# *Yersinia enterocolitica*

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# *Yersinia enterocolitica*

Rod shape, facultative anaerobic, non-spore forming Gram negative bacteria

11 species, 6 biovars/biogroups, 60 serotypes
3 species cause foodborne infection in human (*Y. enterocolitica, Y. pestis, Y. pseudotuberculosis*)

Motile – express peritrichous flagella at lower temp. (22–30°C) but loss motility at at 37 °C

Pigs are the main reservoir

Can multiply at low temperature
Survive & reproduce in vacuum packaging and refrigerated foods

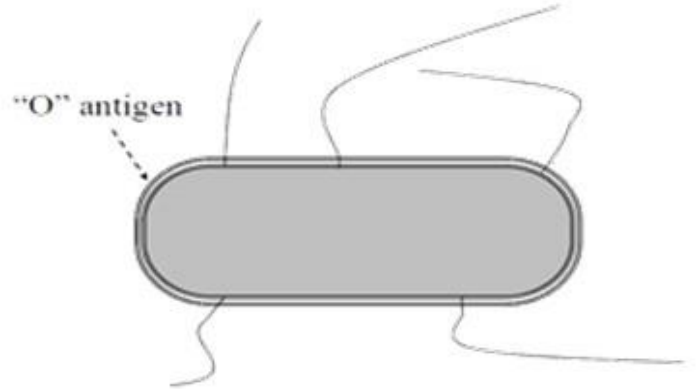
Opportunistic pathogen; Widespread in nature, mostly non pathogenic


Shoaib et al. (2019)

https://doi.org/10.1039/C9RA06988G

Fig. 1 Geographical distribution of Yersiniosis. Source: European Centre for Disease Prevention and Control, Yersiniosis, in ECDC, Annual epidemiological report for 2016, Stockholm, ECDC, 2018.

# SEROGROUP




- Based on heat-stable somatic **antigens O**
- Classified into 6 biogroups based on their pathogenicity, ecologic and geographic distribution , 60 serotypes
- 5 of 6 biogroups (1B, 2, 3, 4, and 5) are regarded as pathogens.
- Eg. Serogroup belong to 1B biogroup ( O:8; O:4; O13a; O13b, O:18, O:20, O:21)
- Strains that belong to serogroups O:3, O:9, O:8, and O:5 – cause most infection in human
- Pathogenic serotypes appeared to be distributed according to geographical niches: O:3 and O:9 (many European countries) > O:9 (Japan) > O:8 (mainly detected in US) – **cold weather during winter**

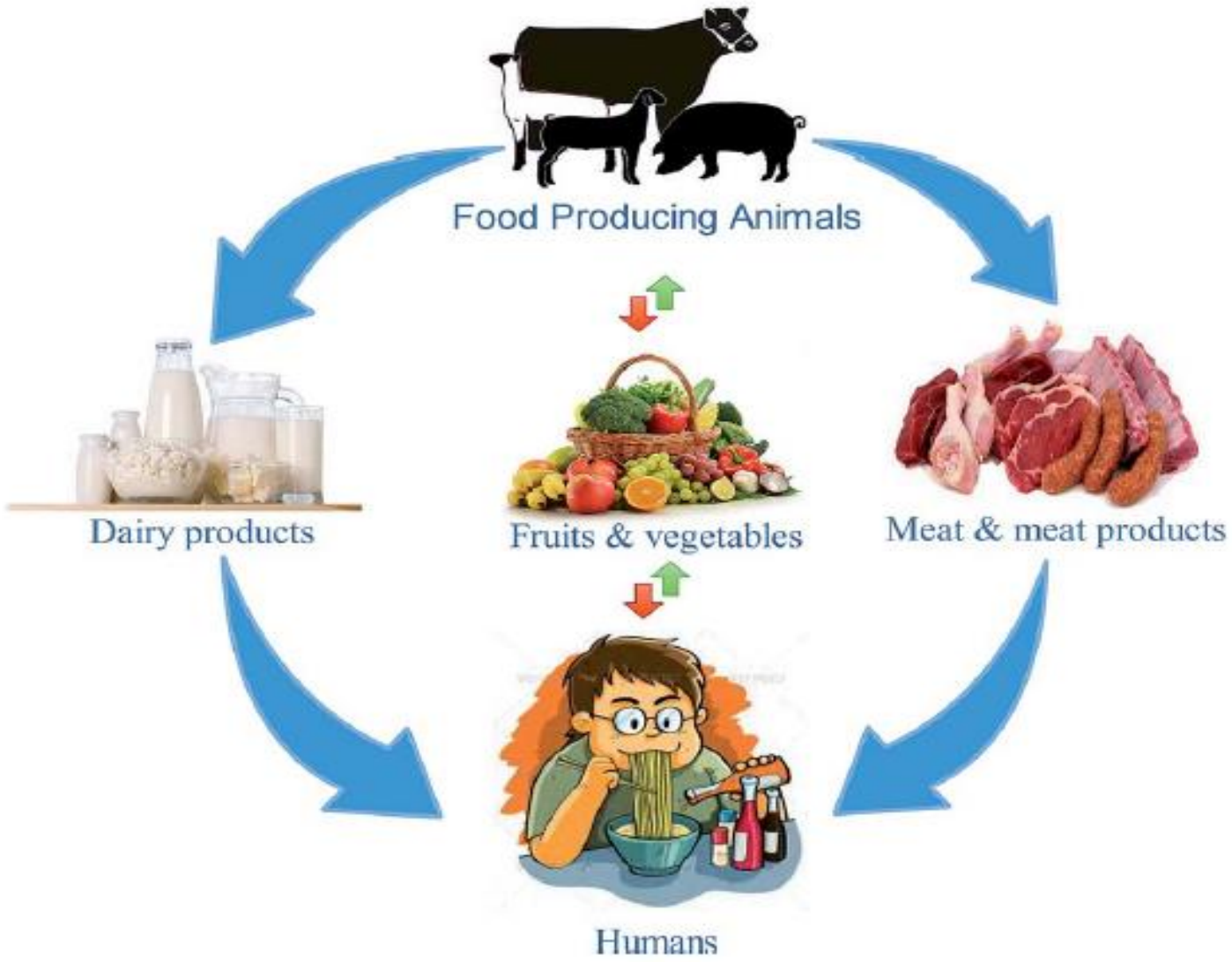



**Fig. 2** *Y. enterocolitica* transmission pathways to humans. Serotypes 2:O9, 2:O5, 3:O3, 4:O3, 5:O3 and 27 are transmitted directly or indirectly *via* animals or animal products; serotypes 2:O9, 4:O3 and 5:O3 are specified for plant-based fresh produce.

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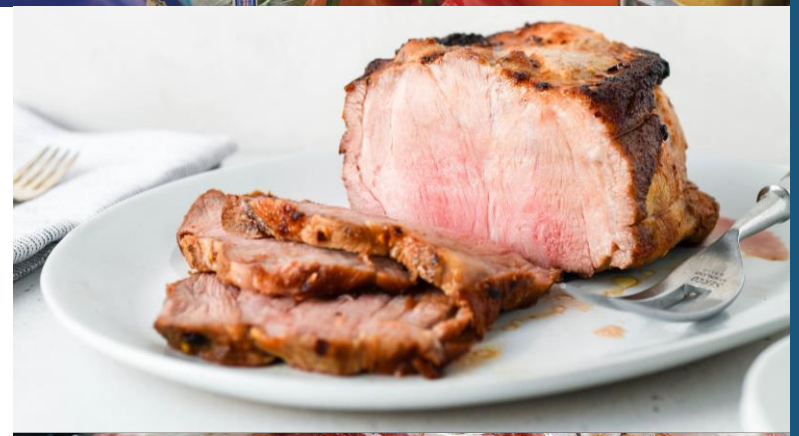
# GROWTH

- Wide growth temperature: 0 to 45°C
- Optimal temperature: 25-28°C
- Can grow in 5% NaCl and pH >4.6
- Can withstand **freezing** & **survive in frozen foods** for extended periods.
- Survived better in **artificially contaminated food** stored at room and refrigeration temperatures.
- It persists longer in **cooked foods** than in raw foods.
- Facultative anaerobic. Can grow easily in **vacuum-packed processed food.**

Image courtesy of USDA Image Library



# SOURCES

- Widely distributed in nature including foods, water, sewage, animal (cattle, sheep, dogs, cat, rodents) – generally non-pathogenic (biogroup 1A)
- **Pig – primary reservoir** of pathogenic strains that cause infection
- Usual route is through contaminated foods or water.
- Fecal-oral-route (*Enterobacteriaceae*)
- **Chitterlings** (swine intestine) **-** remains to be the only known **reservoir**
- Other sources: Vacuum-packed meat, boiled eggs, boiled fish, pasteurized liquid eggs, pasteurized whole milk, cottage cheese, and tofu.

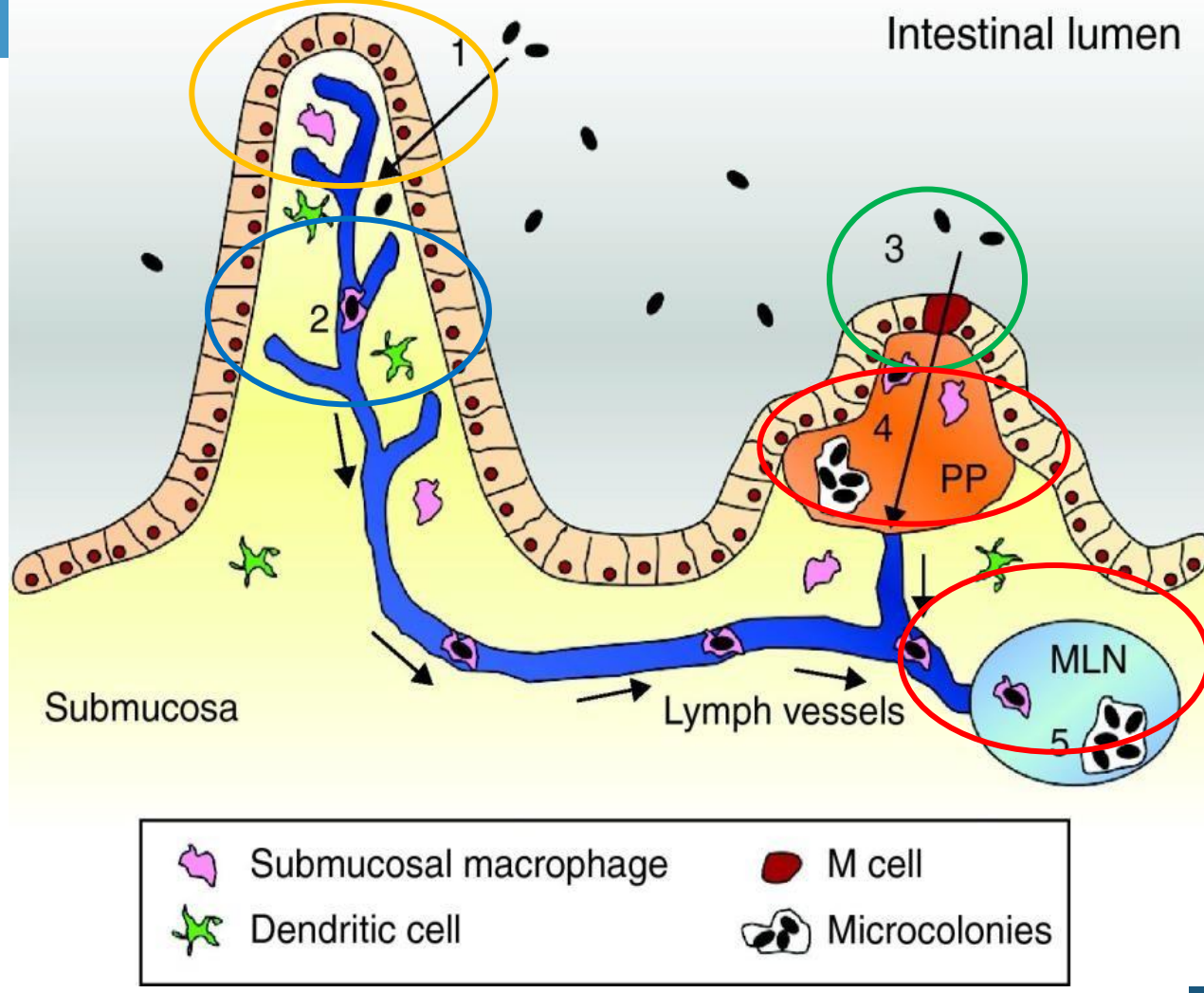

# YERSINIOSIS

- Infection is normally caused by eating **raw or undercooked pork**
- More common in **winter**
- Infective dose:**$10^4$ to $10^6$**
- More susceptible to young children **<10 years old**.
- Incubation period: 1 day to 2 weeks, or longer
- Duration: few days to 3 weeks
- Symptoms: febrile diarrhea (high fever), enterocolitis (diarrhea can be bloody in children), sometimes,vomiting.
- Cause acute mesenteric lymphadenitis (inflammation of lymph nodes) that mimic's appendicitis.
- Complication such as skin rash, joint pains or septicemia that may affect **heart**.
- Mild cases – **self limiting** but may cause a variety of autoimmune complications

# VIRULENCE FACTORS & PATHOGENESIS

- Virulence factors
  - **Invasin** –encoded by *inv* gene, **facilitates bacterial colonization** and translocation through M-cells , promote inflammatory immune response,
  - **Attachment invasion locus (Ail**) – membrane protein involve in **adhesion, prevent bacterial lysis**
  - **Enterotoxins**- Yersinia stable toxin (**Yst**) involve in diarrhea
  - **T3SS** – secrete **effector proteins** that involve in actin cytoskeletal rearrangement & ~~induce~~ block phagocytosis. Apoptosis, and inflammatory response

- Primary infection via **mucosal invasion**: colonization of terminal ileum & proximal colon.
- (1) *Yersinia* traverse intestinal epithelium via epithelial cells to the submucosa (induced phagocytosis)
- (2) Submucosal macrophages phagocytose the pathogen and enter into the lymphatic system reaching mesenteric lymph nodes (MLN).
  - Lymph nodes (or lymph glands) are small lumps of tissue that contain white blood cells, which fight infection
- (3) Alternatively, bacteria can be **engulfed by M cells of Peyer's patches (PP).**
- (4) Once in the PP, *Yersinia* forms microcolonies and starts replication.

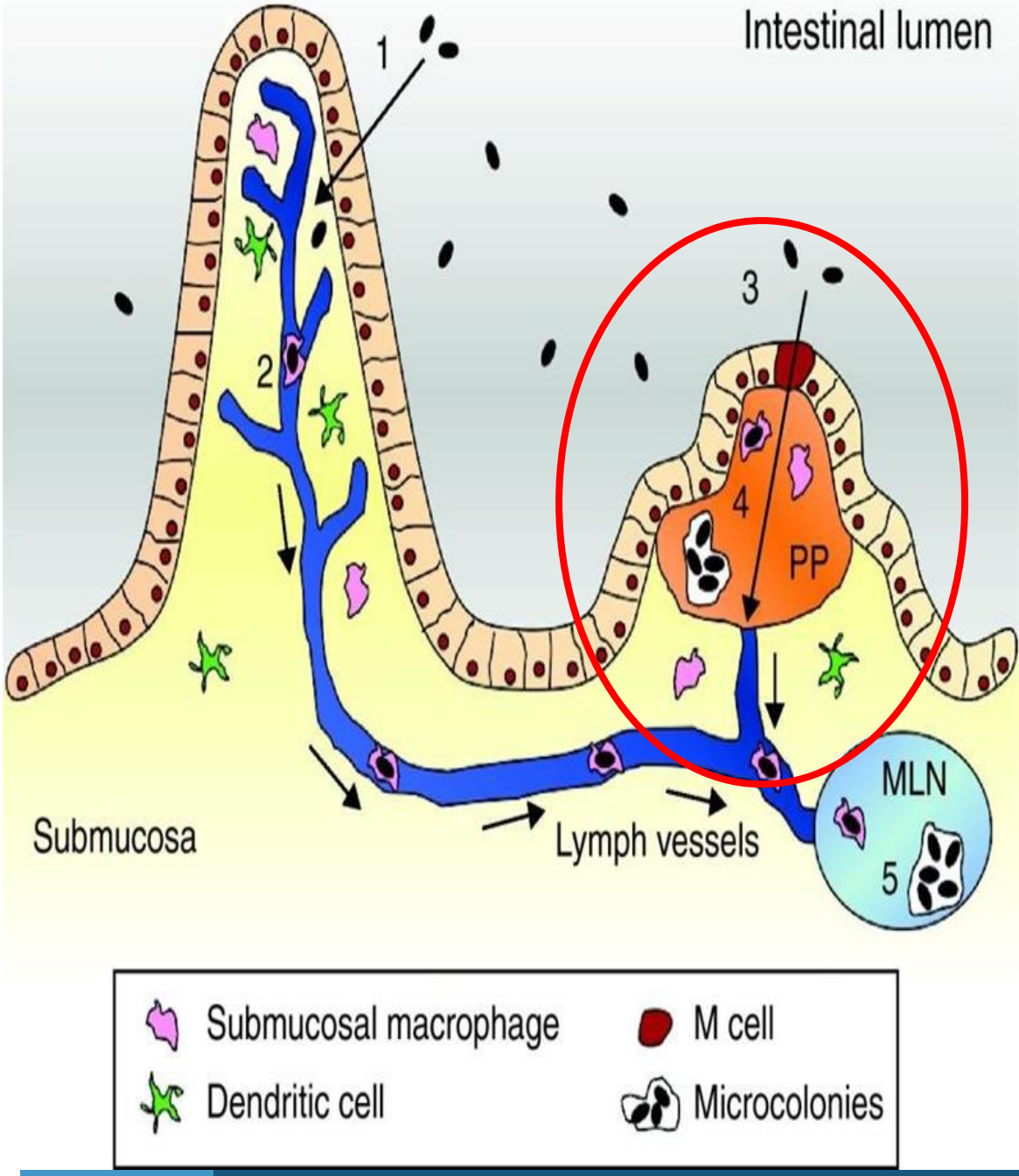



- (5) Bacterial cells will be translocated into the MLN, replicate, and cause inflammation to the lymph nodes, spread to liver, spleen, lungs
- Results in acute mesenteric lymphadenitis

- **Peyer's patches** (in red circle)
  - a group of **lymphoid follicles** in the mucus membrane that lines your small intestine.
  - Located in mucosa layer and extend into the submucosa layer
  - contain a variety of immune cells (**macrophages, dendritic cells, T cells, and B cells)**

- **Microfold cells (M cells)**
  - specialized cells, located next to the Peyer's patches.
  - M cells feed antigens to the macrophages and dendritic cells and then show it to **T cells and B cells**

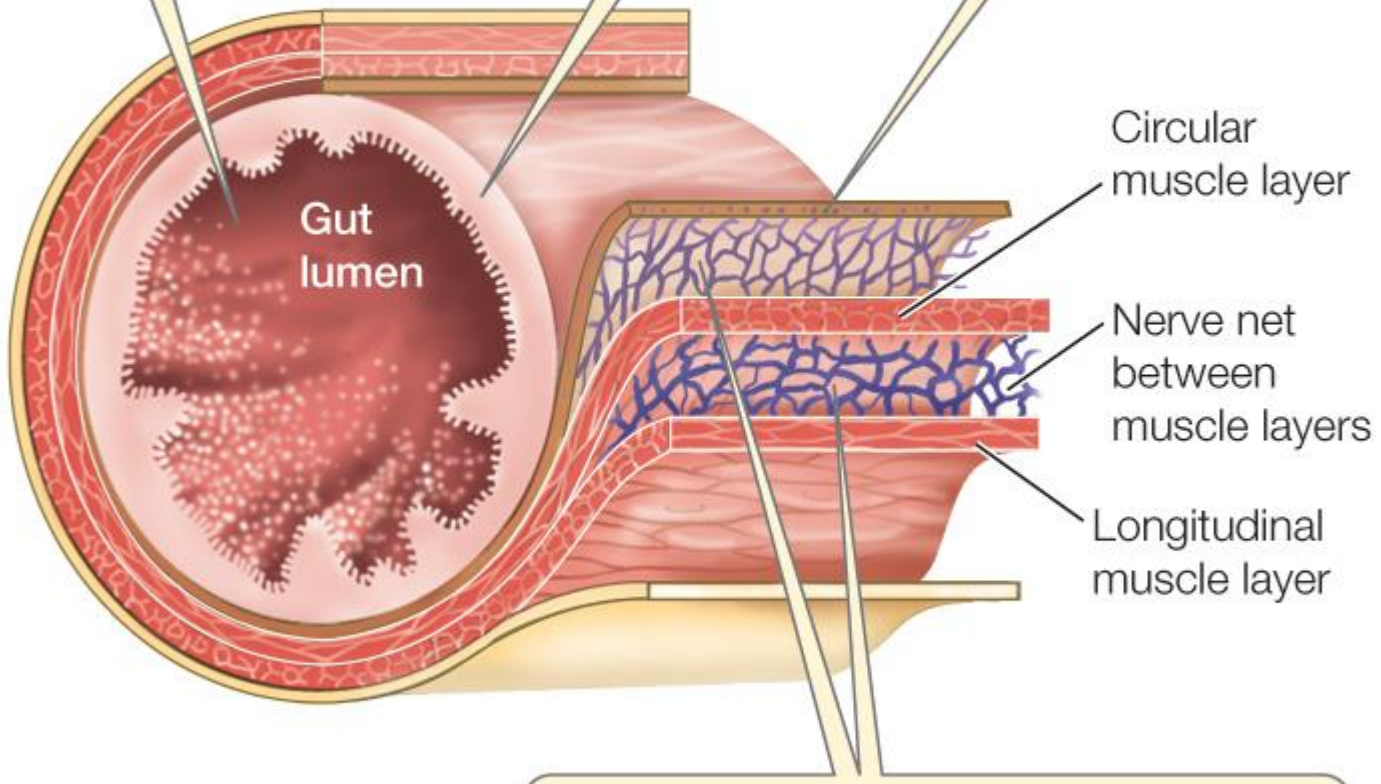
- **T-cells and B-cells**
  - Will determine whether or not the antigen requires an immune response.
  - If **harmful** pathogen, they will trigger **signal to the immune system** to attack it.



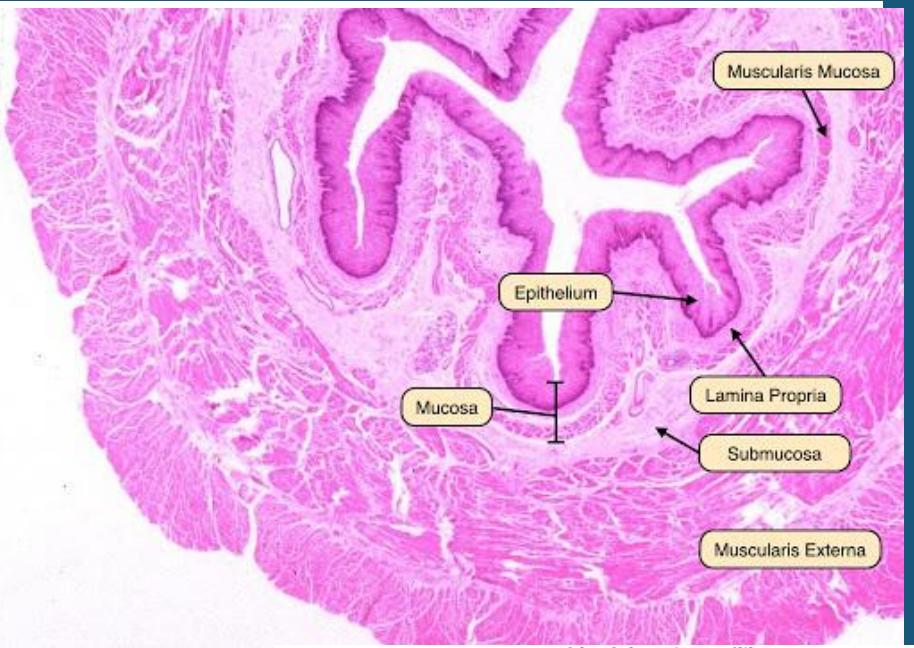
The gut lumen is lined by the gut epithelium, a single layer of epithelial cells.

Together, the gut epithelium and underlying connective tissue are termed the mucosa.

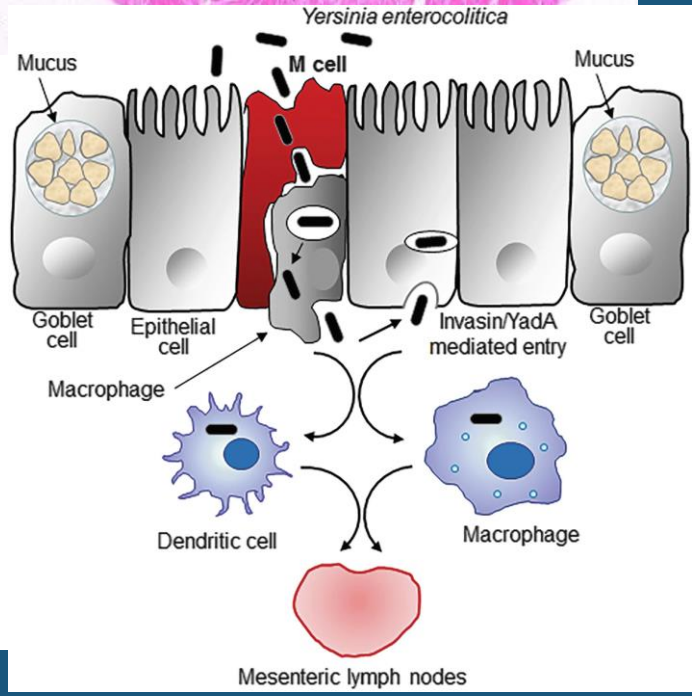
The submucosa contains a neural network, plus blood vessels and lymph vessels.




The enteric nervous system is a complex of nerve nets made up of neurons that reside entirely within the gut.




*Yersinia enterocolitica*



# OUTBREAK

- 2002 Georgia, US: Nine infants had been fed Chitterling
- 2002 Alaska: Ethnic Style Restaurant Vehicle Unknown
- 2002 New Mexico: Ham Salad in private home
- 2005 Norway: Norwegian Ready-To-Eat, Processed Pork
- 2007 Ontario: A Child became seriously ill after drinking Unpasteurized Raw Milk
- 2011 Pennsylvania:5 people sick from drinking 'Brunton Dairy' Pasteurized Milk, Ice Cream, and home made yogurt.
- 2011 Norway: 9 cases people affected Ready-to-Eat Salad Mix
- 2014 Norway: 133 cases in 4 Military bases and 16 were civilians associated with consumption of mixed salad

# SUMMARY

- *Yersinia* pathogen able to grow at 4°C & survive freezing.
- Fecal-oral-route.
- Prevalent in temperate countries, cold weather during winter.
- Pathogenic serotypes appeared to be associated with geographical area.
- Pathogenesis mechanism involves invasion of intestinal cells, production of enterotoxin,and manipulation of host immune system.
- Symptoms similar to pseudo-appendicitis

# THANK YOU