

FOODBORNE PARASITES

PHR 250

Foodborne Infections
and Intoxications

OVERVIEW

- *Some of the parasites transmitted via food & water, mostly from North America
- *Macroscopic, transmitted as microscopic forms
- *Reproduce sexually; some are hermaphrodites
- *Life cycles in >1 host species

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



FOODBORNE PARASITE GROUPS

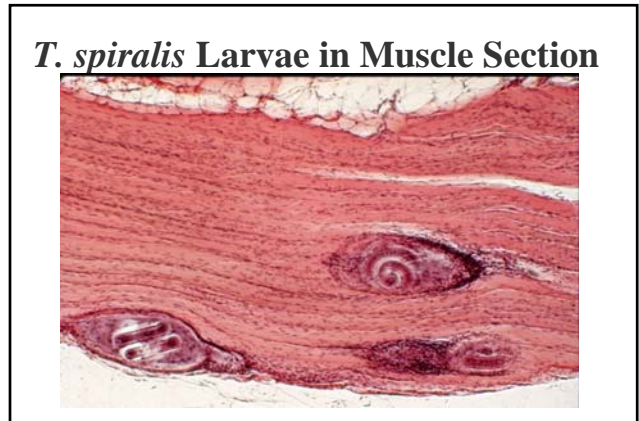
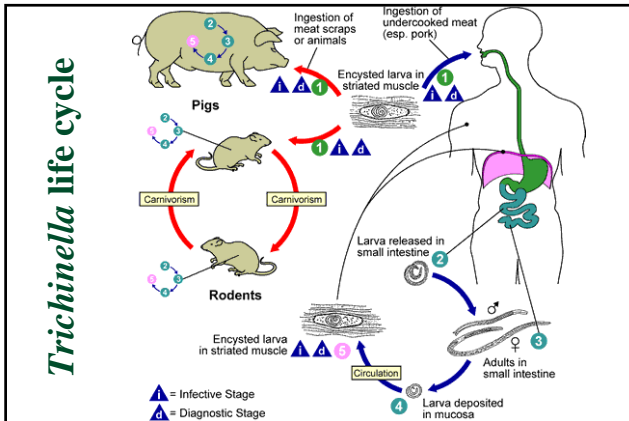
- *Roundworms
- *Tapeworms
- *Flukes

FOODBORNE ROUNDWORMS

- **Trichinella spiralis*
- **Ascaris lumbricoides*
- *Anisakids
 - *Anisakis simplex* (herringworm, whaleworm)
 - *Pseudoterranova decipiens* (codworm, sealworm)

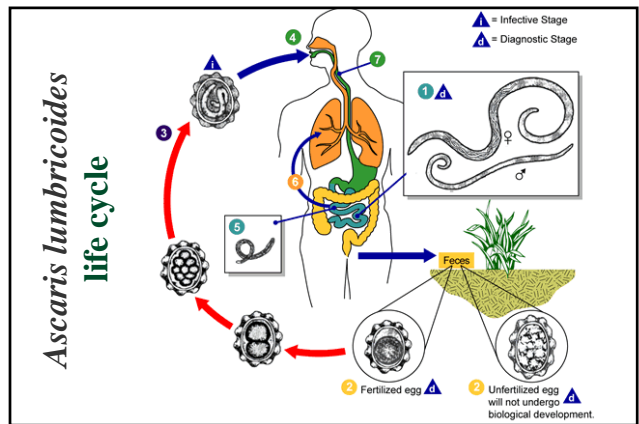
Trichinella spiralis

- *Trichinosis (potentially fatal)
- *Larval cysts in muscles of swine, other carnivores (bears)
- *Mate in intestine, ovovivipary, larvae via lymph & blood to muscles, encystation
- *Prevention: thorough cooking (or freezing or irradiation) of meat



Ascaris lumbricoides

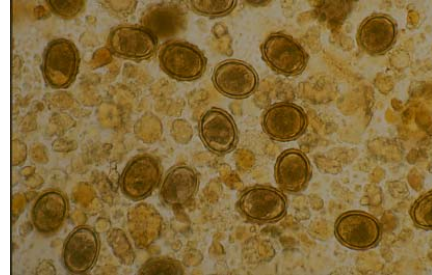
- *Large roundworms — intestinal obstruction
- *Transmitted by eggs in human feces; under favorable conditions, eggs mature after 2–3 weeks, may remain viable in soil or sewage sludge for years



Swine Ascariasis



Ascaris eggs



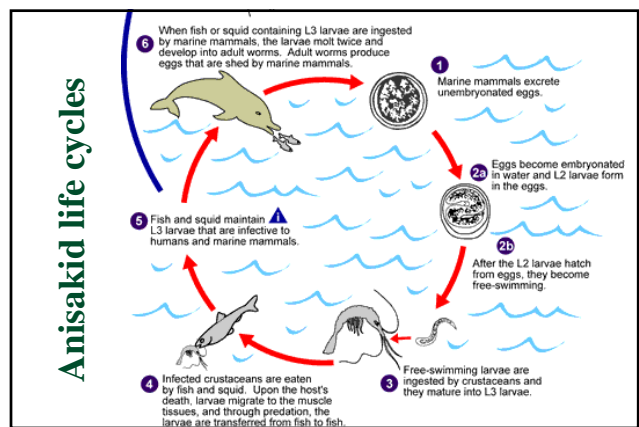
Baylisascaris larva emerging from egg following 4 months in formalin

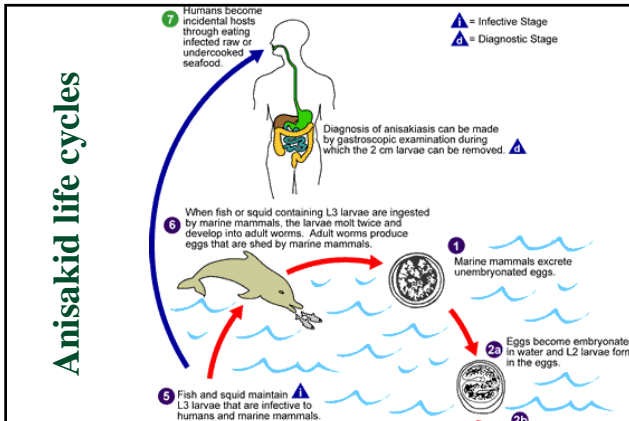
Anisakids (principal species *Anisakis simplex*, *Pseudoterranova decipiens*)

- *Larvae from raw marine fish (sushi, ceviche, etc.), sometimes invasive
- *Prevention by cooking fish thoroughly, or freezing

Anisakid life cycles

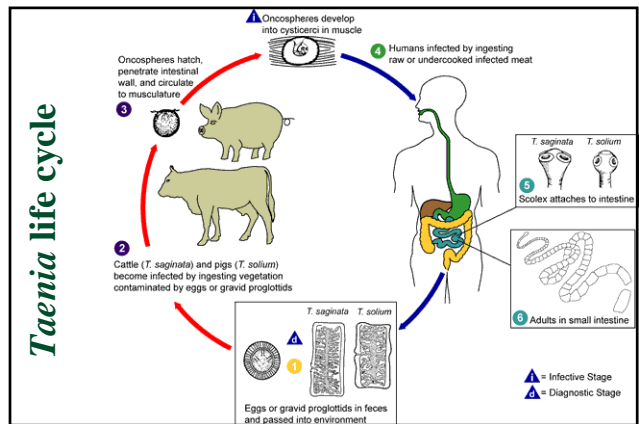
- **Anisakis* **definitive** hosts are cetacea (e.g., dolphins, porpoises → “whaleworms”)
- **Pseudoterranova* **definitive** hosts are pinnipeds (seals, walruses → “sealworms”)





FOODBORNE TAPEWORMS

- **Taenia saginata* (beef tapeworm)
- **Taenia solium* (pork tapeworm)
- **Diphyllobothrium latum* (fish tapeworm)



Taenia saginata

- *Beef tapeworm (rare in US and Canada)
- *Cysticerci (macroscopically visible, “beef measles”) ingested with raw or undercooked beef



***Taenia saginata* in humans**

*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.

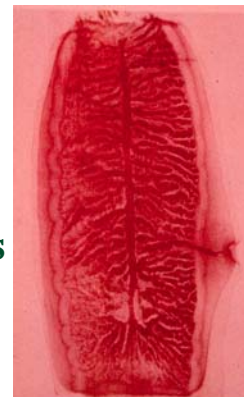
***Taenia* spp. tapeworm**



***Taenia saginata* scolex**



***Taenia saginata* gravid proglottis**



***Taenia* (spp.?) eggs**



***Taenia saginata* transmission**

*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. cases principally imported from Latin America)
- *Cysticerci (macroscopically visible, “pork measles”) ingested with raw or undercooked pork

***Taenia solium* in humans**

- *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.

***Taenia solium*
scolex**



***Taenia solium*
gravid
proglottis**

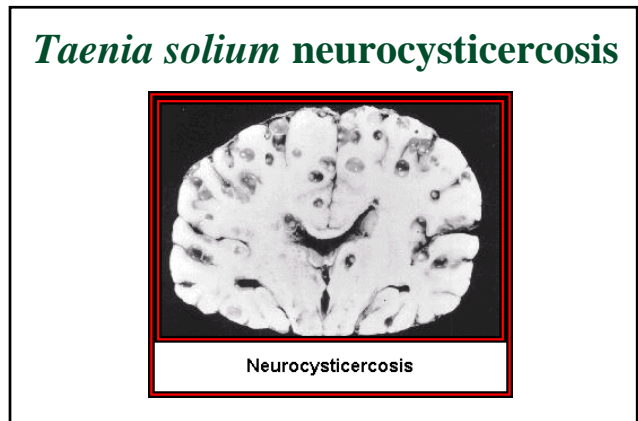
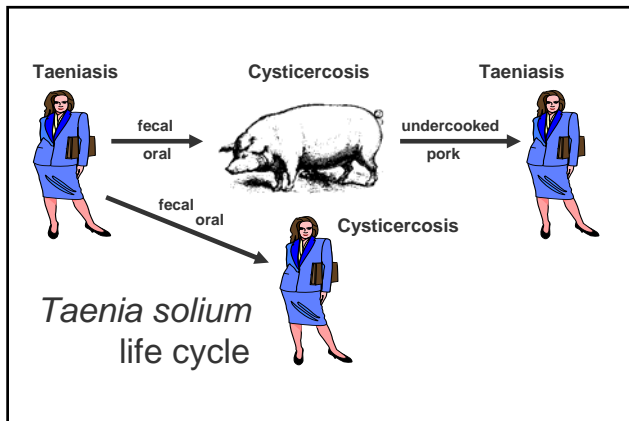


***Taenia solium* transmission**

- *If human feces are disposed where swine can ingest them, the eggs produce oncospheres, which give rise to cysticerci in the swine tissues.

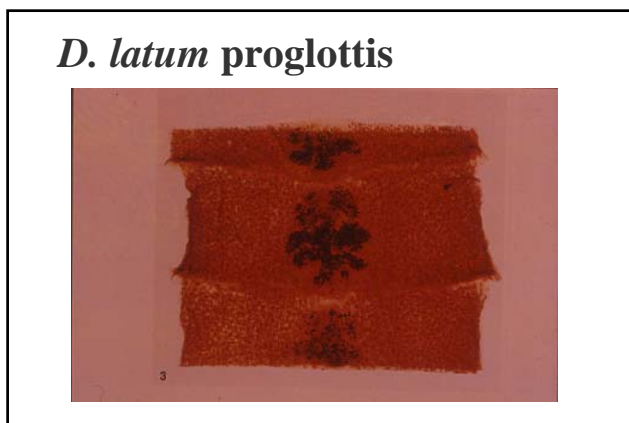
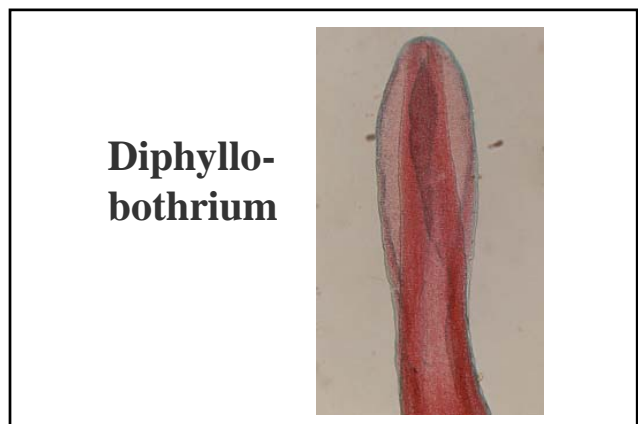
***Taenia solium* eggs to humans**

- **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.



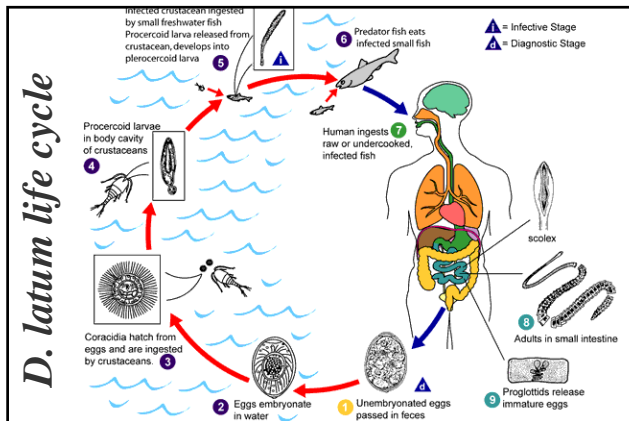
Diphyllobothrium latum

- *Fish tapeworm (Asia, Europe, the Americas)
- *Plerocercoid ingested with fresh water fish



***D. latum* definitive hosts**

- *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.



D. latum in humans

- *Symptoms in humans are usually trivial, but vitamin B₁₂-deficiency anemia sometimes occurs.

FOODBORNE FLUKES

- **Clonorchis sinensis*, *Opisthorchis* spp., *Metagonimus yokagawai*, *Heterophyes heterophyes* (fish flukes)
- **Paragonimus westermani* (lung fluke)
- **Fasciola hepatica* (liver fluke)
- **Fasciolopsis buski* (intestinal fluke)

Clonorchis sinensis, *Opisthorchis* spp., *Metagonimus yokagawai*, *Heterophyes heterophyes*

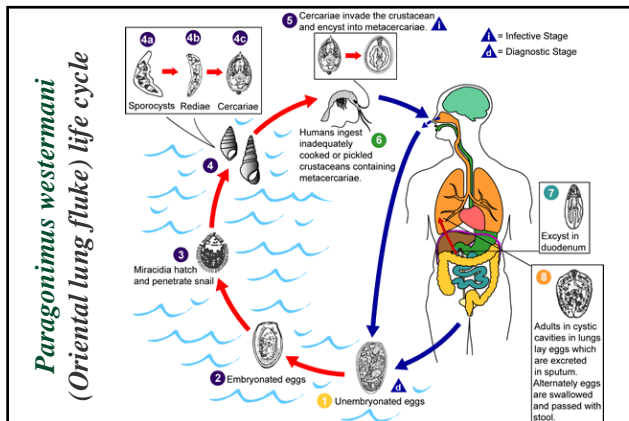
- *Fish flukes (limited geographic distributions)
- *Definitive hosts are humans or other fish-eating vertebrates

Fish flukes

- *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.

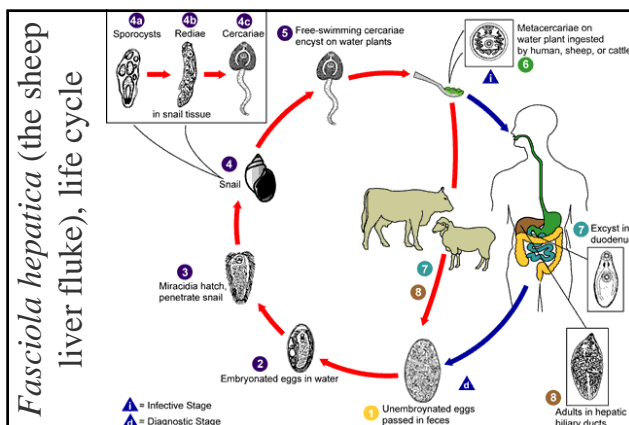
Paragonimus westermani

- *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

- Fasciola hepatica***
- * 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) – largest intestinal fluke of humans
 - * 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.



Fasciolopsis buski

- *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.

Summary

- *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.

Parasites transmitted to humans from drinking water

Source or mode of contamination	Parasite species	Infectious form
Feces (human)	<i>Cyclospora cayetanensis</i>	Oocyst
	<i>Entamoeba histolytica</i>	Cyst
Feces (human and animal)	<i>Cryptosporidium parvum</i>	Oocyst
	<i>Cryptosporidium hominis</i>	Oocyst
	<i>Giardia lamblia</i>	Cyst
	<i>Toxoplasma gondii</i>	Oocyst

Parasites transmitted to humans from foods contaminated in handling

Source or mode of contamination	Parasite species	Infectious form
Handled by infected person (feces)	<i>Cryptosporidium parvum</i>	Oocyst
	<i>Cryptosporidium hominis</i>	Oocyst
	<i>Entamoeba histolytica</i>	Cyst
	<i>Giardia lamblia</i>	Cyst
	<i>Taenia solium</i>	Egg (proglottis)

Parasites transmitted to humans from fruits & vegetables contaminated in the field

Source or mode of contamination	Parasite species	Infectious form
Agent in feces— contaminated soil & water	<i>Ascaris lumbricoides</i>	Egg
	<i>Cryptosporidium parvum</i>	Oocyst
	<i>Cyclospora cayetanensis</i>	Oocyst
	<i>Entamoeba histolytica</i>	Cyst
	<i>Fasciola hepatica</i>	Metacercaria
	<i>Fasciolopsis buski</i>	Metacercaria
	<i>Giardia lamblia</i>	Cyst
	<i>Taenia solium</i>	Egg (proglottis)
	<i>Toxoplasma gondii</i>	Oocyst

Parasites transmitted to humans from raw or rare meats

Source or mode of contamination	Parasite species	Infectious form
Infected food animal	<i>Taenia saginata</i>	Cysticercus
	<i>Taenia solium</i>	Cysticercus
	<i>Toxoplasma gondii</i>	Bradyzoite
	<i>Trichinella spiralis</i>	Cyst (larval)

Parasites transmitted to humans from raw or rare fish & seafood

Source or mode of contamination	Parasite species	Infectious form
Infected fish (ocean)	Anisakids	Larva
Infected fish (fresh water)	<i>Clonorchis sinensis, etc.</i>	Metacercaria
	<i>Diphyllobothrium latum</i>	Plerocercoid
Crustacea	<i>Paragonimus westermanii</i>	Metacercaria