

1  **Bacteria: The Proteobacteria**

Chapter 15

2 3  **15.1 Phylogenetic Overview of Bacteria**▪ Proteobacteria

- many common bacteria
- Gram negative
- Most metabolically diverse
 - chemolithotrophy, chemoorganotrophy, phototrophy
- Morphologically diverse
- Divided into five classes (gene sequences)
 - *Alpha-, Beta-, Delta-, Gamma-, Epsilon-*
- Members of different classes often have common traits (phenotype)
 - Phototrophy- 3 , nitrifying-4 & separate phylum

4 5  **II. Phototrophs, Chemolithotrophs, and Methanotrophs**

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- 15.2 Purple Phototrophic *Bacteria*
- 15.3 The Nitrifying *Bacteria*
- 15.4 Sulfur- and Iron-Oxidizing *Bacteria*
- 15.5 Hydrogen-Oxidizing *Bacteria*
- 15.6 Methanotrophs and Methylotrophs

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- Purple phototrophic
 - Anoxygenic photosynthesis
 - No oxygen released
 - Purple sulfur bacteria
 - Use hydrogen sulfide (H₂S) as electron donor
 - Gammaproteobacteria
 - Purple nonsulfur bacteria
 - Also use sulfur (low levels)
 - Photoheterotrophy
 - Light = energy source
 - Organic compounds = carbon source

7  **15.3 The Nitrifying Bacteria**▪ Nitrifying Bacteria

- grow chemolithotrophically
 - inorganic nitrogen compounds
- *Alpha-, Beta-, Gamma-, and Deltaproteobacteria*
- Nitrification (oxidation of ammonia to nitrate)
 - two separate reactions by different groups of bacteria
- Widespread in soil and water
- Highest in habitats with ammonia
 - protein decomposition and sewage treatment facilities

8  **15.4 Sulfur- and Iron-Oxidizing Bacteria**▪ Sulfur-Oxidizing Bacteria

- Grow chemolithotrophically
 - sulfur compounds
- Two broad classes
 - Neutrophiles

- Acidophiles
- freshwater sediments, thick mats found on ocean floor off Chile and Peru
- 9 **15.5 Hydrogen-Oxidizing *Bacteria***
 - Hydrogen-Oxidizing Bacteria:
 - grow autotrophically
 - H₂ as sole electron donor and O₂ as electron acceptor ("knallgas" reaction)
 - Some can grow on carbon monoxide (CO) as electron donor (carboxydrotrophs)
 - gram-negative and gram-positive
- 10 **15.6 Methanotrophs and Methylotrophs**
 - Methanotrophs
 - Use CH₄ and other one-carbon (C1) compounds
 - Widespread in soil and water
 - Obligate aerobes
 - Morphologically diverse
 - Methylotrophs
 - grow using carbon compounds that lack C-C bonds
- 11 **15.6 Methanotrophs and Methylotrophs**
 - Classification of Methanotrophs
 - Two major groups
 - Type I
 - *Gammaproteobacteria*
 - Membranes - bundles of disc-shaped vesicles
 - Type II
 - *Alphaproteobacteria*
 - membranes - paired & run along periphery of cell
- 12 **III. Aerobic and Facultatively Aerobic Chemoorganotrophs**
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 - 15.7 *Pseudomonas* and the *Pseudomonads*
 - 15.8 Acetic Acid *Bacteria*
 - 15.9 Free-Living Aerobic Nitrogen-Fixing *Bacteria*
 - 15.10 *Neisseria*, *Chromobacterium*, and Relatives
 - 15.11 Enteric *Bacteria*
 - 15.12 *Vibrio*, *Alivibrio*, and *Photobacterium*
 - 15.13 Rickettsias
- 13 **15.7 *Pseudomonas* and the *Pseudomonads***
 - Pseudomonad
 - Straight or curved rods with polar flagella
 - Chemoorganotrophs
 - Obligate aerobes
 - Nutritionally versatile
 - Ecologically important organisms in water and soil
 - Some species are pathogenic
 - human opportunistic pathogens & plant pathogens
- 14 **15.7 *Pseudomonas* and the *Pseudomonads***
 - *Zymomonas*
 - large, gram-negative rods
 - fermentation of sugars to ethanol
 - production of fermented beverages
- 15 **15.8 Acetic Acid *Bacteria***
 - Acetic Acid Bacteria

- complete oxidation of alcohols and sugars
 - accumulation of organic acids as end products
- Motile rods
- Aerobic
- High tolerance to acidic conditions
- Commonly found in alcoholic juices
 - Used in production of vinegar
- 16 **15.9 Free-Living Aerobic Nitrogen-Fixing *Bacteria***
 - A variety of soil microbes are capable of fixing N₂ aerobically
 - Nonsymbiotically
 - *Azotobacter*, *Azospirillum*, and *Beijerinckia*
- 17 **15.10 *Neisseria*, *Chromobacterium*, and Relatives**
 - *Neisseria*, *Chromobacterium*, & relatives
 - isolated from animals
 - some are pathogenic
 - *N. gonorrhoeae* causes gonorrhea
- 18 **15.11 Enteric *Bacteria***
 - Enteric *Bacteria*
 - *Gammaproteobacteria*
 - Facultative aerobes
 - Motile or non-motile, nonsporulating rods
 - relatively simple nutritional requirements
 - Ferment sugars to a variety of end products
- 19 **15.11 Enteric *Bacteria***
 - two broad groups
 - Mixed-acid fermentators
 - 2,3-butanediol fermentators
- 20 **15.11 Enteric *Bacteria***
 - Identify using diagnostic tests & differential media
- 21 **15.11 Enteric *Bacteria***
 - Escherichia
 - intestinal tract of humans and warm-blooded animals
 - Synthesize vitamins for host
 - Some strains are pathogenic
 - Salmonella and Shigella
 - Closely related to *Escherichia*
 - Usually pathogenic
 - *Salmonella* characterized immunologically by surface antigens
- 22 **15.11 Enteric *Bacteria***
 - *Proteus*
 - Genus containing rapidly motile cells; capable of swarming
 - Frequent cause of urinary tract infections in humans
- 23 **15.12 *Vibrio*, *Alivibrio*, and *Photobacterium***
 - The *Vibrio* Group
 - Cells are motile, straight or curved rods
 - Facultative aerobes
 - Possess a fermentative metabolism
 - Best known genera are *Vibrio*, *Alivibrio*, and *Photobacterium*
 - Most inhabit aquatic environments
 - Some are pathogenic

- Some are capable of light production (bioluminescence)
- 24 **15.13 Rickettsias**
 - Rickettsias
 - Small, coccoid or rod-shaped cells
 - Most are obligate intracellular parasites
 - Causative agent of several human diseases
- 25 **IV. Morphologically Unusual Proteobacteria**
 - - 15.14 Spirilla
 - 15.15 Sheathed *Proteobacteria*: *Sphaerotilus* and *Leptothrix*
 - 15.16 Budding and Prosthecate/Stalked *Bacteria*
- 26 **15.14 Spirilla**
 - *Spirilla*
 - Group of motile, spiral-shaped *Proteobacteria*
 - Key taxonomic features include
 - Cell shape and size
 - Number of polar flagella
 - Metabolism
 - Physiology
 - Ecology
 - few are magnetotactic
- 27 **15.15 Sheathed *Proteobacteria*: *Sphaerotilus* & *Leptothrix***
 - Sheathed Bacteria
 - Filamentous *Betaproteobacteria*
 - Unique life cycle
 - flagellated swarmer cells form within sheath
 - Under unfavorable conditions
 - swarmer cells move out to explore new environments
 - Common in freshwater habitats rich in organic matter
- 28 **15.16 Budding and Prosthecate/Stalked *Bacteria***
 - Budding and Prosthecate/Stalked *Bacteria*
 - Large and heterogeneous group
 - Primarily *Alphaproteobacteria*
 - cytoplasmic extrusions bounded by a cell wall (collectively called *prosthecae*)
- 29 **Assignment (ch 15)**
 - Pick a specific bacteria from 2 different groups covered in this chapter and do additional research on them to put together a brochure explaining the following information:
 - Cell shape and size
 - Special characteristics (flagella, etc)
 - Metabolism
 - Physiology
 - Ecology