

- 1 **Bacteria: Gram-Positive and Other Bacteria**
Chapter 16
- 2 **I. Overview of Gram-Positive and Other Bacteria**
 - *Bacteria* has many other phyla, including
 - Gram-positive bacteria
 - Large group of mostly chemoorganotrophic
 - Cyanobacteria
 - Oxygeneic phototrophs that have evolutionary roots near those of gram-positive bacteria
 - Phylogenetically early-branching phyla
 - Such as *Aquifex*
 - Other morphologically distinct groups
- 3 **II. Gram-Positive Bacteria and Actinobacteria**
 - 16.1 Nonsporulating Gram-Positive Bacteria
 - 16.2 Endospore-Forming Gram-Positive Bacteria
 - 16.3 Cell-Wall-Less Gram-Positive Bacteria: Mycoplasmas
 - 16.4 Actinobacteria: Coryneform and Propionic Acid Bacteria
 - 16.5 Actinobacteria: *Mycobacterium*
 - 16.6 Filamentous Actinobacteria: *Streptomyces* and Relatives
- 4 **II. Gram-Positive Bacteria and Actinobacteria**
 - large and diverse group
 - Previously divided into two groups
 - High G+C (Actinobacteria), >50% G+C
 - Low G+C <50% G+C
- 5 **16.1 Nonsporulating Gram-Positive Bacteria**
 - Key genera: *Staphylococcus*, *Micrococcus*, *Streptococcus*, *Lactobacillus*, *Sarcina*
 - *Staphylococcus* and *Micrococcus*
 - Aerobic, cocci
 - Tolerate high salt
 - Many are pigmented
- 6 **16.1 Nonsporulating Gram-Positive Bacteria**
 - *Sarcina*
 - Obligate anaerobes
 - Extremely acid tolerant
 - Can grow in stomachs of animals
- 7 **16.1 Nonsporulating Gram-Positive Bacteria**
 - *Streptococcus*
 - *Homofermentative*
 - production of buttermilk, silage, and other products
 - Some are pathogenic
 - *Lactococcus*: genera of dairy significance
 - *Enterococcus*: genera of fecal origin
- 8 **16.1 Nonsporulating Gram-Positive Bacteria**
 - *Lactobacillus*
 - Rod-shaped
 - Common in dairy products
 - Resistant to acidic conditions
 - Grow in pH as low as 4
 - *Listeria*
 - Gram-positive *coccobacilli*

- Form chains 3–5 cells long

9 10

16.2 Endospore-Forming Gram-Positive Bacteria

- Key Genera: *Bacillus*, *Clostridium*, *Sporosarcina*, *Heliobacterium*
 - Distinguished by
 - cell morphology
 - shape
 - cellular position of endospore
 - found in soils

11 12

16.2 Endospore-Forming Gram-Positive Bacteria

- Bacillus and Paenibacillus
 - extracellular hydrolytic enzymes
 - break down polymers
 - produce antibiotics
 - *Paenibacillus popilliae* and *Bacillus thuringiensis* produce insect larvicides

13 14

16.2 Endospore-Forming Gram-Positive Bacteria

- Clostridium
 - Lack a respiratory chain, anaerobic
 - Some perform Stickland reactions
 - Metabolism of pair of amino acids
 - anaerobic pockets in soil & mammalian intestinal tract
 - Some pathogenic
 - Botulism
 - Tetanus
 - Gangrene

15 16

16.2 Endospore-Forming Gram-Positive Bacteria

- Sporosarcina
 - Unique among endospore formers
 - cocci instead of rods
 - Strictly aerobic, spherical cells
 - Common in soils

17

16.2 Endospore-Forming Gram-Positive Bacteria

- Heliobacteria
 - Phototrophic gram-positive bacteria
 - Anoxygenic phototrophs
 - Strict anaerobes
 - soils & highly alkaline environments
 - soda lakes and alkaline soils
 - Nitrogen- fixation capabilities

18

16.3 Cell-Wall-Less Gram-Positive Bacteria: Mycoplasmas

- Key genera: *Mycoplasma*, *Spiroplasma*
- Lack cell walls
- smallest organisms capable of autonomous growth
- Parasites inhabit animal and plant hosts
- pleomorphic
 - Cells may be cocci or filaments of various lengths

19

- 20 **16.4 Actinobacteria: Coryneform & Propionic Acid Bacteria**
- Key genera: *Corynebacterium*, *Arthrobacter*, *Propionibacterium*
 - Actinobacteria form their own phylum
 - Over 30 taxonomic families
 - Rod-shaped to filamentous, usually aerobic
 - Mostly harmless
 - *Mycobacterium* tuberculosis - notable exception
 - Valuable for antibiotics and certain fermented dairy products
- 21 **16.4 Actinobacteria: Coryneform & Propionic Acid Bacteria**
- *Corynebacterium*
 - Gram-positive, aerobic, non-motile, rod-shaped
 - Form club-shaped, irregular-shaped, or V-shaped cell arrangements
 - Extremely diverse
 - *Arthrobacter*
 - Primarily soil organisms
 - Remarkably resistant to desiccation and starvation
- 22 **16.4 Actinobacteria: Coryneform & Propionic Acid Bacteria**
- *Propionic Acid Bacteria*
 - First discovered in Swiss cheese
 - Gram-positive anaerobes
 - metabolic strategy called secondary fermentation
 - energy from fermentation products produced by other bacteria
- 23 **16.5 Actinobacteria: *Mycobacterium***
- *Mycobacterium*
 - Rod-shaped organisms, exhibit acid-fastness
 - First discovered by Robert Koch
 - Cells somewhat pleomorphic
 - Separated into two groups: slow and fast growers
 - Classified into three groups based on pigmentation
- 24 **16.6 Filamentous Actinobacteria: *Streptomyces* & Others**
- Key genera: *Streptomyces*, *Actinomyces*
 - Filamentous, gram-positive bacteria
 - Produce mycelium
 - analogous to filamentous fungi
 - Over 500 species of *Streptomyces*
 - *Streptomyces* spores are called conidia
 - Primarily soil microorganisms
 - earthy odor of soil
 - Strict aerobes that produce many extracellular enzymes
- 25 **16.6 Filamentous Actinobacteria: *Streptomyces* & Others**
- *Streptomyces*
 - 50% of all isolated *Streptomyces* produce antibiotics
 - Over 500 distinct antibiotics produced by *Streptomyces*
 - Some produce more than one antibiotic
 - Genomes are typically quite large (8 Mbp and larger)
 - Knowledge of the ecology of *Streptomyces* remains poor
- 26
- 27 **III. Cyanobacteria and Prochlorophytes**
- 16.7 Cyanobacteria
 - 16.8 Prochlorophytes

28 **16.7 Cyanobacteria**

- Key genera: *Synechococcus*, *Oscillatoria*, *Nostoc*
 - Oxygenic phototrophs
 - Impressive morphological diversity
 - Unicellular (divide by binary fission)
 - Unicellular (divide by multiple fission)
 - Filamentous (with heterocysts)
 - Nitrogen fixation
 - Filamentous (nonheterocystous)
 - Branching filamentous

29 **16.7 Cyanobacteria**

- Gas vesicles
 - Keep cell in water column where there is light
- Heterocysts
 - rounded, enlarged cells
 - Anoxic environment inside
 - Site for Nitrogen fixation
 - Nitrogenase is sensitive to oxygen
- Many display gliding motility

30 **16.7 Cyanobacteria**

- Most are obligate phototrophs
- Many produce potent neurotoxins
- terrestrial, freshwater, and marine habitats
 - Can be phototrophic component of lichens
 - extensive crusts in desert soils

31 32 **16.8 Prochlorophytes**

- Key genera: *Prochloron*, *Prochlorothrix*, and *Prochlorococcus*
- euphotic zone of the open oceans
 - smallest and most abundant photosynthetic microorganism on Earth
 - 0.5–0.8 micrometers in diameter
 - 10^5 *Prochlorococcus* per milliliter of seawater

33 **IV. Chlamydia**

- 16.9 The Chlamydia

34 **16.9 The Chlamydia**

- Key genera: *Chlamydia*, *Chlamydiaphila*
- Obligately parasitic with poor metabolic capacities
 - simplest biochemical capacities of all known bacteria
- one of the leading sexually transmitted diseases

35 **IX. Green Sulfur Bacteria**

-
- 16.15 *Chlorobium* and Other Green Sulfur Bacteria

36 **16.15 Chlorobium and Other Green Sulfur Bacteria**

- Key genera: *Chlorobium*, *Chlorobaculum*, *Prosthecochloris*, *Chlorochromatium*
- phylogenetically distinct, non-motile, anoxygenic phototrophs
- Utilize H_2S as an electron donor
- Autotrophy is supported using a reversal in the citric acid cycle
- Have chlorosomes:
 - oblong bacteriochlorophyll-rich bodies bounded by a thin membrane
- Green- and brown-colored species exist

37 38 **Assignment (ch 16)**

- 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