

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 chromosomes) 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 microcompartments
- 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
 - three 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 favourable 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/flexirotaxons**
 - two or more long, coiled threads that are present on spirochetes
 - enclosed in space between the cell wall & the cytoplasmic membrane
- fimbriae**
 - bristlelike fibres 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

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**Eldon D.. Enger,Enger,Frederick C..
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1. Understanding the eBook Bacteria And Archaea Study Guide Answers Complete
 - The Rise of Digital Reading Bacteria And Archaea Study Guide Answers Complete
 - Advantages of eBooks Over Traditional Books
2. Identifying Bacteria And Archaea Study Guide Answers Complete
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Bacteria And Archaea Study Guide Answers Complete
 - User-Friendly Interface
4. Exploring eBook Recommendations from Bacteria And Archaea Study Guide Answers Complete
 - Personalized Recommendations
 - Bacteria And Archaea Study Guide Answers Complete User Reviews and Ratings
 - Bacteria And Archaea Study Guide Answers Complete and Bestseller Lists

5. Accessing Bacteria And Archaea Study Guide Answers Complete Free and Paid eBooks
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 - Bacteria And Archaea Study Guide Answers Complete eBook Subscription Services
 - Bacteria And Archaea Study Guide Answers Complete Budget-Friendly Options
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 - ePub, PDF, MOBI, and More
 - Bacteria And Archaea Study Guide Answers Complete Compatibility with Devices
 - Bacteria And Archaea Study Guide Answers Complete Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Bacteria And Archaea Study Guide Answers Complete
 - Highlighting and Note-Taking Bacteria And Archaea Study Guide Answers Complete
 - Interactive Elements Bacteria And Archaea Study Guide Answers Complete
8. Staying Engaged with Bacteria And Archaea Study Guide Answers Complete
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Bacteria And Archaea Study Guide Answers Complete
9. Balancing eBooks and Physical Books Bacteria And Archaea Study Guide Answers Complete
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Bacteria And Archaea Study Guide Answers Complete
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Bacteria And Archaea Study Guide Answers Complete
 - Setting Reading Goals Bacteria And Archaea Study Guide Answers Complete
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Bacteria And Archaea Study Guide Answers Complete
 - Fact-Checking eBook Content of Bacteria And Archaea Study Guide Answers Complete
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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