

Bacillus cereus

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Introduction:

- Gram-positive, spore-forming microorganism
- At present three enterotoxins, able to cause the diarrheal syndrome:
 - Hemolysin BL (HBL), nonhemolytic enterotoxin (NHE) and cytotoxin K
 - HBL and NHE are three-component proteins
 - Cytotoxin K is a single protein toxin

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Introduction:

- Symptoms caused by the latter toxin are more severe and may even involve necrosis.
- In general, the onset of symptoms is within 6 to 24 h after consumption of the incriminated food
- *B. cereus* food poisoning is underestimated probably because of the short duration of the illness (~24 h)

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History

- First discovered in 1880
- 1950 many outbreaks from meat and vegetable soups, cooked meat and poultry, fish, milk and ice cream were described in Europe
- In 1969, the first well-characterized *B. cereus* outbreak in the USA was documented

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Best estimates of the annual cases and deaths caused by *B. cereus* in the US

Agent	Cases	Percent	Deaths	Percent
<i>B. cereus</i>	27,360	0.2	0	0
Total bacterial	4,175,565	30.2	1,297	71.7
Total foodborne	13,814,924	100	1,809	100

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Classification of *B. cereus*

- The genus *Bacillus* presently divided into subgroups based on spore morphology
- *B. cereus* falls in the *Bacillus subtilis* group, and it is closely related to *B. anthracis*, *B. mycoides* and *B. thuringiensis*.
- *B. cereus* and *B. anthracis* are both recognized as pathogens, but the former is implicated with foodborne disease. *B. anthracis* can infect perorally, but is inefficient.

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Criteria to differentiate among four closely related *Bacillus* spp.

Species	Colony	Motile	Hemolysis	Susceptibility to Penicillin	Parasporal Body	Virulent to Mice
<i>B. cereus</i>	White	Yes	Yes	No	No	No
<i>B. anthracis</i>	White	No	No	Yes	No	Yes
<i>B. mycoides</i>	Rhizoid	No	No	No	No	No
<i>B. thuringiensis</i>	White/ Grey	Yes	Yes	No	Yes	No

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Factors Affecting Growth of *B. cereus*

- Growth temperature 7-49°C with a minimum of 4-5°C , maximum 48-50°C
- Generally, spore germination temperature range from 8-30°C
- pH 4.9-9.3

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Factors Affecting Growth of *B. cereus*

- Water activity 0.91-0.93
- Salt as high as 7.5% NaCl, some tolerate 10%
- D value for spores at 100°C around 3 min
- The dose for 90% reduction of spores is 1.25 - 4kGy
- 0.17-0.65 kGy for vegetative cells

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Name of Illness Caused by *B. cereus*

- *B. cereus* has two recognized types of foodborne illness: diarrheal , emetic
- The emetic syndrome is caused by cereulide, a heat- and pH stable peptide toxin
- Consumption of food contaminated with this toxin may lead to emesis between 30 min and 5 h after ingestion

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Name of Illness Caused by *B. cereus*

- The diarrhoeal syndrome is caused by enterotoxins that are produced during growth of *B. cereus* in the small intestine
- The diarrheal illness (more common in North America and Europe) is caused by a high molecular weight protein
- In some outbreaks there seems to be an overlap between the diarrheal and the emetic types of illness

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Comparison of diarrheal and emetic types of *B. cereus* food poisoning

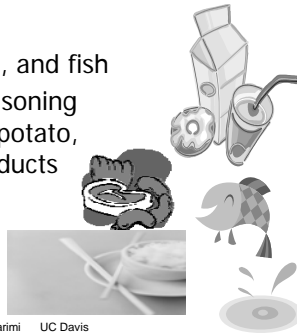
Syndrome	Incubation	Duration	Dose	Foods
Diarrheal	8-16 h	12-24 h	10 ³ -10 ⁷ CFU, ingested	Milk, soup, meat products, puddings
Emetic	1-5 h	12-24 h	10 ⁵ -0 ⁸ per g of food	Rice, pasta, noodles, pastries

Granum, P.E. (1994).

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Which Food?

- Milk, vegetables, meat, and fish
- The emetic type of poisoning include rice products, potato, pasta, and cheese products



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Which Food?

- Other foods such as sauces, pastries, soups, puddings, and salads were identified as vehicles in food poisoning outbreaks



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Comparison of food poisoning caused by different bacterial agents¹.

Pathogen	Incubation (h)	Duration of Illness, h	Dominating Signs	Type of Disease	Frequently Implicated Food
<i>B. cereus</i> ^{ns} , diarrheal	8-16	12-24	Diarrhea	toxico-infection	Meat products, soups, vegetables, puddings and sauces
<i>C. perfringens</i>	8-16	12-24	Diarrhea	toxico-infection	Meats, meat products, and gravy
<i>B. cereus</i> ^{ns} , emetic	1-5	12-24	Diarrhea (fairly common) vomiting	Intoxication	Fried rice from Chinese restaurants and take out shops
<i>S. aureus</i>	1-5	12-24	Diarrhea Vomiting	Intoxication	Cooked meats and poultry and dairy products

Gilbert, R.J. and Kramer, J.M. (1987).

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Infective Dose

- Infective dose of *B. cereus* ranges from 10^4 to 10^{11} cells per gram of food



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Detection of *B. cereus*

- Blood agar can be used as a plating medium
- Nutrient broth followed by blood agar useful for most probable number count

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Prevention:

- Preventing contamination of food with its spores is almost impossible
- Inhibit spore germination and prevent the growth of vegetative cells in cooked, ready-to-eat foods

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Prevention:

- Temperatures under 100°C (212°F) might allow spore survival
- Non-refrigerated storage of foods and especially rice should be avoided
- Foods that require heating or cooling should undergo that process rapidly

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Thank you !

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