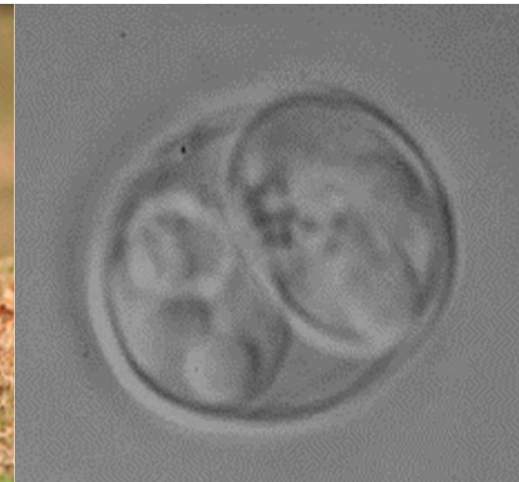


NEOSPOROSIS

ETIOLOGY

- ▶ Neosporosis is caused by the microscopic, one-celled, protozoan parasite *Neospora caninum*.
- ▶ Having wide host range - major domestic livestock species, companion animals, a few wild animals and marine mammals.



Neospora caninum

- Canine coccidian
- Bovine abortion
- Canine neurologic disease
- Complex Life Cycles

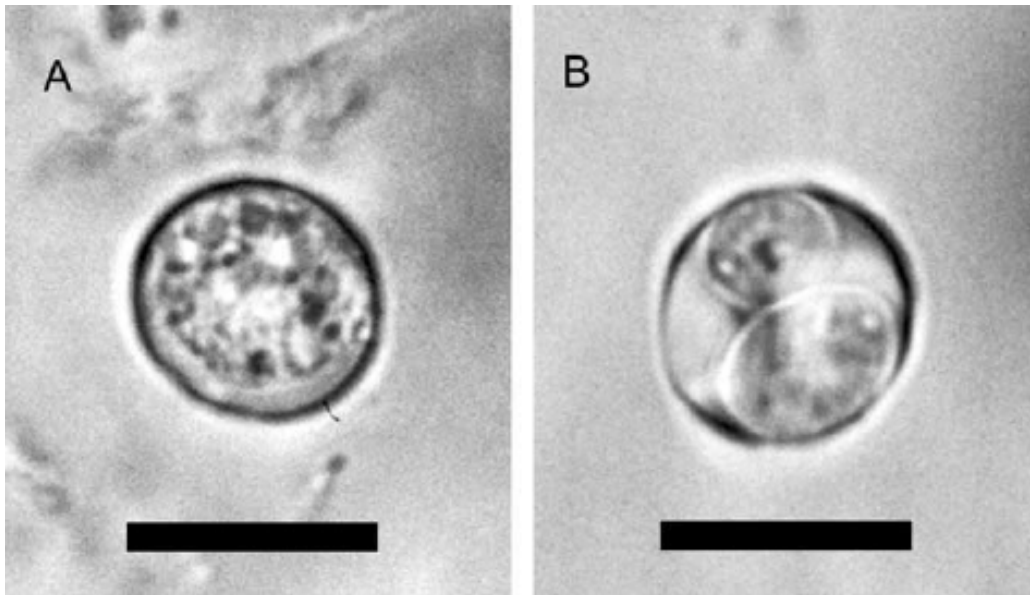


INTRODUCTION

- ▶ Neosporosis is a worldwide disease of dogs that can cause neurologic signs and muscle inflammation.
- ▶ It also causes reproductive failure in cattle.
- ▶ Earlier misclassified as *Toxoplasma gondii*.
- ▶ First recognized in dogs in 1984 in Norway and defined as a new genus and species *Neospora caninum*.

Morphology: *Neospora caninum*

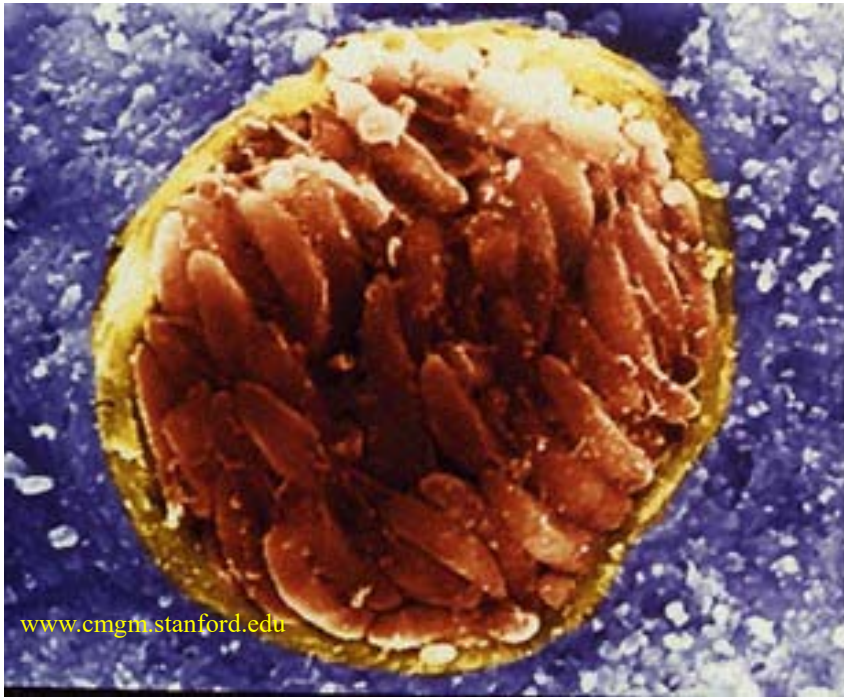
- Oocyst
 - Small, sub-spherical, smooth coat, no polar cap, single embryo when passed = unsporulated (sporulate after 1-3 days)
 - Sporulated oocyst contains 2 sporocysts with 4 sporozoites each = 8 sporozoites total



https://www.researchgate.net/figure/8663822_fig2_Fig-2-PCR-for-Neospora-caninum-and-Hammondia-heydorni-using-DNA-extracted-from-oocysts

Morphology: *Neospora caninum*

Bradyzoite cyst (cysts found in tissue); facilitate persistent infection



Neospora caninum tissue cysts in histologic sections of tissues

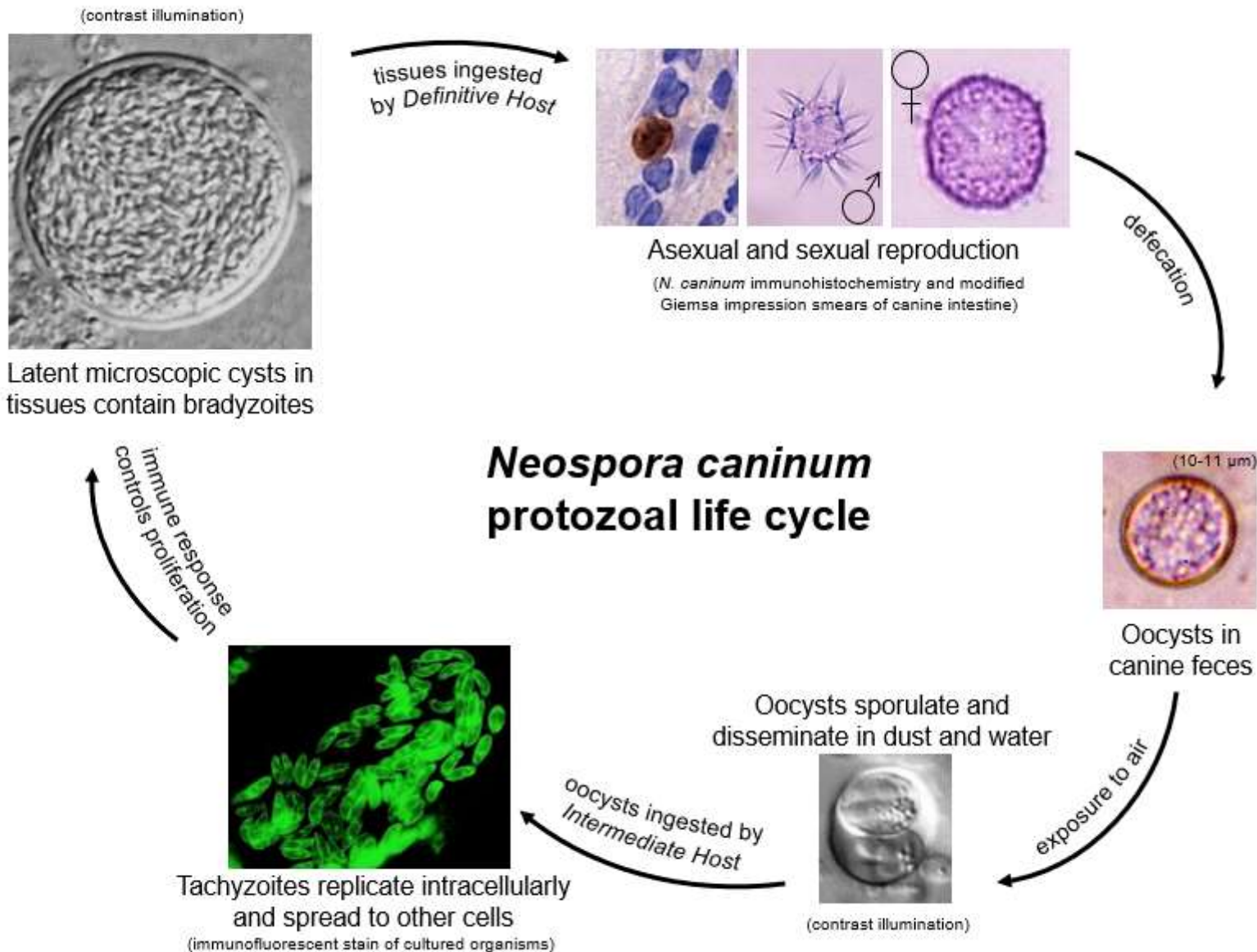
EPIDEMIOLOGY

- ▶ *N. caninum* infections reported from most parts of the world causing abortion and neonatal mortality.
- ▶ Studies in the USA, New Zealand, the Netherlands and Germany indicate that 12 to 42% of aborted fetuses from dairy cattle are infected.
- ▶ In India, sero-prevalence of 12.61 and 9.97 % in dairy cattle and water buffaloes respectively were documented in Karnataka and Andhra Pradesh (2012) .

RISK FACTORS

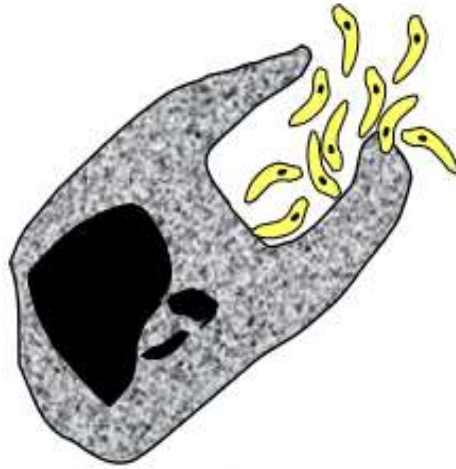
- ▶ *Age of cattle*
- ▶ *Definitive hosts*
- ▶ *Intermediate hosts other than cattle*
- ▶ *Feeding colostrum or milk*
- ▶ *Seropositivity of individual cattle*

LIFE CYCLE AND TRANSMISSION



Stages of *Neospora caninum* or *Toxoplasma gondii*

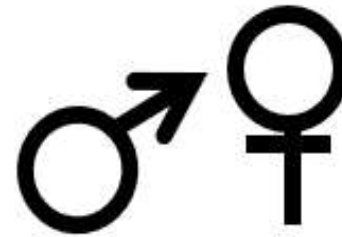
Tachyzoites
(like dividing caterpillars)



Bradyzoites in cysts
(crysallis in cocoon)



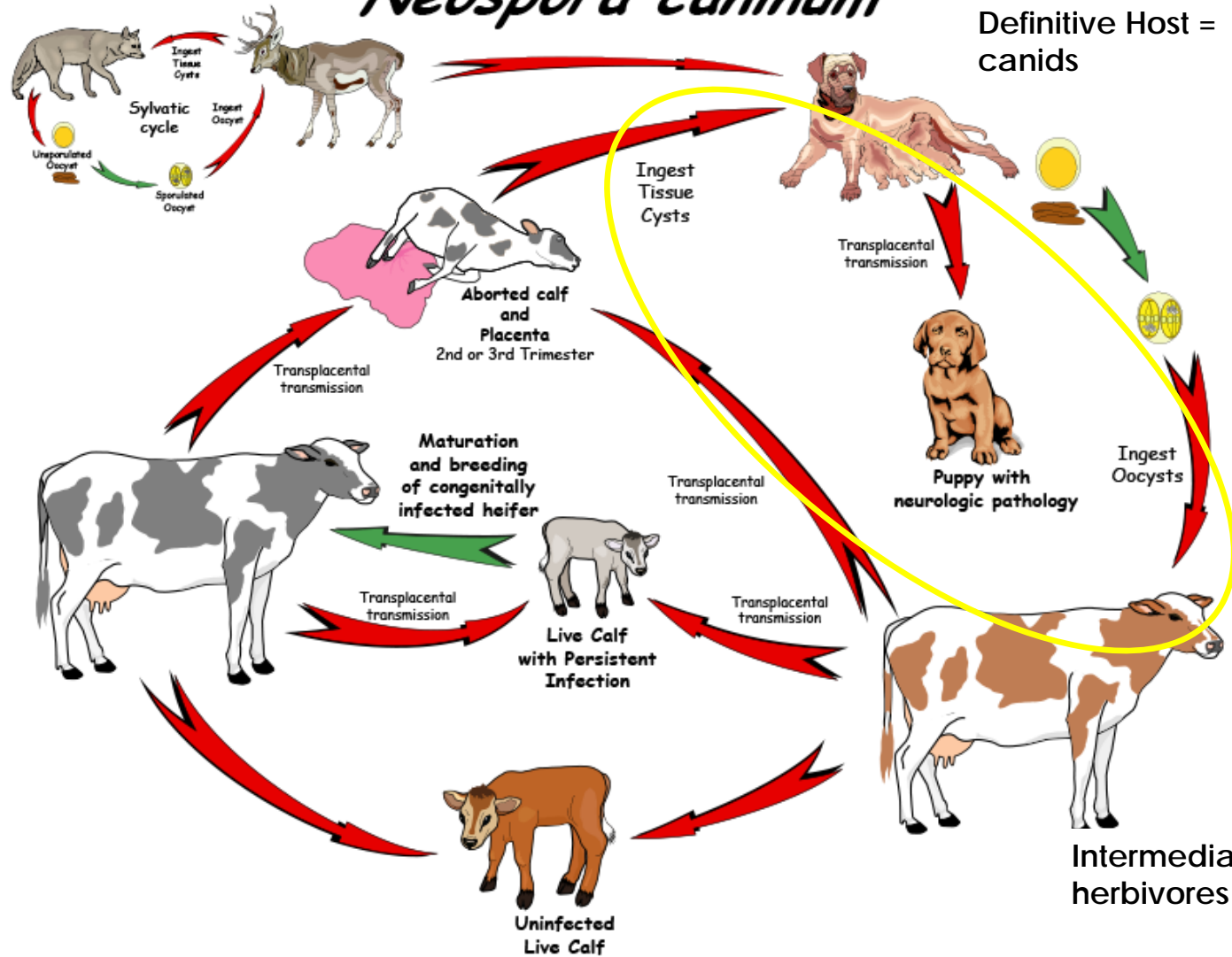
Oocysts
(eggs)



Sexual forms
(butterflies)

Neospora caninum

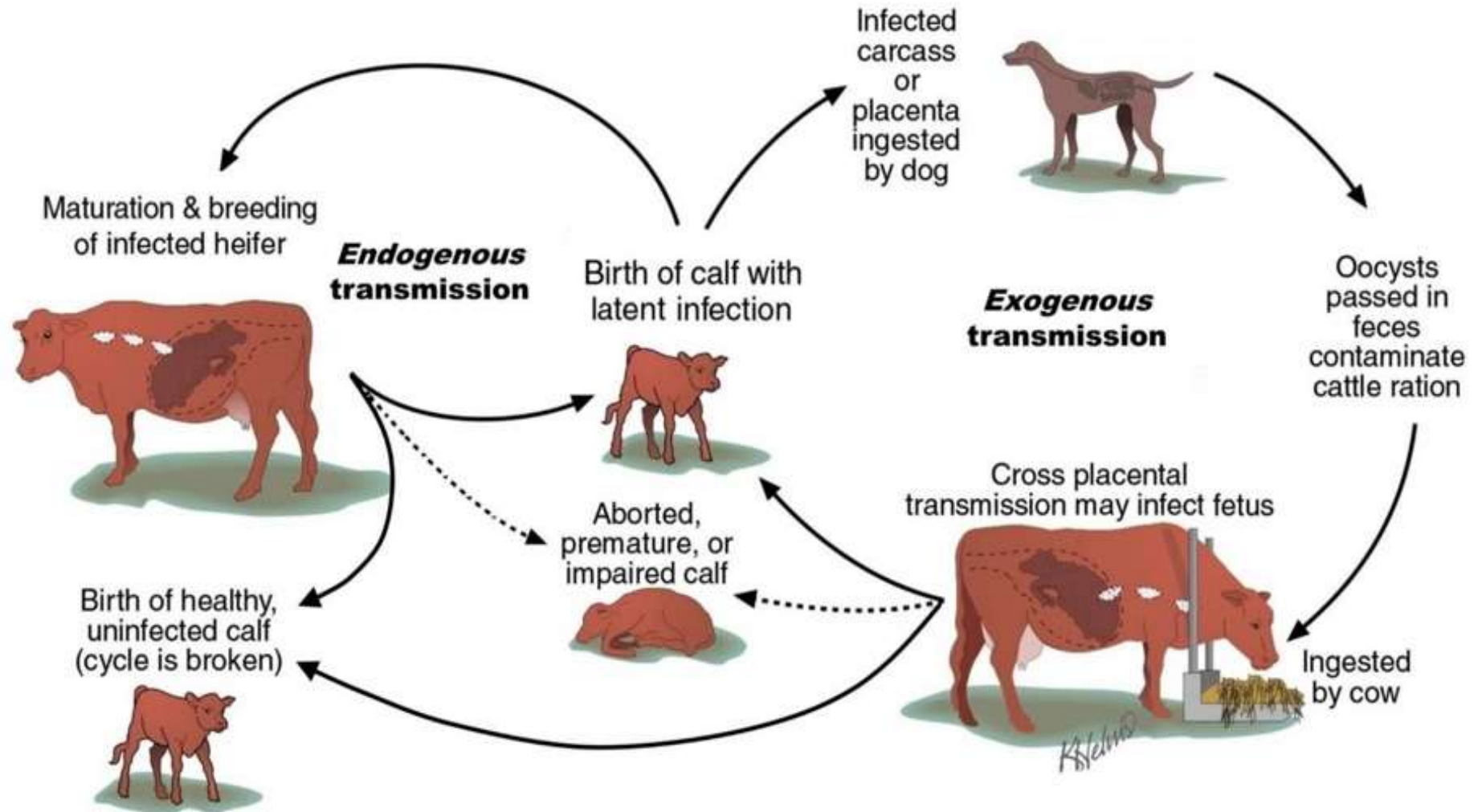
Definitive Host =
canids



Obligate
Indirect Life
Cycle

Trans-
generational
infection

Transmission of *Neospora caninum*.





Obligate Indirect Life Cycle: *N. caninum* Canids

- Obligate Indirect Life Cycle (heteroxenous)
 - Definitive host – Canids only (Dog, Coyote, Wolf, etc.)
 - Intermediate Host (IH) – Cattle and other animals
- **Transmission** -- carnivorous, ingestion of tissue cysts from aborted cattle fetus
- **Invasion** -- Zoites excyst from tissue cyst and invade enterocytes
- **Asexual reproduction** (enterocytes and other cells)
 - endodyogeny AND merogony

definitive host



Obligate Indirect Life Cycle: *N. caninum* Canids

- **Sexual reproduction** (only occurs in canids) in enterocytes
 - Gametogony, Macrogamete, Microgamete, Exflagellation, Fertilization, Zygote, Oocyst formation.
- **Dissemination**
 - Oocysts (unsporulated) exit the canid in the feces and contaminate the environment ~ 4 days post ingestion → sporulate after 1-3 days
 - Canids (definitive hosts) are the only hosts to pass oocysts
 - Oocysts highly resistant and remain infectious for many months.

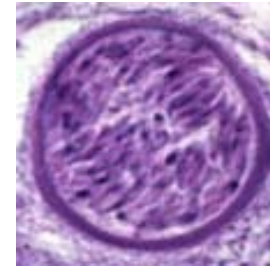
definitive host



Obligate Indirect Life Cycle: *N. caninum* Canids

Transmission / Invasion (details)

- After ingestion of cow tissue cyst
 - Intestinal
 - Some zoites infect intestinal cells to complete **sexual cycle** → oocyst in the feces
 - Systemic
 - Other zoites go to deeper tissue and go through **asexual cycles** → **tachyzoites** become tissue cysts with **bradyzoites** (predilection for neural tissue).
 - Congenital
 - If dog is pregnant, zoites → transplacental to puppies.



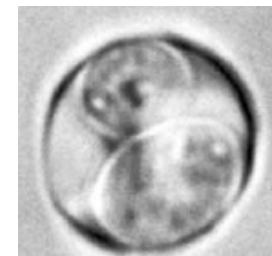


definitive host



intermediate host

Obligate Indirect Life Cycle: *N. caninum* Cattle

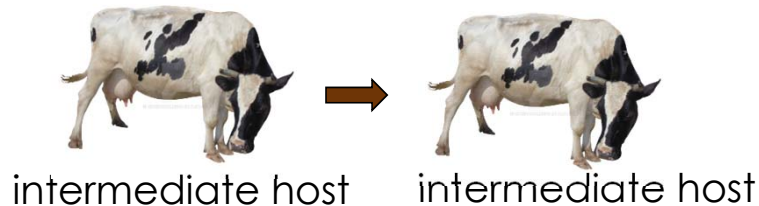


Transmission - Cattle ingest sporulated oocysts from canid feces

Invasion

- Intestinal – sporozoites **penetrate intestinal lining**
(no replication and invasion of enterocytes)
- Systemic - zoites move to extra-intestinal cells → asexual replication
 - **tachyzoites** (fast replication and transform into bradyzoites)
 - **bradyzoite** (slow replication, form tissue cysts in neural, muscle, myocardial, placenta, fetus)
- Congenital Transmission - zoites → transplacental to infect calf

Complex Life Cycle: *N. caninum* Cattle



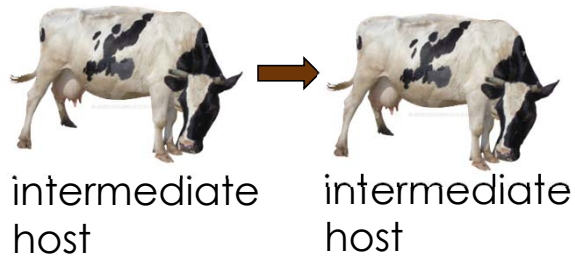
Congenital Transmission (details)

- Infected fetus aborts in 2nd or 3rd trimester, or born early, impaired

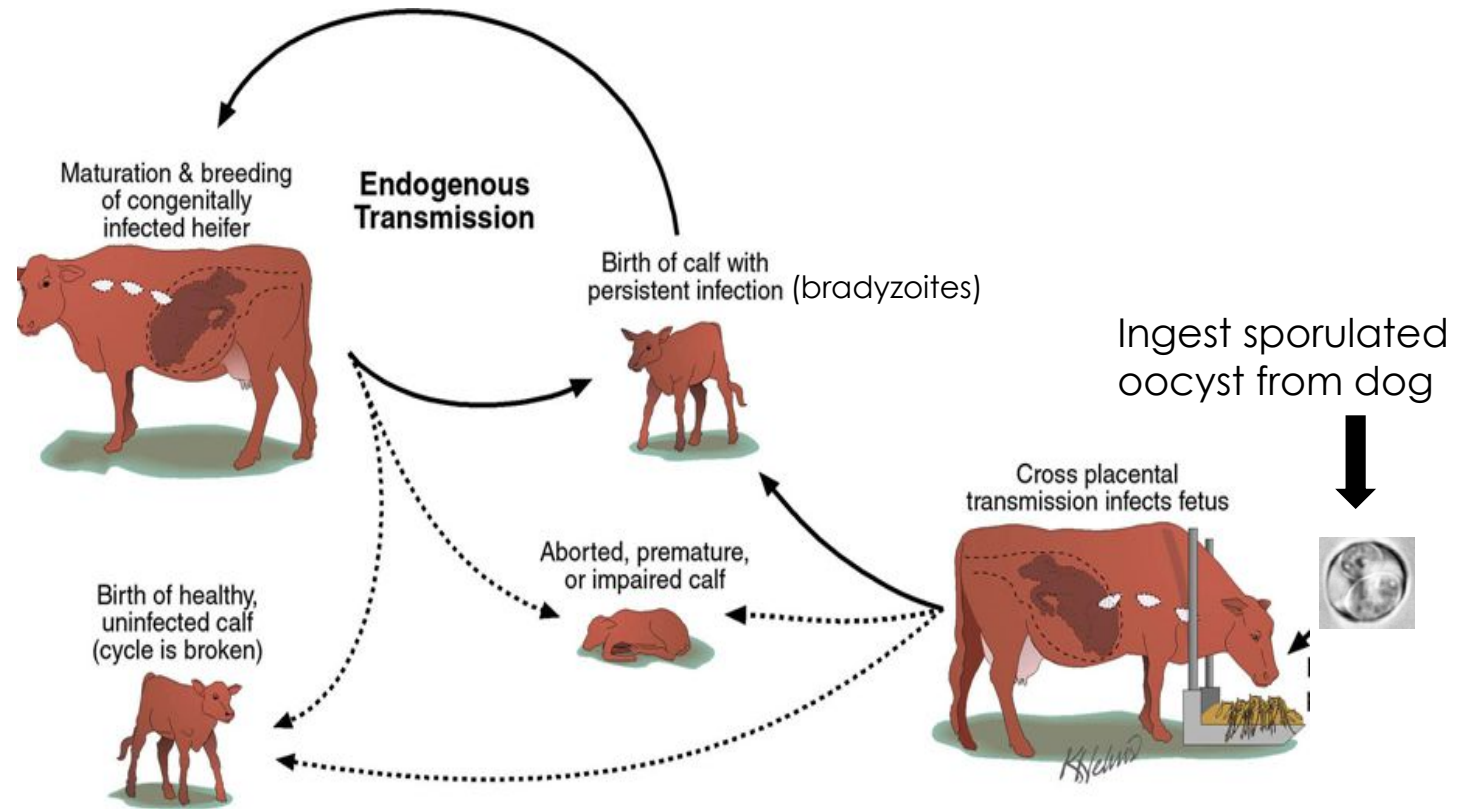
OR

- Infected fetus survives, passes infection on to offspring
= **Trans-generational infection**
 - Cows infected in utero will in-turn infect their calves, without reinfection from sporocyst in dog feces
 - These calves are usually seropositive and less likely to have abortions

Complex Life Cycle: *N. caninum* cow-to-cow (Congenital Neosporosis)



“re-activated”
bradyzoites invade
the placenta and
fetus



PATHOGENESIS

Intestinal phase = no pathology
(only in canids)

- ▶ The organism has a predilection for foetal chorionic epithelium and foetal placental blood vessels producing a foetal vasculitis and inflammation and degeneration of the chorioallantois, and widespread necrosis in the placentome.
- ▶ Tachyzoites penetrate host cells and are located in a parasitophorous vacuole.
- ▶ They can be found in macrophages, monocytes, vascular endothelial cells, fibroblasts, hepatocytes, renal tubular cells, and in the brain of infected animals.
- ▶ Cell death is by the active multiplication of tachyzoites.

Tissue cysts bradyzoites

may cause tissue damage; low inflammation; latent
Re-activation” source for transplacental transmission

“

CLINICAL DISEASE (DOGS)

- ▶ Signs more severe in young and immunocompromised.
- ▶ Weakness (Part. Neck), Incoordination and difficulty in swallowing.
- ▶ In dogs, neurological signs esp in congenitally infected pups- cysts in CNS.
- ▶ Neuromuscular degeneration observed- Hind limb paralysis.
- ▶ Adult dogs may develop skin lesions or pneumonia.

Clinical Disease: *N. caninum*

Puppies

Congenital Neosporosis

- Litter-mates dying with signs of **polyradiculitis** (inflammation of the nerve roots, especially of the hind limbs)
- Puppy with signs of **paralysis** of the rear limbs at 3-8 weeks of age (ascending paralysis)
- Puppy with **flaccid hind limb paresis**



CLINICAL DISEASE (CATTLE)

- ▶ Abortion in cattle.
- ▶ Abortion from 3 month gestation to term. Mostly 5-6 month.
- ▶ Foetuses may die in-utero, be resorbed, mummified, autolysed, stillborn, born alive with clinical signs, or born clinically normal but chronically infected.
- ▶ Clinical signs reported in cattle younger than 2 months of age.
- ▶ Hind limbs or forelimbs or both may be flexed or hyperextended.
- ▶ Neurologic examination may reveal ataxia, decreased patellar reflexes, and loss of conscious proprioception.
- ▶ Calves may have exophthalmia or asymmetrical appearance in the eyes.



Clinical Disease: *N. caninum* Cattle

- **Abortions** (10-20% of abortions caused by *N. caninum*)
 - Abortions usually occur with 1st post-infection pregnancy; autolysis of fetus
 - Later pregnancies usually go to term, but calves are infected (maintenance of dz in herds)
- Trans-generational infections
 - Seropositive calves give birth to seropositive calves – without reinfection via sporocyst ingestion
- ↓ milk production and ↓ weight gain

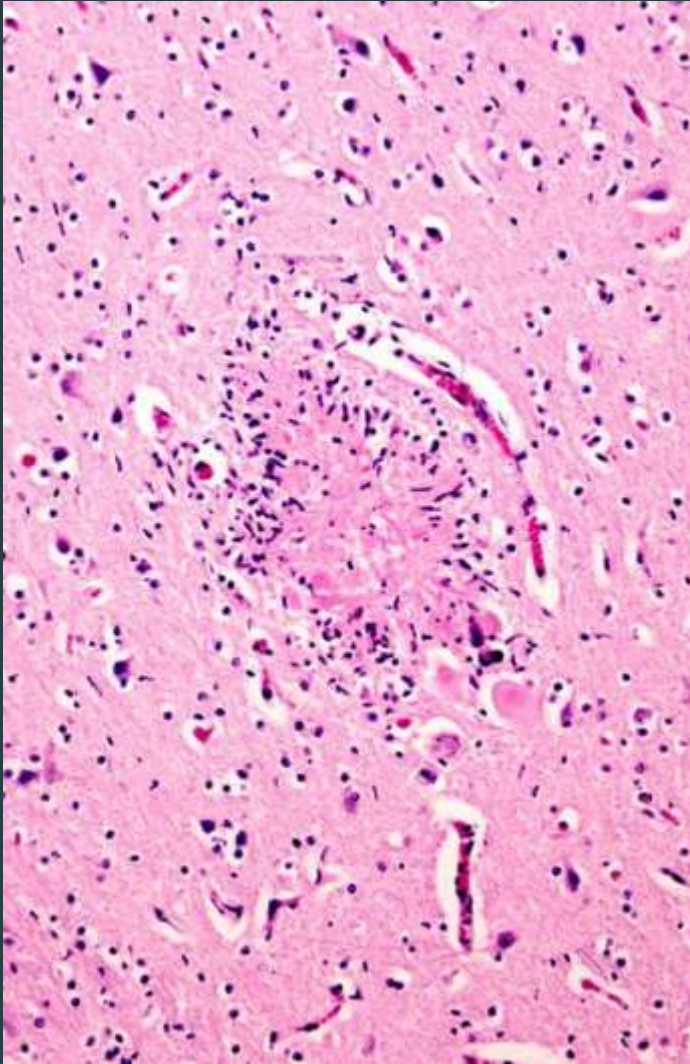


<https://www.cityu.edu.hk/ph/en/Research/VDP.html>

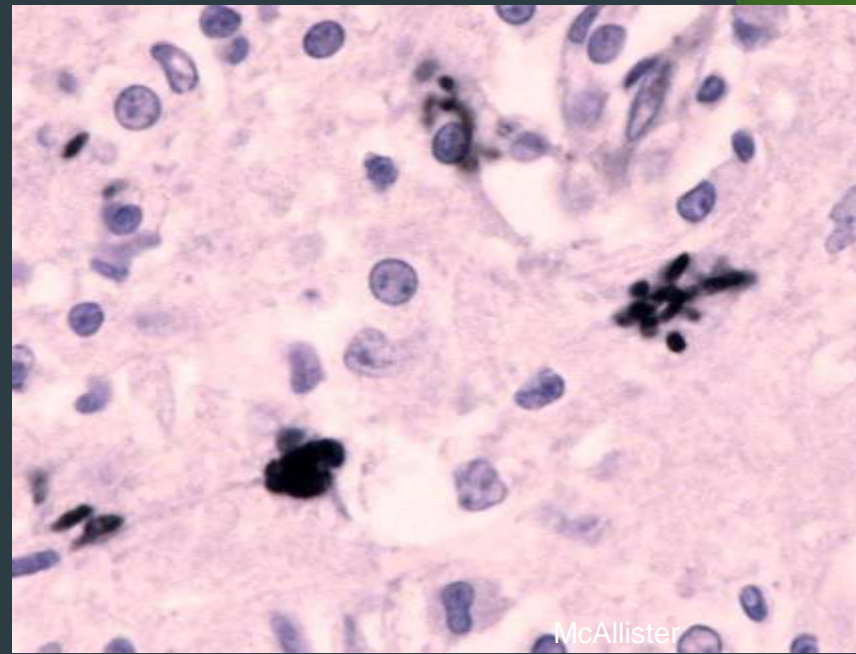


DIAGNOSIS (CATTLE)

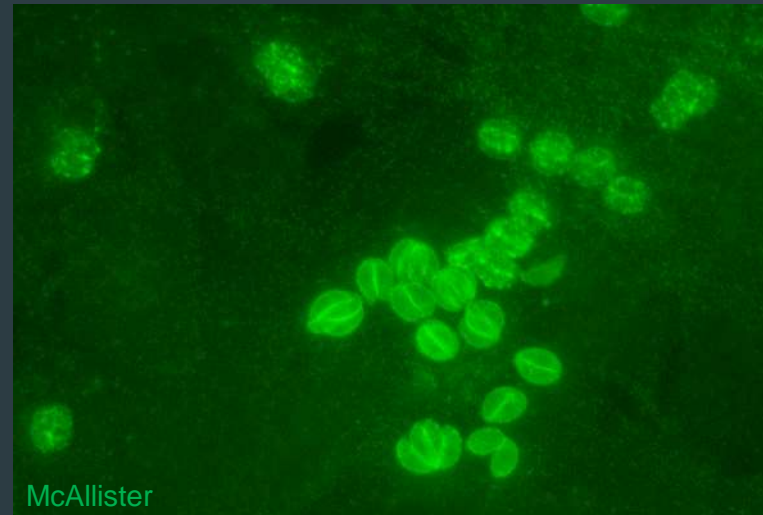
- ▶ Serum from aborting cow only indicative of exposure.
- ▶ Histologic examination of the foetus necessary for DD.
- ▶ Brain, heart, liver, placenta, and body fluids or blood serum are best specimens.
- ▶ The most characteristic lesion of neosporosis is focal encephalitis characterized by necrosis and non-suppurative inflammation.
- ▶ Other serological tests- ELISA, IFAT, NAT.
- ▶ Necropsy findings: Gross findings - Autolysis (Brain).



Necrotic focus rimmed by infiltrating leukocytes in the brain of an aborted calf



Immunohistochemistry demonstrating tachyzoites (black) within a cerebral lesion



Tachyzoites in cell culture (fluorescent antibody label)

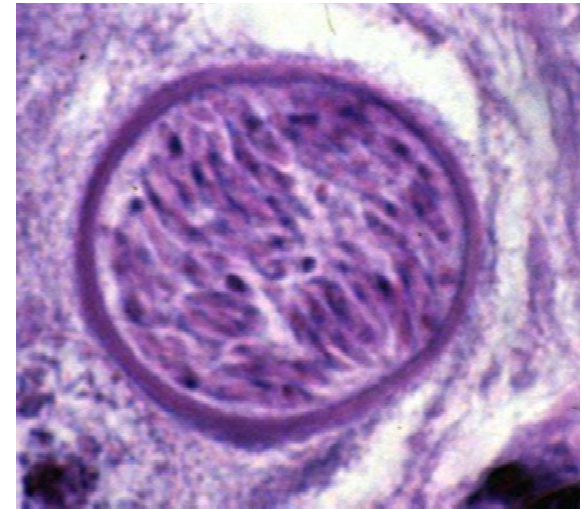
DIAGNOSIS (DOGS)

- ▶ Routine laboratory tests, chest and abdominal x-rays, and abdominal ultrasound recommended.
- ▶ Tests for antibodies- blood samples or CSF.
- ▶ Electromyography (EMG) may show numerous abnormalities.
- ▶ Microscopic examination- Tissue samples, CSF, cells from the trachea or lungs helpful in identification and diagnostic confirmation.

Diagnosis: *N. caninum*

- Dogs
 - Puppy – classic flaccid hind limb
 - Serology, molecular tests-PCR
 - Organism on biopsy, necropsy of litter mates
- Cattle
 - Diagnostic arrays for multiple abortion infectious agents
 - Serology and molecular tests-PCR
 - Antibody tests for whole milk

cyst filled with bradyzoites



<https://www.koofers.com/flashcards/cpb-exam-2-egglist-add-ons/review>

DIFFERENTIAL DIAGNOSIS

- ▶ From *Toxoplasma gondii* and *Sarcocystis cruzi*.
- ▶ Immunohistochemical and detection of parasite DNA by PCR can distinguish them from *N. caninum* .
- ▶ *Sarcocystis cruzi* - schizonts in vascular endothelium, rarely in aborted foetal brains. *N. caninum*- in extravascular tissues.
- ▶ Infection by *T. gondii* in bovine foetuses is rare.
- ▶ Other causes of abortion (DD) -brucellosis, trichomoniasis, genital campylobacteriosis, Leptospirosis, IBR, mycotic abortion, listeriosis, epizootic viral abortion (borrelia-like spirochete), nutritional reasons.

TREATMENT

- ▶ Clindamycin- Upto 22mg/kg bid for 60 days- drug of choice for muscle and skin involvement.
- ▶ Trimethoprim-sulfa drugs- 15-30 mg/kg bid for 28 days- particularly when neurologic disease is present.
- ▶ Additional supportive care.
- ▶ Treatment uneconomical in cattle- no chemotherapy for bovine neosporosis that has been shown to be safe and effective.

PREVENTION AND CONTROL

DOGS

- ▶ No vaccines that prevent disease in dogs.
- ▶ Avoid feeding raw meat.
- ▶ Avoid access to aborted bovine fetal materials.
- ▶ Cease breeding from infected dams- transplacental route.
- ▶ Introduce serological monitoring programme in pups.

PREVENTION AND CONTROL

CATTLE

- ▶ Bulk milk testing- monitoring seroprevalence in lactating cows.
- ▶ Prevention of transmission from dogs and other potential definitive hosts.
- ▶ Transfer of embryos from infected dams into uninfected recipients can prevent endogenous transplacental transmission of *N. caninum*.
- ▶ Quarantine and testing of replacement and purchased cattle.
- ▶ Bovilis Neoguard is commercially developed vaccine contains killed Neospora tachyzoites and applied to healthy pregnant cows during first trimester @ 5 ml twice s/c at 3-4 wk interval efficacy is upto 54%

THANK YOU!!!