
Multicellular Parasites

A number of species of roundworms can infect the blood and lymphatic vessels of humans. Mostly, they are contracted in tropical countries, transmitted by biting insects. The adult female worms live in the lymphatic vessels and deposit their offspring, tiny microfilaria, directly into the skin, lymphatics, or bloodstream, where they can be identified in biopsies or blood smears to make the diagnosis. The disorder these roundworms produce is termed **filariasis**, and it may be asymptomatic or produce dramatic symptoms. Two examples are **elephantiasis**, marked swelling of a body part due to lymphatic obstruction, caused by *Wuchereria bancrofti* and *Brugia* sp., and **river blindness**, caused by *Onchocerca volvulus*.

Completely different kinds of parasitic worms live in the blood vessels that carry venous blood from the intestines to the liver, or in the veins of the bladder. They are responsible for the disease schistosomiasis.

Schistosomiasis

Schistosomiasis, endemic in countries of Africa, Asia, the Caribbean, and South America, involves more than 200 million people worldwide and causes over 500,000 deaths annually. About 400,000 individuals with the disease now live in the United States, having emigrated from places where schistosomiasis is endemic. Schistosomiasis is caused not by roundworms, but by flukes. Flukes are short, bilaterally symmetrical worms that usually attach by one or more sucking discs.

Symptoms

Itching skin may occur at the time of exposure to fresh water containing the worm larvae. The itching subsides, and weeks later, a

generalized acute illness occurs, with fever, hives, cough, abdominal, joint and muscle pain, and diarrhea. Some people die during this stage, but usually the symptoms subside and infected individuals are free of symptoms for a number of years. Then a chronic, slowly progressing illness appears, with weakness, accumulation of fluid in the abdominal cavity, and sometimes vomiting blood.

Causative Agent

Most cases of schistosomiasis are caused by three species of flukes in the genus *Schistosoma*. Other genera of flukes that infect humans are hermaphroditic, meaning that each worm has both male and female reproductive organs, but *Schistosoma* species have male and female worms. *Schistosoma* means “split-body,” referring to a deep groove running along the male’s body in which he clasps his female partner. *Schistosoma mansoni*, the only species established in the Americas, and the most common cause of schistosomiasis worldwide, is 10 to 20 mm long

and lives in the small veins of the human intestine. Because it lives in blood vessels, it is called a blood fluke. The life cycle of *S. mansoni* is shown in **figure 28.13**. The slender female worm deposits ova that rupture through the tiny intestinal veins and wall of the intestine to enter the lumen, ultimately to be eliminated with the feces. The ova hatch in fresh water, releasing ciliated larvae called **miracidia** which can live up to 6 hours. When a miracidium encounters a certain species of snail, it penetrates the snail’s body and multiplies asexually. Over about 6 weeks, thousands of elongated fork-tailed larvae called **cercariae** develop and leave their snail intermediate host to enter the water. When they encounter a human being wading in the water, they burrow through his or her skin, leaving their tails behind them. These larvae proceed to enter the circulatory system, are carried by the bloodstream through the heart and lungs, and eventually reach veins of the intestine, where they mature, mate, and begin ova production.

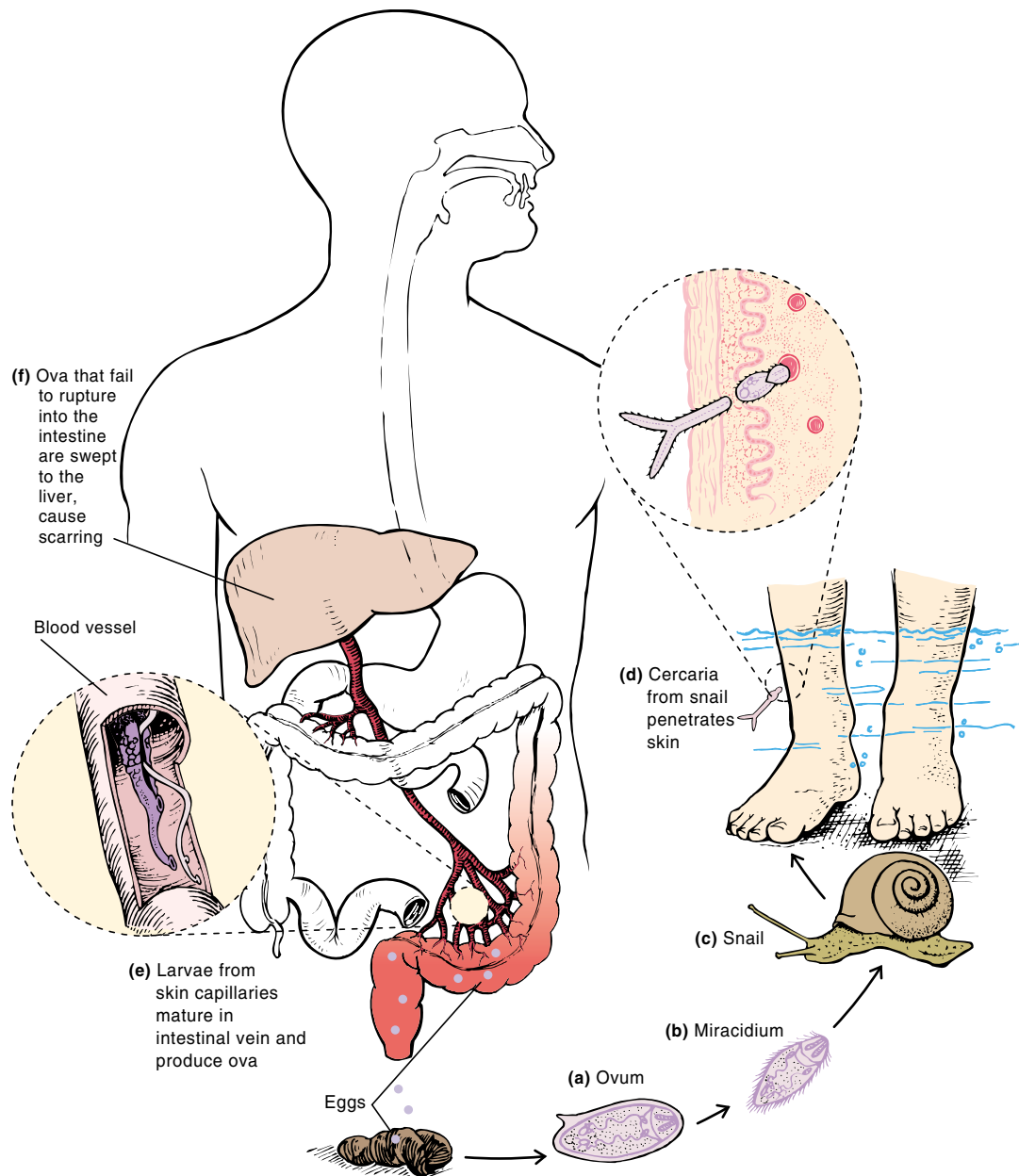


Figure 28.13 Life Cycle of *Schistosoma mansoni* (a) Eggs (ova) from feces reach fresh water. (b) First larval form (miracidium) hatches from ovum and (c) infects snail. (d) Asexual reproduction in body of snail and transformation into another larval form (cercaria). (e) Cercariae break out of snail and penetrate human skin. Tail left behind, larva enters capillary, is carried by bloodstream to intestinal veins, and develops into mature fluke. (f) Ova deposited, break into the intestine or are swept to the liver by the blood.

Pathogenesis

Many of the cercariae die upon entering the skin, causing an inflammatory and immune response that becomes more and more intense with each exposure to the parasites. Each skin penetration by the schistosomes causes an itchy skin rash that gradually subsides. Weeks later, when the mature worms begin to deposit their ova, a generalized illness occurs, probably due to circulating schistosomal antigens reacting with antibodies. Although some people die from the reaction, usually it subsides within several months. Unfortunately, the worms continue to deposit hundreds of ova per day over a lifetime that can exceed a quarter century. Perpetuation of the species depends on ova staying close to the intestine, where an intense inflammatory response liquefies the tissue and allows them to rupture into the intestinal lumen. The spine on the ovum probably helps hold them in place, but many are swept away by the bloodstream to the liver. The same inflammatory response to the ova occurs in the liver, causing gradual destruction of liver cells and their replacement with scar tissue. The end result is malnutrition and a buildup of pressure in the abdominal veins and connecting veins in the esophagus. Fluid accumulates in the abdominal cavity (**figure 28.14**), and hemorrhage occurs if the engorged esophageal veins rupture.

Swimmer's itch is a schistosomal disease that is common across the United States. The disease is characterized by an itchy rash caused by cercariae of schistosomes of wild birds and other animals. The cercariae penetrate the skin of swimmers and then die. These schistosomes are otherwise harmless, since they are unable to complete their life cycle in humans.

Epidemiology

Transmission occurs in northern and eastern South America, parts of the Caribbean, much of the African continent, parts of the Middle and Far East, Philippines, Southeast Asia, China, and Japan. The distribution depends on abundant fresh water,



Figure 28.14 Child with Schistosomiasis Notice the distended abdomen, probably due to inflammatory enlargement of the liver and spleen. Later in the development of the disease the abdomen will fill with fluid, the result of scarring that obstructs the flow of blood through the liver.

extensive contamination of water by human feces, and a suitable snail intermediate host. Farmers and people who fish or wade in fresh water are at high risk for the disease. Large irrigation projects to enhance agriculture have extended the range of the disease. Schistosomiasis cannot be contracted in continental United States because there is no appropriate snail intermediate host.

Prevention and Treatment

Preventing schistosomiasis depends on avoiding skin exposure to fresh water contaminated with the miracidia, preventing untreated human feces from entering fresh water, treatment of cases of the disease, and measures, both chemical and biological, to control the snail intermediate hosts. Promising synthetic peptide and DNA vaccines are under development. Effective medications are available that kill the parasites in disease victims.

The main features of schistosomiasis are presented in **table 28.9**.

TABLE 28.9 Schistosomiasis

Symptoms	Acutely: fever, hives, cough, abdominal, joint, and muscle pain. These symptoms subside and after years are replaced by generalized weakness and swelling of the abdomen
Incubation period	Usually 2 to 6 weeks
Causative agents	Most cases are caused by three species of <i>Schistosoma</i> , the most prevalent being <i>S. mansoni</i> . The male schistosome has a longitudinal slit in its body in which he clasps the female. Perpetuation of the life cycle depends on rupture of their eggs into the lumen of the intestine from the tiny intestinal veins where the adults live. The eggs hatch in fresh water, releasing a free-swimming miracidium that penetrates into the flesh of the snail intermediate host. In the snail, the organism multiplies and differentiates into forked-tail cercariae that leave the snail and can infect humans by penetrating their skin
Pathogenesis	Inflammatory and immune response to skin penetration by the cercariae causes intense itching. Allergic reaction to released schistosomal antigens as the worms mature and begin depositing ova causes the acute illness. Chronic malnutrition and swelling of the abdomen result from liver damage caused by ova that fail to penetrate into the intestinal lumen, and are carried to the liver by the bloodstream
Epidemiology	Distribution of the disease is favored by large bodies of shallow fresh water, extensive contamination of the water with human feces, and a suitable snail intermediate host. Farmers, people who fish, and children who wade in fresh water at high risk
Prevention and treatment	Prevention depends on proper disposal of human feces, identifying and treating infected patients, and measures to control the snail intermediate host. Praziquantel is effective treatment

MICROCHECK

The health and economic burden of multicellular parasite infections challenges that of malaria. The complex life cycle of *Schistosoma mansoni* provides a number of possibilities for attacking schistosomiasis.

- Trace the life cycle of *Schistosoma mansoni*.
- How long would it take *S. mansoni* to become extinct if snail-eating fish eliminated the intermediate host?