Acoelomate Animals

several phyla including **Platyhelminthes** share the following characteristics:

1. have 3 true embryonic tissue layers (=**triploblastic**):
   - ectoderm
   - mesoderm
   - endoderm
   
   between epidermis and digestive cavity is filled with a 3rd tissue layer = **mesoderm**
   
   ↤ mesoderm allows development of muscle layers in body wall
   
   ↤ mesoderm allows more elaborate organs
   
   more specialization and greater division of labor than in Cnidaria

2. have **true organs**

   each organ is a combination of several tissues specialized for a particular function

   sponges have various specialized cells but no true tissues or organs

   jellyfish and corals have 2 true tissue layers and a few simple organs

3. **acoelomate** = without body cavity

   → organs are embedded in tissue, not in any body space (like us)

   like cnidaria and ctenophora

   → only 1 “internal space” = digestive cavity

4. in terms of development these organisms are **protostomes**

   → mouth develops first in embryo during gastrulation

5. most have **bilateral symmetry**

   such design allows for a “front end” = **cephalization**

   head contains sense organs, simple brain

   was a major new design

   → more efficient search for food, mates, etc

   most animals before this were sedentary filter feeders

Phylum Platyhelminthes 
(Flatworms)

[helminth = worm] simplest phylum at “organ level” of complexity very diverse group but most are poorly known includes flatworms, flukes, tapeworms 25,000 living species, few fossils → no hard parts poorly known in fossil record but possible trails have been found from 565MY may be first animal to have a head & tail may be first animal to have bilateral symmetry may be first animal to show directed movement wide variety of body forms all with bilateral symmetry body is usually elongated & slender, leaf-like or long & ribbon-like flattened body allows them to still rely on diffusion for exchange of gasses, nutrients and wastes range in size from few mm → 10 M long free living in ocean and freshwater habitats, moist soil diverse array of parasitic species that parasitize members of virtually every other animal phylum more specialization and division of labor among greater variety of tissues and organs **acoelomate** = no body cavity around digestive system have three true tissue layers (primary germ layers) = **triploblastic**

- embryonic tissues
  - ectoderm
  - mesoderm
  - endoderm

- adult tissues
  - epidermis
  - parenchyma
  - gastrodermis

mesoderm makes more elaborate organs possible it differentiates into different kinds of muscle layers

organ systems are better developed only major phylum that is mostly parasitic species of 4 classes, 3 are made up of entirely parasitic species

**Body Wall**

A. **Epidermis**
free living forms have single layer of ciliated cells
parasitic forms have syncytial layer that lacks cilia

B. Muscle Layers

two layers around body wall:
circular muscle
longitudinal muscle

no rigid skeleton for muscles to act on

thick muscle layers in pharynx (=feeding tube) make it "prehensile"
in some primitive species these muscle cells resemble the epitheliomuscular cells of cnidarians

Feeding & Digestion

free living forms are mainly carnivores
most species are endoparasites

incomplete digestive tract in most
in some planarians digestive tract is highly branched to distribute food throughout the animal
some parasites (eg. tapeworms) completely lack a digestive system

pharynx = muscular "throatlike" tube

with true synapses between nerve cells

Excretion

they are the simplest major phylum with an excretory system

some wastes like ammonia are eliminated by diffusion through the body wall

others have primitive excretory system = protonephridia (tube closed at one end and exiting body at other end)

→ in most takes the form of "flame cells"
  cupshaped area with tuft of flagella beat of flagella resemble candle flame under microscope
  wastes and excess water diffuse into bulb
  flagella create current to send wastes through tube which opens to outside of the body

Reproduction

many reproduce both sexually and asexually

Asexual

fission
pinch in half

eversible in some → can be extended to find food
secretes enzymes to partially digest food before "eating" then suck in liquified food

once ingested enzymes are secreted into GVC
mostly extracellular digestion
some intracellular after phagocytosis

Respiration

no respiratory system

flatworms have high surface/volume ratio
gas exchange through flattened body wall

Nervous System

beginnings of cephalization
ie. at least some members have distinct head

flatworms were probably the first creatures to have a "brain"
head with cephalic ganglia (~ simple brain)

have pair of ventral nerve cords
connected by ladder like interconnections

some times produces a chain of zooids
  → superficial resemblance to segmentation

regeneration

flatworms have considerable powers of regeneration
replacement of lost parts
also to recover from long food shortage

budding

tapeworms bud off proglottids (reproductive sacs)

polyembryony

flukes
one egg can produce 100’s of larvae
increases chances finding a host

Sexual

almost all flatworms are monoecious (hermaphrodites)
cross fertilization not self fertilization
some with internal fertilization

Class Turbellaria (planarians)
almost all are free living
mostly bottom dwelling aquatic forms
mostly freshwater
some are marine
a few are even terrestrial (6 sp in US)
flattened, slender, ribbonlike or leaflike bodies
→ still rely on diffusion for much exchange of
gasses, nutrients and wastes
often brightly colored
some marine forms have warning coloration

Body Covering
epidermis is ciliated
secretes mucous trail and uses cilia to glide on it
land planarians can glide ~6/hr
contains rhabdites
discharge into water
swell and form protective mucous sheet around body
may also release toxins to subdue prey and escape
predators

Feeding & Digestion
incomplete digestive tract in most
→ mouth, no anus
some have more than one mouth & more than one
pharynx
mainly carnivorous
feed on small crustacea, nematodes, rotifers,
insects
can detect food at a distance by chemoreceptors
entangle their prey in mucous
wraps its body around prey
some marine flatworms prey on molluscs using a
neurotoxin produced by symbiotic bacteria
they engulf the whole animal or cover the opening of its
shell then produce the toxin to kill it
pharynx = muscular "throatlike" tube
extend prehensile proboscis to get prey
secretes enzymes to help "predigest" prey
sucks up bits of prey
in intestine secrete enzymes which further digest prey
phagocytic cells in gastrodermis take up bits of pieces
of prey and complete digestion intracellularly
GVC extends to most parts of body
→ also serves as distribution system
undigested food is egested through mouth

**Nervous System & Senses**
distinct head with cephalic ganglia

- pair of **ventral nerve cords** connected by ladder-like interconnections
- sense organs concentrated on head (vision, smell, touch, taste)
- paired sense organs allow brain to discern the direction of the stimulus
  - 2 eyespots (=ocelli)
  - can't form images, only detect light
- **auricles** contain tactile cells
tactile cells are also distributed over body surface

**Excretory System**
protonephridia with "flame cells"
in freshwater forms this is mainly a way to get rid of excess water
metabolic wastes still excreted through body wall
reduced or absent in marine forms

**Reproduction**

**Asexual Reproduction**

- **Regeneration**
  - turbellarians have considerable powers of regeneration
  - replacement of lost parts
  - also to recover from long food shortage
  - some can survive for months by self digesting up to 90% of their body

- **transverse fission**
  - pinch in half: anterior end splits from posterior end
  - sometimes produces a chain of zooids
  - superficial resemblance to segmentation

- **fragmentation**
  - when alarmed, some land planarians can break up into dozens of "blobs of slime"
  - in a few hours each piece will become a new worm

**Sexual Reproduction**
most are monoecious (hermaphrodites)
during breeding season each individual develops both male and female organs
 cross fertilization not self fertilization
some with **internal fertilization**
some with vaginas & penises - usually open through common genital pore

- in some monoecious flatworms mating ritual resembles a fight:
  - the male organ consists of two dagger-like penises.
  - during mating, two flatworms "penis fence" each trying to get penis in genital pore of the other
- some without vagina or genital pore use hypodermic impregnation:
  - each tries to stab the other with its penis while trying to avoid getting stabbed by the other
  - the one who gets stabbed absorbs the sperm and fertilizes its eggs
fertilized egg is enclosed in cocoon which is attached by stalks to underside of stones or plants
most have no larval stage
embryos emerge as juveniles that grow into adults

- a few marine species produce planula-like larva
  - (=Muller's larva)
  - ciliated ball of cells (has 8 ciliated lobes)
Examples of Turbellarians

eg. Dugesia
common in fw streams

eg. Phagocata
up to 20 pharynxes each with a mouth

eg Terricola = land planarians
fraction of an inch to almost 1’ long
creatures of dark or dim light
no eyes, 2 eyes or 100’s of eyes
hunters and scavengers
some terrestrial planarians are fast enough to catch fruit flies (*Drosophila*)
eg. one Brazilian species pursues earthworms into their burrows
enfolds it
mouth exudes digestive enzymes that liquifies it
then sucks up liquified worm

eg. Bipalium

terrestrial planarian common here
It also can eat small earthworms

eg. some marine planarians have symbiotic *zoophyllum* (algae) or feed on algae

some marine forms also have "kleptonematoxysts”
they eat cnidarian polyps and keep the stinging cells to use for defense

Animal Parasites

the other classes of Platyhelminths contain only parasitic species

Parasitism → most common form of symbiosis
20-50% of all animal species are parasitic
1/4th of all animal families are parasites

ectoparasites
→ parasite lives on outside of host
some can use gut for food storage and expand to many times their normal size
eg. leeches, ticks, fleas

endoparasite
→ parasite lives on the inside of host
digestive system often very simple or gone altogether
eg. tapeworms, flukes, roundworms

Benefits to Endoparasitic Lifestyle:
constant environment
gets easy access to food
protection from predators

Costs to Parasite:
host is a small "discontinuous” habitat parasite must locate and infect new hosts to propagate its species
must be able to overcome hosts defenses: inflammation immune response
but can’t kill host
→ the most successful parasites do as little harm as possible to their hosts

Some Typical Endoparasitic Adaptations

1. Structures for penetration and attachment to host
hooks, suckers, teeth, enzymes
most common point of entry to host is through mouth

2. Usually have a resistant stage in life cycle
for getting from one host to another which is often in a different kind of environment if endoparasite - needs to survive trip through digestive system

3. Reduction in “unnecessary” structures
reduced sense organs
reduced nervous system
reduced locomotion
reduced digestive system
some endoparasites have lost guts entirely
some ectoparasites use gut mainly for food storage
(eg. leeches, ticks)

4. Tendency toward being Hermaphrodite
only need any two, not male and female
some can even self fertilize if necessary but usually don’t

5. Enhancement of reproductive capacity
host is a small “discontinuous” habitat
→ need extraordinary powers of reproduction to insure survival
reproductive organs are often the largest, most apparent organ systems present
often able to produce of large #’s of eggs
Liver fluke (F. hepatica) → 20,000 eggs/day
Ascariis → 200,000 eggs/day
Tapeworm (Diphyllobothrium) → 1M eggs/day for 15 years (=5.5 trillion eggs/lifetime)

6. Use of intermediate larval stages on intermediate hosts
→ to enhance chances of getting to final host
Even with large numbers of eggs chances of success are relatively small

eg. F. Hepatica
in most favorable situation
3-4 out of 20,000/day will actually hatch

7. Behavioral Adaptations
behavior is an important tool for animal survival
this is also true for parasites: behavior can be used to enhance their chances for success
Examples:

1. Simple host finding behaviors
eg. Entobdella (Monogenea)
skin parasite of a stingray
eggs are released and settle to bottom
larvae emerge from eggs within 3 seconds of sudden darkness
then swim vertically upwards

2. Periodic Behaviors
parasite keys in on cyclic stimulus
eg. Filarial Worms
live in blood
transmitted by mosquito or fly

Amphipods (fw crustaceans) typically hide in dark vegetation during the day to avoid predation
when infected with acanthocephalan worm which as adult infects birds, became highly photophilic and conspicuous
eg. burrowing clams infected with a fluke,
rather than burrowing into sediment, remain closer to surface where they are more likely to be preyed upon
eg. Fluke (Leucochloridium)
adult in birds; larva in snail
when infected, snails tend to crawl to tips of vegetation instead of hiding like normal
in snail, larvae migrate to tentacles of snail
larvae are brightly colored with red and green bands
they pulsate
makes snails very conspicuous in daytime
at night the larvae withdraw into the snails body
eg. Sacculina
one of best adapted parasites known
Sacculina is a highly modified barnacle that has become a parasite of crabs
as it matures it sheds all appendages, becomes an oval sac and penetrates a crab host
develops an extensive system of branches extending into every appendage
a saclike growth appears under the crab’s abdomen
where eggs and sperm form (Sacculina is a hermaphrodite)
the crabs metabolism is completely altered:
if crab is female:
changes are not as extensive but egg development is inhibited
if crab is a male:
body assumes shape of a female
reduced length of some segments  
broadening of abdomen  
testes reduced or converted to ovaries  
→ both male and female resemble mature female  
bearing eggs: physically and behaviorally

**Helminths**

The most common human endoparasites are flukes, tapeworms (classes of Platyhelminths) and roundworms

These three are grouped together as "helminths" (=parasitic worms)

over 25% (1.5-2 Billion) of the world’s population is infected at any one time

that’s orders of magnitude greater infection rate  
as HIV

yet proportionally, helminth diseases receive only a small fraction of the research dollars

as such most are listed as "neglected tropical diseases"

over 135,000 die each year from helminth infections

helminth infections also have considerable effects on:

overall health and tissue damage & inflammation, anemias

over 135,000 die each year from helminth infections

class includes some of our most serious parasites

almost all are endoparasitic

adults mainly found in vertebrates

leaf-like body shape (=flukes)

two suckers for attachment:

  one around mouth
  the other further down on the body

adults & larvae inhabit a wide variety of sites in hosts:

  digestive tract
  respiratory tract
  circulatory system
  urinary system
  reproductive system

flukes tend to inflict greater harm to their hosts than do tapeworms

flukes can be found in veins of intestines, bladder, bile ducts and lungs

in high numbers they can cause blockages and damage

they feed aggressively on body fluids

can clog ducts and trigger gall stones and excessive enlargement of liver

**Body Wall**

body covered by thin flexible cuticle

protects from hosts digestive enzymes

integument is syncytium (not divided into individual cells) with no cilia

muscle layers are embedded in “tegument”

**Feeding & Digestion**

like turbellaria, they have well developed, incomplete digestive tract

→but with mouth at anterior end

gut usually divided into two branches

some dissolved nutrients can also be absorbed directly through skin

excretory and nervous systems similar to planarians

**Reproduction**

most are monoeocious and capable of self fertilization

Animals - Animal Phyla - Phylum: Platyhelminthes; Ziser Lecture Notes, 2015.10
trematodes typically have a complex life cycle with 1 or more larvae occurring in intermediate hosts and adults in definitive host

adults are typically parasites of fish or other vertebrates

1 to 5 larvae occur in intermediate hosts, usually a mollusc

polyembryony occurs usually in several larval stages allowing a single egg to develop into 100’s of potential adults

typical life cycle:

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egg → miracidium → cercaria → redia → sporocyst → metacercaria → adult
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egg
usually passes in feces
must reach water to develop

miracidium
free swimming larva
penetrates tissue of snail

seize the grass in their jaws and remain there until the next morning
sheep are early grazers and eat the ant

eg. *Fluke (Leucochloridium)*
adult in birds; larva in snail
when infected, snails tend to crawl to tips of vegetation instead of hiding like normal in snail, larvae migrate to tentacles of snail larvae are brightly colored with red and green bands they pulsate
makes snails very conspicuous
at night the larvae withdraw into the snails body during the day they are easy prey for birds

Examples of Flukes

eg. *Clonorchis sinensis* (Chinese Liver Fluke)
the most important human liver fluke
one of most complex life cycles:
primary host and two intermediate hosts
5 larval stages
serious problem in China, Asia, Japan
humans are final host (also cats, dogs, pigs) in which the adult lives
transmitted to humans by eating raw fish

Adult

10-20 mm long
oval, with 2 ventral suckers
simple digestive sacs
hermaphrodite
almost 80% of body is devoted to reproduction
flukes mature in intestine then move to bile ducts in liver

typically lives 15-30 years (up to 50 yrs)
light infection are asymptomatic or may produce light abdominal pain

heavy infection (up to 20,000) can cause liver damage, cirrhosis and death

1000’s of eggs released each day in feces into water

eggs can survive weeks in water

if snail eats egg miracidium larva hatches from egg and develops into sporocyst then redia then cercaria

table polyembryony, a single egg can produce 250,000 cercaria

cercariae burst out of snail and burrow into fish and encyst in muscle as metacercariae

if fish is eaten by mammal the metacercaria cyst dissolves in intestine and fluke moves to liver of their adult host

eg. *Fasciola hepatica* (Sheep Liver Fluke)

adult lives in liver and bile ducts of liver of sheep, other ruminants and can live in humans

feed on blood

can produce up to 50,000 eggs/day for several years

eggs passed in feces

if pasture is wet the eggs hatch into free living miracidium

miracidium ingested by snail or penetrates land snail and becomes sporocyst, then redia, then cercaria

table polyembryony, a single miracidium larva can produce up to 4000 cercaria larvae

cercaria leaves snail and encysts as metacercaria on vegetation

when vegetation is eaten by sheep or ruminants, the adult hatches and moves to liver

eg. *Schistosoma* (blood fluke, schistosomiasis)

doesn’t occur in US; but >400,000 immigrants are infected

one of the world’s major helminth infections

→ affects 200M worldwide:

esp Africa, S. America, Mid East, Far East

150,000 die each year from direct effects of the parasite; especially renal failure

another 200,000 die from related causes

snail is intermediate host, humans are final host for 3 mainly human species

other species of *Schistosoma* infect birds and mammals

mature adults live in portal vein of liver, feeding on blood

differ from most other flukes by being dioecious (separate sexed)

males larger

females smaller, stay in groove (=gynecophoric canal) in males body

female penetrates wall of blood vessel in liver and release eggs into bile ducts

eggs move from bile ducts to intestine and passed in feces

eggs might also enter bladder and be released in urine

many eggs can lodge in liver and cause abdominal pain, fever and bloody diarrhea, ulcerations, etc

eggs may also be carried to lungs causing inflammation

if eggs reach water they hatch into ciliated miracidium

have only a few hours to find snail host or they die

if eaten by snail they develop into sporocyst, then cercaria (no redia stage)

if humans are in contaminated water: cercariae bore directly thru skin to get into blood

cercaria are one of few parasites that can bore through skin

rice farmers are easily infected

in North America some blood flukes of birds may attempt to bore into humans

they don’t survive and cannot infect us
but their burrowing and death in skin can cause **swimmers itch**

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**eg. Paragonimus (Lung fluke)**

- lives in lungs of host
- many mammals are hosts
- found in East Asia, SW Pacific and parts of S. America
- eggs coughed up, swallowed then eliminated in feces
- metacercaria develop in fw crabs
- infection is acquired by eating uncooked crab meat
- infection causes breathing difficulties and chronic cough
- fatalities are common
- one species found in N America infects minks with its larvae in crayfish
  - only 1 human case reported

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**Class Monogenea**

A group of small (rarely >.75") mostly ectoparasitic flatworms

- widespread and common
- 1000’s of species
- once placed with trematodes
- all are parasites
  - mainly ectoparasites on gills or skin of fish
  - some species infect other cold blooded animals
    - one species infects the eye of hippos, no other warmblooded birds or mammals
  - a few are found in urinary bladder of frogs and turtles
- have anterior and posterior attachment organs
- seem to cause little damage to their hosts
- all are hermaphrodites
- direct life cycle with single host
  - they have no intermediate hosts

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**egg hatches into ciliated larva**

- larva and adult have large posterior attachment organ with hooks
Class Cestoda (Tapeworms)

- >1000 species
- most specialized class of flatworms
- all are endoparasites
- can grow up to 10 M (30') long
  - 1991: doctors removed 37' tapeworm from Mississippi woman
  - max tapeworm length ever recorded is over 90' taken from a sperm whale's intestine
- adult can live up to 20 years

**Body Plan**

- very different from other classes of flatworms
  - no head
  - front end of the animal is not a head, it's a special organ for attachment (=scolex)
  - has suckers and hooks
  - use for attachment, not for feeding or sensing the environment
  - "body" consists of a long chain of reproductive sacs = proglottids

  - proglottids bud off the scolex (a chain of proglottids = strobila)
  - bud from scolex with oldest ones furthest away
    - not same as segmentation since each proglottid acts as an individual animal
  - some individuals can produce a dozen proglottids/day
  - some tapeworms have up to 3000 proglottids

**Body Wall**

- tegument is syncytial (not subdivided into separate cells) with microvilli (microtrichs) to increase surface area for absorption
- tegument secretes a protective cuticle
- no external cilia
- well developed muscle layers beneath body wall

**Feeding & Digestion**

- completely lack digestive system
- typically the intermediate host is the prey of the adult host
- all are monoecious (hermaphrodites)
- the most mature proglottids are those furthest away from the scolex
- unlike most hermaphrodites, tapeworm proglottids can cross fertilize in same animal
  - testes usually develop before ovaries so generally can self-fertilize a single proglottid
- eggs or mature proglottids are shed in feces
- once egg is released must be ingested by intermediate host (another vertebrate)
  - usually a vertebrate "prey" of a final host
- once eggs ingested larva hatches and bores through intestines of host and into blood
- travels to skeletal muscle, heart and other organ
- secretes a protective cyst
- in some, cyst develops into a "bladder-worm" or cysticercus

**Nervous System**

- simple nervous system
- proglottids are united by nerve cords,
  - but no special sense organs

**Excretion**

- somewhat similar to other flatworms
  - protonephridia continuous throughout proglottids

**Reproduction & Life Cycles**

- each proglottid acts as "individual"
  - any two proglottids can exchange sperm
  - when gravid each proglottid may contain up to 100,000 eggs each

**Life Cycle**

- almost all tapeworms require at least 2 hosts; mainly vertebrates
  - but same host can bear either the adult or the larval parasite
humans can get infected with eggs by unsanitary habits with feces, not washing hands, kissing pets, etc

but humans make poor intermediate hosts from the parasites perspective

→ nothing eats them

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**Examples of Tapeworms**

**eg. Beef Tapeworms** (*Taenia saginata*)

> 50 Million infection worldwide; especially South America, SE Asia, Africa

adult in human intestine

mature adult may reach 10 M (30 ft) or more

scolex buries itself in intestinal wall

→ has 4 suckers to attach (no hooks)

can bud over 2000 proglottids

numerous proglottids are released each day:

- gravid proglottids break off and pass with feces

- sometimes they crawl out anus

- they crawl out of feces into nearby vegetation

- proglottids dry and release eggs

→ can remain viable on grass up to 5 months

picked up by grazing cattle

when eaten by cattle the eggs hatch

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**eg. Pork Tapeworm** (*Taenia solium*)

pork tapeworm is more dangerous to humans since the larval stage can more easily develop in humans

adults usually live in human small intestine

juvenile in muscles of pigs

adult can live up to 10 years and grow to 10’ long

generally doesn’t occur in US but thrives in Mexico and Central America

occasionally shows up along border.

WHO estimates that 2.5 Million are infected with adult worm and many more with larvae worldwide

scolex has hooks and suckers

life cycle is similar to beef tapeworm

each proglottid can release 50,000 eggs

eggs eaten by pigs and larva migrates to skeletal muscles

humans usually infected by eating poorly cooked pork and adult develops in intestine
if humans ingest eggs rather than the larva
the eggs will develop into a bladderworm that
encysts in body tissues
=cysticercosis

can cause serious problems by lodging in:
eyes → blindness
brain → neurological symptoms or death
muscle → pain and weakness, inflammation
and other visceral organs
treatment usually involves surgery

grows quickly; 1 cm/month, for up to 20 years
may be no symptoms for years
can reach size of basketball
→ up to 4 gallons
within main cyst daughter cysts bud off
each daughter cyst contains 1000’s of
scolices
symptoms and signs depend on the cyst’s
location and size
in humans, growth of cyst can cause damage to
organ
if cyst ruptures the fluid itself can produce
anaphylactic shock, even death
only treatment is surgical removal

eg. Echinococcus (dog tapeworm)
about 1 Million are infected worldwide.
one of the most dangerous tapeworms
a group called “tissue tapeworms”
adult is very small: only a few mm
adults occur in dogs, coyotes, wolves and other
canines
juvenile develops in >40 species of mammals
(eg. monkeys, sheep, reindeer, cattle)
including humans
sheep infected with juvenile lag behind healthier
members of heard → more easily caught and
eaten by coyote
humans can become intermediate hosts by
fecal-oral route; eg. kissing pets
(humans are dead end choice for parasite since few
eat humans)
once ingested, juvenile moves to various
tissues; eg. liver, lungs, brain
juvenile stage is special kind of cysticercus
= hydatid cyst

eg. Fish Tapeworm (Diphyllobothrium latum)
humans and other animals are definitive host
occurs wherever fish are an important food
source and the water supply is easily
contaminated with sewage
endemic in Europe, Asia, US & Canada
2 intermediate hosts: copepods & fish
in humans, adult attaches to intestinal lining by
scolex (no hooks)
eggs are released in feces
if feces enters water eggs may be eaten by tiny
crustacean, copepod
fish eats copepod and bladderworm encysts in fish
muscle
if fish are improperly cooked, or eaten raw (sushi)
the infection is transferred to humans
thorough cooking or freezing (-10º C) for 24
hrs kills the parasite
eg. *Diphylidium caninum*

- adult in small intestine of dog or cat
  - up to 6” long
- fleas are intermediate host
  - fleas eat tapeworm eggs released in pet feces
  - egg hatches and encysts in flea
- dog eats fleas and bladderworm hatches into adult

**Human Costs of Parasitic Flatworms**

250-300 Million people worldwide are infected with some type of parasitic flatworm
- (some put that number much higher)
results in Billions of dollars in healthcare costs and lost productivity
also affects livestock and pets

**Beneficial Effects of Parasitic Flatworms**

1. **weight loss**

   - light infections of adult tapeworms cause little damage and may cause a loss in weight
   - larvae once sold as weight loss pills in US
today the treatment is only available in Mexico, the approximate cost is $1500.
tapeworm infestation can result in a loss of one to two pounds per week.
   - once the target weight loss is reached, a deworming agent is given

However, Tapeworm infestation can result in:

- The formation of cysts in the liver, eyes, brain, and spinal cord with potentially lethal consequences.
  - if pork tapeworm much more serious
- intestinal blockages
- malnutrition

2. **Helminth Therapy**

   - a type of immunotherapy to treat autoimmune diseases and immune disorders by deliberately infecting patient with intestinal parasites
research has found that intestinal parasites, particularly roundworms have the ability to temper the immune system and prevent the overreactions that cause allergies, asthma, ulcerative colitis, Chron’s disease, etc
helminthes have thrived in mammals for millions of years
over that time they have adapted to survive the onslaught of the hosts immune responses to the infection

"Hygiene Hypothesis"

- as hygiene has improved allergies, asthma and other autoimmune diseases have dramatically increased
in developed countries, where improved sanitation has largely eliminated helmint infections there has been an increase in such autoimmune disease in the past 100 years
these same diseases are rare in poor countries where intestinal parasites are endemic
there is a large "underground market" in helminth parasites fueled by these findings – medicine is just now catching up