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- Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.
- The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.
- Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files (.ppt), as well as uneditable versions in smaller file sizes, such as PowerPoint Shows (.pps) and Portable Document Format (.pdf), for ease of printing. The font "Jokerman" is used frequently in titles. It has a microbiology feel to it. If you do not have this font, some titles may appear odd, oversized and off-center. Find free downloads of Jokerman by Googling "download jokerman font microsoft".
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Alicia Cepaitis, MS
Chief Creative Nerd
Science Prof Online
Online Education Resources, LLC
alicia@scienceprofonline.com

Tami Port, MS
Creator of Science Prof Online
Chief Executive Nerd
Science Prof Online
Online Education Resources, LLC
info@scienceprofonline.com

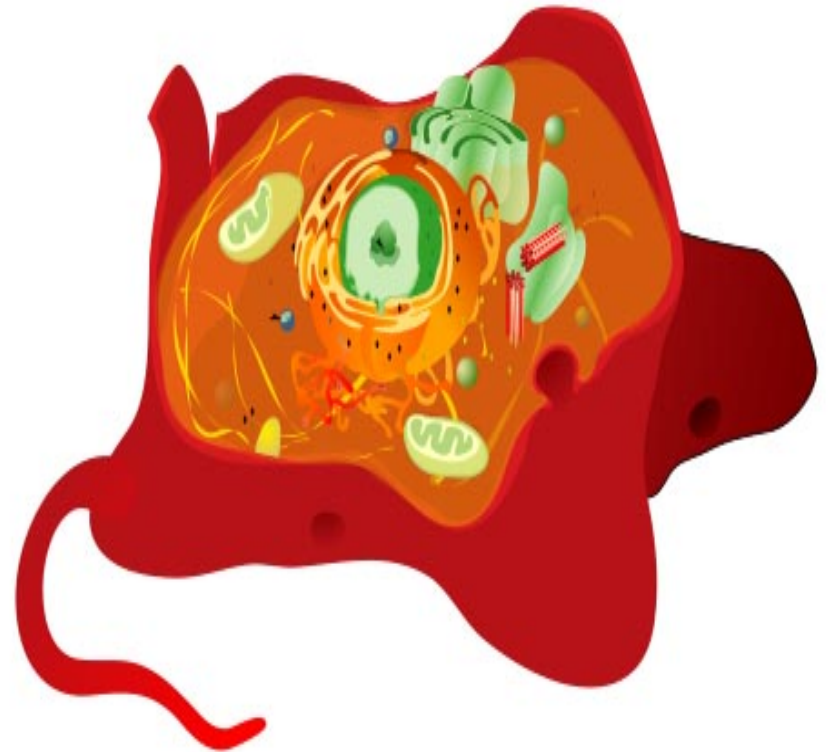
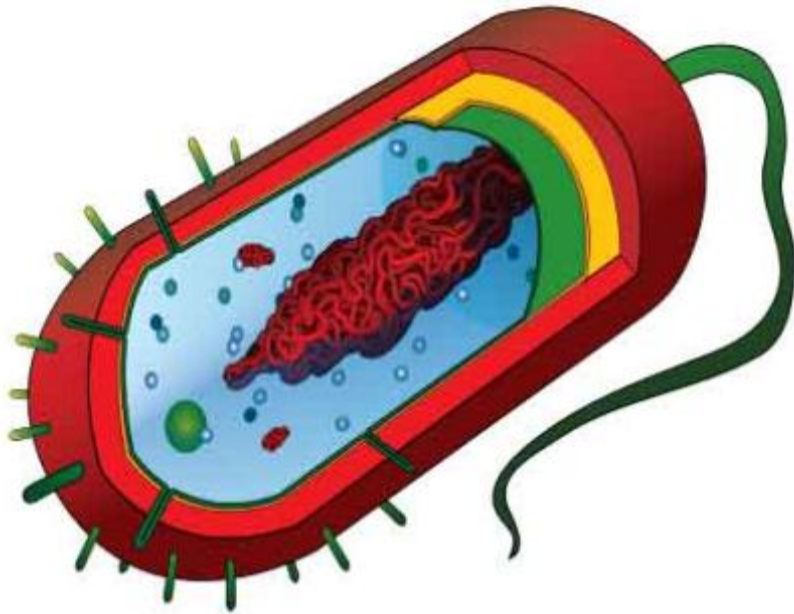
Meet the
Microbes:
Eukaryotes

HI
my name is:

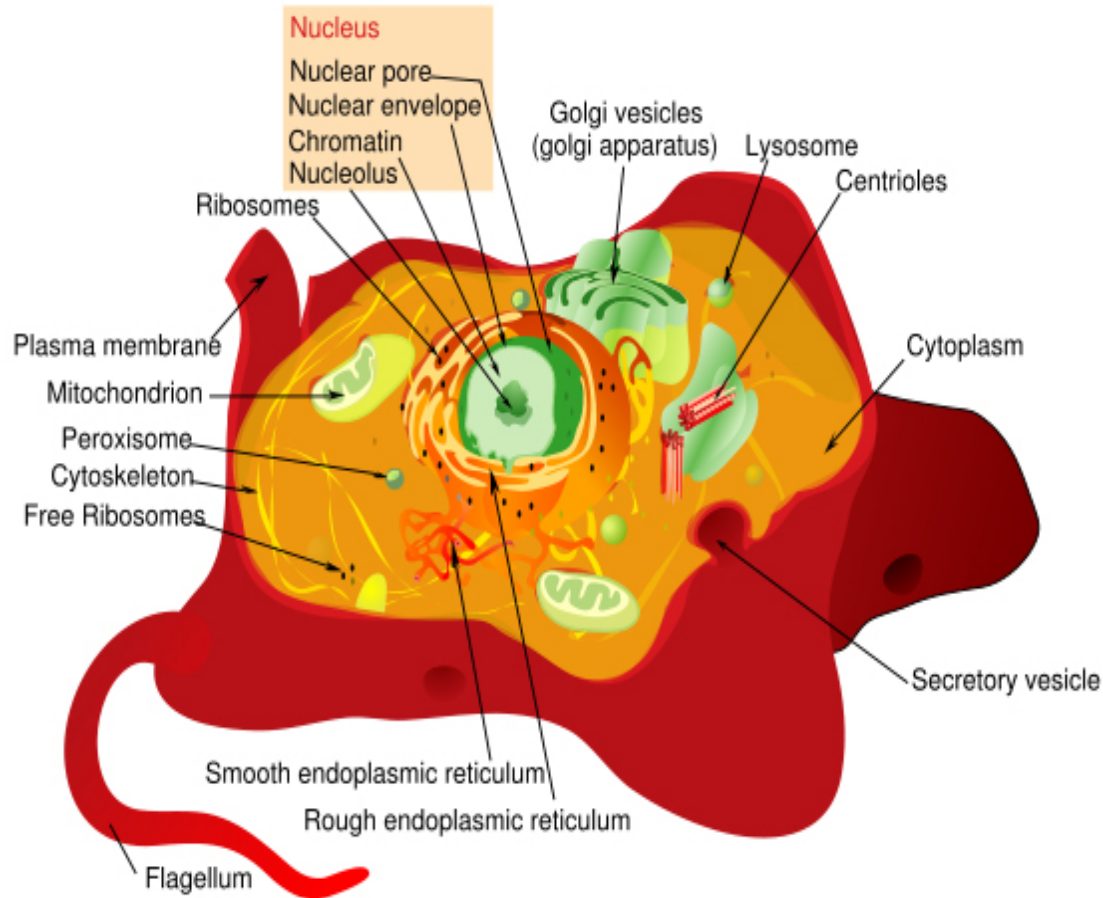
*Aspergillus
fumigatus*



Q: *What are the two basic types of cells?*

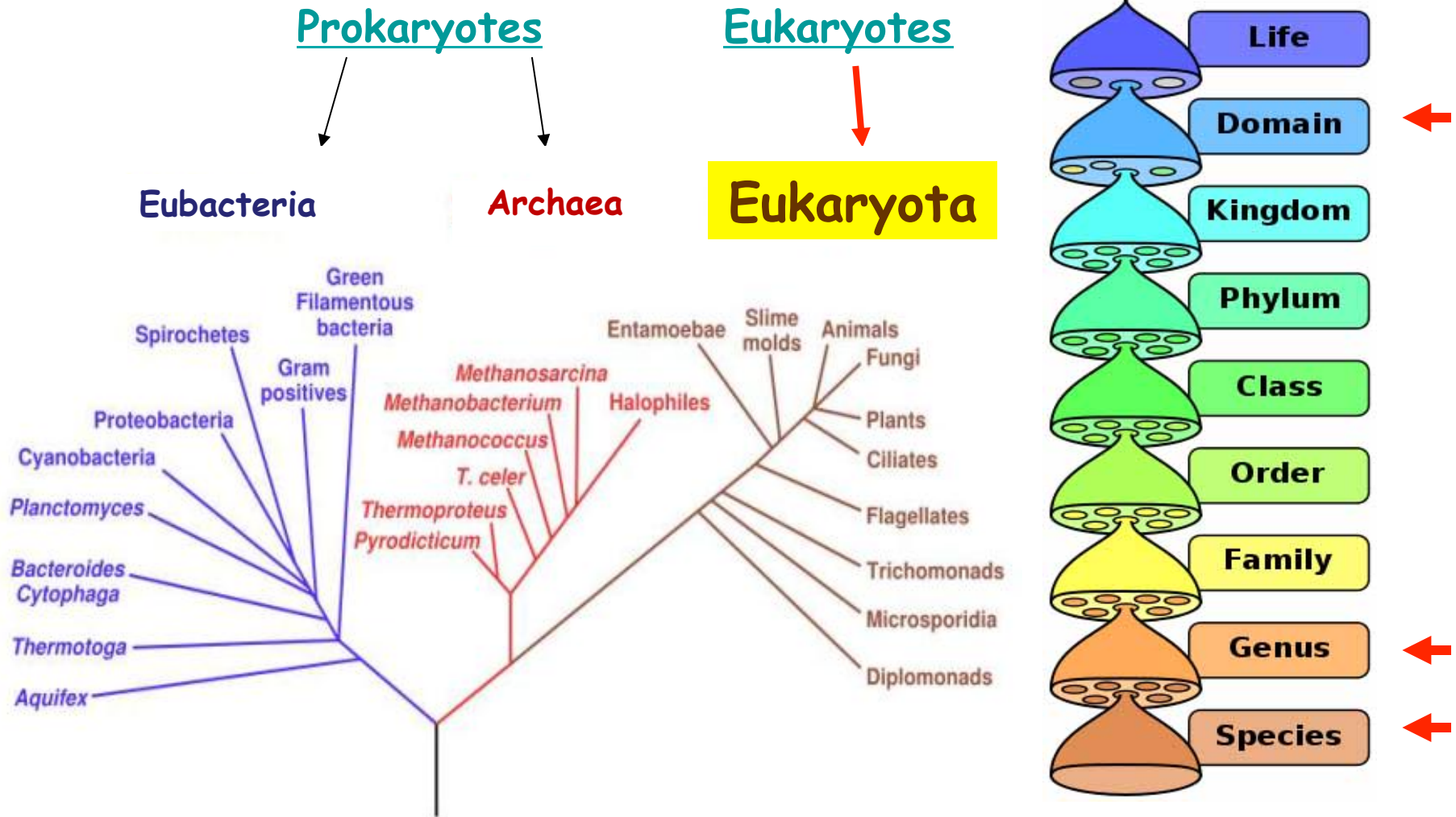


Eukaryotic Cells



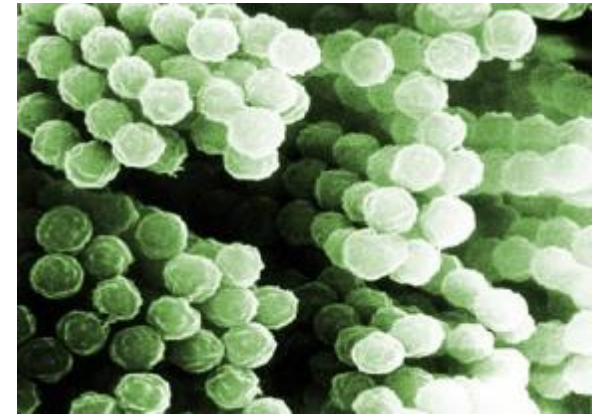
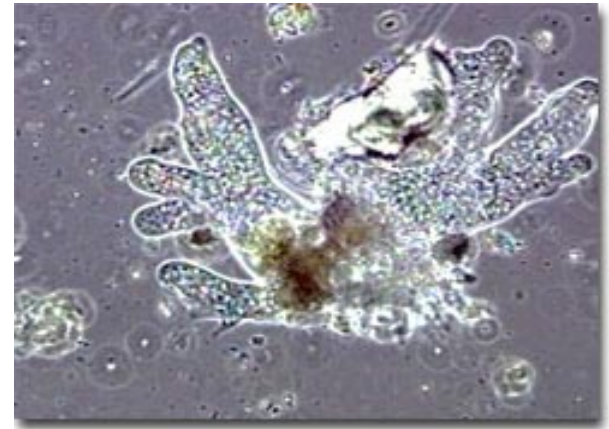
Q:
How are eukaryotic cells different from prokaryotic cells?

Classifying Living Things



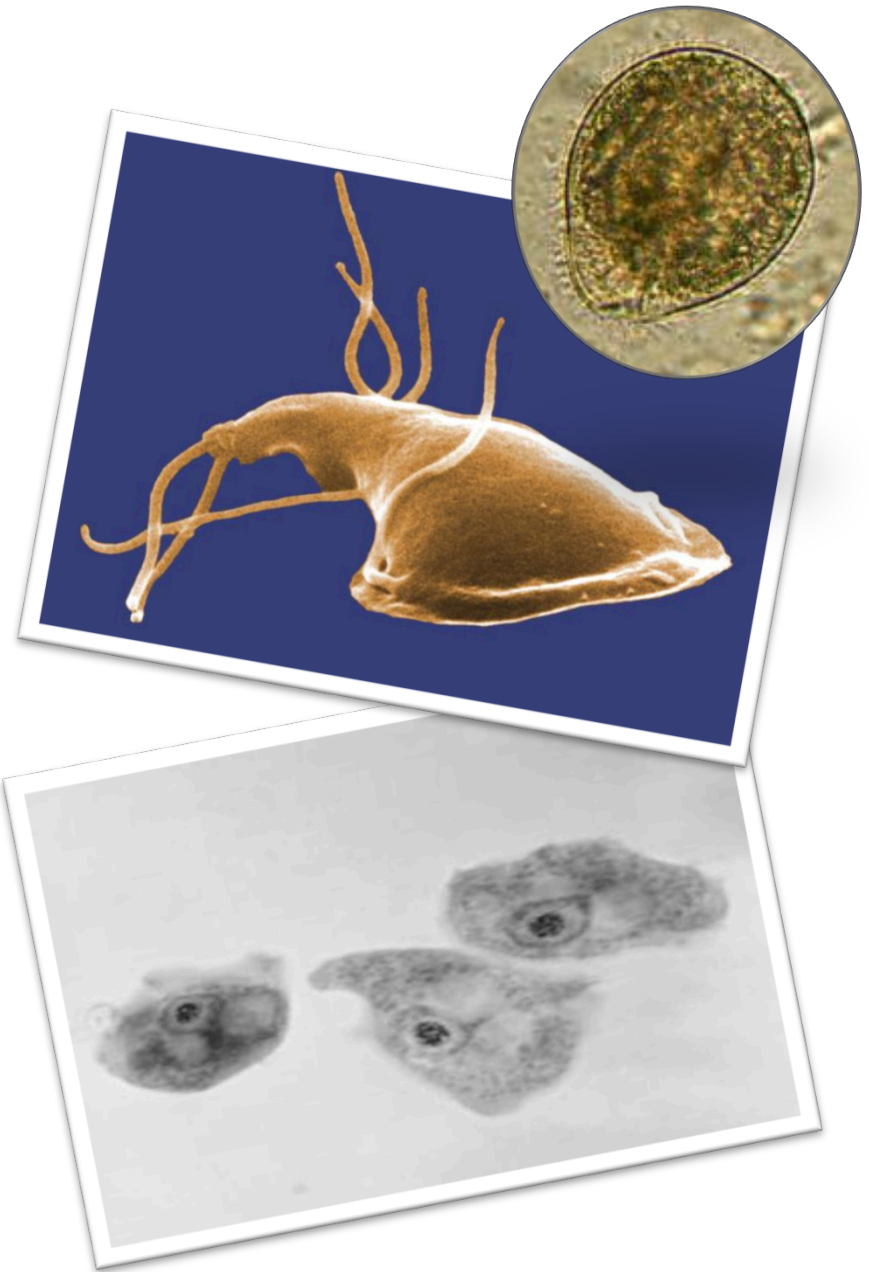
Domain: Eukaryota

- Three major groups are of interest medical microbiologists as directly causing disease:
 1. **Protozoans** kingdom Protista
(some can cause infectious disease)
 - x **Algae** kingdom Protista
(DO NOT cause infectious disease in humans, but some result in toxic fish & shellfish)
 - x **Slime & Water Molds** kingdom Protista
(DO NOT cause infectious disease in humans)
 2. **Fungi** kingdom Fungi
(some can cause infectious disease)
 3. **Helminths** kingdom Animalia
(worms that can cause infectious disease)
- Some **arachnids** and **insects**, members of kingdom Animalia, are also associated with infectious disease, as **vectors**.
- **Q: What do vectors do?**

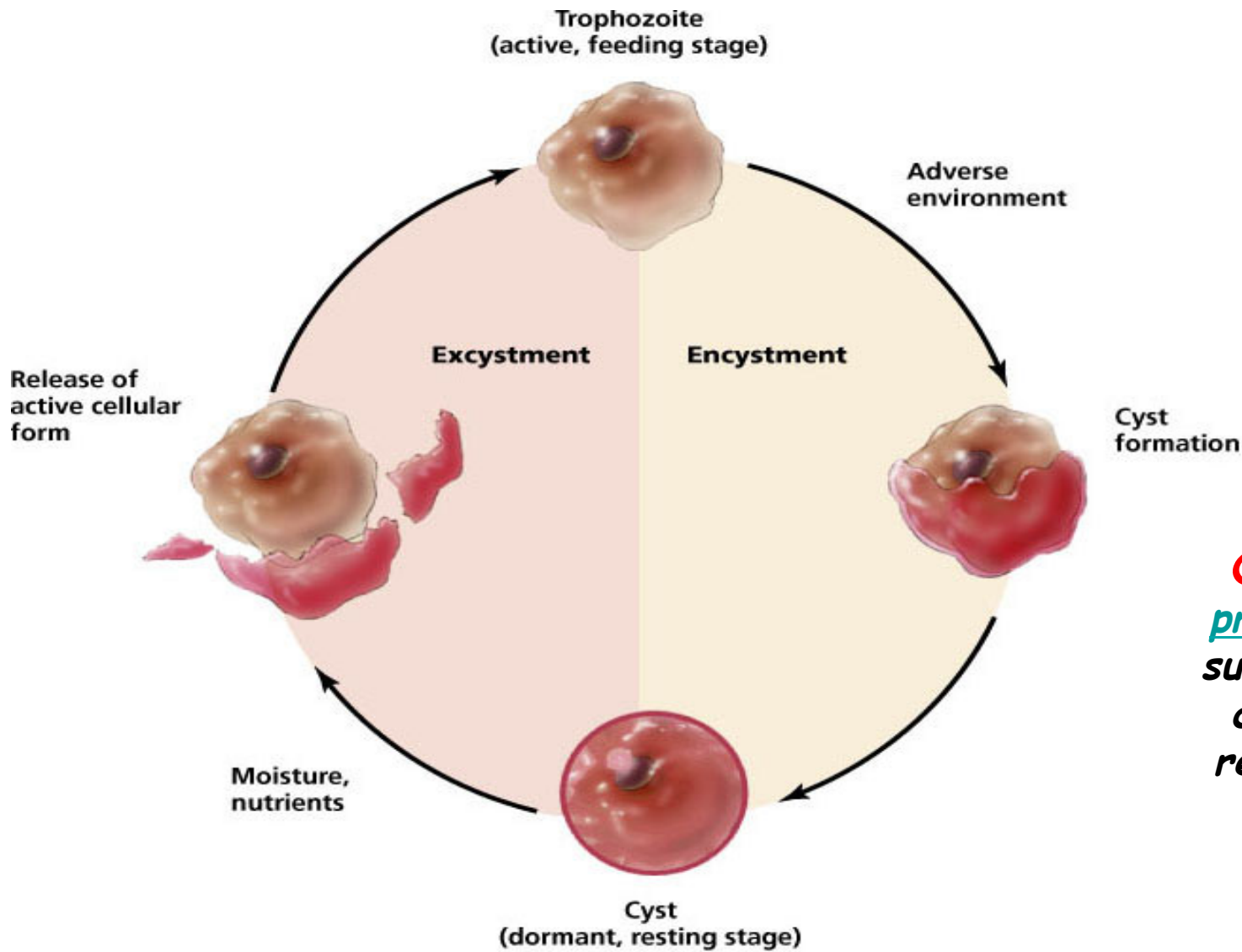


1. Protozoans

- Protozoans are generally defined by four characteristics:
 - [Eukaryotic](#)
 - Single-celled (unicellular)
 - No cell wall
 - Motility (nearly all are able to move due to cilia, flagella or pseudopodia)
- Require moist environments.
- Most are free-living and harmless. Very few are pathogens.
- Motile feeding stage called **trophozoite**.
- Many have hardy resting stage called **cyst**.



Protozoan Life Cycle



Q: What prokaryotic survival skill does this remind you of?

Disease, Please: Dysentery

- Inflammatory disorder of the intestine, especially the colon, that results in severe diarrhea containing mucus and/or blood in the feces.
- Untreated, dysentery can be fatal due to massive dehydration.
- Can be caused by bacteria, protozoans or parasitic worms.



WATER

New formulation! 50% less dysentery!*

"I preferred the old formulation."

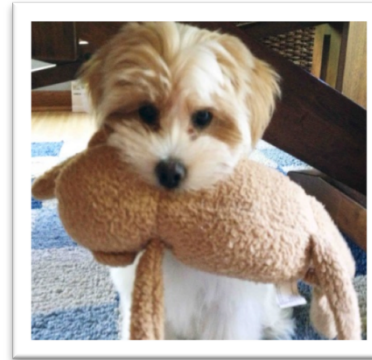
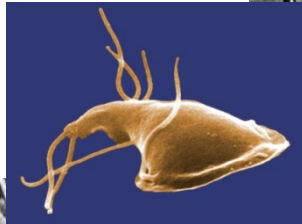
Don't Fret!

Water Classic contains our originally available amount of dysentery, and is available in drinking fountains across the country.



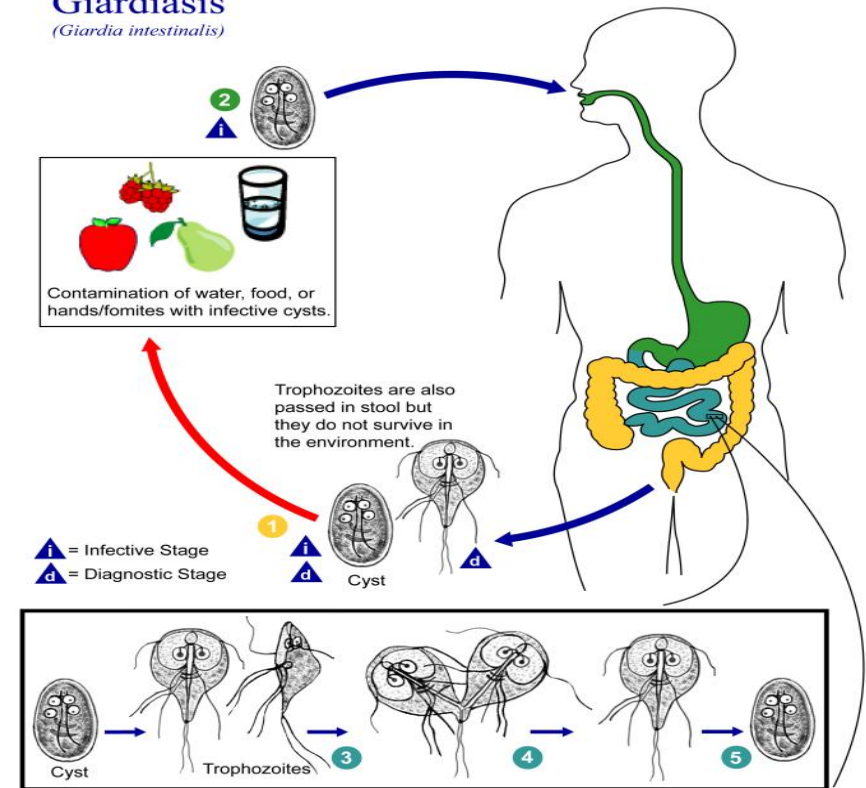
Protozoan Species: *Giardia lamblia* (aka *G. intestinalis*)

- Pathogenic species that feed off the intestinal lining.
- Infection results from eating food / drinking water contaminated by the organism - usually from feces.
- A large number generates inflammation, which causes nausea, stomach ache and diarrhea.
- Chronic infection may result in malnourishment, blocking absorption of food across their intestinal wall.



As a puppy, my dog Lulu was diagnosed with *Giardia*. The vet ordered an ELISA test on a stool sample. Unlike a routine flotation stool check that gets parasite eggs and cysts to float to the top of a solution, the ELISA test looks for a specific antigen (or protein) of the *Giardia* organism. Giardiasis is typically treated over several days with the drug Metronidazole.

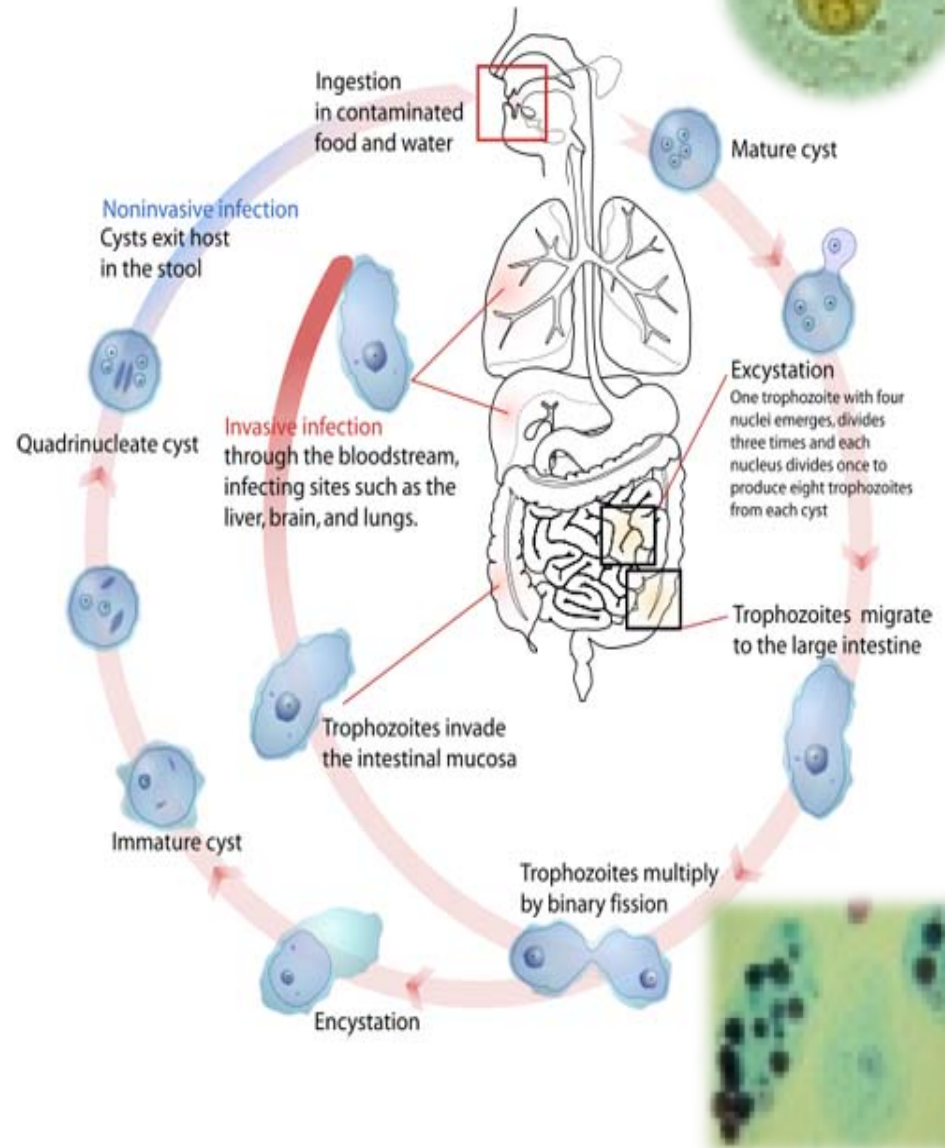
Giardiasis (*Giardia intestinalis*)



Protozoan Species: *Entamoeba histolytica*

(ENT-ah-MEE-bah HISS-tow-LIT-ick-ah)

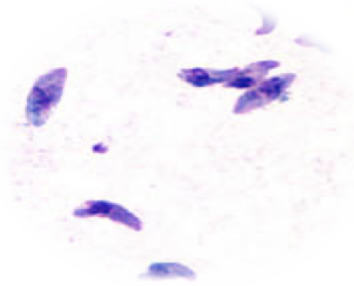
- A type of **amoebae**.
- Eat and move by extending parts of their bodies to form pseudopods (SUE-dough-pods).
- Exists asymptotically in 10% of world's population.
- When disease develops, can be fatal (kills 100,000 annually).
- Feeds on the lining of the gut. Irritation created can lead to condition known as **amoebic dysentery**.
- Contracted by eating or drinking fecally contaminated food or water.



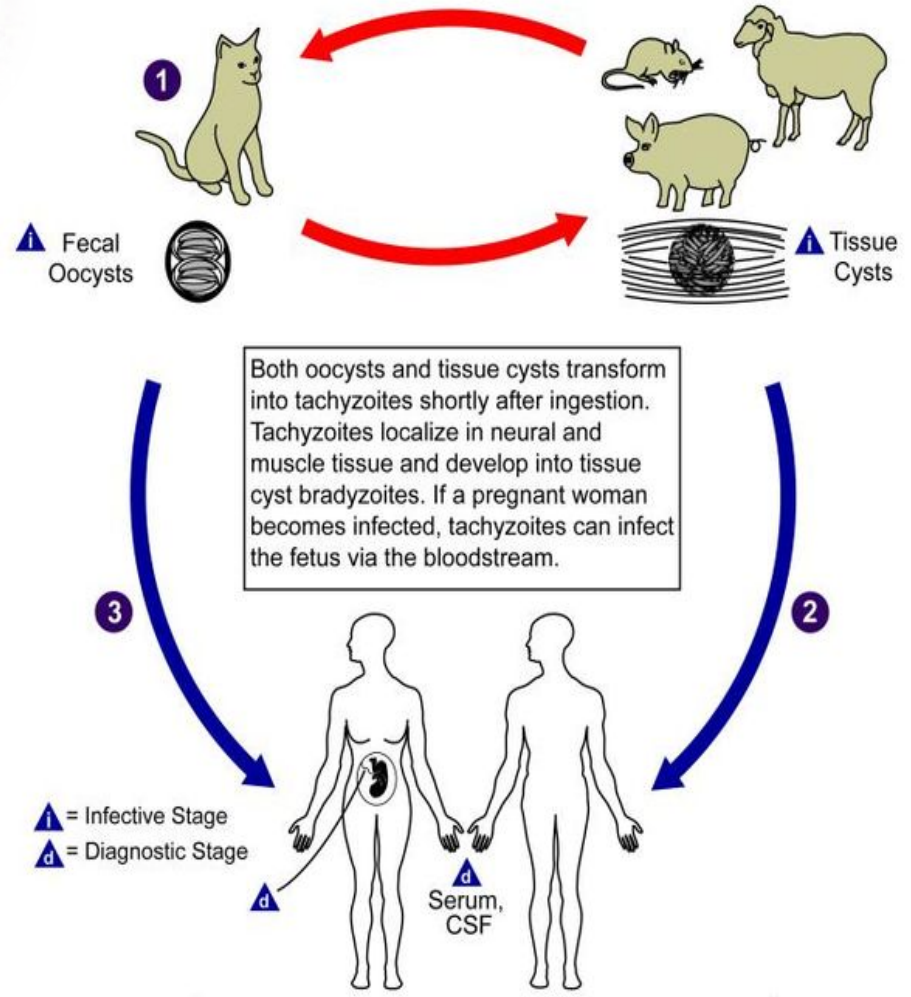
Disease, Please:

Toxoplasmosis

- Caused by parasite *Toxoplasma gondii*.
- Can get from contaminated water, eating undercooked infected meat (especially pork, lamb & venison), or contact with cat feces that contain *Toxoplasma*.
- 1/3 of the global population and 60 million people in US may be infected, but few have symptoms.
- Mild symptoms are flu-like.
- Pregnant women and people with compromised immune systems could develop serious health problems.
- Severe toxoplasmosis can damage the brain, eyes and other organs. Severe cases are more likely in individuals who have weak immune systems.
- A leading cause of death attributed to foodborne illness in the United States.



Toxoplasmosis (*Toxoplasma gondii*)



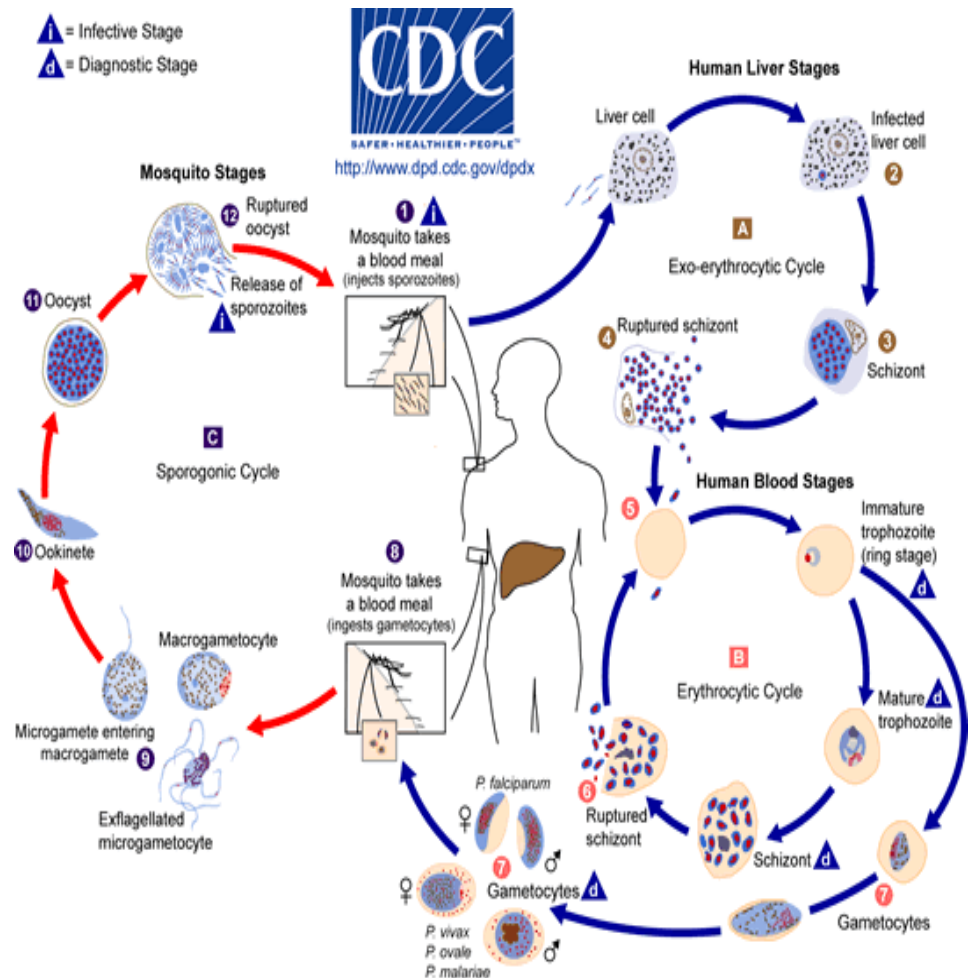
Disease,

Please:

Malaria



- Life-threatening disease caused by *Plasmodium* protozoan parasites transmitted through the bites of infected mosquitoes.
- Symptoms include fever, chills, and flu-like illness. Left untreated can cause coma and death if progresses to cerebral malaria.
- ~ 198 million cases of malaria in 2013.
- In 2013, malaria caused an estimated 584 000 deaths, mostly among African children.
- Increased malaria prevention and control measures are dramatically reducing the malaria burden in many places.
- ~ 1,500 cases diagnosed in US each year. Most are travelers and immigrants returning from countries where malaria commonly occurs (mainly sub-Saharan Africa and South Asia).
- Travellers from malaria-free areas are very vulnerable to the disease.



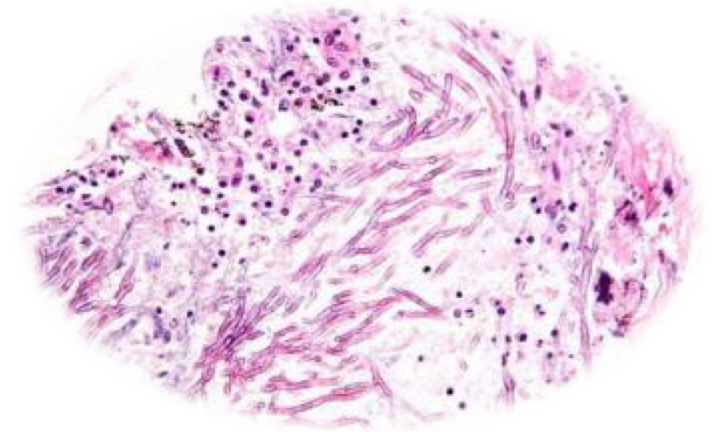
2. Fungi

- Heterotrophic (consumers) digest their food **externally**, secrete digestive **enzymes** and then absorb nutrient molecules into their cells.
- **Examples:** yeasts, molds, and mushrooms.
- Often have important symbiotic relationships with other organisms, mainly **plants**. (*Plants photosynthesize and provide carbon to the fungi in return for nutrients that fungi take up from the soil*).
- Fungi are also used extensively by humans:
 - **yeasts** responsible for fermentation of beer & bread
 - **mushroom farming** is big industry
 - produce some **antibiotics**
- ~30% can cause disease in plants, animals & humans. Pathogenic fungi very resistant to antimicrobial drugs.
- Fungi and bacteria are the primary **decomposers** of organic matter.



Fungal Infections

- Also called **mycoses** (singular mycosis)
- If you have ever had **athlete's foot** or a **yeast infection**, you can blame a fungus.
- A fungus is actually a primitive vegetable. Mushrooms, mold and mildew are examples.
- Reproduce through tiny **spores** in the air. You can inhale the spores or they can land on you. As a result, fungal infections often start in the lungs or on the skin.
- You are more likely to get a fungal infection if you have a **weakened immune system** or take antibiotics.
- Fungi can be **difficult to kill**. For skin and nail infections medication applied directly to the infected area. Oral antifungal medicines available for serious infections.



Fungal Infections: Types of Mycoses

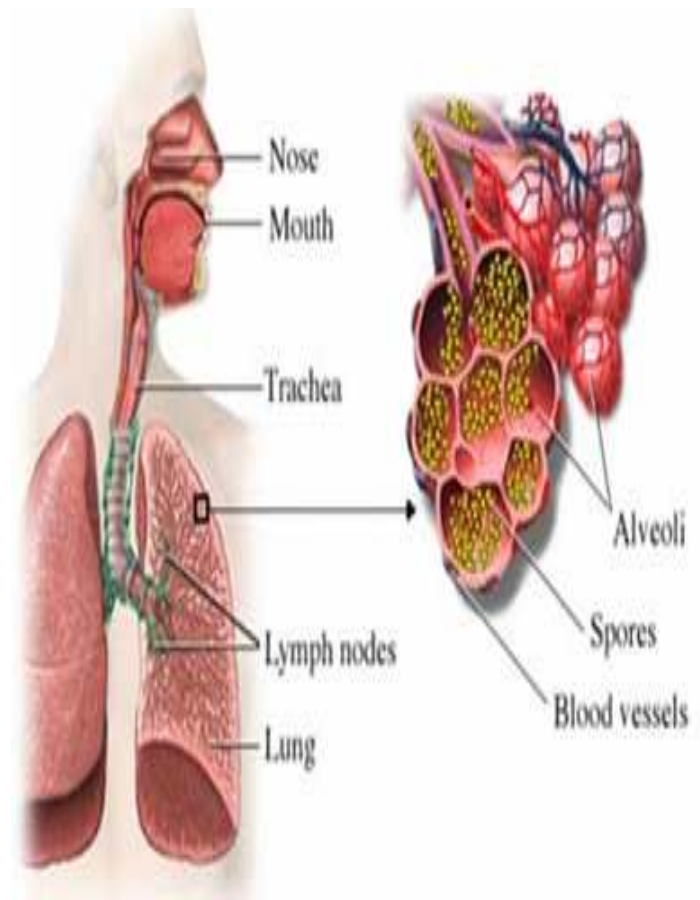
- Happen when fungi pass the resistance barriers of the body and establish infection.
- Characterize mycoses by how widely / deeply infection has penetrated.
- **Superficial Mycoses:** Most patients are not even aware that they have condition. Fungi only growing on dead skin, hair and nails. Fungus doesn't secrete metabolites into body.
- **Cutaneous Mycoses:** Fungi growing and secreting metabolites into the skin. Person is definitely aware of the infection. An example of this is *Epidermophyton floccosum*, one of the causes of athlete's foot.
- **Subcutaneous Mycoses:** Fungus must be traumatically implanted into the body.
- **Systemic Mycoses:** Fungi are inhaled into the lungs and subsequently are transported to other internal organs, usually through the bloodstream.



Epidemiology of Mycoses

Transmission and Prevalence of Fungal Infections

- Fungi and their spores are found almost everywhere in the environment. You can't avoid them.
- It is your **immune system** that keeps you safe from fungal infection.
- Mycoses are typically acquired via **inhalation**, **trauma** or **ingestion**.
- Only very infrequently are they spread from person to person.
- Still, epidemics of mycoses occur, but typically through mass exposure (like bird droppings in or near the ventilation system of a building).
- Since usually not contagious, difficult to report incidence, other than epidemics or when they effect a specific population (such as AIDS patients).



True Fungal Pathogens vs. Opportunistic Fungi

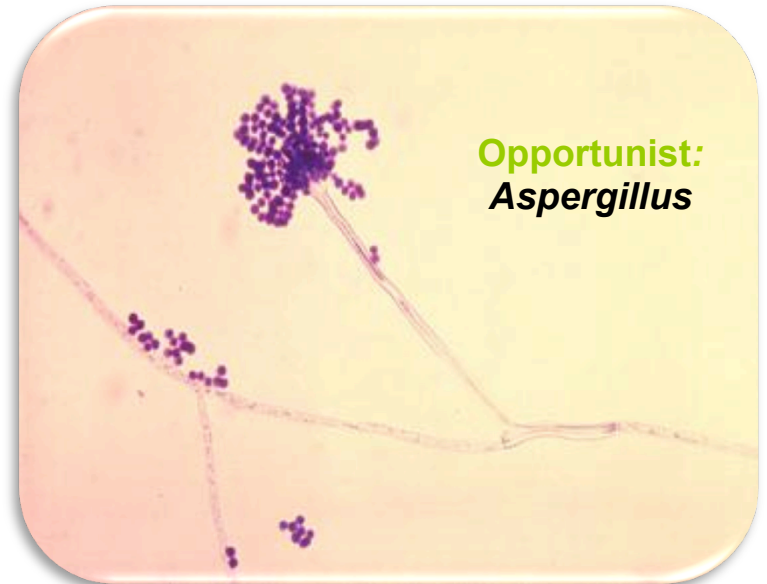
There are only four types of fungi that are considered true pathogens...

- *Blastomyces dermatitidis*
- *Coccidioides immitis*
- *Historplamsa capsulatum*
- *Paracoccidioides brasiliensis*

... the rest are considered opportunistic.

What's the difference?

- **True pathogenic fungi** have the ability to actively attack and invade tissues of healthy individuals. Have specific **enzymes** and **proteins** that help them survive and reproduce within the body.
- **Oppurtunistic fungi** do not cause disease in healthy individuals, but can cause disease in those with weakened immune system.



True Fungal Pathogen

Species: *Blastomyces dermatitidis*

(blast-o-MICE-ease dur-ma-TID-id-iss)

- **What Is Blastomycosis?**

Caused by fungus found in soil in the eastern and central US.

Infection occurs by inhalation of spores. Once inhaled, fungus grows and may disseminate through blood to other organs.

Incubation period 30 to 100 days, although infection can be asymptomatic.

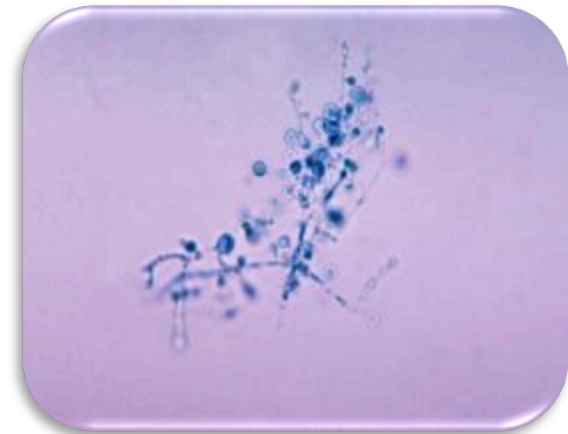
- **Pulmonary Blastidiomycosis**

Resolves on its own in most people. In immune compromised can cause respiratory failure.

- **Disseminated Blastidiomycosis**

If disseminates from lungs, can result in wart-like or recessed skin lesions (cutaneous blastidiomycosis) or damage to bones (osteoarticular blastidiomycosis).

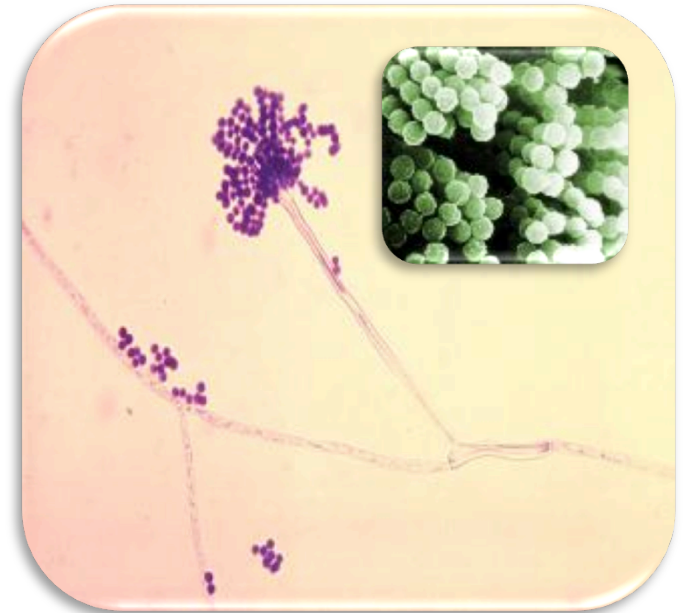
AIDS patients are prone to develop meningitis from infection.



Opportunistic Fungal Pathogen

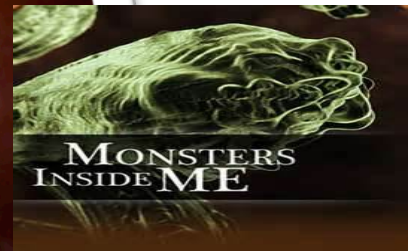
Species: *Aspergillus fumigatus*

- Can cause disease aspergillosis.
- Has become leading infectious cause of death in leukemia and bone marrow transplant patients.
- Can result in:
 - allergic reaction
 - pulmonary mass
 - systemic infection
 - can also exacerbate asthma
- Researchers dissected pillows (both feather and synthetic) and identified several thousand spores of fungus per gram of used pillow - more than a **million spores per pillow**.
- Five things increase a persons risk of experiencing opportunistic mycoses:
 - Invasive medical procedures
 - Medical therapies that weaken the immune system
 - Certain preexisting conditions / Immune compromised
 - Specific lifestyle factors



3. Helminths

- Helminths are **parasitic worms** that live inside their host.
- **Examples:** hook, whip, pin, heart and round worms
- Belong to the Kingdom Animalia.
- Live in and feed off living hosts.
- Receive nourishment and protection while disrupting their hosts' nutrient absorption, causing weakness and disease.
- Many types of helminths live in the digestive tract of their host. These are referred to as **intestinal parasites**.



Watch a video clip, called [Worm in My Butt](#), of a man describing his helminth infection.

Ancylostoma duodenale



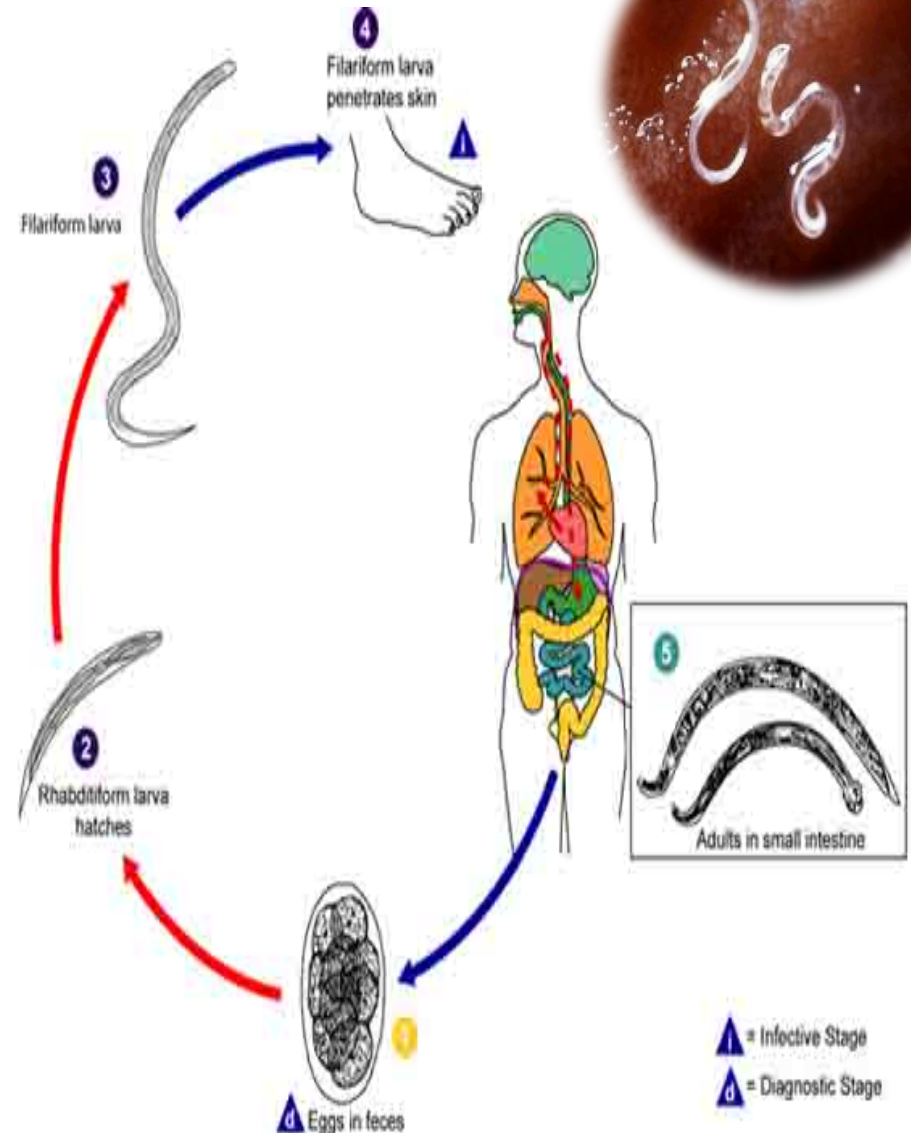
**YOU ARE
MY HOST!**

I am burrowing
up through your
feet, to your
throat, where
you'll swallow me.

I live and grow,
with my teeth
hooked into the
lining of your
intestine!

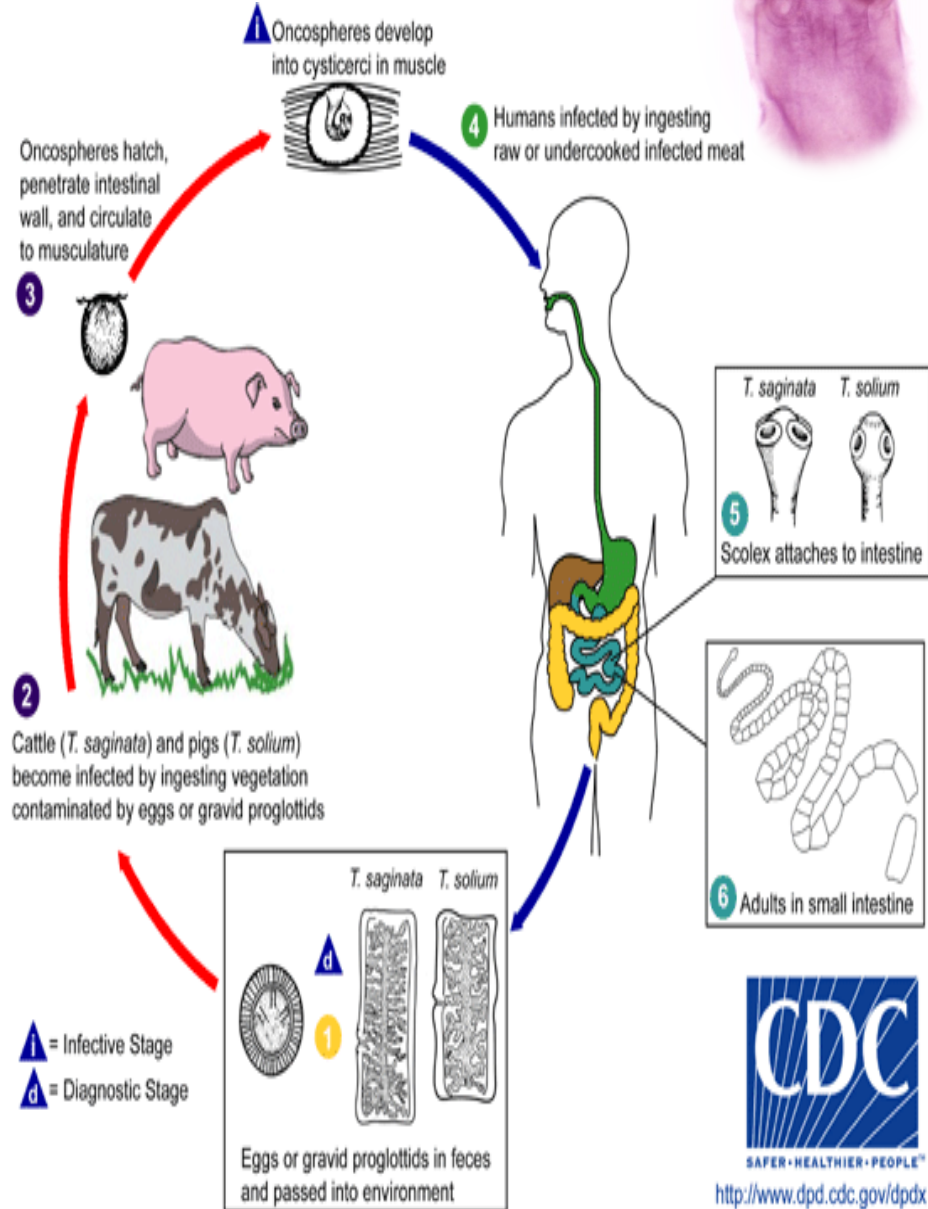
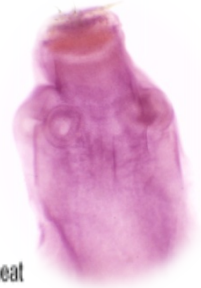
Helminth: Hookworms

- Parasitic nematode worm (helminth) that lives in small intestine of host.
- Helminths belong to Kingdom Animalia.
- Two species commonly infect humans: *Ancylostoma duodenale* and *Necator americanus*.
- Infect > 600 million worldwide.
- Eggs in fecally-contaminated soil mature into larvae.
- Larvae penetrate skin of foot (sometimes causing "ground itch"), ride the lymph system to the right side of heart, and pumped into lungs, are coughed up, and are then swallowed.
- Enter digestive system, and mature into adult worms in small intestines.
- Worms suck blood voraciously. Cause anemia, loss of iron & protein, and damage mucosa.



Helminth: Tapeworms

- Parasitic nematode worm (helminth) that lives in small intestine of host.
- Helminths belong to Kingdom Animalia.
- Taeniasis is the infection of humans with adult tapeworm of *Taenia saginata* (beef) or *Taenia solium* (pork).
- People with taeniasis may not know they have an infection because symptoms usually mild or absent.
- T. solium* tapeworm infections can lead to [cysticercosis](#), a disease that can cause seizures, so it is important seek treatment.



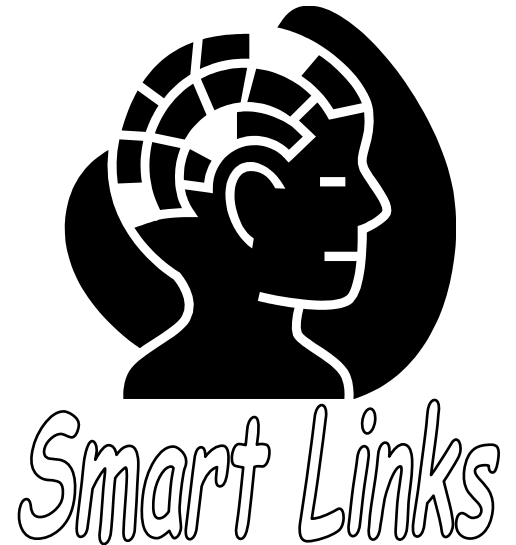
Can you get taeniasis from your dog or cat?
Extremely unlikely. Dogs and cats get the flea tapeworm (*Dipylidium caninum*) as a result of swallowing a parasite-contaminated flea.



Confused?

Here are some links to fun resources that further explain Cell Biology:

- [Eukaryotes: Meet the Microbes](#) Main Page on the Virtual Cell Biology Classroom of [Science Prof Online](#).
- Play [Pandemic 2](#) a video game of strategy, where you try to become a successful pandemic microbe and infect the world.
- "[Dysentery Gary](#)", a song by Blink182.
- [Cells Alive](#) interactive 3-D cell.
- [Eukaryotic Cell Tour](#) an Animated Science Tutorial.
- [Endoplasmic Reticulum & Golgi Apparatus](#) animation and quiz.
- [Endomembrane System](#) animation and quiz.
- "[Classification Rap](#)" hilarious music video from 1989.
- [Endocytosis / Exocytosis](#) animation from McGraw Hill.
- [Evolution of the Three Domains](#) Animated Science Tutorial.



Grr.

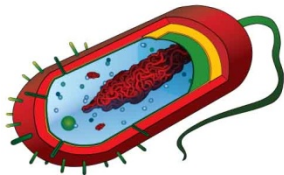


Are microbes intimidating you?

Do yourself a favor. Use the...

Virtual Microbiology Classroom (VMC) !

The VMC is full of resources to help you succeed,
including:



- practice test questions
- review questions
- study guides and learning objectives

You can access the VMC by going to the Science Prof Online website

www.ScienceProfOnline.com