

Bacillus

Bacillus

■ Classification

- All are large Gram-positive bacilli
- Are aerobic
- Form endospores
- Most are found in dust and soil
- *Bacillus cereus* is a Gram-positive, facultatively anaerobic spore former whose cells are large rods (with flagella).
- It has been isolated from air, soil and water
- Morphology and Cultural Characteristics
(***Bacillus cereus***)

Bacillus cereus

- G+B with square cut ends
- Form endospores
- Non-motile
- Capsule made of glutamic acid (a polypeptide).
 - The capsule is not found in cultured bacteria unless the bacteria are grown on bicarbonate containing media and in the presence of increased CO² concentrations.

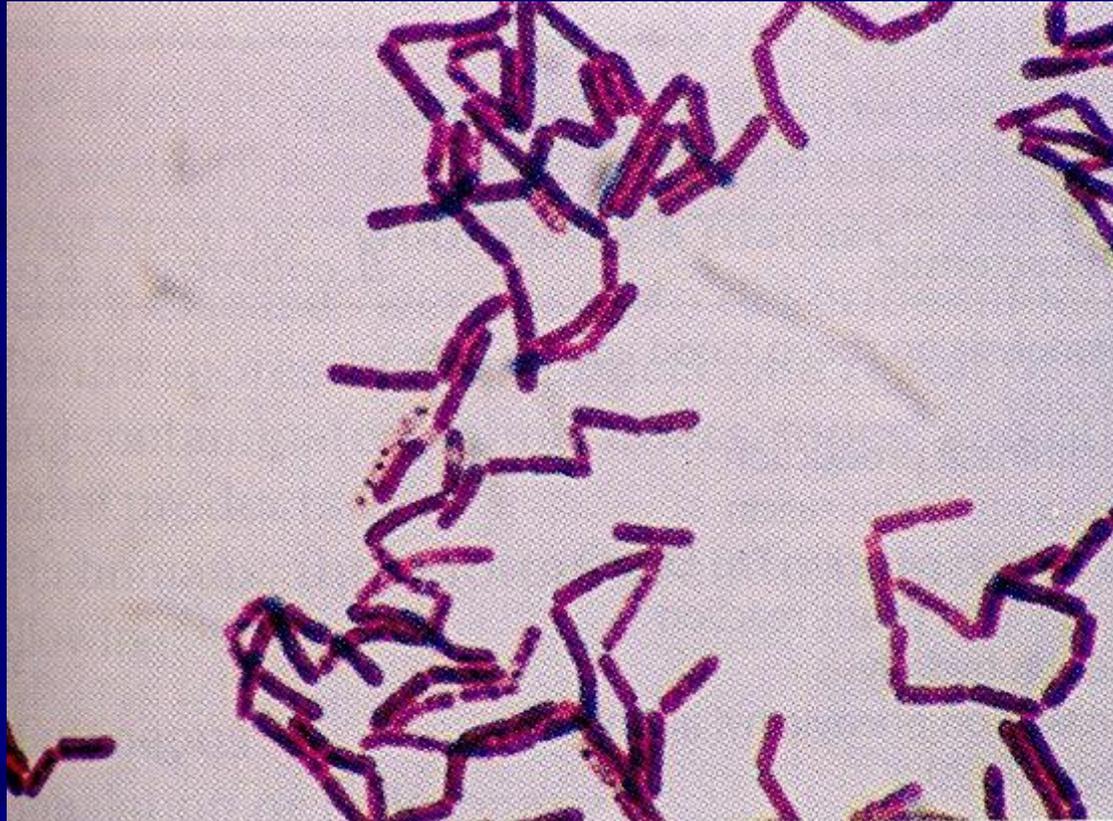
Spores of Bacillus cereus

- ❖ Ellipsoidal and widely distributed in nature.
- ❖ D at 95°C = 24 min
- ❖ Relatively resistant to irradiation
- ❖ Spore germination can occur between 5 and 50°C in cooked rice.
- ❖ Highly adhesive to the surfaces.

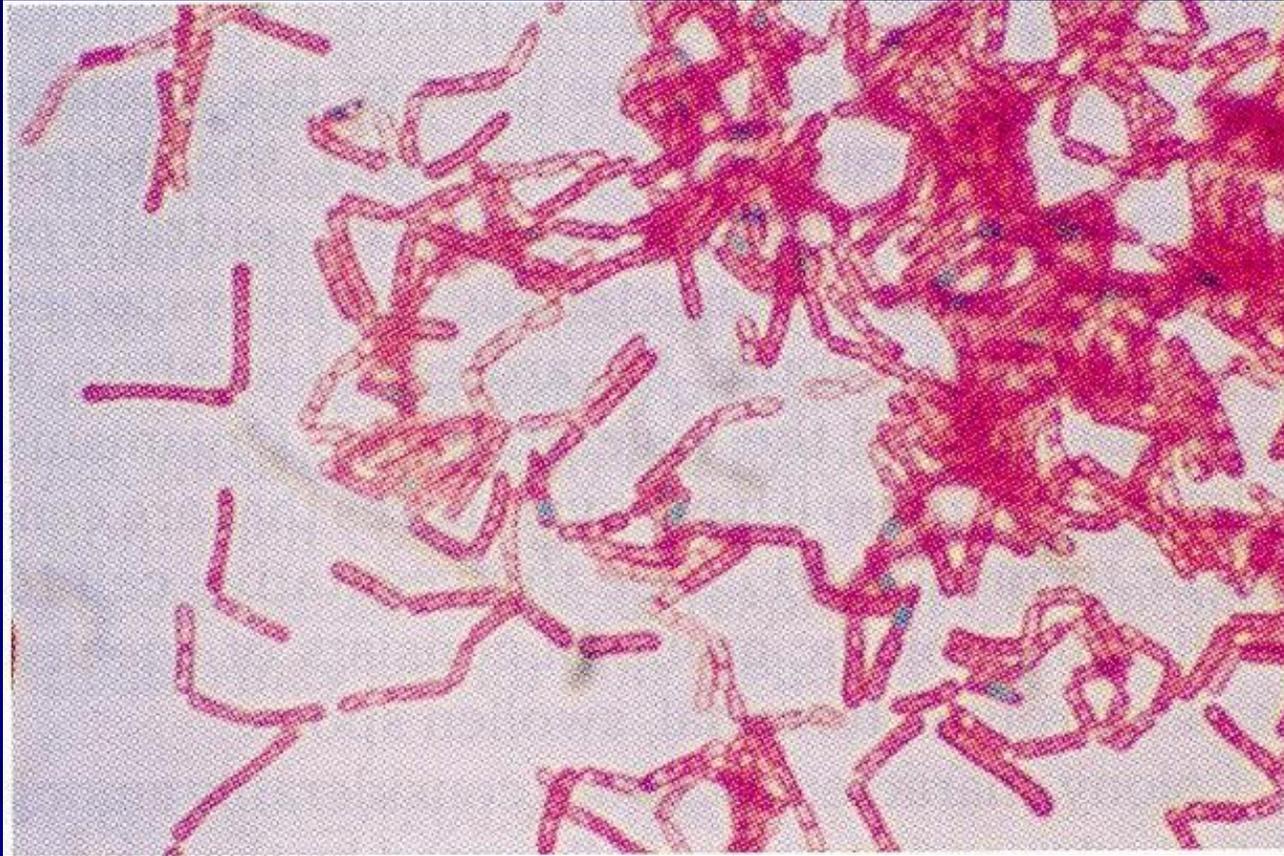
***Bacillus cereus*: Vegetative Growth**

- ❖ Between 5 and 50°C. Generation time = 9 to 75 hrs at 7°C. But in boiled rice at 30°C the generation time is 26 to 57 minutes.
- ❖ pH range 4.4-9.3

Gram stain of *Bacillus sp.*



Endospores of *Bacillus sp.*



Bacillus cereus

- Grow well on ordinary lab media producing large granular colonies with a coarse texture.



Bacillus cereus: Toxin

- ❖ A 40 kDa protein (plus contamination of small amounts of hemolysins L1 and L2) enterotoxin.
- ❖ May stimulate adenylate cyclase and thus affect fluid absorption such as Na^+ and Cl^- by the epithelial cells.
- ❖ Malabsorption of glucose and amino acids.
- ❖ Necrosis and mucosal damage.
- ❖ Destroyed at 55°C after 20 min.
- ❖ Emetic variety, called cereulide, is cyclic dodeca-peptide with a Mol wt = 1.2 kDa (resembling valinomycin)- stable for 90 min at 126°C .

Associated Foods

- ❖ A wide variety of foods including meats, milk, vegetables, and fish have been associated with the diarrheal type food poisoning. The vomiting-type outbreaks have generally been associated with rice products; however, other starchy foods such as potato, pasta and cheese products have also been implicated. Food mixtures such as sauces, puddings, soups, casseroles, pastries, and salads have frequently been incriminated in food poisoning outbreaks.

Bacillus cereus

- ❖ *B. cereus* food poisoning is the general description, although two recognized types of illness are caused by two distinct metabolites. The diarrheal type of illness is caused by a large molecular weight protein, while the vomiting (emetic) type of illness is believed to be caused by a low molecular weight, heat-stable peptide.

Nature of Disease

- ❖ The symptoms of *B. cereus* diarrheal type food poisoning mimic those of *Clostridium perfringens* food poisoning. The onset of watery diarrhea, abdominal cramps, and pain occurs 6-15 hours after consumption of contaminated food. Nausea may accompany diarrhea, but vomiting (emesis) rarely occurs. Symptoms persist for 24 hours in most instances. The emetic type of food poisoning is characterized by nausea and vomiting within 0.5 to 6 h after consumption of contaminated foods. Occasionally, abdominal cramps and/or diarrhea may also occur.
- ❖ Duration of symptoms is generally less than 24 h. The symptoms of this type of food poisoning parallel those caused by *Staphylococcus aureus* foodborne intoxication. Some strains of *B. subtilis* and *B. licheniformis* have been isolated from lamb and chicken incriminated in food poisoning episodes. These organisms demonstrate the production of a highly heat-stable toxin which may be similar to the vomiting type toxin produced by *B. cereus*.
- ❖ The presence of large numbers of *B. cereus* (greater than 10^6 organisms/g) in a food is indicative of active growth and proliferation of the organism and is consistent with a potential hazard to health.

Diagnosis of Human Illness

- ❖ Confirmation of *B. cereus* as the etiologic agent in a foodborne outbreak requires either:
 - ❖ (1) isolation of strains of the same serotype from the suspect food and feces or vomitus of the patient,
 - ❖ (2) isolation of large numbers of a *B. cereus* serotype known to cause foodborne illness from the suspect food or from the feces or vomitus of the patient, or
 - ❖ (3) isolation of *B. cereus* from suspect foods and determining their enterotoxigenicity by serological (diarrheal toxin) or biological (diarrheal and emetic) tests. The rapid onset time to symptoms in the emetic form of disease, coupled with some food evidence, is often sufficient to diagnose this type of food poisoning.

Course of Disease and Complications

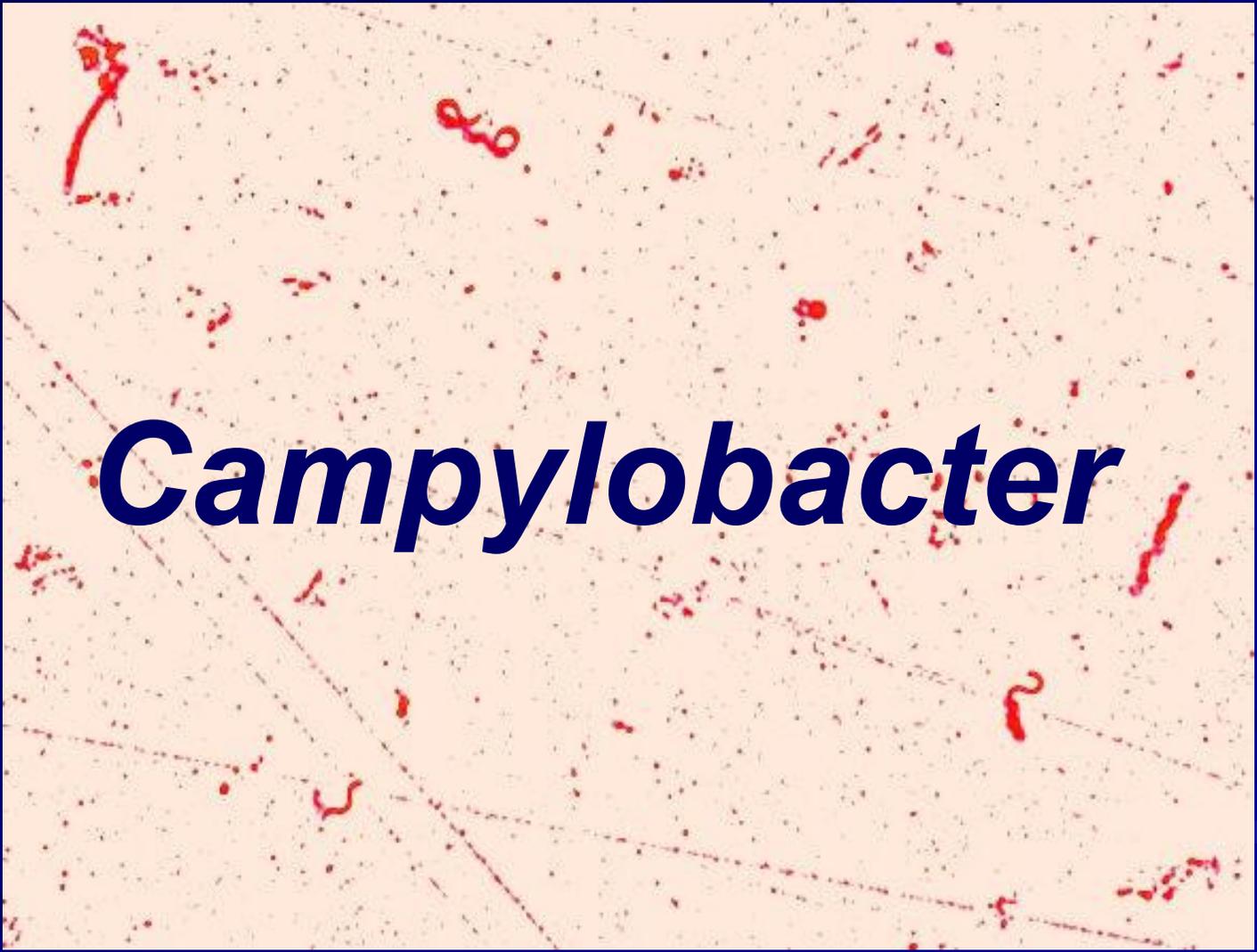
- ❖ Although no specific complications have been associated with the diarrheal and vomiting toxins produced by *B. cereus*, other clinical manifestations of *B. cereus* invasion or contamination have been observed. They include bovine mastitis, severe systemic and pyogenic infections, gangrene, septic meningitis, cellulitis, panophthalmitis, lung abscesses, infant death, and endocarditis.

Treatment and Prevention

- ❖ All people are believed to be susceptible to *B. cereus* food poisoning.
- ❖ Symptoms are mild and self-limiting.
- ❖ Maintain food at 60°C or above or cooled rapidly to 7°C, and thoroughly reheated before serving.

Food Analysis

- ❖ A variety of methods have been recommended for the recovery, enumeration and confirmation of *B. cereus* in foods. More recently, a serological method has been developed for detecting the putative enterotoxin of *B. cereus* (diarrheal type) isolates from suspect foods. Recent investigations suggest that the vomiting type toxin can be detected by animal models (cats, monkeys) or possibly by cell culture.
- ❖ Spores can be detected by PCR. Toxin can be detected by ELISA.

A microscopic image showing numerous red-stained Campylobacter bacteria. The bacteria appear as thin, curved, and sometimes spiral-shaped structures scattered across a light-colored background. The word "Campylobacter" is overlaid in the center in a bold, blue, italicized font.

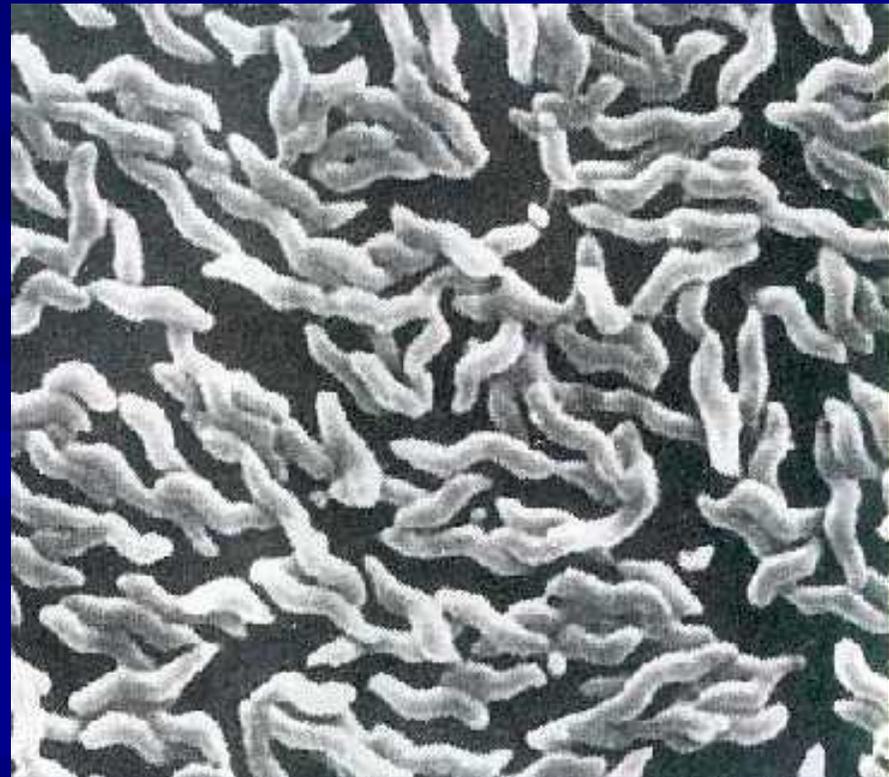
Campylobacter

Campylobacter

- Among the most widespread cause of infection in the world.
- Cause both diarrheal and systemic diseases
- *Campylobacter jejuni*

Typical Organisms

- Gram-negative rods with comma, S, or “gull-wing” shapes.
- Motile, with a single polar flagellum
- No spore & no capsule



Culture

- An atmosphere with reduced O₂ (5% O₂) with added CO₂ (10% CO₂)
- At 42 °C (for selection)
- Several selective media can be used (eg, Skirrow's medium)
- Two types of colonies:
 - ☺ watery and spreading
 - ☺ round and convex

Virulence Factor

- Lipopolysaccharides (LPS) with endotoxic activity
- Cytopathic extracellular toxins and enterotoxins have been found

Pathogenesis

- The infection by oral route from food, drink, or contact with infected animals or animal products (**Milk, meat products**).
- Susceptible to gastric acid (about 10^4 organisms)
- Multiply in the small intestine → invade the epithium → produce inflammation → cause bloody stools →
- Occasionally, the bloodstream is invaded

Campylobacter - symptoms

- Incubation: 4-8d
- Acute enteritis: 1w, stools remain positive for 3 w
- Acute colitis
- Acute abdominal pain
- Bacteremia: <1% *C. jejuni*
- Septic abortion
- Reactive arthritis
- diarrhea
- malaise
- fever
- abdominal pain
- usually self-limiting
- antibiotics occasionally
- bacteremia –small minority

Diagnostic Laboratory Tests

- Specimens: Diarrheal stools
- Smears: Gram-stained smears of stool may show the typical “gull-shaped” rods.
- Culture: (have been described above)

Control

- The source of infection may be food (eg, milk, under-cooked fowl) or contact with infected animals or humans and their excreta.