• several important parasites of domestic animals encyst in muscle &/or cause myositis
PARASITIC MYOSITIS

Trichinellosis (Trichinosis)

- infection by the nematode *Trichinella spp* is an important zoonotic disease

- rare in USA & Canada (except in the Arctic)

- acquired through eating incompletely cooked meat; esp pigs, bears, aquatic mammals

- adults in small intestinal mucosa $\rightarrow$ larvae migrate from intestine $\rightarrow$ encyst in muscle

- predilection for active muscle; eg tongue, masseter, larynx, diaphragm, intercostals & eye
Fig 8-115 Trichinella spiralis adult in the mucosa of the small intestine of a rat (×480). Two cross-sections through a female (white arrows) contain prelarvae and a longitudinal section through the stichosome esophagus (black arrow). Georgis' Parasitology for Veterinarians, 10th ed
Trichinellosis (Trichinosis)

- after initial larval invasion of myofiber there is mild focal inflammation, esp LØ’s & EØ’s
- after cyst formation see fibrous-like capsule; need “trichinoscope” to see

Note two encysted larvae of *Trichinella spiralis* (arrows) with a mild inflammatory response characterized by an inflammatory cell infiltrate (asterisk) of predominately lymphocytes, plasma cells and eosinophils.

FIG 3-102 (Maxie) *Trichinella spiralis* larvae encysted in muscle. (note; after inflammatory cell reaction has subsided)
Trichinellosis (Trichinosis)

Trichinoscope

Two glass plates compress the meat sample making it transparent enough to view the Trichinae.

Fig 4-163 Trichinella spiralis larvae in muscle press (squash preparation). Georgis’ Parasitology for Veterinarians, 10th ed
Trichinellosis (Trichinosis)

- larvae can remain viable for many years
- in some cases the larvae die, become calcified and can be seen as small white nodules

Fig. 15-42 (Zachary) Trichinosis, encysted larvae, diaphragm, bear. A, Encysted larvae of *Trichinella spiralis* appear as pale elongated gray-white foci in the muscle. [Encysted larvae are typically not visible on gross examination, although dead larvae can calcify and be visible as 0.5 to 1 mm white nodules]
PARASITIC MYOSITIS

Cysticercosis

- another important zoonotic disease (only occasionally in Canada & USA)
- a cysticercus is the larval stage of a taenia (tapeworm)
- adult tapeworms reside in the intestine of definitive hosts (carnivores)
- cysticerci reside in the muscle / viscera of an intermediate host (pigs & cattle)
- cysticercosis in humans implies fecal / oral contamination; ie ingestion of taenia eggs
  (since ingestion of cysticerci leads to tapeworm infestation)
Cysticercosis

Embryonated eggs ingested by human host

1. Infective Stage
2. Embryonated eggs and/or gravid proglottids ingested by pigs
3. Oncospheres hatch, penetrate intestinal wall, and circulate to musculature
4. Humans infected by ingesting raw or undercooked infected meat
5. Scolex attaches to intestine
6. Adults in small intestine
7. Drugs in small intestine
8. Cysticerci may develop in any organ, being more common in subcutaneous tissues as well as in the brain and eyes

Eggs or gravid proglottids in feces and passed into environment

http://www.dpd.cdc.gov/dpx
the cysticerci of some tapeworms have a predilection for skeletal muscle and myocardium

*Taenia saginata* (mostly humans) → *Cysticercus bovis* mostly in muscles of cattle

*Taenia solium* (mostly humans) → *C. cellulosae* mostly in muscles of domestic or wild pigs

*Taenia ovis* (many carnivores) → *C. ovis* mostly in muscles of sheep and goats
Cysticercosis

Gross Pathology:

- Cysticerci form visible cysts (1-2 cm) which generally contain a clear fluid & larvae

Large numbers of cysticerci in the costo-chondral musculature of this pig. These parasitic cysts contained fluid and a white nodule that corresponds to a larval scolex (arrows).
Cysticercosis

Gross Pathology:

- cysticerci form large visible cysts (1-2 cm) which generally contain a clear fluid & larvae

Fig 7-73  Muscle of a sheep from Canada with three evident cysticerci of *Taenia ovis*. Georgis' Parasitology for Veterinarians, 10th ed.
Cysticercosis

- in some hosts the cysticercus may reside in brain ("neurocysticercosis")

MRI (left) and coronal section of human brain (right) showing large numbers of cysticerci scattered throughout.
Cysticercosis

- in some hosts the cysticercus may reside in brain ("neurocysticercosis")

Brain of a dog with neurological signs that was euthanatized because of suspected rabies. On postmortem examination, a large cysticercus (arrow) was found in a distended left lateral ventricle. This case was diagnosed as hydrocephalus with intrallesional cysticercus. It tested negative for rabies.

FIG 1: (a) Coronal slice of the brain of a dog showing multiple cysticercal cysts with prominent scoleces in the posterior parieto-occipital cortex in the cortical ribbon (arrows). (b) Occipital cortex showing three cysticercal cysts in the cortical mantle close to the subarachnoid space. A scolex within the bladder can be seen in two of them (arrow). Luxol fast blue for myelin. x10

Sarcocystosis

- protozoal disease affecting primarily herbivores & pigs & birds

- indirect life-cycle where carnivores are definitive hosts and prey are the intermediate hosts

- most herbivores have sarcocystis cysts in their muscle

- muscle cysts are incidental, but sarcocystosis can cause abortion
Sarcocystosis
Sarcocystosis

- generally no inflammatory reaction to the cysts and generally too small to be visible grossly

Histologic section of muscle from a bovine shows cross-section of myofiber containing one Sarcocystis cyst filled with hundreds of bradyzoites. Note no evidence of an inflammatory response.

Fig 8-32 (Georgis) Sarcocyst of *Sarcocystis muris* in longitudinal section of skeletal muscle of a mouse *Georgis’ Parasitology for Veterinarians, 10th ed.*
Sarcocystosis

- **exception #1** - there are some large sarcocysts of birds & sheep

In some animals (e.g., sheep & wild birds) the particular species of sarcocystis have grossly visible cysts with massive numbers (billions) of bradyzoites inside the cyst; seen as white nodules (still no inflammatory reaction). Many hunters submit parasitized birds to diagnostic laboratories.

Note the many large white sarcocysts in the pectoral muscles of this duck.
**Sarcocystosis**

- exception #2 - cysts rupture in small % of cattle & swine → focal necrosis & eosinophilic granuloma
- at slaughter see yellow-green foci, a few mm in diameter in skeletal & heart muscle

Note multifocal eosinophilic myositis seen in bovine muscle at slaughter. Note, microscopically (inset) that the inflammatory response is centered on a degenerating sarcocystis cyst within a myofiber.
Sarcocystosis

- Also, small % of cattle at slaughter have locally extensive green discoloration of muscles
- Microscopically see severe eosinophilic myositis; (HS reaction to sarcocysts?)

Locally extensive grey-green discoloration of muscle from beef cow found at slaughter (no clinical signs); this is characteristic of eosinophilic myositis of cattle.

Microscopically see expansion of the interstitium and effacement of myofibers with a massive infiltrate of predominately eosinophils.
NEOPLASTIC DISEASES OF MUSCLE

- Spontaneous tumors of striated muscles are rare.
- Primary striated muscle tumors likely develop from pluripotent mesenchymal stem cells.
- Most frequently in heart & skeletal muscles, but also sporadically in non-muscular sites.
Rhabdomyoma

• a benign and often congenital tumor of skeletal muscle; most frequently found in pigs
• most common in the heart; occasionally in larynx of dogs

Note, pale white mass (rhabdomyoma) in the left ventricular myocardium of a ewe
NEOPLASTIC DISEASES OF MUSCLE

Rhabdomyosarcoma

- reported in the cow, sheep, horse and dog
- frequent metastasis to lung, spleen, lymph nodes and kidneys
- occasionally seen at sites with no striated muscle (esp kidney & urinary bladder)
Rhabdomyosarcoma

**Gross pathology:** poorly encapsulated spherical nodules of pale tissue

Rhabdomyosarcoma infiltrating the muscles in the leg. Rhabdomyosarcomas are generally pale in color and poorly encapsulated as shown in this photograph (asterisk).
Rhabdomyosarcoma

Histopathology:

- extremely variable; can be well-Df (with striations) or poorly-Df (no striations)
- anaplastic tumors require IHC, eg myoglobin / sarcomeric actin & myoD / myogenin

Note the poor parallel alignment of the tumor cells, the presence of striation (arrows), and slightly pleomorphic nuclei (mild to moderate anisokaryosis)
Bovine skeletal muscle. Numerous white tumor masses (in this case lymphoma) are scattered throughout the skeletal muscle. This cow also had markedly enlarge lymph nodes and masses in the liver, heart, abomasum and kidney.

- **nonmuscle primary tumors**: nerves (neurofibroma)
  adipose cells (lipoma/-sarcoma)
  vascular cells (hemangioma/-sarcoma)
  fibrous connective tissue (fibroma/-sarcoma)

- **secondary tumors of skeletal muscle**: via infiltration or metastasis (uncommon)