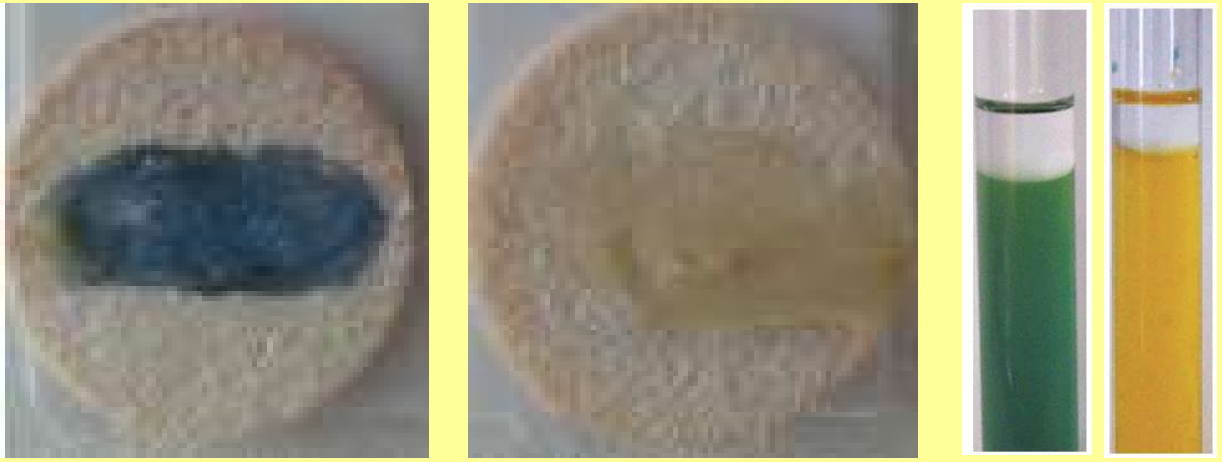
Nonfermenters

(Gram negative non-fermentative rods)

Characteristics

* **gram-negative rods**
* **easy to culture**; room temperature (approx. 30°C) to 37°C is sufficient (ubiquitous bacteria)
* **strictly aerobic**
* **oxidize glucose dont ferment glucose** (enterobacteria ferment glucose)
* usually **oxidase-positive** (enterobacteria are oxidase-negative)

Oxidase production
glucose oxidation/fermentation



A B C D

Pseudomonads and other **non-fermenting rods** typically **produce** the enzyme **oxidase** (A – a blue color in the test indicates oxidase production), in contrast to enterobacteria (B, negative reaction), which are very similar to them in terms of morphology (Gram-negative) and growth. Pseudomonads and other non-fermenting rods do not ferment glucose (C), in contrast to enterobacteria (D). (Media containing glucose are overlaid with paraffin oil)

Occurence

* **Ubiquitous** (environment; colonizes plants, animals, and humans)
* **common in hospital settings** – usually strains resistant to 3 or more antibiotics (**multidrug-resistant strains**) – transiently colonize the respiratory and gastrointestinal tracts of patients treated with broad-spectrum antibiotics
the **causative agents of most infections** are - ***Pseudomonas aeruginosa, Burkholderia cepacia, Stenotrophomonas maltophilia, Acinetobacter baumannii***

Pseudomonas aeruginosa

P. aeruginosa on nutrient agar – S phase (left), M phase – mucoid colonies (right) – correlate with biofilm formation in vivo; isolated from the same sputum sample from a patient with cystic fibrosis.

Significant pathogens

Pseudomonas aeruginosa

infections of various organs

MOST COMMONLY
primary skin infections
Ear and eye infections
urinary tract infections
lower respiratory tract infections

Respiratory infections

Ventilator-associated pneumonia (VAP)
Chronic infections in patients with cystic fibrosis
Severe course, often caused by multidrug-resistant strains

Treatment:
antipseudomonal antibiotics:
piperacillin/tazobactam
ceftazidime / cefepime
meropenem / imipenem
often in combination with an aminoglycoside or a fluoroquinolone

Urinary tract infections

*** especially in catheterized patients**
biofilm → poorer response to treatment

Treatment:
based on susceptibility (culture!)
e.g.: ciprofloxacin, ceftazidime
piperacillin/tazobactam

Skin and soft tissue infections

folliculitis
burn infections (typically green in color – pyocyanin)
chronic wounds

Treatment:
topical vs. systemic, depending on the extent
severe cases: piperacillin/tazobactam, meropenem

Ear infections

Otitis externa (“swimmer’s ear”)
in people with diabetes → malignant otitis externa (very serious)

Treatment:
topical antibiotic drops (e.g., ciprofloxacin)
severe cases → IV antibiotics

Sepsis

originates from another site (lungs, urinary tract, wounds)
high mortality rate

Treatment:
urgent IV antibiotics (combination therapy)
always based on culture results

Drugs of choice: The primary drug of choice for *Pseudomonas aeruginosa* is typically a **beta-lactam** with antipseudomonal activity, most commonly **cefepime, ceftazidime**, or **piperacillin-tazobactam.** For **MDR** infections, **ceftolozane tazobactam** or **ceftazidime-avibactam** are preferred, **with aminoglycosides** (e.g., tobramycin) or **fluoroquinolones** (e.g., ciprofloxacin) used **in combination**.

Other Nonfermenters

Acinetobacter baumannii – a causative agent of serious hospital-acquired infections (e.g., ventilator-associated pneumonia or urinary tract infections), often multidrug-resistant

Drugs of choice: For carbapenem-susceptible *Acinetobacter baumannii*, **carbapenems** (meropenem, imipenem) are generally considered the drug of choice. For multidrug resistant **(MDR) or carbapenem-resistant strains** (CRAB**), colistin** (polymyxin E) or minocycline typically show the highest susceptibility, with sulbactam-durlobactam or **tigecycline** used as alternatives.

Other Nonfermenters

- ***Burkholderia cepacia***

Chronic lung infections: most common in patients with cystic fibrosis; complications include sepsis (Cepacia syndrome)

Hospital-acquired infections: urinary or systemic infections in patients with indwelling catheters
Prevalence of multidrug-resistant strains (resistant to most antibiotics)

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Drugs of choice: The first-line drug for the treatment of *Burkholderia cepacia* complex (Bcc) infections is **cotrimoxazole** (trimethoprim/sulfamethoxazole). Given the **high multidrug resistance** of these bacteria, combination therapy is often used, with other effective antibiotics including **ceftazidime, meropenem, minocycline, and levofloxacin**.

Other Nonfermenters

Stenotrophomonas maltophilia

Hospital-acquired pathogen: causative agent of various infections (primarily of the respiratory and urinary tracts) in immunocompromised patients, particularly those who have been treated with broad-spectrum antibiotics

Drugs of choice: Trimethoprim-sulfamethoxazole (TMP-SMX) is generally recognized as the drug of choice for *Stenotrophomonas maltophilia* infections. Due to high rates of intrinsic resistance to many antibiotics, this pathogen has limited treatment options. When TMP-SMX cannot be used due to allergies, resistance, or toxicity, preferred alternatives include **minocycline, levofloxacin, or cefiderocol**.

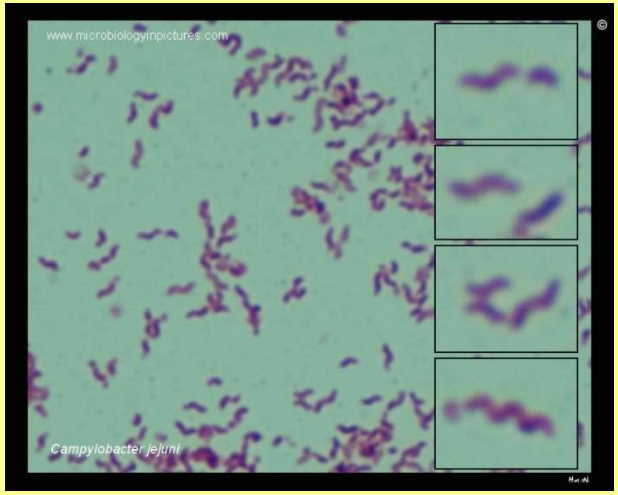
Campylobacteriosis

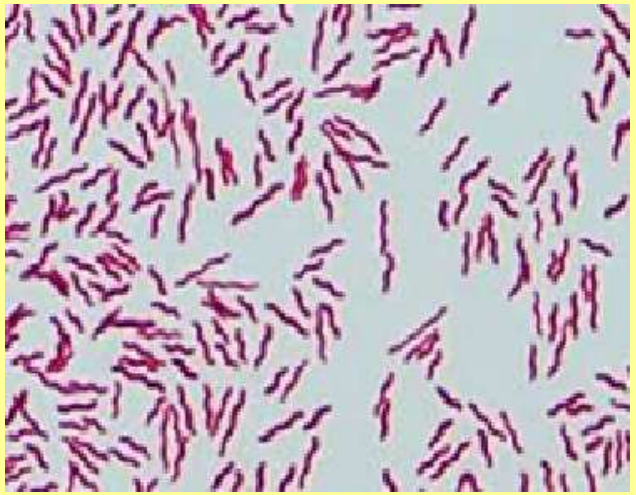
Etiology, epidemiology

- most frequent worldwide diarrheal infection
- hemorrrhagicenterocolitis- immunocompetent patients
- extraintestinal–immunocompromised
- Gramnegative rods, microaerophilic, special culture media, higher temperature(42C), ***Campylobacter jejuni***, ***C. coli*** and others
- **zoonosis**–commensal in the intestine of wild and domestic animals, source –ingestion of contaminated food (e.g. chicken, pork)

Campylobacteriosis

C. jejuni is a **motile, microaerophilic, zoonotic, thermophilic bacterium** that is considered worldwide to be the **leading cause** of foodborne **bacterial gastroenteritis**. It is a member of the genus Campylobacter, characterized by polar flagella and a **spiral morphology**, which it uses to **move through viscous fluids,** including the mucus layer of the gastrointestinal tract.





Main sites of infection

small intestine (especially the jejunum and ileum) and large intestine (colon)

The bacteria attach to the intestinal epithelium, penetrate the mucosa, and cause inflammation of the intestinal wall (enterocolitis).

Mechanism

After ingestion (most commonly through contaminated chicken or water), the bacteria colonize the intestine

produce toxins → cell damage

resulting in: diarrhea (often bloody) , abdominal pain (typically cramps)

fever

In rare cases, the infection can spread beyond the intestine:

the bloodstream (bacteremia)

the joints (reactive arthritis)

the nervous system (e.g., Guillain-Barré syndrome – an autoimmune complication)

Microbiological diagnosis

Diagnosis: stool culture, specialized media and atmosphere, or **PCR gastrointestinal panel**; **extraintestinal – blood culture and other specimens**.
Treatment: mild or moderate cases – rehydration, diet, adsorbent, probiotics; severe diarrhea and systemic infection **– macrolides,** fluoroquinolones (systemic infection – weeks, depending on susceptibility).

Charcoal-based selective media (CSM)

Sample – swab, stool, and transport media (e.g., selective media based on activated charcoal (CSM)) for the isolation of Campylobacter spp. from fecal samples
– small whitish or grayish colonies; microaerophilic atmosphere at 42 °C, 48 hours; microscopy
– curved Gram-negative rods; phenotypic identification – oxidase-positive; mass spectrometry (MALDI)

Helicobacter pylori

* Helicobacter pylori is a **spiral (helical), microaerophilic, Gram-negative bacterium** that **colonizes the gastric mucosa.**

* The **prevalence of *H. pylori*** infection in our population is estimated at **30–55%**. Prevalence increases with age. *H. pylori* infection is present in 90–95% of patients with **duodenal ulcers** and in 60–80% of patients with **gastric ulcers**.

* ***Helicobacter pylori* is classified as a Group 1 carcinogen by the WHO**. However, there is no evidence that its eradication reduces the risk of stomach cancer.

Etiology and epidemiology

* Helicobacter pylori is spiral-shaped (helical),
* motile, resembling a corkscrew or a flying bird
* lives in the mucus of the stomach lining
* high urease production
* strictly a human pathogen; not detected in animals or soil

it is estimated that about 50% of the population is infected; prevalence is lower in developed countries

* transmission − fecal-oral or oral-oral; direct and indirect person-to-person transmission is possible (e.g., contaminated food, utensils)

most infections occur during childhood—the most common route is direct transmission from an infected mother; however, new infections can also occur in adulthood, particularly in people with weakened immune systems

Microbiological diagnosis

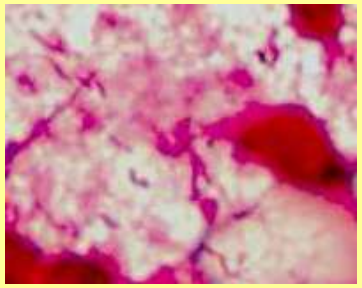
Polymerase chain reaction (PCR) test in stool, **stool antigen test.**

Serological testing for antibodies against *Helicobacter pylori* using the ELISA method (**IgG, IgA**).

Biopsy samples obtained endoscopically can be tested using **Gram staining** (see also figure below), a **rapid urease test**, histologically, or by culture (Skirow medium).

Breath test with 13C-labeled urea.

Serological detection of **preneoplastic markers** may be useful in the prevention of gastric cancer.



Gram staining of bioptate. Gram-negative **spiral-shaped bacteria (or bird-shaped bacteria)**

Urease test
Positive on the right (red), negative on the left (yellow)

Treatment

* The gold standard for eradication is a **three-drug regimen** administered for 7 days:
omeprazole + amoxicillin + clarithromycin (or any other macrolide)
* If the patient is allergic to penicillin: omeprazole + metronidazole + clarithromycin
* In recent years, there has been a decline in the success rate of eradication following standard triple therapy due to increased antibiotic resistance, particularly to clarithromycin. In cases of growing resistance to clarithromycin, bismuth quadraterium (bismuth) is recommended. Probiotics may reduce the incidence of adverse effects associated with standard eradication therapy. The most successful eradication therapy is currently the subject of numerous studies.