APPLIED ENTOMOLOGY AND PARASITOLOGY

ZOO611

Lecture (6)

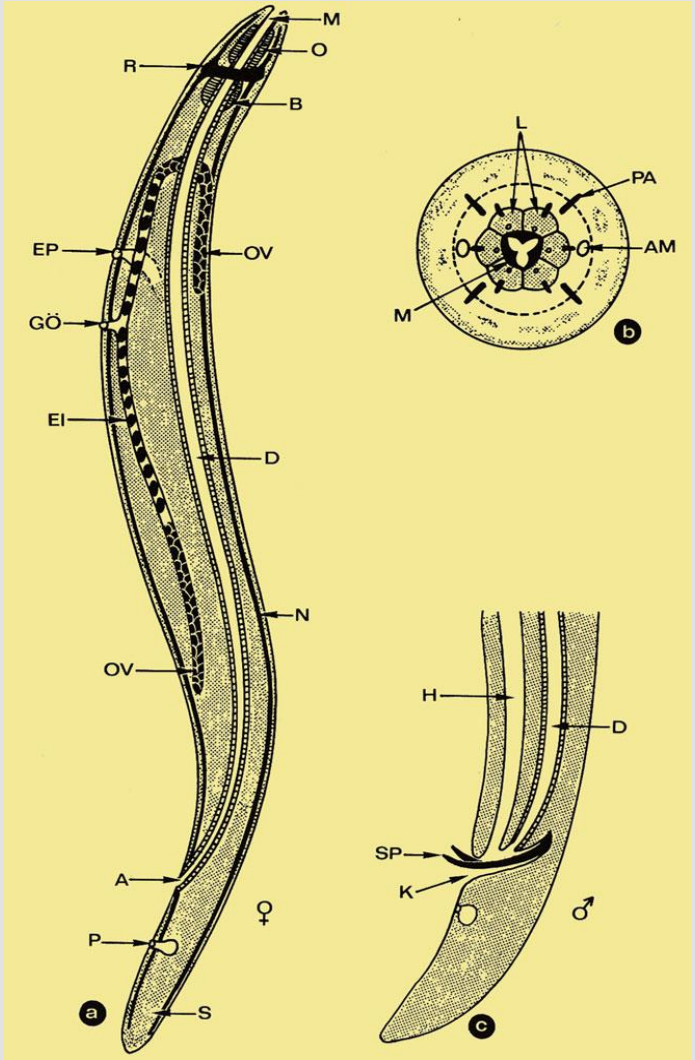
Nematodes and related diseases

Nematodes (Nematozoa, Roundworms)

… Nematodes have depending on the species a cylindrical or filament-like body shape.
… They mostly are sexually differentiated in males and females, which in their largest numbers of species are free living in the soil or in fresh or salt waters.
… However, also many species have developed a parasitic life cycle in humans, animals and plants.

Zoonotic infections of humans by important nematodes

Species	Nonhuman hosts	Observations in humans
Ascaris suum	Pigs	Mature adults in small intestine
Ancylostoma braziliense	Cats, dogs	Cutaneous larva migrans
Ancylostoma caninum	Dogs	Adults, cutaneous larva migrans
A. ceylonicum	Cats, dogs	Adults
A. japonica	?	Larva migrans
A. malayanum	Bears	Larva migrans
A. tubaeforme	Cats	Larva migrans
Necator suillus	Pigs	Adults
Trichuris suis	Pigs	Adults
Trichuris vulpis	Foxes, dogs	Adults



Diagrammatic representation of the morphology of female and male nematodes in longitudinal sections (a, c) and in cross sections (b, d). (a) Female in longitudinal section; (continued) (b) Cross section through the mouth region; (c) Male terminal end in longitudinal section; A=anus; AM=amphids; B=bulbus; D¼intestine; EL=oviduct, with eggs; EP¼excretion pore; GO=genital opening; H=testis; K=cloaca; L=lip; M=mouth; N=longitudinal nerve; O=oesophagus; OV=ovarial tube; P=phasmids; PA=sense papillae; R=ring of nerves; S=tail; SP=two spicula

Phylum: NEMATHELMINTHES (selected extract)
Subphylum: Nematoda
Class: Adenophorea (Aphasmidea)
Order: Enoplida
Family: Trichuridae (Trichurinae, Capillariinae)
Family: Trichinellidae
Family: Dioctophymatidae
Order: Mermithida
Family: Mermithidae
Class: Secernentea (Phasmidea)
Order: Rhabditia
Family: Rhabditidae
Family: Strongyloididae
Order: Strongylida
Superfamily: Ancylostomatodea
Family: Ancylostomatidae
Family: Uncinariidae
Superfamily: Trichostrongyloidea
Family: Trichostrongylidae
Family: Dictyocaulidae
Family: Heligmosomatidae
Superfamily: Metastrongyloidea
Family: Metastrongylidae
Family: Angiostrongylidae
Family:Protostrongylidae
Superfamily: Strongyloidea
Family: Strongyloidae

According to their recent taxonomy status

… Nematodes and their subdivision into classes is based on the presence and absence of:
1- caudal papillae and its numbers
2- visible sensory organs (called phasmids)
3- their ability to become attached by the help of secretions of caudal glands at surfaces.

… Furthermore, the taxonomy uses criteria like the shape of the oesophagus, which are often hardly detectable.

Order: Ascaridida
Superfamily: Ascaridoidea
Family: Ascarididae
Family: Toxocaridae
Family: Anisakidae
Family: Cosmocercidae
Superfamily: Oxyuroidea
Family: Oxyuridae
Superfamily: Heterakoidea
Family: Heterakidae
Family: Ascaridiidae
Order: Spirurida
Superfamily: Spiruroidea
Family: Spiruridae
Family: Spirocercidae
Superfamily: Physalopteroidea
Family: Gnathostomatidae
Family: Physalopteridae

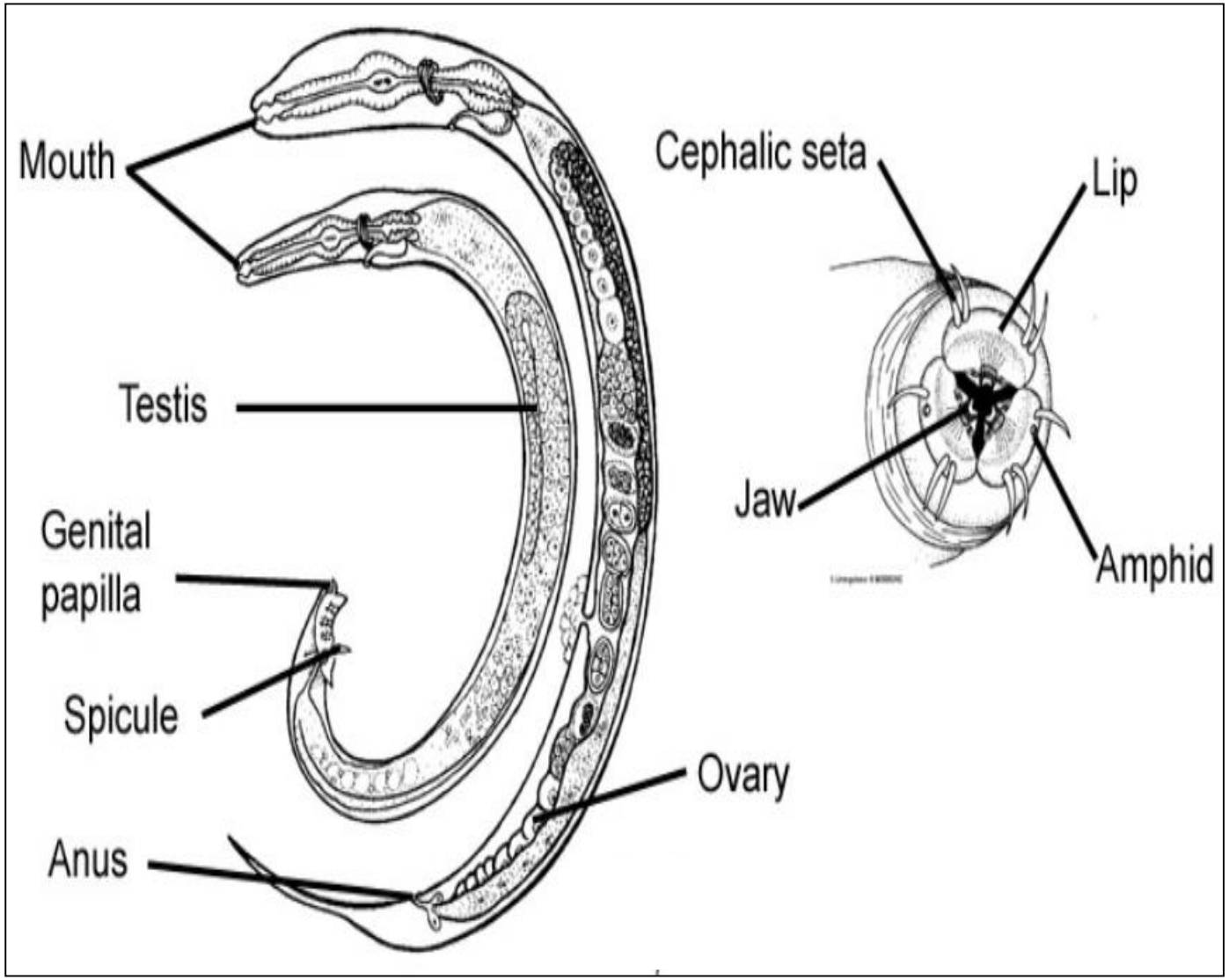
Superfamily: Filarioidea
Family: Filariidae
Family: Onchocercidae
Order: Camallanida
Superfamily: Camallanoidea
Family: Camallanidae
Superfamily: Dracunculoidea
Family: Dracunculidae
Family: Philometridae
Family: Micropleuridae
Family: Anguillicolidae
Order: Diplogasterida
Order: Aphelenchida
Order: Tylenchida
Superfamily: Sphaerularioidea
Family: Sphaerulariidae

Dictyophyme renale (Dictyophymiasis)

… It is commonly referred to as the **giant kidney worm** is a parasitic roundworm whose mature form is found in the kidneys of mammals.

… The adult worms reach as females an extraordinary size and appear intensively red due to the fact that they engorge blood. It possess only a single ovarial cord.

… The males are equipped with a protrusible hook (=spiculum), which is used to hold fast the female during copulation.

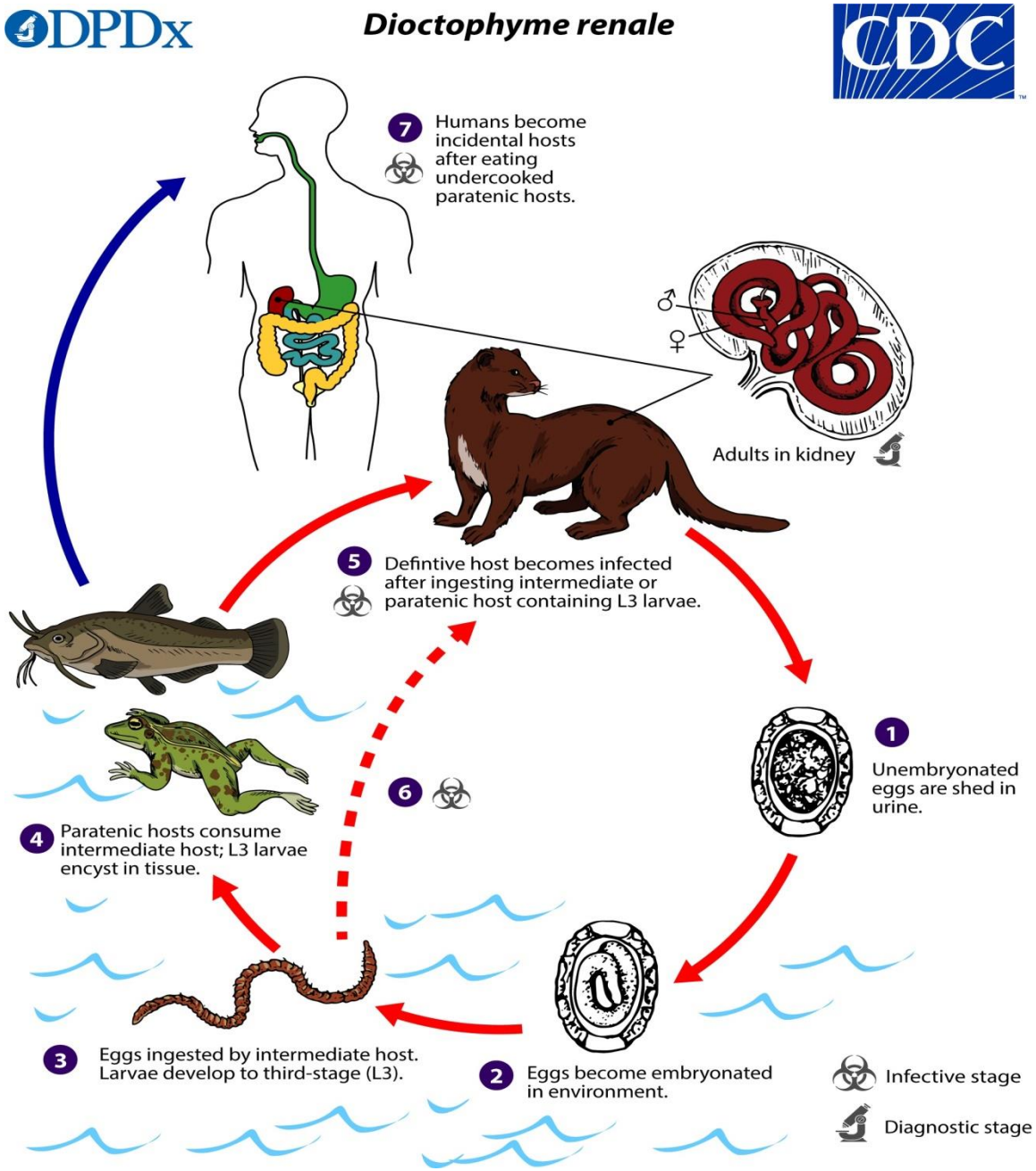


… The eggs are excreted in the urine of their hosts.

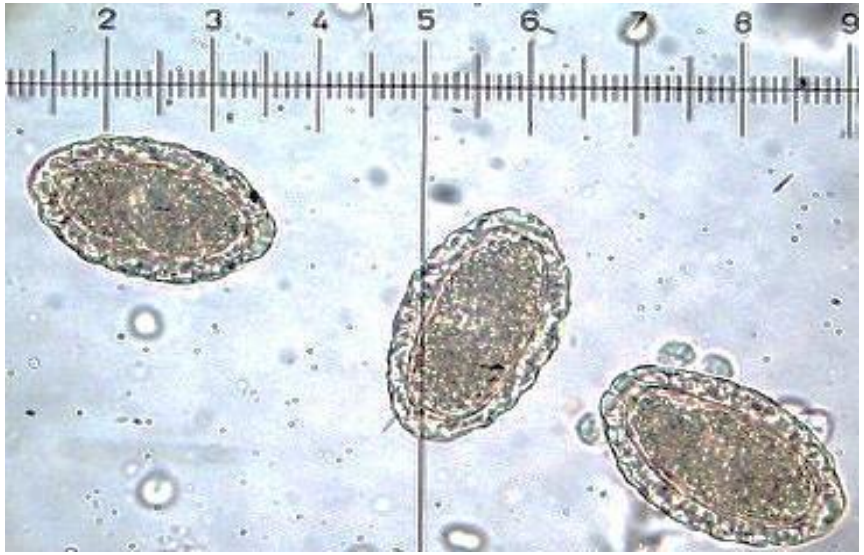
… Outside of the body a larva is developed, and ingested by a freshwater leech (first intermediate host). These leeches attach themselves to crabs, which are ingested by fish, which become second intermediate hosts.

… Inside these fish, the third-stage larva (L3) is developed or even (after a long waiting time) the pre-adult stage. The infection of humans and other final hosts occurs during *ingestion of raw or undercooked fish meat containing the infectious larvae*.

… The pre-adult worms wander into the kidney, where they reach within 3–6 months maturity and may survive for 1–3 years.



Diagnosis:
Microscopically demonstrations of the eggs in the sediment of centrifuged urine.



Symptoms of the disease:
Due to the large size of the worms, the kidney tissues are destroyed mechanically at many places, which leads to the fact that bloody urine is excreted (haematuria). Also secondary bacterial infections are common.

Incubation period: 1 month.

Patency: 1–3 years.

Therapy:
Removal of the adult worms from the interior of the kidneys and additional treatment with antibiotics to eliminate secondary bacterial infections.

Filariasis

… Filarial worms are thin, filamentous nematodes that are acquired following a bite from arthropod vectors, namely, black flies (*Simulium*) and mosquitoes.
… The parasites typically enter and interfere with lymphatic function or cause damaging inflammation in the organs they inhabit.
… Filariasis is a worldwide tropical disease best known as causes of elephantiasis.

… Filariasis is classified into 3 types:

1) Lymphatic filariasis (*Wuchereria bancrofti*, *Brugia malayi*, *B. timori*)

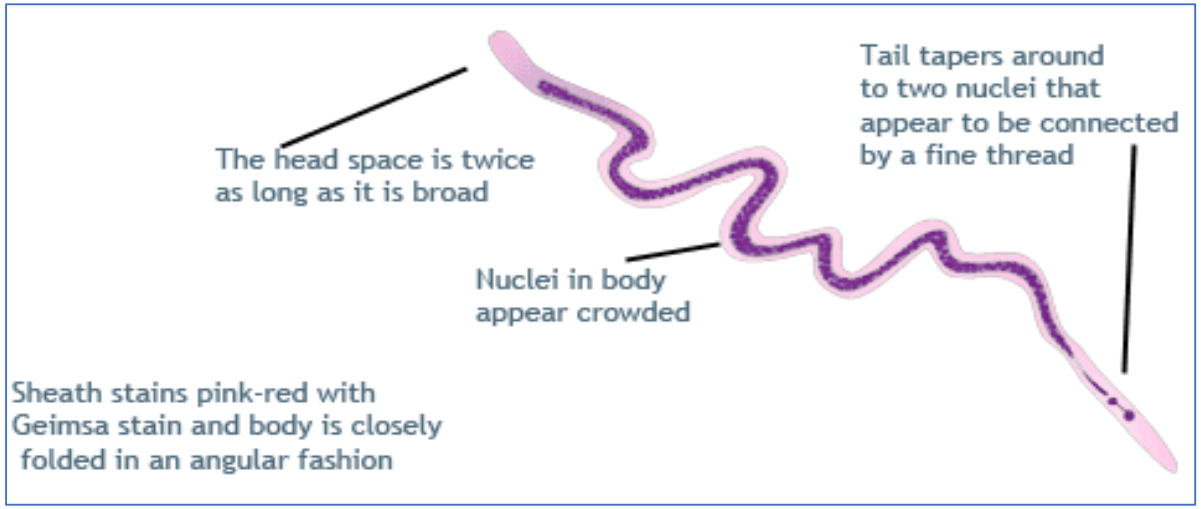
2) Subcutaneous filariasis (*Loa loa*, *Onchocerca volvulus*)

3) Serous cavity filariasis (*Mansonella* spp.)

Species	Site of inhabitation	Vector	Pathogenesis	Periodicity	Distribution
W. bancrofti	Lymphatic tissues	Mosquito	Lymphatic damage	Nocturnal	Worldwide
Brugia malayi	Lymphatic tissues	Mosquito	Lymphatic damage	Nocturnal	Asian
Brugia timori	Lymphatic tissues	Mosquito	Lymphatic damage	Nocturnal	Island of timor
Onchocerca volvulus	Subcutaneous, eye	Black fly	River blindness	Non-periodic	Africa
Loa loa	Subcutaneous	Deer fly	Skin swellings	Diurnal	Africa
Mansonella ozzardi	Peritoneal cavity	Midge	indefinite	Non-periodic	South America

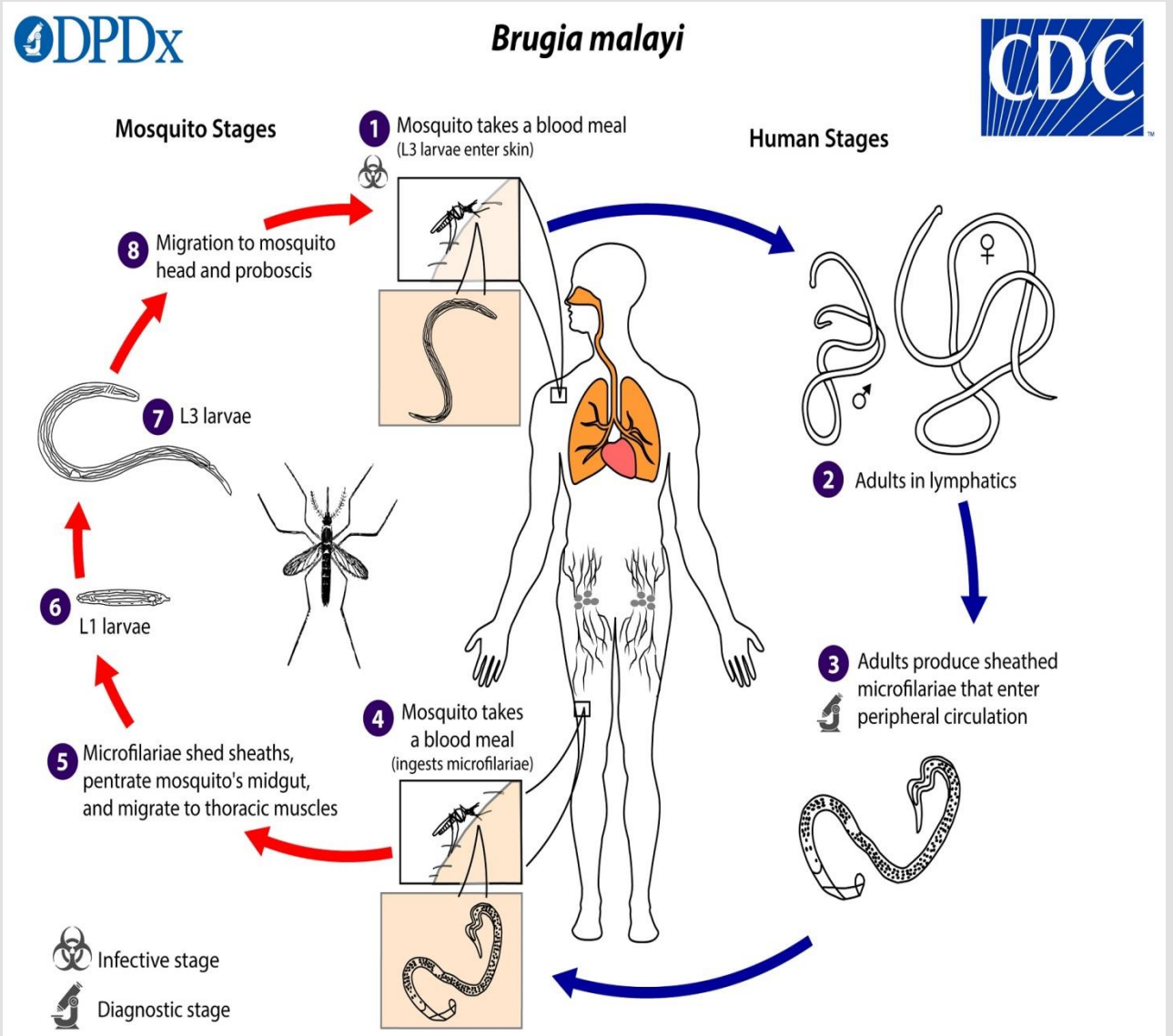
Brugia malayi (Lymphatic Filariasis)

It is a nematode (roundworm), one of the three causative agents of lymphatic filariasis in humans. Lymphatic filariasis, also known as elephantiasis, is a condition characterized by swelling of the lower limbs.



Pathway of infection:

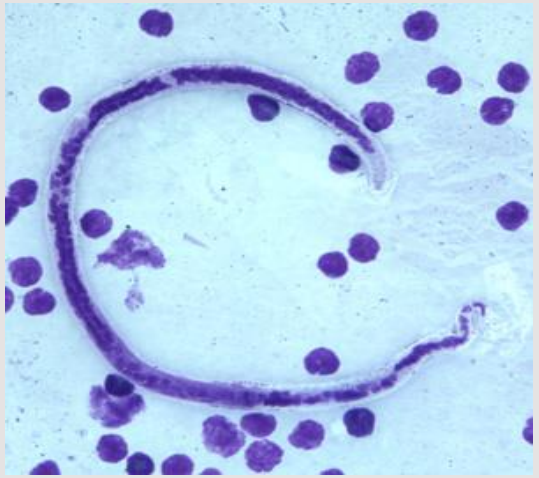
Cutaneously of microfilariae during bloodsucking of nightly active mosquitoes (intermediate host) of genera *Mansonia* & *Anopheles*. The development inside the mosquito takes about 6–7 days.

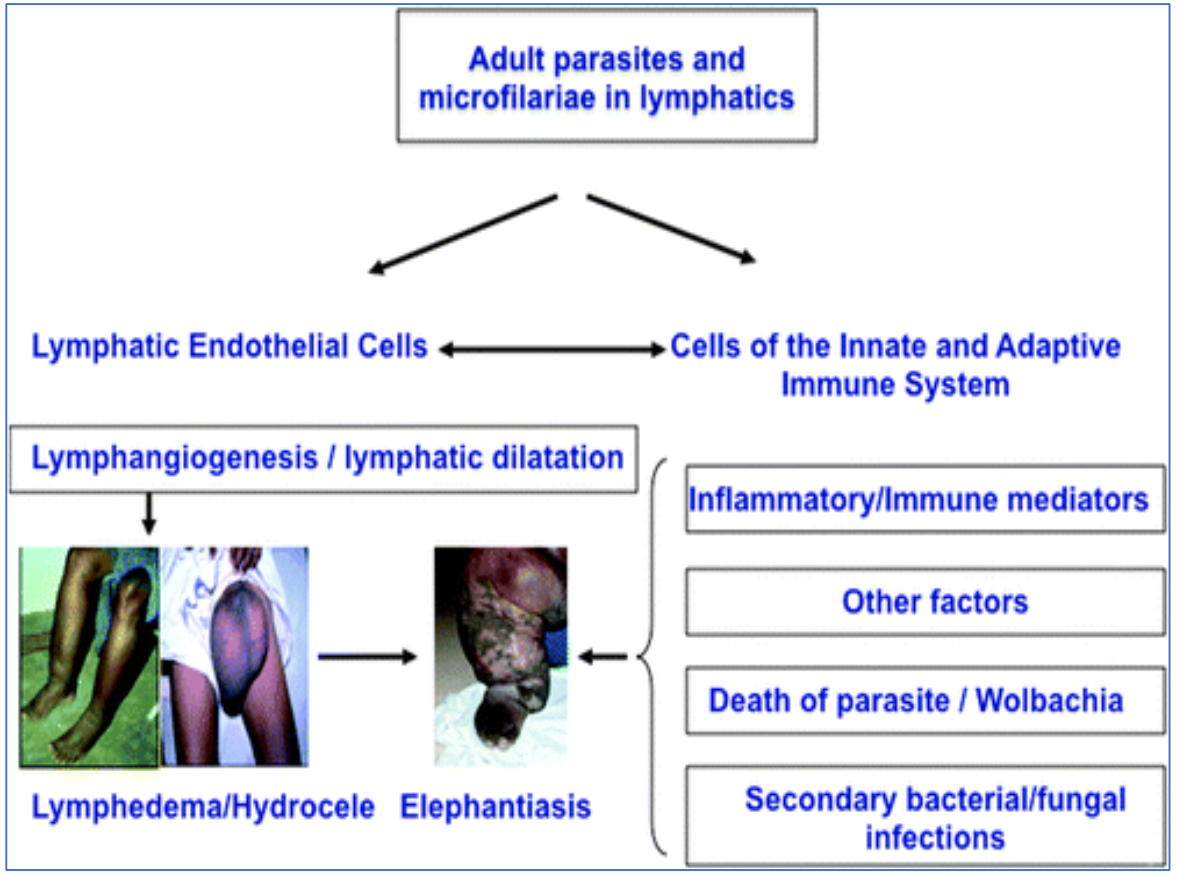


The sheathed microfilariae are from the nocturnal type.

Symptoms of the disease:
Early signs are lymphangitis and lymphadenitis being visible mainly along the legs and only rarely along arms.

Diagnosis:
Microscopically determination of the nightly in the peripheral blood appearing microfilariae.





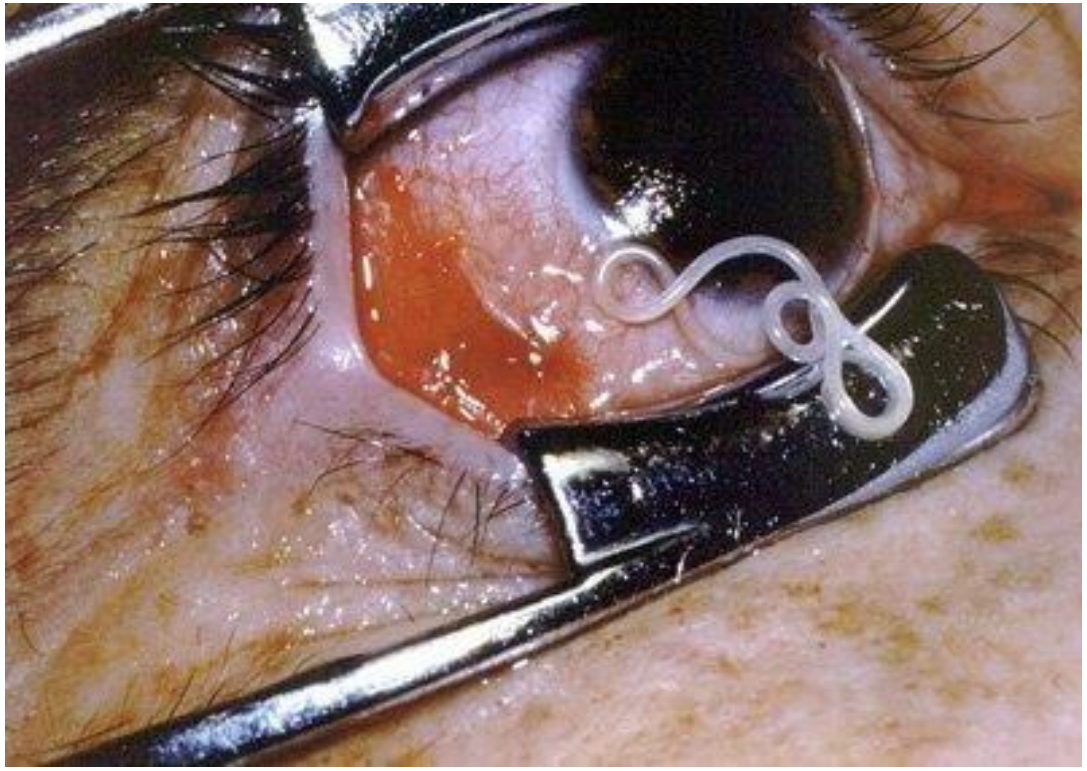
Incubation period: *B. malayi*: 30–60 days; *B. timori*: 60–90 days.

Patency: 8–10 years.

Therapy:
Mostly the treatment period can be reduced to 1–2 weeks using a total dose of 36 mg diethylcarbamazine per kg bodyweight. In the case of the use of doxycycline, 100 mg/day for 6 weeks was shown to be effective.

Loa loa (Eye worm - Loiasis)

… It is a blood dwelling Nematode that is parasitic to human beings.
… The adult worm wanders through the subcutaneous tissue but is most obvious as it crosses the conjunctiva of the eye leading to its common name, the African Eye Worm.
… Like all round worms it has separate male and female sexes.
… Infection with loa loa is called Loiasis.

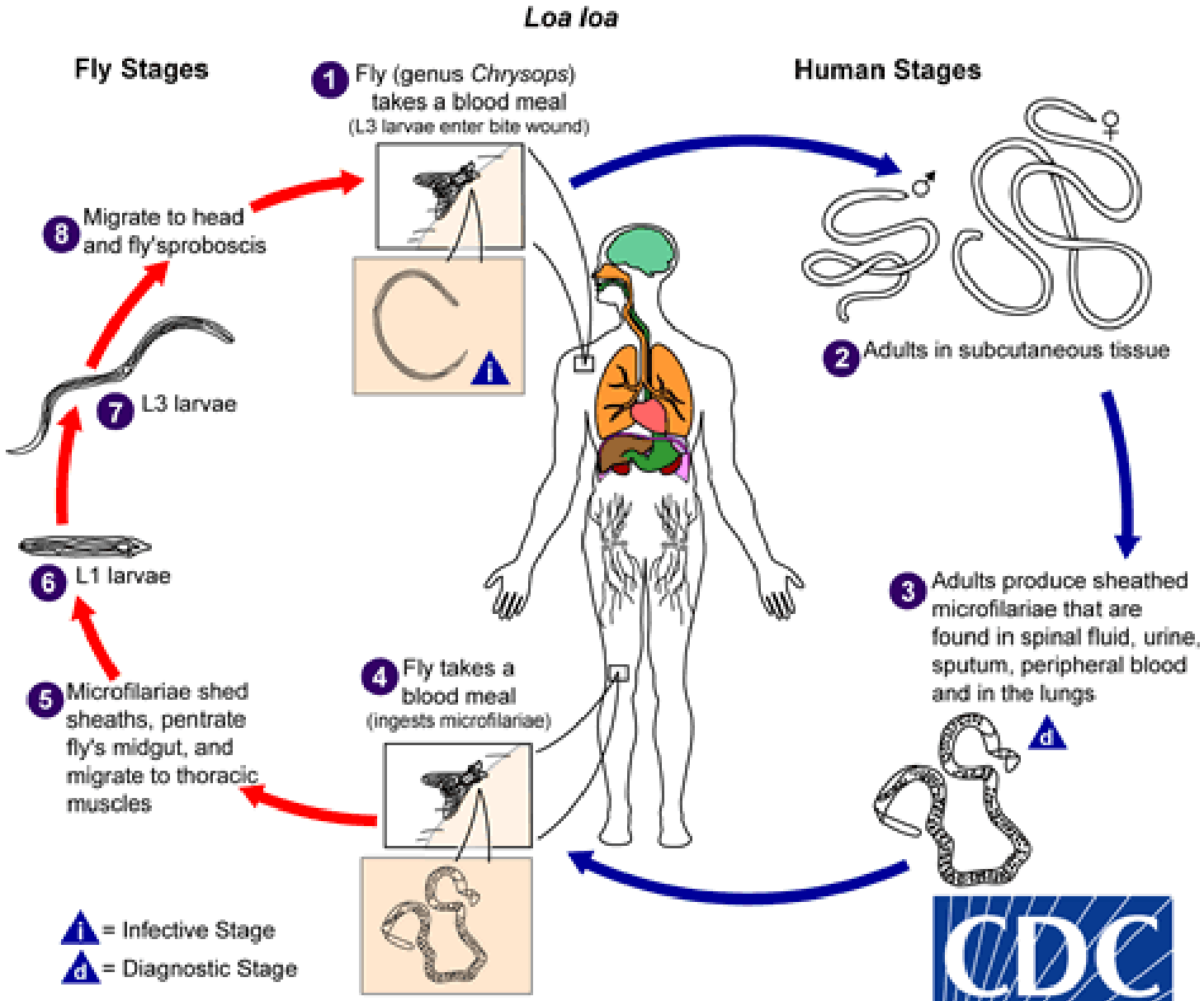


Loa loa microfilaria

… The larvae enter the bite wound, wander in the body, and develop into adults.

… The females release microfilariae that enter the blood, particularly during the day.

… The microfilariae are taken up by the fly during a blood meal and differentiate into infective larvae, which continue the cycle when the fly bites the next person.



Pathway of infection:

Humans are infected by the bite of the deer fly (mango fly, Chrysops) which deposits infective microfilariae on the skin.

Signs and symptoms:

1) There is redness, pain and itching in the eye but does not result in any long term symptoms.
2) The patients may also experience hives, itching, muscle pain and fatigue.
3) Sometimes, it can cause swollen glands and fluid collection around the lungs.

Diagnosis:

Definitive diagnosis:

1) Detection of microfilariae in daytime blood
2) Identification of adult worm in the subconjunctiva or subcutaneous tissue
3) PCR using Loa loa repeat sequence

Presumptive diagnosis:

Compatible clinical picture + positive antifilarial antibodies

Incubation period: 6–17 months.

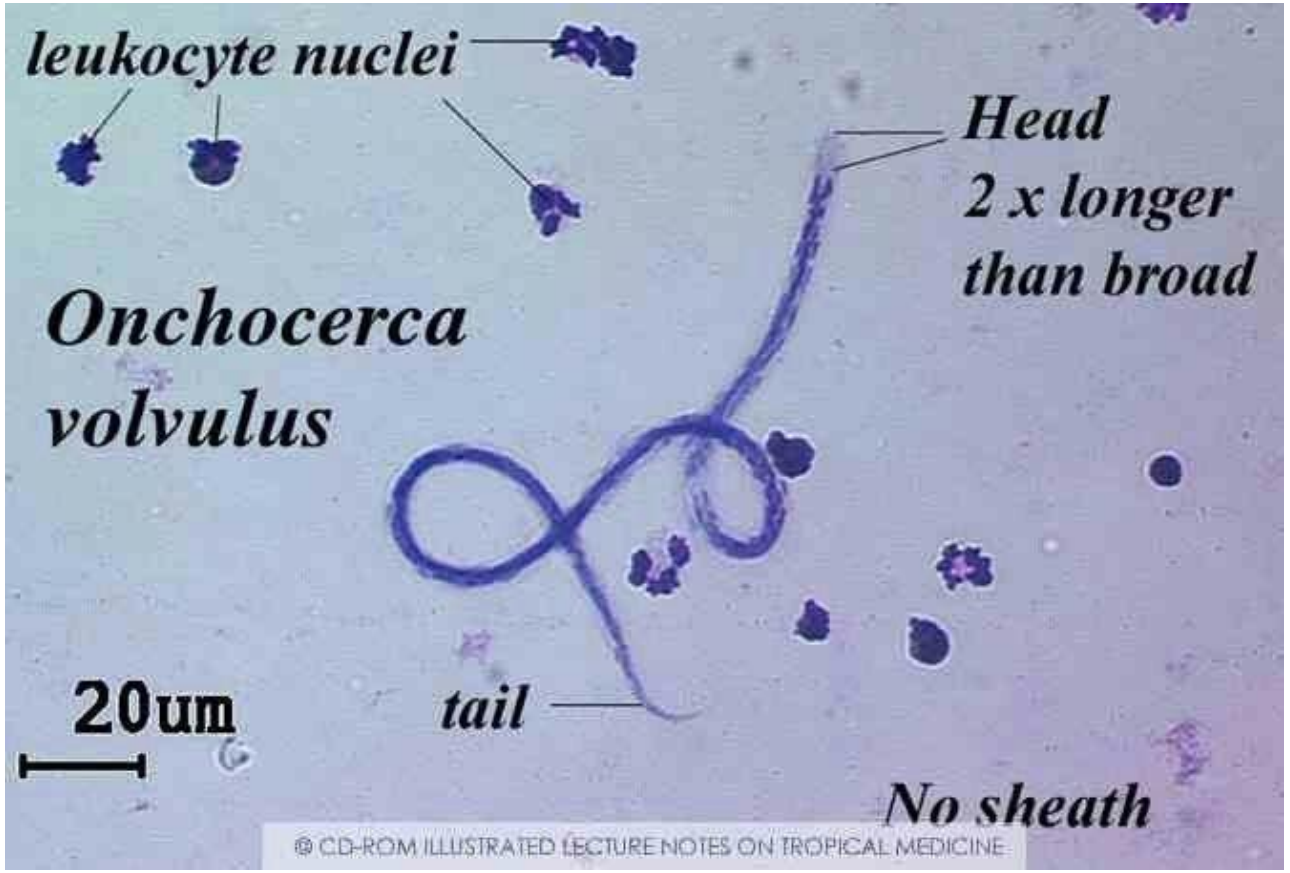
Patency: 4–17 years.

Therapy:

1) **Diethylcarbamazine (DEC)** treatment for 3–4 weeks with a total dose of 125 mg/kg bodyweight.
2) **Mebendazol** or **albendazol** (200–500 mg daily for 1–2 months) or **ivermectin** (1 × 0.3–0.4 mg/kg bodyweight) are also very effective.

Onchocerca volvulus (River blindness- Onchocerciasis)

It is a nematode that causes Onchocerciasis (river blindness), and is the second-leading cause of blindness worldwide after trachoma.
This parasite gets transmitted to humans through the bite of the infective female black fly with microfilariae.



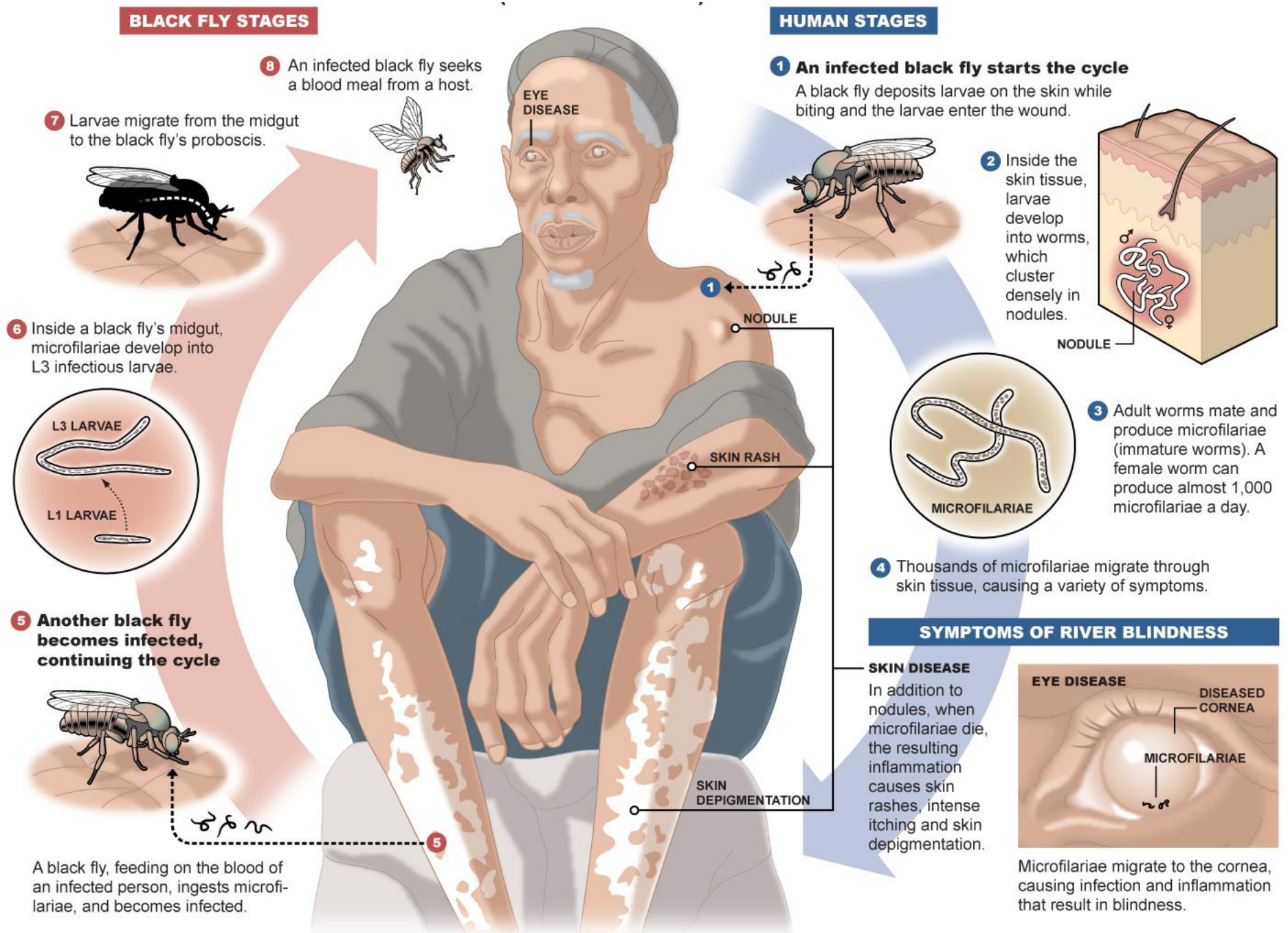
… Microfilariae are transmitted by blackflies.

… Humans appear to be the only natural definitive host.

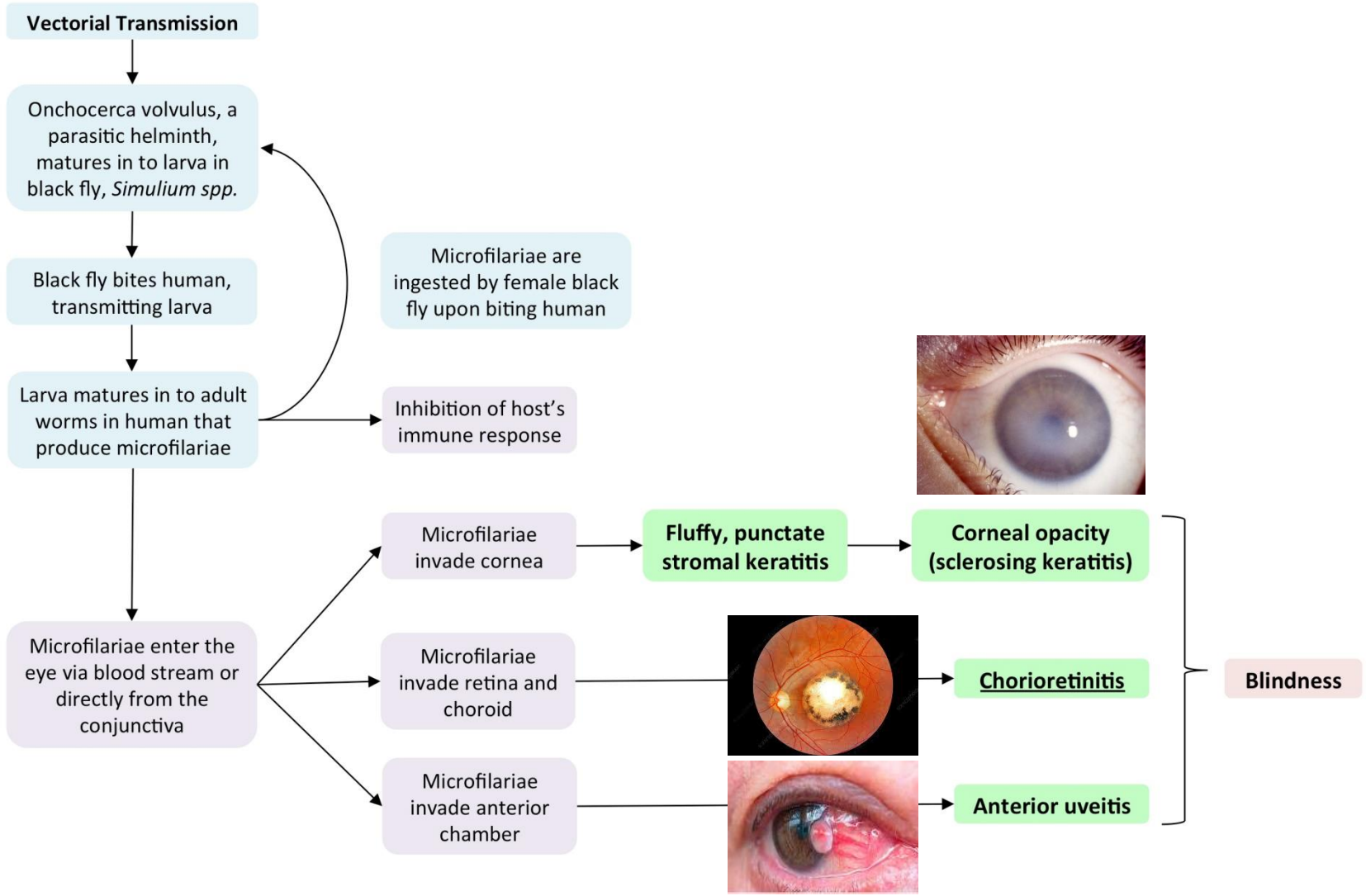
… Adults are encapsulated in subcutaneous nodules.

… Females give birth to microfilariae larvae.

… Larvae escape capsule and travel to other body tissues.



Onchocerciasis 'River Blindness': *Pathogenesis and ocular manifestations*



Diagnosis: Microscopically demonstration of the microfilariae obtained by the help of so-called skin snips.

Incubation period: 3–4 months.

Patency: 10–16 years.

Therapy:
Drug of choice is **ivermectin** (1 × 50–200 mg/kg bodyweight) due to its easy use and absence of side effects. It acts slowly, but only on microfilariae and not on adult worms.

Diethylcarbamazine (DEC) acts also only against microfilariae, but has a higher risk of allergic reactions and may endanger eye functions.

Published **September 23, 2016** on www.thecalgaryguide.com

Subkingdom Metazoa
Branch Eumetazoa (Enterozoa)
Division Bilateria (Triploblastica)
Section Eucoelomata (Coelomata)
Group Protostomia (Mouth first & Anus second)
Phylum Annelida (Ring or segmented worms)

General characters of annelids

1- Body elongate and clearly segmented both externally and internally.

2- Appendages are minute rod-like chitinous setae.

3- Body is covered by a thin, moist cuticle.

4- Circulatory system is a closed type, pseudohearts are present. Blood plasma usually contains dissolved haemoglobin and free amoebocytes.

5- Sexes may be separate and sometimes united. Some reproduce asexually by budding.

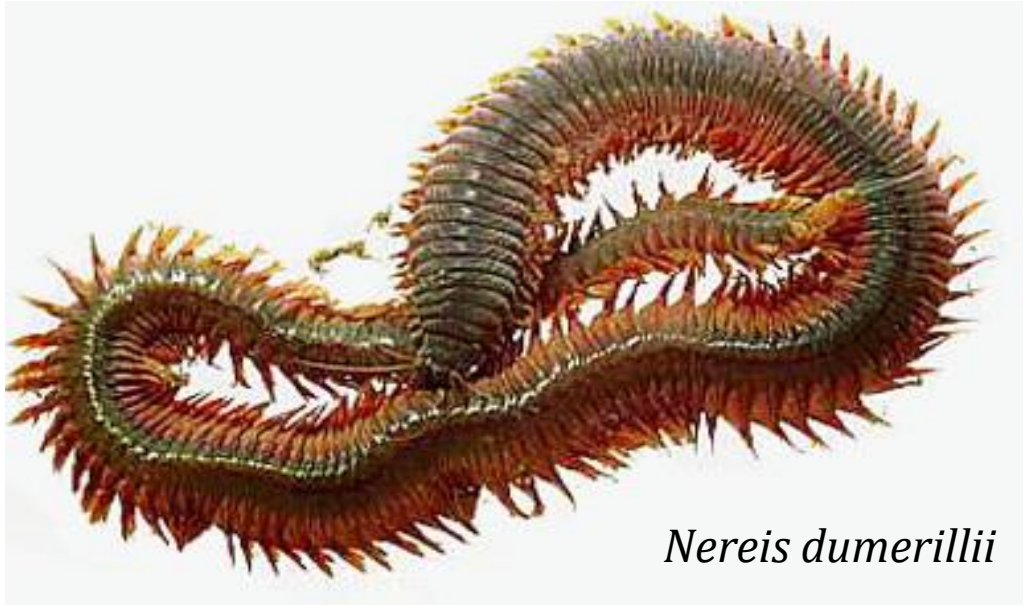
Classification of Phylum Annelida

Annelids are divided into 3 main classes according to some morphological features

Point of comparison	Class Oligochaeta	Class Polychaeta	Class Hirudinea
Examples	Earthworms Ex. *Allolobophora* Ex. *Pheretima*	Sand worms with 2 types 1- Errant polychaetes Ex. *Nereis* 2- Sedentary polychaetes: a- True tubicolous Ex. *Amphitrite* b- Burrowing Ex. *Arenicola*	Leeches Ex. *Hirudo medicinalis* Ex. *Limnatis nilotica*
Chaetae (Setae)	Present & few	Present & numerous	Absent
Habitat	Terrestrial or aquatic (mostly freshwater)	Aquatic (mostly marine)	Aquatic (freshwater or marine) or terrestrial
Mode of living	Free-living	Free-living	Free-living or ectoparasites
Head region **- Tentacles & palps** **- Simples eyes**	Absent Absent Absent	Present & well-developed Present Present	Absent Absent Absent
Clitellum	Present & permanent	Absent	Appears only at sexual maturity (breeding)
Coelom	True & wide	True & wide	True & reduced by connective tissue and muscles
Parapodia (serve as limbs & also as gills)	Absent	Present	Absent
Suckers (anterior & posterior)	Absent	Absent	Present
Sex	Hermaphroditic (bisexual)	Mostly unisexual	Hermaphroditic (bisexual)
Gonads	Few, fixed in number and position	Not fixed in number and position	Few, fixed in number and position
Male & female gonopores	Paired & fixed position	Absent and gametes are released through coelomoducts or nephridiopores	Median, unpaired and fixed position
Development and larval stages	Direct in cocoons without larval stages	Indirect through a trochophore larva (trochosphere)	Direct in cocoons without larval stages
Excretory organs	Nephridia beside the yellow cells (chloragogenous) as in *Allolobophora*	Nephridia only	Nephridia beside the botryoidal tissue as in *Hirudo medicinalis*
External division of body segments into secondary segments (annuli)	Absent	Absent	Present

Examples of Phylum Annelida


Allolobophora caliginosa


Nereis dumerillii


Amphitrite ornata

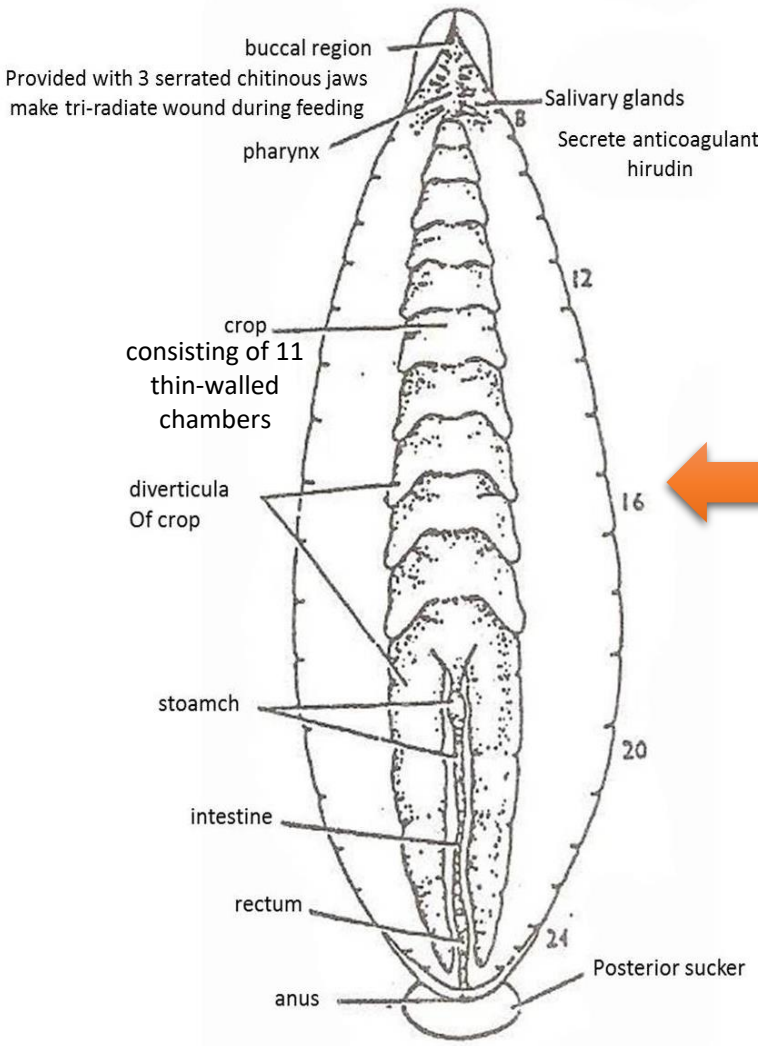

Arenicola marina

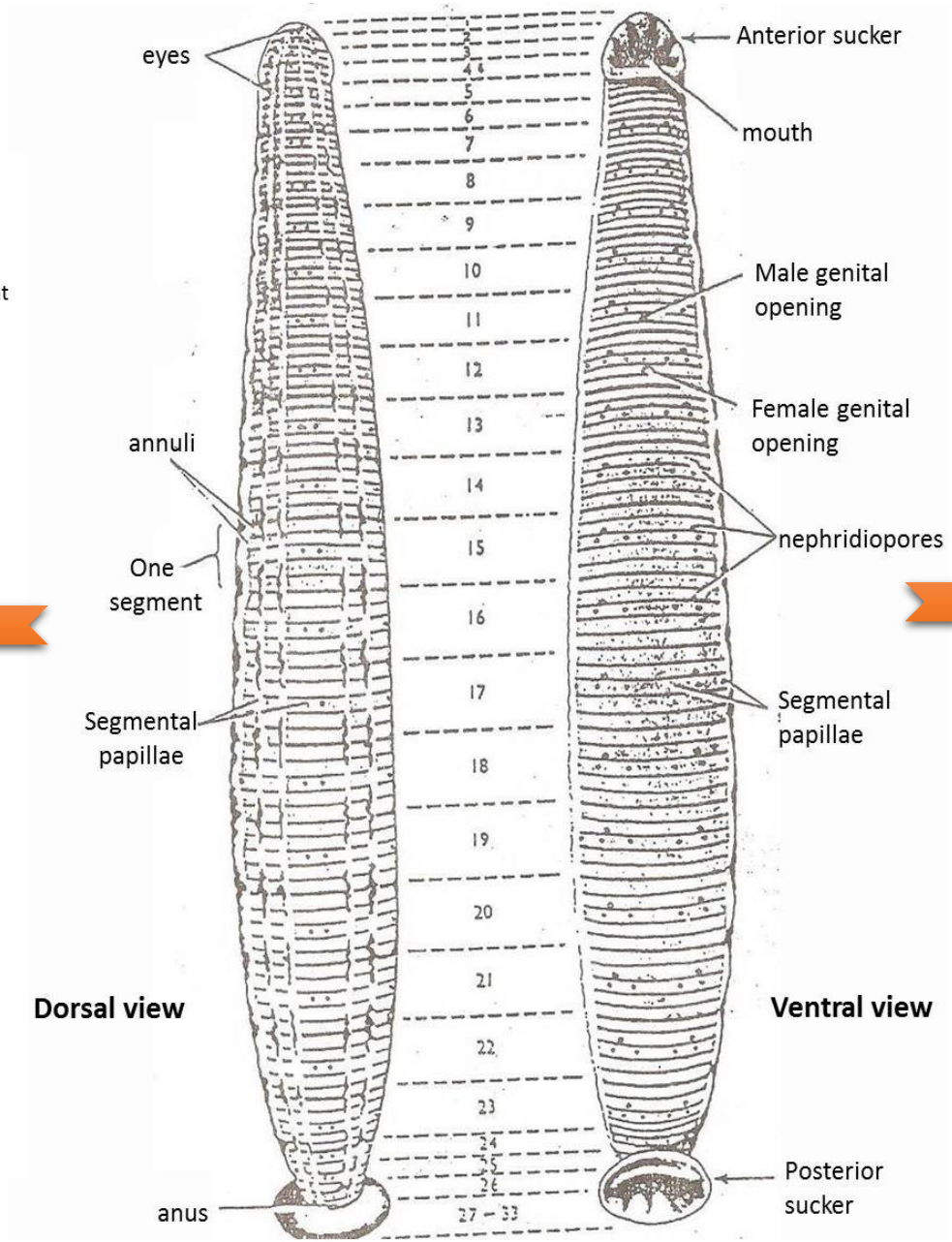

Pheretima hawayana


Hirudo medicinalis

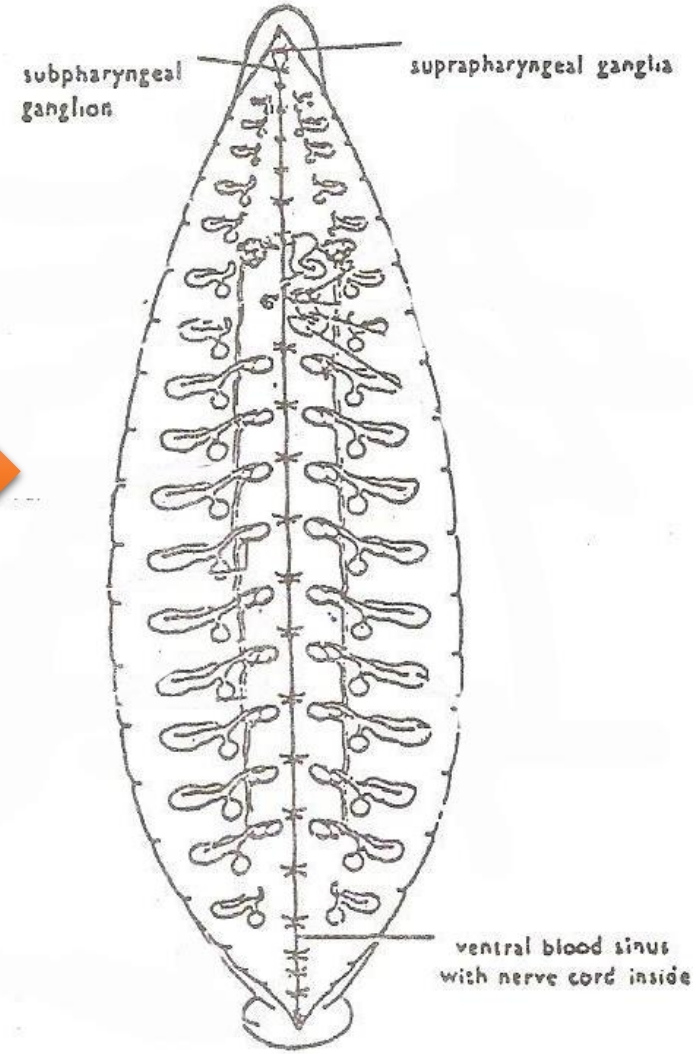
Hirudo medicinalis (Medicinal leech)

Digestive system





Nervous systems



Circulatory system of *Hirudo*

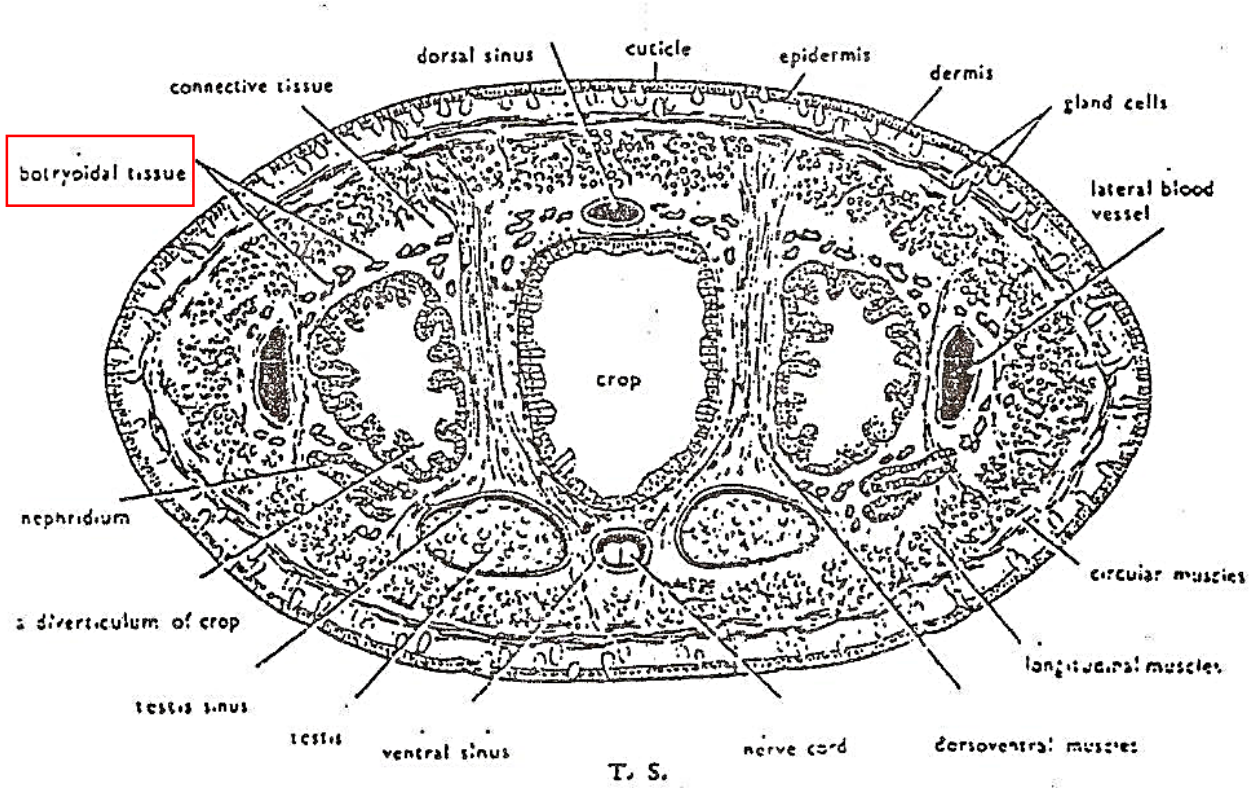
There are no true blood vessels, but only coelomic spaces which are filled with blood.

There are four longitudinal blood vessels as follows:

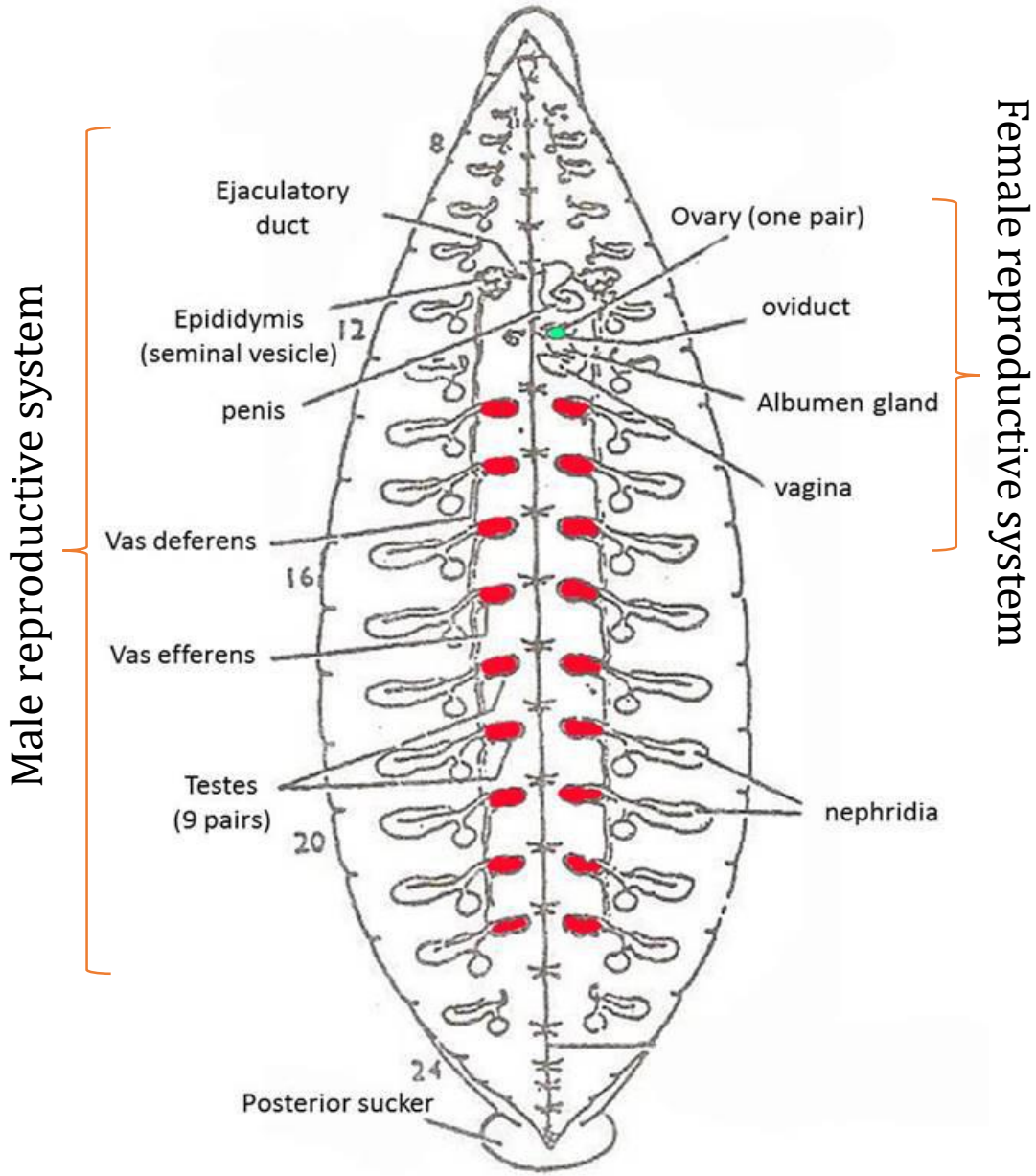
1- Dorsal blood vessel
2- Ventral (sub-intestinal) vessel
3- Two lateral nerve vessels

Excretory system of *Hirudo*

The excretory material is carried out of the body by a number of nephridia. In addition, close a round the gut and blood sinuses there is a peculiar spongy pigmented tissue known as the botryoidal tissue which probably of excretory function



Reproductive system of *Hirudo* (Hermaphroditic)



Mating of *Hirudo*

As in earthworms, mutual copulation and cross fertilization is the rule and clitellum appears at sexual maturity. Eggs are laid in cocoons on stream banks outside the water and develop directly, without a larval stage, each hatching into a young leech which resembles the parents

Feeding in the medicinal leech *Hirudo medicinalis*

1- Leech clings with its suckers to the host's skin, making a triradiate wound with its jaws and sucks large amounts of blood of victim by its muscular pharynx

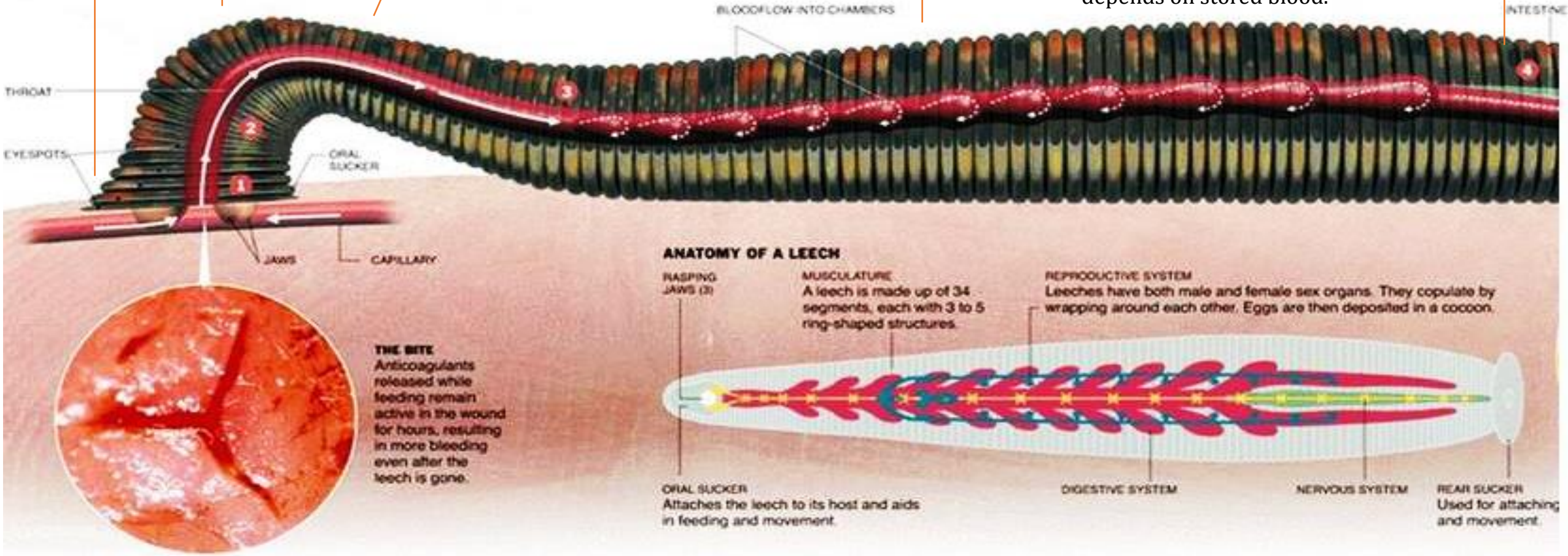
2- Leech secretes anticoagulant (Hirudin) from salivary glands to prohibit blood coagulation during feeding

3- Blood is stored in the crop and its diverticula which become extremely turgid

4- Blood sucked into chambers in the gut. Bacteria in the chambers provide additional nutrients

5- Blood is slowly moved as needed into intestine, where it is digested

6- Leech eventually drops off, seeks a shelter and remains fasting for several weeks during time it depends on stored blood.




Any
questions