

# Bacteria & Archaea

## Form & Function

- bacteria & archaea have their nuclear material free inside the cell
  - they lack a nucleus
  - some archaea wrap their DNA around **histones** (proteins that compact & condense chromosomal) but bacteria do not
- their cell walls differ from eukaryotes
  - bacteria have walls made of peptidoglycan
  - archaea cell walls are tough & made of chemicals distinct from bacteria & eukaryotes
- lack organelles
  - some have internal membranes but they aren't as organised
- cellular structure**
  - all contain a cytoplasmic membrane, cytoplasm, ribosomes, a cytoskeleton, & one (or more) chromosomes
  - most have a cell wall & a surface coating called a glycocalyx
  - some have flagella, an outer membrane, pili, fimbriae, nanowires/nanotubes, plasmids, inclusions, endospores, and/or micro-compartments
- cellular shapes & arrangements**
  - function as independent single-celled, or unicellular, organisms
  - each individual cell is capable of carrying out all necessary life processes
    - can sometimes act as a group
  - communicate w/ each other through chemicals
    - some communicate w/ nanotubes or nanowires & may even transfer electrons or other substances w/ them as well
  - have an average size of  $\sim 1\mu\text{m}$ 
    - cocci average a circumference of  $1\mu\text{m}$
    - rods average a length of  $2\mu\text{m}$  & a width of  $1\mu\text{m}$
  - pleomorphism** is the phenomenon of cells of a single species to vary in shape & size due to individual variations in cell wall structure
  - caused by nutritional or slight genetic differences
- cellular shapes**
  - cocci** are spherical or ball-shaped
  - rod-shaped** are rod-shaped, may be blocky, spindle-shaped, round-ended, threadlike, club-shaped, or drumstick-shaped
  - spirilla** are singly occurring rods that are slightly curved
  - spirochetes** are curled or spiral-shaped that are twisted twice or more about its axis
  - spirochetes** are flexible & spring-shaped
  - some bacteria have **terminal flagella** off of a basic rod
- bacterial cells may also be categorised by the style of grouping
  - dependent upon its pattern of division while growing & how the cells remain attached after
  - greatest variety in cocci dividing in a single plane (single, **diplococci**, or **tetrads** w/ a variable number of cocci in chains) in two perpendicular planes (packet of four called a **tetrad**, a cubical packet of 8-64 cocci called a **cubical**), or in several intersecting planes (irregular clusters w/ different numbers such as in **streptococci** & **staphylococci**)
  - rods are less varied because they divide in only one plane (single cells, a pair w/ their ends attached called **diplococci**, a chain of several called **streptococci**, or a **palisade** where a chain remains partially attached by a hinge region at their ends)
  - spirilla are occasionally in chains
  - spirochetes rarely remain attached after division

## External Structures

- appendages are common but not present on all species
  - can be divided into three major groups
    - those that provide motility
    - those that provide attachment points/channels
- flagella**
  - provides the ability of self-propulsion
  - divides parts, the filament, the hook/sheath, & the basal body
    - the filament is composed of proteins,  $\sim 20\text{nm}$  in diameter, &  $1-20\mu\text{m}$  long
    - the filament is inserted into the curved & tubular hook, which is anchored to the cell by the basal body
    - the basal body is a stack of rings anchored through the cell wall to the cytoplasmic & outer membranes
  - previously thought to move back & forth but it rotates 360°
  - all spirilla, about half of the rods, & some cocci have flagella
  - they may be **polar** or **peritrichous**
    - polar arrangement is w/ flagella at one or both ends w/ three subtypes: **monotrichous** (a single flagellum), **amphitrichous** (small bundles of flagella at the same site), or **lophotrichous** (flagella at both poles)
    - peritrichous arrangement is flagella present randomly over the surface of the cell
  - allows detection of & movement based upon the response to chemical signals (**chemotaxis**)
    - positive chemotaxis is movement toward a favorable chemical stimulus
    - negative chemotaxis is movement away from a potentially harmful substance
  - rotation counterclockwise causes a smooth linear movement called a **run**
    - interrupted at various intervals to stop & change course, & is called a **tumble**
    - alternating between runs & tumbles is called a **random walk**
- periplasmic flagella/flexa/fimbriae**
  - two or more long, coiled threads that are present on spirochetes
  - enclosed in space between the cell wall & the cytoplasmic membrane
- fimbriae**
  - bristlelike filaments that sprout off the surface
  - composition varies, but most contain protein
  - tendency to stick to each other & surfaces
    - partially responsible for clinging that leads to biofilms & accumulations of microbial organisms
- pili**
  - a long & rigid tube made of a special protein (**pilin**)
  - conjugation pili are used for **conjugation** (mating)
    - production of these are controlled genetically
    - conjugation this way only occurs between gram-negative bacteria
  - sex pili** have multiple functions
    - can transfer genetic material
    - can act like a fimbriae
    - can act like a flagella
- nano-wires/nanotubes**
  - thin, long, tubular extensions of the cytoplasmic membrane
  - channel to transfer amino acids or harvest energy (by shuttling

# Bacteria And Archaea Study Guide Answers Complete

**D. Peter Snustad, Harold James  
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