

Chapter 19

Pseudomonas aeruginosa and *Burkholderia* species

Pseudomonas aeruginosa, *Burkholderia mallei* and *B. pseudomallei* are Gram-negative rods (0.5 to 1.0 x 1 to 5 µm) which are obligate aerobes and oxidize carbohydrates. Most isolates are oxidase-positive and catalase-positive. They are motile by one or more polar flagella, with the exception of *B. mallei* which is non-motile. The majority of these organisms have no special growth requirements and grow well on MacConkey agar. *Burkholderia mallei* requires 1% glycerol in media for optimal growth. *Pseudomonas aeruginosa*, characterized by the production of diffusible pigments, causes a variety of opportunistic infections in a wide range of animals. A number of other *Pseudomonas* species may be isolated from clinical specimens. *Pseudomonas fluorescens* and *P. putida* occasionally infect freshwater fish.

Burkholderia species, previously classified in the genus *Pseudomonas*, include *B. mallei*, the cause of glanders and *B. pseudomallei*, the cause of melioidosis. Both diseases are zoonoses.

Usual habitat

Pseudomonas species are environmental organisms which occur worldwide in water and soil, and on plants. *Pseudomonas aeruginosa* is also found on the skin, on mucous membranes and in faeces. *Burkholderia pseudomallei*, which is found in soils, occasionally infects animals and man. Wild rodents can act as reservoirs of this organism. It is widely distributed in some tropical and subtropical regions of southeast Asia and Australia. Although *B. mallei* can survive in the environment for up to 6 weeks, its reservoir is infected *Equidae*.

Differentiation of *Pseudomonas* and *Burkholderia* species

- The comparative colonial and biochemical features of these organisms are presented in Table 19.1.
- Many *Pseudomonas* species produce pigments. *Pseudomonas aeruginosa* strains can form up to four diffusible pigments (Box 19.1). Pyocyanin, unique to this organism, is produced by most strains and specifically identifies *P. aeruginosa*. Pyocyanin-enhancing media are available for isolates which are weak pyocyanin producers. Pigment production is observed

Key points

- Medium-sized, Gram-negative rods
- Obligate aerobes
- Most isolates are oxidase-positive and catalase-positive
- *Pseudomonas* species and *Burkholderia pseudomallei* are motile by polar flagella
- *Burkholderia mallei* is non-motile and requires 1% glycerol in media for optimal growth
- Diffusible pigments are produced by *P. aeruginosa*
- *Burkholderia mallei* causes glanders
- *Burkholderia pseudomallei* causes melioidosis
- *Pseudomonas aeruginosa* causes opportunistic infections

most clearly on media without dyes such as nutrient agar. Pyorubin and pyomelanin develop slowly and may be detectable only after incubation for 1 to 2 weeks. Colonies of *B. pseudomallei* and *B. mallei* become brownish with age but do not produce pigments.

- The majority of *Pseudomonas* and *Burkholderia* species are motile. Absence of motility distinguishes *B. mallei* from other members of the group.

Clinical infections

Burkholderia mallei, a major pathogen of *Equidae*, causes both acute and chronic disease. It manifests mainly as lesions in the skin and the respiratory tract. Infection with *B. pseudomallei* can cause chronic suppurative lesions in the lungs and other organs of a wide range of species. In contrast, *P. aeruginosa* is an opportunistic pathogen which may occasionally cause acute systemic disease.

Pseudomonas aeruginosa infections

Pseudomonas aeruginosa causes a wide range of opportunistic infections (Table 19.2). Although predisposing

Table 19.1 Comparative features of *Pseudomonas aeruginosa*, *Burkholderia mallei* and *Burkholderia pseudomallei*.

Feature	<i>P. aeruginosa</i>	<i>B. mallei</i>	<i>B. pseudomallei</i>
Colonial morphology	Large and flat with serrated edges	White and smooth becoming granular and brown with age	Ranges from smooth and mucoid to rough and dull becoming yellowish-brown with age
Haemolysis on blood agar	+ ^a	–	+ ^a
Diffusible pigment production	+	–	–
Colony odour	grape-like	none	musty
Growth on MacConkey agar	+	+ ^b	+
Growth at 42°C	+	–	+
Motility	+	–	+
Oxidase production	+	– ^c	+
Oxidation of:			
glucose	+	+	+
lactose	–	–	+
sucrose	–	–	+ ^b

a 40% of strains positive

b over 75% of strains positive

c 25% of strains negative

factors are associated with the occurrence of many of these infections, some species, such as farmed mink, appear to be particularly susceptible to the organism (Long *et al.*, 1980). Haemorrhagic pneumonia and septicaemia, caused by *P. aeruginosa*, occurs sporadically in ranched mink with mortality rates up to 50% in some outbreaks. Bovine mastitis associated with this organism (Crossman and Hutchinson, 1995) is often linked to contaminated water used for udder washing or to the insertion of contaminated intramammary antibiotic tubes. Fleeces-rot of sheep, a condition associated with heavy or prolonged rainfall, has been reported from the UK and Australia. Maceration of the skin surface following water penetration of the fleece allows colonization by *P. aeruginosa*, resulting in suppurative dermatitis. The bluish-green pyocyanin pigment produced by *P. aeruginosa* discolours the wool. *Pseudomonas aeruginosa* is often found in the oral cavity of snakes and can cause necrotic stomatitis in captive reptiles kept under poor husbandry conditions.

Box 19.1 Pigments produced by *Pseudomonas aeruginosa*.

- Pyocyanin (blue green)
- Pyoverdin (greenish-yellow)
- Pyorubin (red)
- Pyomelanin (brownish-black)

Pathogenesis and pathogenicity

Pathogenic strains of *P. aeruginosa* produce a variety of toxins and enzymes which promote tissue invasion and damage. Attachment to host cells is mediated by fimbriae. Colonization and replication are aided by antiphagocytic properties of exoenzyme S, extracellular slime and outer-membrane lipopolysaccharides. Resistance to complement-mediated damage and the ability to obtain

Table 19.2 Clinical conditions arising from infection with *Pseudomonas aeruginosa*.

Host	Disease condition
Cattle	Mastitis, metritis, pneumonia, dermatitis, enteritis (calves)
Sheep	Mastitis, fleeces-rot, pneumonia, otitis media
Pigs	Respiratory infections, otitis
Horses	Genital tract infections, pneumonia, ulcerative keratitis
Dogs, cats	Otitis externa, cystitis, pneumonia, ulcerative keratitis
Mink	Haemorrhagic pneumonia, septicaemia
Chinchillas	Pneumonia, septicaemia
Reptiles (captive)	Necrotic stomatitis