



*Functional Anatomy of
Prokaryotic and Eukaryotic Cells*

Chapter 4



Prokaryotic vs. Eukaryotic Cells

◆ Prokaryotic cells

- No Nucleus
- No Organelles
- Cell Wall of peptidoglycan
- Binary Fission
- 1 circular chromosome

◆ Eukaryotic Cells

- Nucleus
- Organelles
- If cell wall, Cellulose or chitin
- Mitosis
- Linear chromosomes



Prokaryotic Cells

◆ Size

- Length 2u to 8u
- Diameter 2u to .2u

Morphology

cocci

bacilli

spiral

Arrangement

Cocci

- diplococci
- streptococci
- tetrads
- sarcinae
- staphylococci

bacilli

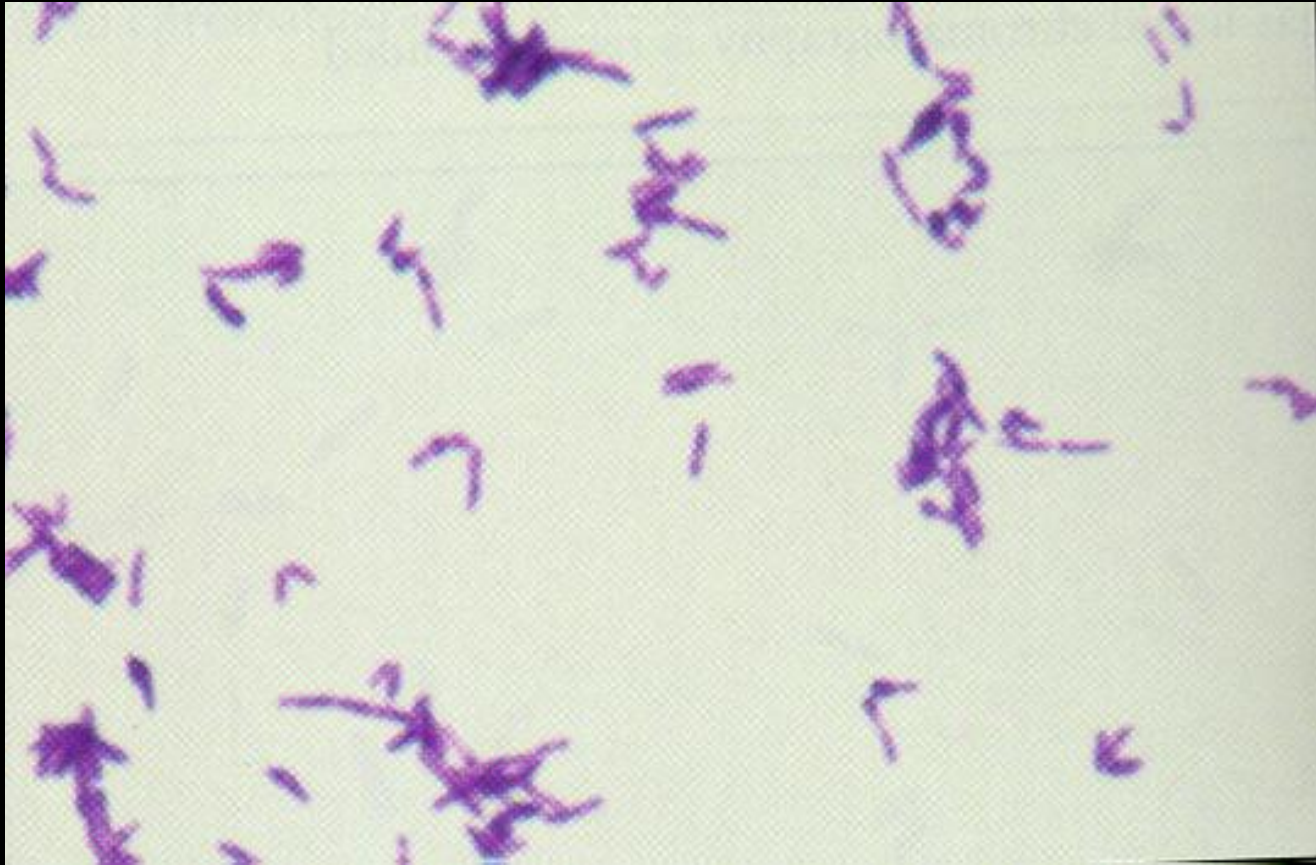
- diplobacilli
- streptobacilli
- coccobacilli

spiral

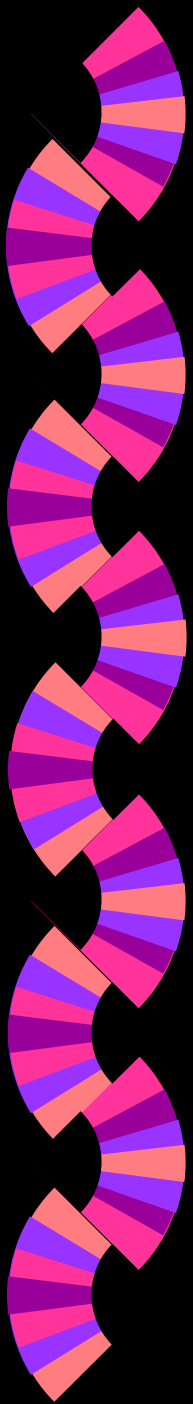
- vibrio
- spirilla
- spirochete



Monomorphic vs. pleomorphic



Corynebacterium diphtheriae





Prokaryotic Cell Structure

- ◆ Glycocalyx - term to describe substances that surround bacterial cells
- ◆ 1. Capsule
 - if substance is organized and firmly attached to cell wall
- ◆ 2. Slime Layer
 - if substance is unorganized and loosely attached to cell wall



Function of Capsule

1. Contribute to Virulence of bacteria by preventing phagocytosis by WBC's

A. *Streptococcus pneumoniae*

B. *Bacillus anthracis*



Functions of Capsules

- ◆ 2. Prevents drying out or dessication
- ◆ 3. Allows bacteria to adhere to various surfaces
 - *Streptococcus mutans* - enamel on teeth to cause dental carries
 - *Klebsiella pneumoniae* - attaches to respiratory tract



Motility

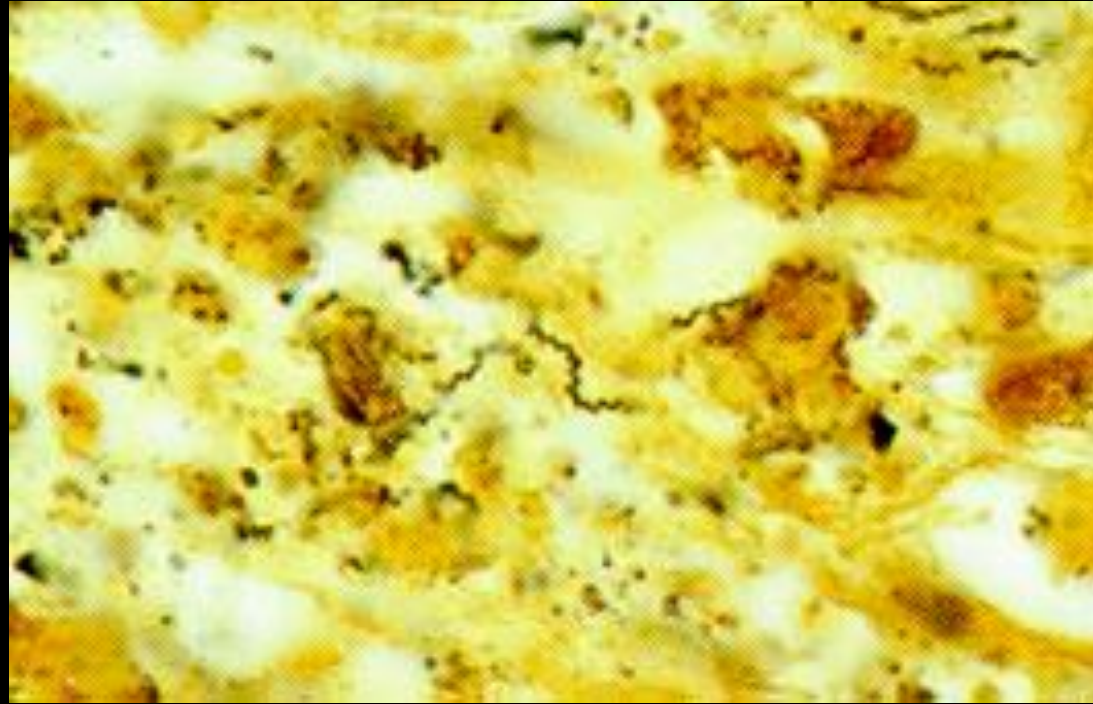
- ◆ Almost all **Spiral** bacteria are **motile**
- ◆ About 1/2 of **Bacilli** are **motile**
- ◆ Almost all **Cocci** are **non-motile**



Flagella

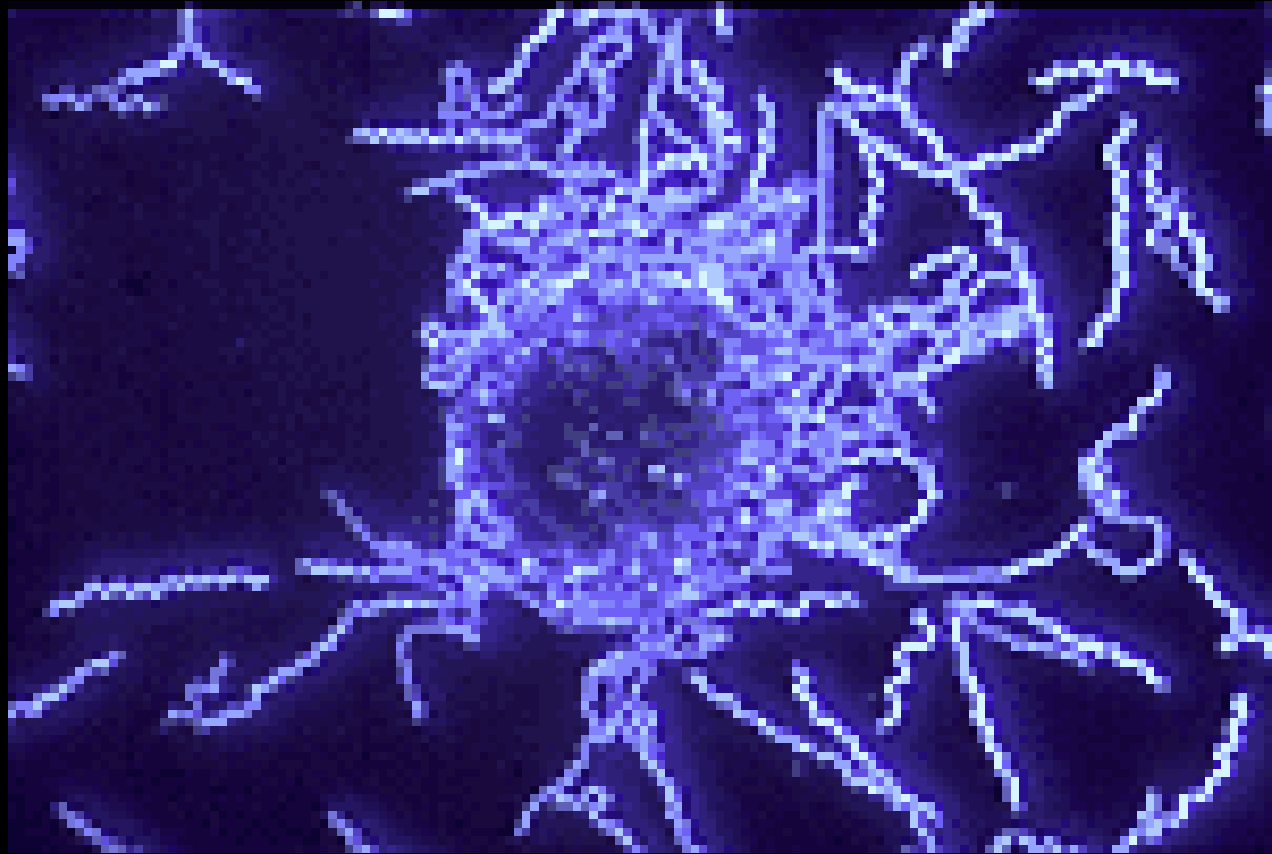
- ◆ 1. Monotrichous
- ◆ 2. Amphitrichous
- ◆ 3. Lophotrichous
- ◆ 4. Peritrichous

Axial Filament - found only in spirochetes
(flexible spirals)



Treponema pallidum





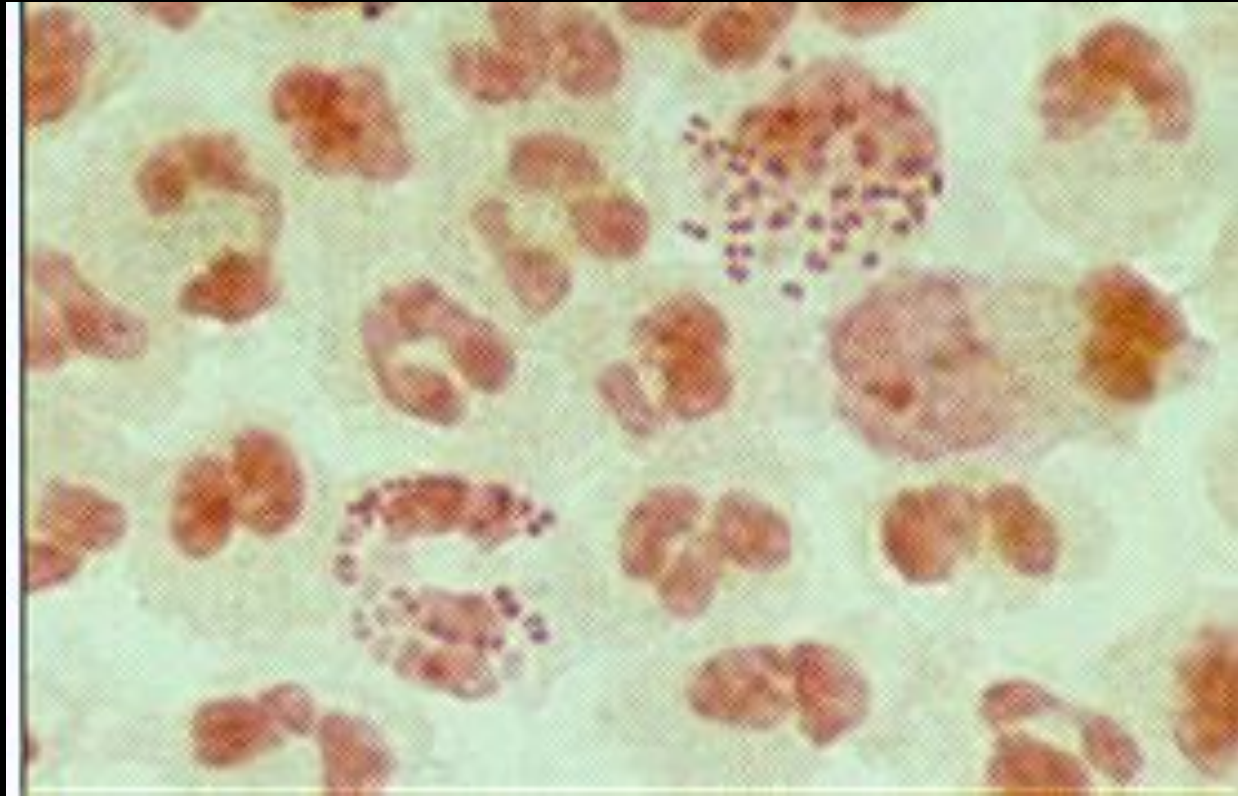
Borrelia burgdorferi





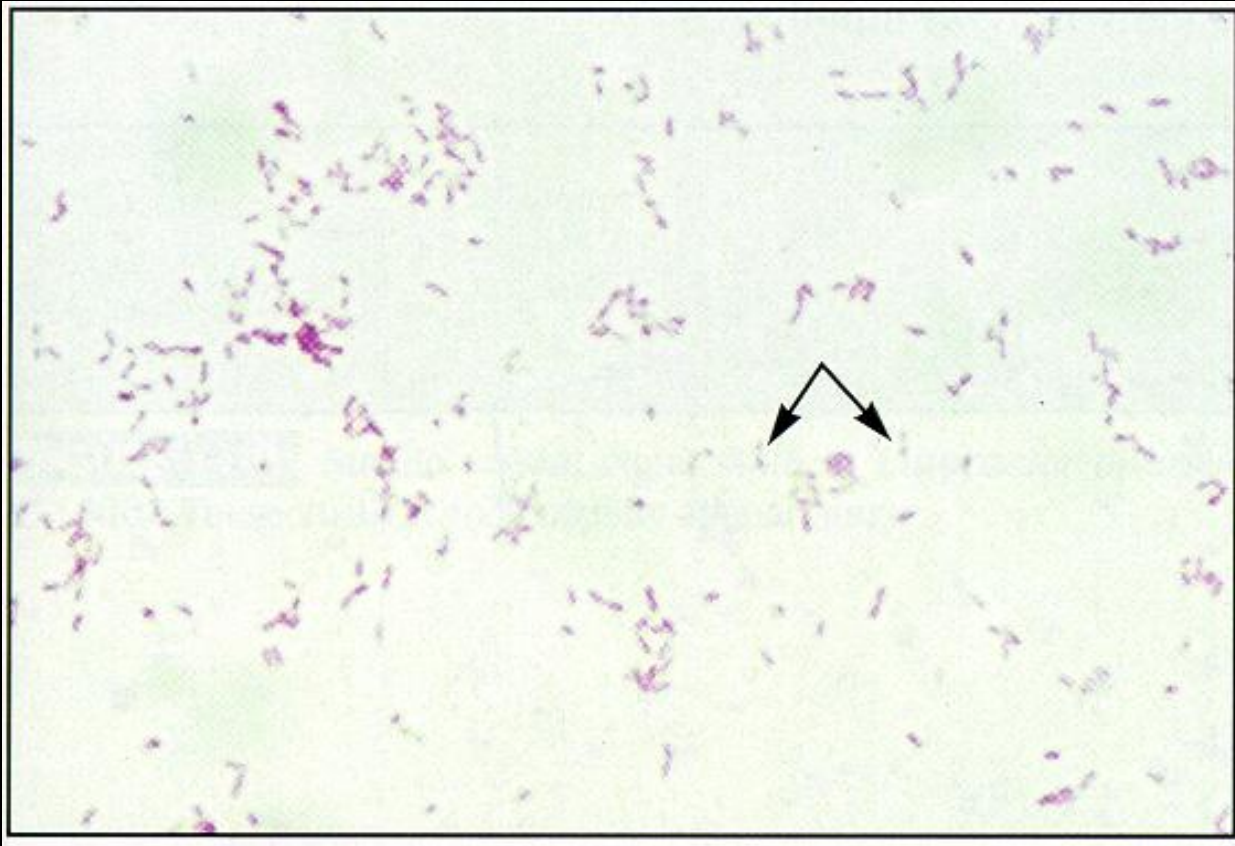
Fimbriae

- ◆ Filamentous appendages that are shorter, straighter and more numerous than flagella
- ◆ found mostly in Gram (-) Bacteria
- ◆ used for attachment not motility

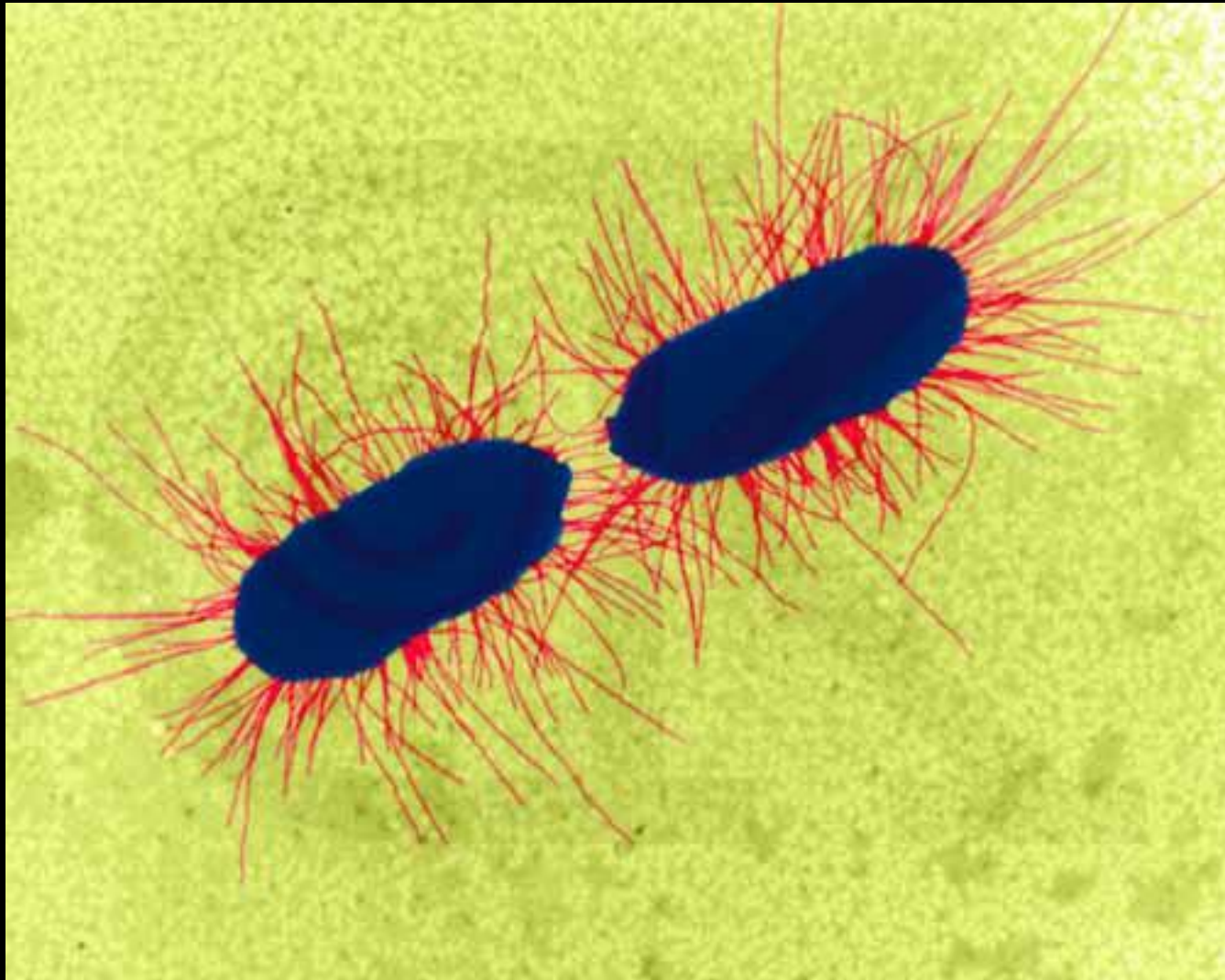


Neisseria gonorrhoeae





Bordetella pertussis



E. coli (pathogenic)



Cell Wall

- ◆ Main structural component - Peptidoglycan
- ◆ Peptidoglycan
 - repeating disaccharide units
 - polypeptides



Gram (+) Cell Wall

- ◆ NAM N-acetylmuramic acid
- ◆ NAG N- acetylglucosamine
- ◆ tetrapeptide side chains
- ◆ pentaglycine crossbridges
- ◆ teichoic acid



Gram (-) Cell Wall

- ◆ NAM
- ◆ NAG
- ◆ Tetrapeptide side chains
- ◆ pentaglycine
- ◆ 2nd Outer membrane
 - Lipopolysaccharides (LPS)
 - Lipid A
 - O Antigen



Bacterial cell wall - chemically unlike any other structure in Animal cells

- ◆ Target for drugs that can attack and kill bacteria without harming the host cell
- ◆ **MANY ANTIBIOTICS** are specifically directed at Cell Wall Synthesis
 - Penicillin
 - works by damaging the pentaglycine crossbridges of the peptidoglycan layer
 - Works best against Gram (+) bacteria



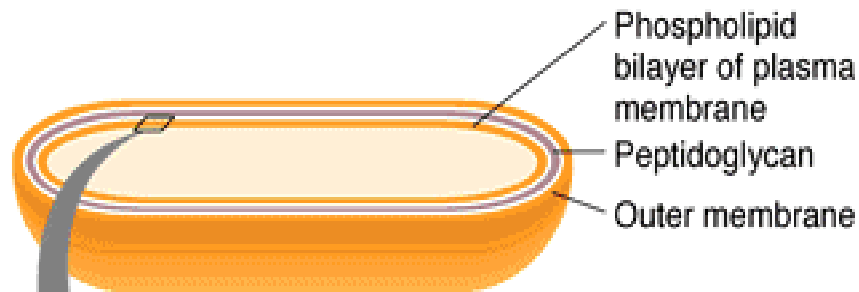
lysozyme

- ◆ Digestive enzyme that damages bacterial cell walls
- ◆ found in tears, saliva & mucus
- ◆ attacks the bond between NAM & NAG
- ◆ Works best on Gram (+) bacteria

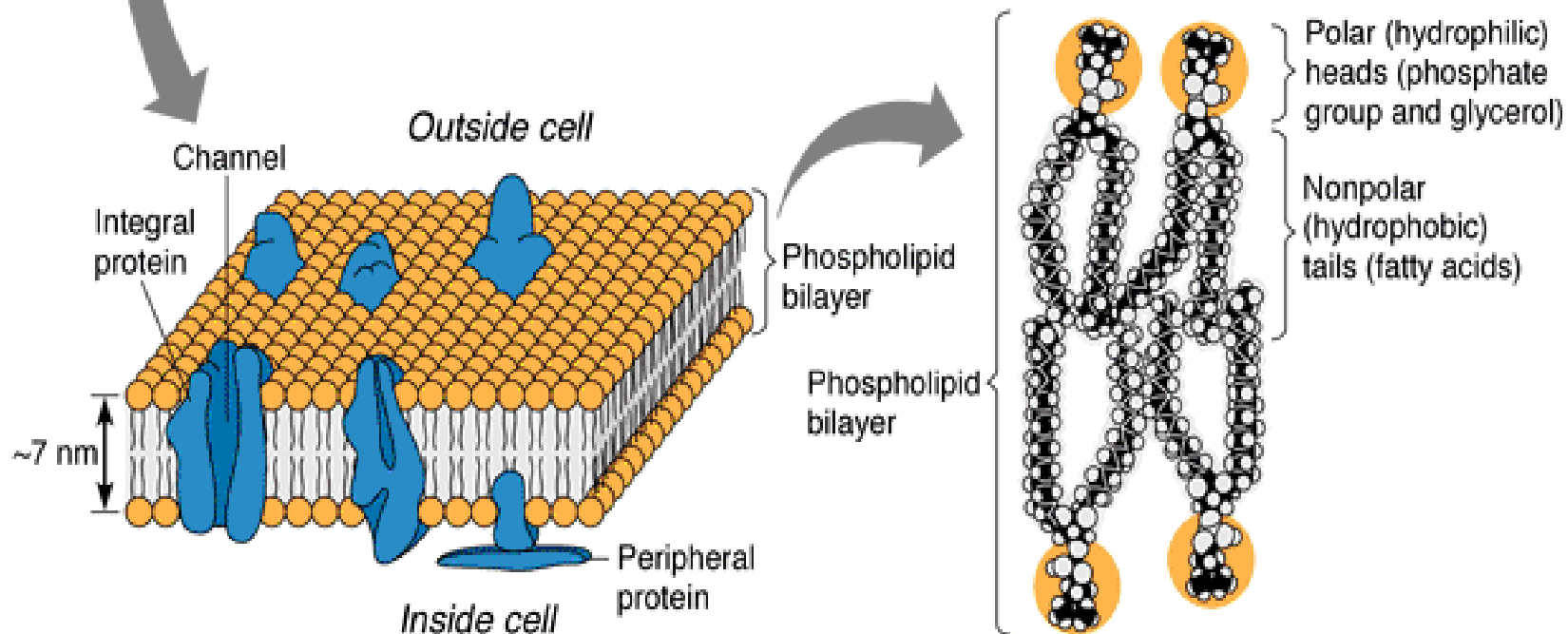


Cell Membrane (Plasma Membrane)

- ◆ 2 structural component
 - double layer of phospholipids
 - proteins
- ◆ Fluid Mosaic Model



(a) Plasma membranes in cell



(b) Phospholipid bilayer of membrane

(c) Phospholipid molecules in bilayer



Functions of Cell Membrane

- ◆ 1. Selective barrier (selectively permeable)
- ◆ 2. Secretes exoenzymes
 - amylases
 - lipases
 - peptidases
 - **CAN NOT UNDERGO PHAGOCYTOSIS**

A decorative graphic on the left side of the slide, consisting of a vertical, wavy, ribbon-like structure. It is composed of many small, overlapping, semi-circular segments in various shades of purple, magenta, and pink, creating a textured, layered appearance that resembles a cross-section of a cell membrane or a biological structure.

Functions of Cell Membrane

- ◆ 3. E.T.S. is located here
- ◆ 4. Enzymes for cell wall synthesis
- ◆ 5. If photosynthesis, enzymes are located on membranous structures called thylakoids
- ◆ 6. Mesosomes - invagination of cell membrane attached to DNA (Binary Fission)?



Antimicrobial Agents

- ◆ Disinfectants and Antiseptics
 - many are aimed at disrupting the cell membrane



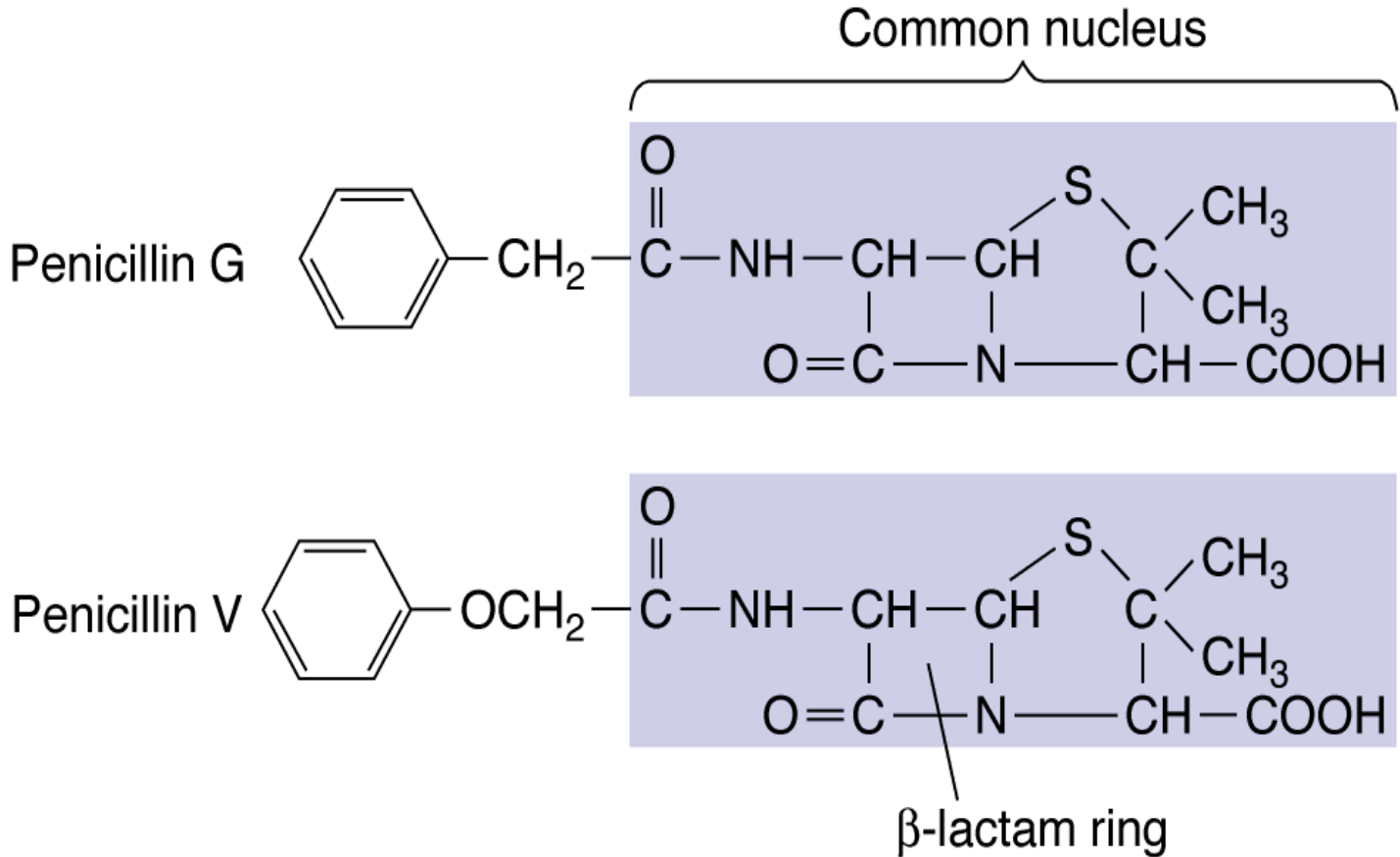
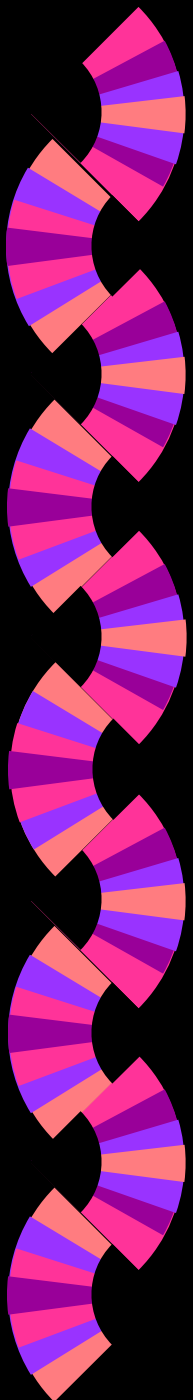
Nuclear area (nucleoid)

- ◆ 1 circular chromosome (ccDNA)
- ◆ attached to a mesosome
 - segregation of DNA during Binary Fission

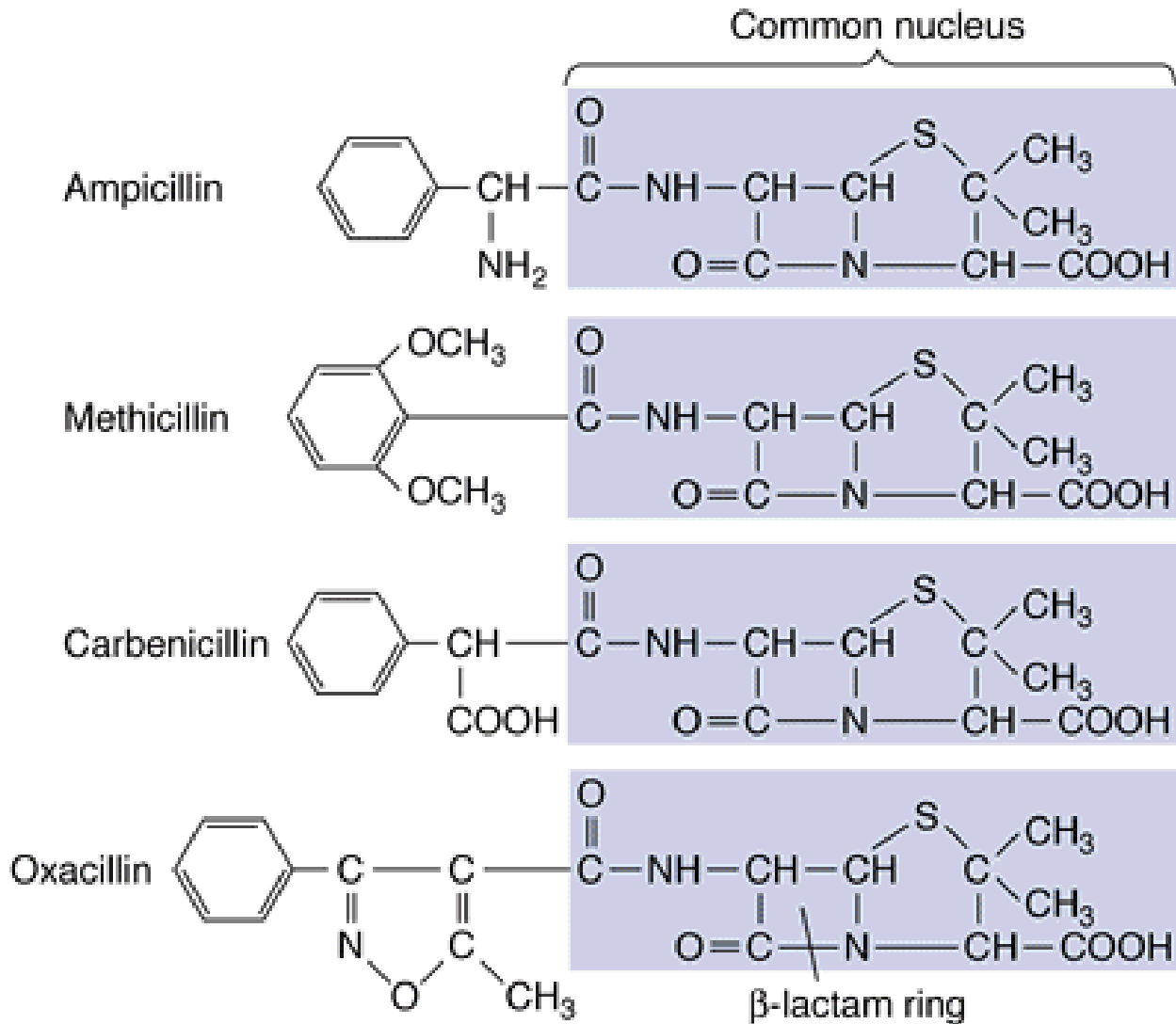


Plasmids

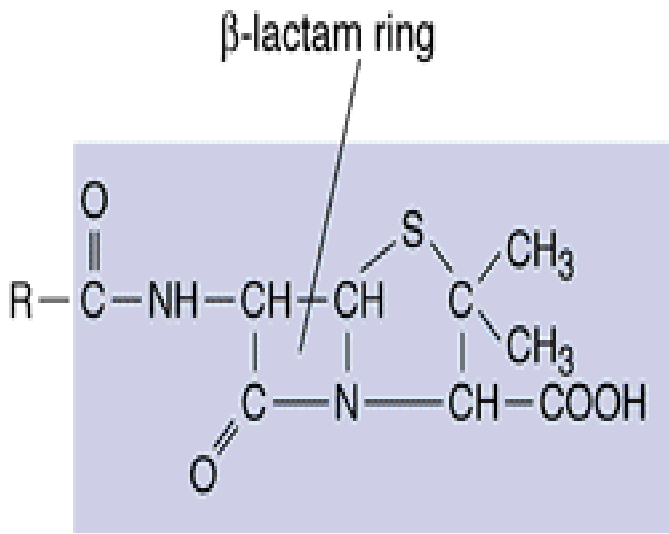
- ◆ Small circular, extra-chromosomal pieces of DNA
- ◆ 5 to 100 genes
- ◆ Code for auxiliary metabolic functions:
 - antibiotic resistance
 - penicillase
 - production of toxins
 - *E. coli* 0157:H7



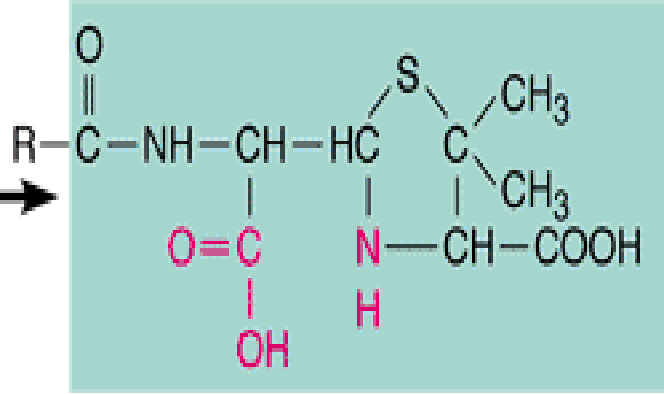
(a) Natural (antibiotic) penicillins



(b) Semisynthetic penicillins



Penicillin



Penicilloic acid



Ribosomes - protein synthesis

- ◆ Prokaryotic Ribosome

- ◆ 70 S

- 50 S

- 30 S

- ◆ Eukaryotic Ribosomes

- ◆ 80 S

- 60 S

- 40 S



Selective Toxicity

- ◆ Some antibiotics are aimed at the 70 S ribosomes of bacterial cells
- ◆ Streptomycin, Neomycin, Erythromycin and Tetracycline work by inhibiting protein synthesis by disrupting the 70 S ribosome



Endospores - formed under periods of environmental stress

- ◆ Only found in Gram (+) Bacteria
- ◆ *Bacillus*
 - *Bacillus cereus*
 - *Bacillus anthracis*
- ◆ *Clostridium*
 - *Clostridium tetani*
 - *Clostridium botulinum*
 - *Clostridium perfringens*



Endospores

- ◆ Extremely resistant to heat, cold, chemicals, lack of water, etc.
- ◆ Most vegetative bacterial cells are killed at temps. above 70 C (160 F)
 - Endospores can survive boiling water for several hours (some for as long as 20 hours)



Endospores

- ◆ Spores can remain viable for weeks, months, years
- ◆ *Thermoactinomyces vulgaris*
 - spores found in Minnesota were 7,500 years old and still germinated



Eukaryotic Cell - Organelles

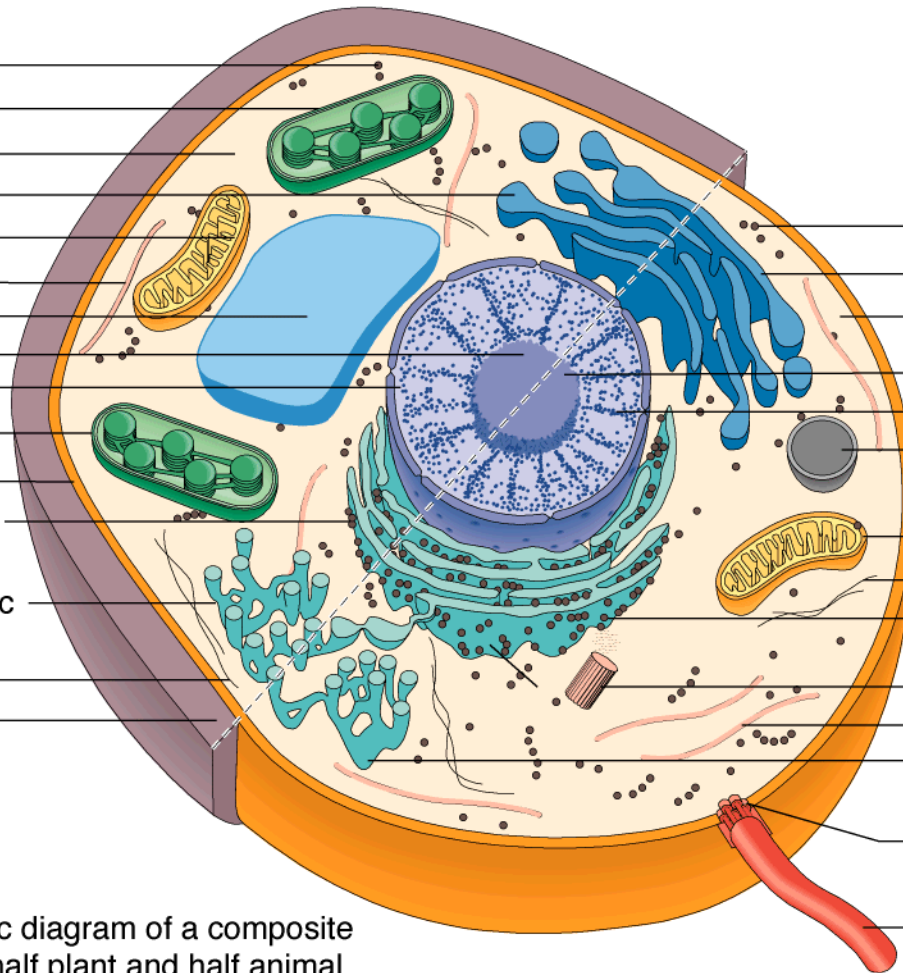
- ◆ Nucleus
- ◆ Nucleoli
- ◆ Endoplasmic Reticulum (E.R.)
 - rE.R.
 - sE.R.
- ◆ Ribosomes
- ◆ Golgi Body
- ◆ Lysosomes

PLANT CELL

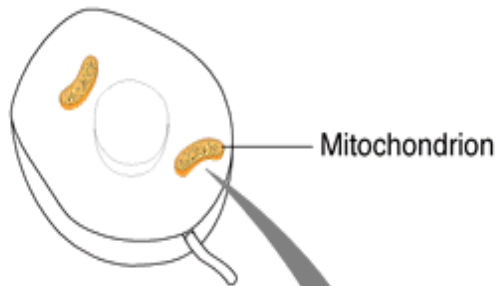
ANIMAL CELL

- Ribosome
- Chloroplast
- Cytoplasm
- Golgi complex
- Mitochondrion
- Microtubule
- Vacuole
- Nucleolus
- Nucleus
- Thylakoid
- Plasma membrane
- Rough endoplasmic reticulum
- Smooth endoplasmic reticulum
- Microfilament
- Cell wall

- Ribosome
- Golgi complex
- Cytoplasm
- Nucleolus
- Nucleus
- Lysosome
- Plasma membrane
- Mitochondrion
- Microfilament
- Rough endoplasmic reticulum
- Centrioles
- Microtubule
- Smooth endoplasmic reticulum
- Basal body
- Flagellum



(a) Highly schematic diagram of a composite eukaryotic cell, half plant and half animal



Outer membrane

Inner membrane

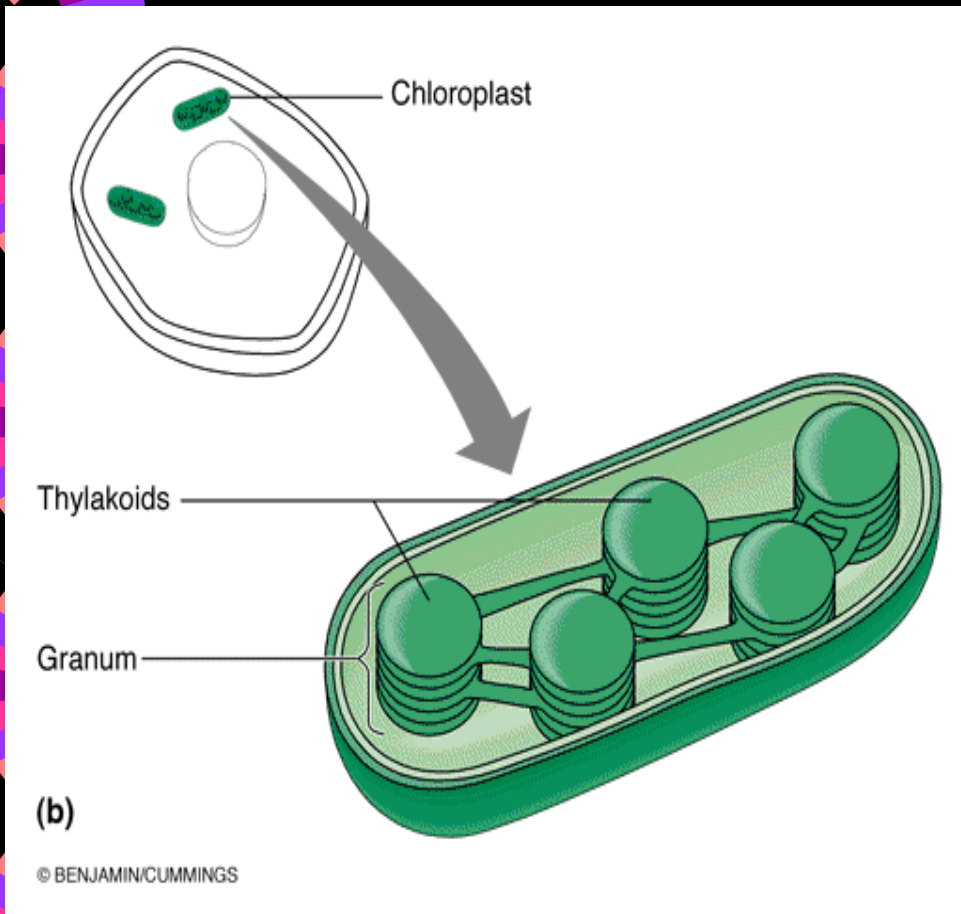
Cristae

Matrix

(b)

© BENJAMIN/CUMMINGS

- ◆ 70 S Ribosomes
- ◆ Circular chromosomes
- ◆ Replicate on their own

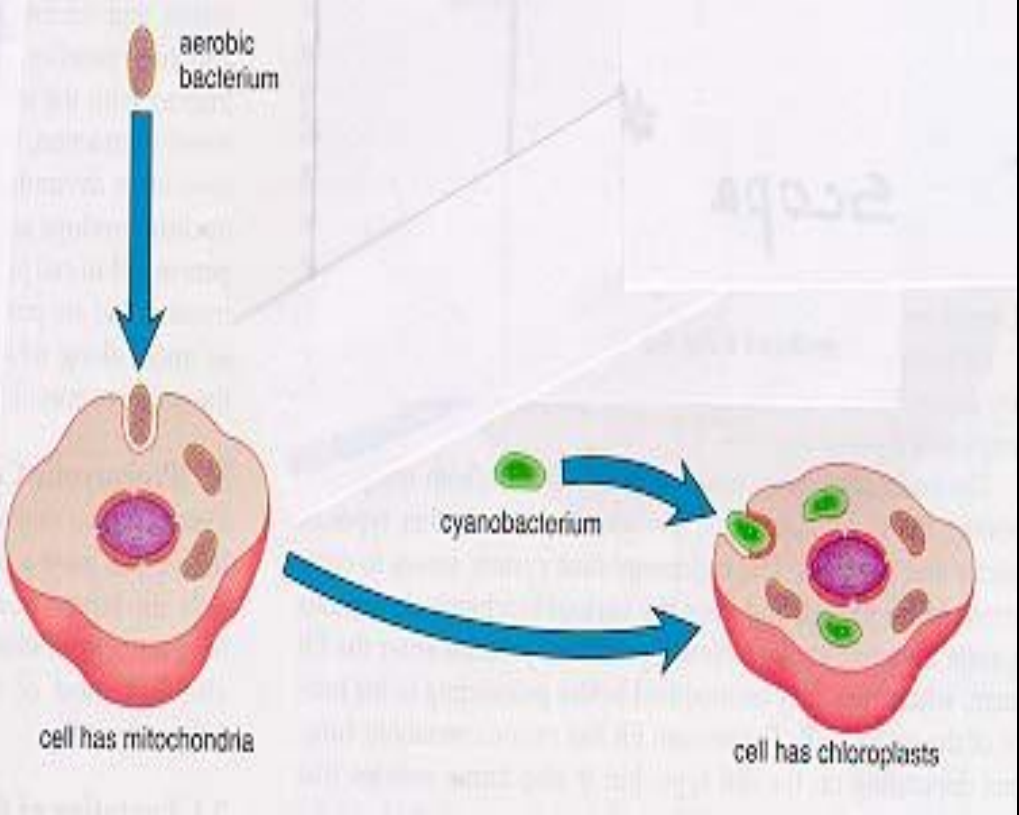
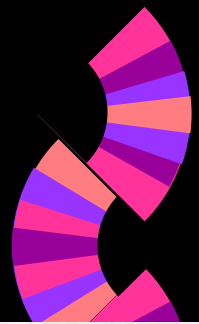


- ◆ 70 S Ribosomes
- ◆ Circular chromosomes
- ◆ Replicate on their own



Endosymbiotic Hypothesis

- ◆ Mitochondria and chloroplasts were once free living prokaryotes that were engulfed by Amoeba-like Eukaryotic cells



- ◆ Same size and shape as bacteria
- ◆ Double membrane
- ◆ 70 S Ribosomes
- ◆ Circular chromosomes
- ◆ Replicate on their own

