KINGDOM ANIMALIA: NINE MAJOR PHYLA

PART 1

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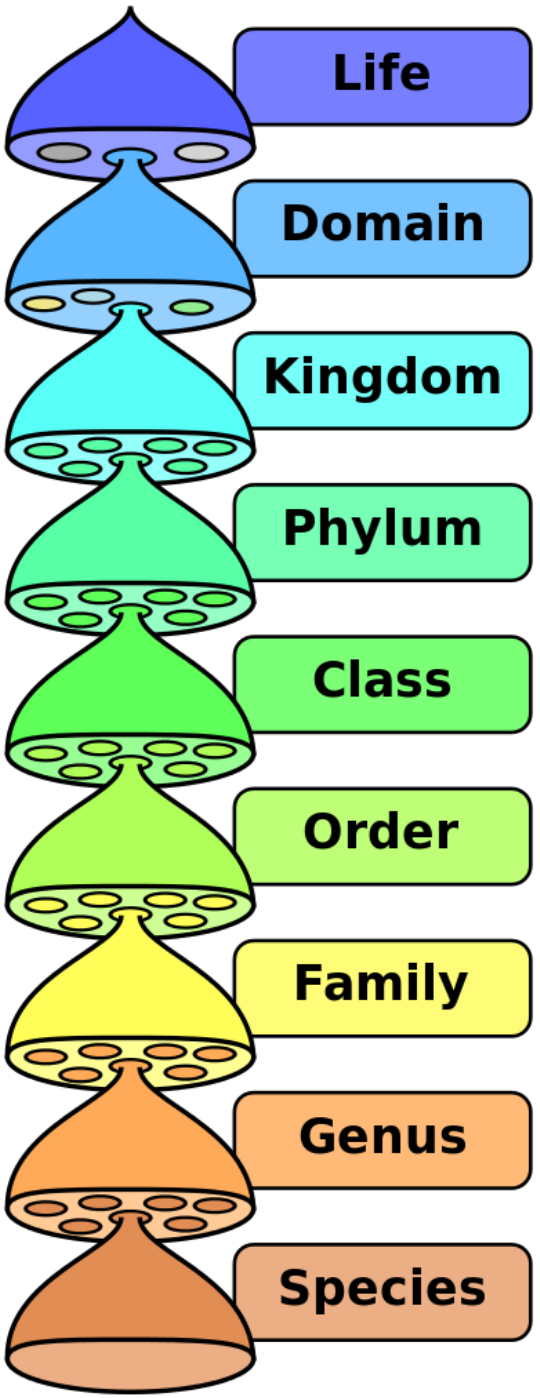
Introduction

A phylum (plural: phyla) is a taxonomic rank below kingdom and above class.



Biologists do not agree on the number of phyla in the kingdom Animalia, but it is usually about 35. Only one phylum contains some species of animals that have backbones. All of the other phyla represent invertebrates - animals without backbones. This lab manual will present the basic characteristics of nine of these major phyla, including chordata and its subphylum vertebrata. Because examples of these organisms are so numerous, this manual will focus on some basic marine organisms in each of the nine phyla. ***Pink Links*** to webpages and videos, as well as activities and basic notes on characteristics, are included to help you understand some of these amazing organisms and their behaviors.

Invertebrate animals often have an immature stage called larva (plural: larvae). The larvae have a completely different body form than the adult stage. Larvae are often very different from adults in how they move and find food. At some point, the larvae must change into the

adult form. This requires changes in its organs, its basic functions, and its overall shape. In the ocean, larvae make up a large part of the plankton. Plankton are limited in their own movement; they drift, moved mostly by the ocean's currents.

In their adult stages, some invertebrates in the ocean move a great deal over long distances. Some move slowly over short distances. Many other marine invertebrates are permanently attached at different levels to rocks or some other part of the bottom of the ocean.

Comparing and Contrasting Kingdoms

Use the chart to compare and contrast the kingdoms of archaebacteria, eubacteria, protists, fungi, plants, and animals. Place an X in each box that represents a characteristic held by the corresponding kingdom.

Kingdom	*Unicellular*	*Multicellular*	*Cells Have Nucleii*	*Cells Have Cell Walls*	*Autotrophs*	*Heterotrophs*
Archaebacteria						
Eubacteria						
Protists						
Fungi						
Plants						
Animals						

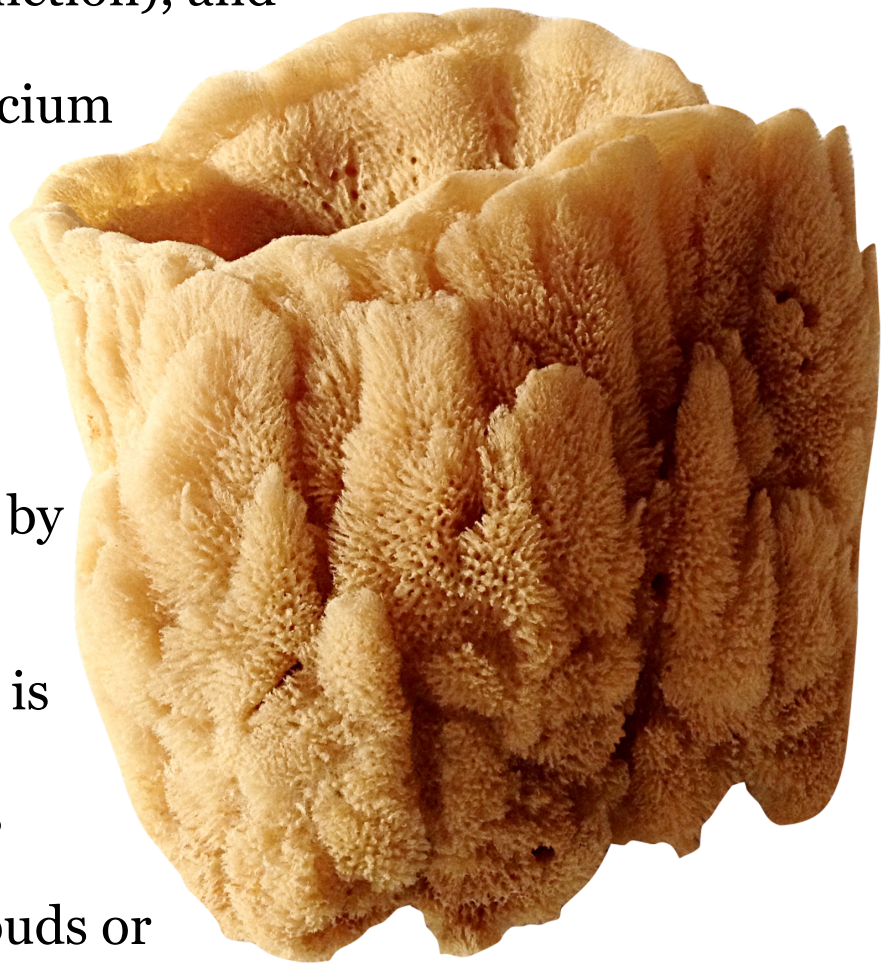
Phylum: Porifera

(poh-rif' er-uh)
(L. *porus*, pore, + *fera*, bearing)

Characteristics

- This phylum includes only sponges.
- They all are eukaryotes.
- They are heterotrophs that digest their food inside their bodies.
- They are multicellular; the body is a collection of several types of cells, each type serving varied functions. Some of the cell types are organized into the beginning stages of tissues (**incipient tissues**).
- Their bodies contain many **pores** - canals and chambers that serve for the passage of water. **Ostia** are for incoming water; the larger **oscula** are for water outlets. The basic unit of the body is shaped like a vase. The overall body shape is like an irregular collection of connected vases.
- Most exhibit **asymmetry**; a few exhibit **radial symmetry**.
- All are **aquatic**; most are **marine** animals.
- The epidermis is made up of **pinacocytes** (thin, flat cells that cover the exterior and some interior surfaces). Most interior surfaces are lined with flagellated collar cells (**choanocytes**) that create water currents and trap food particles. A gelatinous protein matrix called **mesohyl** (**mesoglea**) contains

amebocytes (cells that move around in the mesohyl functioning for digestion, forming reproductive cells, secretion of spicules, and other tasks), **collencytes** that act like muscle tissue (contractile function), and skeletal elements (**spicules**).



- They have a skeleton of **calcareous** (calcium carbonate) or **siliceous** (silica) crystalline spicules, protein **spongin**, or a combination. These are often used to identify different groups of sponges.
- They have no organs or true tissues; digestion takes place inside of cells (intracellular); excretion and respiration by diffusion.
- Their reactions to stimuli are apparently local and independent; a nervous system is probably absent.
- All adults are **sessile** (fixed in one place, immobile) and attached to substratum.
- They carry out asexual reproduction by buds or **gemmules**.
- They carry out sexual reproduction by eggs and sperm; fertilization can happen outside the sponge or within the sponge.
- Free swimming ciliated larvae.

Marine Education Society of Australasia: Porifera (three pages)

http://www.mesa.edu.au/porifera/default.asp

Jonathan Bird's Blue World: Sponges!

https://youtu.be/m8aOoNsDEx8

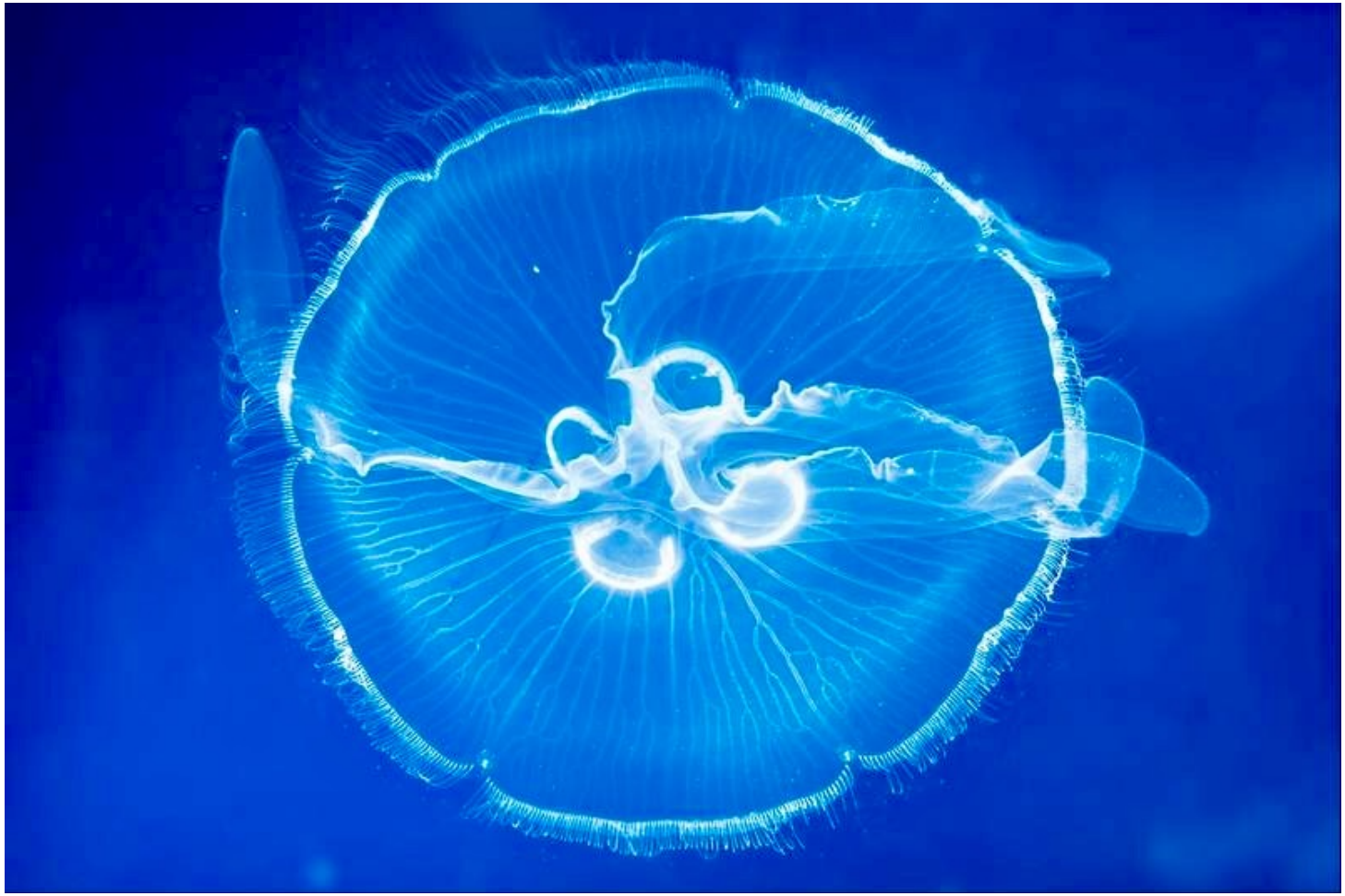
Your personal notes of the information given in the lab manual, on the websites, and the videos must be written on your own paper. The following questions must be answered as part of those notes to help guide your study. These personal notes will be turned in for a short time to be recorded as a grade.

- What are the main physical features of the phylum Porifera?
- Into how many different classes have scientists divided this phylum?
- What kind of cellular organization do these organisms have? Do they have tissues? Organs? Organ systems?
- How do Porifera grow and develop? Do they have different stages of development? If so, describe those stages?
- How do Porifera obtain and use food? Describe the food of these organisms.

- Describe the surroundings or habitat where Porifera live. How do Porifera protect themselves?
- How do Porifera reproduce?
- In what ways are Porifera different from other phyla that we will study?
- What are your most important questions about the animals in this phylum?
- Which concepts relating to this phylum are most striking for you personally?

Phylum: Cnidaria

(nahy-dair' ee-uh) (Gr. *knide*, nettle, + L. *-aria* [pl. suffix] like or connected with)



Characteristics

- Examples of cnidarians are anemones, hydras, jellies, and corals.
- All cnidarians are eukaryotes.
- They are heterotrophs that digest their food inside their bodies.
- They are entirely aquatic; some in fresh water but mostly marine.
- They exhibit **radial symmetry** or **biradial symmetry**. They have no definite head, no right side or left side, just a top and a bottom.
- There are two basic types of individuals: **polyps** that are sessile with tentacles pointing up and **medusae** that move around with tentacles pointing down.

- Some have an **exoskeleton** or **endoskeleton** of **chitinous**, calcareous, or protein components.
- Their bodies have two layers (**diploblastic**), epidermis and **gastrodermis**, with mesoglea sandwiched between. The mesoglea in some types is made up of cells and connective tissue (**ectomesoderm**) making them **triploblastic**, having three cell layers. These layers are true tissues; they are made up of cells with a specific function.
- They have a **gastrovascular cavity** (often branched or divided with **septa**). Tentacles move captured food into the gastrovascular cavity where cnidocytes secrete digestive enzymes. Food particles are utilized by **phagocytosis**. A single opening serves as both the mouth and the anus.
- They have **extensible tentacles** usually encircling the mouth or oral region.
- They have **cnidocytes**, special stinging cells, each containing a **nematocyst** (thread bag) containing a coiled thread-like structure with barbs at the tip. These nematocysts fire into prey usually when they are touched. Many nematocysts produce chemicals that paralyze prey. Nematocysts are abundant on the tentacles, where they may form batteries or rings.
- They have no brain or true nervous system, only a **nerve net**, a network of nerve cells with some sensory organs such as balance organs and light receptors.
- Their muscular system is made up of long fibers and circular fibers in the dermal layers that strain against a **hydrostatic skeleton**. The hydrostatic skeleton is created when the cnidarian traps a volume of water in the gastrovascular cavity by closing its mouth.

- Reproduction is by asexual budding (in polyps) or sexual reproduction by gametes (in all medusae and some polyps). Sexual forms are **monoecious** or **dioecious**. They develop as **planula** larva.
- They have no **excretory** or **respiratory** systems.
- They have no **coelomic cavity** (space between the intestine and the body wall).

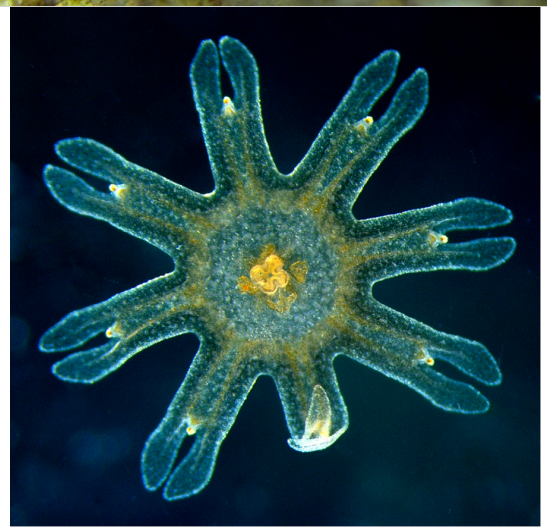
Marine Education Society of Australasia:

Cnidaria (nine pages)

http://www.mesa.edu.au/cnidaria/default.asp

Exotic Jellyfish

https://youtu.be/aJUuotjE3u8



Amazing Jellies: KQED QUEST

https://youtu.be/pimlbTqJLZc

Sea Anemone Dissection

https://youtu.be/uw-5Loq2VRc

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- What are the main physical features of the phylum Cnidaria?
- Into how many different classes have scientists divided this phylum?
- What kind of cellular organization do these organisms have? Do they have tissues? Organs? Organ systems?
- How do cnidarians grow and develop? Do they have different stages of development? If so, describe those stages?
- How do cnidarians obtain and use food? Describe the food of these organisms.
- Describe the surroundings or habitat where cnidarians live. How do cnidarians protect themselves?
- How do cnidarians reproduce?
- In what ways is Cnidaria different from other phyla that we will study?
- What are your most important questions about the animals in this phylum?
- Which concepts relating to this phylum are most striking for you personally?

Comparative Physiology
Symmetry in Marine Organisms
Learning Symmetry

The body plans of organisms found in the ocean demonstrate many different types of symmetry. You will learn about three different types in this activity. Read the sections below. Complete on your own paper the directions and answer the questions in the bulleted sections to finish this activity.

Most animals exhibit some form of body symmetry; sponges are often the exception. Having symmetry means they have a balanced distribution of duplicate body parts or shapes. The kind of body symmetry an animal exhibits is important, since it helps us to understand its lifestyle. We can also use body symmetry and its pattern of development in identifying an animal's relationship to other animals.

In this activity, you will learn about these types of symmetry, so that you can note whether specimens in your future studies are asymmetrical (lack body symmetry) or have one of the major body symmetries, radial or bilateral.

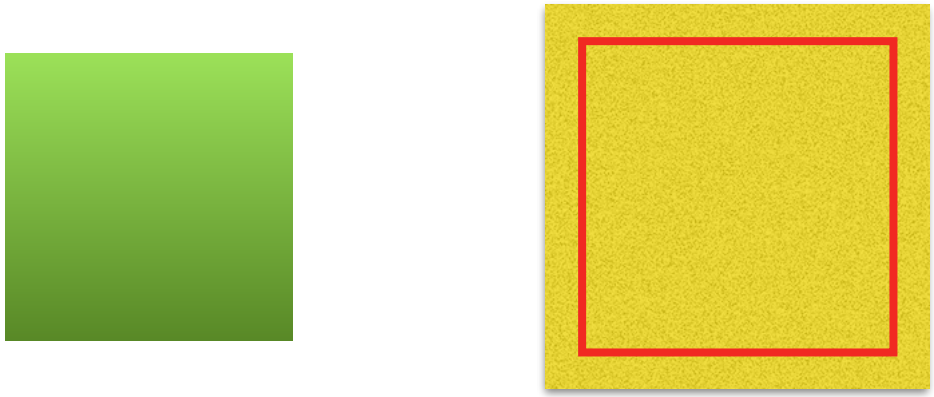
Some animals exhibit a type of symmetry called radial symmetry. These animals have a central point about which they can be rotated without changing their appearance. Thus this radial symmetry is a kind of rotational symmetry. Think of a pizza that has just been taken from the oven. You could rotate this pizza on the counter any distance in either direction and it would look the same. It has a top (dorsum) and a bottom (venter), but you could divide the pizza into two equal halves in any direction as long as you cut it through the center point.

- On your paper, draw a pizza and divide it into eight equal slices. You are welcome to put on as many toppings as you like, but they need to be evenly spaced so that each slice of pizza will appear the same.

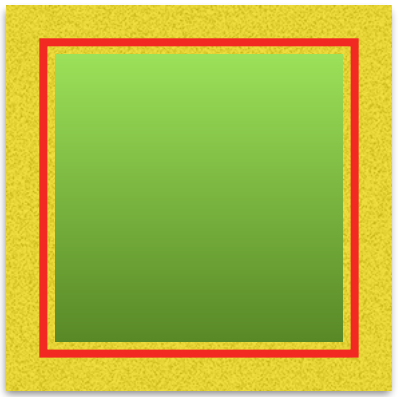
This pizza demonstrates **Radial Symmetry;** body parts are arranged in a repeating pattern around a central axis (like a wagon wheel), or are completely symmetrical about a central axis (like a dinner plate).

Animals belonging to the phylum Cnidaria (hydras, jellyfish, sea anemones, and corals) exhibit a high degree of radial symmetry. Most cnidarians have a sessile life style. That is, they are anchored and cannot exhibit directed movement. Radial symmetry permits these animals to respond to stimuli received on any side with retreat into an exoskeleton they have secreted or the sand in which they are anchored.

- Make a small square piece of paper. Trace around the outer edge (perimeter) on your larger piece of paper.

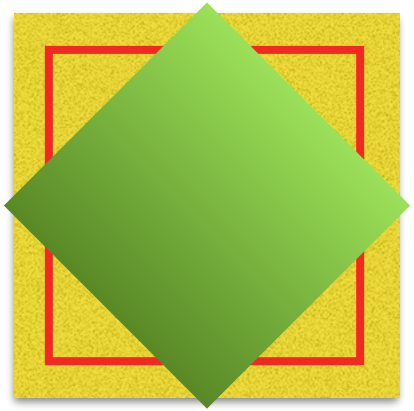


- Keep the object in place so that it is still in the position it was in when you traced the shape.

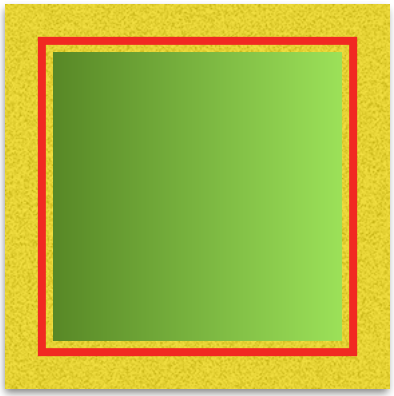


- Make a mark on one edge of the square (the top, for example), so you can keep track of that particular edge.

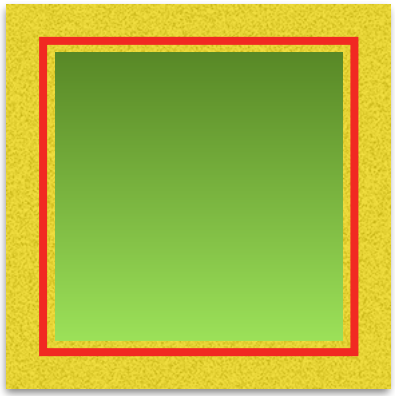
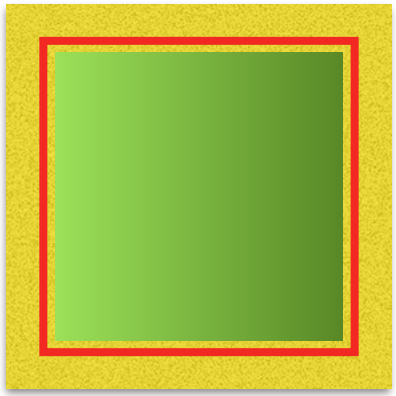
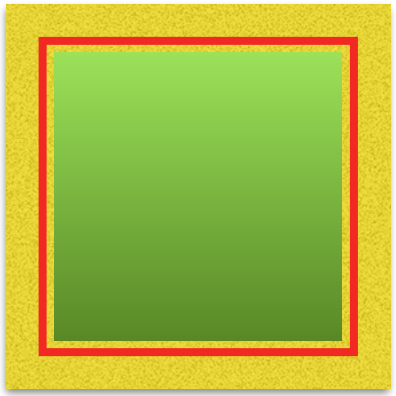
- Place a finger on the shape at its center and hold the shape firmly enough that it remains in place without sliding across the paper, but also so you can rotate it with your other hand.



- Turn the object just until the shape fits into the traced edges again. Do not move or slide the shape, only rotate it while your finger holds it at the center.



- Turn it another time until it fits into traced edges again.

- How many times can you turn the shape so that it fits into traced edges and you make one complete circle?

What you have just demonstrated is the square's rotational symmetry. The shape can be rotated four times and still look exactly the same. It was not moved to a different location, only turned about the center of the shape.

To have rotational symmetry, it is not necessary that any rotation position preserves the object's appearance, as in our pizza example, but if a shape only matches itself once as you go around (i.e. it matches itself after one full rotation) there is really no rotational symmetry present. As defined, symmetry comes from the Greek words "syn," meaning 'together' and "metron," meaning 'measure'. For an object to have rotational symmetry, there must be at least two identical parts that 'come together' at a central point. It is important to note that because cnidarians possess tentacles, they do not have the same degree of rotational

symmetry of the perfectly formed pizza. Many sea anemones and corals have a great degree of rotational symmetry. Echinoderms including sea stars and sea urchins, which we will study in the next section, exhibit a variation of radial symmetry.

- On your paper, draw a five-pointed star and divide it into five equal pieces (there should be one point per piece).

- How many rotational positions preserve the appearance of the star you drew?

The star that you drew demonstrates **Pentamorous Radial Symmetry**. This means that body parts are arranged around the center in five equal parts.

- How many rotational positions preserve the appearance of the sea star?

- How many rotational positions preserve the appearance of the moon jellies?

- How many rotational positions preserve the appearance of the sand dollar skeleton.

Other phyla of animals exhibit another type of symmetry called bilateral symmetry. Bilateral symmetry is sometimes called line symmetry, reflection symmetry, or mirror symmetry. If an object can be folded along one line so that the two sides fold right onto each other without any gaps or overlaps, the object is said to have bilateral symmetry. The prefix bi- means two (for two sides), and the root word lateral refers to having sides. So, an organism exhibiting bilateral symmetry has two sides that match, one fitting exactly onto the other, when folded along a dividing line.

- On your paper, draw a gingerbread person and divide him/her into two equal pieces, vertically down the center of the body (from mouth down to anus). Each half of the gingerbread person should have one eye, one nostril, half of the mouth, one arm, one leg, etc. Remember he/she is just a cookie; do not draw a complete, anatomically correct person.

This gingerbread person demonstrates **Bilateral Symmetry**, which means an organism has two halves that are mirror images.

- Take the sheet of paper with half of a crab drawing and fold it in half so that the blank side of the page is underneath and the crab drawing is facing up where you can see it.

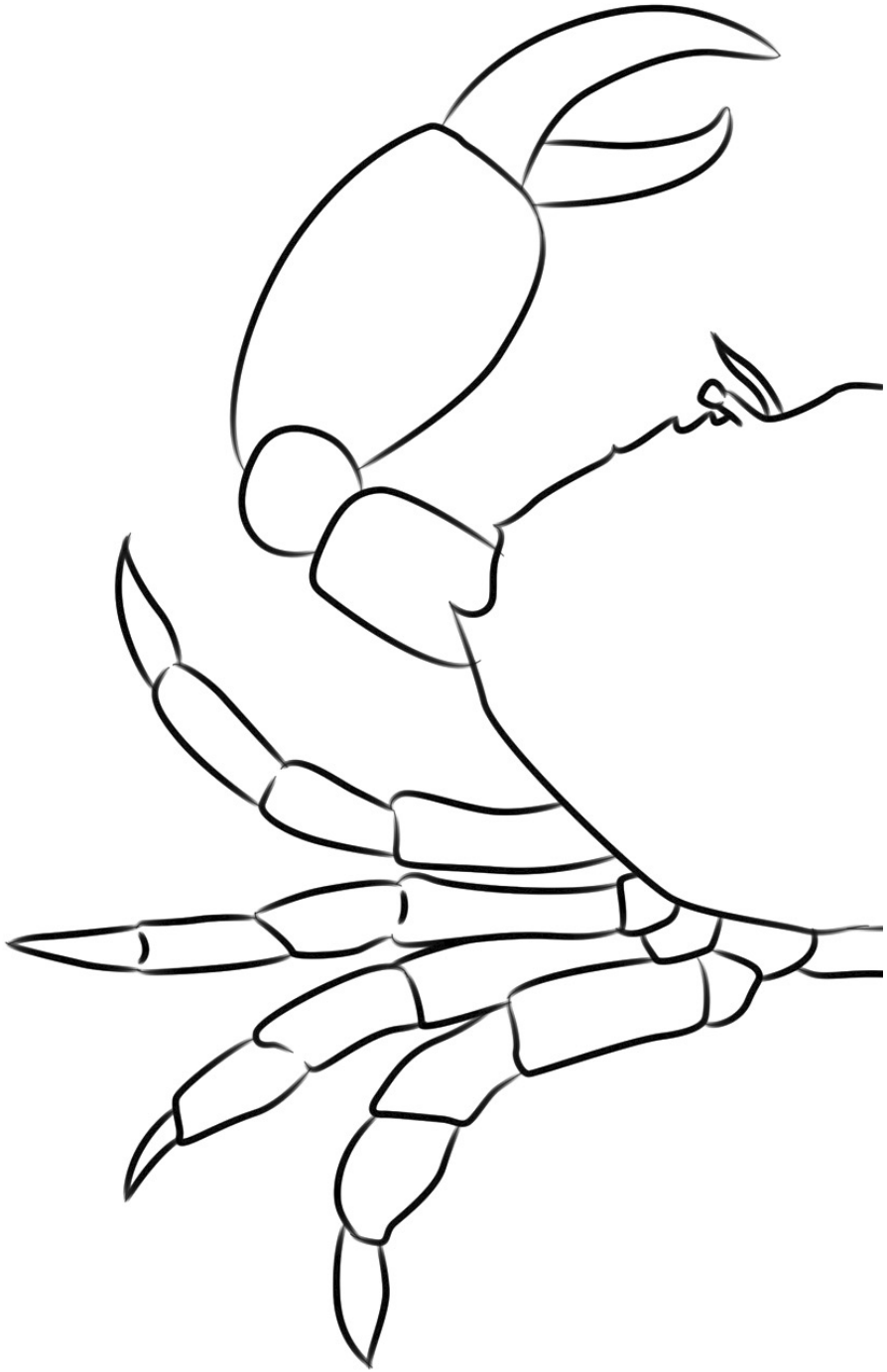
- With the paper folded in half, use scissors to cut out the shape of the crab.

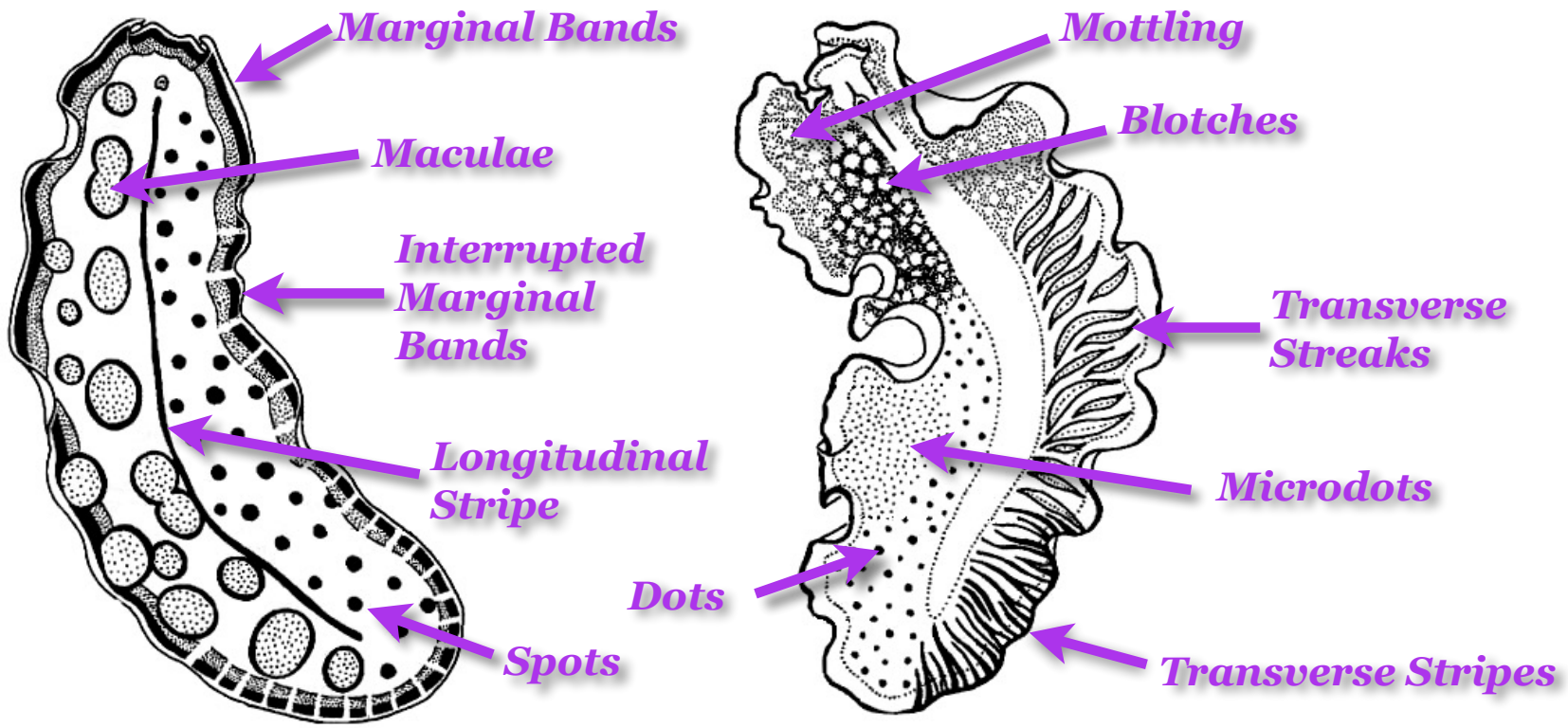
- After you have cut the paper, open the folded paper.

Notice the fold line going through the middle of your crab. The fold line is a line of symmetry. You have just created a shape that has bilateral symmetry, because you have two sides that can be folded one onto the other and they match. This type of symmetry is also called mirror symmetry, because one side is a mirror image of the other. If you were to stand a mirror along your fold line with the mirror facing you, the image of your shape that you see in the mirror will look like the other side of your shape. The two sides are the same but facing different directions. Mirror symmetry is also called reflection symmetry (you see your reflection when you look in a mirror).

Bilateral symmetry in animals is associated with a more active lifestyle, in which individuals need to exhibit directed movement towards and away from various stimuli. For instance, predators need to follow prey, and prey need to move away from predators. Bilateral symmetry is associated with the concentration of nerve cells at the anterior end of the body in the form of a brain. Stimuli received by sensory nerves on the right and left sides of the body are processed in the brain, and messages sent to the appendages through motor neurons. Directed movement is thus achieved.

As we study different animal phyla, you will be able to identify the type of symmetry each exhibits and explain why it is so.





Phylum: Platyhelminthes

(plat' ee-hel-min' theez) (Gr. *platys*, flat, + *helmins*, worm)

Characteristics

- They all are eukaryotes.
- They are heterotrophs that digest their food inside their bodies. They exhibit two lifestyles, **free-living** and **parasitic**.
- Their bodies are made up of three germ layers (**triploblastic**).

- They exhibit **bilateral symmetry** with definite **polarity** of **anterior** and **posterior** ends.
- The body is flattened **dorsoventrally**.
- The **oral** and **genital apertures** (openings) are mostly on **ventral** surface. They have a muscular structure called the **pharynx** that extends out of the mouth to capture prey and pull it inside the body.
- The epidermis may be cellular or **syncytial** (ciliated in some).
- They have a muscular system originating from the mesoderm; the layers have **circular**, **longitudinal**, and **oblique** fibers beneath the epidermis using a hydrostatic skeleton in cavities between tissue layers.
- They have no internal body space other than a digestive tube (**acoelomate**); the spaces between organs are filled with **parenchyma**, a form of connective tissue or **mesenchyme**.
- The digestive system is incomplete (gastrovascular type) or absent in some.
- Their nervous system consists of a pair of anterior **ganglia** with longitudinal nerve cords connected by transverse nerves and located in the mesenchyme in most forms; it is similar to cnidarians in primitive forms.
- They have simple sense organs; some have eyespots.
- The excretory system consists of two lateral canals with branches bearing flame cells (**protonephridia**). Primitive forms lack an excretory system.
- They are lacking respiratory and circulatory systems.
- Most forms are **monoecious**. Their reproductive system is usually complex, with well-developed **gonads**, **ducts**, and **accessory organs**. **Internal fertilization** takes place. They develop directly into free swimming forms

with those having a single **host** in the life cycle. This is usually indirect in internal parasites in which there may be a complicated life cycle often involving several hosts.

- The class Turbellaria are mostly **free living**. The classes Monogenea, Trematoda, and Cestoda are entirely parasitic.

Marine Education Society of Australasia:
Marine Worms - Platyhelminths (Flatworms)
http://www.mesa.edu.au/marine_worms/marine_worms01.asp

Leopard Flatworm
https://youtu.be/zCH37KI_R_E

Marine Flatworm Hunts Down Crab!
https://youtu.be/cOJqbqESoGO

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- Into how many different classes have scientists divided this phylum?
- What kind of cellular organization do these organisms have? Do they have tissues? Organs? Organ systems?
- How do platyhelminths grow and develop? Do they have different stages of development? If so, describe those stages?
- How do platyhelminths obtain and use food? Describe their food.
- Describe the surroundings or habitat where platyhelminths live. How do platyhelminths protect themselves?
- How do platyhelminths reproduce?
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