



Toxoplasma gondii – only species of the genus

- clonal population structures – different genotypes

Three clonal strains – I, II, III

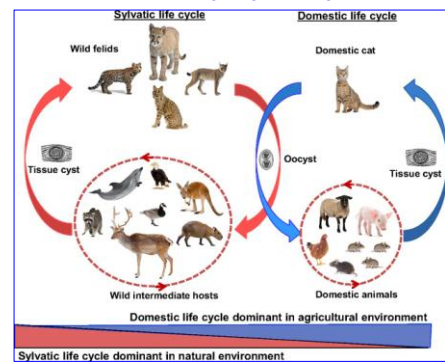
In the life cycle – several infection stages – relevant for parasite transmission

Toxoplasma gondii

is a protozoan parasite that infects most species of warm blooded animals, including humans, causing the disease toxoplasmosis.

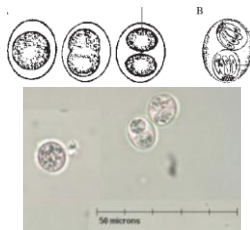
- cosmopolitan distribution
- seropositive prevalence rates vary
 - generally 20-75%
- generally causes very benign disease in immunocompetent adults
- tissue cyst forming coccidia
 - predator-prey life cycle
 - **felines are definitive host**
 - infects wide range of birds and mammals (**intermediate hosts**)

Predator-prey life cycle



PARASITE FORMS

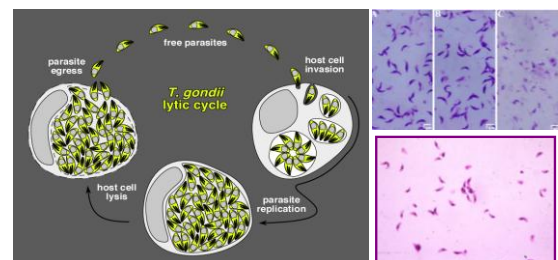
- **OOCYSTS** (12 x 12 µm)
- Highly resistant form.
- Infective for IH
- 2 sporocysts / 4 **SPOROZOITS**



- Shed in cat feces
- 1 to 14 (21) days
- Oocysts can remain viable in warm, moist soil for more than 1 year

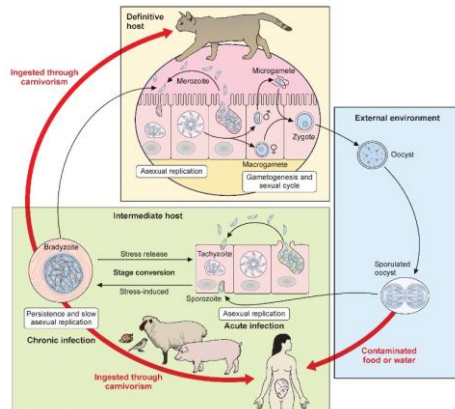
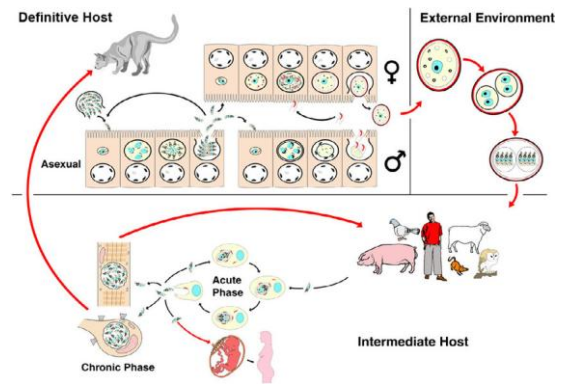
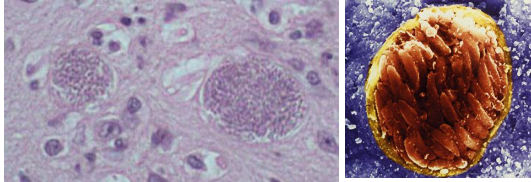
Tachyzoites

- Most common in brain, skeletal muscle, and cardiac muscle
- Rapid multiplication (**endopolygony**) lyses cell

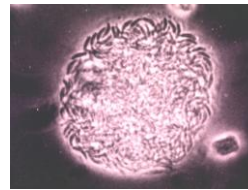


Bradyzoite Stage

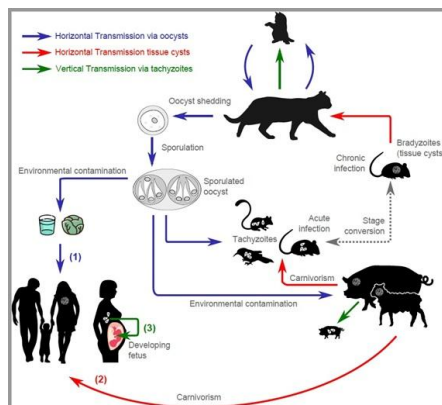
- dormant, slowly replicating (**endodyogeny**)
- **due to host immune response**
- chronic or latent infection - 50 – 150 μm (1000 – 3000 bradyzoites)
(mainly in the brain, skeletal muscle, and cardiac muscle)
- Remain for the life of the host
- Recrudescence of infection in immunocompromised hosts



Bradyzoite cysts are highly infective if ingested



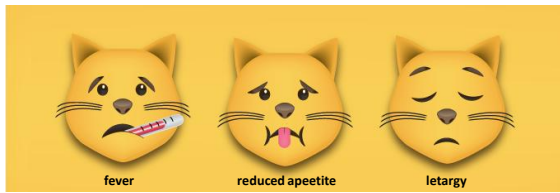
- Bradyzoites marks the beginning of the chronic phase of infection;
- Tissue cysts show very little evidence of inflammation or immune cell infiltrates;
- **Bradyzoites (not tachyzoites) are resistant to low pH and digestive enzymes during stomach passage;**
- Protective cyst wall is finally dissolved and bradyzoites infect tissue and transform into tachyzoit;



Feline Clinical Toxoplasmosis

- High prevalence, but very rare
- Effects young and immunocompromised
- Reactivation of infection in older cats
- Most common in < 2 year olds
- **Infects all nucleated cells; no erythrocytes !**
- Cats support **both sexual and asexual development**
- Enteritis, lymphadenopathy, pneumonia (esp. in FIV + cats), encephalitis, nephritis, anorexia, weight loss, lethargy, dyspnoea, ocular signs
- Most cats asymptomatic
- Transplacental transmission **rare** in cats

Feline Clinical Toxoplasmosis



Pre-patented period:

20-24 days (with oocysts) 7-10 days (when consuming tachyzoites) 3-5 days (when chewing the right / bradyzoites)

Excretion oocyst - 1x for life, 5-7 days, max. 14- 21 days;

asymptomatic

- **eye form - retinitis** (retinal inflammation), uveitis, chorioretinitis;
- lethal course in cats with impaired immune system;



Seropositive cat is **epidemiologically safe** - only in immunosuppressed cats can secondary infection and oocyst production occur;

Oocysts produced into the environment from DH - cats are not immediately infectious because they are not shed; therefore, **direct contact with a cat does not !!! usually result in infection.**

Diagnosis - Felines

- **Detection of oocysts**
- Difficult, shedding done before clinical signs
- Dif. dg: *Hammondia hammondi*
- **Serology**
- IgG-class immunoglobulins,
- IgM-class, higher titers



Clinical signs - dogs (IH)

- **Acute** – increased temperature, lymph node enlargement, nose and eye discharge, tonsillitis, dyspnoea, diarrhea, progressive weight loss, pneumonia (most commonly);
- **Chronic** – hepatitis, myocarditis, pneumonia; **in dogs frequent nerve symptoms** during CNS involvement - apathy, tremor, ataxia, hemiparesis, paresis, paralysis;

Toxoplasma gondii and other IH - food animals

- Large ruminants - Aborts
- Small ruminants - sheep, goats - abortions, CNS disorders
- Pigs - as with dogs - temperature, enlarged lymph nodes, nose and eye discharge
- Horses
- Race game
- Poultry

asymptotically



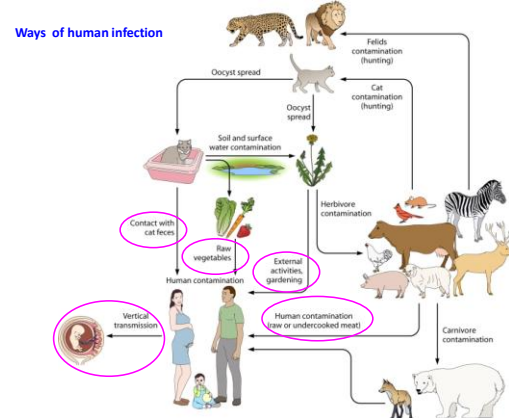
Treatment

- **Toltrazuril** – cats (20 mg/kg b.w.)
- **Clindamycin (15 mg/kg b.w.) + trimetoprim (10 mg/kg b.w.)** – dogs, cats with systemic clinical toxoplasmosis;
- **Sulfonamids + trimetoprim** in dogs at regular doses;

Toxoplasmosis

Zoonotic Potential

Human Transmission



Pathogenesis

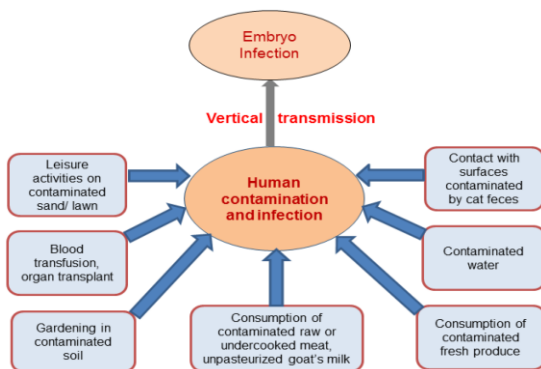
The **tachyzoites directly destroy host cells**, especially parenchymal and reticuloendothelial cells.

Clinical Features

- **Prenatal (congenital) toxoplasmosis**
- **Postnatal toxoplasmosis**

Prenatal toxoplasmosis may cause:

- Stillbirths
- Chorioretinitis
- Intracerebral calcification
- Hydrocephaly/microcephaly
- Neurological Damage
- Learning Difficulties



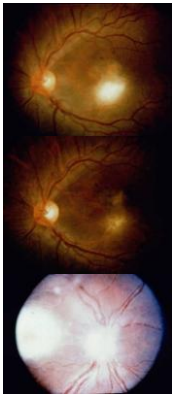
Congenital Toxoplasmosis

- acute infection of the expectant mother. **Severity depends on the stage of pregnancy**
- severity varies with age of fetus
 - **more severe early in pregnancy**
 - more frequent later in pregnancy
- **Spontaneous abortions** or **neurological disorders** such as blindness and mental retardation can result.
- stillbirth, premature birth, or full-term ± overt disease, chorioretinitis, Intracerebral calcification, Hydrocephaly/microcephaly, Neurological Damage, Learning Difficulties

Congenital toxoplasmosis

- If a woman is infected for the first time during pregnancy the parasite can transverse the placenta and cause fetal disease;
- Both the probability and severity of the disease depend on when the infection takes place during pregnancy (early: low transmission, but severe disease, late: high transmission, more benign symptoms);





Ocular Toxoplasmosis

- **chorioretinitis**: likely due to both active parasite proliferation and immune hypersensitivity
- generally a recrudescence - rarely from primary infection
- **congenital infection**
 - 20% exhibit ocular symptoms at birth
 - 82% by adolescence
- most lesions are focal and self-limiting
- rapidly destructive in AIDS patients

Clinical Features

Acquired Postnatal toxoplasmosis

Postnatal toxoplasmosis may cause:

- Lymph node infection similar to mononucleosis
- Local hypersensitivity
- Blood vessel blockage
- Cell death near the cyst
- All of these symptoms are rare in healthy human patients;

- 1-2 week **incubation period**
- **acute parasitemia** persists for several weeks until development of tissue cysts
 - often asymptomatic (>80%)
 - a common symptom is lymphadenopathy without fever
 - occasionally mononucleosis-like (fever, headache, fatigue, myalgia)
- likely persists for life of patient
- immunosuppression can lead to reactivation (eg., organ transplants)

Diagnosis

- Because methods for direct evidence of toxoplasma are very difficult, basic laboratory diagnosis relies primarily on **indirect** diagnostic methods for evidence of toxoplasma antibodies in serum.
- Investigative procedures consist of a combination of basic and complementary (supra-basic) investigative methods.
- By combining appropriate tests allowing the **determination of individual classes of immunoglobulins** and **monitoring the dynamics of antibody production**, fresh infection can be distinguished from latent, inactive infection.

Diagnosis

- In acute toxoplasmosis, **high titers** of specific **IgM** and **IgA** antibodies can be detected in the serum, while **IgG levels are initially low**.
- A rise in antibody titer is indicative of an **active infection**, stable high titer of a recent resolving infection and stable **low** titer of a **chronic, latent** infection.

Prevention of toxoplasmosis (human)

Primary prevention - adherence to strict hygiene rules, especially pregnant women and immunosuppressed patients:

- > Wearing gloves when working with soil, processing raw meat
- > Washing fruit and vegetables before consumption
- > Eating only sufficiently cooked meat (71.1 °C);
- > Regular cleaning of cat boxes
- > Preventing insect contamination of food (house fly)
- > Serological examination in the pre-gestation period

Secondary prevention - the aim is to prevent infection of the fetus or to prevent the consequences if infection has occurred

- - Regular serological screening once every trimester (Expert Guideline of the Ministry of Health of the Slovak Republic on the diagnosis of toxoplasmosis No. 106/2006);
- - Women's health education on the possibility of infection and its prevention;
- Surveillance and monitoring for *Toxoplasma gondii* - especially sheep and goats, organic and pasture-raised pigs;
- Surveillance and monitoring of food and food products (meat, milk and milk products, but also water);

Hammondia - Hammondiosis

- There are two species in domestic animals:
- ***H. hammondi*** in **cats (FH)**, mice, rat (IH)
- ***H. heydorni*** in **canines (FH)**, cattle, sheep, goat, dog (IH)
- Both are obligatory two-host parasites with **life cycles similar to *Toxoplasma***.
- The generalized life cycle involves the intermediate hosts becoming infected by eating sporulated oocysts.
- Sporozoites excyst and **invade intestinal cells**, become tachyzoites and multiply. The parasite eventually encysts in muscles.

Hammondia hammondi

- **Hosts:**
 - **Definitive:** Cats
 - **Intermediate:** Rodents
- **Life Cycle:**
 - The unsporulated oocyst leaves the cat in the feces.
 - It takes 3 days in the environment to develop to the infective, sporulated stage (which contains 8 sporozoites).
 - When a rodent ingests the infective oocyst, the sporozoites invade intestinal cells and multiply as tachyzoites.



Hammondia hammondi

- ***Hammondia hammondi*** The life cycle and structure are essentially the same as *T. gondii* with the following exceptions:
 - (1) *H. hammondi* does not have an extraintestinal cycle in the cat;
 - (2) Intermediate hosts are infected only by ingestion of oocysts;
 - (3) Definitive hosts are infected only by ingestion of tissue cysts of intermediate hosts.

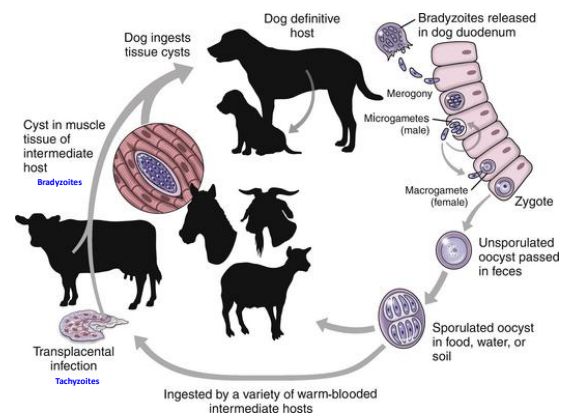
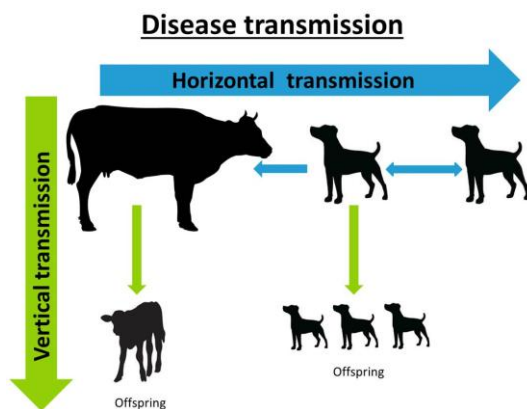


Clinical Findings

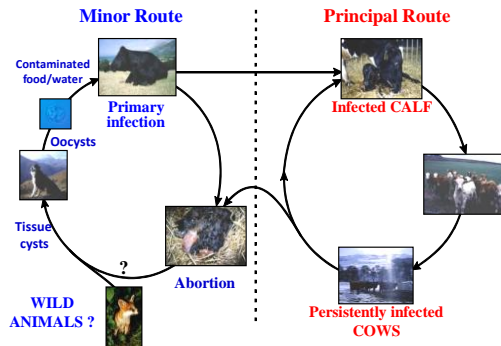
- There is loss of hair and epidermis.
- In addition to the skin lesions, there may be focal, disseminated myositis, keratitis, periostitis, endostitis, lymphadenitis, pneumonia, periorchitis, orchitis, epididymitis, arteritis, and perineuritis.
- Severely affected animals become emaciated.
- **Common Diagnostic Test:**
 - Faecal flotation
 - **Treatment:**
 - None known. Try treating as for *Toxoplasma*: Clindamycin.

Neospora caninum

- Toxoplasma - like (dog, cattle, sheep)
- Life cycle similar to *T. gondii* - dog is definitive host
- Can differentiate using serology (antibody specific rx to differentiate from *T. gondii*) morphology of organisms slightly different
- Route of natural transmission is trans-placental and via ingestion of oocysts - infection life long?



Transmission of Bovine Neosporosis



Clinical signs

- Abortion is the only clinical sign in adult cows (they may abort from 3 months of gestation to term)
- Fetuses may die in utero, be absorbed,
- Mummified, autolyzed, stillborn, born alive but diseased, or born clinically normal but chronically infected
- Within herds, abortion may be clustered, sporadic or epidemic
- *N. caninum* – induced abortions occur year round
- Cows with *N. caninum* antibodies (seropositive) are more likely to abort than seronegative cows

Neosporosis DH



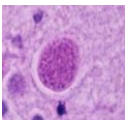
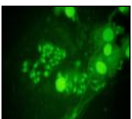
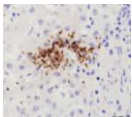
- prenatal infection – young dogs – focal necroses – brain, spinal cord and nerves;
- muscular atrophy, ataxia, paresis, ascending paralysis, muscular pain in lumbal, pelvic region, torticollis, dysphagia, incontinence;



Clinical signs

- Only in individual calves younger than two months
- *N. caninum* – infected calves may be born underweight, unable to rise and with neurologic signs
- Hind limbs and / or forelimbs may be flexed or hyper-extended and neurologic examination reveal ataxia, decreased patellar reflexes, and loss of conscious proprioception.
- Exophthalmia or an asymmetrical appearance of the eyes may also be observed

Diagnosis



- Clinical findings
- Serology
- Immunohistochemistry
- PCR
- Histopathology
- Examination of the foetus is necessary for a definitive diagnosis
- Differential diagnosis

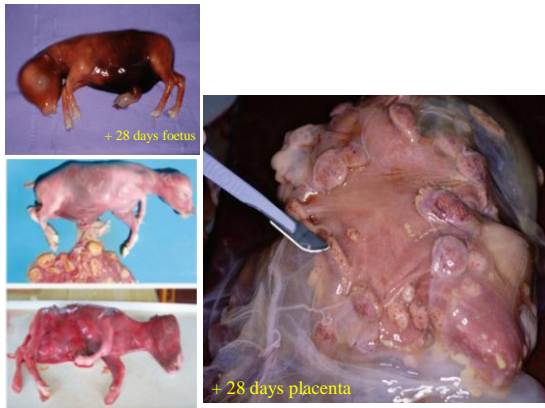
Neosporosis in cattle



Occurrence: cosmopolitan

- Affects dairy cows and fattening cattle Europe: UK 1996, Germany 1996, Belgium 1997, Denmark 1997, Italy 1998, Spain 1998, Hungary 1998, Czech Republic 1999; SLOVAKIA: since 2007 in north-eastern Slovakia, average seropositivity up to 39,8 %;

- Clinical signs: neurological signs in calves younger than 2 months: ataxia, flexion or hyperextension of limbs, exophthalmia in adults, abortions from 3 months of gestation, in some geographical prevalence up to 45 % in some areas;



Bovine neosporosis

Control: management

- Dogs can produce oocysts, persist in the environment
- Prevent animal contamination of feed
- Prevent bovine/canine contact with placenta or abortion tissues
- Embryo transfer

Bovine neosporosis

Control: pharmaceuticals

- Sulfonamides, pyrimethamine and clindamycin, toltrazuril: **canine neosporosis**
- No drug effective against tissue cysts
- No effective treatment to prevent vertical transmission in cattle
- Potential problem of drug residues in the milk of lactating cows

CARYOSPORA

- Coccidia of the genus *Caryospora* are found primarily in **birds** and **snakes**.
- Species of *Caryospora* have two-host life cycles, in which the hosts have a predator-prey relationship.
- There are **owl-mouse** and **snake-mouse** cycles.
- *Caryospora bigenetica* and *C. simplex*

Caryospora

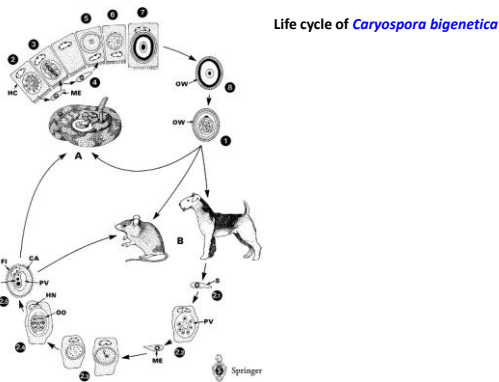
- Unsporulated oocysts are shed in the faeces of the predatory or definitive host (**birds and reptiles**).
- Sporulated oocysts contain a **single sporocyst** with **eight sporozoites**.
- Ingestion of sporulated oocysts by the **definitive host** results in **schizogony**, **gamogony**, **fertilization**, and **formation of oocysts** in the intestinal epithelium.

Pathogenesis

- Formation of pyogranulomes in subcutaneous tissues
- In immunocompromised hosts - fatal

Symptoms

- Oedema around eyes, nose, inflammation interdigital spaces, abdominal region,
- pyogranulomes;



FRENKELIA

- Coccidia of the genus *Frenkelia* have an obligatory two-host life cycle involving a **rodent intermediate host (prey)** and a **raptorial bird definitive host (predator)**.
- The life cycle is nearly identical to that of *Sarcocystis* spp.
- Rodents are infected by ingestion of sporulated oocysts or sporocysts. Schizogony occurs in the **rodent liver** and **tissue cysts are found in CNS**.
- Mature tissue cysts can be macroscopic.
- They are multilobulated and surrounded by a thin wall, with many thousands of slender bradyzoites, which are infectious to the definitive host.
- After ingestion, bradyzoites enter the **intestinal cells** and form gametes, which develop into oocysts after fertilization. Oocysts sporulate in situ and are shed in the faeces.

➤ The **life cycle** is nearly identical to that of *Sarcocystis* spp.

