

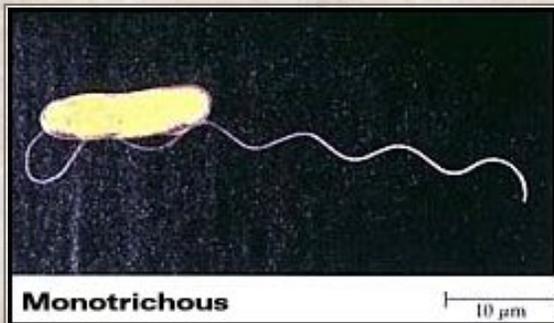
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 Medical Microbiology
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Mechanisms of Bacterial Motility

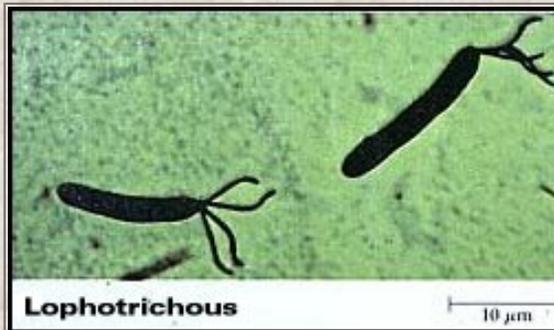
Motile bacteria move using flagella, threadlike projections that extend out from the cell wall. While you can see the bacterial cells under the high-power objective of a light microscope, most flagella are so thin that they cannot be visualized with brightfield microscopy and are 15 - 20 μm in length.

FLAGELLAR DISTRIBUTION

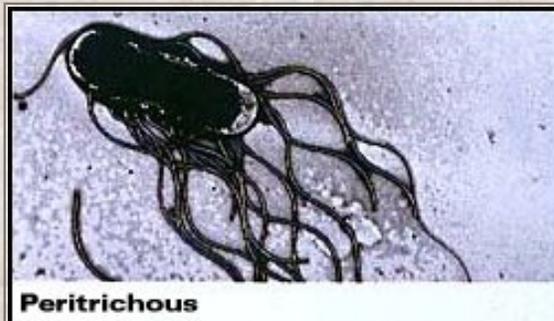
Both Gram-positive and Gram-negative bacteria can have similar hook and filament flagellar structures. Different bacterial species have distinctive arrangements of flagella and unique flagellar antigens. These characteristics can be exploited in the identification of infectious agents that may be involved in a given disease process.



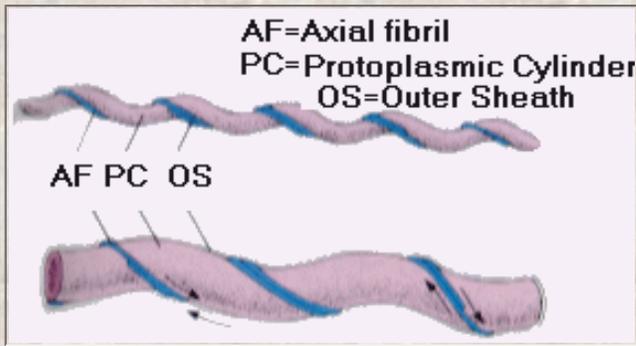
Monotrichous distribution means that each cell has a single flagellum. If the flagellum is located at the end of the cell, the cell is said to have monotrichous polar distribution, as is the case with *Pseudomonas* sp. (see picture at left). **Amphitrichous** bacteria have a single flagellum at each pole.



Lophotrichous distribution is a pattern in which bacteria appear to have a tuft ("lopho") of hair ("trichous") at one or both ends. *Spirillum* is an example of this type of distribution (see picture at left).



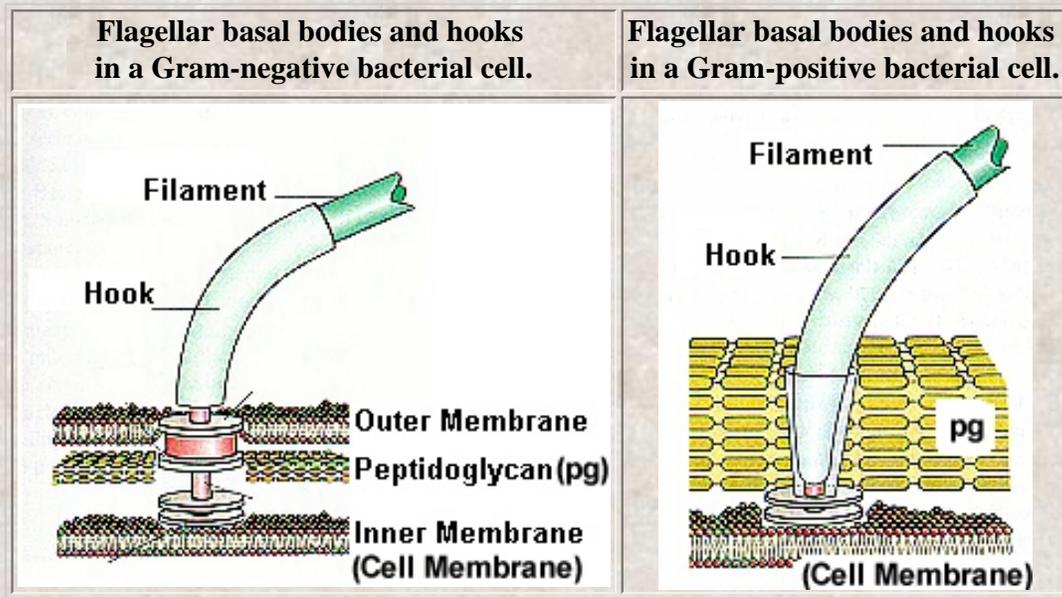
Peritrichous flagella are distributed uniformly over the surface of each bacterial cell. This pattern is characteristic for highly motile organisms like *Proteus vulgaris* (see picture).



A fourth type of flagellar distribution is the **axial filament** characteristic of the Spirochetes (see picture at left). Hundreds of individual periplasmic flagella are bundled together to create a structure that allows spinning and flexing motility.

FLAGELLAR ULTRASTRUCTURE

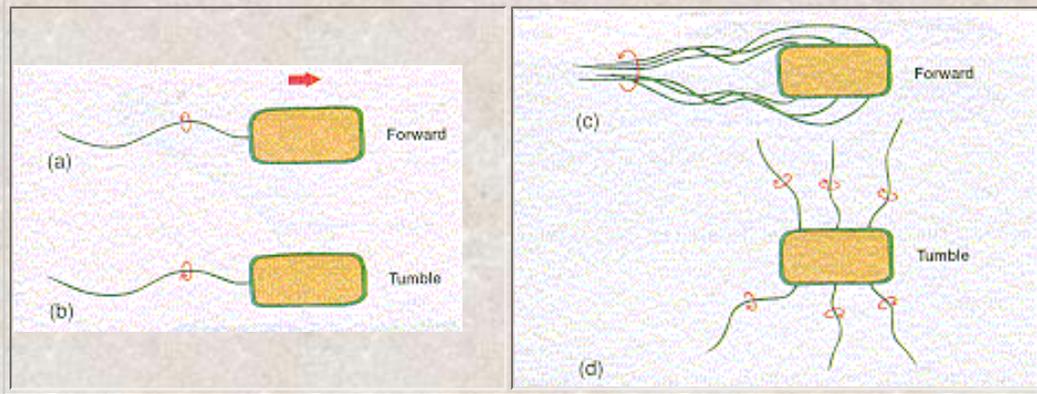
Flagellar ultrastructure is fundamentally different in the eukaryotes and the prokaryotes. Only prokaryotic flagella will be discussed here. Bacteria possessing flagella have basal bodies embedded in the plasma membrane as anchoring mechanisms. The Gram-negative bacteria have an additional basal body embedded in the outer membrane.



BACTERIAL MOVEMENT

Bacterial movement is produced through the action of the flagella (see the diagrams below). Bacteria move toward attractive stimuli and away from harmful substances and waste products in the process known as [chemotaxis](#). Monotrichous bacteria move forward in a simple response to chemotactic stimuli, the counterclockwise rotation of the flagellum. This forward movement is termed the "run". Negative chemotaxis causes clockwise rotation of the flagellum and results in a random tumbling motion. Peritrichous bacteria move in a similar fashion, even though the situation is somewhat complicated by a requirement for bundling of the flagella to produce coordinated action during counterclockwise rotation. The "tumble" in peritrichous bacteria is the result of bundle disruption during clockwise flagellar rotation.

Movement in Monotrichous Bacteria	Movement in Peritrichous Bacteria



Bacterial movement in the absence of a chemical concentration gradient can be described as random (left).

In contrast, bacteria moving in an attractant gradient have a reduced tumble frequency (right) that results in greater net forward motion.



Bacterial chemotaxis is controlled by a complex series of events beginning with the binding of an attractant molecule to a cell surface chemoreceptor. Chemoreceptors are often clustered at the ends of rod-shaped cells like *E. coli*. Chemoreceptors do not influence flagellar motion directly, but convey information through a phosphorylation cascade. Information about the environment can be translated into motion within 200 milliseconds. A return to steady-state is assured by a coordinated feedback loop that quickly causes a reversion to original levels of protein phosphorylation in the absence of stimuli.

References:

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- Manson, M.D. (1992) "Bacterial motility and chemotaxis" *In Advances in microbial physiology*, vol 33, A.H. Rose, editor, 277-346. New York: Academic Press.

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