Filarial nematodes

- 3 of the species are primarily responsible for most cases of human filariasis (Two billion exposed and at least 200 million infected)

  - *Wucheraria bancrofti* (lymphatic)
  - *Onchocerca volvulus* (subcutaneous)
  - Loa loa

Wuchereria bancrofti

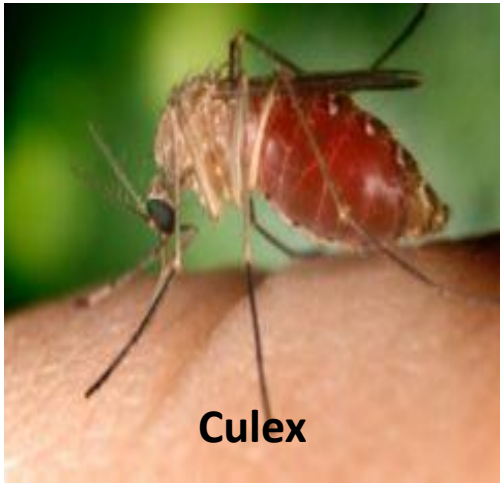
Lymphatic Filariasis

Elephantiasis

Spread by several species of night - feeding mosquitoes

- Humans are the definitive host for the worms that cause lymphatic filariasis, There are no known reservoirs for *W. bancrofti*
- Intermediate host , *W. bancrofti* is transmitted by Culex, Aedes, and Anopheles species

Anopheles

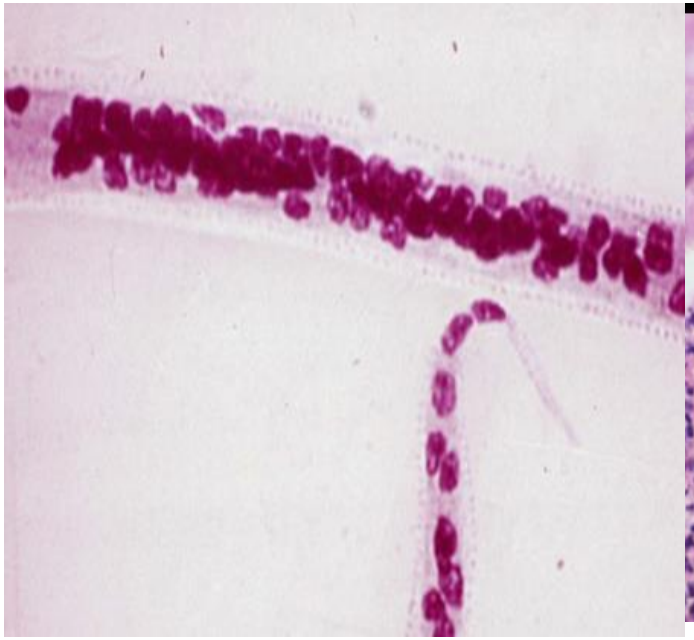


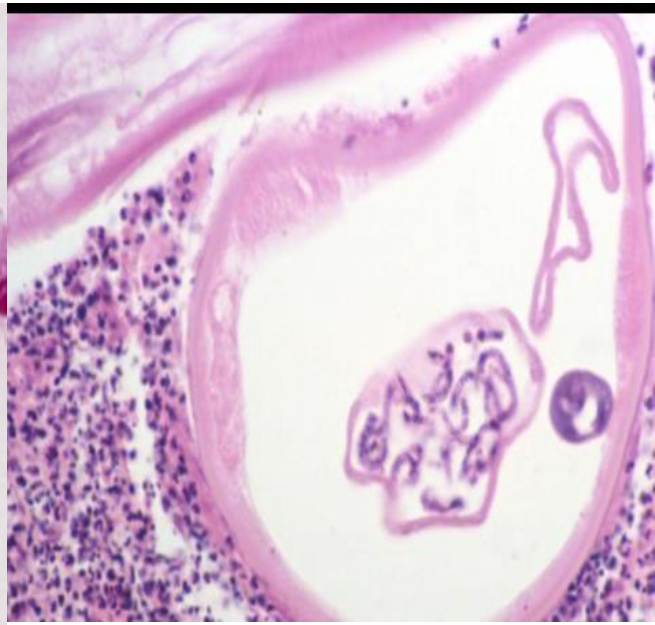
Culex

Aedes

Microfilariae

The microfilaria of *Wuchereria bancrofti* are sheathed and measure 240-300 µm, They have a gently curved body, and a tail that is tapered to a point. The nuclear column (the cells that constitute the body of the microfilaria) is loosely packed; the cells can be visualized individually and do not extend to the tip of the tail.





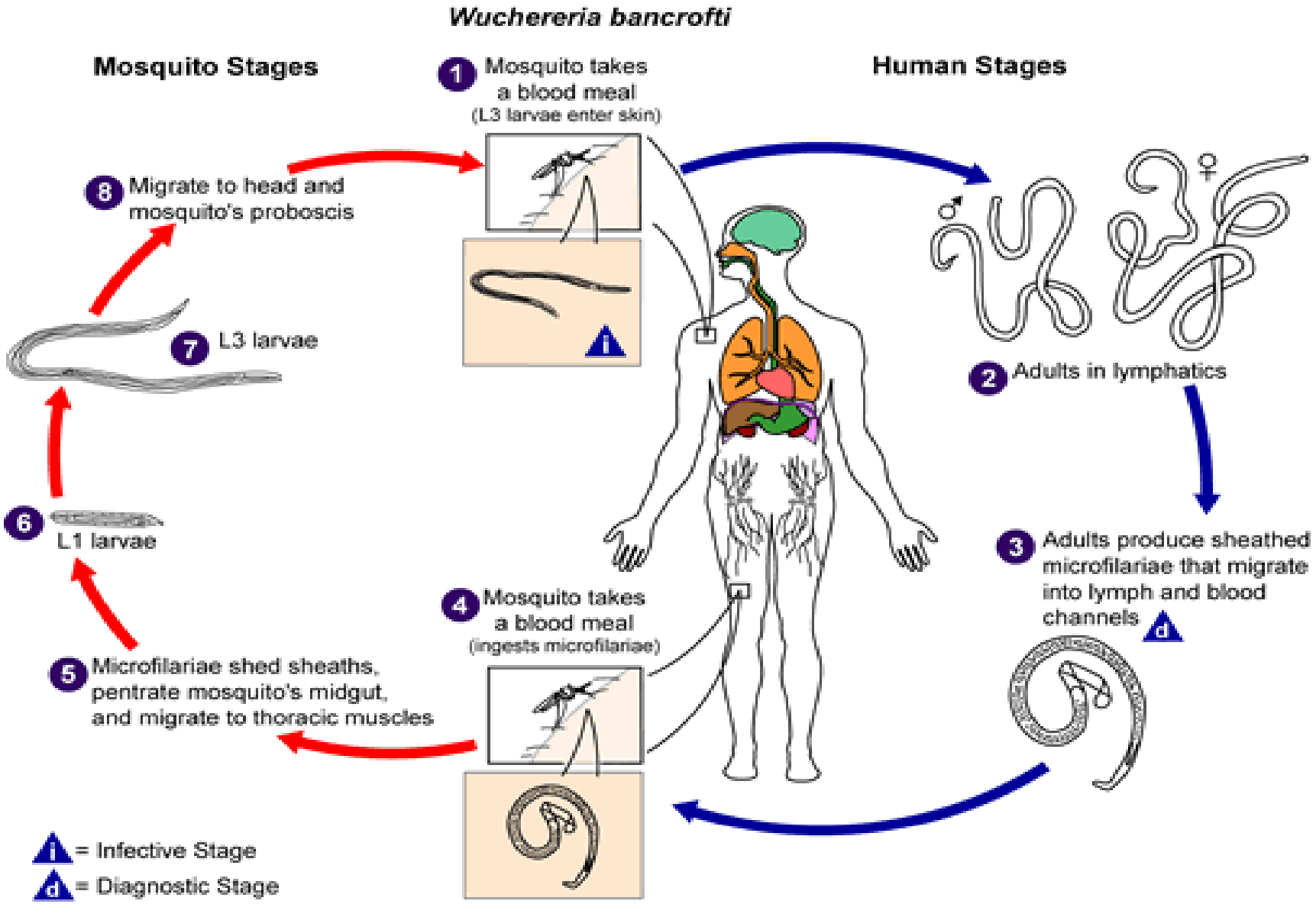
Adults

Adults of *Wuchereria bancrofti* are long and threadlike. The males measure up to 40 mm long and females are 80-100 mm long. Adults are found primarily in lymphatic vessels, less commonly in blood vessels.

Adults of W. bancrofti. The male worm is on the left; the female is on the right.

Life Cycle

Different species of the following genera of mosquitoes are vectors of *W. bancrofti* filariasis depending on geographical distribution. Among them are: *Culex Anopheles and Aedes*. During a blood meal, an infected mosquito introduces third-stage filarial larvae onto the skin of the human host, where they penetrate into the bite wound . They develop in adults that commonly reside in the lymphatics . Adults produce microfilariae ,which are sheathed and migrate into lymph and blood channels moving actively through lymph and blood . A mosquito ingests the microfilariae during a blood meal . After ingestion, the microfilariae lose their sheaths and some of them work their way through the wall of the proventriculus and cardiac portion of the mosquito's midgut and reach the thoracic muscles . There the microfilariae develop into first-stage larvae and subsequently into third-stage infective larvae . The third-stage infective larvae migrate through the hemocoel to the mosquito's prosbocis and can infect another human when the mosquito takes a blood meal .


Wuchereria bancrofti
Mosquito Stages
Human Stages
1 Mosquito takes a blood meal
(L3 larvae enter skin)
2 Adults in lymphatics
3 Adults produce sheathed microfilariae that migrate into lymph and blood channels
4 Mosquito takes a blood meal
(ingests microfilariae)
5 Microfilariae shed sheaths, pentrate mosquito's midgut, and migrate to thoracic muscles
6 L1 larvae
7 L3 larvae
8 Migrate to head and mosquito's proboscis
i = Infective Stage
d = Diagnostic Stage

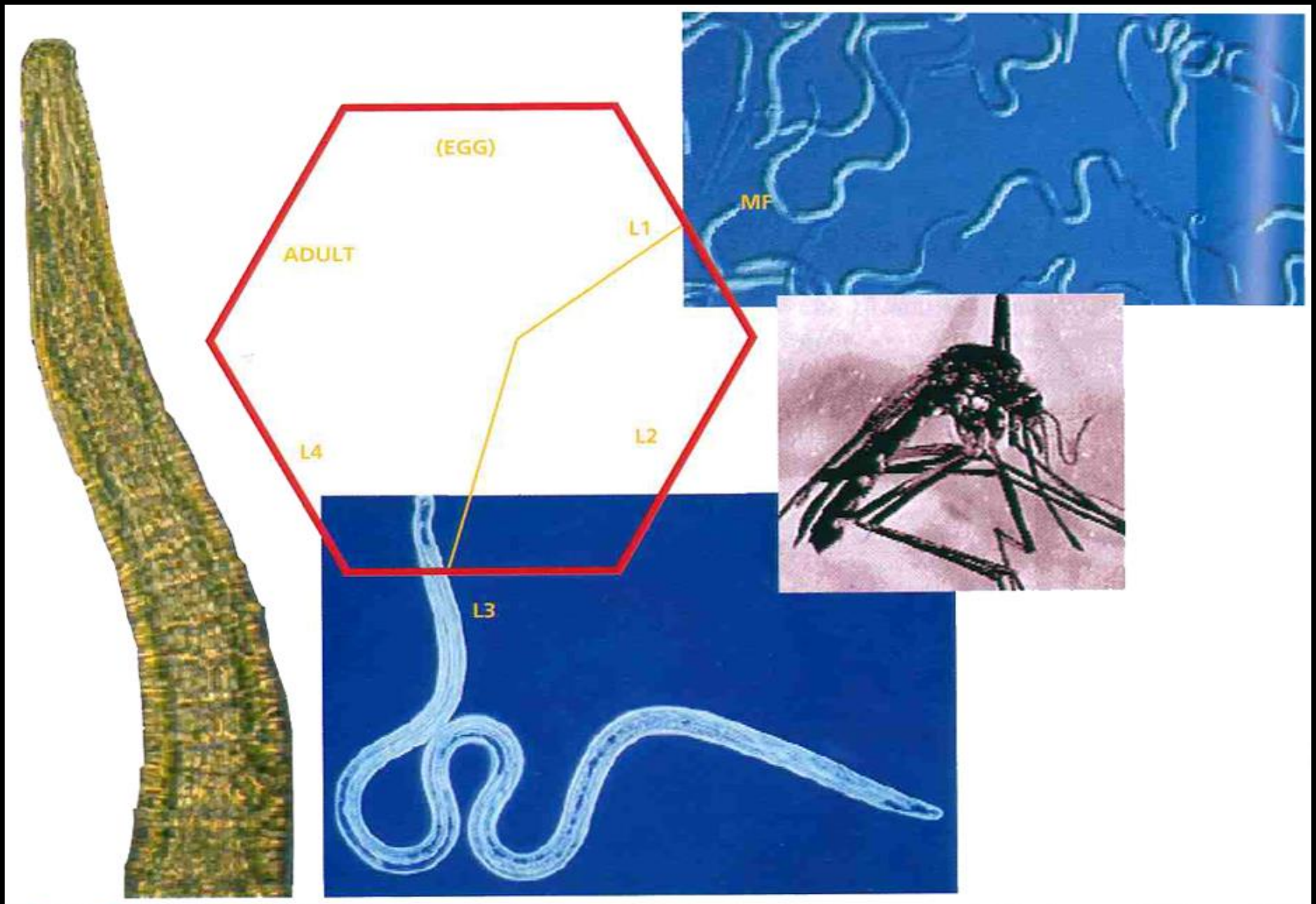


Figure 38.1 *Life cycle of the filarial parasites showing the microfilarial stages (MF), the mosquito, the infective stage (L3) larvae, and adult worm*

Early lymphedema

Advanced lymphedema

Elephantiasis

Hydrocoele

Diagnosis

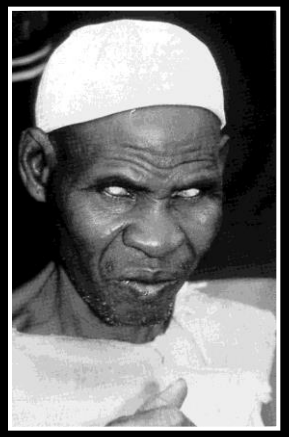
- Microscopy

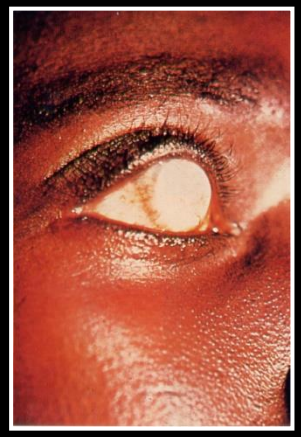
Lymphatic filariasis is usually identified by the finding of microfilaria in peripheral blood smears (thick or thin) stained with Giemsa or hematoxylin-and-eosin. For increased sensitivity, concentration techniques can be used. These include centrifugation of the blood sample(Knott's technique), or filtration through a Nucleopore® membrane. An accurate diagnosis is best achieved on smears collected at night (10 PM-2 AM).

- Antigen Detection

Antigen detection using an immunoassay for circulating filarial antigens constitutes a useful diagnostic approach because sensitivity for detection of microfilariae can be low and variable, filarial antigens can be detected in blood samples collected at any time of day. A rapid format immunochromatographic test has been shown to be a useful and sensitive tool for the detection of *Wuchereria bancrofti* antigen.

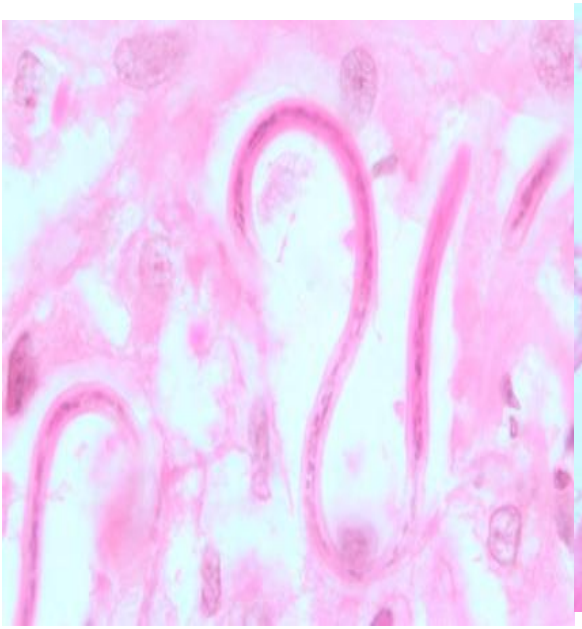
Onchocerca volvulus : Onchocerciasis
Blinding filarial, river blindness



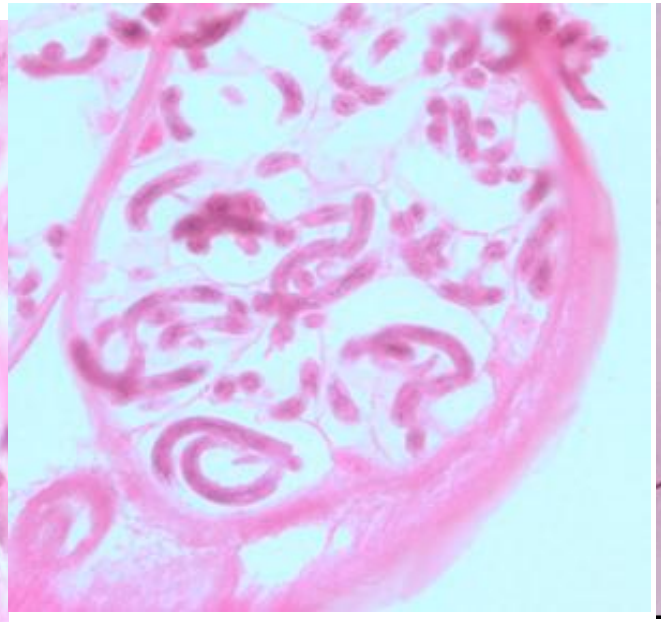


Microfilariae

Microfilariae of *Onchocerca volvulus* are unsheathed. The tail tapers to a point and is often sharply bent. The nuclei do not extend to the tip of the tail. Microfilariae typically reside in skin but may be found in blood or urine during heavy infections, or invade the eye and cause a condition known as river blindness.



Microfilariae from a skin nodule of a patient from Zambia



Microfilariae within the uterus of an adult female. The specimen was taken from the same patient

Adults

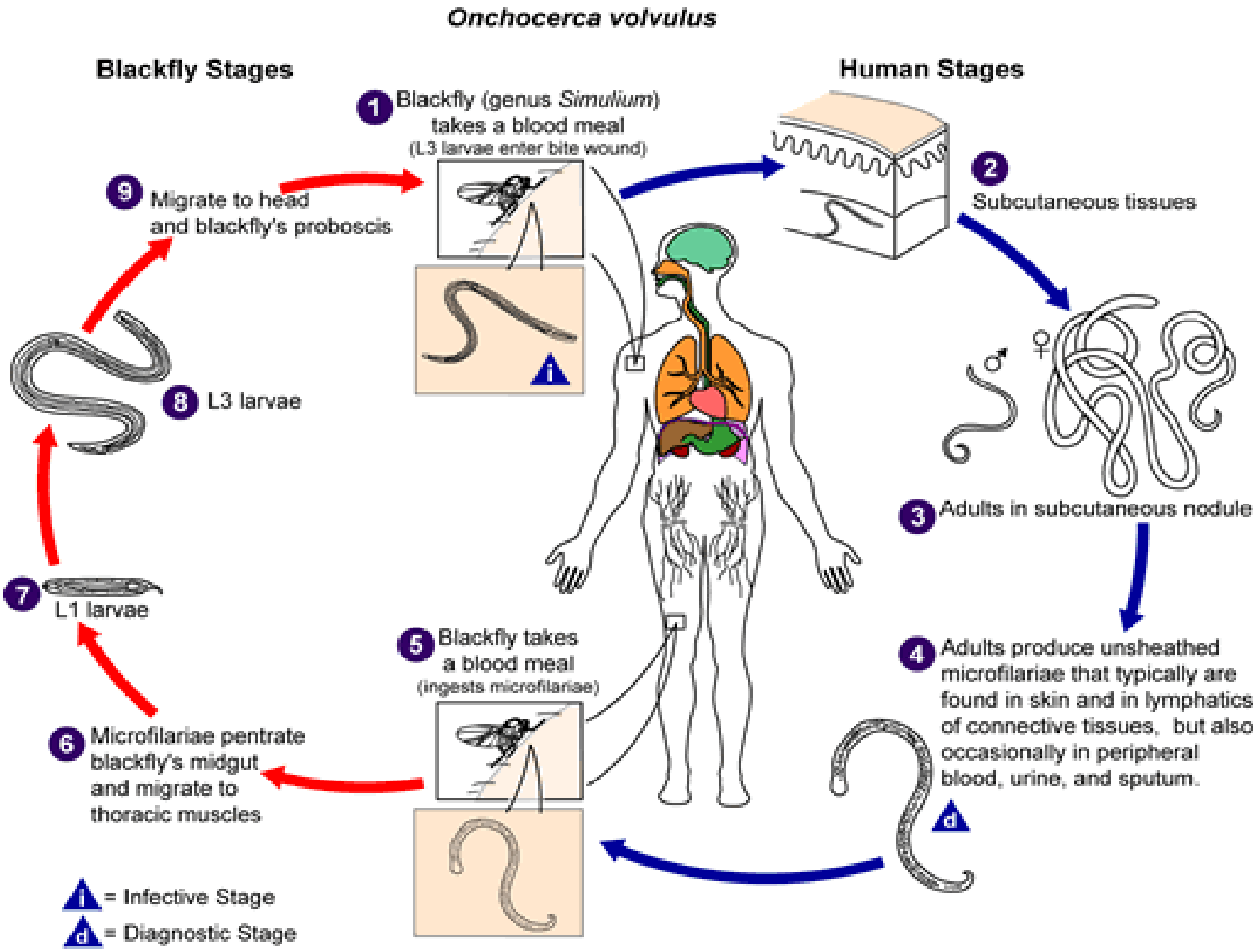
Adult males of *Onchocerca volvulus* measure 15-45 mm in length; females are 30-50 cm. Adults usually reside in nodules (onchocercomas) in subcutaneous tissue.

Adult O. volvolus

Life Cycle

During a blood meal, an infected blackfly (genus Simulium) introduces third-stage filarial larvae onto the skin of the human host, where they penetrate into the bite wound. In subcutaneous tissues the larvae develop into adult filariae, which commonly reside in nodules in subcutaneous connective tissues. Adults can live in the nodules for approximately 15 years. Some nodules may contain numerous male and female worms. Females measure 33 to 50 cm in length and 270 to 400 µm in diameter, while males measure 19 to 42 mm by 130 to 210 µm. In the subcutaneous nodules, the female worms are capable of producing microfilariae for approximately 9 years.

The microfilariae, measuring 220 to 360 µm by 5 to 9 µm and unsheathed, have a life span that may reach 2 years. They are occasionally found in peripheral blood, urine, and sputum but are typically found in the skin and in the lymphatics of connective tissues. A blackfly ingests the microfilariae during a blood meal. After ingestion, the microfilariae migrate from the blackfly's midgut through the hemocoel to the thoracic muscles. There the microfilariae develop into first-stage larvae and subsequently into third-stage infective larvae. The third-stage infective larvae migrate to the blackfly's proboscis and can infect another human when the fly takes a blood meal.


Onchocerca volvulus
Blackfly Stages
Human Stages
1 Blackfly (genus Simulium) takes a blood meal
(L3 larvae enter bite wound)
2 Subcutaneous tissues
3 Adults in subcutaneous nodule
4 Adults produce unsheathed microfilariae that typically are found in skin and in lymphatics of connective tissues, but also occasionally in peripheral blood, urine, and sputum.
5 Blackfly takes a blood meal
(ingests microfilariae)
6 Microfilariae pentrate blackfly's midgut and migrate to thoracic muscles
7 L1 larvae
8 L3 larvae
9 Migrate to head and blackfly's proboscis
i = Infective Stage
d = Diagnostic Stage

Diagnosis

The diagnosis of onchocerciasis can be difficult in light infections, There are multiple ways that the diagnosis can be made:

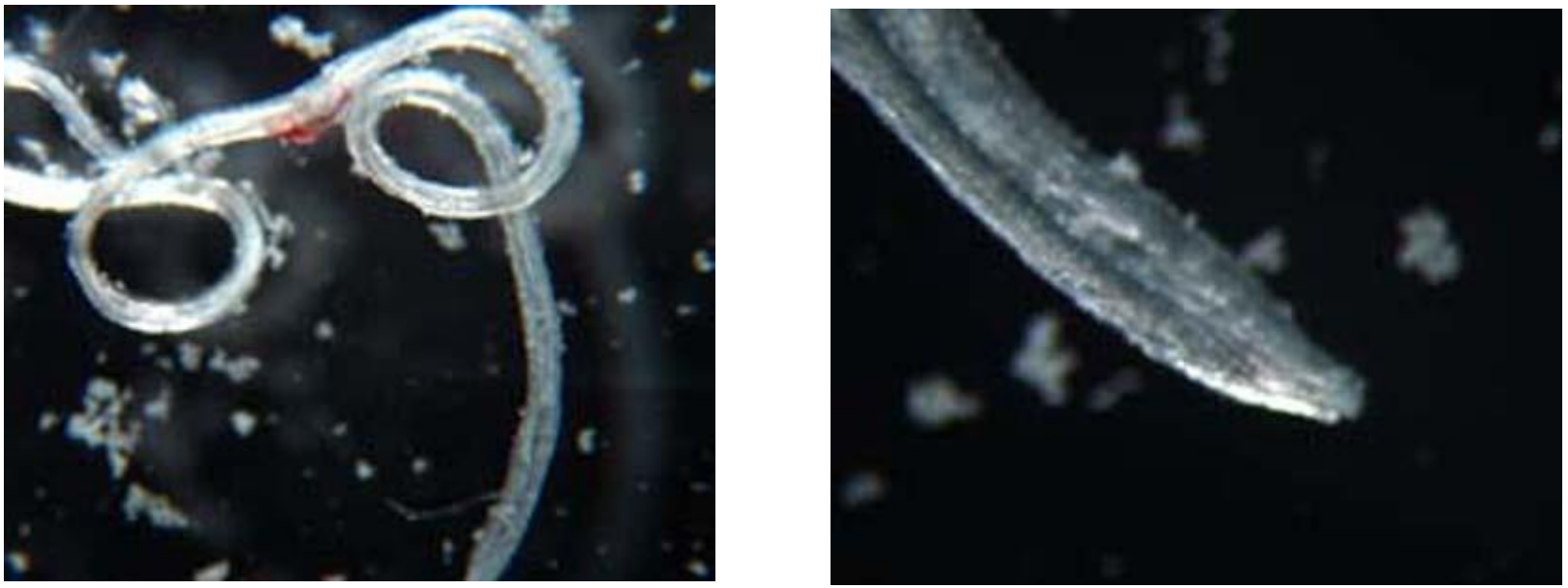
- The most common method of diagnosis is the skin snip. A 1- to 2- mg shaving or biopsy of the skin is done to identify larvae, which emerge from the skin when it is put in physiologic solutions (e.g. normal saline). Typically 6 snips are taken from different areas of the body.
- In patients with nodules in the skin, the nodule can be surgically removed and examined for adult worms.
- Infections in the eye can be diagnosed with a slit-lamp examination of the anterior part of the eye where the larvae or the lesions they cause are visible.
- Antibody tests have been developed to test for infection, though they are not widely available in the United States. These tests cannot distinguish between past and current infections, so they are not as useful in people who lived in areas where the parasite exists, but they are useful in visitors to these areas. Some of the tests are general tests for infection with any filarial parasite and some are more specific to onchocerciasis.

Loa loa
Loiasis

Loiasis, also known as African eye worm, is caused by the parasitic worm *Loa loa*. It is transmitted through the repeated bites of deerflies (also known as mango flies or mangrove flies) of the genus Chrysops. The flies that transmit the parasite breed in the high-canopied rain forest of West and Central Africa. In addition to eye worm, the infection is most commonly associated with recurrent episodes of itchy swellings (local angioedema) known as Calabar swellings.

Adult

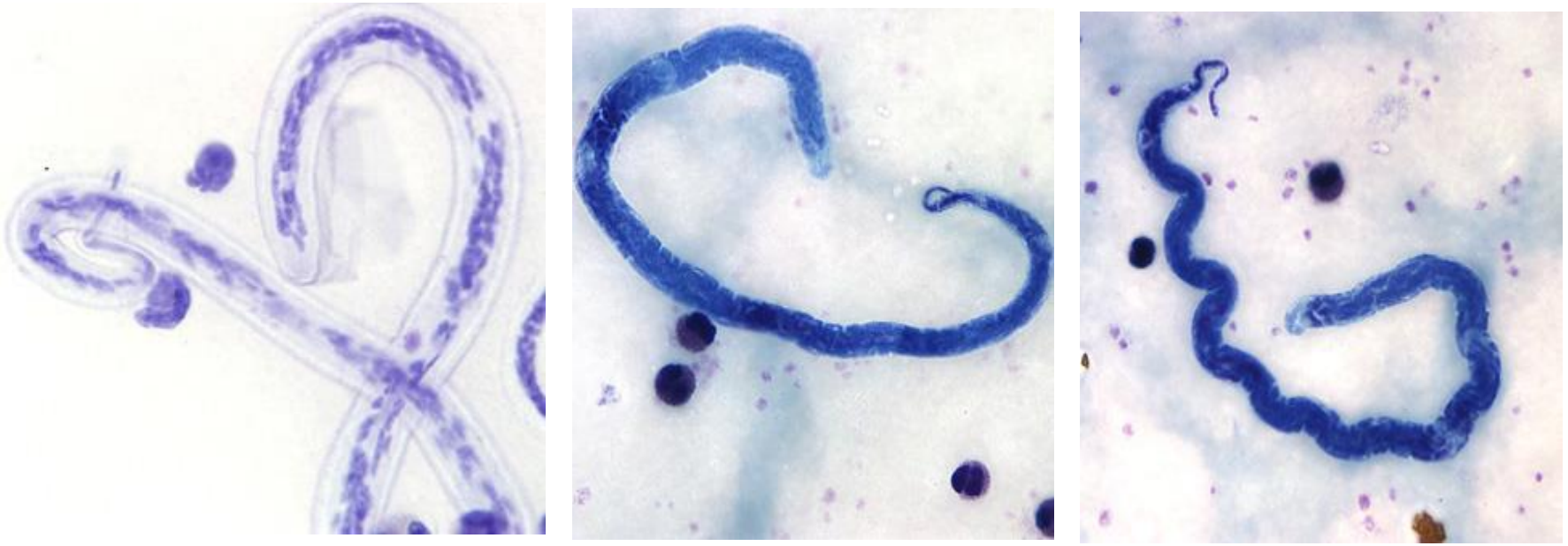
Adult of *Loa loa* are often isolated from the subconjunctiva. Adult females are 40-70 mm in length and 0.45-0.60 mm wide; males are smaller at 30-34 mm long and 0.35-0.40 mm wide.



Adult of *L. loa* removed from the eye of a patient

Microfilariae

Microfilariae of *Loa loa* are sheathed an measure 230-250 µm long in stained blood smears and 270-300 µm in 2% formalin. The tail is tapered and nuclei extend to the tip of the tail. Microfilariae circulate in the blood.

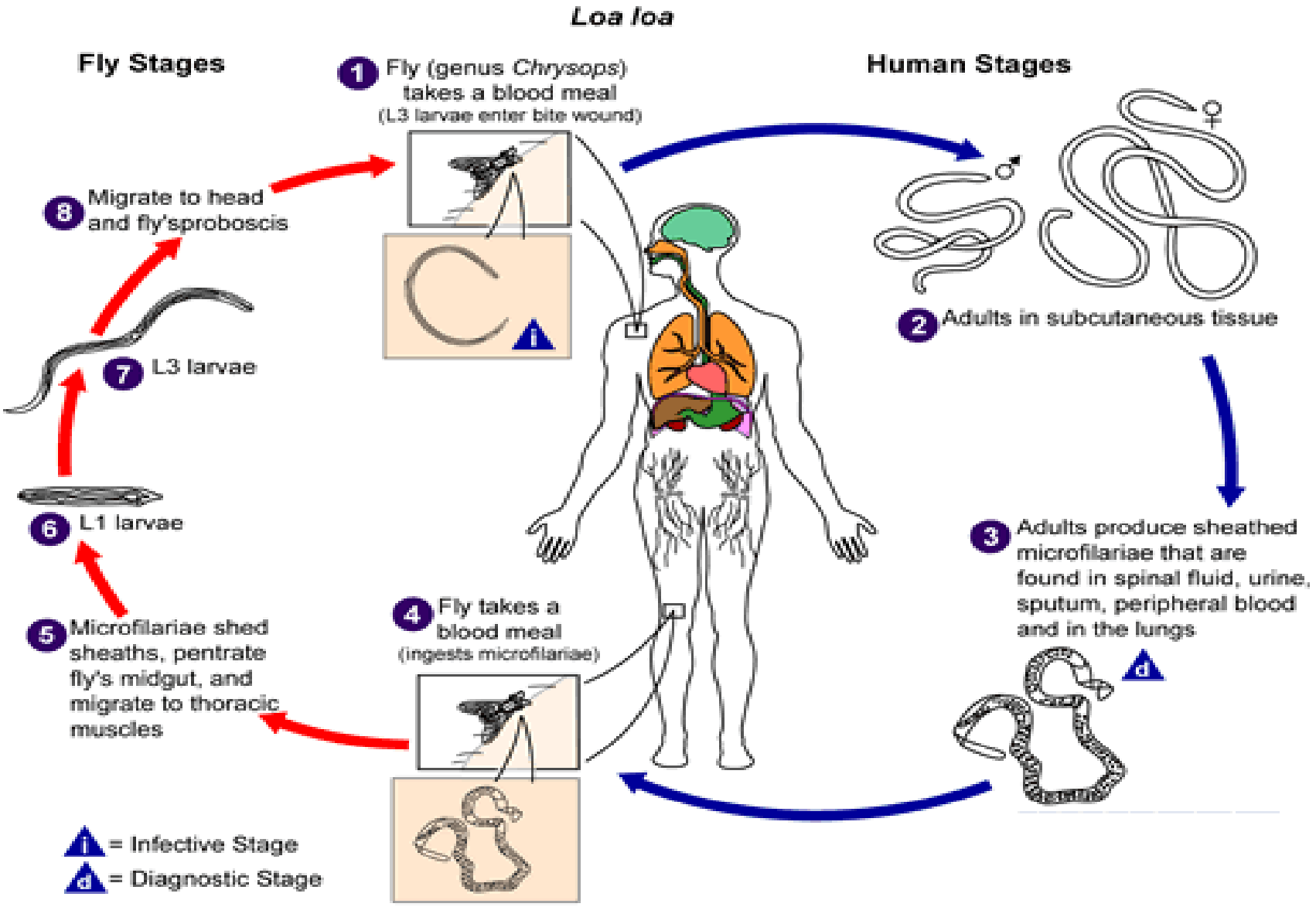


Microfilaria of *L. loa* in a thick blood smear, stained with Giemsa.

Life Cylce

The vector for *Loa loa* filariasis are flies from two species of the genus Chrysops, C. silacea and C. dimidiata. During a blood meal, an infected fly (genus Chrysops, day-biting flies) introduces third-stage filarial larvae onto the skin of the human host, where they penetrate into the bite wound, The larvae develop into adults that commonly reside in subcutaneous tissue,The female worms measure 40 to 70 mm in length and 0.5 mm in diameter, while the males measure 30 to 34 mm in length and 0.35 to 0.43 mm in diameter. Adults produce microfilariae measuring 250 to 300 µm by 6 to 8 µm, which are sheathed and have diurnal periodicity. Microfilariae have been recovered from spinal fluids, urine, and sputum.

During the day they are found in peripheral blood, but during the noncirculation phase, they are found in the lungs. The fly ingests microfilariae during a blood meal. After ingestion, the microfilariae lose their sheaths and migrate from the fly's midgut through the hemocoel to the thoracic muscles of the arthropod.There the microfilariae develop into first-stage larvae and subsequently into third-stage infective larvae. The third-stage infective larvae migrate to the fly's proboscis and can infect another human when the fly takes a blood meal.


Loa loa
Fly Stages
Human Stages
1 Fly (genus Chrysops) takes a blood meal
(L3 larvae enter bite wound)
2 Adults in subcutaneous tissue
3 Adults produce sheathed microfilariae that are found in spinal fluid, urine, sputum, peripheral blood and in the lungs
4 Fly takes a blood meal
(ingests microfilariae)
5 Microfilariae shed sheaths, pentrate fly's midgut, and migrate to thoracic muscles
6 L1 larvae
7 L3 larvae
8 Migrate to head and fly'sproboscis
i = Infective Stage
d = Diagnostic Stage

Diagnosis

Loa loa is usually diagnosed by the finding of microfilaria in peripheral blood smears or adults in the subconjunctiva. The blood films may be thick or thin and stained with Giemsa or hematoxylin-and-eosin. For increased sensitivity, concentration techniques can be used. These include centrifugation of the blood sample lysed in 2% formalin (Knott's technique), or filtration through a Nucleopore® membrane. Microfilariae of *L. loa* exhibit diurnal periodicity and a diagnosis is best made from blood collected during the mid-day. The presence of Calabar swellings can aid in the diagnosis.