Parasite Name: *Enterobius vermicularis* (formerly *Oxyuris vermicularis*)

Synonyms: pinworm, threadworm, seatworm

Classification: Helminth (nematode)

Taxonomy: **Animalia Nematoda Secernetae Rhabditida Oxyuridae Enterobius vermicularis**

Pinworm has the broadest geographic range of any helminth, and is the most prevalent helminth infection in the USA and Western Europe. It is commonly found in school-aged children, though it is seen in adults as well.
Pinworm eggs are flattened asymmetrically on one side, ovoid, approximately 55 mm x 25 mm in size, and embryonate in six hours. These eggs can remain viable for about twenty days in a moist environment, and viable eggs and larvae were even found in the sludge of sewage treatment plants in Czechoslovakia in 1992.

It has also been recently speculated that pinworms themselves may serve as an intermediate host to *Dientamoeba fragilis*, a relatively mysterious protozoa that is still struggling to gain recognition as a human pathogen in certain countries. However, an increasing number of studies are incriminating it as a legitimate enteric pathogen, and it has been associated with clinical syndromes such as abdominal pain, diarrhea, nausea, vomiting, and fatigue. However, much about this pathogen, including its transmission, is still being investigated. Most intestinal protozoa are transmitted fecal-oraly via a cyst form, but *D. fragilis* is generally accepted as not having a cyst form. Therefore, researchers have turned to its proposed nearest relative, *Histomonas meleagridis*, for comparison. *H. meleagridis* possesses several characteristics comparable to those of *D. fragilis*, and it is interesting to note that it is transmitted via the eggs of the nematode *Heterakis gallinae*. Burrows and Swerdlow proposed in 1956 that *D. fragilis* is transmitted via pinworm eggs based on the analysis of 22 appendices in which *D. fragilis* was isolated: There was a 20-fold greater incidence of pinworm infection than calculated, and small ameboid bodies bearing great resemblance to the nuclei of *D. fragilis* were observed in the pinworm eggs. However, it is still worth bearing in mind that *D. fragilis* has been associated with other intestinal parasites (such as *Ascaris lumbricoides*), and that the lack of a cyst stage yet to be conclusively proven, as *D. fragilis* has been found to have a high rate of co-infection with organisms which are transmitted fecal-oraly.

**History of Discovery**

The first evidence of pinworm infection dates back to Roman-occupied Egypt (30 BC-AD 395), and the oldest known pinworm ova have been found in human coprolites dating back to 7800 BC from Danger Cave, Utah (Fry and Hall, 1969). Pinworm has
also been found to be referenced in the ancient writings of Hippocrates, dating back to 430 BC.

Ferreira et. al in 1997 and Hugot et. al in 1999 established pinworms as an example of an inherited parasite, meaning it is a host-specific parasite that has a long history of co-evolution with ancient human ancestors dating back to Africa before human dispersion across the continents.

Ancient pinworm finds have occurred in a variety of archaeological sites, and according to Goncalves et. al in 2002, the majority have been from coprolites from sites in the USA, with two from Chile and one each from Peru, Mexico, Germany, Denmark, and Argentina, as well as one finding from a Han dynasty mummy in China.

Pinworm findings in archaeological material outside the New World have been scarce for unknown reasons, and it is hypothesized that this parasite did not originate in the Americas, but rather arrived via land route through the Beringia. Pinworm is one of the few helminths that could have possibly arrived through this route, as most helminths require a particular soil temperature to progress to the infective stage, a stage pinworms do not require and would not have been possible to attain through migration in the cold northern territories.

A supposed second species of pinworm has been documented in Europe, Africa, and Asia. Known as Enterobius gregorii, this parasite was isolated in 1983 by Jean-Pierre Hugot. The morphology, life cycle, clinical presentation, and treatment for this parasite are identical to Enterobius vermicularis, and the only difference lies in the fact that E. gregorii possesses a smaller spicule (70-80 micrometers versus 100-122).

Enterobius vermicularis
Epidemiology
Pinworm is a cosmopolitan parasite with particularly high prevalence in countries with a temperate climate. It has the widest distribution of any parasitic helminth, and it is estimated that approximately 200 million people are infected internationally. The most common helminth infection in the USA and Western Europe, it has become the most common intestinal parasite seen in a primary care setting, regardless of factors such as race, socioeconomic status, and culture. As such, pinworm serves as an exception to the general rule that intestinal parasites are uncommon in affluent societies.

In the United States alone, prevalence is estimated to be between 20-40 million, and a CDC surveillance study conducted in 1992 in 35 states found that 11.4% of 9597 tests for pinworm infection were positive. While it is mainly seen in children, pinworm cases have been documented in adults, especially in households where infected children transmit the infection to the rest of the family. Prevalence in children in certain communities has been found to be as high as 61% in India, 50% in England, 39% in Thailand, 37% in Sweden, and 29% in Denmark.

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**Transmission**

As with many other GI nematodes, pinworms do not need to rely on a vector for transmission. Pinworm infection usually occurs via ingestion of infectious eggs by direct anus-to-mouth transfer by fingers. This is facilitated by the perianal itch (pruritis ani) induced by the presence of pinworm eggs in the perianal folds, and commonly occurs as a result of nail biting, poor hygiene, or inadequate hand-washing.

Retroinfection is also possible, where some of the pinworm larvae which hatch on the anus return to the gastrointestinal tract of the original host, leading to a very high parasitic load as well as ensuring continued infestation.

However, the transfer can also occur by touching contaminated surfaces, such as clothing, bed linen, and bathroom fixtures followed by ingestion, or even through inhalation or ingestion of aerosolized eggs from the aforementioned surfaces. As such, pinworm infections are easily spread among young children with the habits of nail biting and poor hygiene, and infected children can easily spread the infection to other family members through the mechanism list above.

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**Clinical Presentation**

Pinworm infection is usually benign, and 1/3 of those infected are asymptomatic. By far the most common clinical sign of pinworm infection is perianal or perineal itching, and the itching is usually the most severe at night. This is caused by the migration of female pinworms to the anus to lay eggs (specifically, insertion of the tail pin into the mucosa for ovideposition), and scratching leads to finger contamination and subsequently the spread of ovum to others. The scratching may also excoriate the skin and lead to secondary bacterial infections. Secondary symptoms, which are due to disturbed sleep caused by pruritis, include anorexia and irritability.

However, pinworm infection is not always harmless, as it has been implicated in causing appendicitis (as high as 2.39% of cases in developing countries), intestinal
obstruction, intestinal perforation, enterocolitis mimicking Crohn's disease, and eosinophilic ileocolitis.

Extra-intestinal infections are also possible, and while most involve the female genital tract, infection of other sites has been documented, including the lungs, breast, liver, and spleen. These extra-intestinal infections may lead to pruritis vulvae, urinary tract infections, postmenopausal bleeding, epididymitis, pelvic mass, chronic sialoadenitis, and unilateral salpingitis, among others. The dead parasites and eggs deposited in ectopic sites can also be responsible for the formation of granulomas and abscesses.

One theory for the mechanism of infection of the female genital tract is that gravid female worms migrate from the perianal region to the vagina, where it may ascend through the fallopian tubes to the peritoneum. This theory is supported by the presence of only female worms and eggs via cervical smears, as well as in peritoneal granulomas.

Another theory states that the pinworms may pass through intact intestinal wall to produce pelvic peritoneal granulomata.

The mechanisms listed above.

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**Diagnostic Tests**

The most common means of diagnosing pinworm infection is via the “Scotch tape” test, where a clear adhesive cellulose tape is applied to the anal area early in the morning before bathing or defecation. This is then observed under a microscope for the presence of pinworm eggs. These eggs may also be stained blue with lactophenol cotton blue, which aids in detection and identification. The sensitivity of this test when performed for three consecutive mornings is 90%. Anal swabs (“Swube tubes:” paddles coated with adhesive material) may also be used.
Alternatively, the adults may be seen in stool or toilet paper, though the ova and larvae are rarely present in either the stool or urine.

Extra-intestinal infections may require more invasive diagnostic tests. One case diagnosed via colonscopy followed by confirmation via microscopy was documented by Petro et al. in 2005, and infections of the female genital tract usually require laparotomy and excision of granulomas for a conclusive diagnosis. Pre-operative diagnosis of finding the parasite via cervical smears, vaginal wet mounts, and vaginal pooled specimen is possible but difficult.

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**Therapy**

For typical pinworm infections, mebendazole can be used. This is given in single doses of 100 mg by mouth, repeated for two weeks to prevent reinfection, and is arguably the safest and most efficient therapy, with an efficacy of 96%. The drug targets adult worms, blocking glucose uptake and subsequently causing death. Albendazole may also be used in 100 mg doses for patients under two years old, or in doses of 400 mg for older patients. As in mebendazole, this should also be repeated for two weeks. Albendazole also targets adult worms, decreasing their ATP production and causing energy depletion, immobilization, and ultimately death.
Pyrantel pamoate is also an option, and is given at 11 mg/kg, not to exceed 1 g. However, it can cause side effects, which include GI distress, neurotoxicity, and transient increases in liver enzymes. Pyrantel pamoate serves as a depolarizing neuromuscular blocking agent, inhibiting cholinesterases and resulting in spastic paralysis of the adult worms.

Other drugs which have been used to treat pinworm infections include piperazine citrate, pyrvinium panoate, oxantel, oxantel-pyrantel, fenbendazole, and nitrazoxamide.

For pinworm infections of the genitourinary tract, mebendazole alone may be inadequate, and as such ivermectin is usually supplemented. Topical insecticides containing malathion or ivermectin may also be applied to the skin of the perineum in order to eliminate pinworm eggs.

In all cases of pinworm infection, treatment of the entire household is strongly suggested, whether or not symptoms are present. This is due to the fact that pinworms are easily transmitted among members of the household. Also, strict handwashing must be completed after using the toilet/changing the diaper of an infected baby, as well as before and after eating, for two weeks, bedding cleaned every 3-7 days for three weeks, and underwear and pajamas washed daily for two weeks.

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**Public Health and Prevention Strategies**

To prevent the spread of infection or reinfection, the following are suggestions from the [CDC pinworm fact sheet](https://www.cdc.gov/dpdx/pinworm/prevention.html):

- Bathe when you wake up to help reduce the egg contamination.
- Change and wash your underwear each day. Frequent changing of night clothes are recommended.
- Change underwear, night clothes, and sheets after each treatment. Because the eggs are sensitive to sunlight, open blinds or curtains in bedrooms during the day.
- Personal hygiene should include washing hands after going to the toilet, before eating and after changing diapers.
- Trim fingernails short.
- Discourage nail-biting and scratching bare anal areas. These practices help reduce the risk of continuous self reinfection.

Daily cleaning and vacuuming of households, as well as washing of sheets are not necessary nor effective, and neither are school-wide pinworm screenings. It is also worth noting that children may return to school after bathing, trimming and scrubbing nails, and taking the first dose of treatment.