

Spirochaetes:

Spirochaetes (G. *spira* = a coil; *chaete* = hair) are gram-negative motile, chemoheterotrophic, tightly coiled bacteria typically slender and flexuous in morphology (Fig. 6.6A). Their size varies from 5 to 250 μm x 0.1 to 3.0 μm . These bacteria are widespread in aquatic environments and in animals and are distinguished by their structure and motility-mechanism.

A spirochete is a type of *bacteria* within the phylum Spirochetes. The spirochetes are so called because they are very long, thin shape and *helically coiled*, hence they have a spiraling corkscrew shape. The helical shape is one of three morphological categories of the *prokaryotes*.

Spirochaetes differ greatly from other bacteria with respect to motility as they easily move through very viscous solutions though they do not possess any external rotating flagellum.

1. Structure:

The spirochaete cell consists of a 'protoplasmic cylinder' surrounded by plasma membrane and gram-negative type cell wall. Two to more than a hundred flagella called axial fibrils, periplasmic flagella or endoflagella are located in the periplasm. They extend from both ends of the protoplasmic cylinder and often overlap one another.

The whole complex of periplasmic flagella is called axial filament. However, both the axial fibrils and the protoplasmic cylinder are surrounded by a multi-layered but flexible outer membrane or outer sheath (Fig. 6.6B) which contains lipids, protein and carbohydrate.

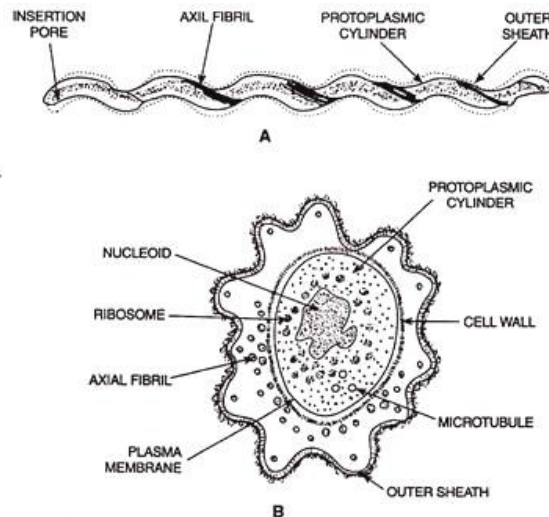


FIG. 6.6. Structure of a Spirochete. A. Surface view, and B. Cross-section showing morphological details.

2. Motility:

Each endoflagellum rotates like typical bacterial flagella. When all the endoflagella rotate in the same direction, the protoplasmic cylinder rotates in the opposite direction. This could cause the corkscrew-shaped outer sheath to rotate and move the cell through the surrounding liquid (Fig. 6.7). Flagellar rotation could also flex or bend the cell and account for the crawling movement on solid surfaces.

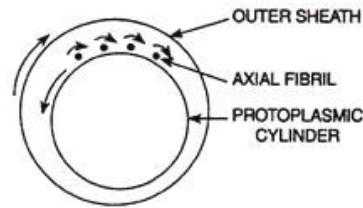


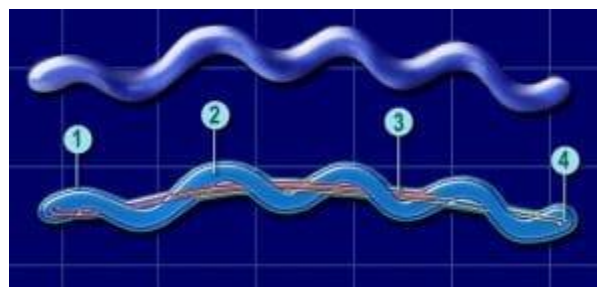
FIG. 6.7. Hypothetical mechanism for Spirochaete motility.

The spirochetes are a diverse phylum, occupying a wide range of *ecological niches*; some are free-living in aquatic environments, while some can only survive by parasitizing the cells of other organisms. Most are *anaerobic* (can sustain themselves without the presence of oxygen), although certain species are aerobic. They are very difficult to culture and are *gram-negative*, meaning they are not easily visible.

Although some play an important role as *symbionts* within the stomach of other animals, many members of the spirochete class are responsible for common diseases such as Lyme disease and syphilis. Some spirochetes have also been found present within marine *bivalves* although with no apparent positive or negative effects; this neutral relationship is called a *commensalism*.

Spirochetes are distinguishable from other bacteria in that they move with unique *endoflagella*. The flagella are tightly wound around the corkscrew shape of the bacteria, between the outer membrane and the cell wall, within the *periplasm*. Together, the endoflagella make up a structure called the *axial filament*. The axial filament is rotated by the rotation of the flagella, causing the spirochete to move with a twisting motion. This method of motility is unique to the spirochetes and—much like the way a corkscrew can penetrate the cork of a wine bottle—allows them to move through viscous materials such as mucus, blood, mud and host connective tissues including cartilage and dental plaque; external flagella do not allow effective movement through these mediums.

Additionally, the presence of endoflagella allows the spirochetes to move backward and forward with equal ease, this allows them to move freely in their environment and target the best site of host attachment or resources.



The image shows the spiral structure of the spirochete form (top) and a cross section (bottom) with the following labeled: 1-Bacterial Cell Envelope; 2-Cytoplasm; 3-Flagella; 4-The Attachment Point of the Flagella.

Spirochetes as Parasites

Spirochetes are best known by their prevalence as causative agents of disease. Three genera contain pathogenic species:

- **Treponema:** The *Treponema palidum* species causes the sexually transmitted disease, syphilis. Closely related to this are three other species which cause yaws, pinta and bejel; these are diseases transmitted either sexually or through skin contact and result in symptoms of mouth and skin sores, lumps in the bone, growths and thick discolored patches of skin. These bacteria can be killed with a *penicillin* injection.

- **Leptospira:** Certain species within this genus cause a disease called Leptospirosis (also known as Weil's disease). The symptoms of this are flu-like; including fever, headaches, and muscle pains, although can become as severe as meningitis and can cause bleeding into the lungs.
- **Borrelia:** There are 52 species of the Borrelia genus, which transmit through the bites of ticks and lice. Of the 52 species, 21 are responsible for causing borreliosis (also known as Lyme disease) while 29 cause Relapsing Fever. Relapsing fever victims experience fever, chills, headaches, nausea and rashes. If left untreated, the symptoms often subside and then return several weeks later.