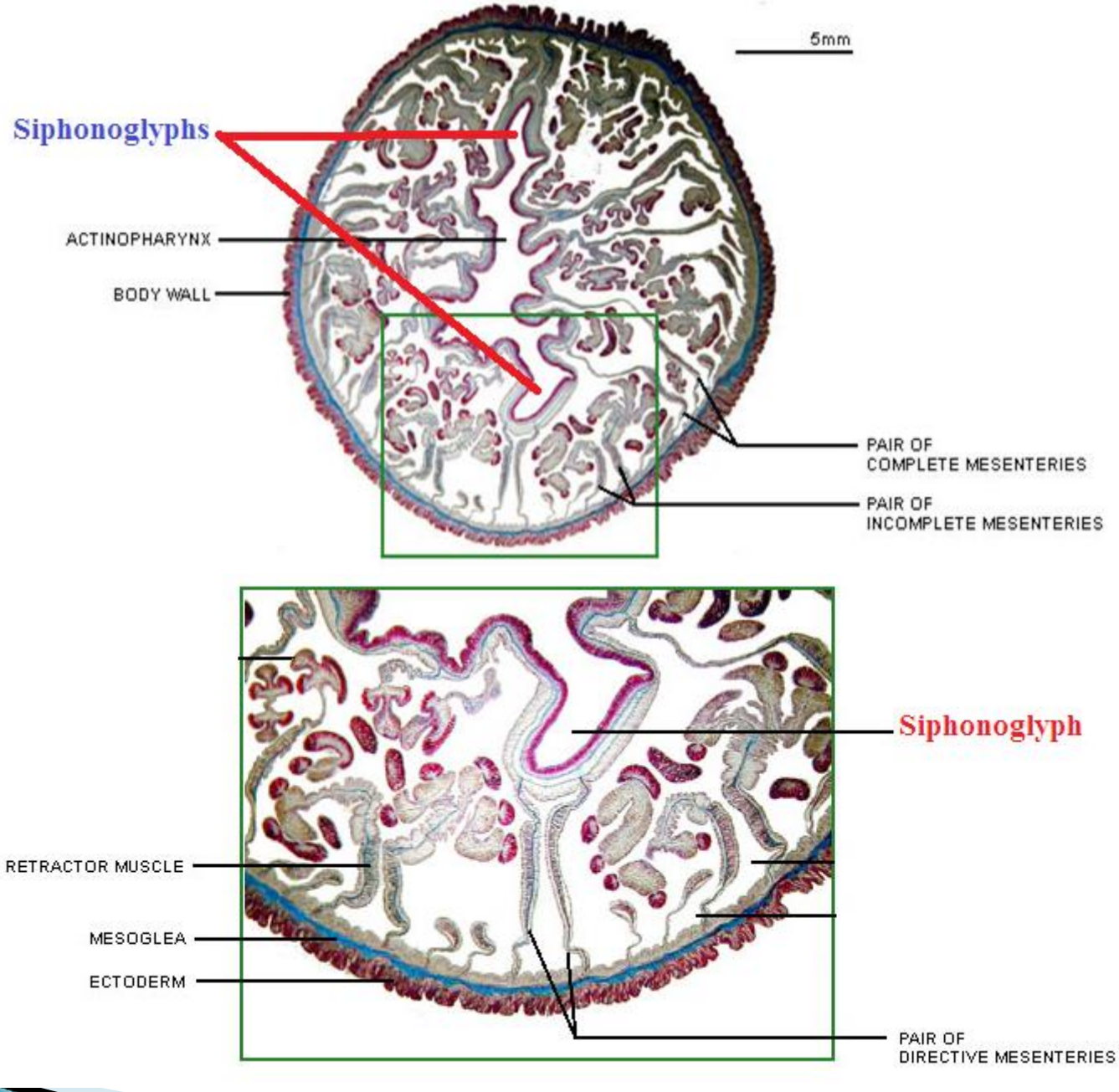
Corals

- All members are marine.
- All are in the polyp form (no medusa).
- Anthozoans are usually gonochoristic (some are sequential hermaphrodites).
- The mesenteries bear the gonads.
- Sexual reproduction:
- Polyp → gametes → planula → polyp.
- The planula of some species is a feeding-stage.

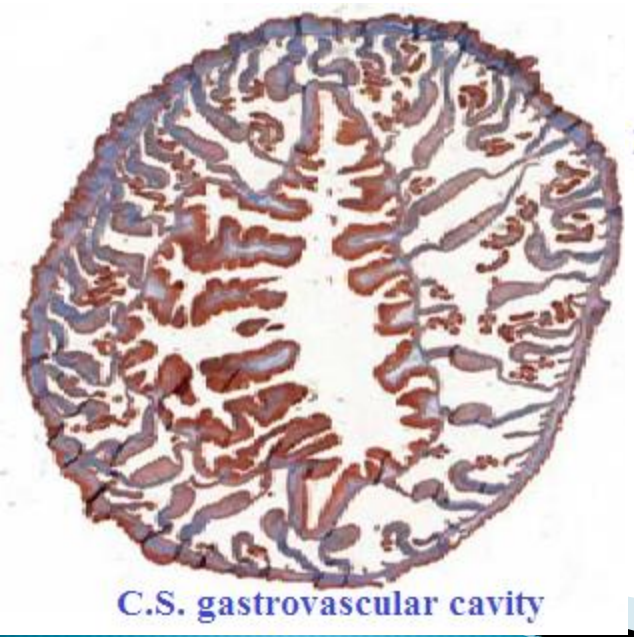
- Many reproduce **asexually** by:
  - **Fission** (longitudinal and transverse).
  - **Pedal laceration**: parts of the pedal disc (foot) detach and give a new organism.
  - **Fragmentation** in coral reefs

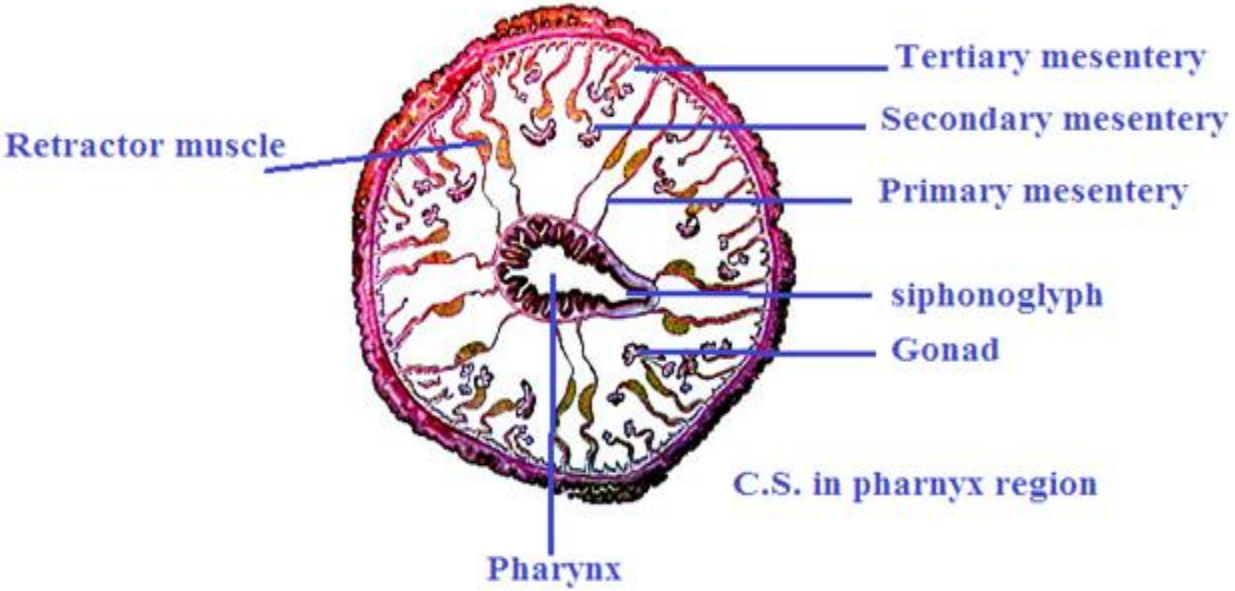
Fission

- **Feeding:**
  - Anthozoans are **carnivorous**.
  - **Mouth** opens into a **tubular pharynx** rather than directly into the **gastrovascular cavity**.
  - **1-2 ciliated grooves (siphonoglyphs)** extend from the pharynx down the mouth.


5mm
Siphonoglyphs
ACTINOPHARYNX
BODY WALL
PAIR OF
COMPLETE MESENTERIES
PAIR OF
INCOMPLETE MESENTERIES
Siphonoglyph
RETRACTOR MUSCLE
MESOGLEA
ECTODERM
PAIR OF
DIRECTIVE MESENTERIES

- **Mesenteries (septa)** are found in the gastrovascular cavity *(increase surface area available for digestion and absorption*).
- **Mesenteries are of two types**:
  - **Complete (primary):** extend from body wall to pharynx wall.
  - **Incomplete (secondary, tertiary):** extend only partway into the gastrovascular cavity.

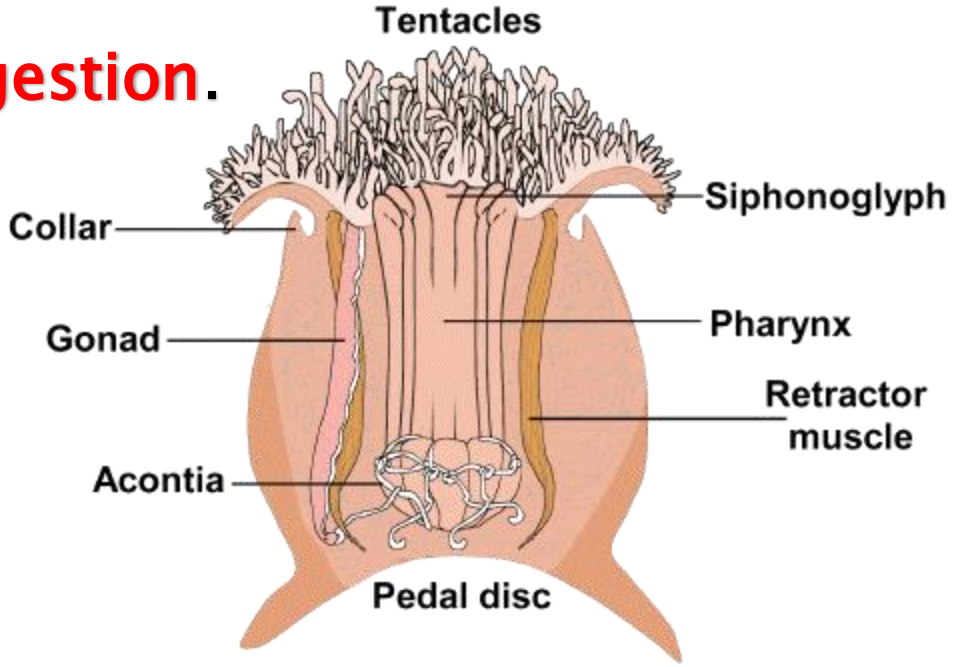




- Internally, near the base, many have thin filaments, rich in **nematocysts** and **secretory cells** called **Acontia.** They can be extended to the outside.

Functions:

  - 1) Have both **defensive** and **offensive** purposes.
  - 2) Play a role in **digestion**.



- Some other anemones have special spherical structures just below the tentacle called **Acrorhagi**.
  - These are used to **defend the territory** of the anemone against other anemones.
- Anemones that lack Acrorhagi have similar structures called **catch tentacles** specialized for fighting.
- Anthozoans have both longitudinal and circular muscles.

Coral Reef [Hunting & Fighting] - YouTube.webm


Tentacles
Acrorhagi
© Gary McDonald


catch tentacles
tentacles

Movement:

- Anthozoan tissues contain both **circular** and **longitudinal** muscle fibers.
- **Most Anthozoan are sessile.**
- However, many **can move** (slowly=few mm/min).
- Others are found **on the back** of other invertebrates that are motile.
- Some can **swim**

Classification of Anthozoans:

- **2 subclasses:**

I) Subclass Hexacorallia (Zooantharia):

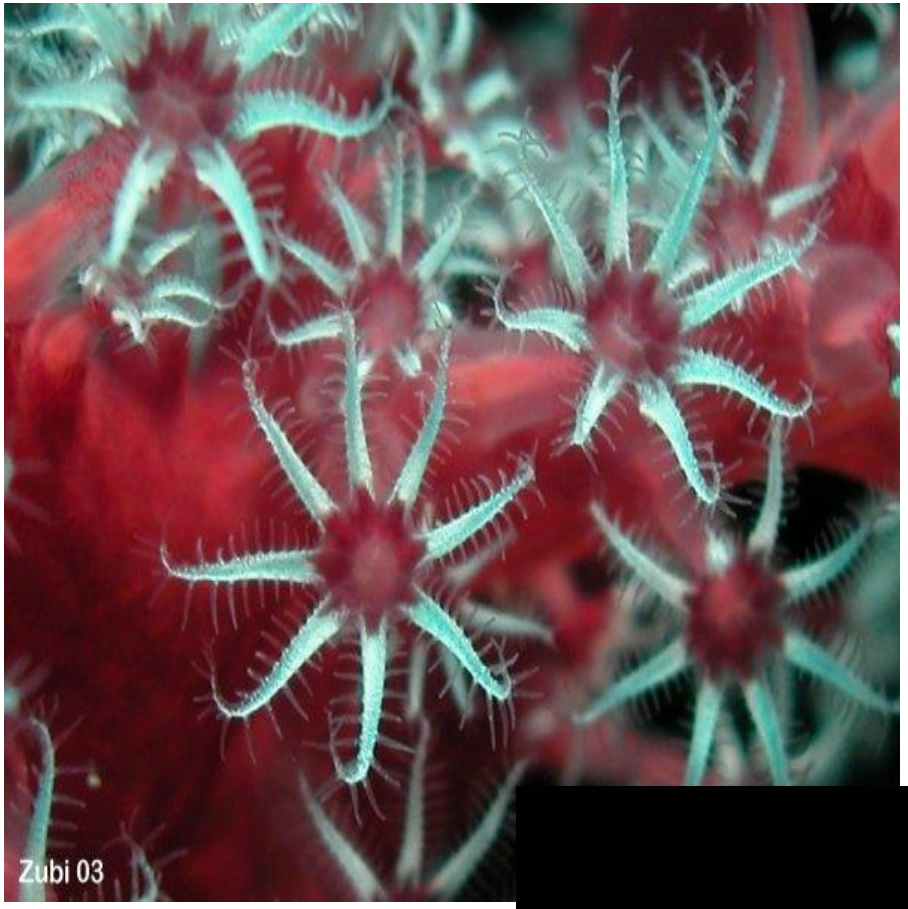
- Includes many **solitary species (Sea anemone)** others **are colonial (Corals).**
- Have **numerous tentacles** that are usually **multiple of 6.**
- **Have 6 pairs of primary mesenteries.**
- Have **1 pair of siphoglyph.**
- Colonies are **monomorphic** (one type of zooids) like the **true (stony, scleractinian) corals**, which secrete $CaCO_3$ skeleton.

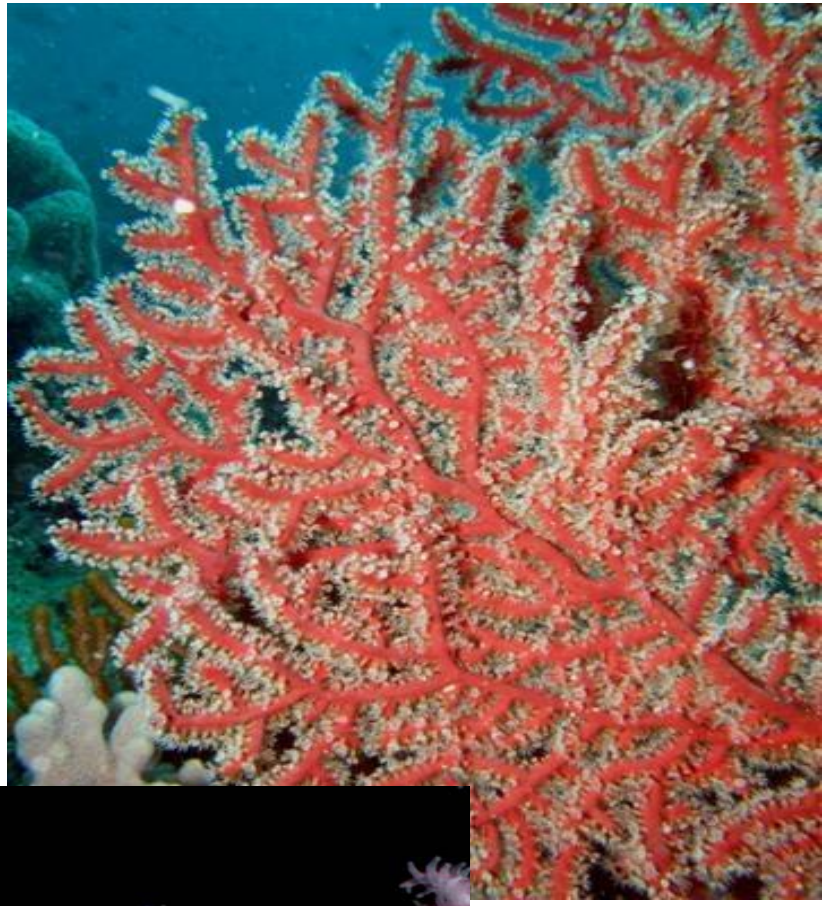
- Stony corals are **two types**:
  - **hermatypic**: reef-building.
  - **ahermatypic**: non-reef-building.
- Most hermatypic corals are restricted to warm, clear waters.
- Example: *Great Barrier Reef of Australia*: Along the Northeast shoreline: **145 km wide X 2000 km long**.
- Although corals are carnivorous, many have endosymbiotic, unicellular algae called **Zooxanthellae** . They give up to 95% of material fixed to the coral.


The Great
Barrier Reef
Australia

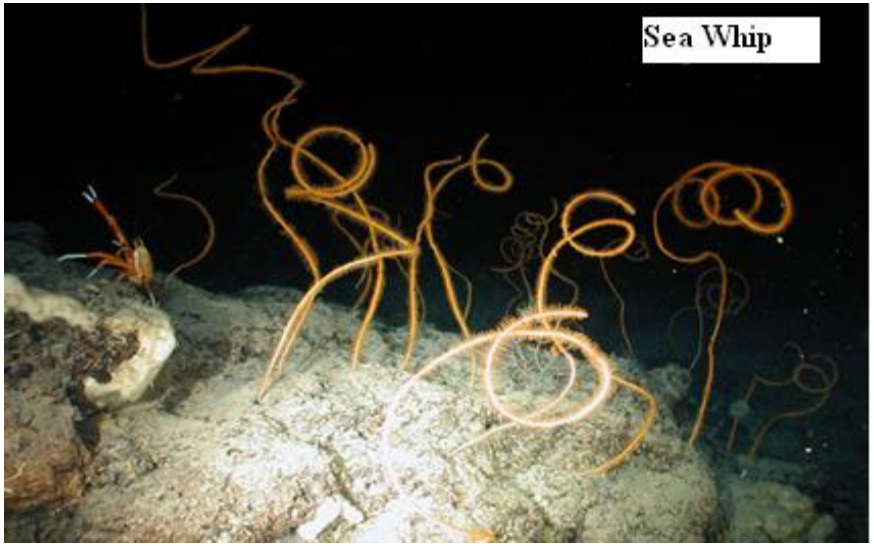
II) Subclass Octocorallia (Alcyonaria):

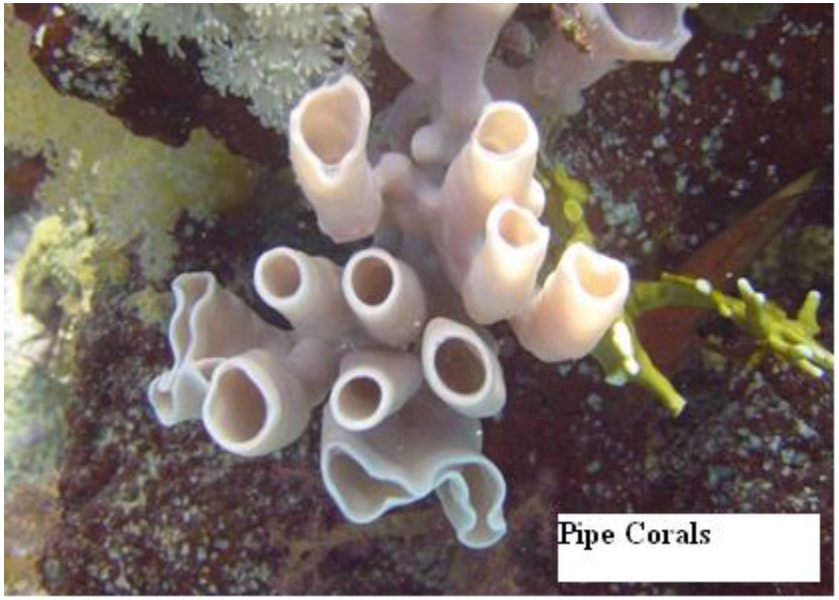
- **Polyps bear 8 tentacles.**
- **Have 8 complete mesenteries.**
- Have only a **single siphonoglyph.**
- Tentacles are **pinnate** (**have pinnules**).
- Tentacles are used by some species to capture phytoplankton.
- All are **colonial** and colonies are often **polymorphic**.


Zubi 03



- **Polyps could be:**
  - **Soft**: embedded in a thick matrix of mesoglea.
  - **Hard**: have proteinaceous or calcareous internal skeleton (e.g. **Sea Fan and Sea Whips**, that are called collectively as **gorgonian or horny corals and pipe corals**).
- **Examples**: Pipe corals, sea fans, sea feathers,





End of Chapter 6