Simple Squamous
Simple Cuboidal
Simple Columnar
Stratified Columnar
Pseudostratified Columnar
Loose Connective Tissue
Fibrous Connective Tissue
Cartilage

Epiglottis
elastic cartilage
Bone
Adipose
Skeletal Muscle
Smooth Muscle
Cardiac Muscle
Neuron
Sponges

Sponges are sessile animals that are made up of a loose aggregate of cells which means they are different from other animals because they have no true tissues. They have a cellular-level of organization and the individual cells retain a large degree of independence. The word *porifera* means “pore-bearers” because a sponge is basically a sac that is full of holes. Sponges are usually classified by their canal systems (with flagellated cells called choanocytes) and the type of skeletal structures they possess.
Body Types and Skeletal Structures

Sponges have a large central cavity called a spongocoel. This cavity opens to the outside by a large opening called an osculum. Sponges have three body types depending on the location of their choanocytes:

- **Asconoid**: flagellated spongocoels
- **Syconoid**: flagellated canals
- **Leuconoid**: flagellated chambers

The skeletal structures in sponges are called spicules (made of calcium carbonate or silica) and spongin (made up of protein).
## Sponge Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Body Types</th>
<th>Skeletal Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcarea</td>
<td>Asconoid, Syconoid, Leuconoid</td>
<td>Calcareous Spicules</td>
</tr>
<tr>
<td>Hexactinellidae</td>
<td>Syconoid, Leuconoid</td>
<td>Silica Spicules</td>
</tr>
<tr>
<td>Demospongiae</td>
<td>Leuconoid</td>
<td>Silica Spicules and/or Spongin</td>
</tr>
</tbody>
</table>
Calcarea
Hexactinellidae
Demospongiae
Sponge Anatomy

Be able to identify the following structures under the microscope:

- Ostia
- Incurrent Canal
- Prosopyle
- Radial Canal
- Apopyle
- Spongocoel
- Osulum
<table>
<thead>
<tr>
<th>Porifera</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Organization</strong></td>
</tr>
<tr>
<td><strong>Tissue Layers</strong></td>
</tr>
<tr>
<td><strong>Digestive System</strong></td>
</tr>
<tr>
<td><strong>Excretory System</strong></td>
</tr>
<tr>
<td><strong>Circulatory System</strong></td>
</tr>
<tr>
<td><strong>Respiratory System</strong></td>
</tr>
<tr>
<td><strong>Nervous System</strong></td>
</tr>
<tr>
<td><strong>Body Cavity</strong></td>
</tr>
<tr>
<td><strong>Asexual Reproduction</strong></td>
</tr>
<tr>
<td><strong>Sexual Reproduction</strong></td>
</tr>
</tbody>
</table>
Cnidaria are separated from other animals because of their radial symmetry. These animals are said to have a tissue-level of organization. They are said to be diploblastic because they have a true outer epidermis and an inner endodermis separated by mesoglea. The body plan for this group is a sac that surrounds a gastrovascular cavity. These organisms are polymorphic and demonstrate two body types in their life cycles (the polyp and the medusa). These organisms all possess nematocysts (stinging cells) that are used to capture prey and for protection.)
Body Forms

- mesoglea
- endoderm
- gastrovascular cavity
- ectoderm
- mouth
- tentacle
- basal disc
- gastrovascular cavity

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Class: Hydrozoa
Class: Scyphozoa
Class: Anthozoa
<table>
<thead>
<tr>
<th>Level of Organization</th>
<th>Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue Layers</td>
<td>Diploblastic with a mesoglea</td>
</tr>
<tr>
<td>Digestive System</td>
<td>Gastrovascular cavity, extra- and Intracellular</td>
</tr>
<tr>
<td>Excretory System</td>
<td>None</td>
</tr>
<tr>
<td>Circulatory System</td>
<td>None</td>
</tr>
<tr>
<td>Respiratory System</td>
<td>Dermal branchiae</td>
</tr>
<tr>
<td>Nervous System</td>
<td>Nerve Net</td>
</tr>
<tr>
<td>Body Cavity</td>
<td>None</td>
</tr>
<tr>
<td>Asexual Reproduction</td>
<td>Budding</td>
</tr>
<tr>
<td>Sexual Reproduction</td>
<td>Egg and Sperm</td>
</tr>
</tbody>
</table>
Phylum Cnidaria: *Hydra*

You need to be able to identify the following structures: tentacles, mouth, gastrovascular cavity, epidermis, gastrodermis, mesoglea and basal disc.
Phylum Cnidaria: *Hydra* Reproduction

Asexual Reproduction: **Budding**

Sexual Reproduction: **Ovaries and Testes**
Phylum Cnidaria: 
*Obelia*

**Polyp:**
- Feeding polyps
- Tentacle
- Medusa buds
- Reproductive polyp

**Medusa**
part of mature colony

feeding polyp

medusa bud

reproductive polyp

starts new colony by asexual budding

settles

medusa

sperm

egg

zygote

blastula

swimming planula
Phylum: Ctenophora

The word Ctenophora means “comb-bearer”. They contain comb plates with cilia for movement and tentacles that contain colloblasts to capture their prey.
Platyhelminthes are different from other animals because there is no space between the gastrovascular cavity and the muscles so they are said to be acoelomates. They are also the first animals that demonstrate bilateral symmetry, which allows these organisms to develop a head with specialized sense organs. These animals are said to have an organ system level of organization. They are said to be triploblastic because they have a true outer epidermis and an inner endodermis separated by a third layer called the mesodermis. The body plan for this group is a solid mass of tissue that surrounds that surrounds a gastrovascular cavity.
Class: Turbellaria

These flatworms have eyespots called **ocelli** that are used for light detection. They have bumps on the side of their head called **auricles** used as a chemical detectors.
Class: Turbellaria

Know the following structures:

- Pharynx
- Mouth
- Gastrovascular Cavity
- Ocelli
- Auricles
- Intestines
- Anterior
- Posterior
Class: Trematoda

The flukes are flatworms which are parasites that have multiple hosts. Many species spend part of their life cycle in invertebrates and vertebrates such as snails, crabs, fish, birds, etc. They have an outer tegument to protect them from their host.
Class: Trematoda

Know the following structures:

- Oral Sucker
- Ventral Sucker
- Esophagus
- Intestine
- Testes
- Ovaries
- Uterus
- Shell Gland
- Yolk Gland
Chloronchis sp.

The human liver fluke is a parasite that lives in the liver of humans, and is found mainly in the common bile duct and gall bladder, feeding on bile. As an adult, it is a very narrow fluke, 10-25 mm. in length, flattened dorsal-ventrally, with an oral and a ventral sucker. The fluke is tapered at the anterior end and rounded at the posterior end. These animals, which are believed to be the third most prevalent worm parasite in the world currently infecting an estimated 30,000,000 humans. 85% of cases are found in China. The fluke begins in freshwater snails and a larval form burrows out of the snail and into a fish. Humans are infected when eating the fish.
Schistosoma mansoni

Schistosomes are atypical trematodes in that the adult stages have two sexes (dioecious) and are located in blood vessels humans. Schistosomes are long, slim worms with a tegument that bears a large number of small tubercules. The lifecycle of schistosomes includes two hosts: humans where the parasite undergoes sexual reproduction, and a single intermediate snail host where there are a number of asexual reproductive stages. When the larvae recognize human skin, they burrow into the skin heading for the lungs and then migrate to the heart which carries them through the circulatory system.
Class: Cestoidea

These flatworms are endoparasitic parasites called tapeworms. They have specialized body parts: a head called a scolex and body segments called proglottids.
<table>
<thead>
<tr>
<th><strong>Platyhelminthes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Organization</strong></td>
</tr>
<tr>
<td><strong>Tissue Layers</strong></td>
</tr>
<tr>
<td><strong>Digestive System</strong></td>
</tr>
<tr>
<td><strong>Excretory System</strong></td>
</tr>
<tr>
<td><strong>Circulatory System</strong></td>
</tr>
<tr>
<td><strong>Respiratory System</strong></td>
</tr>
<tr>
<td><strong>Nervous System</strong></td>
</tr>
<tr>
<td><strong>Body Cavity</strong></td>
</tr>
<tr>
<td><strong>Asexual Reproduction</strong></td>
</tr>
<tr>
<td><strong>Sexual Reproduction</strong></td>
</tr>
</tbody>
</table>
Class: Turbellaria
Cross Sections

Know where the following cross sections were taken

Anterior:  Pharyngeal  Posterior
Class: Cestoidea

Know the following structures:

- Scolex
- Hooks
- Rostellum
- Suckers
- Proglottids
- Uterus
- Yolk Gland
- Testes
- Ductus deferens
- Genital Pore
- Vagina
The rotifers are animals that exhibit a pseudocoelomate body plan. They are one of the early animals to exhibit an alimentary canal (which has both a mouth and an anus). They exhibit an organ-system level of organization and they are triploblastic. The word rotifer means wheel bearer because they have jaws and a crown of cilia.
Phylum: Nemertea

The ribbon or proboscis worms are animals that are different from other animals because they exhibit an acoelomate body plan but have a fluid sac that some suggest may be an early coelom. They have an alimentary canal, closed circulatory system and the fluid sac mentioned above.
Phylum: Tardigrada

The tardigrades are animals that are commonly called water bears. Tardigrades are classified as extremophiles, organisms that can thrive in extreme conditions. Tardigrades can withstand temperatures from just above absolute zero to well above the boiling point of water, pressures about six times greater than those found in the deepest ocean trenches, and ionizing radiation at doses hundreds of times higher than the lethal dose for a human. They can go without food or water for more than 10 years, drying out to the point where they are 3% or less water, only to rehydrate, forage, and reproduce.
The nematodes are animals that exhibit a pseudocoelomate body plan. They are one of the first animals to have an alimentary canal (which has both a mouth and an anus). They exhibit an organ-system level of organization and they are triploblastic. The muscles of nematodes are all longitudinal so they demonstrate a snake-like movement.
Ascaris lumbricoides

The human intestinal roundworm may actually be found living as a parasite in the intestines of horses, pigs, and humans. Children that play in the dirt often ingest the eggs. The body is long, slender, smooth, unsegmented and pointed at both ends and lives in the host's small intestine. The males of this species are about 6 to 10 inches long and have a curved posterior end that bears bristle-like copulatory spicules near the genital pore. The females are about 12 to 14 inches long are not curved near the genital pore.
Necator americanus

The American hookworm lives in warm climates because the larvae form is found in the soil and can’t survive colder climates. The adult male is 7-9 mm long and the female adult is 9 – 11 mm long. The adult is found in the small intestines of the host. The eggs are passed in the feces and the juveniles live in the soil until they can burrow into the skin of the host and work their way back into the intestines via the lungs. Heavy infestations can cause anemia or death. Males have conspicuous copulatory bursa supported by fleshy rays.
Trichinella spiralis

The pork roundworm is a parasite that infects pigs, rats, humans, and other mammals that are carnivorous. It causes the lethal disease trichinosis. Adult worms penetrate the small intestine where the adult female produces living young. The juveniles burrow into the circulatory system and are carried throughout the body and eventually burrow their way into skeletal muscle and form a cyst. The organism enters the host when a host ingests raw or undercooked meat.
Enterobius vermicularis

The pinworm is a common intestinal parasite that infects children of all nations and social classes. The female worm migrates to the anal region and night and deposits her eggs. This causes an irritation around the anus causing it to itch. Scratching the area, may transfer the eggs to the hands which can than be swallowed and a person than is reinfected. Be able to recognize this species (It has a clear tail with the anus at the end of the worm).
Macracanthorhynchus hirudinaceus

This species is known as a spiny-headed worm and is often placed in the phylum Acanthocephala. It is an endoparasite entering the small intestines by a spiny proboscis. It is usually found in pigs but can sometimes be found in humans. The larvae of this species is found in beetle larvae (gubs) and can be taken into the body by eating the grubs. Be able to recognize this species.
The vinegar eel is a tiny, free-living nematode sometime found in vinegar. The was more common in the past, before commercial vinegar was pasteurized and had preservatives added to prevent their growth. The worms are most abundant in the bottom sediments of unpasteurized vinegar and other fermented fruit juices. Vinegar eels thrive in such acid conditions, and feed on the yeast and bacteria growing in the sediment.
Wuchereria bancrofti

This worm is a human parasitic roundworm. It infects the lymphatic system to cause lymphatic filariasis. These filarial worms are spread by a mosquito vector and affects over 120 million people, primarily in Central Africa and the Nile delta, South and Central America, and the tropical regions of Asia including southern China and the Pacific. If the infection is left untreated, it can develop into a chronic disease called elephantiasis.
This worm is also called the **guinea worm**. A person becomes infected *when he drinks water that contains water fleas infected with guinea worm larvae*. Initially there are no symptoms. About one year later, the person develop a painful burning feeling as the **female worm forms a blister in the skin, usually on the lower limb**. The worm then comes out of the skin over a few weeks. During this time it may be difficult to walk or work. **Humans** are the only known animal that guinea worms infect.
Class: Nematoda

Know the following structures:

- Cuticle
- Epidermis
- Pseudocoel
- Longitudinal Muscles
- Dorsal Nerve Cord
- Ventral Nerve Cord
- Intestines
## Nematoda

<table>
<thead>
<tr>
<th>Level of Organization</th>
<th>Organ-system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue Layers</td>
<td>Triploblastic</td>
</tr>
<tr>
<td>Digestive System</td>
<td>Alimentary Canal</td>
</tr>
<tr>
<td>Excretory System</td>
<td>Protonephridia or absent</td>
</tr>
<tr>
<td>Circulatory System</td>
<td>None</td>
</tr>
<tr>
<td>Respiratory System</td>
<td>None, body surface</td>
</tr>
<tr>
<td>Nervous System</td>
<td>Pair of cerebral ganglia with long nerve cords</td>
</tr>
<tr>
<td>Body Cavity</td>
<td>False (not completely lined with mesoderm)</td>
</tr>
<tr>
<td>Asexual Reproduction</td>
<td>None</td>
</tr>
<tr>
<td>Sexual Reproduction</td>
<td>Complicated life cycles</td>
</tr>
</tbody>
</table>
A lophophore is a horse-shoe shaped structure covered with ciliated tentacles. The three phyla usually included in this group are: the ectoprocts, phoronids, and the brachiopods. These phyla also exhibit a U-shaped alimentary canal and they lack a distinct head which are adaptations to a sessile existence. These animals have a true coelom completely lined by mesoderm.
The word ectoproct means outside anus. They are often called bryozoans because they resemble mosses and are therefore called moss animals. They are normally found in the sea in colonies encased in a hard exoskeleton associated with coral reefs but are also found in lakes and rivers.
Brachiopods or lamp shells are different than clams because although similar in appearance to the bivalves, their valves (shells) are dorsal and ventral rather than lateral. They are found only in the marine environment usually attached to the sea floor.
Phylum: Phoronids

Phoronids are tube dwelling marine worms. There is no example in lab.
Mollusca differ from other animals because they are **coelomates that are soft bodied and unsegmented.** This phylum is the second largest and probably one of the most familiar invertebrate groups. They have an **organ system level of organization** and are **triploblastic.** Mollusks are soft-bodied animals but many are protected by a hard, **calcium carbonate shell.** Despite their apparent differences, all mollusks have a similar body plan, which consists of a muscular foot for movement, a visceral mass containing the internal organs, and a mantle that may secrete a shell. Most mollusks also contain a rasping organ called a **radula (except bivalves).**
Monoplacophorans are single-shelled animals that their body (unlike other molluscs) are segmented. They are found in deep marine environments.
Class: Polyplacophora

Chitons are marine species with a shell with eight overlapping plates. The foot is used for locomotion. They have a reduced head that contains a radula.
Gastropods are found in marine, freshwater and terrestrial habitats. They are asymmetrical due to torsion. The shell is coiled (reduced or absent in some) and the foot is used for locomotion.
The tooth or tusk shells are *benthic* (deep) species. They are filter feeders that use their *foot* to burrow into the sand. The *radula* is used to move food into the *gizzard*.
Bivalves are marine and freshwater organisms. They have a flattened shell with two valves. They have a reduced head. They are filter feeders (with siphons) and they do not have a radula like other mollusks.

Class: Bivalvia (Pelecypoda)
Cephalopods are all marine species that have a head surrounded by tentacles. The shell is external, internal or absent. They have a mouth with a radula. Their locomotion is by a siphon (made from the mantle).
<table>
<thead>
<tr>
<th><strong>Mollusca</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Organization</strong></td>
<td>Organ-system</td>
</tr>
<tr>
<td><strong>Tissue Layers</strong></td>
<td>Triploblastic</td>
</tr>
<tr>
<td><strong>Digestive System</strong></td>
<td>Alimentary Canal</td>
</tr>
<tr>
<td><strong>Excretory System</strong></td>
<td>Metanephridia</td>
</tr>
<tr>
<td><strong>Circulatory System</strong></td>
<td>Open system with heart</td>
</tr>
<tr>
<td><strong>Respiratory System</strong></td>
<td>Gills, lungs or body</td>
</tr>
<tr>
<td><strong>Nervous System</strong></td>
<td>Pair of cerebral ganglia with nerve cords</td>
</tr>
<tr>
<td><strong>Body Cavity</strong></td>
<td>True</td>
</tr>
<tr>
<td><strong>Asexual Reproduction</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Sexual Reproduction</strong></td>
<td>Most are dioecious</td>
</tr>
</tbody>
</table>
Annelids are eucoelomates that have a true coelom lined with mesoderm and they are soft bodied and segmented which makes them different from other animals. They have an organ system level of organization and are triploblastic. They are worms whose bodies are divided into segments with bristles called setae and false feet called parapodia. Body segmentation is this phylum’s greatest advancement and leads to more highly specialized segmentation in animals like the arthropods. Annelids remove waste by a structure found in each segment called a metanephridia. Annelids have a worldwide distribution and occur in marine and fresh water along with terrestrial soils.
Oligochaeta have only a few setae. They have a reduced head and no parapodia.
Polychaeta have a well developed head. They have parapodia with setae that used for locomotion and gas exchange. They are tube-dwelling and free-living.
Be able to recognize the following structures:

- Parapodia
- Mouth
- Prostomium
- Setae
- Tentacles
- Palps

Class: Polychaeta
Leeches usually have a body that is flattened. They have reduced segments and a reduced coelom. Setae are absent and they have suckers at both ends. They are parasites, predators, and scavengers.
<table>
<thead>
<tr>
<th><strong>Level of Organization</strong></th>
<th>Organ-system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tissue Layers</strong></td>
<td>Triploblastic</td>
</tr>
<tr>
<td><strong>Digestive System</strong></td>
<td>Alimentary Canal</td>
</tr>
<tr>
<td><strong>Excretory System</strong></td>
<td>Metanephridia</td>
</tr>
<tr>
<td><strong>Circulatory System</strong></td>
<td>Closed system</td>
</tr>
<tr>
<td><strong>Respiratory System</strong></td>
<td>Skin, Gills, or parapodia</td>
</tr>
<tr>
<td><strong>Nervous System</strong></td>
<td>Pair of cerebral ganglia with double ventral nerve cords</td>
</tr>
<tr>
<td><strong>Body Cavity</strong></td>
<td>True</td>
</tr>
<tr>
<td><strong>Asexual Reproduction</strong></td>
<td>Budding in some</td>
</tr>
<tr>
<td><strong>Sexual Reproduction</strong></td>
<td>Monecious or dioecious</td>
</tr>
</tbody>
</table>
Phylum: Onychophora

This animal has raised questions in taxonomy in the past. Often called the walking worm, these animals were once thought to be a link between annelids and arthropods. The reason they were considered a link between the two phyla is they are segmented like annelids but they have appendages like arthropods. Unlike arthropods, the appendages are unjointed. This animal in probably most closely related to the arthropods.