Parasitic Helminths

Objectives

After completing this exercise, you should be able to:

1. Differentiate nematode, cestode, and trematode.
2. Explain how helminth infections are diagnosed.

Background

Helminths are multicellular eukaryotic animals that generally possess digestive, circulatory, nervous, excretory, and reproductive systems. Some are free-living in soil and water. Helminths are studied in microbiology because they cause infectious diseases and most are diagnosed by microscopic examination of eggs or larvae. Eggs may have striations (lines), a spine, or an operculum (hatch by which the larva leaves).

Helminths infect more than one-third of the world population. Helminth infections differ from bacterial or protozoan infections because the worms do not usually increase in number in the host. Symptoms are usually due to mechanical damage, eating host tissues, or completing for vitamins. In this exercise, we will examine prepared slides of parasitic helminthes.

Life cycle

Parasitic helminths are highly modified compared to free-living helminths. They often lack sense organs such as eyes, and may even lack a digestive system. Their reproductive system, however, is often complex, which ensures infection of new hosts. Some flukes can produce 25,000 eggs per day.

Adult helminths may be **dioecious;** male reproductive organs are in one individual, and female reproductive organs are in another. In those species, reproduction occurs only when two adults of the opposite sex are in the same host. Adult helminths may also be **monoecious,** or **hermaphroditic**—one animal has both male and female reproductive organs. Two hermaphrodites may copulate and simultaneously fertilize each other.

Intermediate host Some parasites have a different host for each larval stage, these are called intermediate hosts. Humans can serve as the intermediate host for the dog tapeworm. The larva encysts as an hydatid cyst in a variety of tissues including the lungs or liver.

Definitive host The adult (reproductively mature) stage of a parasite lives in a definitive host. Humans can serve as the definitive host for beef, pork, and fish tapeworms.

Eggs infective The eggs of some parasitic roundworms are infective for humans. Adult pinworms are found in the large intestine. From there, the female pinworm migrates to the anus to deposit her eggs on the perianal skin. The eggs can be ingested by the host or by another person exposed through contaminated clothing or bedding.

Larvae infective Some parasites are infective for mammals in the larval stage. Larva of filarial worms such as *Wucheria* that infect humans and dog heartworm are transmitted to their mammalian host by mosquitoes. They mature into adults in the mammal.

Flatworms

Platyhelminthes, or flatworms**,** are flattened from the dorsal to ventral surfaces. The classes of this phylum include trematodes and cestodes. Trematodes, or **flukes,** often have flat, leaf-shaped bodies with ventral and oral suckers (*Microbiology* Figure 12.25a). The suckers hold the animal in place. Flukes obtain food by absorbing it through their outer covering, called the **cuticle.** Flukes are given common names according to the tissue of the definitive host in which the adults live (for example, lung fluke, liver fluke, blood fluke).

Cestodes, or **tapeworms,** are intestinal parasites. Their structure is shown in *Microbiology* Figure 12.27. The head, or **scolex** (plural: *scoleces*), has suckers for attaching to the intestinal mucosa of the definitive host; some species also have small hooks for attachment. Tapeworms do not ingest the tissues of their hosts; in fact, they completely lack a digestive system. To obtain nutrients from the small intestine, they absorb food through their cuticle. The body consists of segments called **proglottids.** Proglottids are continually produced by the neck region of the

scolex, as long as the scolex is attached and alive. Each mature proglottid contains both male and female reproductive organs. Each proglottid matures as it is pushed away from the neck by new proglottids. Each proglottid contains both male and female reproductive systems and eggs are fertilized as the proglottid reaches the middle of the worm. The proglottids farthest away from the scolex are basically bags of fertilized eggs that will be shed in feces.

Roundworms

Nematodes, or roundworms, are cylindrical and tapered at each end. Roundworms have a *complete* digestive system, consisting of a mouth, an intestine, and an anus (*Microbiology* Figure 12.29). Most species are dioecious. The reproductive system consists of long tubules that serve as ovaries or testes. In females, the reproductive tubule (ovary) is usually double. Males are smaller than females and have one or two hardened **spicules** on their posterior ends that guide sperm to the female's genital pore. Species identification is often based on spicule structure.

Materials

Prepared slides

Enterobius vermicularis (pinworm)
Wucheria bancrofti (filarial worm)
Trichinella spiralis cyst
Taenia sp. (tapeworm)
Echinococcus (hydatid cyst)
Clonorchis sinensis (liver fluke)
Fecal smears of eggs

Techniques Required

Compound light microscope, Exercise 1
Dissecting microscope, Appendix E

Procedure

1. Using a compound light microscope, examine the male and female pinworms. Sketch the parts of the worms that show anatomic differences. Using a dissecting microscope, measure the length of the male and female pinworms.
2. Observe the blood smear containing *Wucheria*. Estimate the length and width of the worm by comparing it to blood cells. (White blood cells =15 µm Red blood cells =7 µm.) Note that these filarial worm larvae are filled with a column of nuclei. Do the nuclei extend all the way to the tail?
3. Examine and sketch a *Trichinella* cyst with a compound light microscope. Using a dissecting microscope, measure the size of *Trichinella* cysts. In what tissue are the nematodes encysted?
4. Using a dissecting microscope, examine the tapeworm slide. Measure the length and width of immature and mature proglottids.
   a. Examine the neck region. Measure the width of a proglottid. Count the number of proglottids that fit into one millimeter. Estimate the length of one proglottid $(= \frac{\text{Number of proglottids}}{1 \text{ mm}})$.
   b. Using a compound light microscope, examine and sketch an hydatid cyst, What structures are visible in the cyst?
5. Examine the liver fluke. Measure the length of the ovaries and the total body.
6. Examine the fecal smears containing worm eggs. Sketch one egg of each species observed. Be aware that the slides may have debris so you will need to search for the regularly-shaped eggs.

Laboratory Report

Parasitic Helminths

Name _____

Date _____

Purpose _____

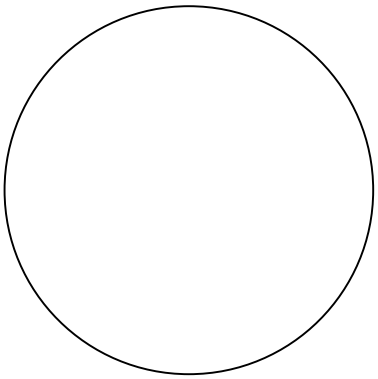
_____

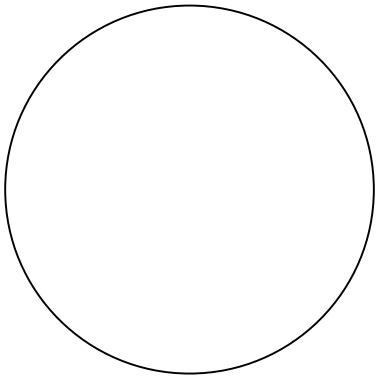
_____

Results

Roundworms

Pinworm. Sketch to show differences between the sexes.





Length:

Female_____ mm

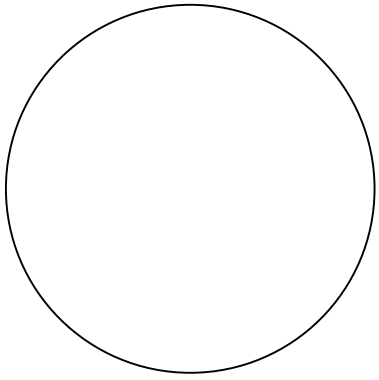
Male _____mm

Wucheria

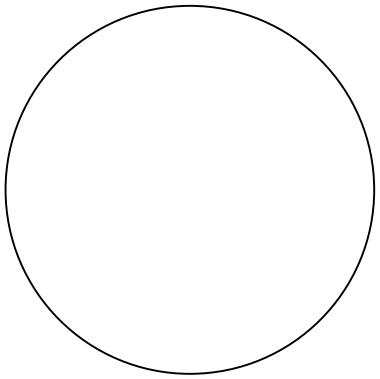
Length_____ µm

Width _____µm

Sketch, label the nuclei.



Trichinella cyst



_____ mm

Tissue: _____

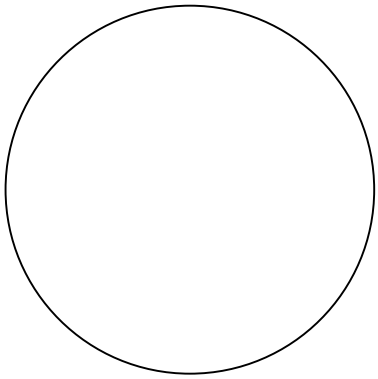
Flatworms

Tapeworm

Mature proglottid	Immature proglottid	Neck proglottids/mm:
Width: _____	Width: _____	Width: _____
Length: _____	Length: _____	Length: _____

Hydatid cyst

Sketch and label the visible structures.

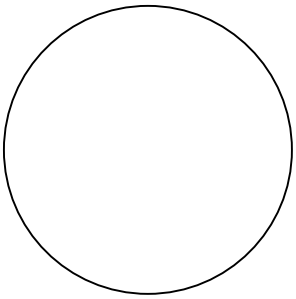


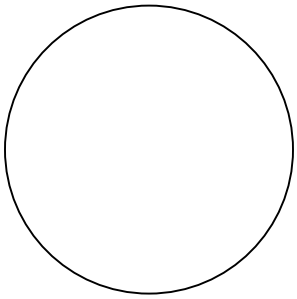
_____ ×

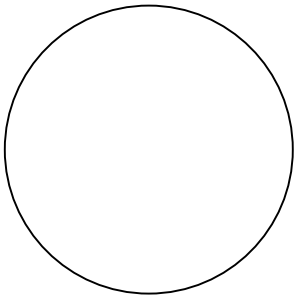
Fluke

Body length_____ mm Ovary length _____mm

Eggs







Species _____ _____ _____

_____ × _____ × _____×

Conclusions

1. Are pinworms visible without a microscope? _____

2. How many times longer is a mature proglottid than the neck-region proglottid? _____

   What occupies most of the space in the mature proglottid?_____

3. What percentage of a fluke's body occupied by reproductive structures?_____

4. Which of the eggs has an operculum (escape hatch for the larva)? _____

5. Which has a rough surface? _____

6. Which egg is flattened on one side?_____

Questions

1. Approximately 10% of the body of a free-living flatworm is occupied by reproductive tissue. Why is the value you obtained for the fluke so much different? _____
   _____

   _____

   _____

2. The nematode, *Wucheria*, lives in lymph capillaries in the human body. The adult worm can be a few millimeters long. How does it fit through capillaries?_____
   _____

   _____

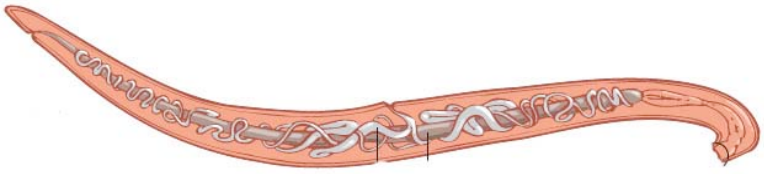
3. Are humans the intermediate or definitive host for *Trichinella*? _____

   How can you tell?_____

   _____

4. To what phylum and class does this animal belong? _____
   List two characteristics that put it in this phylum. Name the body parts. What is the name of the encysted larva of this animal? _____

5. To what phylum and class does this animal belong? _____
List two characteristics that put it in this phylum. Identify the intestine, ovary, and genital pore. What is the name of the encysted larva of this animal? _____



Critical Thinking

1. A woman found a worm in her laundry basket. The worm measured approximately 6 centimeters in length (figure a). Eggs were removed from the worm and examined at 400× magnification (figure b). What is your diagnosis? Based on what criteria?

a.

b.

2. A 25-year-old previously healthy woman had a physical examination, including a chest x-ray, as one of her pre-employment requirements. The x-ray showed a cyst-like lesion in her left lung. The cyst measured 3-4 cm in diameter (see the figure). What is your diagnosis? Based on what criteria?