


## Biomedical Parasitology


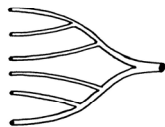

# HOOKWORMS



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## Nematode infections

gastro-intestinal	vascular	tissues, organs
		
simple cycle (egg infective) diarrhoea/obstruction complex cycle (larvae infective) blood loss/anaemia	vector-borne (microfilariae) oedema	intermediate hosts (larval stages) lesions/malfunction

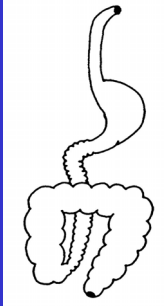
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## ENTERIC NEMATODES

Simple life cycles	- eggs ingested - larvae/adults in gut e.g. <i>Trichuris</i> (whipworm) <i>Enterobius</i> (pin worm) <i>Trichostrongylus</i> (hair worm) <i>Capillaria</i> (round worm)
More complex	- egg ingested - larvae migrate through lungs - adults in gut e.g. <i>Ascaris</i> (round worm)
Most complex	- larvae penetrate skin - larvae migrate through lungs - adults in gut e.g. <i>Ancylostoma/Necator</i> (hookworm) <i>Strongyloides</i> (threadworm)

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## ENTERIC NEMATODES



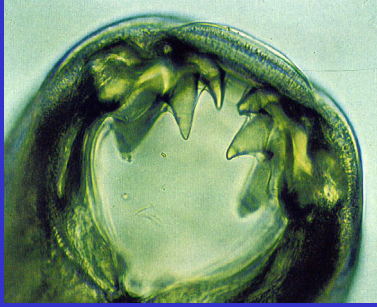
<i>Trichuris trichiura</i> <i>Enterobius vermicularis</i> <i>Trichostrongylus orientalis</i> <i>Capillaria phillippinensis</i> <i>Ascaris lumbricoides</i>	} enteritis
<i>Ancylostoma duodenale</i> <i>Necator americanus</i> <i>Strongyloides stercoralis</i>	} anaemia

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## *Ancylostoma/Necator* (hookworms)

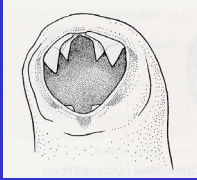

Order: Strongylida

- anterior end hooked dorsally
- buccal capsule with teeth or cutting plates
- used to feed on host tissues and blood

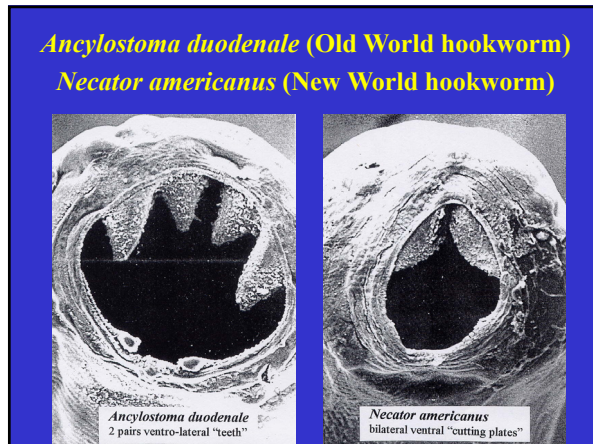


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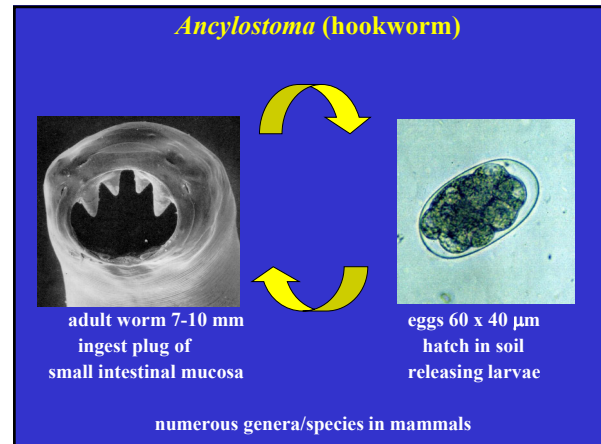
## Hookworms in Australia

<b><i>Ancylostoma</i> - with teeth</b> <i>A. caninum</i> - dog, fox, cats (human) <i>A. duodenale</i> - human <i>A. tubaeforme</i> - cat <i>A. braziliense</i> - dog, cat, fox (tropics)	
<b><i>Uncinaria</i> - without teeth</b> <i>U. stenocephala</i> - dog, cat, fox	
<b><i>Bunostomum</i> - without teeth</b> <i>B. phlebotomum</i> - cattle <i>B. trigonocephalum</i> - sheep	
<b><i>Necator</i> - with plates</b> <i>N. americanus</i> - human (probably extinct in Australia)	

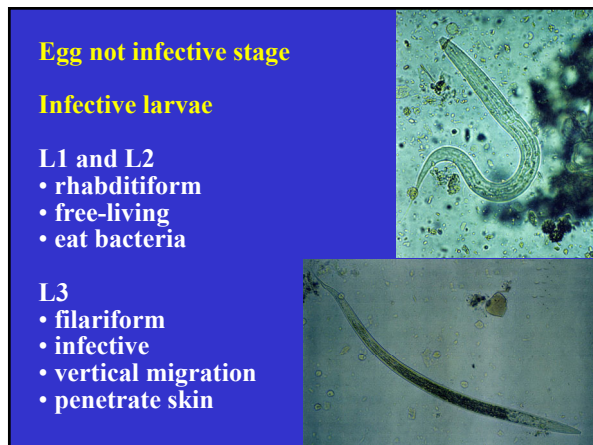
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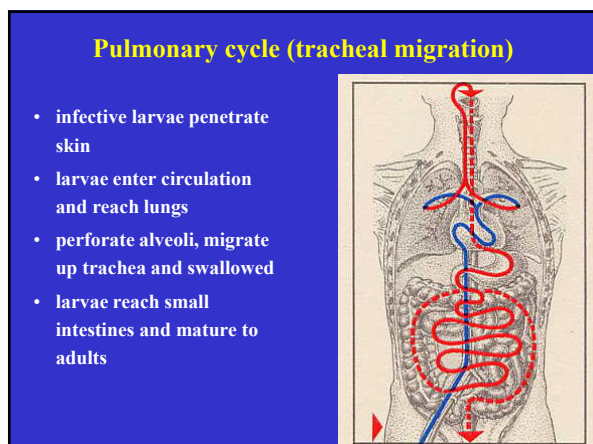
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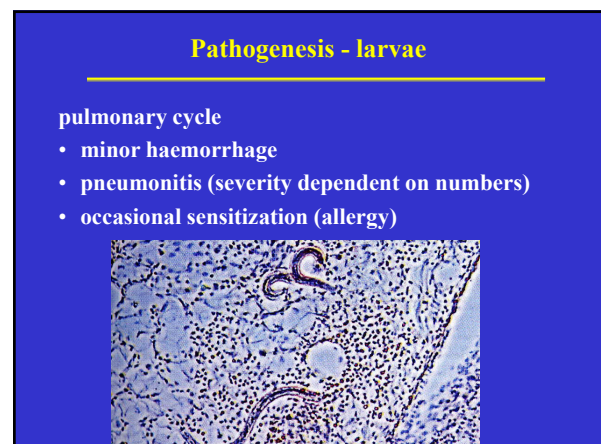
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**transmission through contaminated soil**

cycle  
2 months – 9 years

esp. prevalent where faecal contamination of moist/irrigated soil/lawns/gardens (also mines)

infections > 100 worms may cause severe disease

*Ancylostoma duodenale* CREPLIN 1845  
*Necator americanus* STILES 1903

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**Pathogenesis**

- biting worms cause tissue necrosis and abdominal pain (acute stage)
- feeding worms cause anaemia, hypoproteinaemia, iron deficiency (chronic stage) 0.03-0.2 ml blood lost per worm per day (wasteful feeders)
- impaired intestinal absorption (diarrhoea with blood/mucus)
- infections may be fatal in severe cases

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**Pathogenesis**

- infections can also cause eosinophilic enteritis
- previously warranted exploratory surgery
- excision and resection (considerable trauma)
- nowadays treated with anthelmintics

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**Phenomenon of HYPOBIOSIS**  
“arrested larval development”

e.g. *A. duodenale*

larvae may become “arrested” in gut or muscles and then recommence their development later

this means that hookworms may enter the intestine weeks or months after infection

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**Infection routes**

- via skin** – larvae penetrate skin
- enteric** - larvae penetrate gut (*A. duodenale*)
- transplacental** - larvae cross placenta (*A. caninum*) and infect offspring
- transmammary** - larvae may infect neonates via breast milk (*A. duodenale/A. caninum*)
- via paratonic hosts** - larvae may survive in tissues of other mammals and even in insects

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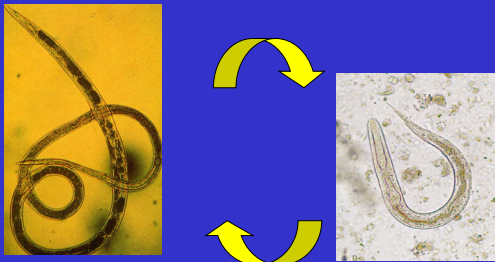
***Strongyloides* (threadworm)**

Order: Rhabditida

- typical species are free-living soil-dwelling nematodes, feed on bacteria, with “rhabditiform pharynx”
- parasitic species of considerable importance
- parasites are hermaphroditic females (ovary produces sperm as well)

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**Strongyloides (threadworm)**



hermaphroditic female 5-7 mm  
embedded in small intestine mucosa

larvae in faeces

numerous taxa ranging from free-living to parasitic  
in cattle, sheep, horses, pigs, dogs, cats and humans

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**Thin-walled eggs hatch in mucosa**

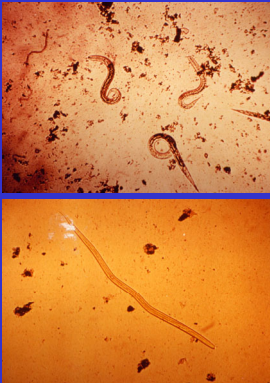
**Larval development**

**L1 and L2 (350 µm)**

- rhabditiform
- passed in faeces

**L3 (600 µm)**


- filariform
- infective
- penetrates skin



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**Pathogenesis - larval**

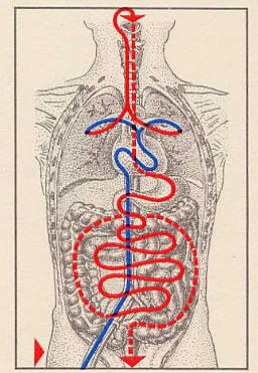
- larval currens (racing larva)  
up to 10 cm/hr
- urticaria
- pruritis
- eosinophilia
- dermatitis
- inflammation



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**Pulmonary cycle (tracheal migration)**

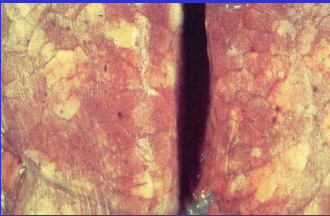
- infective larvae penetrate skin
- larvae enter circulation and reach lungs
- perforate alveoli, migrate up trachea and swallowed
- larvae reach small intestines and mature to adults



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**Pathogenesis – pulmonary cycle**

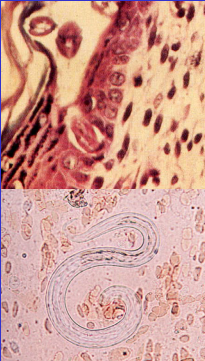
- asymptomatic
- pneumonia
- cough, wheezing
- shortness of breath
- transient pulmonary infiltrates (Loeffler's syndrome)



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**AUTO-INFECTION**


- Eggs may hatch and emergent larvae moult twice in intestine to become infective
- Auto-infection may then occur by penetration of larvae in lower gut or peri-anal region
- Auto-infection allows infection to persist and to become very heavy if conditions are right



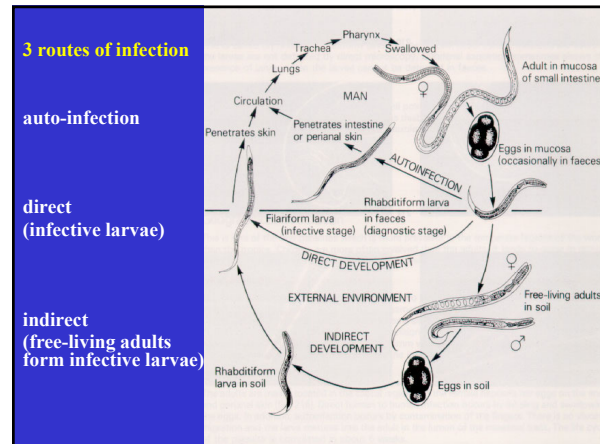
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### Free-living adults

- some rhabditiform larvae passed in faeces form free-living adults (male and female)  
[not in temperate climates]
- females produce eggs
- larvae hatch and moult twice to form infective filariform larvae
- infective L3 larvae penetrate skin (rarely ingested)
- tracheal migration
- form parasitic females



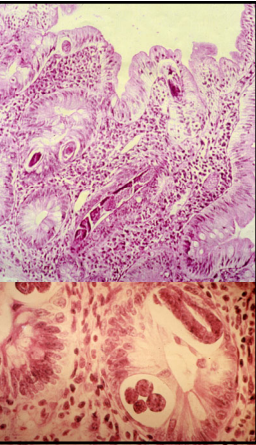
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### Pathogenesis

- many asymptomatic
- infections may persist for years (auto-infection or re-infection)
- heavy infections damage mucosa
- sloughing, haemorrhage
- epigastric pain (may mimic peptic ulcer or Crohn's disease)
- peripheral eosinophilia
- reactive arthritis?




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### Pathogenesis - Hyperinfection

Heavy infections can develop when individuals are immunosuppressed/stressed

- large numbers filariform larvae produced
- penetrate bowel and disseminate
- cause colitis
- polymicrobial sepsis
- pneumonitis
- meningitis



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### TREATMENT - nematocides

Anthelmintic	mebendazole	albendazole	pyrantel
<i>Ancylostoma</i> (hookworm)	+	-	+
<i>Strongyloides</i> (threadworm)	-	+	-

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### SUMMARY

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