Microbiology

Consumer Safety Concerns

1. Additives
2. Antibiotics/Implants
3. Fertilizers
4. Food intoxicants
5. Irradiation
6. Microbial Contamination
7. Pesticides/Pollutants
8. Tampering
9. BSE/Foot and Mouth Disease

Bovine Spongiform Encephalopathy (Mad-Cow)

- First diagnosed in 1986 (UK)
- 182,000 head in Europe
- 2 cases in U.S. (December 2003)
- Linked to variant Creutzfeldt-Jakob disease (vCJD)
- Transmitted through feed
- 1997, FDA banned use of ruminant products for livestock feed

Foot-And-Mouth Disease

- In every country except
  - Antarctica, Australia and North America
- Found in all cloven hooved (2 toes) animals
- Blister form on mouth, tongue, teats and between toes
- Causes decreased milk and meat production
- Non-fatal to most
- Not transmittable to humans
  - Human form exists
- Humans spread disease
- Mass sacrifice elimination required

Foodborne Pathogens

Estimates of Foodborne Diarrhea

- 24 to 81 million per year
- $5 to $7 billion/year

- Sources of outbreaks:
  - Food Service 77%
  - Home 20%
  - Food Processors 03%

- Why is most regulation targeting only 3% of cases?

Primary reason for Foodborne Illness?

- Ignore safe handling instruction

Most Common Reason for Ignoring Safe Handling

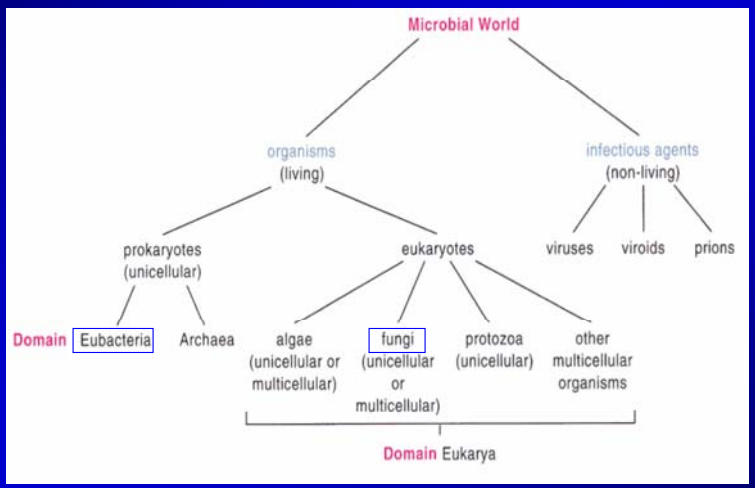
- I've done it this way for 20 years and I haven't killed anyone yet!!

Reasons you MUST follow Safe Handling

- Communication is better today
- Today's consumer is better informed and more particular
- We have very potent strains of microbes

- Do you wish to be responsible for the death or serious illness of someone's child?

The Microbial World

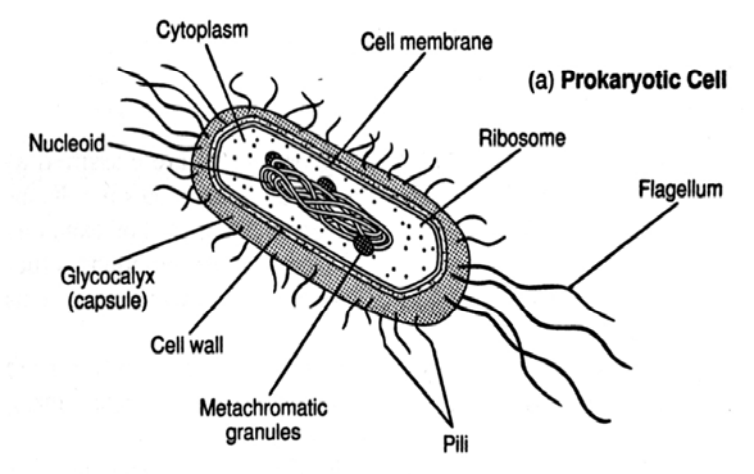


Most Microbes are Helpful

Example of Good Bacteria

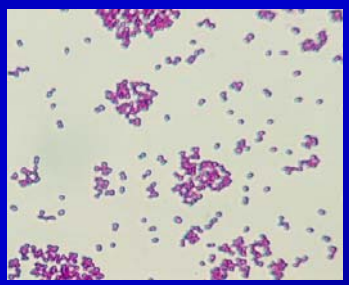
- Starter culture for sausage
- Lactocel:
  - *Micrococcus aurantiacus*
    - Converts nitrate to nitrite
  - *Lactobacillus plantarum*
    - Converts sugars to lactic acid and reduces ph
  - *Pediococcus cerevisiae*
    - Converts sugars to lactic acid and reduces ph

Parts of Bacterium



Common Shapes

- Spherical (coccus)

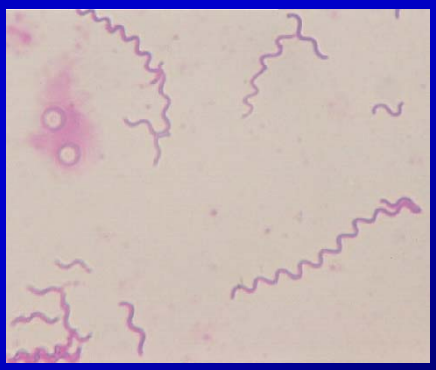


Common Shapes

- Rod-Shaped (Bacillus)

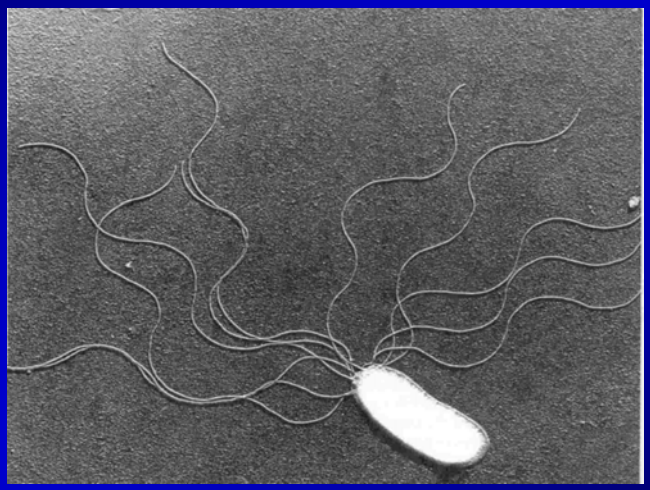
Common Shapes

- Spiral Shaped (Spirillum)



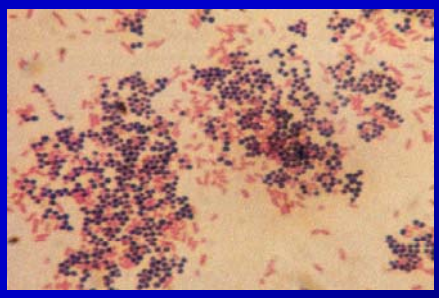
Dying *E. coli*

Bacterial Flagellum



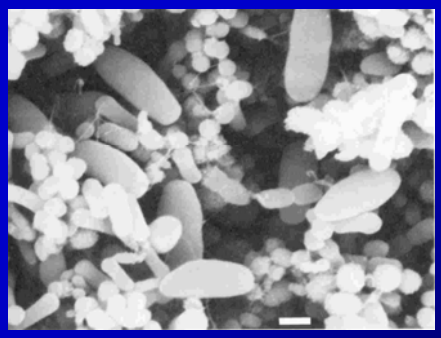
Bacterial Identification

- Gram Negative
  - Stain red
  - Do not take up dyes
  - Membranes turn red
  - *E. coli*
- Gram Positive
  - Stain Purple
  - Take up dyes
  - Staphylococcus

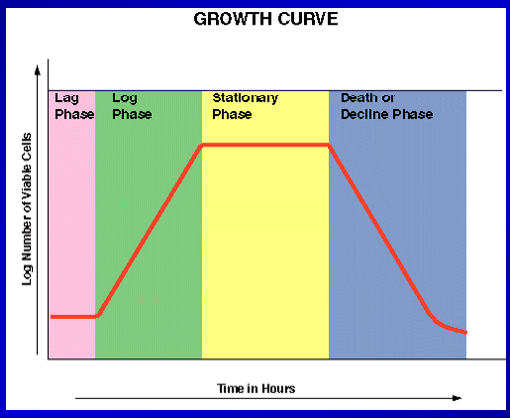


Bacteria Everywhere

- Bovine Stomach
- Why are gut contents dangerous?
- Is sterile better?



Bacterial Growth Curve



1 > 2 > 4 > 8 > 32 > 64 > 128 > 16384

- Under optimal conditions microbes can double every 20 minutes
- 1 *E. coli* can become 300,000,000 in 9.5 hrs

Doubling Times

Species	Doubling Time (min.)	Time to Colony Formation (hr.)
C. perfringens	10	8
E. coli	20	16
Salmonella	20	18
Tuberculosis	800	336

Control of Microbial Growth Rate

1. Reduce initial inoculum (HACCP)
2. Reduce nutrients (water)
3. Reduce temperature (refrigeration)
4. Change pH from optimum (value added)
5. Change O_2 availability (packaging)
6. Increase competitive microbes (why sterilize?)
7. Change osmotic pressure (packaging)

Water Activity

- Optimal A_w for most microbes is .995 to .999
- Water activity = Moles of Solvent/(Moles of Solute + Solvent)
- Salt decreases water activity (cure)

Table 34.2 Approximate Minimum a_w for Growth of Some Foodborne Microorganisms

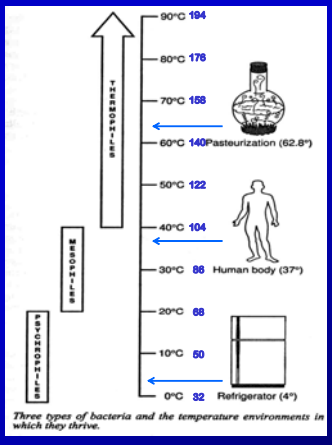
Organism	Minimum a_w
Most foodborne bacteria	0.90
Pseudomonas	0.97
Escherichia coli	0.94
Staphylococcus aureus	0.86
Most yeasts	0.88
Most molds	0.80

Table 34.1 Approximate a_w of Some Foods

Food	Typical a_w*
Fresh meat	0.99
Processed cheese	0.95
Ham	0.91
Maple syrup	0.90
Jam	0.85
Cake	0.70

Temperature and Microbes

- Thermophilic
  - Heat Loving
  - Volcanic ridges
- Mesophilic
  - Majority of microbes
- Psychrophilic
  - Cold loving
  - Ocean bottoms



Three types of bacteria and the temperature environments in which they thrive.

Effect of Temperature on Shelf-life (storage)

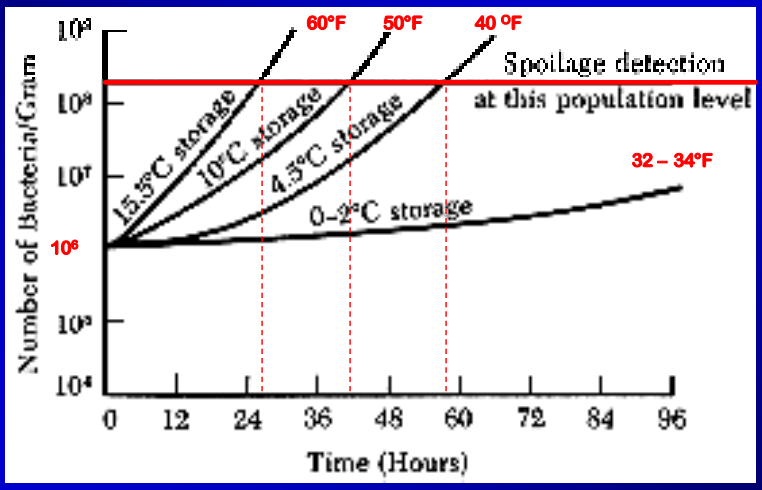
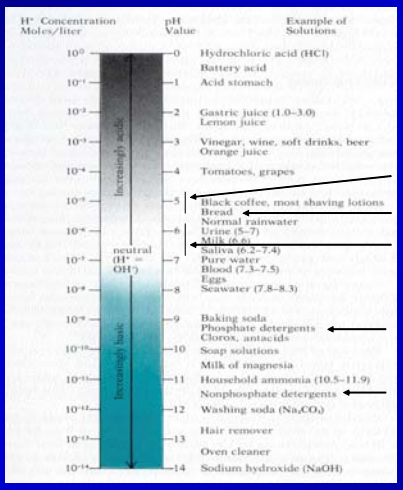


Table 34.4 Minimum pH for Growth of Some Foodborne Microorganisms	
Organism	**Minimum pH**
Pseudomonas	5.5
Staphylococcus	4.5
Lactic acid bacteria	3.5
Yeasts	1.5
Molds	0

REMEMBER THAT NORMAL FRESH MEAT HAS A pH OF 5.5 - 5.8



pH OF SOME SUBSTANCES

DRY SAUSAGE

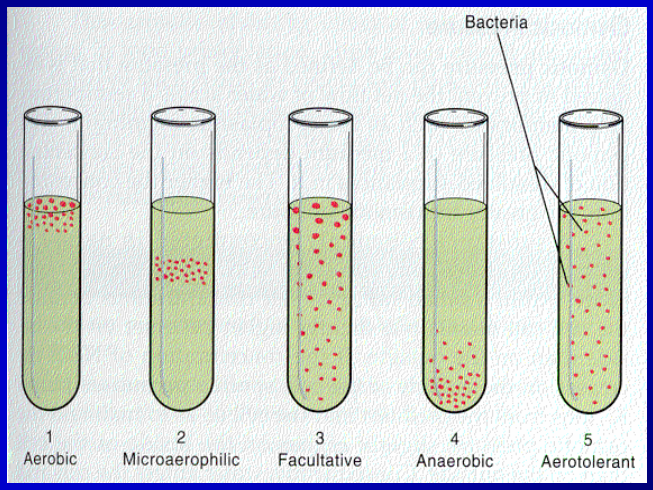
NORMAL FRESH MEAT

DARK CUTTING MEAT

Table 34.3 Approximate pH of Common Foods

Food	Approximate pH
Milk	6.4
Chicken	6.3
Spinach	5.6
Carrots	5.0
Cherries	3.8
Lemons	2.2

Oxygen Requirement



Natural Antibiotics

Table 34.5 Naturally Occurring Antimicrobial Substances in Foods

Food	Antimicrobial Substance	Mode of Action
Eggs	Lysozyme	Lyses cell walls
	Conalbumin	Chelates iron
	Riboflavin	Chelates iron
Fruit	Wax on skin	Retards entry
Horseradish	Allyl iothiocyanate	Inhibits bacteria growth best at 37°C
Garlic	Allicin	Inhibits growth of bacteria and fungi
Onion	Lacrimatory factor	Inhibits growth of bacteria and fungi
Cranberries	Benzoic acid	Inhibits growth of fungi

Source of Microbes on Meat

- People
  - Does not require contact
- Air
  - Usually associated with dust particles
- Water
  - Major contaminant
- Equipment
  - Problem in food service
- Utensils
  - Problem in homes
- Walls, Floors and Ceilings
- Insects and Rodents
  - The cockroach never dies

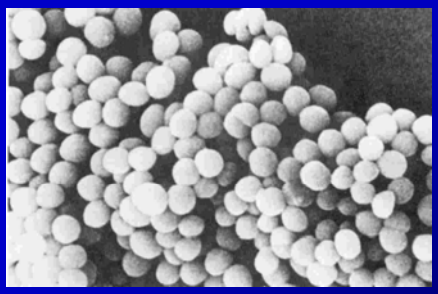
Types of Food Illness

- Food poisoning
  - Microbes produce their toxins outside of our body (i.e., in food) and then we consume the food with the toxin
- Food infection
  - We eat the microbes and they produce the toxin in our gut

Some bacteria are both an infection and a poisoning

Staphylococcus aureas

- Produces a heat stable toxin
- Problem in cooked foods
- Food infection



Clostridium botulinum

- Produces a spore that causes the problem
- Food poisoning
- 5,000 year-old spores have been found
- Heat stable
- Major concern in canned goods

Friendly Microbes

- Should a goal of zero tolerance be established?
- What would happen if all good microbes are gone?

Effects of Microbial Contamination

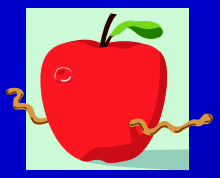
- Reduce shelf life
- Spoilage with:
  - Discoloration
  - Off-odors
  - Off-flavors
  - Slimy surface
  - Poor texture
  - Rancidity
  - Reduced nutrient content
- Possibility of food poisoning

How to Reduce Chance of Contamination

- Teach Sanitary techniques
- Keep meat cold
- Thoroughly clean and sanitize
- Pest control
- Monitoring of cleaning activities

At Home Preventions

- The three C's
  - Cool (cold)
  - Clean
  - Covered



- Prevent cross contamination
  - Wash all equipment and utensils with hot soapy water
- Refrigerate immediately after cooking

Thawing Meat

- Never thaw meat on the counter
  - The outside will get warm enough after 20 minutes to support microbial growth
- Thaw in microwave on defrost
- Thaw in refrigerator overnight
- Cold water is acceptable means of thawing meat.

Table 9.2 Using Heat to Control Microorganisms

Method	Limitations	Uses
Dry heat	Slow; high temperature required	Glassware, large metal objects
Boiling	Unreliable for killing endospores	Drinking water
Steam under pressure	Unreliable for sterilizing substances impenetrable to steam	Canned foods, surgical instruments
Pasteurization	Unable to kill many microorganisms	Foods and beverages

What is the $F_{\circ}$ Value?

- If a canned good has an F value of 8, the time and temperature used have the same lethal effect on microbes as 8 minutes at 250°F.
- TDT = Thermal Death Time = the time at a given temperature required to sterilize a suspension of bacteria and their spores.

Table 9.5 Recommended Time and Temperature Necessary for Processing Several Foods*

Food	Temperature (Degrees F)	Time (Minutes)
Baked beans	240	105
Corn, cream style	240	90
Corn, in brine	240	50
Tomatoes	212	34

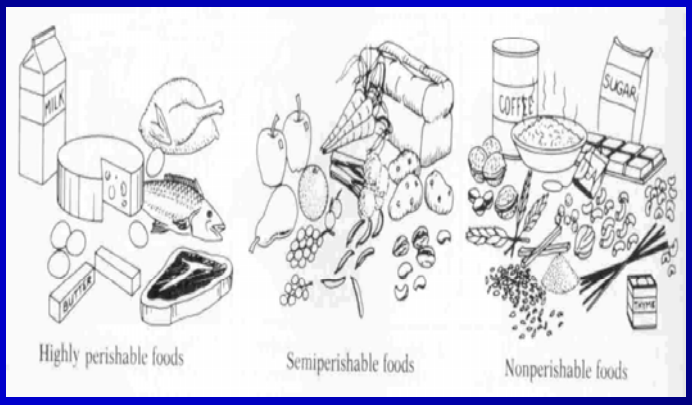
Table 9.3 Relationship of Altitude to Boiling Point of Water

Locations	Approximate Altitude (in feet)	Boiling Point (H_2O)	
New Orleans	10	100°C	(212°F)
Atlanta	1,000	99°C	(210°F)
Tucson	2,500	97.5°C	(207.5°F)
Lubbock 3,240 97			
Denver	5,300	94.7°C	(202.5°F)
Mt. Rainier	14,410	85.3°C	(185.5°F)
Mt. McKinley	20,320	79.3°C	(174.7°F)

What Happens to Microbes in the Freezer?

- If we freeze meat for 6 months and then test for microbes.
  - Will find microbes
  - Freezer preserves everything including the bugs

What is different about these foods?



Potentially Hazardous Meats

- Foods with a pH above 4.6
  - Most fresh meats
- Foods with water activity greater than .85
  - Most meats
- Foods high in proteins
  - All meats
- Foods high in starch

A TRUE STORY

The author and his wife went to a hamburger fry at the home of a couple who had a baby.

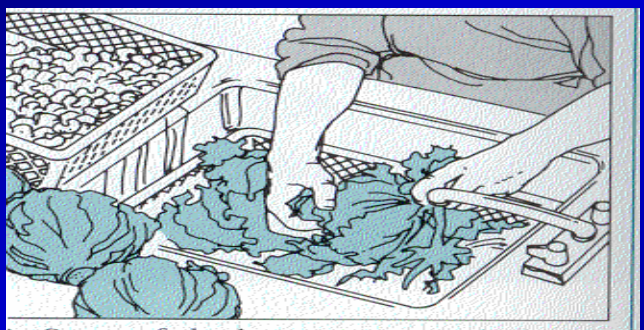
The mother changed a dirty diaper on the kitchen counter top.

Without washing the formica, the mother came back later and formed hamburger patties on the bare formica in the very spot where the baby's "poopey" diaper had been changed.

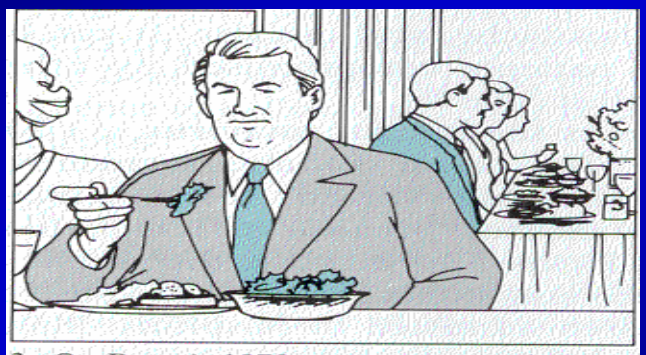
The author whispered to his wife, "make sure your hamburger is cooked very well-done!"

Another True Story

1. In early December, 1979, a New Jersey restaurant and catering facility received a shipment of lettuce from a produce market in Philadelphia.



2. Some of the lettuce was washed in a kitchen sink generally used for preparing meat and seafood. In this particular case, shrimp was washed in the sink previous to the lettuce, and the same table was used for preparing both shrimp and lettuce.



3. On Dec. 6, 1979, a group attended a luncheon banquet at the restaurant and was served green salad made with the lettuce. A second group received cole slaw instead of salad.

4. About 30 hours later, 63 of the 87 people who ate green salad developed gastroenteritis. None of those who had cole slaw became ill. Health department microbiologists identified Norwalk virus as the agent and theorized that it entered the lettuce from contaminated shrimp.

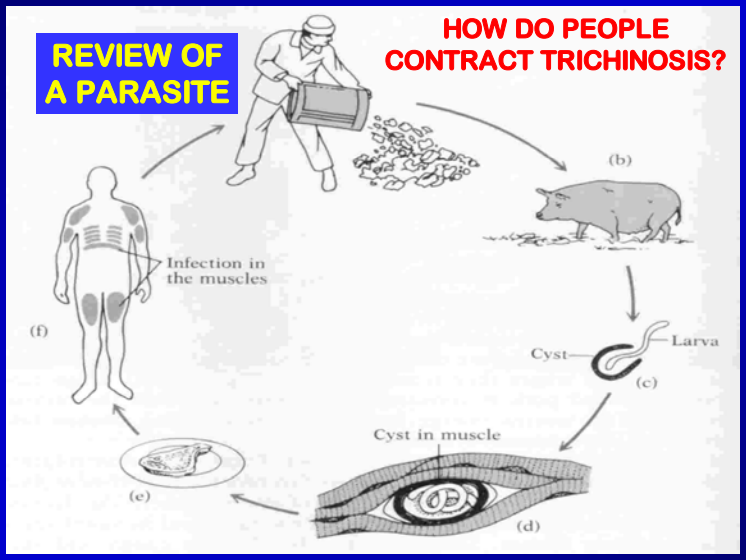
Another True Story

Cleaning and Sanitizing

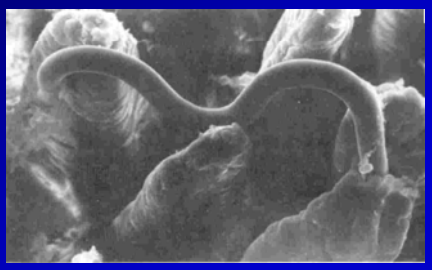
- Pick up all meat pieces
  - Pieces will plug drains and spread microbes
- Use alkaline cleaner and hot water (180°F)
  - At 140°F this will loosen fat, 180°F sanitizes
  - This temperature can be a problem for removing protein, makes it sticky
- Follow alkaline cleaner with acidic cleaner
  - Only use once per week

Types of Sanitizers

- Steam
  - Above 200°F - expensive
- Hot water
  - 175 to 195°F – not effective as a spray
- Chlorine based cleaners
  - 50 to 200 ppm
- Iodine based cleansers
- Quaternary ammonia compounds
  - 200 ppm
- Acids
  - Lactic and Propionic most common

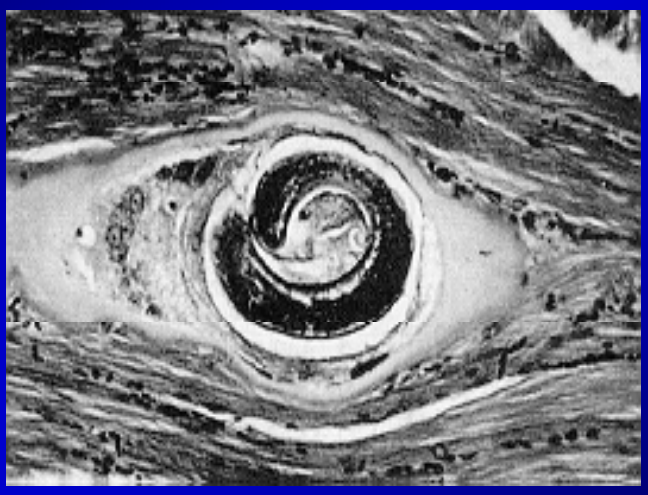


Trichinella Spiralis



- Trichinella leaving the one small intestinal villi and entering another

Encysted *Trichinella Spiralis*



Toxoplasmosis

- Dangerous for pregnant women
- Cause mental defects in children
- No cats around the pregnant