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# MICRO- ORGANISMS IN FOODS

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## MICROBIOLOGICAL SPECIFICATIONS OF FOOD PATHOGENS

ICMSF

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## Bacillus cereus

### History

*Bacillus cereus* was first isolated and described in 1887 (Frankland and Frankland). Definite proof that this organism could cause foodborne illness came with the publications of Hauge (1950, 1955) who described four outbreaks, all involving vanilla sauce. These outbreaks, and those described by others over the ensuing 20 years, were characterized by watery diarrhoea occurring 8–16 h after ingestion of the food vehicle. These outbreaks are summarized in reviews by Goepfert *et al.* (1972), and Kramer and Gilbert (1989).

In 1971 an outbreak characterized by nausea and vomiting 1–5 h after ingestion of cooked rice was reported (PHLS, 1972). This report was met with scepticism but, as subsequent investigations were to document, certain strains of *B. cereus* are able to cause a 'staphylococcal-type' illness. It would now appear that this form of *B. cereus* food poisoning is more common than the type described originally by Hauge (Johnson, 1984).

Other species of *Bacillus*, including *B. subtilis* and *B. licheniformis*, have also been associated with foodborne disease, but definitive evidence is lacking to identify these organisms as foodborne pathogens. *B. subtilis* and *B. licheniformis* will not be addressed in this chapter, but information about them can be found in several review articles (Gilbert *et al.*, 1981; Kramer *et al.*, 1982; Kramer and Gilbert, 1989; Shinagawa, 1990).

### Taxonomy

The taxonomy of the bacilli could best be described as chaotic until the classic reports of Smith *et al.* (1946, 1952), which divided them into three groups based on spore and sporangium morphology. Group I bacilli (which includes *B. cereus*) are defined as having a sporangium that is not swollen by the spore. Within the group, subdivision of the species may be made on the basis of cell diameter. The large-celled species (including *B. cereus*) have cell diameters  $\geq 0.9 \mu\text{m}$ . The other large-celled Group I bacilli are *B. megaterium*, *B. anthracis*, *B. mycoides* and *B. thuringiensis*. Means of differentiation is shown in Table A and is described below.

### Symptoms

*B. cereus* food poisoning occurs after the ingestion of foods in which the organism has grown and formed its toxin(s). There are two types of intoxication. The first is characterized by diarrhoea occurring 8–24 h after the ingestion of large numbers of cells or toxin. The major symptom is diarrhoea, which is normally not severe, complete recovery typically occurring within 24 h. Large numbers of *B. cereus* organisms may be found in the faeces if samples are examined 1–2 days after ingestion of the food. The organisms are voided from the body quickly upon recovery.

The second type of intoxication is characterized by emesis occurring within a short period of time (1–6 h) after ingestion of the toxin. Again, the illness is relatively mild and recovery occurs within 12–24 h. Neither form of illness should be considered life-threatening to a normal healthy individual.

### Pathogenicity

Many strains of *B. cereus* elaborate a variety of extracellular metabolites, including toxins or virulence factors identified on the basis of their behaviour in animal models and their epidemiological association with diseases. These metabolites are produced mainly during the exponential phase of growth, and include a diarrhoeal enterotoxin (Spira and Goepfert, 1975; Turnbull *et al.*, 1979; Thompson *et al.*, 1984; Kramer and Gilbert, 1989), an emetic factor (Melling and Capel, 1978; Turnbull *et al.*, 1979; Kramer and Gilbert, 1989), a primary haemolysin (haemolysin I) (Turnbull *et al.*, 1979), a secondary haemolysin (haemolysin II) (Kramer and Gilbert, 1989), phospholipase C (Kramer and Gilbert, 1989) and an enterotoxin described by Ezepchuk and Fluer (1973; Gorina *et al.*, 1975). The primary toxic metabolites of *B. cereus* have been described in a review by Kramer and Gilbert (1989).