

# MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

## ➤ Origins of Multicellularity

## ➤ Phylum Porifera

- Cell Types, Body Wall, and Skeletons
- Water Currents and Body Forms
- Maintenance Functions
- Reproduction

## ➤ Phylum Cnidaria (Coelenterata)

- The Body Wall and Nematocysts
- Alternation of Generations
- Maintenance Functions
- Reproduction
- Class Hydrozoa
- Class Scyphozoa
- Class Cubozoa
- Class Anthozoa

## ➤ Phylum Ctenophora



**PHYLUM CNIDARIA (COELENTERATA)**

## PHYLUM CNIDARIA (COELENTERATA)

The Cnidaria include over **nine thousand species**, are **mostly marine**, and are important in coral reef ecosystems.

### **Characteristics of the phylum Cnidaria include:**

1. Radial or biradial symmetry
2. Diploblastic, tissue-level organization.
3. Gelatinous mesoglea between the epidermal and gastrodermal tissue layers.
4. Gastrovascular cavity.
5. Nervous system in the form of a nerve net.
6. Specialized cells, called cnidocytes, used in defense, feeding, and attachment.

## Phylum Cnidaria (ni-dar'e-ah)

Radial or biradial symmetry, diploblastic organization, a gastrovascular cavity, and cnidocytes. Over 9,000 species.

### Class Hydrozoa (hi "dro-zo'ah)

Cnidocytes present in the epidermis; gametes produced epidermally and always released to the outside of the body; no wandering mesenchyme cells in mesoglea; medusae usually with a velum; many polyps colonial; mostly marine with some freshwater species. *Hydra*, *Obelia*, *Gonionemus*, *Physalia*.

### Class Scyphozoa (Si "fo-zo'ah)

Medusa prominent in the life history; polyp small; gametes gastrodermal in origin and released into the gastrovascular cavity; cnidocytes present in the gastrodermis as well as epidermis; medusa lacks a velum; mesoglea with wandering mesenchyme cells of epidermal origin, marine. *Aurelia*.

### Class Cubozoa (ku "bo-zo'ah)

Medusa prominent in life history; polyp small; gametes gastrodermal in origin; medusa cuboidal in shape with tentacles that hang from each corner of the bell; marine. *Chironex*.

### Class Anthozoa (an "rho-zo'ah)

Colonial or solitary polyps; medusae absent; cnidocytes present in the gastrodermis; gametes gastrodermal in origin; gastrovascular cavity divided by mesenteries that bear nematocysts; internal biradial or bilateral symmetry present; mesoglea with wandering mesenchyme cells; marine. Anemones and corals. *Metridium*.

# CLASSIFICATION OF CNIDERIA

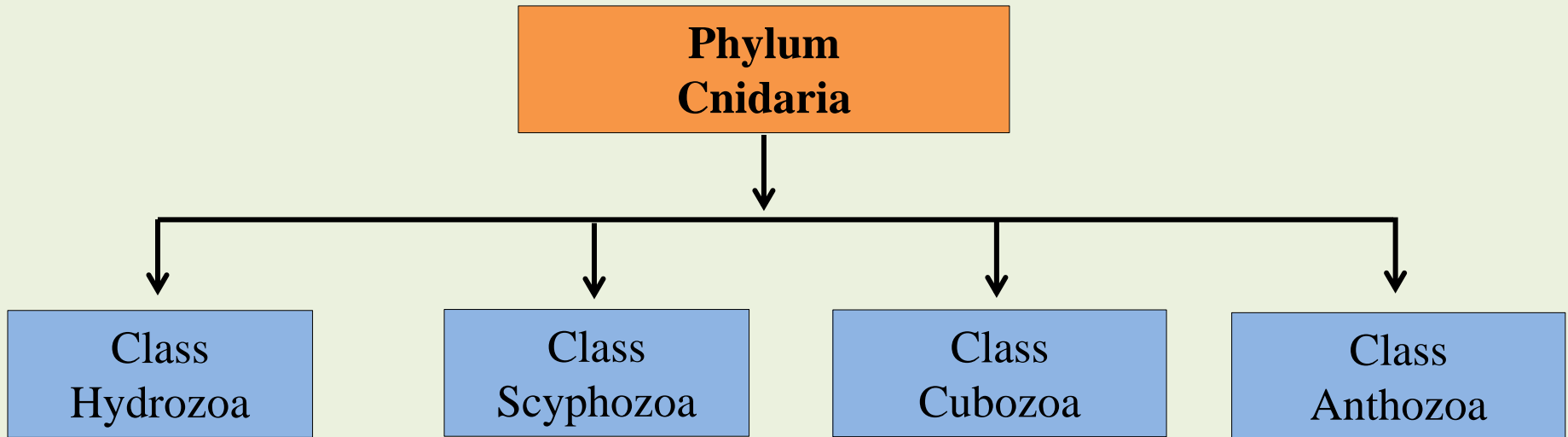
**Phylum  
Cnidaria**

**Class  
Hydrozoa**

**Class  
Scyphozoa**

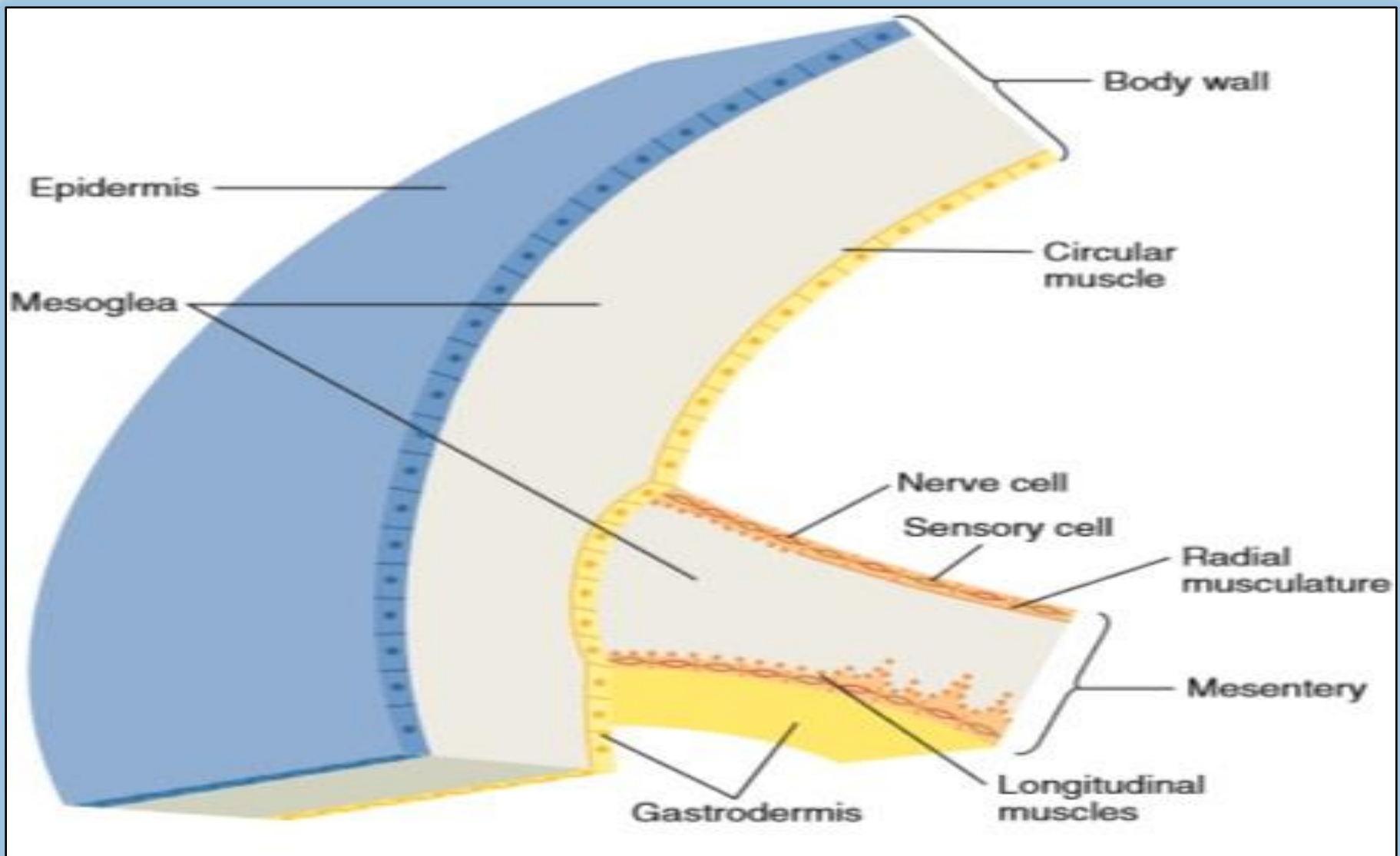
**Class  
Cubozoa**

**Class  
Anthozoa**



## ➤ THE BODY WALL AND NEMATOCYSTS

- ✓ The ectoderm of the embryo gives rise to **epidermis**.
- ✓ Inner layer of the body wall, called the **gastrodermis**, is derived from endoderm.
- ✓ Epidermal and/or gastrodermal cells called **cnidocytes** produce structures called **nematocysts**.
- ✓ A nematocyst is a fluid-filled, intracellular capsule enclosing a coiled, hollow tube.
- ✓ Nematocysts are used for attachment, defense, and feeding.
- ✓ Zoologists have described nearly **30 kinds** of nematocysts.



**Fig: Body Wall of a Cnidarian (Class Anthozoa).** Cnidarians are diploblastic (two tissue layers). The epidermis is derived embryologically from ectoderm, and the gastrodermis is derived embryologically from endoderm. Between these layers is mesoglea

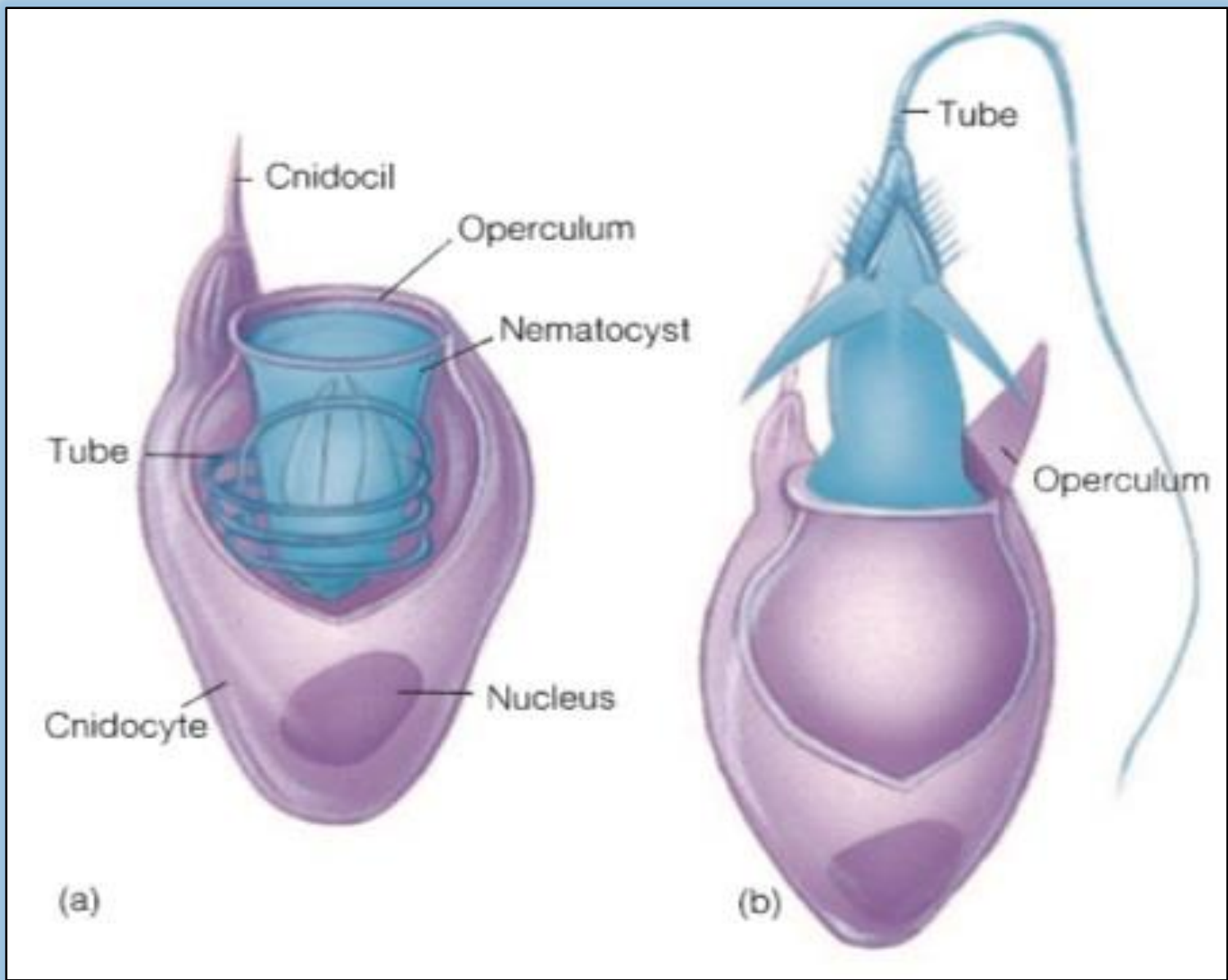


Fig: Cnidocyte Structure and Nematocyst Discharge



## ➤ ALTERNATION OF GENERATIONS

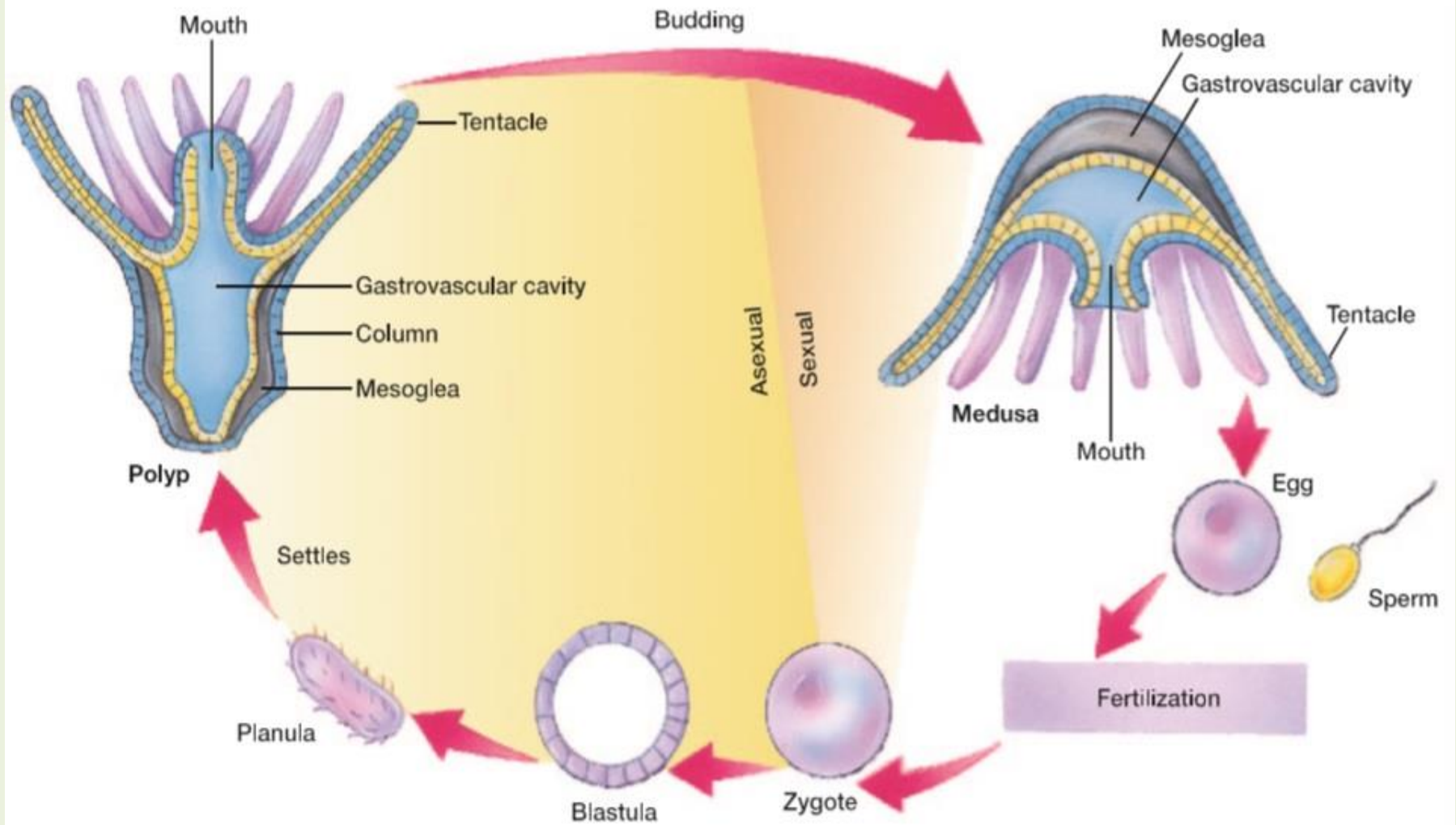
Most cnidarians possess two body forms

### polyp

- ✓ usually asexual and sessile.
- ✓ It attaches to a substrate at the aboral end, and has a cylindrical body, called the column, and a mouth surrounded by food-gathering tentacles.

### medusa

- ✓ The medusa is dioecious and free swimming.
- ✓ It is shaped like an inverted bowl, and tentacles dangle from its margins.
- ✓ The mouth opening is centrally located facing downward, and the medusa swims by gentle pulsations of the body wall.



**Fig: Generalized Cnidarian Life Cycle.**

## ➤ MAINTENANCE FUNCTIONS

- ✓ Gastrovascular cavity functions in digestion, exchange of respiratory gases and metabolic wastes, and the discharge of gametes.
- ✓ Nematocysts entangle and paralyze prey.
- ✓ contractile cells in the tentacles cause the tentacles to shorten, which draws food toward the mouth.
- ✓ As food enters the gastrovascular cavity, gastrodermal gland cells secrete lubricating mucus and enzymes, which reduce food to a soupy broth.
- ✓ Certain gastrodermal cells, called nutritive-muscular cells, phagocytize partially digested food and incorporate it into food vacuoles, where digestion is completed

## hydrostatic skeleton

- ✓ A hydrostatic skeleton is water or body fluids confined in a cavity of the body and against which contractile elements of the body wall act.
- ✓ In the Cnidaria, the water-filled gastrovascular cavity acts as a hydrostatic skeleton.
- ✓ Certain cells of the body wall, called **epitheliomuscular** cells, are contractile and aid in movement.

# Locomotion of Polyps

## Polyps use a variety of forms of locomotion

### Somersaulting:

- ✓ They may move by somersaulting from base to tentacles and from tentacles to base again,

### Inchworm fashion:

- ✓ or move in an inchworm fashion, using their base and tentacles as points of attachment.

### Glide:

- ✓ Polyps may also glide very slowly along a substrate while attached at their base or walk on their tentacles

## Locomotion of Medusae

- ✓ Medusae move by swimming and floating.
- ✓ **Water currents** and **wind** are responsible for most horizontal movements.
- ✓ Vertical movements are the result of swimming.
- ✓ Contractions of **circular and radial epitheliomuscular cells** cause rhythmic pulsations of the bell and drive water from beneath the bell, propelling the medusa through the water

## Nerve cells

- ✓ Nerve cells are located below the epidermis, near the mesoglea, and interconnect to form a two-dimensional nerve net.
- ✓ This net conducts nerve impulses around the body in response to a localized stimulus.
- ✓ The extent to which a nerve impulse spreads over the body depends on stimulus strength.

### **For example:**

A weak stimulus applied to a polyp's tentacle may cause the tentacle to be retracted. A strong stimulus at the same point may cause the entire polyp to withdraw.

## Sensory structures

- ✓ Sensory structures distributed throughout the body.
- ✓ Include receptors for perceiving touch and certain chemicals.
- ✓ More specialized receptors are located at specific sites on a polyp or medusa

## Excretion

- ✓ Cnidarians have large surface-area-to-volume ratios.
- ✓ Oxygen, carbon dioxide, and nitrogenous wastes exchange by **diffusion.**



## ➤ REPRODUCTION

- ✓ Most cnidarians are dioecious.
- ✓ A **blastula** forms early in development, and migration of surface cells to the interior fills the embryo with cells that will eventually form the gastrodermis.
- ✓ The embryo elongates to form a ciliated, **free-swimming larva, called a planula.**
- ✓ The planula attaches to a substrate, interior cells split to form the gastrovascular cavity, and a young **polyp** develops.
- ✓ **Medusae** nearly always form by budding from the body wall of a polyp, and polyps may form other polyps by budding.
- ✓ Buds may detach from the polyp, or they may remain attached to the parent to contribute to a colony of individuals.

## □ CLASS HYDROZOA

**Three features distinguish hydrozoans from other cnidarians:**

- (1) nematocysts are only in the epidermis;
- (2) gametes are epidermal and released to the outside of the body rather than into the gastrovascular cavity; and
- (3) the mesoglea never contains amoeboid mesenchyme cells

**Example:**

*Obelia*

*Gonionemus*

*Physalia physalis*

# *Obelia*

In *Obelia*, a common marine cnidarian, the planula develops into a feeding polyp, called a gastrozoid.

## ➤ GASTROZOID

- The gastrozoid has tentacles.
- Feeds on microscopic organisms in the water
- Secretes a skeleton of protein and chitin, called the **perisarc**, around itself.
- Growth of an *Obelia* colony results from budding of the original gastrozoid.
- The entire colony has a continuous gastrovascular cavity, body wall, and perisarc, and is a few centimeters high.
- Gastrozooids are the most common type of polyp in the colony

## ➤ gonozoid

- ✓ reproductive polyp that produces medusae by budding.

## ➤ medusae

- ✓ Obelia's small medusae form on a stalklike structure of the gonozoid.
- ✓ When medusae mature, they break free of the stalk and swim out an opening at the end of the gonozoid.
- ✓ Medusae reproduce sexually to give rise to more colonies of polyps.

# *Gonionemus*

hydrozoan in which the medusa stage predominates .

## *Gonionemus medusa*

- ✓ The margin of the *Gonionemus* medusa projects inward to form a shelflike lip, called the **velum**.
- ✓ The velum concentrates water expelled from beneath the medusa to a smaller outlet, creating a **jet-propulsion system**.
- ✓ The mouth is at the end of a tubelike **manubrium** that hangs from the medusa's oral surface.
- ✓ In addition to a nerve net, *Gonionemus* has a concentration of nerve cells, called a **nerve ring**.
- ✓ Embedded in the mesoglea around the margin of the medusa are sensory structures called **statocysts**

## Structure and function of statocyst

- ✓ A statocyst consists of a small sac surrounding a calcium carbonate concretion called a **statolith**.
- ✓ When *Gonionemus* tilts, the statolith moves in response to the pull of gravity.
- ✓ This initiates nerve impulses that may change the animal's swimming behavior.

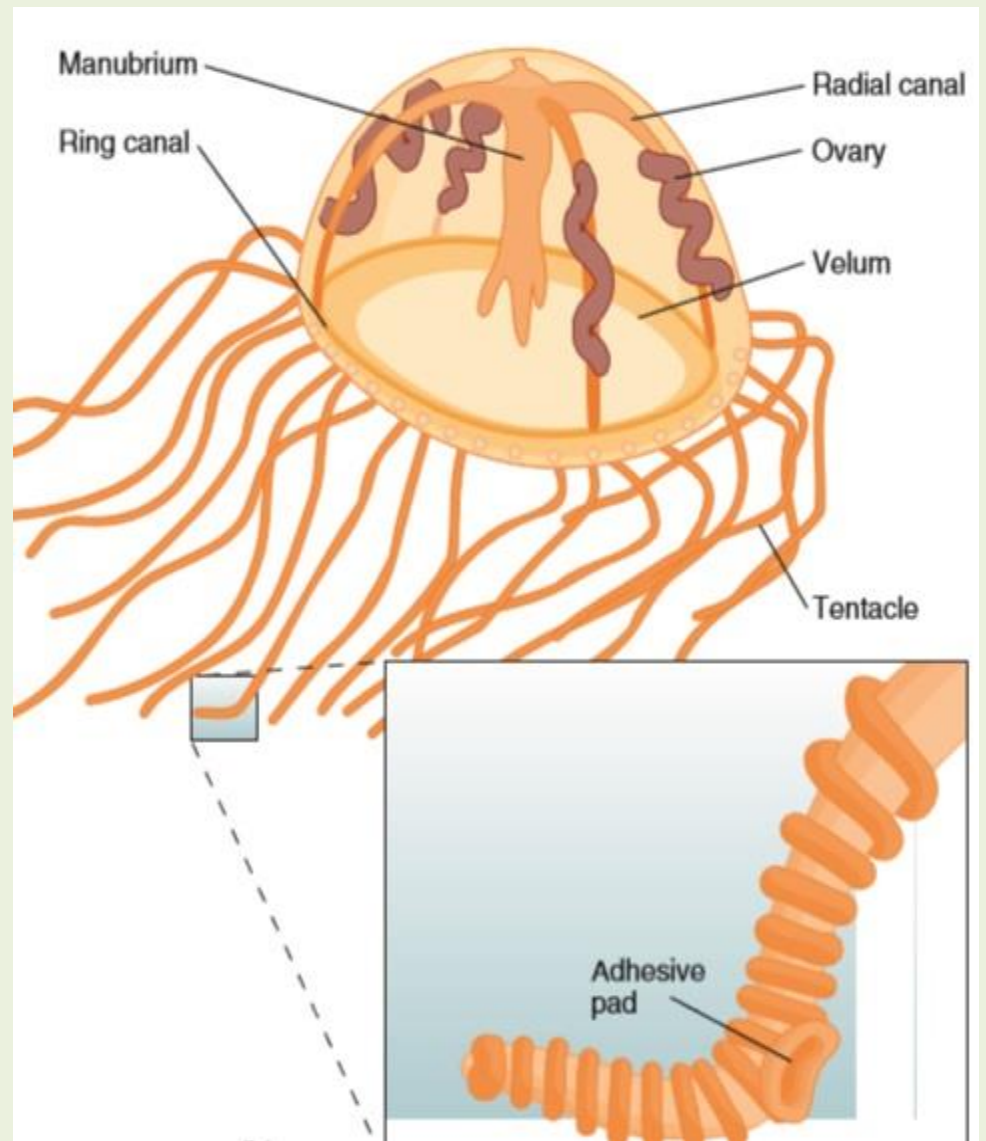
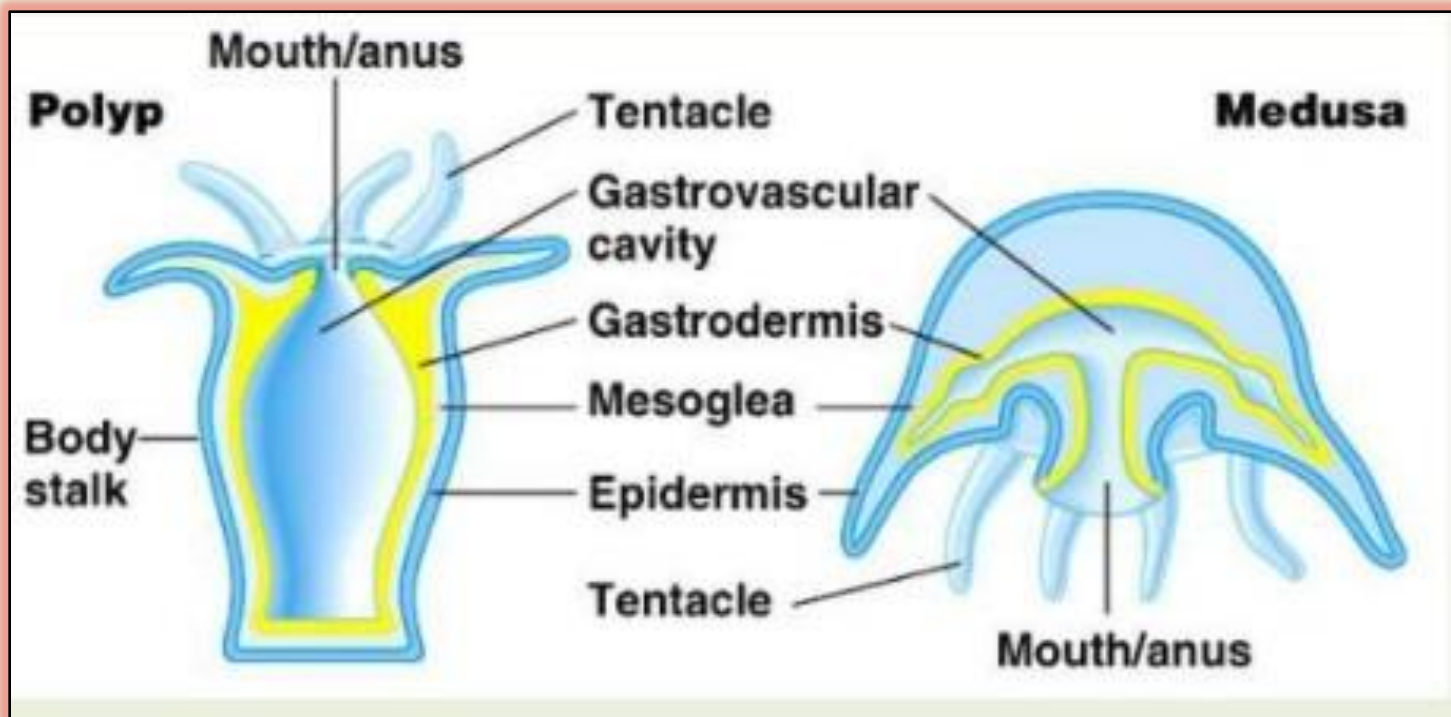


Fig: A Hydrozoan Medusa. (a) A *Gonionemus* medusa. (b) Structure of *Gonionemus*.

## Hydra

- ✓ common freshwater hydrozoan.
- ✓ Sexual reproduction occurs in the polyp stage.
- ✓ Testes form from the mitosis of certain epidermal cells, called interstitial cells.
- ✓ Ovaries also form from interstitial cells. One large egg forms per ovary.
- ✓ After fertilization and early development, epithelial cells lay down a resistant chitinous shell.
- ✓ The embryo drops from the parent, overwinters, hatches in the spring, and develops into an adult.





**Fig: Hydra structure, Gastrovascular cavity----digestive cavity**

## ➤ *Physalia physalis*

- ✓ commonly called the Portuguese man-of-war
- ✓ large, colonial siphonophore.
- ✓ Lacks swimming capabilities and moves at the mercy of wind and waves.
- ✓ Its cnidocyte-laden dactylozooids are lethal to small vertebrates and dangerous to humans.

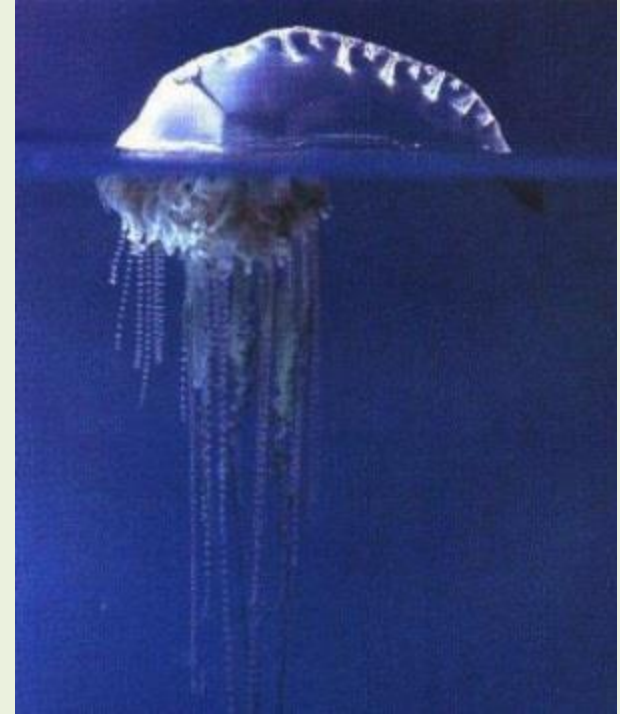
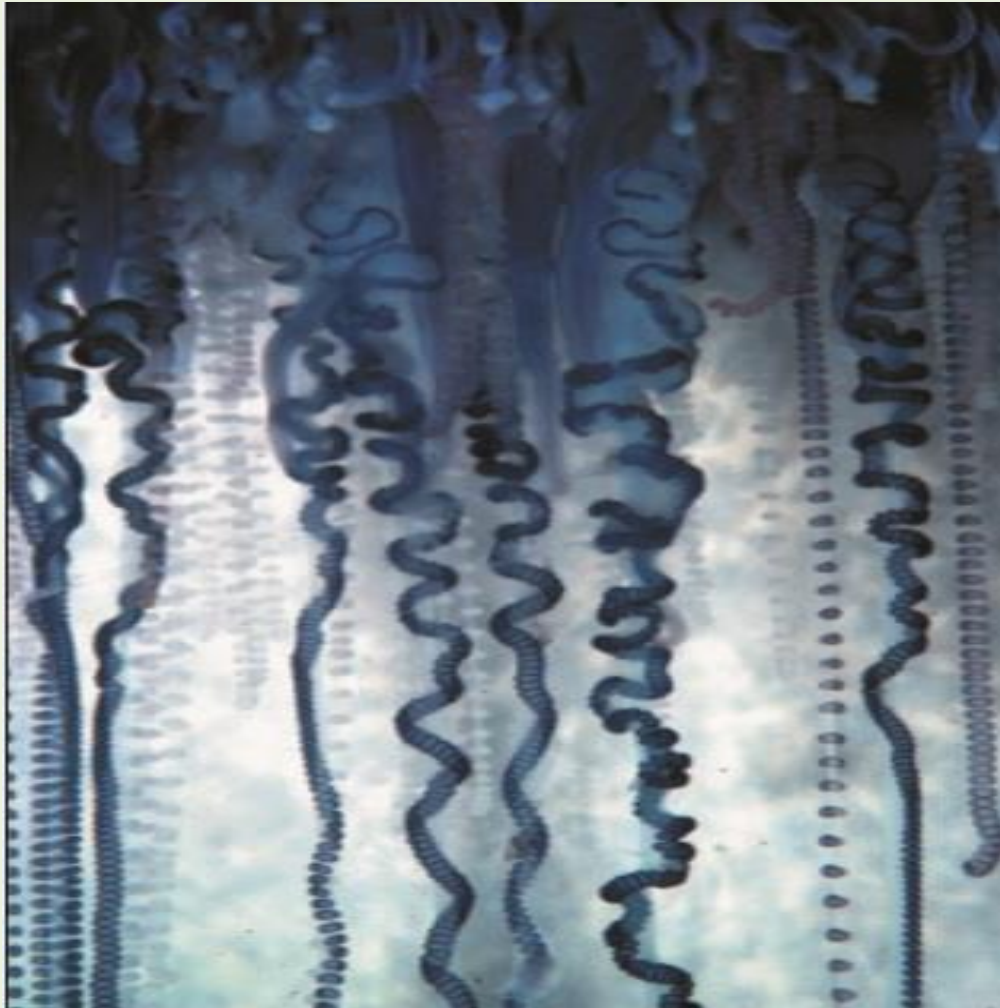


Fig: Portuguese man-of-war



**Fig: *Physalia physalis*, the Portuguese Man-of-War. The tentacles shown here can be up to 9 m long and are laden with nematocysts that are lethal to small vertebrates and dangerous to humans. A bluish float at the surface of the water is about 12 cm long. It is not shown in this photograph. The entire organism is actually a colony of polypoid and medusoid individuals.**

## □ CLASS SCYPHOZOA

- ✓ all marine
- ✓ “true jellyfish” because the dominant stage in their life history is the medusa.
- ✓ scyphozoan medusae lack a velum,
- ✓ the mesoglea contains amoeboid mesenchyme cells,
- ✓ cnidocytes occur in the gastrodermis as well as the epidermis.
- ✓ gametes are gastrodermal in origin.

### For example,

- *Mastigias quinquecirrha*
- *Aurelia*



(a)



(b)

**Fig: Representative Scyphozoans. (a) *Mastigias quinquecirrha*.(b) *Aurelia sp.***