

# From Disease, to Personality, to Culture, to the Future of Civilization

- Weird infectious diseases exist
- Syphilis makes people go crazy
- Guinea worms eat their way through the body

# Guinea worm disease

- Worms typically chemically burn a hole or blister in the skin of the lower leg
  - (from the inside out)
- The victim eases the pain by soaking the limb in the nearest water supply
- The worm senses the water and immediately lays many thousands of eggs into the water

# Guinea worm disease (cont.)

- The **eggs** hatch and the **larvae** are eaten by **water fleas**
- **People** drink the **fleas** with the **water**
- The larvae then burrow into the body, turn into worms, mate, the male dies and the female begins her painful journey
  - (Painful to us, that is)
- To remove a worm that burned its way through the skin:
  - Wrap it around a stick, pulling a few mm out every day, for weeks until worm is out
    - Up to 3' long; “as wide as a paper clip wire” (<http://www.dhpe.org/infect/guinea.html>)

# Guinea worm disease

## – broader picture

- The Carter Center leads the eradication campaign
- People need to filter their water with a cloth to remove the fleas before drinking
  - Simple, but one needs to understand why
- People also need to not dunk painful exit wounds in the drinking water supply!
- Children tend to forget the most
- The disease can be wiped out forever

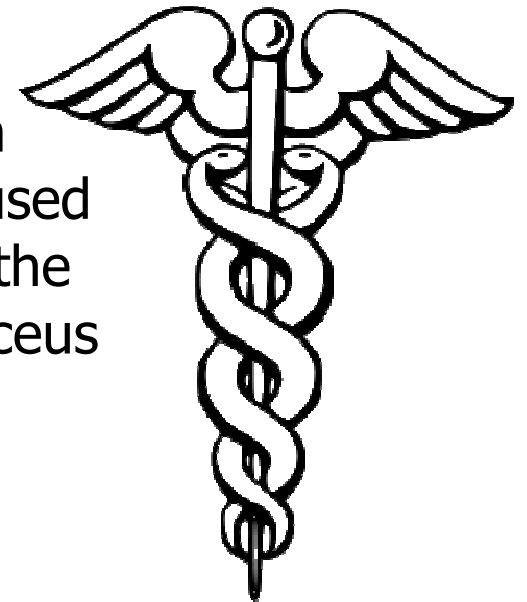
# Guinea worm – historical note

- First described by the ancient Greeks
- At one time millions were infected
- May have inspired the long-time symbol of medicine: the rod of Asclepius

EMS (Emergency  
Medical Services)  
symbol



Often  
confused  
with the  
caduceus



- Do you think you might have guinea worm disease (dracunculiasis)??

# Warning!



You

may  
have

something  
weirder than  
guinea worm  
disease

# About this disease

- Sufferers look healthy but have **changes in personality**
- Many changed personalities can **change a culture**
- Changing culture can **change the course of nations**
- Changing the course of nations could **change the future of civilization**

*What spreads it?*



# How the disease spreads...

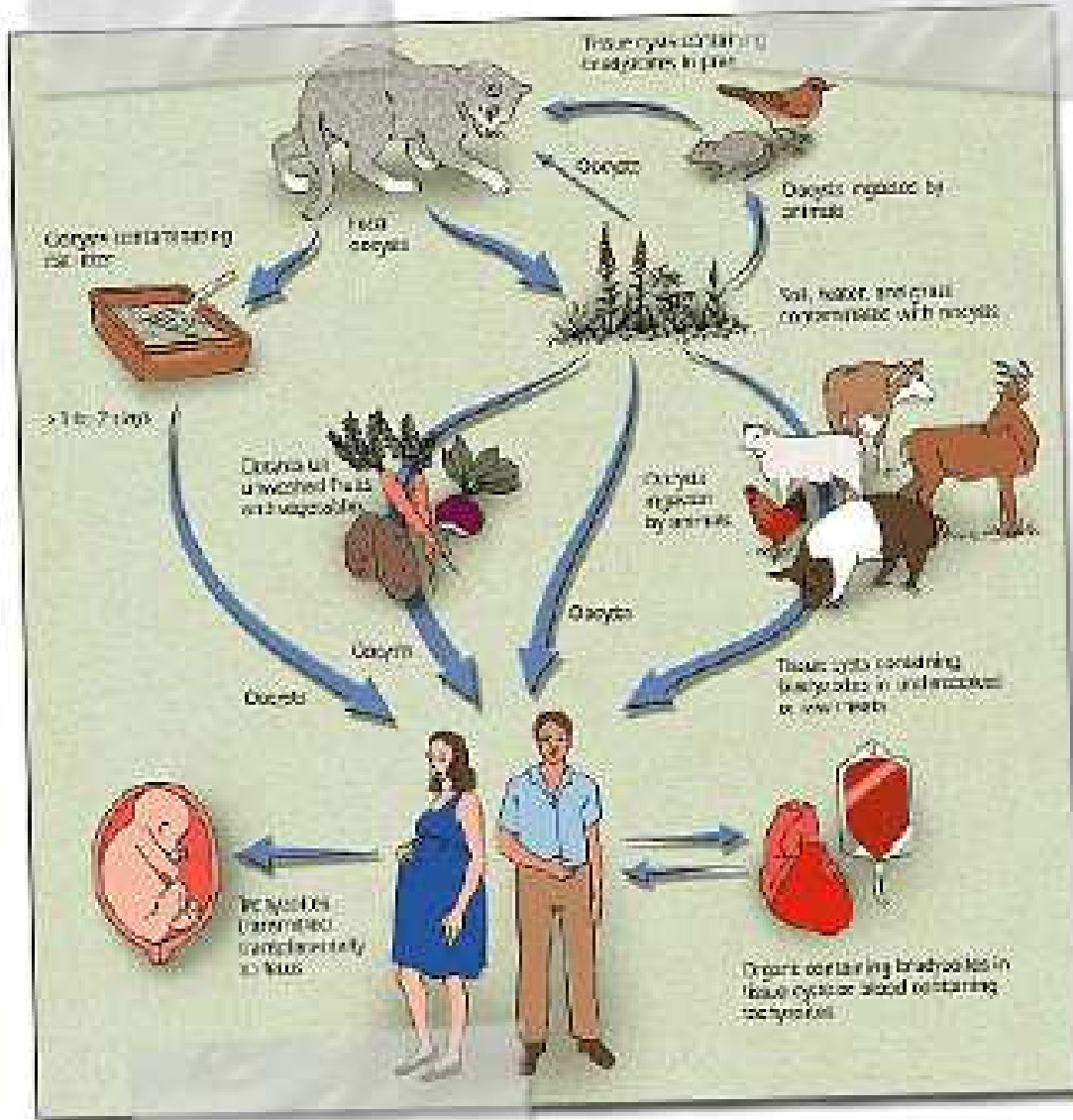


Cats

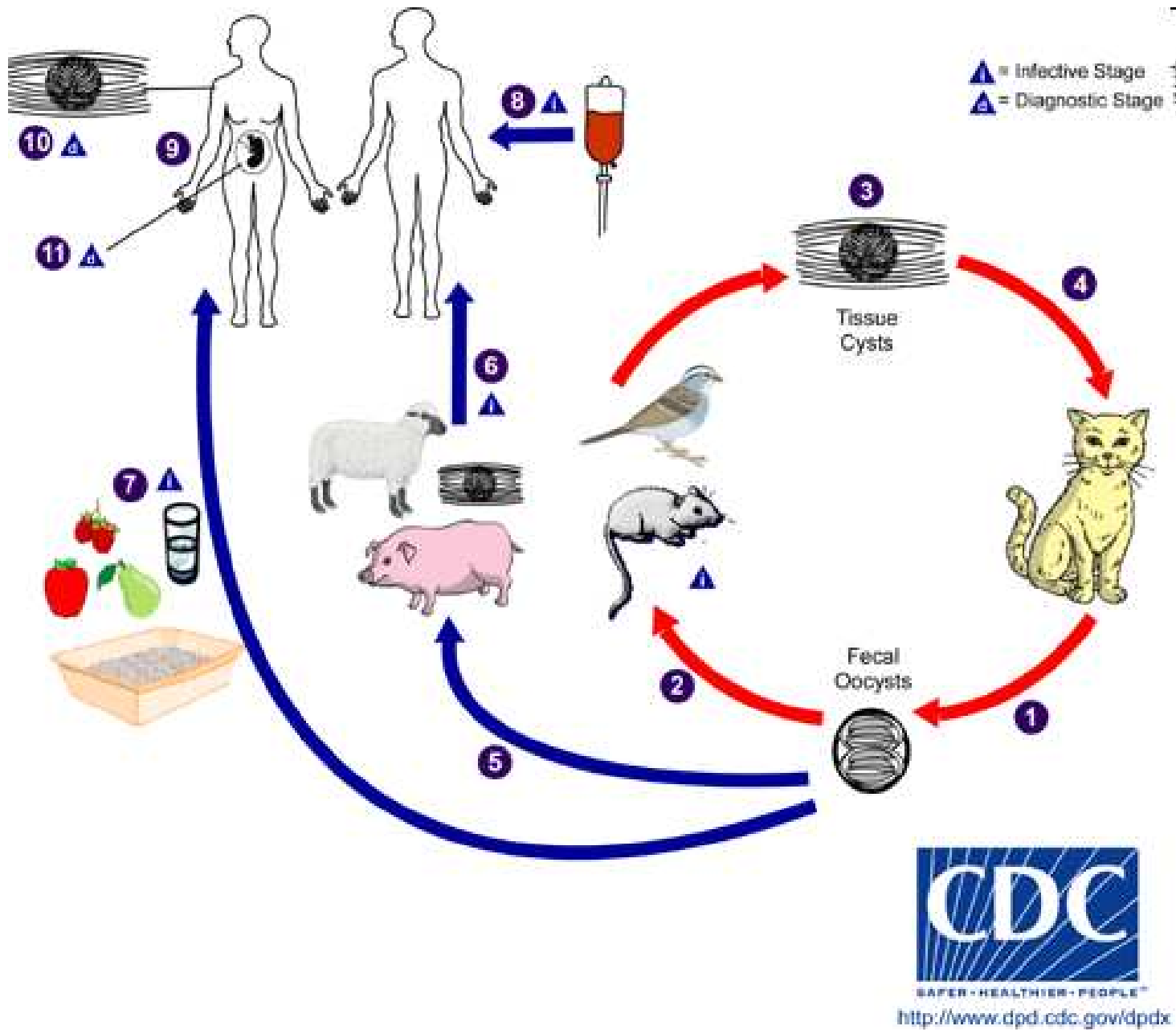
Credits: <http://www.animals-in-need.org/Images/Cat.jpg>

# Many in the U.S. have **toxoplasmosis**

- **12.3%** (normalized by age - **KD Lafferty, 2006**, Can the common brain parasite, *Toxoplasma gondii*, influence human culture? *Proc. R. Soc. B*, vol. 273, pp. 2749-2755)
- **22.5%** (Centers for Disease Control, <http://www.dpd.cdc.gov/dpdx/HTML/Toxoplasmosis.htm>, accessed 10/11/09)
- **How it spreads:**
  - Cat eats infected small animal (e.g. mouse)
  - Cat does not get sick, but sheds many microscopic “oocysts” in droppings
  - Animal eats oocysts; **mice get less fearful of cats**
  - Another cat eats the animal and the cycle is complete
- **We get it by eating oocysts (or transplacentally)**
  - From undercooked meat, handling cat litter, etc.



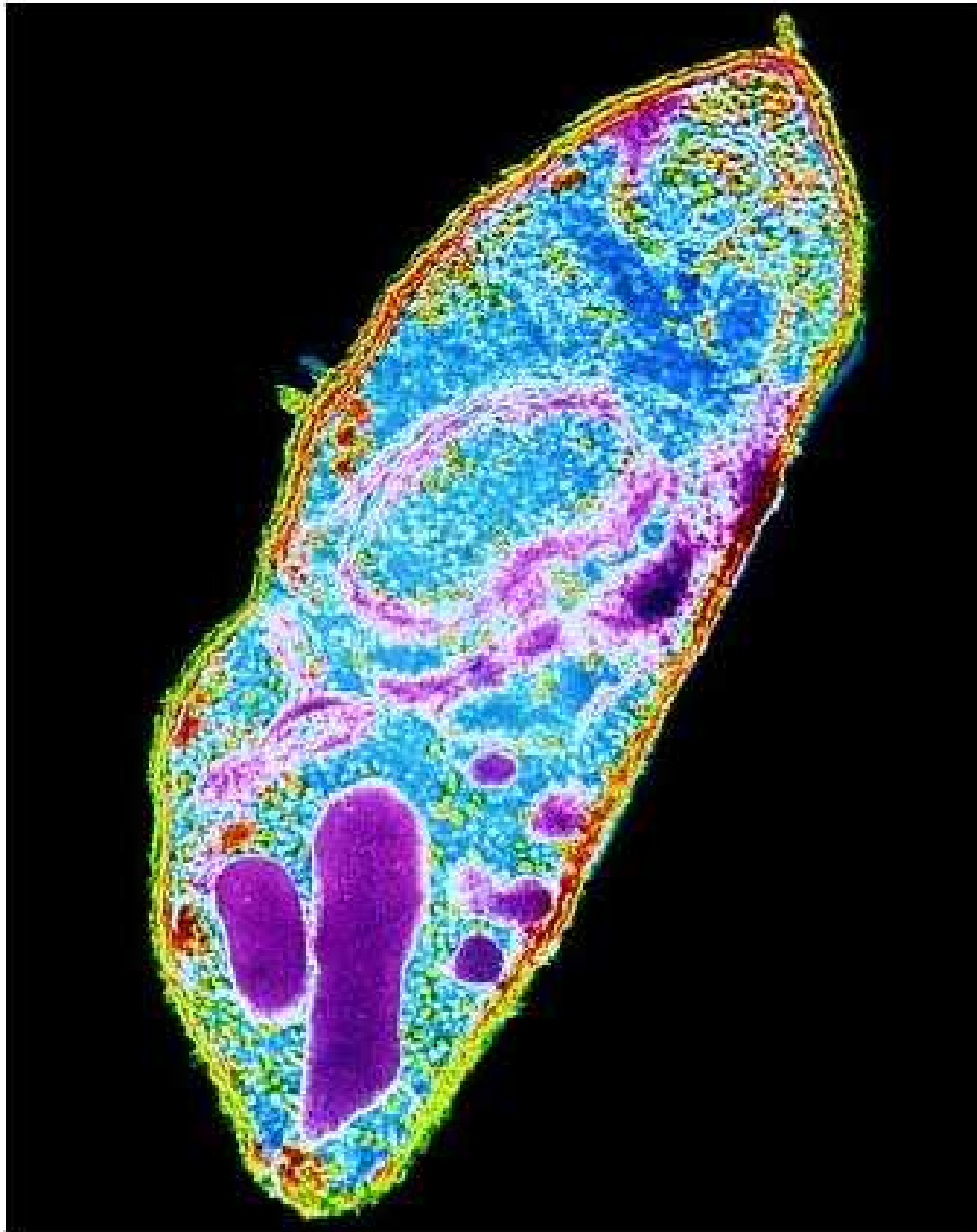
Source: <http://www.mascotissimo.com/wp-content/uploads/2007/07/toxoplasmosis.jpg>



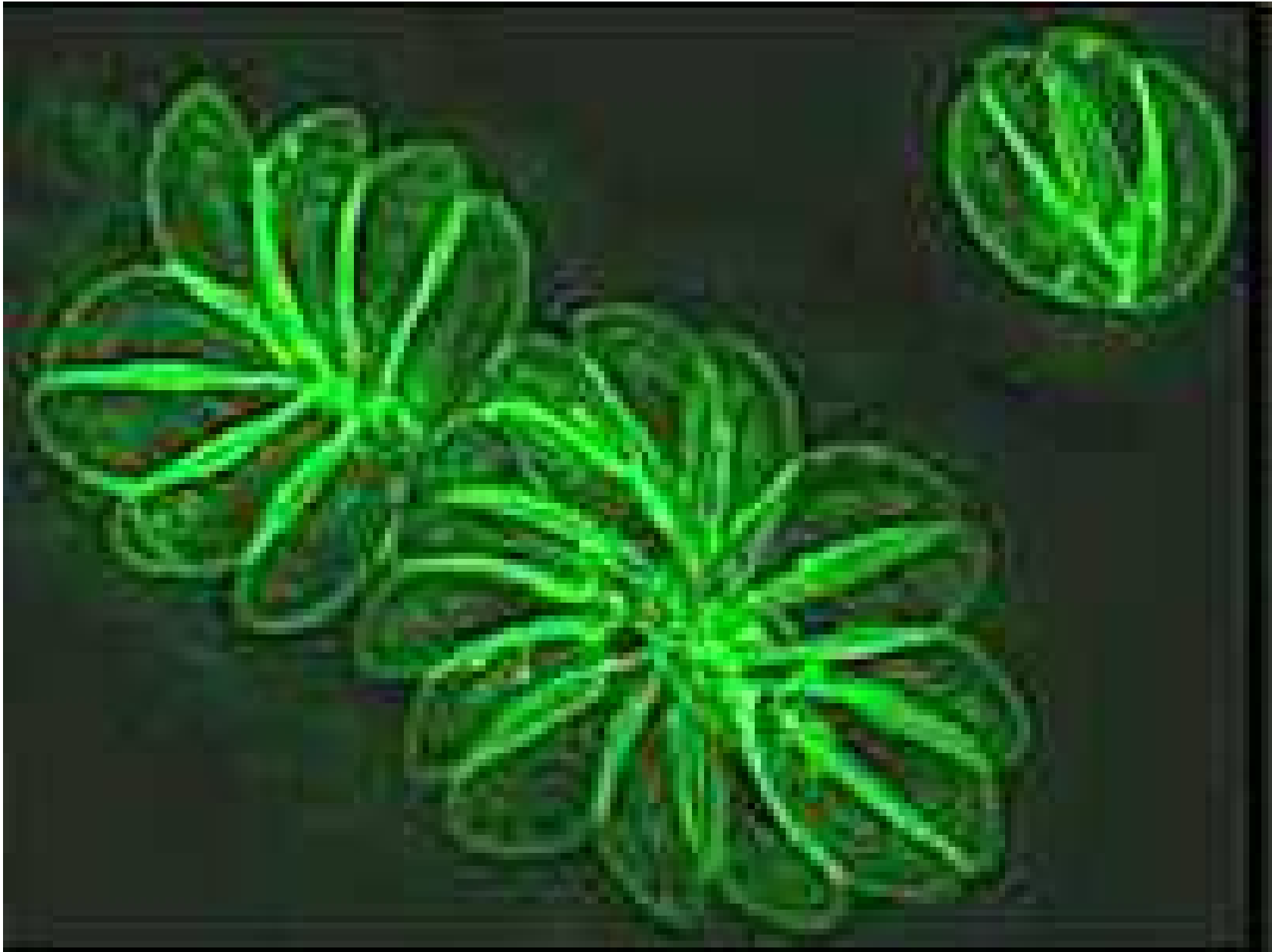
Source: [http://www.dpd.cdc.gov/dpdx/images/ParasiteImages/S-Z/Toxoplasmosis/Toxoplasma\\_LifeCycle\\_BAM1.gif](http://www.dpd.cdc.gov/dpdx/images/ParasiteImages/S-Z/Toxoplasmosis/Toxoplasma_LifeCycle_BAM1.gif)



T. gondii  
parasites  
(source:  
CDC)



Source:  
[brianmclark.com/images/texts\\_images/toxoplasma\\_gondii.jpg](http://brianmclark.com/images/texts_images/toxoplasma_gondii.jpg)



***Toxoplasma gondii***. Source:

[http://newsimg.bbc.co.uk/media/images/41351000/jpg/\\_41351230\\_toxoplasma203.jpg](http://newsimg.bbc.co.uk/media/images/41351000/jpg/_41351230_toxoplasma203.jpg)

# Toxoplasmosis Symptoms

- Infection by *Toxoplasma Gondii* is **usually symptom-free**
  - Some people get temporary flu-like symptoms or swollen lymph glands in the neck
  - Prenatal & natal infection can lead to retinochoroiditis & vision loss many (even 20+) years later
- According to Flegr (2007) it is “the most common protozoan parasite in developed nations”



# Yet apparently there *are* symptoms

- See J. Flegr, Effects of Toxoplasma on human behavior, Schizophrenia Bulletin, vol. 33 no. 3 pp. 757-760, 2007
- Infection causes
  - poorer motor coordination
    - (2.65x higher traffic accident risk)
  - more apprehensiveness
  - less novelty-seeking
  - clothes tidiness
    - decreases in men, increases in women
  - self control decreases in men, increases in women

# Gender differences in symptoms

## – Men

- tend to disregard rules more
- are more “expedient, suspicious, jealous, and dogmatic”

## – Women

- are more “warm hearted, outgoing, conscientious, persistent, and moralistic”

# Symptoms increase over time

- In general,

**longer duration of infection**

**increases the differences**

**between**

**infected and uninfected individuals**

# but...Why?

- *Toxoplasma Gondii* manipulates behavior of mice
  - so cats can catch them easier!
- Does it manipulate monkey and chimp behavior?
  - at any rate, leopards etc. (“cats”) eat them in the wild
- So why not accidentally manipulate humans too?
  - more car accidents = easier to eat us?
  - Or “on purpose” ...make us want to own cats...
- Important: correlation  $\neq$  causality
  - What if the causality was reversed?
  - What if both things were caused by a third factor?
  - We could look back at the previous slides...

# Toxoplasmosis: mechanisms of behavior change

- It is thought that *T. gondii* increases dopamine in the brains of mice and men
  - Dopamine modification can explain some behavioral changes
- *T. gondii* is also thought to increase testosterone
  - Testosterone affects behavior
    - (thereby improving transmission? What do you think?)
  - Testosterone reduces immune function
    - (thereby improving transmission?)

# From Behavior to Culture

- **Source:** KD Lafferty, Can the common brain parasite, *Toxoplasma gondii*, influence human culture? Proc. Royal Society B, 2006, vol. 273, pp. 2749-2755
  - If many people have behavior changes
    - then their culture may be changed as well
  - We might describe part of culture in terms of
    - Individualism
    - Sex roles
    - Uncertainty avoidance
    - Class distinctions

# Personalities and *T. gondii* infection

More effects of latent toxoplasmosis infection...

(according to Lafferty, p. 2753, but not fully proven)

- Men:
  - Less intelligent, more reflective, rigid, stoic, loyal, slow-tempered, frugal, emotionally reactive, changeable, affected by feelings, emotionally less stable, easily upset
- Women:
  - More intelligent, rule-conscious, dutiful, conscientious, conforming, moralistic, staid, rule-bound, warm, outgoing, attentive to others, kindly, easy-going, participating

# Personalities and culture

- Collective behavior could change culture
  - Maybe collective behavior *\*is\** culture?
- “Environmental determinism”
  - the theory that the physical environment controls the course of civilizations
    - *T. Gondii* is part of the physical environment
    - It affects people by accident, because it affects rodents
      - Infected rodents are
        - » more active, prone to enter traps, less fearful of cats and cat smells like urine, and mice have more brain dopamine
        - » But what’s that got to do with people?



# *T. gondii* and people

- “Currently, cats rarely eat humans, so there should be little selective advantage for *T. gondii* to specifically manipulate human behaviour. Still, *T. gondii* cysts infecting a human have nothing to lose, evolutionarily speaking, in trying manipulative strategies adaptive in other intermediate host species.” – Lafferty, p. 2750
- I predict:
  - infection and cat ownership are correlated
  - Does A cause B? B cause A? C cause A and B? Accident?

# More effects on people

- Men often have different (even opposite) effects from women
- Increases ratio of newborn boys to girls up to 2.6:1 (<http://discovermagazine.com/2007/feb/toxoplasma-gondii-culture-sex-ratio>)
- Guilt-proneness increases for both genders
  - Implies greater apprehensiveness, self-doubt, worry, insecurity, tendency self-blame
- Guilt-proneness “corresponds” to neuroticism
  - “Male control, materialism, rules and structure” are “associated with neuroticism”
- Do these traits propagate to the larger culture?

# Results: *T. gondii* and Culture

- Positive, but weak association with infection rate was found with
  - A national culture of uncertainty avoidance
  - Masculine sex roles (male control)
- What are the implications of this for
  - technology, law, politics, war, ...?

# Results: *T. gondii* and Culture II

- Highly infected countries play soccer better!
- See e.g. <http://www.slate.com/id/2259350>
  - The 5 top FIFA team countries won 8 of last 10 World Cups
  - Toxo increases testosterone in men (& mice)

# Results: *T. gondii* and Culture III

- *T. gondii* has a gene for making tyrosine hydroxylase
  - Has a mammalian version of this, in fact!
  - (How might that have happened?)
  - Tyrosine hydroxylase upregulates dopamine
    - A neurotransmitter also upregulated by, e.g., cocaine
- Motorcycle fatalities have high rates of infection
- 3-4x risk of fatal auto wrecks “involving reckless speeding” - [http://www.edge.org/3rd\\_culture/sapolsky09/sapolsky09\\_index.html](http://www.edge.org/3rd_culture/sapolsky09/sapolsky09_index.html)

# Some notes...

- Recall the correlation-causation fallacy:
  - Did A cause B?
  - Or did B cause A?
  - Or did C cause both A and B?
- “38% of meat products...in the UK test...positive for *T. gondii*, some...probably viable” – p. 2753
- Cultural effects of *T. gondii* might differ for western cultures vs. asian, african, etc.
- “Both anti-toxoplasma drugs and dopamine antagonists normalize the behaviour of infected rats” – p. 2750

# Toxoplasmosis and the future

- If culture is affected, so may other things
  - Laws
  - Politics
  - War and peace (also title of novel by Tolstoy)
  - Career choices
  - Technological change
  - Economic growth
  - Disaster preparedness (inc. existential disasters)
  - Nuclear weapon policies
- Imagine a world mostly without *T. gondii* . . .
  - This is possible!
- How much of the future of civilization, and even the survival of humanity, at stake?

# Toxoplasmosis and the future II

- Perhaps biotech engineers could mutate toxo and fine tune it for psychiatric use
- Military types are interested in toxo
  - Is it a national security issue?!!



<http://verydemotivational.memebase.com/2010/07/13/demotivational-posters-security-alert/>



<http://blog.omy.sg/aussiepete/files/2010/08/fear01.jpg>



<http://www.clker.com/clipart-28744.html>



[http://www.skydivekc.com/Uploads/jagarrett/300x300\\_alert.jpg](http://www.skydivekc.com/Uploads/jagarrett/300x300_alert.jpg)



# Toxoplasmosis and the future II

- Perhaps biotech engineers could mutate toxo and fine tune it for psychiatric use
- Military types are interested in toxo
  - Is it a national security issue?!!
  - Might laws be passed requiring testing and antibiotic treatment?
  - Might it be deliberately spread in an enemy country?
- Will employers require testing?
- Would you want people running for office to be tested, treated/not, and/or disclose results?

# What do you think?

- Get tested. There is a standard lab test for it
- If positive, get treated(?). It can be treated
- Vaccinate your cat(s). There is a vaccine
- Demand politicians reveal infection status
- Employment screening; other screenings
- Support research into more-resistant cats
- Cover sand boxes that children play in
- Consider not owning a cat(!?).
  - Rats are friendly, social animals and make great pets! And “rat” rhymes with “cat” so they’re almost the same thing

<http://www.woodplay.com/images/accessories/sandbox.jpg>

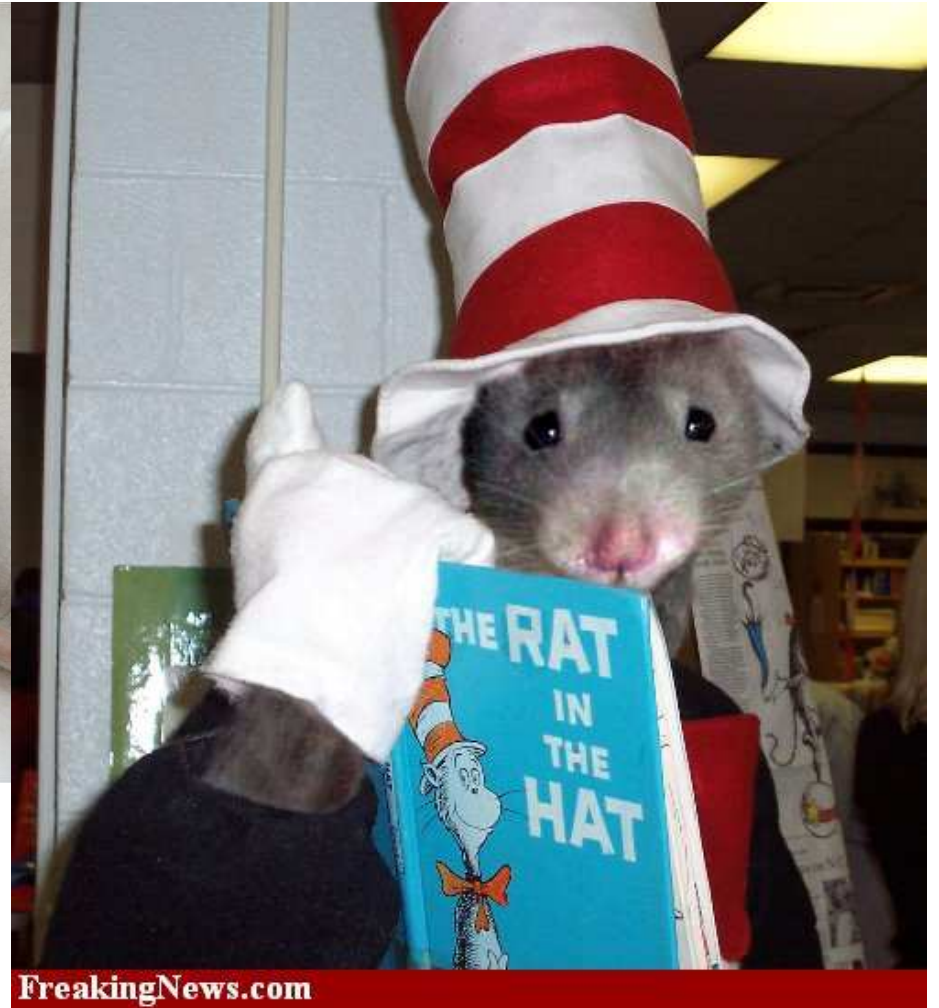




[http://www.pets747.com/uploaded\\_images/pet-rats-717618.jpg](http://www.pets747.com/uploaded_images/pet-rats-717618.jpg)



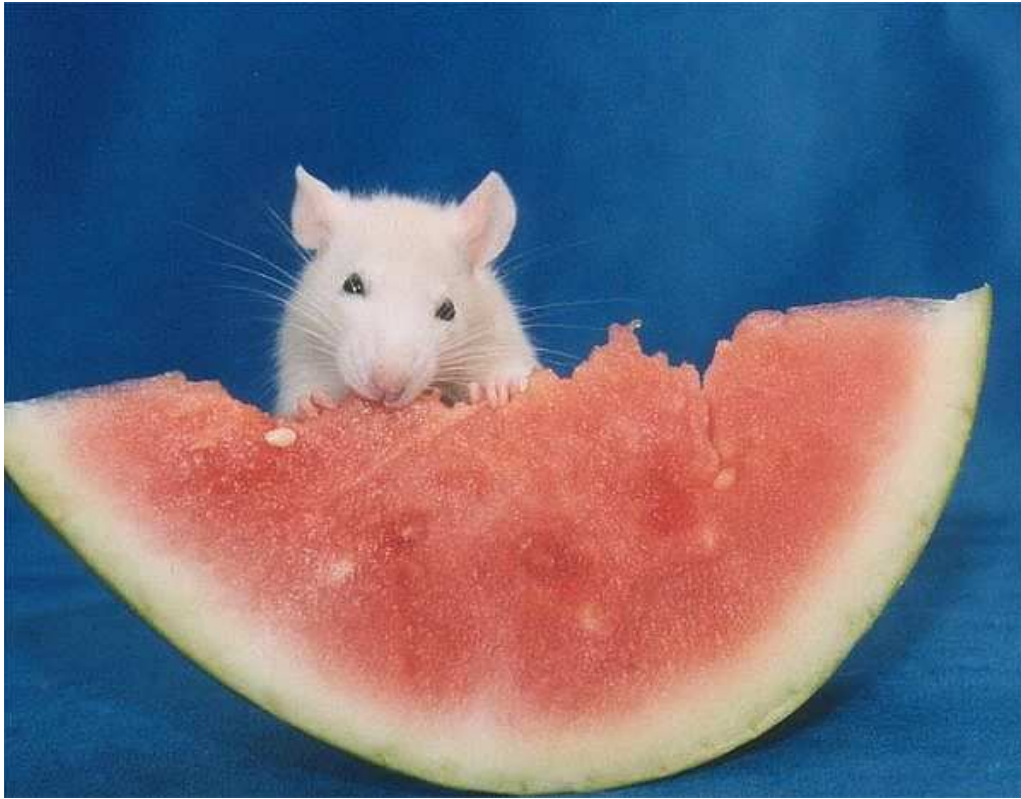
[http://www.photoshoppix.com/modules/coppermine/albums/userpics/10002/normall\\_pet\\_rats.jpg](http://www.photoshoppix.com/modules/coppermine/albums/userpics/10002/normall_pet_rats.jpg)



[http://api.ning.com/files/7TmaLfpwq19P0xma6K3CwuIcs0AulXoozMG23PFUpBfgZ66n-qqUwiO5wHPACNboF9\\*qWd83eEtf6L\\*O-Wyeo-QJeLNjRS-/Two\\_Female\\_Pet\\_Rats.jpg](http://api.ning.com/files/7TmaLfpwq19P0xma6K3CwuIcs0AulXoozMG23PFUpBfgZ66n-qqUwiO5wHPACNboF9*qWd83eEtf6L*O-Wyeo-QJeLNjRS-/Two_Female_Pet_Rats.jpg)

<http://www.freakingnews.com/pictures/27000/Pet-Rats--27284.jpg>





[http://i.ehow.com/images/GlobalPhoto/Articles/2111920/Fancyrat1-main\\_Full.jpg](http://i.ehow.com/images/GlobalPhoto/Articles/2111920/Fancyrat1-main_Full.jpg)



<http://discovermagazine.com/2007/jan/letters/rathhead300.jpg>



<http://pattihaskins.files.wordpress.com/2008/02/rat.jpg>