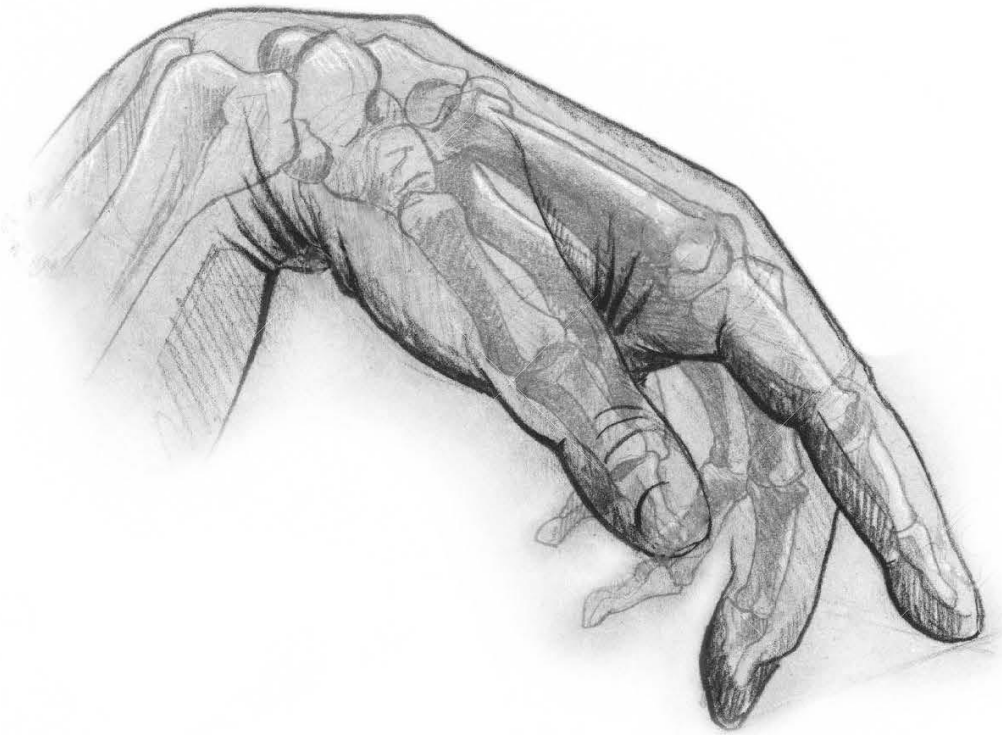
The

Musculoskeletal

System



Microbiology

☑ Sheet ☐ Slide ☐ Handout

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Parasites that affect the musculoskeletal system:

1) Trichinella Spiralis

This is an example of a nematode (Helminth) (round worm). It's very small in size, measuring about 2-3 mm in length. This particular nematode has something peculiar about it. Usually, parasites can have 1 host, or sometimes 2 separate hosts (a primary host, and an intermediate host). What is peculiar about this nematode is that it has primary and intermediate stages, but both happen in the same host, so the same animal can serve as a primary host and an intermediate host.

It can affect more than one animal (it is not specific to one type), such as rats, pigs, bears, etc. All of these animals can serve as hosts. As it infects one animal, that animal serves as a primary host and an intermediate host at the same time.

The Life Cycle of Trichinella Spiralis:

We start with this worm being present in the gastrointestinal tract of an animal. It lives in the submucosa (under the epithelium of the small intestines). These nematodes have separate sexes: male and female. After the fertilization of the female, the male returns to the lumen and gets discarded with feces.

You very rarely see these worms, as they live in the submucosa of the small intestines. Furthermore, the male is discarded with feces, so there is no chance for it to be seen or examined.

Unlike other nematodes, the females of Trichinella Spiralis do NOT lay eggs. Actually they initially produce eggs in the ovary, and afterwards, they lay larvae, so the larvae come after the eggs (it's like they are giving birth rather than producing eggs).

These larvae are deposited in the submucosa, and then they wander in the lymphatics and gain access to blood and are distributed in the portal circulation. From there, they can go to the liver to the venous systemic circulation and to the lungs, which gives them access to the systemic circulation. They can go anywhere from there.

Although they can be distributed to anywhere in the body , they can only complete their maturation in striated skeletal muscles. There, they become bigger larvae, spiral in shape (this is where the naming comes from).

This entire process usually takes about 3-4 weeks (from the deposition of larvae in the gastrointestinal tract, then to circulation, and then to skeletal muscles, maturating in there).

Once they have settled inside the skeletal muscles, they become surrounded by fibrous tissue, which makes them produce cysts. This process turns them into encysted larvae. These larvae stay alive for 1-2 years. Eventually, they die and may become calcified.

→ *How does this parasite get transmitted from one animal to another?*

By eating the flesh of the animal that is infected with encysted larvae.

Quick recap:

1. The presence of male and female worms in the GI tract → primary stage. The animal is considered the primary host.
2. The presence of encysted larvae in the striated muscles → intermediate stage. The animal is considered the intermediate host.

Again, this is considered an exception, as the animal served as both the primary host and the intermediate host.

If an animal eats the meat of an infected animal of its own species (for example a pig ate another pig) , or from a different species (for example a pig ate a died rice), these encysted larvae will integrate in the small intestines of the animal eating the meat, and the larvae will invade the wall and settle in the submucosa, and they will reproduce and give rise to other male and female worms in the small intestines.

If you ate an undercooked meat, you will ingest the larvae and become infected.

If the meat is cooked before it's eaten, the larvae will be killed, so there wouldn't be a problem. Also, if you freeze the meat at -20°C for 2-3 weeks, it will also kill the larvae.

Man is a **dead end host**, as far as Trachinella Spiralis goes (since it is obviously very unlikely that people will eat each other), unless you live in an African country and encounter any cannibalistic tribes, or you're eaten by a pig and then the pig is eaten by someone else.

→*What happens to the person who becomes infected?*

Infection is mostly acquired due to eating ground pork, or ground beef that is usually cheated and mixed up with cheap pork, and this meat is not cooked properly, which leads to an infection.

So the larvae are released in the GI tract, where they will travel to the submucosa and release more male and female worms. The female worms start producing other larvae (while the male worms enter the lumen and are discarded with feces) (after giving the larvae the female eventually die). The larvae enter the lymphatic circulation, and then to the liver to the portal circulation, then to the lungs and systemic circulation. During the presence of worms in the GI, you may show some local symptoms, such as nausea, diarrhea, vomiting, and some abdominal pain. These systems are present locally in the GI tract, and will disappear after the worms produce their larvae.

When the larvae are distributed in the body, they show various **other symptoms**: (These symptoms depend on the amount of larvae that are produced)

- ✓ **Lungs** → may cause pneumonitis, if present in large numbers (inflammatory reaction in the lungs).
- ✓ **Heart** → may cause myocarditis.
- ✓ **Brain** (in severe cases) → may cause encephalitis, if present in large numbers.
- ✓ **Fever** (also called pyrexia)
- ✓ **Allergic reactions**
- ✓ **Muscle pain**

NOTE : as a general rule, Parasites (especially worms) do NOT usually cause fever, but this type(Trichinella Spiralis) sometimes produces fever**.**

These symptoms should be self-limiting (unless the load of the larvae is so high that it would cause death in the infected person), and the larvae would die, except for the ones found in striated skeletal muscles. These larvae will be surrounded by fibrous tissue and form encysted larvae and live there for about 2 years.

For diagnostic purposes, you can suspect this disease based on the environment, such as if you live in an endemic area where people eat peculiar animals.

Other methods for diagnosing this disease are through blood samples and various methods:

1. The presence of a high number of **eosinophils** [eosinophilia], making ~30%-40% of white blood cells. especially in early stages. **NOTE:** Normally, the percent of eosinophils in blood is 2-3 %
2. A rise in the amount of **IgE** in the blood, which could be specific for the parasite or nonspecific.
3. A rise in the amount certain **enzymes in skeletal muscles**, such as CPK (creatine phosphokinase), and sometimes ADH.
4. Taking **a biopsy** from the muscle (which is the main indicator for diagnosis of this disease).

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2) Filaria

It is a tissue nematode *[remember: parasites can be either tissue or luminal]*. They live in lungs, lymphatics, subcutaneous tissue, etc. Their length can reach 8-10 cms. The strange thing about them is that they cannot really pass directly from one patient to another;

they cannot produce eggs. Instead, they produce baby filarial worms which are called **microfilaria**.

Thus, these worms are transmitted from one person to another by the means of an arthropod, an insect. It could be a mosquito or a fly.

An example of a filarial worm is Wuchereria bancrofti. It is usually found in the lymphatics. After about a few months when these worms are mature [both male and female], they start producing microfilaria. In this case, these microfilaria need mosquitoes as a means of transferring the disease. Here, **the intermediate host (Vector) is the mosquito.** So, the microfilaria will leave the lymphatics and reach the blood, and the mosquito will bite the infected person and suck some of the blood that is carrying the parasites.

After that, the microfilaria will develop within the gut of the mosquito and turn into infective microfilaria. This same mosquito bites someone else and will inject these infective microfilaria into their blood → lymphatics → they start to develop into adult filarial worms. This process takes about 5-6 months to happen.

This disease is mostly present in tropical areas, so we cannot find it in Jordan.

The outcome of it may vary. In most cases, children who are infected with it may only have very little reaction to the worm itself. The worms actually develop and produce microfilaria, which are distributed in the blood and lymphatics. This will lead to a **balance or tolerance** between the host and the worm.

The worm benefits from this balance by being able to produce large amounts of microfilaria which can be transmitted to other

people, and the child benefits by not having an inflammatory reaction to the worm. Eventually, the worms die and the disease subsides, but in some cases, it may lead to an allergic reactive process against the worms called **Acute Filariasis**, which will lead to an inflammation around the worms present in the body (in the lymph nodes). This will lead to large, tender, swollen lymph nodes, and the lymphatics will be inflamed.

All of this usually settles and goes away, unless in around 10% of cases, the inflammatory process continues for a long period of time and becomes chronic. This ultimately leads to complete obliteration of lymphatics. It may affect the scrotum, testes, legs, and sometimes the arms. They become so huge that we call it **elephantiasis**.

Diagnosis:

Usually, a blood sample is taken and we look for the presence of microfilaria in it. It is advisable to take it in the night, because the microfilaria are usually present in the blood at night since that is when mosquitoes usually bite people. Or, it may be because of the lowered pH in the blood at that time, and lowered oxygen tension.

So, the presence of microfilaria in the blood is related to **diurnal rhythm.**

3) Loa Loa

- It's a nematode.
- It lives in the subcutaneous tissues
- Its intermediate host happens to be a **mango fly**.

It's not very long, its length is usually around **5-6 cm**. It does not really produce a lot of damage in the body as it lives in the subcutaneous tissue and tries to moves around the body, so some patients can actually feel the worm moving in their bodies. They may produce an allergic reaction depending on where they settle.

This allergic reaction causes some swelling that lasts for a few hours then goes away. However, it is a very large swelling that may reach the size of a hen's egg. Very often, it occurs in the wrists and is known as **Calabar swelling** → an allergic manifestation caused by the Loa Loa worm in the subcutaneous tissue.

Sometimes, these worms may settle in the conjunctiva [the white of the eyes], and the patient will complain about the presence of a foreign body in their eye. Some of the symptoms include:

1) Inflammation
2) Redness
3) Extensive tear production
4) Itching

In this case, we need to remove the worm from the eye using forceps.

→*How does this parasite get transmitted from one person to another?*

The worms produce microfilaria, and the microfilaria wander in the subcutaneous tissues and end up in the blood, waiting for a mango fly to bite the patient and be sucked by it. This also has a diurnal rhythm, as mango flies are usually active in the afternoon, which is the optimal time to take a blood sample.

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4) Onchocerca volvulus

It is also a filarial worm that lives in the subcutaneous tissues. The intermediate host is the black fly, which can only reproduce in the banks of fast-flowing rivers.

These parasites can cause blindness, and since they reproduce near fast-flowing rivers, it is called **River Blindness**. This blindness from the Onchocerca volvulus is the second infectious cause for blindness after trachoma.

When the black fly bites a person, it injects the microfilaria into their skin. These microfilaria then travel under the skin and produce an inflammatory reaction, some swelling and indurations. After that, they mature into adult worms and stay there. Unlike Loa Loa, the adult worms don't wander around. Only the microfilaria which are produced by the adult worms are able to move around. They can reach the eyes and settle in the retina and lead to **chorioretinitis**.

The black fly bites an infected person and sucks up the microfilaria (usually from an induration) and it becomes infected, and it will pass

the infection to someone else. We do not take blood samples for diagnosis since the worms only stay in one place (the induration). What we do is that we take a snip from the induration and we leave it in normal saline. We examine the saline the next day to notice the presence of the worms.

Occasionally, the disease can progress a lot and produce profound changes in the skin that resemble the skin of a **lizard**.

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