Zoology **Name: _____** **Block: _____**
Exercise #8: The Radiate Animals, Phylum Cnidaria
Lab Guide

These animals are called **radiates** because all are **radially** (or **biradially**) symmetrical, a form of symmetry in which body parts are arranged around an **oral-aboral axis.** They are the simplest animals to have a **tissue** level of organization, in which similar cells becomes clumped together into definite patterns or layers. Most of these tissue, though, are not organized into organs having special functions and thus lack a feature that is characteristic of all the more complex metazoans. The radiates include several successful groups such as **hydra, jellyfish, sea anemones, and corals.**

Two important metazoan features shared by all radiates are:
1. Two embryological germ layers **(ectoderm & endoderm)**
2. An internal space for digestion, the **gastrovascular cavity**, which opens to the outside by a mouth

Some cnidarians have a skeleton (ex. Corals), but most have a fluid filled gastrovascular cavity which serves as a "**hydrostatic skeleton".**

Cnidarians also have characteristic stinging cells called "**cnidocytes**".

There are two main body forms:
1. **Polyp**: which is often sessile
2. **Medusa**: which is free swimming

In some groups both body forms are found in their life cycle. In others, there will only be a polyp form and no medusa stage (sea anemones & corals).

There are 5 main classes in the Phylum Cnidaria: (we will focus on only 3 of the 5 classes)
1. Class **Hydrozoa**: both polyp and medusa stages represented, found in fresh and marine environments (ex. Hydra & Obelia)
2. Class **Scyphozoa**: solitary, medusa stage is emphasized, polyp stage is reduced or absent, true jellyfish (ex. Aurelia)
3. Class **Anthozoa**: All polyps, no medusa, gastrovascular cavity is subdivided by mesenteries. (ex. Sea anemone)
4. Class **Staurozoa**: **WE WILL NOT STUDY**
5. Class **Cubozoa**: **WE WILL NOT STUDY**

Exercise 8A: Class Hydrozoa – Hydra & Obelia

These are both solitary (**Hydra** – 2-25mm in length) and colonial (**Obelia** – 2-20cm tall/colony). Hydra are freshwater (pools, quiet streams, ponds, etc.) and Obelia are marine.

External Structure (Hydra)

Hydra have a cylindrical body with a conical **hypostome** at the oral end which bears the **mouth**. This mouth is surrounded by 6-10 **tentacles**. The **basal or aboral end** secretes a sticky substance for attachment.

The outline of the gastrovascular cavity can sometimes be seen through the animal by adjusting the light. Digestion will occur within the **gastrovascular cavity** by cells lining the cavity secreting digestive enzymes (**extracellular digestion**). Then, when food particles are small enough, other cells of this gastrodermis will engulf these particles (**intracellular digestion**). Undigestable materials will be regurgitated because there is no anus.

When examining the tentacles, you will notice wartlike elevations. These contain specialized cells called **cnidocytes**. Each contains a stinging organelle called a **nematocyst**. This nematocyst is coiled and thread-like. Tiny projections from the cnidocytes are triggers called "**cnidocils**". When triggered, the nematocyst is discharged to capture food or to protect itself. The toxin is a **hypnotoxin**, which penetrates and paralyzes its prey.

Internal Structure (Hydra)

The body wall is made up of two layers, an **outer epidermis** and an **inner gastrodermis**. These two layers are separated by a noncellular layer called **mesoglea**. This mesoglea will serve as an elastic skeleton for hydra and provide increased flexibility.

The epidermis contains cells which are used for muscular contractions (**epitheliomuscular cells**). The "**nerve net**" also lies just beneath the epidermal layer. **Interstitial cells** are also found which can transform into other kinds of cells when needed. Then there are **gland cells** which secrete mucus onto the body surface.

Sensory cells may also be found in both the epidermis and gastrodermis. **(These are difficult to identify)**

Reproduction can be:

1. **Asexual**: via **budding** which involves a part of the body growing out as a hollow outgrowth, or bud. It lengthens and develops tentacles and a mouth at its distal end. Eventually the bud constricts at its basal end and breaks off from the parent.
2. **Sexual**: Some species are **monoecious**, having both male (testes) and female (ovaries) body parts. Others may be **dioceious**, separate male and female sexes.

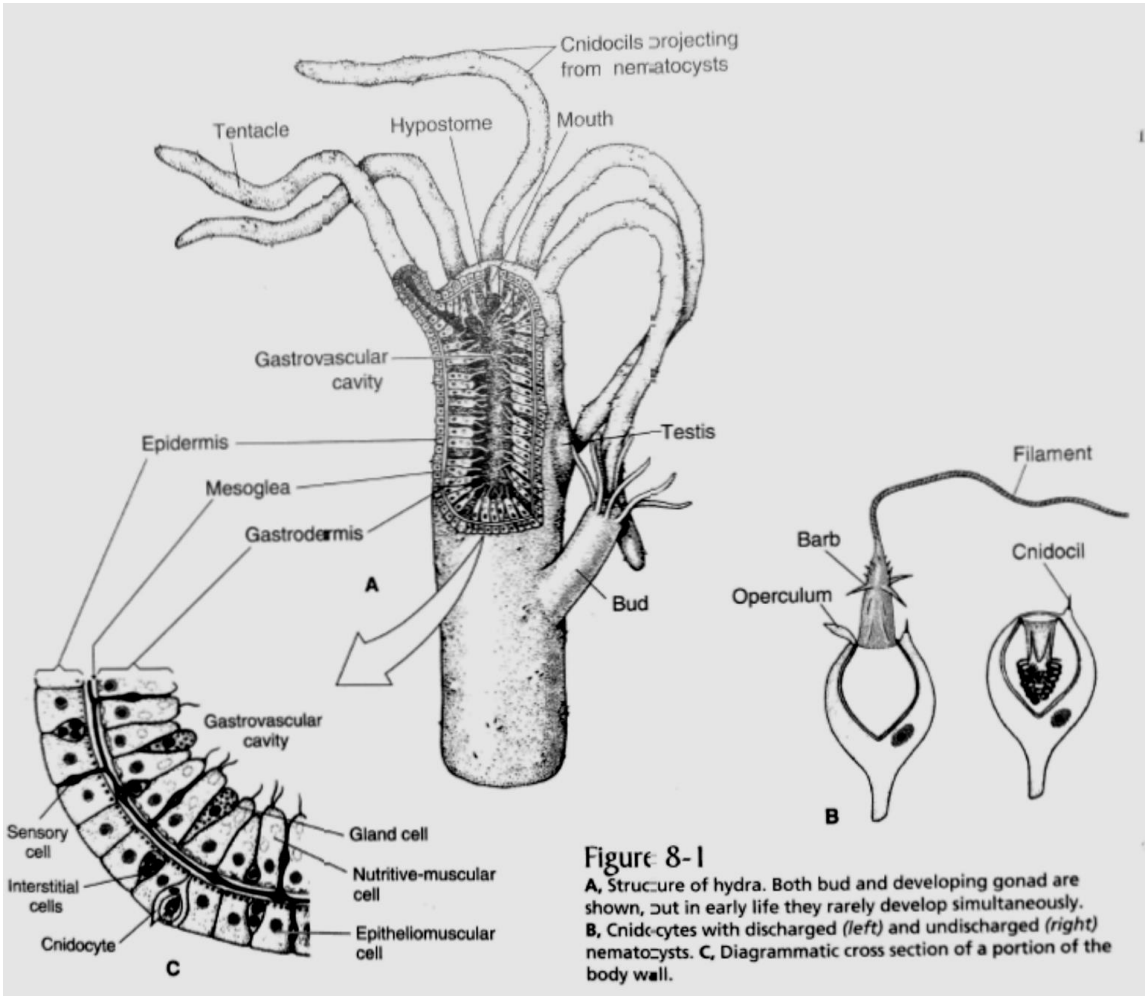


Figure 8-1
A, Structure of hydra. Both bud and developing gonad are shown, but in early life they rarely develop simultaneously. B, Cnidocytes with discharged *(left)* and undischarged *(right)* nematocysts. C, Diagrammatic cross section of a portion of the body wall.

Procedure

1. Using a depression slide, obtain a "live" hydra from your instructor.
2. Examine with a hand lens, dissecting microscope or the scanning objective of a compound microscope.
3. **SKETCH** and label the following parts: **(tentacle, hypostome, cnidocytes (lumps), gastrovascular cavity (seen through the epidermis of animal), bud (if present), mouth, basal disc (used for attachment))**

4. Obtain a stained "cross section of hydra" from your instructor.
5. Examine under both low and high power.
6. **SKETCH** and label the following parts: **(gastrovascular cavity, epidermis, mesoglea, gastrodermis, epitheliomuscular cells, nutritive-muscular cells, cnidocyte)**

7. Obtain a stained slide that shows a hydra budding.
8. Examine under both low and high. Examine whether the gastrovascular cavity is continuous or separate between the parent and the budding hydra.
9. **SKETCH** and label the bud on the parent hydra.

Obelia are hydroids that are found in marine waters. This colonial hydroid has both polyp and medusa life stages. The hydroid arises from a free swimming **planula larva**, which settles and attaches to the substrate. Then by budding, a colony is formed.

The colony includes two kinds of polyps:
1. **Hydranths**: for nutrition
2. **Gonangia**: for reproduction

Medusa buds are produced by **gonangia** and create free swimming medusa. These are **dioceious** and when mature, produce **gametes (sperm and egg)** into the water where fertilization takes place. The planula larva will attach to the substrate and repeat the cycle.

The main stem of Obelia is the **hydrocaulus**. It will give rise to many lateral branches. The entire colony will be encased in a thin, transparent, protective layer called the **perisarc**. The inner part is called the **coensarc**. This hollow tube is composed like the hydra with an **epidermis**, **mesoglea**, and **gastrodermis**. A transparent extension of the perisarc is the **hydrotheca**, which forms a protective cup around the **hydranth**. Each hydranth will have an elevated **hypostome** with a mouth surrounded by tentacles. Each tentacle has swellings with **cnidocytes** (bearing **nematocysts**).

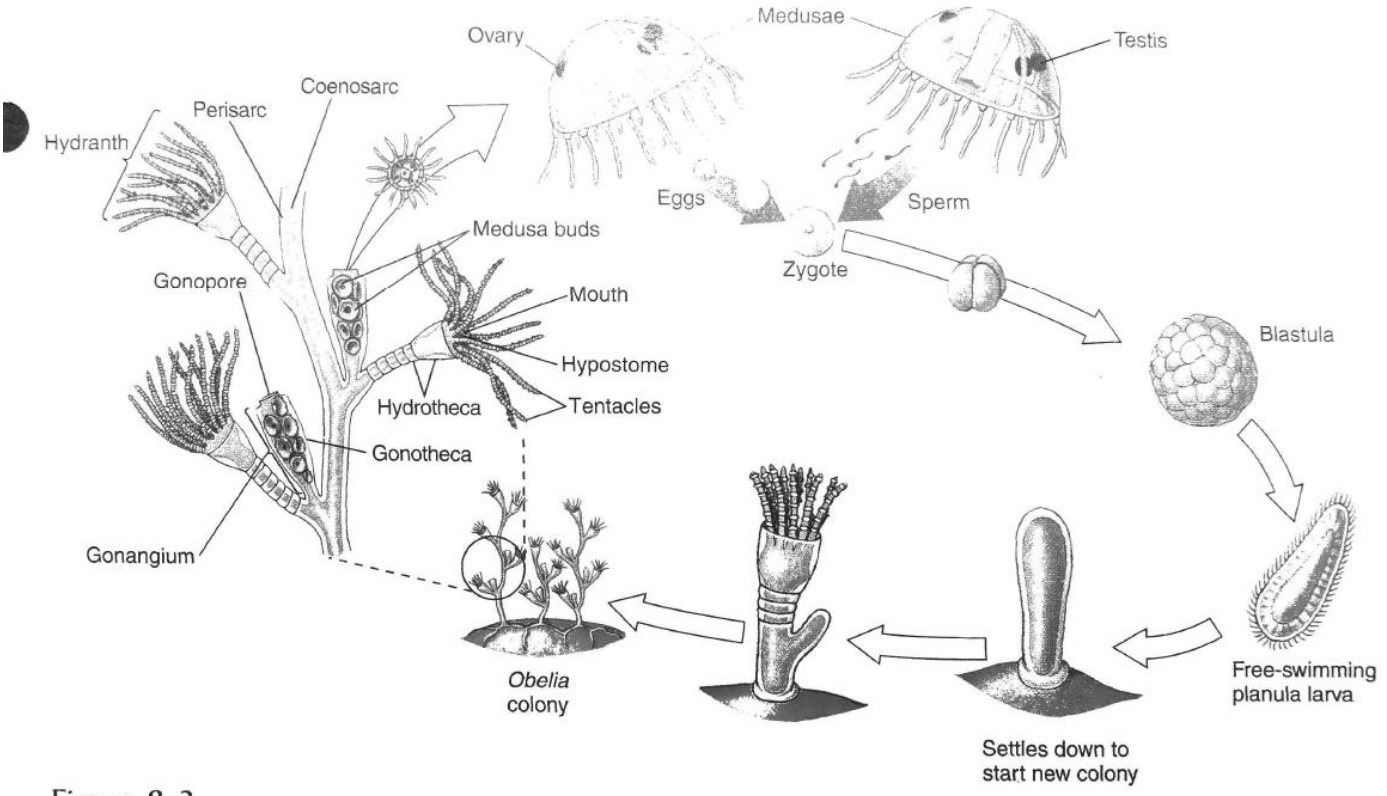


Figure 8-3

Obelia life cycle, showing alternation of polyp (asexual) and medusa (sexual) stages. In *Obelia* both its polyps and stems are protected by continuations of the perisarc. In some hydroids, only the stems are so protected.

Procedure

1. Obtain a stained slide of Obelia from your instructor.
2. Examine using low power on your compound microscope.
3. **SKETCH** and label the following parts: **(perisarc, coensarc, hydranth, mouth, hypostome, tentacles, gonotheca, hydrotheca, gonangium (gonangia))**

Analysis

1. Describe how the Hydra reacted when startled.

2. Describe feeding and digestion in hydra. Make sure to discuss both extracellular and intracellular digestion.

3. What is the function of the nutritive-muscular cells in hydra?

4. How do you think hydra respire (breathe) if they don't have a respiratory system? (use your textbook/online sources if necessary).

5. How does the hydra excrete waste? (use your textbook/online sources if necessary)

6. Describe sexual and asexual reproduction in hydra.

Exercise 8B: Class Scyphozoa – Aurelia (true jellyfish)

Aurelia, moon jelly, is common along both coasts of North America. It can be found in temperate, tropical and even sub-polar zones. Most range in size from about 2-40cm, but some can be as much as 2 meters or more in diameter. The jelly layers are thicker and contain cellular material, which gives this area a firmer consistency. All jellyfish are largely water, 94-96%. Their parts are arranged symmetrically around the oral-aboral axis, usually in fours or multiple of fours, so they are said to have **tetramerous radial** symmetry. The large size and fiery **nematocysts** of many jellyfish make them dangerous to swimmers.

Aurelia shows a circular shape with 8 regular marginal notches. Each notch has a **rhopalium** which consists of two sense organs. A **statocyst** (for balance) and an **ocellus** (which can sense light). Each rhopalium is flanked by an extension called the **lappet**.

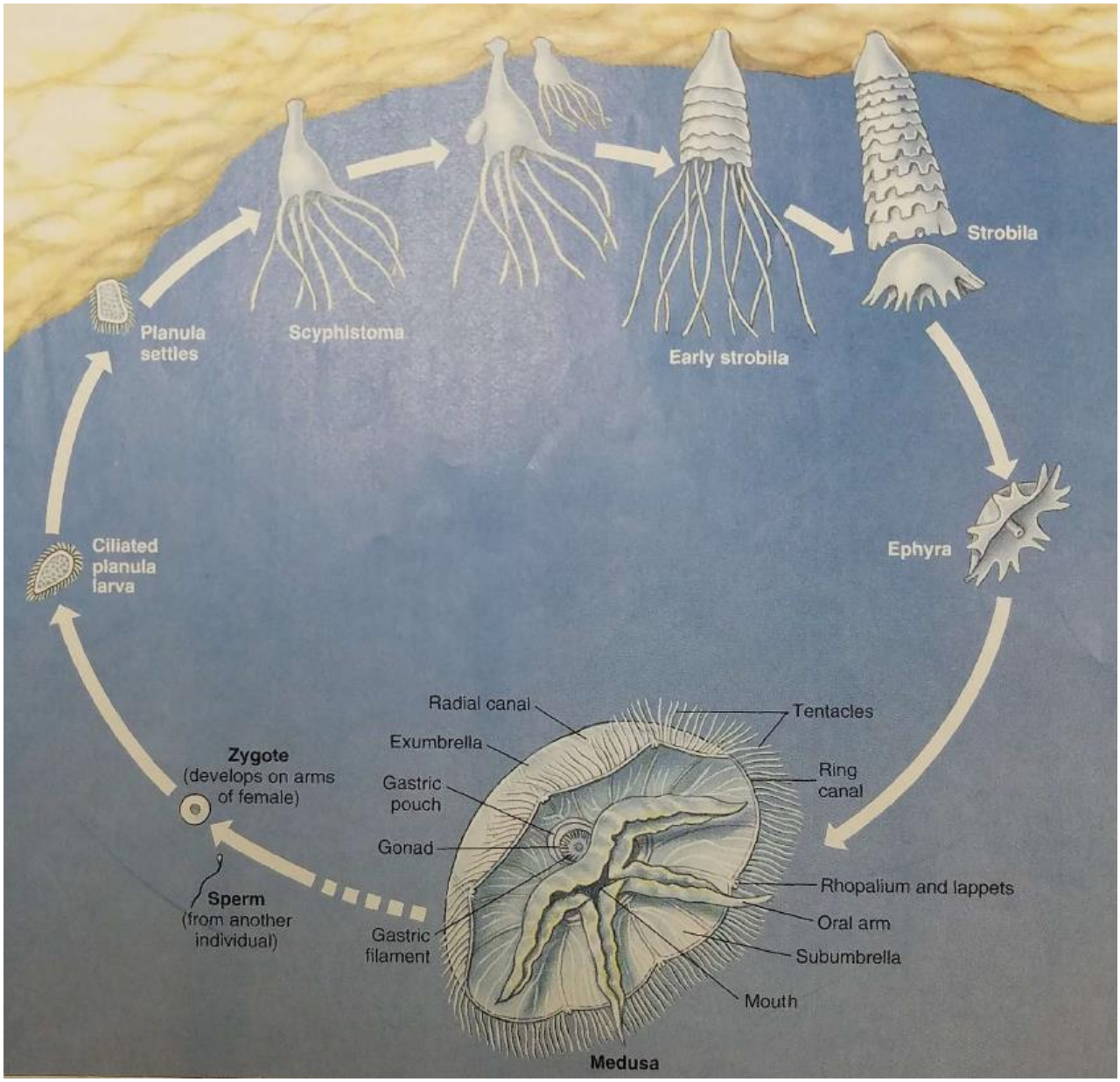
The short **tentacles** of Aurelia form a fringe around the animals margin.

The center of the oral side has 4 long, **oral arms**. The **mouth** is located in the center of the animal. It opens into a short **gullet** which leads to the **stomach**. From the stomach extend 4 **gastric pouches**. They can be identified by the horseshoe shaped **gonads** that lie within them.

A complicated system of **radiating canals** run from the gastric pouches to the **ring canal**, which follows the outer margin. This system of canals resembles the spokes and rim of a wheel on a bike.

Jellyfish are **carnivorous**, most feed on fish and a variety of marine invertebrates. Aurelia is the exception, where it feeds primarily on zooplankton. In Aurelia, food is captured by mucus and moved to the margin by cilia. The oral arms collect this food from the margin and transfer it to the stomach. Digestive enzyme are secreted. Partially digested food and sea water is circulated through the system of canals and carried to all parts of the body. Cells that line the canals complete digestion of the food. So digestion is both **extracellular** and **intracellular**.

Sexes are separate in Aurelia. Sex cells (sperm and egg) are shed from the gonads into the gastrovascular cavity and discharged through the mouth for external fertilization. Free swimming **planula larva** are produced. They attach to the substratum and become **scyphistomae**, and develop into **strobilia**, which begins to bud off young medusa in layers resembling a stack of saucers. This budding process is called **strobilation**.



Procedure

1. Obtain a preserved specimen of jellyfish (Aurelia) from your instructor and place it in a bowl of water.
2. **SKETCH** and label the following parts: **(rhopalium, lappets, oral arms, mouth, tentacles, gastric pouches, gonads, radiating canals, ring canals)**

Analysis

1. The lappet contains sensory structures. What is the function of the statocyst and ocellus?

2. Go ONLINE and find a video of "LIVE" Scyphozoans swimming. Describe how they swim.

3. These animals will digest their food using both "extracellular" and "intracellular" digestion. Compare and contrast both.

4. These animals do not have a traditional circulatory system, but they do have a method to distribute nutrients and oxygen. Explain how this occurs.

Exercise 8C: Class Anthozoa – Sea Anemone (Metridium)

Metridium is the most common sea anemone on the Atlantic and Pacific coasts. Most sea anemones are solitary animals and are all polyps in body form. There is a great variety of size, structure, and color among sea anemones. All are marine.

External Structure

The body of a sea anemone is **cylindrical**, but in preserved specimens it may be somewhat wrinkled. The body can be divided into three main regions:

1. **Oral disc**: free end with numerous tentacles and mouth
2. **Column**: forming the main body of the animal
3. **Basal disc**: used to attach the animal to a solid object by means of glandular secretions. Although it's considered sessile, it can glide slowly on its basal disc.

The inner surface of the mouth is lined with ridges and it also has a smooth-surfaced groove called the **siphonoglyph**. This is found to one side of the mouth. It aides in circulating water throughout the gastrovascular cavity with the help of **cilia**.

The outer covering is a tough **epidermis**.

The mouth will open into a **pharynx**, which extends down only part way into the body, eventually opening into the **gastrovascular cavity**. The gastrovascular cavity is subdivided into six radial chambers, by six **primary (complete) septa**. They are edged by thickenings called **septal filaments**. The primary septa run from the oral to the aboral end. These larger, primary septa chambers are further subdivided by smaller pairs of **incomplete septa**. In many sea anemones, the lower edges of the gastrovascular cavity have long, delicate threads called **acontia**. They have stinging cells and are shot out through the mouth and body pores when frightened for defense.

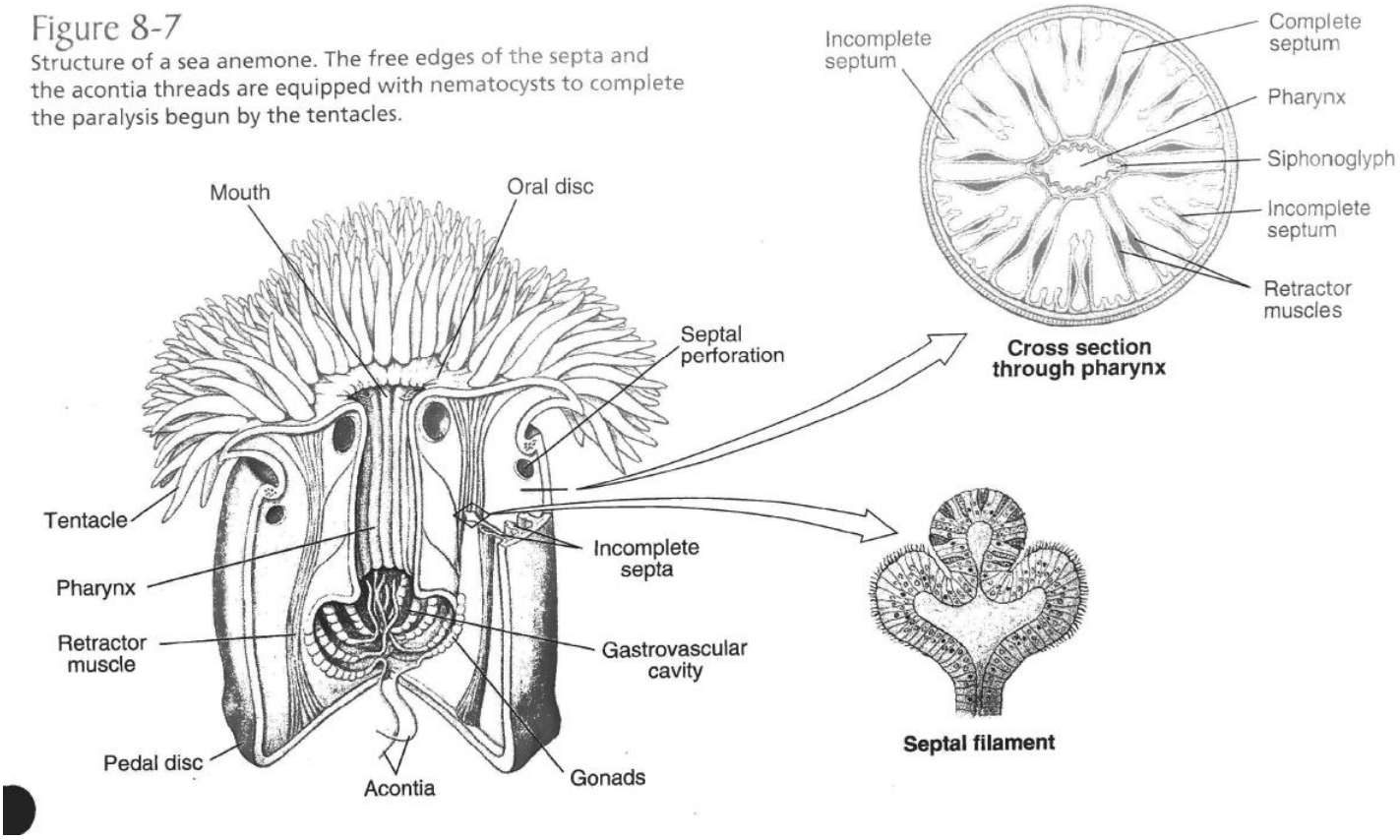
The **gonads** of sea anemones resemble thick bands, looking like stacks of coins, often orange-red in color. They lie in the septa, just to the side the septal filaments.

These animals will reproduce both asexually and sexually. Some will split longitudinally (**longitudinal fission**) as a form of asexual reproduction, but the main asexual form will be **pedal laceration**. Bits of tissue from the pedal disc are split from the

anemone as the animal moves along the substrate. These tissue pieces later regenerate an entire small anemone, literally in the footsteps of its parent.

Sexually, reproduction occurs seasonally when gametes (sperm and egg) are released from the gonads into the gastrovascular cavity. The gametes are released and fertilized externally. The fertilized eggs develop into free-swimming **planula larva**. After a period of free swimming, the planula settle on some hard surface and metamorphoses into an anemone.

Figure 8-7
Structure of a sea anemone. The free edges of the septa and the acontia threads are equipped with nematocysts to complete the paralysis begun by the tentacles.



Procedure

1. Obtain a preserved sea anemone specimen from your instructor and place it in your dissecting pan.
2. Examine its external structure. Think about how it compares to the other Cnidarians you have studied.
3. **SKETCH** and label the following parts: **(tentacles, basal (pedal) disc, oral disc, mouth, body column, siphonoglyph)**

4. Now, cut your sea anemone "longitudinally". Make a second cut "transversely" right under the ring of tentacles.
5. Examine both sections.
6. **SKETCH** and label the following parts: **(mouth, oral disc, pharynx, gastrovascular cavity, gonads, acontia (if visible))**

Analysis

1. What is the function of the acontia in sea anemones?

2. Contrast the two forms of asexual reproduction in sea anemones.