19

Microbiology

Doctor 2017 | Medicine | JU

Sheet Slides

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Dear students, in this sheet we will mainly go through 4 different types of bacteria (pathogens) that cause diseases and they are ***Campylobacter, Helicobacter, Bartonella and Rickettsiaceae.***

1- Campylobacter

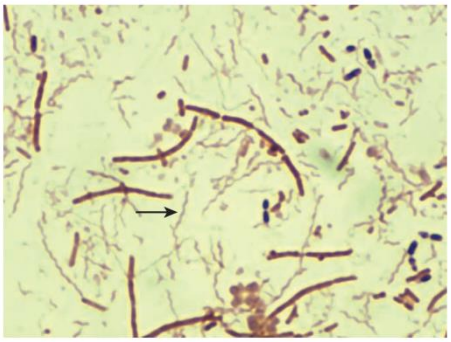


FIGURE 28-1 Mixed culture of bacteria from a fecal specimen. *Campylobacter jejuni* is the thin, curved, gram-negative bacteria *(arrow)*.

- It is small gram negative rods , motile and curved.

- Campylobacter is the most common cause of **bacterial gastroenteritis**, with **(Campylobacter jejuni)** being responsible for most infections.

So, the pathogen that we are most interested with is Campylobacter jejuni (**C. Jejuni**), because it cause the most of the damage in the part of the mucosal surface of the intestine called jeujenum.

The growth condition of this bacteria are meant to be fastidious. In other words, it needs **microaerophilic** conditions***. (microaerophilic means that this bacteria need different concentraions of oxygen)*** **.**The organisms grow best in an atmosphere of reduced oxygen (5% to 7%) and increased carbon dioxide (5% to .10%).**C. jejuni grows better at 42° C than at 37° C**

- These bacteria express **lipooligosaccharides** (LOS s) >>> (LOSs lack O-antigen in LPS)

- The organisms are killed when exposed to gastric acids, so conditions that decrease or neutralize gastric acid secretion favor disease.

Now let's have a look at the following picture

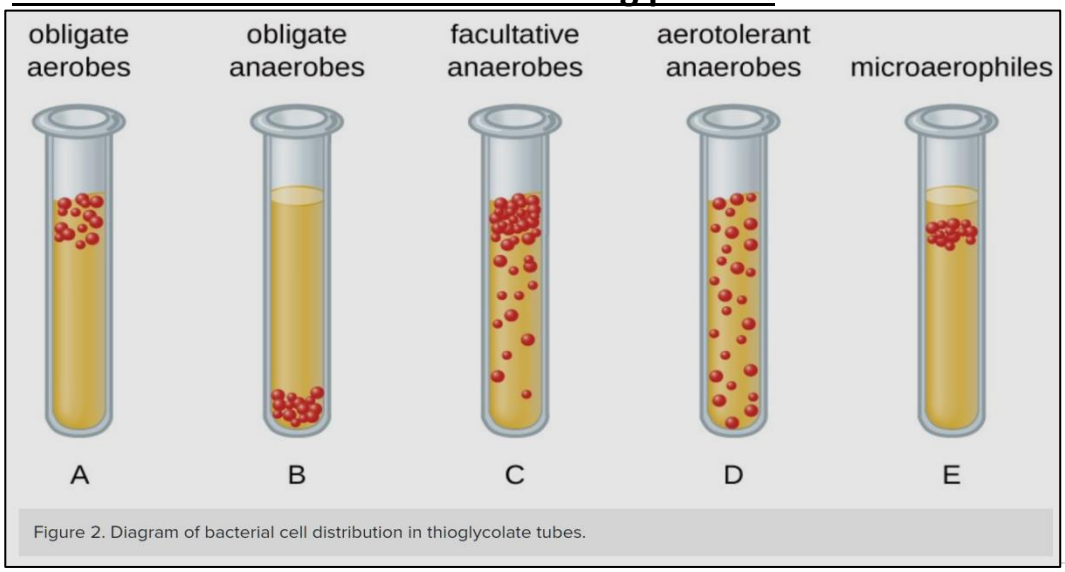


Figure 2. Diagram of bacterial cell distribution in thioglycolate tubes.

As you can see, these test tubes represent a certain media to determine the oxygen requirements of microorganisms of the bacteria. This media is called **Thioglycolate media.**

- Obviously. The **obligate aerobes** grow on the top of this media. However, the **obligate anaerobes** can be seen grwon at the bottom of the media as they are harmed by thr oxygen or even to avoid the oxygen. Also, the **facultative anaerobes** which use the oxygen present and sometimes use this oxgen to undergo, for exmaple, fermentaion. Remember, there is more ATP produced by obligate anaerobes than facultative anaerobes.

Furthermroe, **aerotolerant anaerobes** don't use oxygen for growth but are tolerate to its presence, so the absence or the presence of oxygen doesn't make any difference for them and that's why you may notice them in the tube growing randomly inside it as they like!. Finally, we have **microaerophiles** which grow at a certain level in the tube forming a band, as at this level, they require a specific concentrations of oxygen. Namely, (*microaerophile is a microorganism that requires O_2 to survive, but requires environments containing lower levels of oxygen than are present in the atmosphere*) (<21% O_2). **Remember that *C. jejuni* referred to as microaerophilic as it better grows at 42° C than at 37° C**.

Note: As Campylobacter bacteria express (**LO**Ss), they have different toxicity profile from the ones that contain lipopolysaccharides (**LP**Ss).

- ***Campylobacter* infections** are described as **zoonotic** infections, which means they can be mostly found in animals serving as reservoirs. **Contaminated poultry** are responsible for more than half of the *Campylobacter* infections in developed countries. Also, it is **uncommon** for the disease to be transmitted by **food handlers**.

- Some of the **symptoms** that might be caused by (**C. Jejuni**) are acute enteritis with diarrhea (may may be bloody on gross examination), fever and severe abdominal pain.

This pictue outlines themicrobiological findings among US emergency department patients presenting with 549 episodes of bloody diarrhea. In other words, these details show the most pathogens that cause bloody diarrhea once isolated, according to those U.S findings.

Microbiological finding	No. (%)	95% CI, %
Stool pathogen isolated[a]	168 (30.6)	27–35
Shigella species	84 (15.3)	12–19
Salmonella species	32 (5.8)	4–8
Campylobacter species	34 (6.2)	4–8
STEC	14 (2.6)[b]	1–4
Other enteropathogens[c]	9 (1.6)	1–3

NOTE. STEC, Shiga toxin–producing *Escherichia coli*.
[a] Three patients' stool specimens yielded 2 enteropathogens; each *Shigella* plus 1 each *Plesiomonas* or *Salmonella* species or *E. coli* O111.
[b] Includes 6 confirmed and 8 possible STEC cases.
[c] Vibrio (4), *Yersinia* (4), *Plesiomonas* (1) species.

Guillain-Barré syndrome and **reactive arthritis** are well-recognized complications of *Campylobacter* infections (although uncommon). Probably through molecular mimicry.

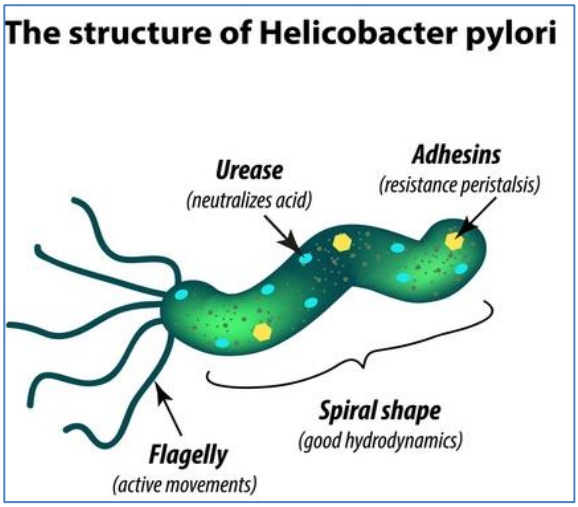
Additional information to just understand the concept of Molecular mimicry .

Molecular mimicry: is defined as the possibility that sequence similarities between foreign and self-peptides are sufficient to result in the cross-activation of auto-reactive T or B cells by pathogen peptides.

A presumptive identification of isolates is based on growth under selective conditions, typical microscopic morphology, and positive oxidase and catalase tests

----------Up to here, *Campylobacter* has been thoroughly discussed ----------

2- *Helicobacter*



- This species are considered to be **spiral gram-negative** rods resembling campylobacters. All gastric helicobacters, including *H. pylori,* are highly **motile** (corkscrew motility) and strong producers of **urease.** Additionally, they are **catalase positive** and **oxidase positive**. Note that some infections are not necessarily caused due to toxins of bacteria. However, they could also be resulted by the molecular mimicry just like what happens with Rheumatic fever. So, there are some bacterial antigens that can be recognised by the immune system and

at the same time have similar structure to those antigens found in the body, thus, an immune response will act against them.

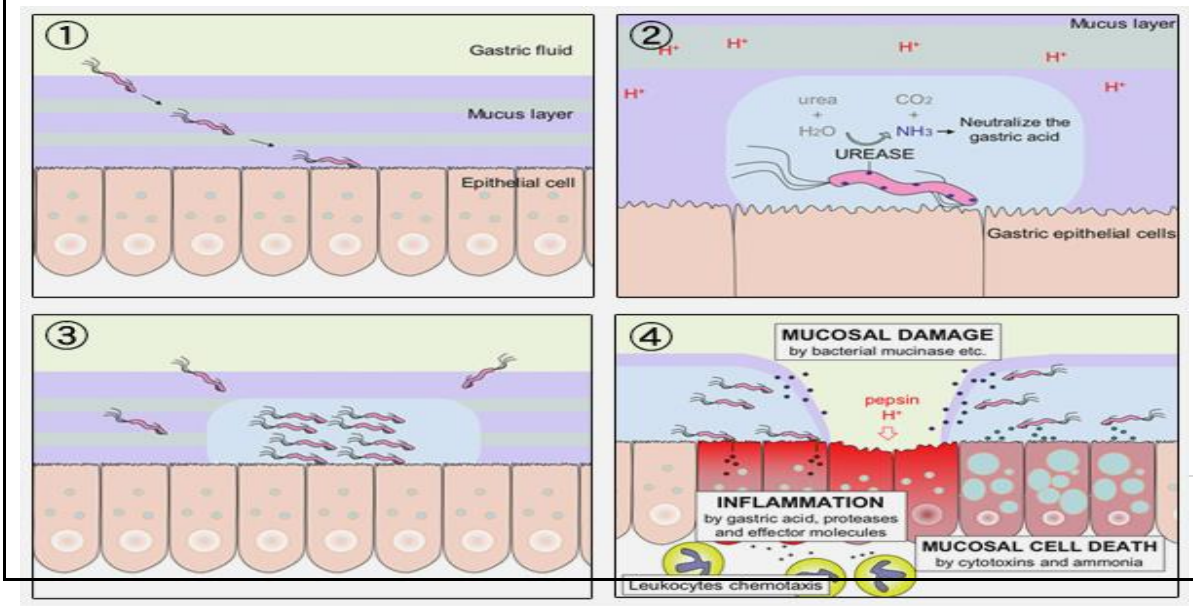
Guillain-Barre syndrome can also be involved in this type of bacteria. Guillain-Barre syndrome is a rare disorder in which your body's immune system attacks your nerve and eventually paralyzing the whole body. Thus, it is considered as a medical emergency. Moreover, in terms of their (*H. pylori*) identification conditions, they grow in selective conditions such as increased temperature and microaerophilic environemnt in additoin to the fact that *H. pylori* adheres to gastric mucosa and is not usually recovered in stool or blood specimens.

H. pylori and other helicobacters requires a complex medium in microaerophilic conditions

- ***H.pylori*** use their motility, chemotaxis, urease production, and other mechanisms to **adapt to the acidic conditions of the stomach** and colonize a narrow protected region near the surface of epithelial cells. Helicobacter is special in a form that they have the ability to colonize the stomach too, and escape (evade) the gastric acids by their motility and chemotaxis reaching the mucous that lines the gastric epithelium and then using their adhesion tools to bind to this gastric epithelium. Therefore, in this case, while *Helicobacter* produce an enzyme called **urease** that breaks down the urea to give ammonia, they are further buffering the gastric acid. *H.pylori* **overlies gastric but NOT intestinal epithelial cells**.

- **So**, *H.pylori* can cause acute gastritis as a gatsrtic epithelial damage and hypochlorhydria *(a case in which, people are ununable to produce enough hydrochloric acid (HCL) in the stomach).* ***H pylori*** is responsible for 85% of the gastric ulcers and 95% of the duodenal ulcers.

➡ **Here is a figure down below (form the slide) illustrates the tissue damage caused by urease**



Localized tissue damage is mediated by urease byproducts, **mucinase, phospholipases,** and the activity of **vacuolating cytotoxin A (VacA),** a protein that after penetration into epithelial cells damages the cells by producing vacuoles. **cytotoxin-associated gene *(cagA)*** interferes with the normal cytoskeletal structure of the epithelial cells

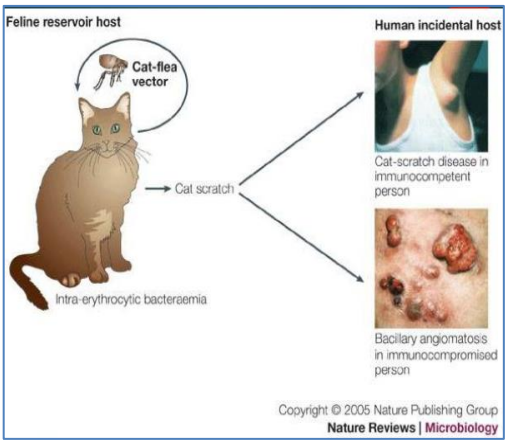
- The **acute phase** of gastritis is characterized by a **feeling of fullness**, **nausea**, **vomiting**, and **hypochlorhydria. However,** chronic gastritis will progress to develop peptic ulcers. The ulcers develop at the sites of intense inflammation, commonly involving the junction between the corpus and antrum (gastric ulcer) or the proximal duodenum (duodenal ulcer). In addition, chronic gastritis increases the risk of gastric cancer and MALT lymphoma (mucosa-associated lymphoid tissue B-cell lymphomas).

- Regarding the diagnosis of the diseases caused by this bacteria, as *H. pylori* adheres to gastric mucosa , *H. pylori* can be detected by **histological examination of gastric biopsy specimens**, but identification is usually done by non-invasive methods. A number of poly-clonal and mono-clonal immunoassays for *H. pylori* antigens excreted in stool, have been developed and demonstrated to have sensitivities and specificities exceeding 95%.

----------Up to here, ***Helicobacter*** has been thoroughly discussed ----------

3- *Bartonella*

with this type of bacteria, we will mainly talk about **Bartonella Henselae *(B. Henselae*)** which causes a disease know as **cat-scratch disease** (a disease acquired after exposure to cats) such as scratches, bites, contact with the contaminated feces of cat fleas. Furthermore, it develops 1-3 weeks after contact with a cat.



Bartonella are **gram-negative, coccobacillary** or bacillary rods with **fastidious** growth requirements, requiring prolonged incubation (2 to 6 weeks). usually **facultative intracellular bacteria.**

- **Bartonella** species **are transmitted by vectors** such as ticks, fleas, sand flies, and mosquitoes. These vectors carry this bacteria with them and then get attached to the cat, so the cat now is carrying this pathogen and transmits it to human body (if the human gets bitted or scratched by the cat). B. henselae is responsible for a disease acquired after exposure to cats (e.g., scratches, bites, contact with the contaminated feces of cat fleas): cat-scratch disease, 1–3 weeks after inoculation. However, symptoms typically include a non-painful **bump or blister at the site of injury** and painful and **swollen lymph nodes.** Some of the regional lymph nodes are axiilary, epi-trochlear, or cervical most commonly). Usually, these symptoms emerge with a self-limited disease unless it occurs with immune-compromised patients. Also, there are another diseases that might be caused by Bartonella species. This includes **Carrion's disease** (*by Bartonella Bacilliformis*) and **trench fever** (*by Bartonella Quintana)*.

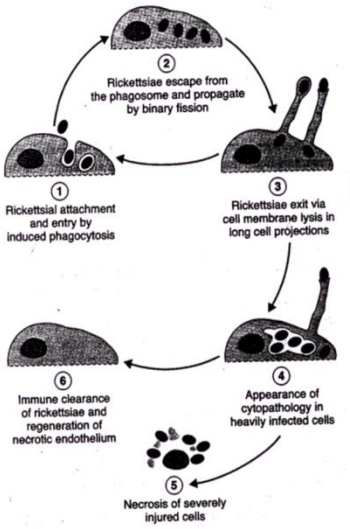
----------Up to here, ***Bartonella*** has been thoroughly discussed ----------

4- *Rickettsiaceae*

- Finally, this is the last pathogen (bacteria) in this sheet being illustrated. This bacteria is **obligate intracellular**, **aerobic**, **gram-negative rods**, and grow **only in the cytoplasm of eukaryotic cells.** Seen best with **Giemsa stain** (*It can be used to study the adherence of pathogenic bacteria to human cells. It differentially **stains** human and bacterial cells purple and pink respectively*).

Pathogenesis

1. Adhesion
2. Internalization
3. Release from phagosome
4. Intracellular growth
5. Release from infected cell
6. Host cell response to infect

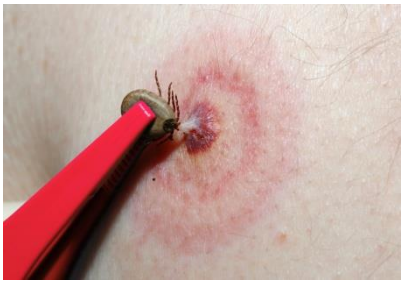


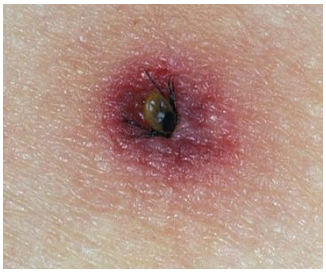
- ***Rickettsia*** can be put into 2 groups depending on the disease they cause. To illustrate, they are subdivided into the **spotted fever group** and the **typhus group.** Also, this bacteria can be carried on vectors like **fleas, lice, mites, and ticks** (*remember how cat-scratch disease is caused!*) and we should mention that all age groups are at risk for Rickettsial infections during travel to endemic areas (e.g. When you go for hiking).

- The distribution of Rickettsial diseases is determined by the distribution of the arthropod host/vector . Moreover, the symptoms emerged by this bacteria appear usually after a week from the infection time. So you can be bitten by these species and

after a period of time you might be noticing some fever, muscle weakness and maybe tiredness and fatigue.

- Most importantly, ***Rickettsia*** does NOT cause most of its damage through toxins **but** via **replicating** inside the cells then destroying them. So it can be included that the primary clinical manifestations appear to result from the **replication of bacteria in endothelial cells**, with subsequent damage to the cells and leakage of the blood vessels .





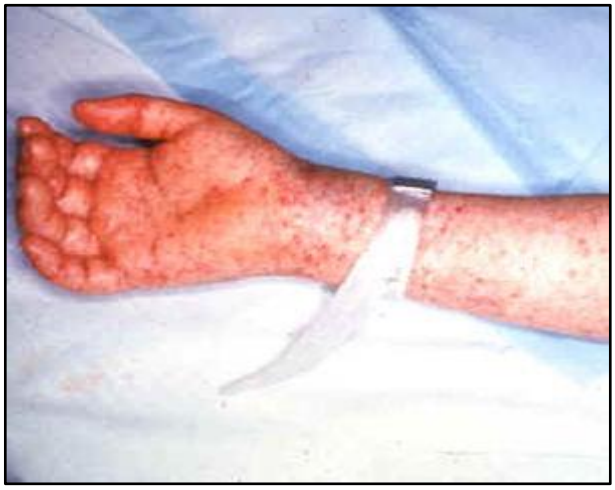
- The destroying cells by *Rickettsia* (from inside out) can either undergo necrosis or apoptosis by the end. Sometimes the immune system can fight this bacteria but often it can't do that leading to tissue destruction as ***Rickettsia*** duplicates inside the tissue.

The following table had been discussed by the doctor during the last 10 mins. of the lecture. However, you may just focus on the red-marked types in this table. Refer to record 19 on the site if you like.

Organism	Disease	Reservoir	Vector	Distribution
Rickettsia rickettsii	Rocky Mountain spotted fever	Ticks, wild rodents	Hard ticks (dog tick, wood tick)	Western Canada, continental US, Mexico, Panama, Argentina, Brazil, Bolivia, Colombia, Costa Rica
R. akari	Rickettsialpox	Mites (chiggers), wild rodents	Mites	North America (particularly urban areas of Northeastern US), Mexico, Europe (e.g., Croatia, Ukraine, Turkey), Asia (e.g., Korea), Africa
R. prowazekii	Epidemic (louse-borne) typhus	Humans	Human body louse	Mountainous regions of Central and Eastern Africa (Burundi, Rwanda, Ethiopia), Central and South America, Asia
	Recrudescent typhus	Humans	Relapse disease	Worldwide
	Sporadic typhus	Flying squirrels, squirrel fleas and lice	Possibly squirrel fleas	United States

Disease	Average Incubation Period (Days)	Clinical Presentation	Rash	Eschar	Mortality without Treatment (%)
Rocky Mountain spotted fever	7	Abrupt onset; fever, headache, malaise, myalgias, nausea, vomiting, abdominal pain	>90%; macular; centripetal spread	No	10-25
Rickettsialpox	9-14	Abrupt onset; fever, headache, chills, myalgias, photophobia	100%; papulovesicular; generalized	Yes	Low
Epidemic typhus	8	Abrupt onset; fever, headache, chills, myalgias, arthralgia	20%-80%; macular; centrifugal spread	No	20

Epidemic typhus caused by ***R. prowazekii*** infection is rarely reported among tourists but can occur in impoverished communities and refugee populations where body lice are prevalent.



Tick-borne spotted fever **rickettsioses** are the most frequently reported **travel**-associated Rickettsial infections.