Vibrio, *Aeromonas*, *Campylobacter*, and *Helicobacter*

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- ***Vibrio, Aeromonas, Campylobacter,* and *Helicobacter*** are Gram-negative rods that are all widely distributed in nature.
- The vibrios are found in marine and surface waters. Aeromonads are are found in fresh and brackish waters, the campylobacters are found in animals (domesticated animals). Helicobacters are found in the gastrointestinal and hepatobiliary tracts of humans and various other mammals (eg, dogs, cats, cattle, and dolphins),chickens and wild birds.
- ***Vibrio cholerae*** produces an **enterotoxin** that causes cholera, a profuse watery diarrhea that can rapidly lead to dehydration and death.
- ***Campylobacter jejuni*** is a common cause of enteritis in humans. ***Helicobacter pylori*** is associated with gastritis and duodenal ulcer disease.

THE VIBRIOS

- Comma-shaped, facultatively anaerobic rods; catalase and oxidase positive, and most species are motile by means of polar flagella.
- Grow within a broad temperature range (14–40°C), high pH range (8.5-9.5), require sodium chloride (NaCl) for growth -halophilic ("salt loving").
- *V. cholerae* serogroups O1 and O139 cause cholera in humans, *V. parahaemolyticus* and *V. vulnificus* can cause skin and soft tissue infections, sepsis, or gastroenteritis.
- Cholera is associated with poor sanitation, direct contact with or consumption of contaminated water and/or food.

TABLE 17-1 The Medically Important Vibrios

Organism	Human Disease
V. cholerae serogroups O1 and O139	Epidemic and pandemic cholera
V. cholerae serogroups non-O1/non-O139	Cholera-like diarrhea; mild diarrhea; rarely, extraintestinal infection
V. parahaemolyticus	Gastroenteritis, wound infections, septicemia
V. vulnificus	Gastroenteritis, wound infections, septicemia

VIBRIO CHOLERAE

Morphology and identification

- *V. cholerae* is a comma-shaped, curved motile rod, grow well at 37°C on routine media as well as selective media such as **thiosulfate-citrate-bile salts-sucrose (TCBS) agar.**
- ***V. cholerae*** produces yellow colonies (sucrose fermented) on TCBS agar, while *V. parahaemolyticus and V. vulnificus* (non sucrose fermenetrs) produce green colonies.
- Stool specimens should be collected early in the course of the diarrheal illness.
- In endemic areas, stool cultures on TCBS and enrichment broth culture are appropriate.

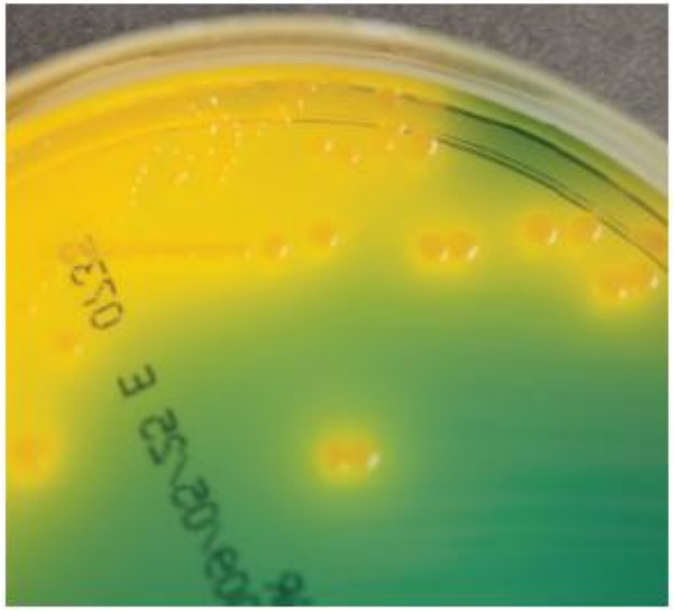


FIGURE 17-2 Colonies of *V. cholerae* growing on thiosulfate, citrate, bile salts, and sucrose agar. The glistening yellow colonies are 2–3 mm in diameter and are surrounded by a diffuse yellowing of the indicator in the agar up to 1 cm in diameter. The plate is 10 cm in diameter.

- ***V. cholerae*** regularly ferments sucrose and mannose but not arabinose, is oxidase positive, and can grow on most agar media without additional salt.
- ***V. cholerae*** has O lipopolysaccharides antigen (200 serogroups) serogroup O1 and O139 cause epidemic and pandemic cholera, non-O1/non-O139 strains can cause cholera-like diarrheal disease.
- The V. cholerae serogroup O1 serotypes are Ogawa, Inaba, and Hikojima.
- Two biotypes of *epidemic V. cholerae O 1* have been defined, classic and El Tor, the latter produce a hemolysin and is resistant to polymyxin B.
- O139, non-O1 *V. cholerae* strains, and *V. vulnificus* produce acidic polysaccharide capsules; but not *V. cholerae* O 1.

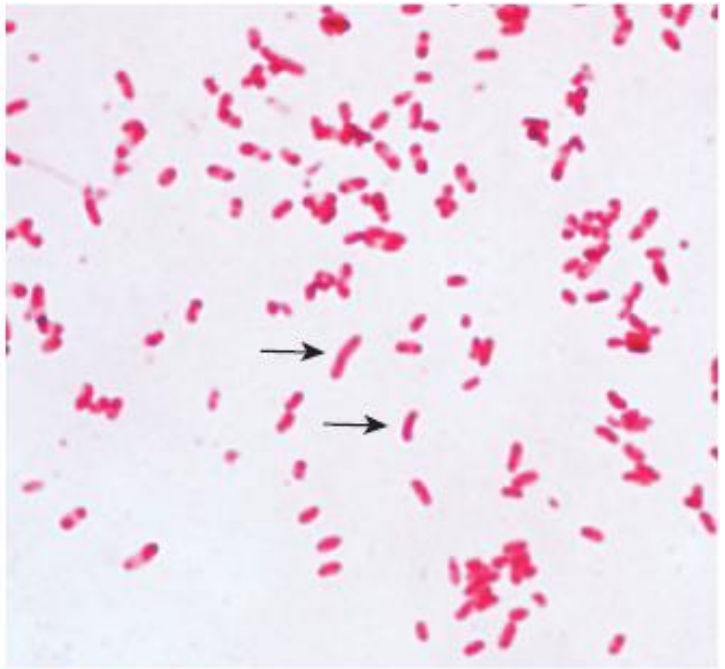


FIGURE 17-1 Gram-stain of *V. cholerae*. Often they are comma shaped or slightly curved (arrows) and 1 × 2 to 4 µm. Original magnification ×1000.

Vibrio cholerae Enterotoxin

- Is a heat-labile enterotoxin consist of A and B subunits, subunit A1 increases intracellular cAMP: prolonged hypersecretion of water and electrolytes.
- *V. cholerae* organisms attach to the microvilli of epithelial cells, multiply and liberate cholera toxin and perhaps mucinases and endotoxin.
- Electrolyte-rich diarrhea occurs with as much as 20–30 L/day, resulting in dehydration, shock, acidosis, and death.
- **Pathogenesis and Pathology**
- *V. cholerae* is pathogenic only for humans and grow in association with copepods and zooplankton.
- Contaminated food and water are more likely source of infections.
- Persons with achlorhydria or hypochlorhydria (or on PPI) require lower infectious dose (10^3 vs 10^10).

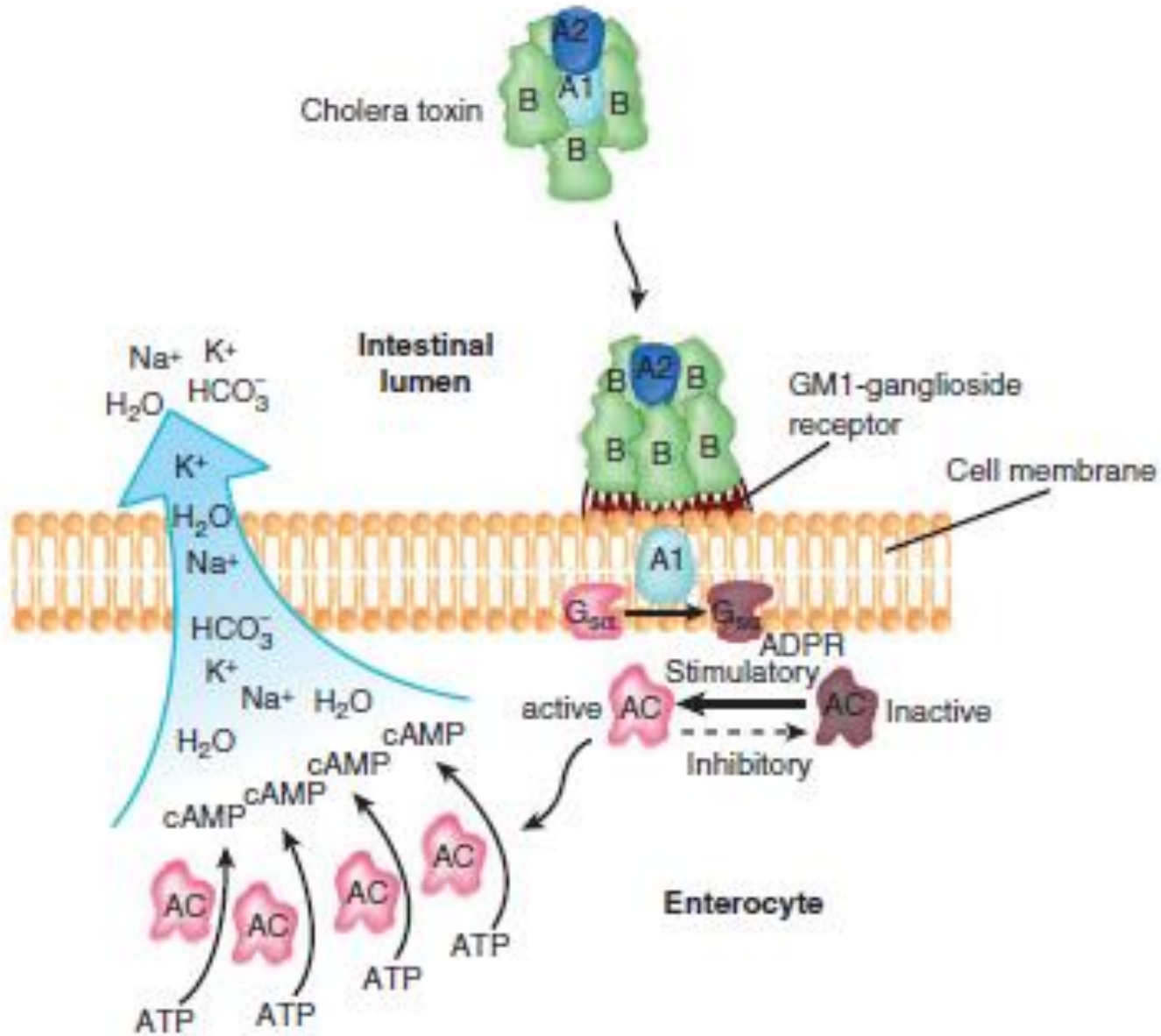


FIGURE 32–2. The action of cholera toxin. The complete toxin is shown binding to the GM1-ganglioside receptor on the cell membrane via the binding (B) subunits. The active portion (A1) of the A subunit catalyzes the ADP-ribosylation (ADPR) of the G_s (stimulatory) regulatory protein, "locking" it in the active state. Because the G_s protein acts to return adenylate cyclase from its inactive to active form, the net effect is persistent activation of adenylate cyclase. The increased adenylate cyclase (AC) activity results in accumulation of cyclic adenosine 3',5'-monophosphate (cAMP) along the cell membrane. The cAMP causes the active secretion of sodium (Na^+), chloride (Cl^-), potassium (K^+), bicarbonate (HCO_3^-), and water out of the cell into the intestinal lumen.

Clinical findings

- Disease severity ranges from asymptomatic intestinal colonization to severe diarrhea.
- The incubation period is 12 hours to 3 days for persons who develop symptoms, depending on the size of the inoculum ingested.
- A sudden onset of nausea and vomiting, followed by profuse diarrhea with abdominal cramps; “**rice water stool”.**
- In sever cholera 1L/hour is lost; dehydration can lead to shock and collapse; mortality 25-50% if untreated, reduced to 1% with early fluid replacement.
- The *V. cholerae* O1 El Tor biotype tends to cause milder disease than the classic biotype.
- An attack of cholera is followed by immunity to reinfection; duration and degree of immunity are not known.
- Vibriocidal antibodies in serum (titer ≥1:20) have been associated with protection against colonization and disease and antitoxin antibodies are not protective.

Diagnostic Laboratory Tests

- **Specimens:** stool specimens collected early in the course of the diarrheal illness, inoculated within 2–4 hours of collection, mixed in a Cary-Blair if delayed.
- **On Dark-field or phase-contrast microscopy**; “shooting star” motility after mixing with a polyvalent O 1 antisera is suggestive of *V. cholerae* O1.
- **Culture**: grow well on most agar media, growth is rapid in alkaline peptone broth or water, containing 1% NaCl with a pH of 8.5, or on TCBS agar.
- *V. cholerae* organisms are further identified by **slide agglutination** tests using anti-O group 1 or group 139 antisera and biochemical reaction patterns.

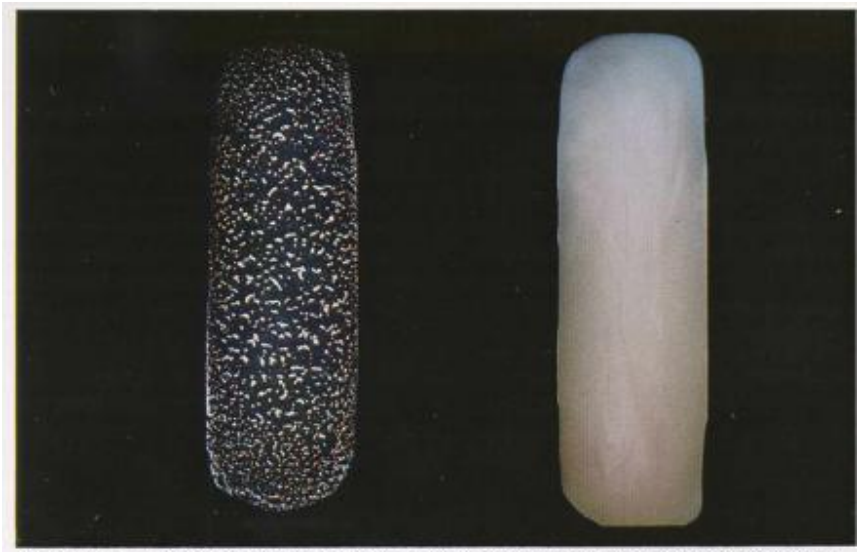


Figure VI-1. Antisera to the O1 serogroup of *V. cholerae* will agglutinate homologous organisms (left). A normal serum or saline control (right) does not show agglutination.

https://www.cdc.gov/cholera/media/pdfs/2024/07/6-Laboratory-Identification-of-Vibrio-cholerae-Laboratory-methods-for-the-diagnosis-of-Vibrio-cholerae_ENG.pdf

Treatment

- Water and electrolyte replacement to correct the severe dehydration and salt depletion is the most important.
- Appropriate antimicrobial therapy can also reduce the duration and amount of shedding of Vibrio organisms in the stool.
- **Tetracycline, trimethoprim–sulfamethoxazole, fluoroquinolones, and doxycycline** are effective; **erythromycin and/or azithromycin** are an appropriate choice of antimicrobial therapy in children and in pregnant women.

Epidemiology, prevention, and control

- Seven pandemics since 1817 have been recorded caused by classic O 1 biotype, except the seventh is type O 1 El Tor.
- Cholera is spread by contact involving individuals with mild or early illness and by water, food, and flies; 1–5% of exposed susceptible persons develop disease.
- Infected people shed only during the first few days of the illness; no long-term carriage in humans; seldom exceeds 3–4 weeks.
- Education and improved sanitation, isolation of patients and disinfection are important preventive measures.
- Antimicrobial treatment reduce clinical symptoms and transmission; chemoprophylaxis to household contacts limit spread of infection.
- Cholera vaccines are available and are advised when traveling to endemic area.

Non-O1 and Non-O139 *V. cholerae*

- **Cholera-like diarrhea and extraintestinal disease**
- V. cholerae strains outside O1 and O139 are generally not associated with classic epidemic cholera.
- These strains may cause mild diarrhea, cholera-like diarrhea, wound infection, or septicemia.
- Disease is usually associated with contaminated water, seafood, or environmental exposure.
- Some strains may produce toxins or other virulence factors, but they usually lack the classic epidemic combination of O1/O139 serogroup and cholera toxin.
- These infections are important in patients with comorbidities or after exposure to contaminated aquatic environments.

Vibrio parahaemolyticus

- ***V. parahaemolyticus*** is a halophilic Vibrio species associated with marine environments.
- Infection commonly follows ingestion of raw or undercooked seafood, especially shellfish.
- The illness is usually acute gastroenteritis with watery diarrhea, abdominal cramps, nausea, vomiting, and sometimes fever.
- Some cases may have dysentery-like features.
- Diagnosis is by stool culture using appropriate selective methods, and the illness is usually self-limited.

Vibrio vulnificus

- ***V. vulnificus*** is an important halophilic Vibrio species associated with seawater and shellfish, especially oysters.
- Infection may occur after ingestion of contaminated raw oysters or after wound exposure to seawater.
- Gastrointestinal symptoms may be followed by rapidly progressive septicemia.
- Wound infection may progress to cellulitis, bullae, necrotizing fasciitis, and septic shock.
- Severe disease is more likely in patients with liver disease, alcoholism, hemochromatosis, immunosuppression, or chronic illness.

Aeromonas

- **Aeromonas** are ubiquitous inhabitants of **fresh and brackish water**.
- They are **Gram-negative, facultative anaerobic rods** that **ferment carbohydrates** and may resemble **Enterobacteriaceae**, but Aeromonas are **oxidase-positive**.
- They grow on **blood agar** and **enteric differential/selective agars**; on blood agar they are usually **β-hemolytic**.
- Main human-associated species: ***A. hydrophila, A. caviae, and A. veronii biovar sobria***.
- ***A. caviae*** is most frequently associated with **gastroenteritis**, ranging from **watery diarrhea** to **dysentery-like illness**, with **abdominal pain, fever, nausea, and vomiting**.
- Infection follows ingestion of **contaminated food or water**, especially during **warm summer months**.
- Gastroenteritis is usually **self-limited**; severe diarrhea, dehydration, or infection in children may require **hospitalization**.

Extraintestinal Disease, Diagnosis, and Treatment

- ***A. hydrophila*** causes **wound infections**, usually after traumatic injury exposed to **fresh or brackish water**.
- Most commonly, **cellulitis develops within 48 hours**, but **fasciitis, myonecrosis, osteomyelitis**, and systemic symptoms may occur.
- Aeromonas soft tissue infection may rarely follow use of **medicinal leeches**.
- **Aeromonas sepsis**, mostly due to ***A. hydrophila***, occurs mainly in patients with hematologic malignancies and/or liver disease.
- Diagnosis is suggested by **Gram-negative rods**, **oxidase positivity**, growth on blood agar/enteric agars, and usually **β-hemolysis.**
- Gastroenteritis usually needs **no antimicrobial therapy**, but severe cases may improve faster with treatment.
- Clinically significant aeromonads are resistant to **penicillin and ampicillin**, often resistant to **cefazolin and ticarcillin**.
- Active options include **third-generation cephalosporins, aztreonam, carbapenems, aminoglycosides**, and especially **fluoroquinolones**; empiric therapy may use **two or more agents** until susceptibility results are available.

Campylobacter

- **Campylobacters cause both diarrheal and systemic diseases** and are among the most widespread causes of infection worldwide.
- ***C. jejuni*** is the prototype organism and is a very common cause of diarrhea in humans; other campylobacters include ***C. fetus, C. coli, and C. upsaliensis***.
- ***C. jejuni* and other campylobacters are curved, comma-, or S-shaped, Gram-negative, non-spore-forming rods** and may have **"sea gull wing" shapes**.
- Campylobacters are **motile**, with a **single polar flagellum at one or both ends**, although some organisms may lack flagella.
- Campylobacter species multiply more slowly than other Gram-negative enteric bacteria, so **selective media containing antibiotics** are needed for stool isolation.
- Examples of selective media include **Campy-Blood agar** and **Skirrow's medium**.

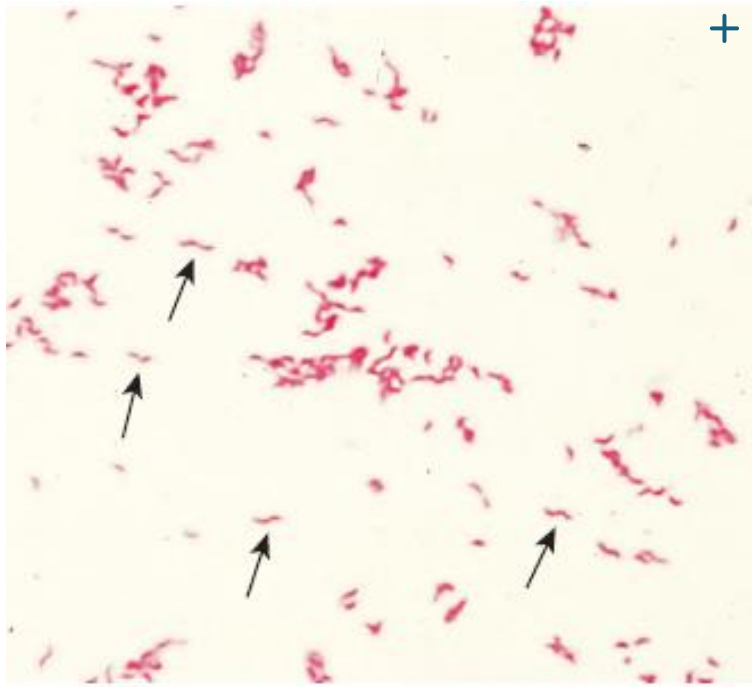
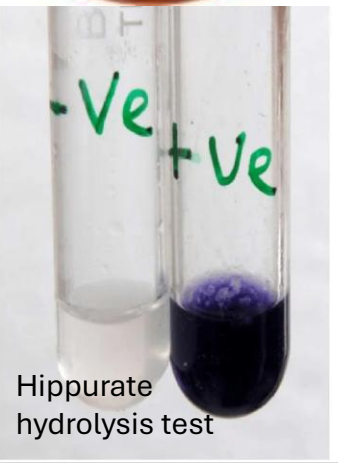


FIGURE 17-3 Gram-stain of *C. jejuni* showing "comma"- or "gull wing"-shaped Gram-negative bacilli (*arrows*). Campylobacters stain faintly and can be difficult to visualize. Original magnification × 1000.

Culture, Biochemical Identification, and Diagnosis

- *Campylobacter* species require a **microaerobic atmosphere** containing reduced **O_2 of 5–7%** and increased **10% CO_2** for optimal growth.
- Most campylobacters grow best at **42°C**, although growth can be seen between **36°C and 42°C**; primary plates *for* ***C. jejuni*** isolation should be incubated at **42°C**.
- **Skirrow's medium** contains **vancomycin, polymyxin B, and trimethoprim** to inhibit growth of other bacteria.
- Colonies are generally **colorless or gray**, may be **watery and spreading** or **round and convex**, and **hemolysis on blood-containing agar media is not observed**.
- ***C. jejuni*** *and* ***C. coli*** are positive for both **oxidase and catalase**; campylobacters **do not oxidize or ferment carbohydrates**.
- **Gram-stained smears** may show typical **"gull wing"–shaped rods**, and dark-field or phase-contrast microscopy may show **darting motility**.
- **Culture on selective media is the definitive test** to diagnose ***C. jejuni*** **enteritis**.
- A positive **hippurate hydrolysis test** distinguishes ***C. jejuni*** from other Campylobacter species


Skirrow's medium



Hippurate hydrolysis test

Disease, treatment, and epidemiology

- Infection is acquired by the **oral route** from contaminated **food, drink, poultry**, or contact with infected animals.
- Organisms multiply in the **small intestine**, invade the epithelium, and cause inflammation with **red and white blood cells in stools**.
- ***C. jejuni*** *and* ***C. coli*** most commonly cause **gastroenteritis**; ***C. fetus*** causes **bacteremia and extraintestinal infections** in pregnant women and immunocompromised patients.
- ***C. jejuni*** **gastroenteritis** presents with **crampy abdominal pain**, **profuse diarrhea that may be bloody**, **headache, malaise, and fever**.
- Illness is usually **self-limited for 5–8 days**; recurrence occurs in about **5–10%** of patients.
- Most cases resolve without antimicrobial therapy, but **macrolides**, especially **erythromycin**, may be used and shorten fecal shedding.
- Postdiarrheal complications include **Guillain-Barré syndrome**, **reactive arthritis**, and **Reiter's syndrome**.
- Reservoirs include **poultry, cattle, sheep, pigs, birds**, and **pet dogs** depending on the species.

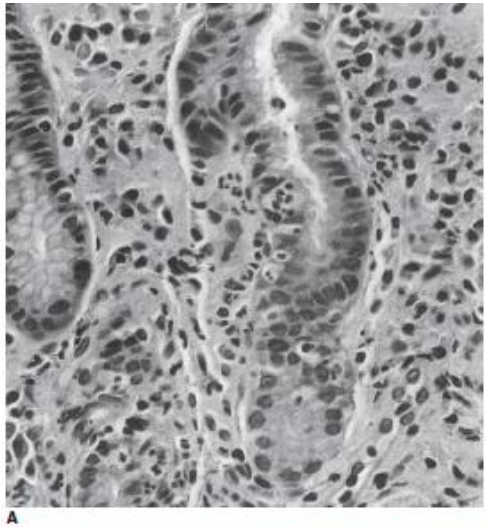
Helicobacter pylori

- ***H. pylori*** is a **spiral-shaped, Gram-negative rod**.
- It is **catalase-positive, oxidase-positive, and urease-positive**.
- It is **motile** and has **single and/or multiple monopolar, typically sheathed flagella**.
- Humans are the primary **host-reservoir** for ***H. pylori***.
- It is associated with **antral gastritis, duodenal peptic ulcer disease, gastric ulcers, gastric adenocarcinoma, and gastric MALT lymphoma**.

Identification

- ***H. pylori*** can be isolated from **gastric biopsy specimens**.
- Culture requires **37°C**, a **microaerophilic and humid atmosphere**, and usually **3–6 days** of incubation.
- If culture is negative, incubation up to **14 days** may be necessary.
- Primary isolation uses enriched media with **blood/blood products**, such as **chocolate agar**, or antibiotic-containing media such as **Skirrow's medium**.
- Colonies on blood agar range from **gray to translucent.**
- **Urease activity** breaks down urea into **ammonia and CO_2**, helping neutralize gastric acid.

https://asm.org/getattachment/ac4fe214-106d-407c-b6c6-e3bb49ac6ffb/urease-test-protocol-3223.pdf



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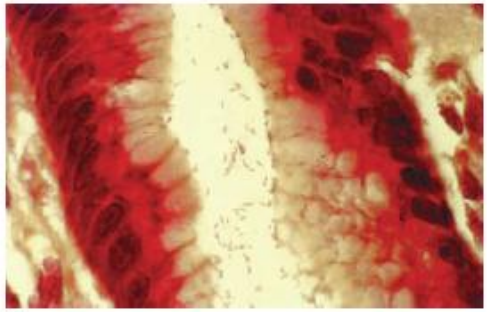


B

FIGURE 32–3. ***Helicobacter*** **gastritis.** **A.** Gastric mucosa shows infiltration of neutrophils and destruction of epithelial cells. **B.** High magnification shows curved bacilli and vacuolization of some cells. (Reproduced with permission from Connor DH, Chandler FW, Schwartz DQ, et al: *Pathology of Infectious Diseases.* Stamford CT: Appleton & Lange, 1997.)

Pathogenesis and virulence factors

- ***H. pylori*** colonizes **gastric-type epithelial cells** and is found deep in the mucous layer near the epithelial surface.
- **Flagella-mediated motility** allows movement through gastric mucus toward the epithelium.
- Tissue damage is related to release of **mucinase, phospholipase, neutrophil-activating protein A, heat shock protein 60cytotoxin-associated gene A protein (CagA), and vacuolating cytotoxin A (VacA).**
- **CagA** induces **IL-8 production**, leading to neutrophil attraction.
- **VacA** affects cell death and proliferation and activates **IL-8 mediated acute inflammation**.
- Histology shows **acute and chronic inflammation** with **polymorphonuclear and mononuclear cell infiltrates**.
- **Antimicrobial therapy results in clearing of H. pylori and improvement of gastritis and duodenal ulcer disease**.

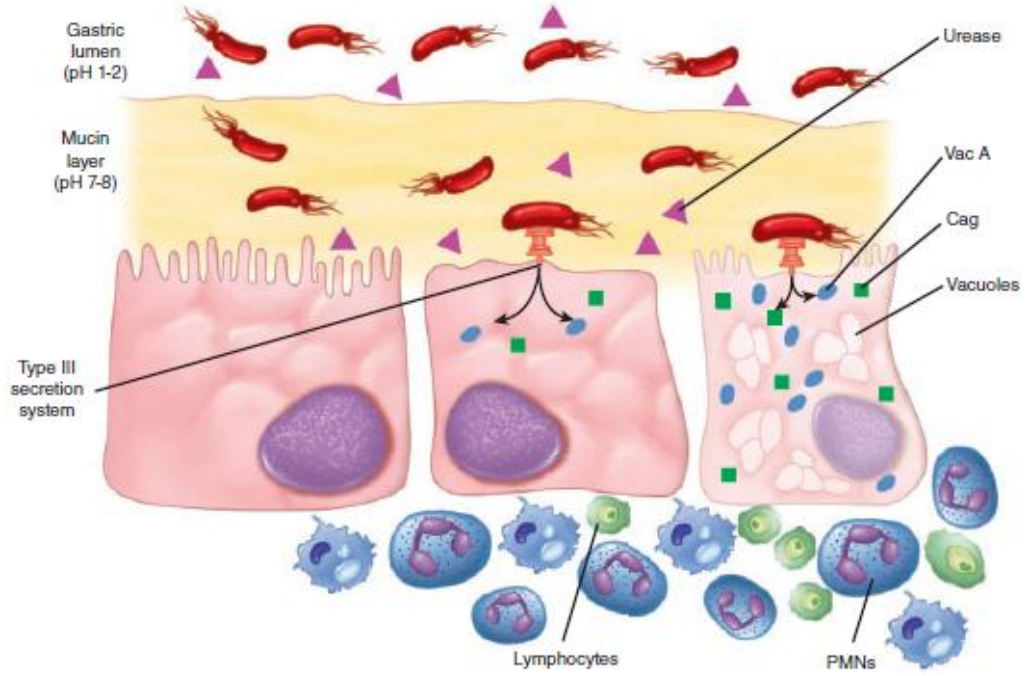


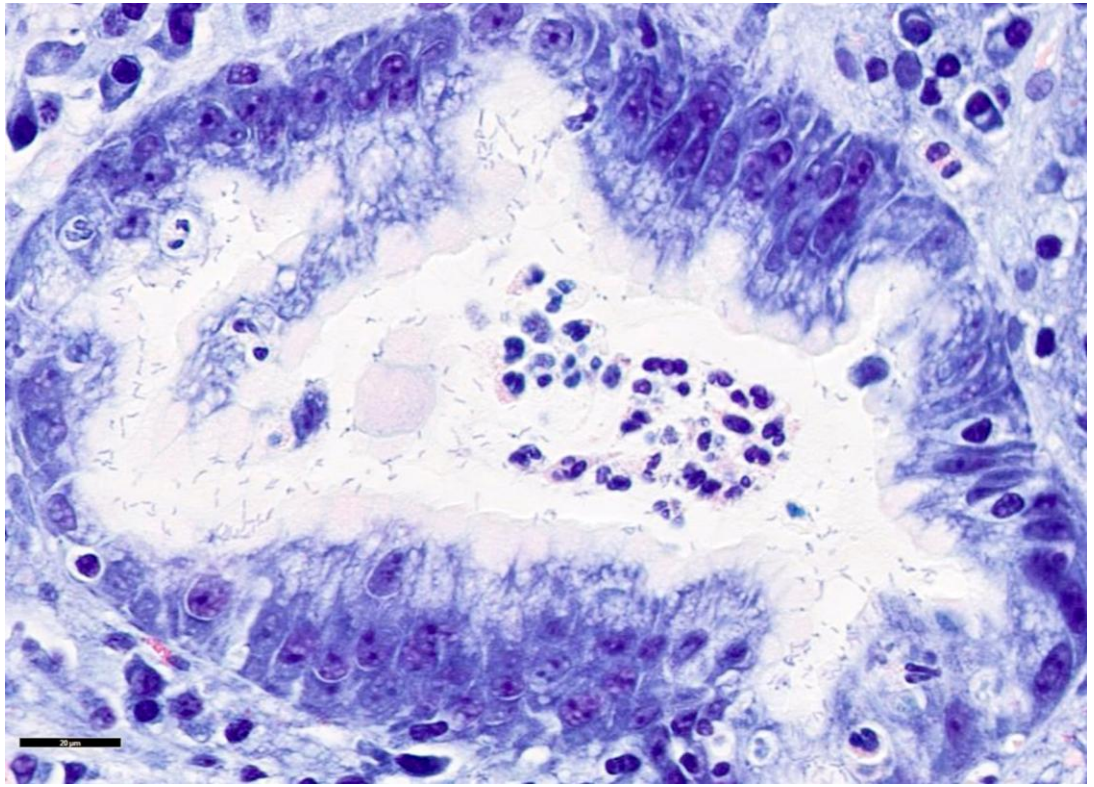
FIGURE 32–4. ***Helicobacter* gastritis, cellular view.** From the low pH gastric lumen *H pylori* swims beneath the mucus layer, produces urease, and persists in a more physiologic environment. A type III secretion system injects the vacuolating cytotoxin (VacA), and Cag, into the gastric

Clinical findings

- Acute infection causes an **upper gastrointestinal illness** with **nausea and pain**; **vomiting and fever** may also occur.
- Symptoms last **less than 1 week to 2 weeks**.
- After acute infection, ***H. pylori* colonization** may persist for **years, decades, or lifelong**.
- About **90% of duodenal ulcer patients** and **50–80% of benign gastric ulcer patients** have ***H. pylori* infection**.
- Long-lasting colonization is associated with **chronic gastritis, intestinal metaplasia, atrophic gastritis**, and **gastric adenocarcinoma**.

Diagnosis

- **Gastric biopsy specimens** are used for **histology** or **culture**; **blood** is used for serum antibodies, and **stool** for ***H. pylori* antigen detection**.
- Histology is generally **more sensitive than culture**.
- **Hematoxylin and eosin** stains show **acute/chronic gastritis**.
- **Giemsa, silver stains, or immunohistochemical stains** show the **curved or spiral-shaped organisms**.
- Culture is used mainly when patients are **not responding to treatment** and **antimicrobial susceptibility testing** is needed



H. pylori gastritis: adundant *Helicobacter pylori*, neutrophilic exudate (Giemsa stain, high power).
Contributed by Andrey Bychkov, M.D., Ph.D.
https://www.pathologyoutlines.com/topic/stainsgiemsa.html

Serology and other tests

- **IgG antibodies** confirm exposure, but titers do not correlate with disease severity.
- **IgM antibodies** disappear rapidly and are of **little diagnostic value**.
- **IgA and IgG persist** even after eradication therefore antibody testing has limited value for active infection or cure.
- Histology of gastric biopsy has **95–100% sensitivity and specificity**.
- Rapid urease test detects urease activity within **1–2 hours** by **pH color change**.
- **Urea breath test** detects labeled **CO_2** after ingestion of **^{13}C- or ^{14}C-labeled urea**; sensitivity and specificity are **94–98%**.
- Stool antigen detection by **ELISA** diagnoses active infection and is useful as a **test of cure**.

Immunity and Treatment

- Infection induces **IgM**, followed by persistent **IgG and IgA** in chronic infection.
- Recommended **triple therapy for 7–14 days**:
  PPI twice daily + amoxicillin 1 g twice daily + clarithromycin 500 mg twice daily.
- Alternative **quadruple therapy for 10–14 days**:
  PPI + metronidazole 250 mg four times daily + tetracycline 500 mg four times daily + bismuth.
- Fourteen-day regimens eradicate ***H. pylori*** in **70–95%** of patients.
- **PPIs directly inhibit *H. pylori*** and act as potent **urease inhibitors**.
- Recurrent or persistent infection may require tailored therapy for **antimicrobial-resistant strains**.

Epidemiology and control

- Humans are likely the **primary, if not sole reservoir** for ***H. pylori***.
- Transmission is mainly **oral–oral and/or fecal–oral**.
- Infection is usually acquired in **early childhood** and may persist lifelong without appropriate antibiotics.
- Prevalence is higher in developing countries; in **Southeast Asia**, adult prevalence may reach **up to 90%**.
- In the United States, prevalence is **fewer than 20%** in persons younger than **30 years**, increasing to **40–60%** in those aged **60 years and older**.
- Person-to-person spread is supported by **intrafamilial clustering**; rare transmission occurs via **improperly cleaned endoscopes**.

- Riedel, S., et al. (Eds.). (2026). *Jawetz, Melnick, & Adelberg's Medical Microbiology* (29th ed.). McGraw Hill –chapter 17
- Ryan, K. J. (Ed.). (2022). Sherris & Ryan's Medical Microbiology (8th ed.). McGraw Hill- chapter 32