

INTRODUCTION

A representative species from each of the major groups of parasitic helminths is illustrated in a series of demonstrations. In addition, a number of specimens of other important parasite helminths are also displayed on the centre bench. A short video detailing the life cycle, pathology and basic immunology of schistosomes will be shown.

TO ALLOW SCARCE MATERIAL TO BE SHOWN EFFECTIVELY, IN THIS PRACTICAL YOU WILL HAVE TO MOVE AROUND THE CLASSROOM FROM ONE DEMONSTRATION TO THE NEXT. THREE COMPLETE SETS OF MATERIAL SHOWING REPRESENTATIVE HELMINTHS ARE LAID OUT IN CIRCUITS & ADDITIONAL EXAMPLES ARE ON THE CENTRE BENCH. MAPS OF THE LAYOUT ARE DISPLAYED ON CLASSROOM WALLS. FOLLOW SAFETY INSTRUCTIONS.

AIMS

You should note: -

- i) The complex lifecycles of these parasitic helminths, which often have one or more intermediate hosts, (see **Figures 1 - 3**). (*Concentrate on the lifecycles of the three representative species*).
- ii) Points in common within different groups of helminths (which features are shared within, for example, the trematodes as a whole group). *Compare the representative specimens (see below) with other parasites from the same group as provided in this practical.*
- iii) After taking account of common features, the diversity possible within these groups is illustrated.
- iv) The importance of helminths in terms of human & veterinary infections worldwide.

HELMINTHS

Although frequently grouped together under the general name of helminths, parasitic helminths comprise a number of distinct groups. The most important in terms of human and veterinary disease belong to three major groups, within two distinct **Phyla**;

i) The **Phylum Platyhelminthes** (Flatworms) - A large group, the most important parasitic members being **Trematodes** (also called Digeneans or Flukes) and **Cestodes** (or Tapeworms)

ii) The Phylum **Nematoda** (Roundworms)

The morphology and biology of representative species of **Trematodes**, **Cestodes** and **Nematodes**, are illustrated in this practical. These groups are different but, as metazoan "macroparasites", they share many characteristics with regard to the epidemiology, pathology and immunology associated with infection. The representative parasitic helminths illustrated in this practical are:

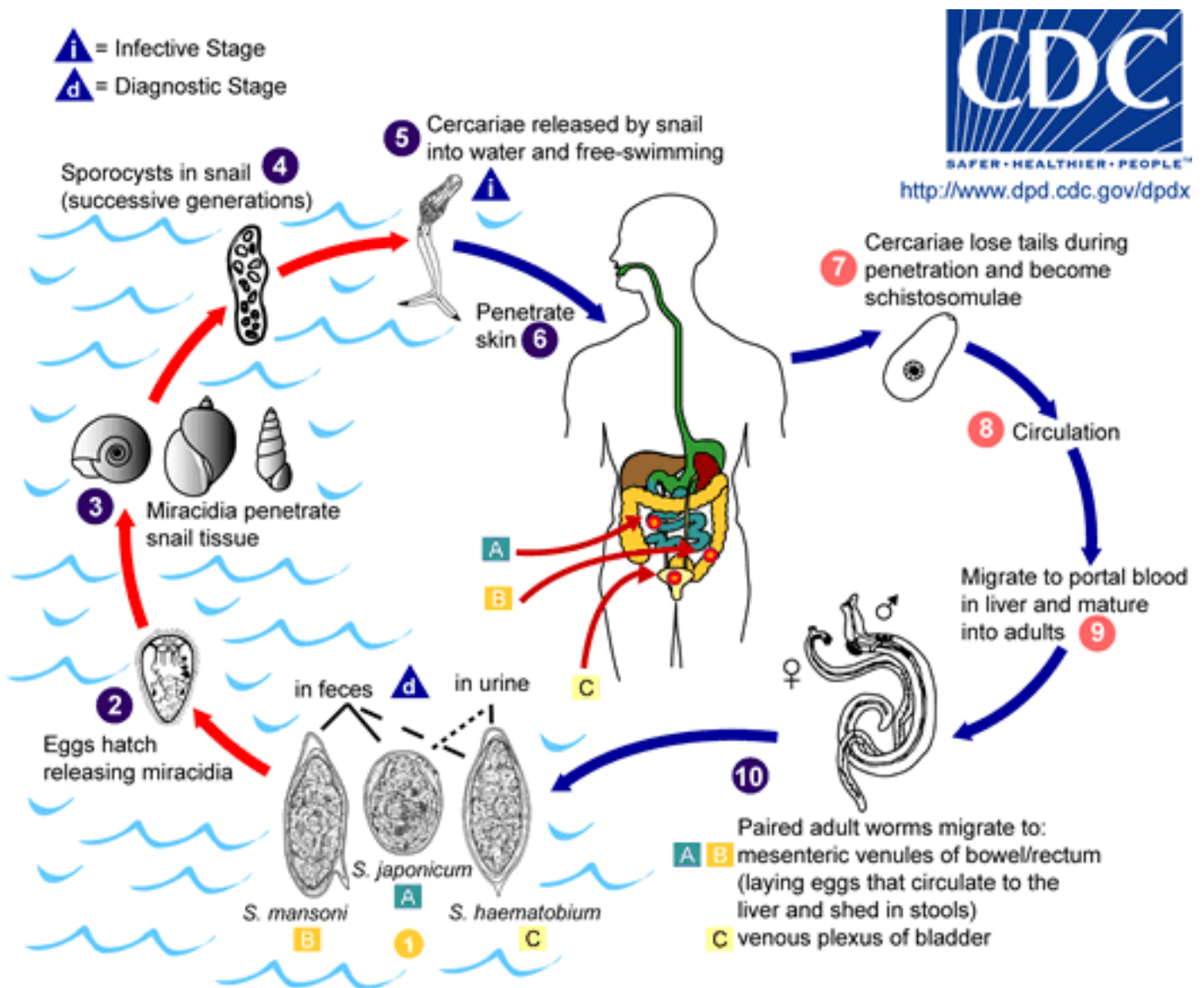
<u>Group</u>	<u>Species</u>	<u>Additional Information</u>
Trematoda	<i>Schistosoma mansoni</i>	a human blood fluke (Figure 1)
Cestoda	<i>Hymenolepis diminuta</i>	a tapeworm normally infecting the rat, but which can occasionally infect man (Figure 2)
Nematoda	<i>Nippostrongylus brasiliensis</i>	an intestinal nematode of the rat, with a very similar lifestyle and morphology to the human hookworms <i>Necator americanus</i> and <i>Ancylostoma duodenale</i> (Figure 3)

In addition to these, other examples from each of the major helminth groups will also be shown, primarily from species infecting man.

Schistosoma mansoni

This trematode has two hosts; man, the definitive host and a snail intermediate host. The schistosomes are unusual among the trematodes in that the sexes are separate. *S. mansoni*, (together with the related species *S. haematobium* & *S. japonicum*), is the causative agent of human schistosomiasis, (or Bilharzia), and is probably the most important helminth infection in terms of human morbidity.

Figure 1 Lifecycle of *Schistosoma* spp.



THE DIGENEANS (FLUKES)

Demonstration 1. Adult *S.mansoni* worms (fixed). The darker female normally lies in a central groove (gynaecophoric canal) of the larger male worms. Oral and ventral suckers, characteristic of trematodes are identifiable.

Demonstration 2. Microscope slide. TS section of *S. mansoni* worms *in situ* lying in mesenteric blood vessel. Note the female worms lying within the gynaecophoric canal of the male worm. Identify the intestines, and if present, the vitelline glands and ovaries in the female, and the testes in the male.

15.1 (68.1079) Microscope slide. TS section of liver showing the granuloma reaction around eggs. Initially examine under low power (x10) to identify areas of normal liver parenchyma and the areas of granulomatous inflammation. Then increase the magnification to x40 to examine the parasite eggs and cellular composition of these granulomas.

Catalogue Number	Small Image	Image Map	Large Image
A_AI_PS_LV_08.jpg	S. mansoni		S. mansoni
A_AI_PS_LV_10.jpg	S. mansoni		S. mansoni
A_AI_PS_LV_09.jpg	S. mansoni		S. mansoni

15.2 (98.119) Microscope slide. Staining of collagen (**blue**) in liver granuloma, illustrating fibrotic reaction in the liver, a major aspect of the morbidity associated with this disease.

Demonstration 3. Microscope slide of *S.mansoni* eggs, note the characteristic lateral spine

Demonstration 4. Microscope slide of *S.mansoni* miracidia, These free-swimming larvae hatch from the egg when the eggs come into contact with water. They seek out and infect the secondary snail host.

Demonstration 5 Cercariae, the infective stage for man with the schistosomes. A suspension of killed and fixed larvae are provided. Resuspend the parasites by gently shaking the vial. Place one drop on a microscope slide, gently apply cover slip and examine under x10 and x40 objectives.

Live (and therefore **highly infective**) cercariae will also be demonstrated throughout this practical on the video monitor, under the strict supervision of one of the class demonstrators.

**DO NOT ATTEMPT TO TOUCH THESE
LIVE CECARIAE!!!**

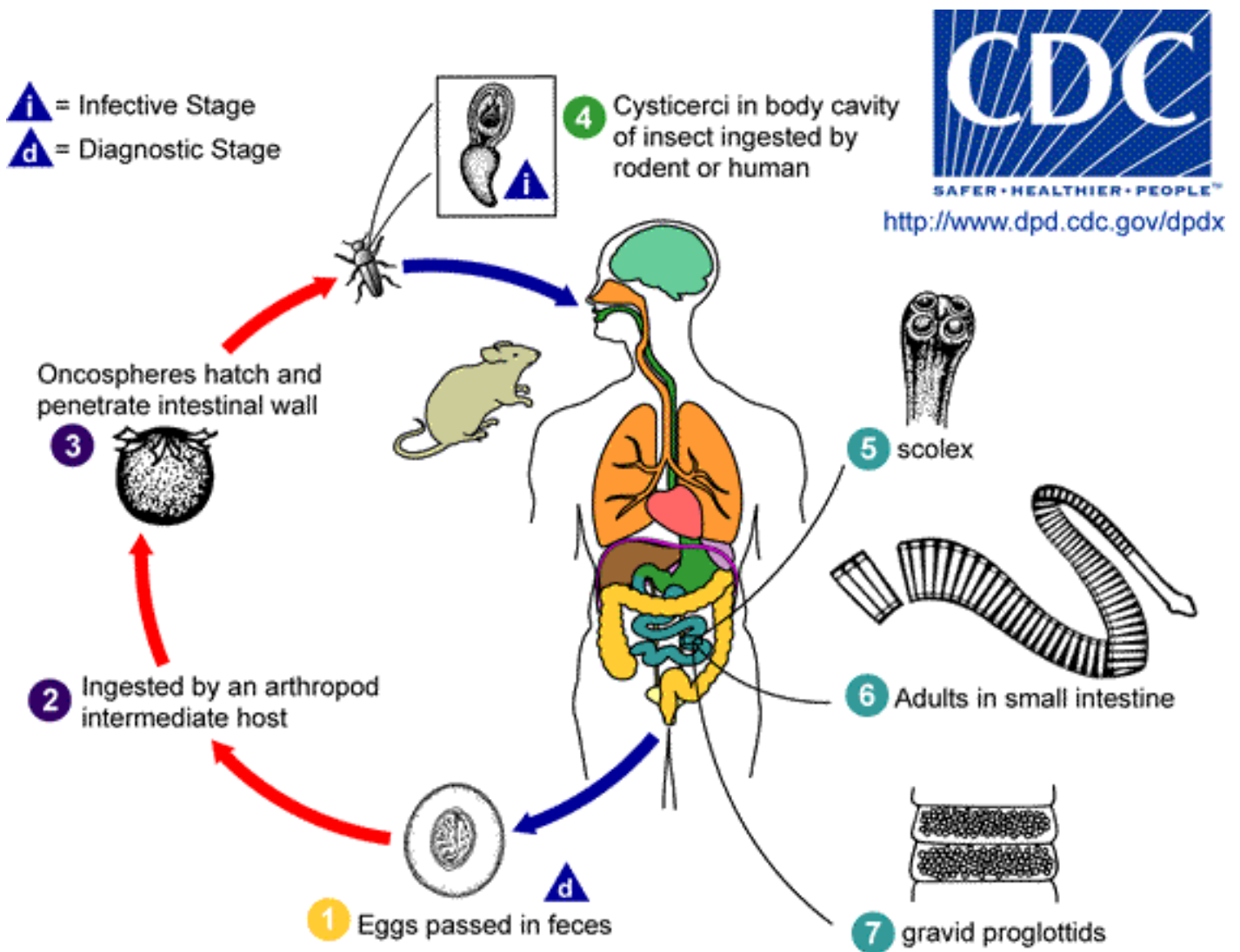
Compare the schistosome blood flukes with other more typical flukes, such as the liver flukes Fasciola hepatica and Chlonorchis sinensis. Obvious features whereby they differ from the blood flukes are that these flukes have much more flattened bodies and that they are hermaphrodites. Features that all the flukes have in common include the first intermediate host being a snail, oral and ventral suckers, a bifurcated gut and a tegumental outer layer.

THE TAPEWORMS

Hymenolepis diminuta. An example tapeworm, its life-cycle being summarised in **Figure 2**. This species has rodents, and occasionally man, as definitive host. Insects, such as the flour beetles, act as intermediate hosts and contain the parasite's larval form. Notice, by comparison with other tapeworm species demonstrated (centre bench), that all tapeworms have similar life-cycles. Adult tapeworms are found in the definitive host, eggs being passed in the faeces. Eggs then infect an intermediate host, where a larval tapeworm grows (cysticercoid, cysticercus hydatid cyst, etc.). The larval parasite is then ingested (with the intermediate host) by the definitive host, and grows into the adult form in the intestinal tract. The definitive host must be carnivorous.

Demonstration 6. Adult tapeworms from the intestine of rats. Examine these parasites under a dissecting microscope. Notice how the body is divided into many segments (proglottids). Under higher power the scolex may be seen at the extreme anterior of the parasite. In this species, the scolex possesses 4 suckers but no hooks.

Figure 2. Life-cycle of *Hymenolepis diminuta*



Compare this adult tapeworm with that of a species infecting man, *Taenia solium*, the 'Pork Tapeworm'. This is an unusual species in that man can act as both a Definitive and an Intermediate host. Severe morbidity is associated with the presence of the larvae of this species.

Demonstration 7. Stool sample containing eggs (see **Figure 4**). Shake the tube containing the faecal material to resuspend the eggs. Then, using a plastic pipette, take a small sample onto a microscope slide, cover with a cover slip and examine under a x10, then x40 objectives.

THE NEMATODES

Nippostrongylus brasiliensis. An example of an intestinal nematode of rodents closely related to hookworms in man and a large number of hookworms of veterinary importance in domesticated animals. The life cycle, as summarised in **Figure 3**, is the same in all hookworms including those infecting man.

Demonstration 8. Adult worms from the gut. Examine under a dissecting microscope, noticing the smaller male worms, which have a copulatory bursa. Notice that: (a) these nematodes are very small, and (b) that there may be many thousands of worms present. This illustrates an important feature of these infections that may have important clinical consequences. For example, in hookworm infections each *individual parasite* may withdraw up to 30 microlitres of blood in each day, and therefore with these large parasite burdens that is such a feature of these infections chronic anaemia is often seen.

Compare these very small nematodes with those of another common parasite, Ascaris lumbricoides. These intestinal worms are much larger. Also, examine the buccal cavities of the human hookworm Nectar Americans. In contrast to Nippostrongylus the buccal cavity here is well developed, with cutting teeth to allow the parasite to penetrate blood vessels of the intestinal mucosa (i.e. these parasites feed on blood).

*Compare the eggs in stool samples from infected humans (Ascaris & Trichuris and human-hookworm eggs, see **Figure 4**). These slides of human stool samples illustrate that multiple infections with a variety of helminthes are a common and important feature of parasitism, (NB. Tapeworm eggs are also present)*

Demonstration 9. Infective L3 larvae cultured from rat faeces. L3 larvae of different hookworms species may either be infective by penetration of the definitive host's skin, as with this species & human hookworms, or may be eaten and penetrate the mucosa of the upper digestive tract (as in many hookworms of veterinary importance).

15.3 (79-117) Microscope slide. TS of intestine containing adult nematodes. Examine using a x10 then x40 objective. Note the important features of the nematode body plan (**Figure 5**), including the pseudocoelome (a fluid filled body cavity), a hard inert outer cuticle and, lying within the pseudocoelome, the parasite's intestine and sexual organs, either testes or ovaries (NB remember, unlike the most of the platyhelminths, all nematodes have separate sexes).

15.4 (74-134) Microscope slide. TS lung containing many migrating larval nematodes. Examine using a x10 then x40 objective, to see numerous cross- and transverse-sections of larvae. Note that migration of nematode larvae is a very common feature of infection with nematodes and this in some species (such as the common roundworm *Ascaris lumbricoides*) may induce host sensitisation, resulting in such allergic manifestations as pulmonary infiltration and asthmatic attacks.

Catalogue Number	Small Image	Image Map	Large Image
A_AI_PS_LU_06.jpg	Nematode in lung		Nematode in lung
A_AI_PS_LU_07.jpg	Nematode in lung		Nematode in lung

Figure 3 *Lifecycle of Nippostrongylus brasiliensis*

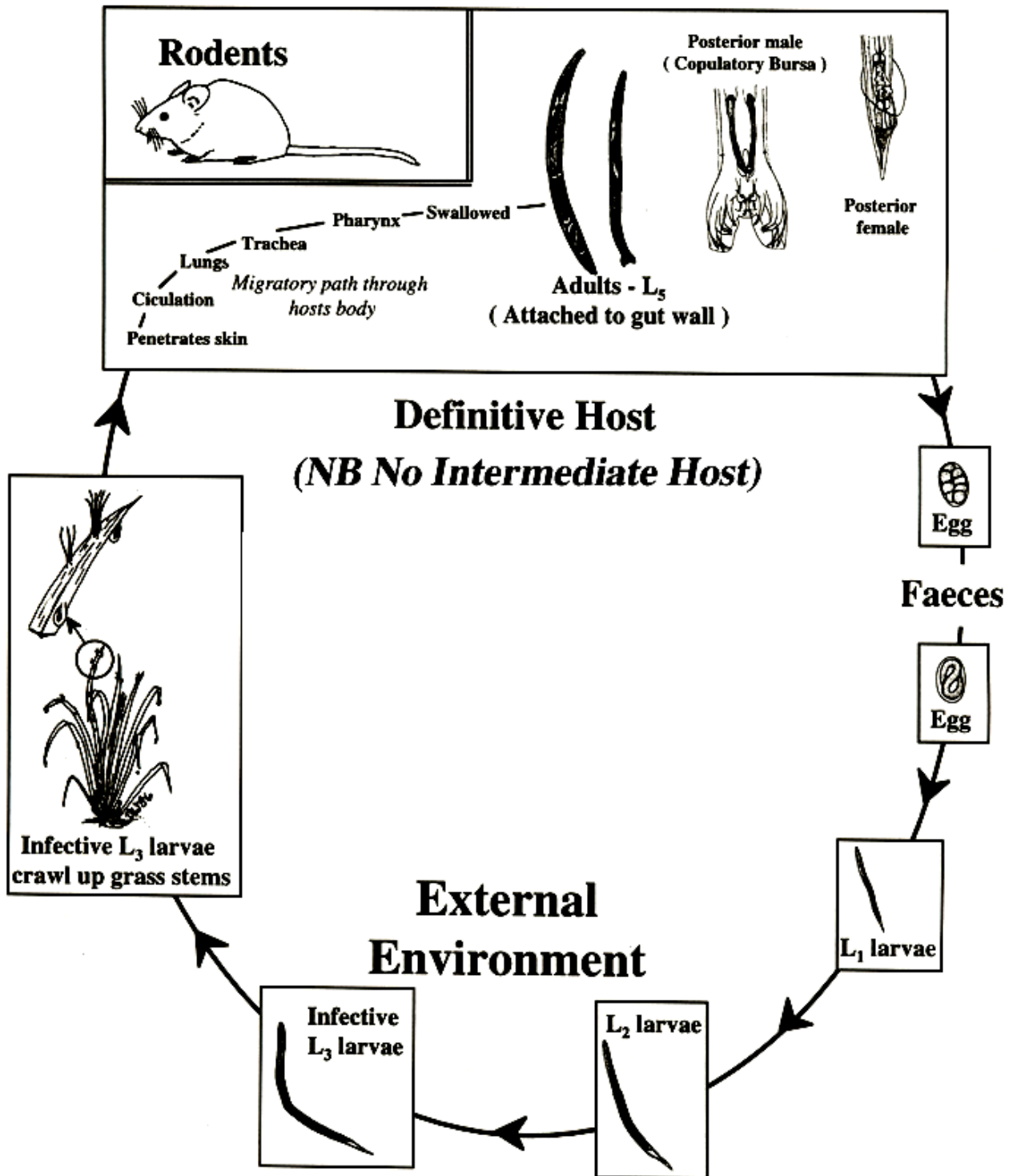


Figure 4. Parasitic helminth egg morphology



<http://www.dpd.cdc.gov/dpdx>



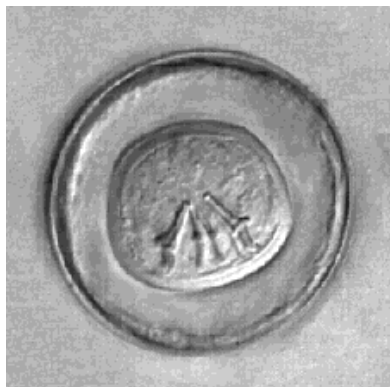
S. mansoni



S. haematobium



S. japonicum



H. nana

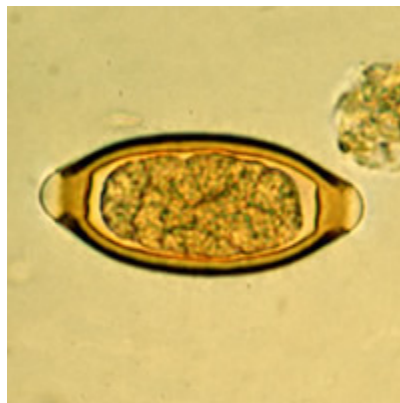


Unembryonated *Fasciola* egg

- Note the thick egg shell wall and the three pairs of hook on the oncosphere



A. lumbricoides with larva



T. trichiura



Hookworm with larva

Figure 5. Nematode morphology

Male Copulatory Bursa

(NB. Only in the hookworms and related species)
 A complex structure of lobes supported by rays
 The exact arrangement and morphology of these rays is of great taxonomic importance

