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PARASITES

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Introduction

- We'll look at **some** of the parasites that are transmitted via food and water, with emphasis on those most prevalent in North America.
- Metazoan parasites may be quite visible, but are typically transmitted at a microscopic stage in their lives.
- All have sexual reproduction, but some are hermaphrodites.
- Life cycles often involve two or more host species.

Roundworms

Trichinella spiralis — trichinosis (potentially fatal)

- Larval cysts in pork or muscles of other carnivores (bears)
- Mating in intestine, ovovivipary, larvae via lymph & blood to muscles, encystation
- Prevention by thorough cooking (or freezing or irradiation) of meat

Ascaris lumbricoides

- Large roundworms may cause intestinal obstruction
- Transmitted by eggs in human feces; under favorable conditions, eggs mature after 2-3 weeks, may remain viable in soil for years

Anisakids (*Anisakis simplex*, *Pseudoterranova decipiens* are principal species)

- Larvae from **marine** fish eaten raw (sushi, ceviche, etc.) are sometimes invasive.
- Complex life cycle: "definitive" hosts are cetacea (e.g., dolphins, porpoises) for *Anisakis* or pinnipeds (seals, walruses) for *Pseudoterranova*
- Prevention by cooking fish thoroughly, or freezing

Tapeworms

Taenia saginata — beef tapeworm (rare in US and Canada)

- Cysticerci (macroscopically visible) ingested with raw or undercooked beef
- Scolex attaches in intestine, generates a tape of proglottides; many years of essentially inapparent infection may follow, with shedding of eggs or proglottides in feces.
- If human feces are applied to land where cattle ingest them, the eggs produce oncospheres which give rise to cysticerci in the bovine tissues.

Taenia solium — pork tapeworm (in U.S. principally as imported cases from Latin America)

- Cysticerci (macroscopically visible) ingested with raw or undercooked pork
- Scolex attaches in intestine, generates a tape of proglottides; many years of essentially inapparent infection may follow, with shedding of eggs or proglottides in feces.
- If human feces are disposed where swine can ingest them, the eggs produce oncospheres, which give rise to cysticerci in the swine tissues.
- *Taenia solium* eggs are infectious perorally for humans: tapeworm carriers may autoinfect themselves or contaminate food they touch, or their feces may transmit the eggs to other people via food or water; the result is cysticercosis, often of the CNS, in the recipient human.

Diphyllobothrium latum — fish tapeworm (Asia, Europe, North & South America)

- Plerocercoid ingested with fresh water fish; scolex attaches in intestine, producing the largest tapeworm that infects humans (other species that eat raw fish are also definitive hosts, but produce a low proportion of viable eggs); eggs shed in feces that reach water infect copepods which are later eaten by fish; other species infect humans.
- Symptoms in humans are usually trivial, but vitamin B_{12}-deficiency anemia sometimes occurs.

Flukes (seldom foodborne in North America)

Clonorchis sinensis, *Opisthorchis* spp., *Metagonimus yokagawai*, *Heterophyes heterophyes* — fish flukes (limited distributions)

Definitive hosts are humans or other fish-eating vertebrates; hermaphroditic adults in liver produce eggs shed in feces, intermediate host is a very specific snail species, fish are the food vehicle, metacercariae the infectious form.

Paragonimus westermani — lung fluke (limited distributions on several continents)

Eggs from flukes in lung are passed with sputum or swallowed and passed in feces; snail intermediate hosts, food vehicles are crustacea (crabs and crayfish) eaten raw.

Fasciola hepatica — liver fluke (widespread, but sporadic in North America)

Principal definitive hosts are sheep and cattle (other species reported, accidental in humans), eggs shed via bile in feces, snail intermediate host; vehicles for human infection are water plants (e.g., watercress) on which metacercariae have encysted, eaten raw.

Fasciolopsis buski — intestinal fluke (occurs in southeast Asia)

Main definitive hosts are humans, pigs, and dogs; unembryonated eggs shed in feces develop and hatch in fresh water within 3–7 weeks at 27–32°C; snail intermediate host; food vehicles are water plants that have encysted metacercariae.

Summary

- Roundworms, tapeworms, and flukes are transmitted to humans via food and water in many parts of the world.
- Nonhuman hosts play a vital role in the life cycles of many of these parasites.
- Careful disposal of human waste can have a significant effect in reducing the threat of some of these.
- Foods can be made safe by cooking, but not all foods are customarily cooked.

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CDC parasites site: http://www.dpd.cdc.gov/dpdx/

Transmission of major foodborne parasites:

Food vehicle	Source or mode of contamination	Parasite species	Infectious form
Drinking water	Feces (human)	*Cyclospora cayetanensis*	Oocyst
		Entamœba histolytica[a]	Cyst
	Feces (human & animal)	*Cryptosporidium parvum*	Oocyst
		Giardia lamblia	Cyst
		Toxoplasma gondii	Oocyst
Foods contaminated in handling	Handling by infected person (feces)	*Cryptosporidium parvum*	Oocyst
		Entamœba histolytica[a]	Cyst
		Giardia lamblia	Cyst
		Taenia solium	Egg (proglottid)
Vegetables and fruits contaminated in the field	Agent in feces-contaminated soil and water	*Ascaris lumbricoides*[b]	Egg
		Cryptosporidium parvum	Oocyst
		Cyclospora cayetanensis	Oocyst
		Entamœba histolytica[a]	Cyst
		Fasciola hepatica	Metacercaria
		Fasciolopsis buski	Metacercaria
		Giardia lamblia	Cyst
		Taenia solium	Egg (proglottid)
		Toxoplasma gondii	Oocyst
Meats (raw or rare)	Infected food animal	*Taenia saginata*	Cysticercus
		Taenia solium	Cysticercus
		Toxoplasma gondii	Bradyzoite (tissue cyst)
		Trichinella spiralis	Cyst
Fish and seafood (raw or rare)	Infected fish (sea)	Anisakids	Larva
	Infected fish (fresh water)	*Clonorchis sinensis*, etc.	Metacercaria
		Diphyllobothrium latum	Plerocercoid
	Crustacea	*Paragonimus westermani*	Metacercaria

[a] Perhaps also *Balantidium coli*
[b] Perhaps also *Trichuris trichiura*