

Toxoplasma gondii: A One Health Problem

What does “One Health” mean?

One Health is the term used to describe the interconnectedness of human, animal, and environmental health. One Health recognizes the importance of holistic approaches to achieve optimal health outcomes. According to the CDC's One Health Office, 6 of every 10 infectious diseases in humans are spread from animals. Such diseases are called "zoonotic."¹



What is *Toxoplasma gondii*?

T. gondii is a protozoan parasite with the ability to infect virtually any bird or mammal, including humans, and which causes the disease toxoplasmosis. This zoonotic disease travels from cats into the environment, where it affects humans and other animals alike.

What are the consequences of infection?

In the USA, **over a million people** are infected with *T. gondii* each year.² Nearly a **quarter of deaths** resulting from foodborne illnesses are caused by toxoplasmosis.³ The disease is the most common cause of ocular inflammation and may result in blindness. Toxoplasmosis has historically been recognized as a risk for pregnant women and individuals with compromised immune systems, but new research is showing it causes problems in otherwise healthy populations as well.⁴

Why do cats play such an important role in the spread of toxoplasmosis?

Felines are the definitive host for *T. gondii*. This means that without cats, **the parasite would not be able to complete its lifecycle**. With an estimated 30–80 million unowned cats in the USA, billions of parasites are deposited as oocysts into the environment through fecal matter, which leads to the contamination of soil and water.⁵ Environmental oocysts cause infection in humans and animals alike.

INTERESTING FACT:

T. gondii can influence the way a host thinks! Infected rodents have been shown to lose their fear of cats and are actually attracted to cat urine.⁶ This brings them into close contact with felines, increasing the likelihood that they will be eaten and that *T. gondii* will complete its life cycle within its definitive host.

Three ways humans contract toxoplasmosis:

Ingesting environmental oocysts

Oocysts can be accidentally ingested through a number of different means including while changing a litter box, while gardening or playing in a sandbox where a cat has defecated, by eating unwashed fruits or vegetables, or by petting a dog that has rolled in contaminated cat feces and then touching your mouth or food.

Consuming tissue cysts

Live tissue cysts can be consumed in undercooked meat from contaminated livestock or wild game, such as pork or venison.

Congenital infection

Vertical transmission of the parasite can infect an unborn child through the placenta if the mother has an infection.

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Biology of *Toxoplasma gondii*:

T. gondii has three infective stages:

The transmission stage, the **tachyzoite**

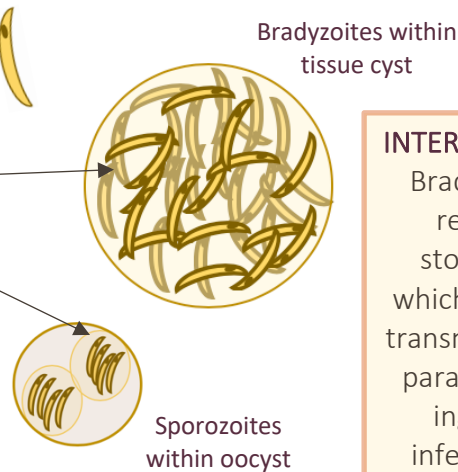
The tissue-cyst stage, the **bradyzoite**

And the environmental stage, the **sporozoite**

Tachyzoites invade warm-blooded animal cells and quickly multiply within them. When a tachyzoite invades a tissue cell, it differentiates into a bradyzoite and forms cysts. Mature cysts hold **hundreds to thousands** of bradyzoites.⁷

Tachyzoites and bradyzoites reproduce asexually within intermediate hosts (like **birds**, **humans**, and other **mammals**), but can only complete its lifecycle once ingested by a **feline**. Once within the intestinal tract of a cat, the parasite undergoes sexual reproduction and sporozoites form within **oocysts**. Oocysts act like an egg, protecting the sporozoites within.

The oocysts are then excreted in cat feces. An infected cat can shed **more than 100 million oocysts**.⁸ Sporozoites within the shed oocysts can survive for **up to a year** without a host if they are deposited in a moist environment!⁹

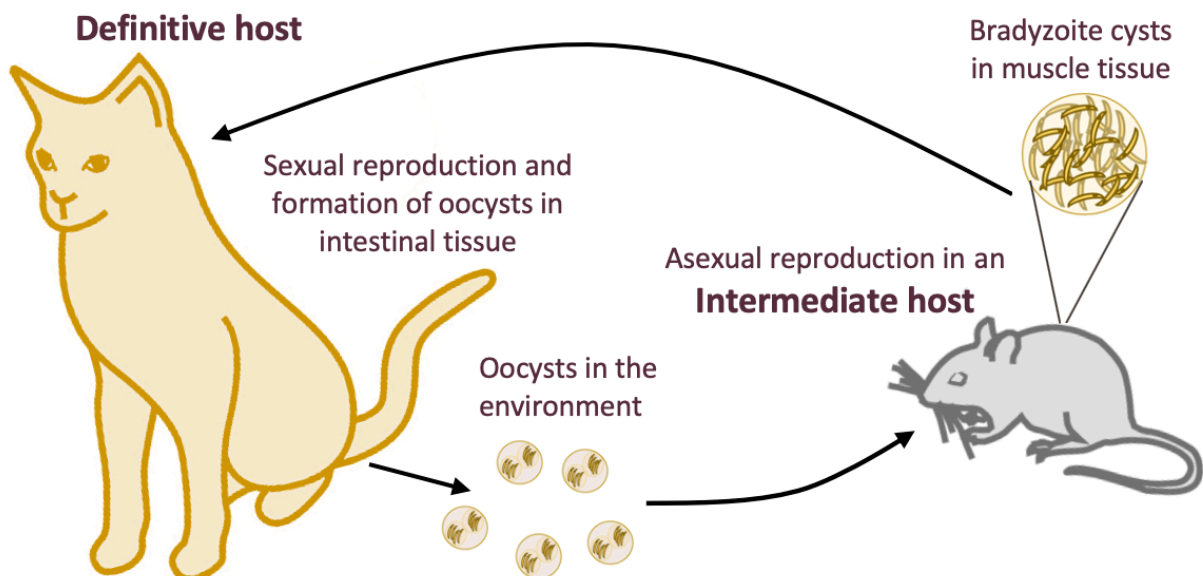


INTERESTING FACT:

Bradyzoites are resistant to stomach acid, which enables the transmission of the parasite through ingestion of infected tissue.

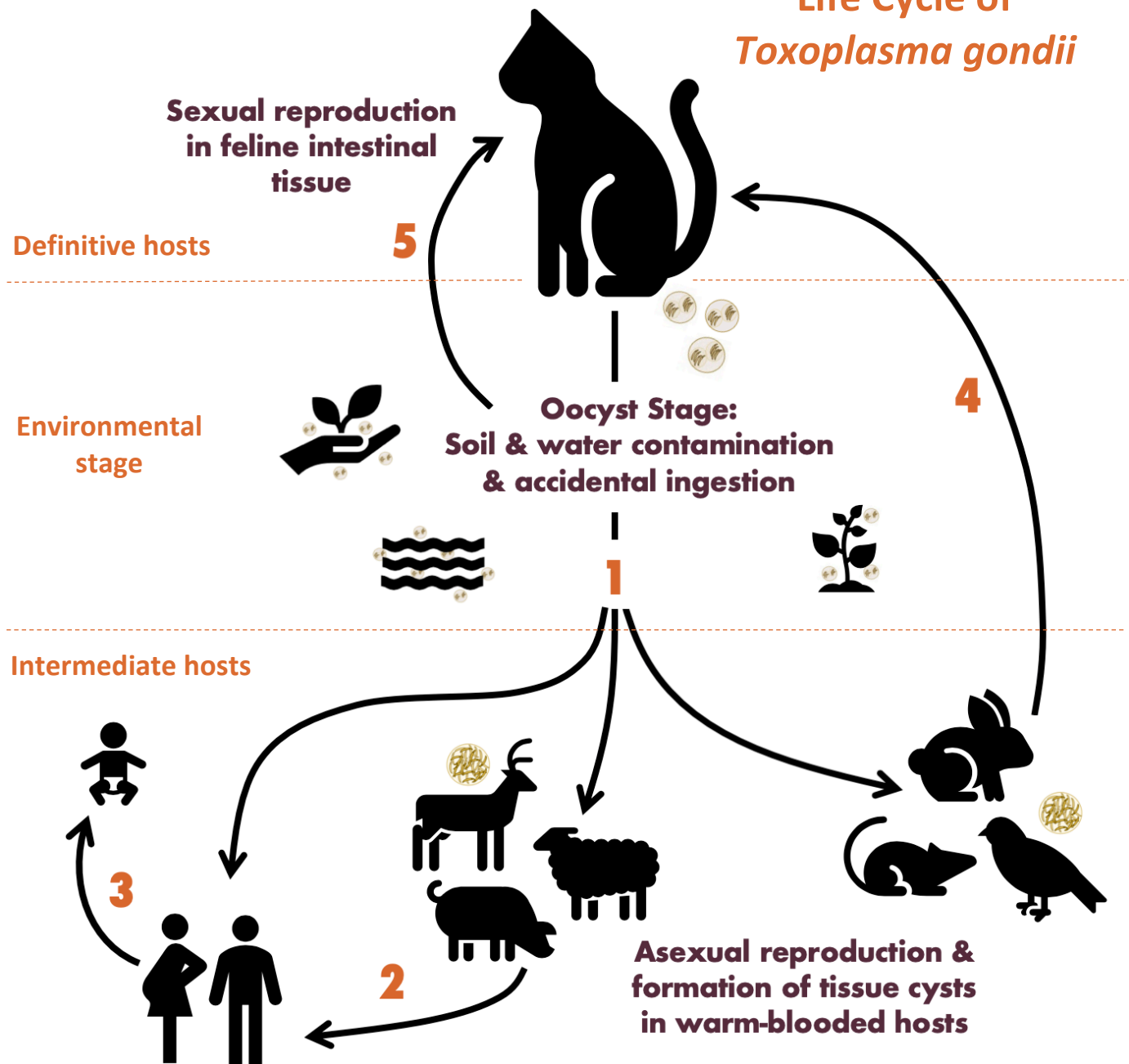
Oocysts **contaminate soil and water** and are transported in runoff.¹⁰ When the oocysts are accidentally ingested, sporozoites penetrate the cells of the intestinal-lining. From there, they differentiate back into tachyzoites and spread throughout the organism.

Tissue cysts can arise **as early as 7 to 10 days** post infection. These may remain in the brain and muscle tissue **throughout the life** of the host. Presence of tachyzoites indicates an acute infection, whereas bradyzoite cysts reveal a chronic infection. Inflammation from the parasite can cause severe problems.



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Life Cycle of *Toxoplasma gondii*



1. Humans, livestock, and wildlife can ingest oocysts from contaminated soil, water, or plant matter. Oocysts can persist in the environment for up to a year before infecting a new host.
2. Humans can also become infected from eating tissue cysts in undercooked meat.
3. Infection may spread from a pregnant woman to her fetus.
4. The lifecycle restarts when cats catch and eat prey with infected tissue cysts.
5. Cats can also become re-infected from environmental oocysts.

**Keeping cats indoors breaks the cycle by removing the definitive host.
Without a definitive host, there is no sexual reproduction or environmental oocyst stage.**

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Solutions for long-term management:

By removing domestic cats from the ecosystem, we eliminate interactions between *T. gondii*'s definitive and intermediate hosts, as well eliminate the risks to wildlife from a non-native predator. Keeping cats contained indoors, in a catio, or within a sanctuary keeps cats, wildlife, and people safe from unwanted disease transmission and promotes longer, healthier lives for all animals.

ENDNOTES:

- 1 Centers for Disease Control and Prevention , National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Page last reviewed: August 23, 2019, <https://www.cdc.gov/onehealth/index.html>
- 2 Aguirre AA, et al. 2019. The One Health Approach to Toxoplasmosis: Epidemiology, Control, and Prevention Strategies. Eco Health Review.
- 3 Scallan E, et al. 2011. Foodborne illness acquired in the United States—major pathogens. Emerging Infectious Diseases 17:7–15
- 4 Flegr J, et al., (2002). Increased risk of traffic accidents in subjects with latent toxoplasmosis: a retrospective case-control study. BMC Infectious Disease 2:11
- 5 Loss S, et al. 2013. The impact of free-ranging domestic cats on wildlife of the United States. Nature Communications 4: 1396
- 6 Berdoy M et al. 2000. Fatal attraction in rats infected with *Toxoplasma gondii*. Proceedings of the Royal Society of Biological Sciences B 267:1591–1594
- 7 Florence Robert-Gangneux and Marie-Laure Dardé. 2012. Epidemiology of and Diagnostic Strategies for Toxoplasmosis. Clin. Microbiol. Rev., 25(2):264-296.
- 8 Dubey JP, Frenkel JK. 1972. Cyst-induced toxoplasmosis in cats. J.Protozool. 19:155–177.
- 9 Jones JL, Dubey JP. 2010. Waterborne toxoplasmosis—recent developments. Exp. Parasitol. 124:10 –25.
- 9 Mai K, et al. 2009. Oocyst wall formation and composition in coccidian parasites. Mem. Inst. Oswaldo Cruz 104:281–289.
- 10 Conrad P.A., et al. 2005. Transmission of *Toxoplasma*: Clues from the study of sea otters as sentinels of *Toxoplasma gondii* flow into the marine environment. International Journal for Parasitology 35, 1155–1



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