A Typical Bacterial Cell

How does prokaryotes differ from eukaryotes?

- Most prokaryotes lack internal membrane system

What are bacterial cell shapes?

- Cocci(spheres), Bacilli(rods), Vibrios(comma), Coccobacilli-(very short rods), Spirilla(rigid helices), Spirochetes(flexible helices),Mycelium, Pleomorp-hic(variable in shape)

What are the examples of smallest and largest bacteria?

- Smallest - Mycoplasma
  Largest - Epulopiscium fishelsoni

What causes bacteria to have a particular size and shape?

- To increase the S/V ratio for more efficient nutrient uptake and protection from predator

Bacterial Cytoplasmic Structures

Types of Cytoskeletons

- Microtubules
- Microfilaments
- Intermediate filaments

Examples of Cytoskeletons

- FtsZ
- MreB/Mbl
- -CreS

Bacterial Cytoplasmic Structures (cont)

FtsZ

- Forms a ring at the center of a dividing cell
- Required for the formation of septum that wull separate the daughter cells

MreB/Mbl

- Only found in rod shaped cell
- Determine cell shape in rod-shaped cell
- Determine cell shape by properly positioning the machinery needed for peptid-oglycan synthesis

CreS

- Rare
- Give bacteria the curved shape

What are inclusions?

- Granules of organic/inorganic material that are stockpiled by the cell for future use

Types of inclusions

- 1. Storage inclusions - Storage for nutrients, metabolic end products, energy, building blocks
  2. Microcompartments- Have specific functions (Carbo-xymes as example)
  3. Gas vacuoles - Provide buoyancy in gas vesicles
  4. Magnetosomes- Identify earth's magnetic field

Bacterial Cytoplasmic Structures (cont)

What is the Nucleoid?

- Location of chromosomes and associated proteins
- Not membrane bounded therefore mix with cytoplasma

How microbes managed to fit their chromosomes into the small space of nucleoid?

- 1. Using physical factors - Macromolecular crowding and Supersoiling
  2. Using architectural proteins - NAPs (HU Protein)

What is Plasmids?

- 1. Double -stranded DNA molecules that can exist independently of the chromosome
  2. Episomes - Can integrate into chromosome and replicate with the chromosome
  3. Contain gene that confer selective advantage to host

The Bacterial Endospore

What is endospores?

- Complex, dormant structure formed by rods and cocci bacteria only

The Bacterial Endospore (cont)

How are endospores structurally different from vegetative cells?

- Consist of a core surrounded by several layers varying in composition.
  1. Core - Has ribosomes and nucleoid and low water content
  2. Inner Membrane
  3. Germ cell wall- Contain peptidoglycan that will form a cell wall in vegetative state
  4. Cortex - occupy half of the endospore's volume
  5. Outer membrane
  6. Coat- Composed of a high cross-linked different proteins
  7. Exosporium - Made up of glycoproteins

What makes endospores so resistant to harsh environmental conditions?

- There are various layers to protect its enzymes and DNA
  1. The coat - protects the endospores from chemicals and lytic enzymes (lysozymes)
  2. The inner core - Extremely impermeable to various chemicals, including those that damage the DNA
  3. The core - High water content, high amount of Ca-DPA, low pH Ph

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Bacterial Plasma Membranes

How bacterial lipid changes in different temperatures?

Saturation levels of membrane lipid depends on the environment conditions.
1. Hot - Have more saturated and long-chained fatty acid
2. Cold - Have more unsaturated and short-chained fatty acids

What is growth factors?

Molecules that bacteria need for survival but can't synthesize and need to obtain from the environment

Classes of growth factors

1. Amino acids - Protein synthesis
2. Purines and Prymidines - Nucleic acid synthesis
3. Vitamins - Enzyme Cofactors
4. Heme - Hemoproteins

How bacteria uptake nutrients?

Microbes can only take in dissolves particles across a selectively permeable membrane by passive and active transports

What are the transport systems used?

1. Facilitated Diffusion
2. Active Transport
3. Group Translocation

Bacterial Plasma Membranes (cont)

Passive Diffusion

1. Molecules move down the concentration gradient
2. Water, oxygens and carbon dioxide move across the membrane this way

Facilitated Diffusion

Diffusion of molecules across the plasma membrane down the concentration gradient with the assistance of protein carrier/ channel

Primary Active Transport (ABC Transporter, Uniport)

Uses energy provided by ATP hydrolysis to move substance against a concentration gradients

Secondary Active Transport (Using proton and sodium gradient, Cotransport-Symport/Antiport)

uses ion concentration gradients to cotransport substances

Group Translocation (Phosphorelay System)

A molecule is chemically modified as it is brought into the cell

What is the advantage of active transport compared to facilitated transport?

Allow bacteria to uptake nutrients when they liv in a low nutrient concentration environment

Bacterial Plasma Membranes (cont)

Why microorganisms require iron?

Important for building molecules needed in energy-conserving processes

What is siderophores?

Low molecular weight molecules secreted by bacteria that helps to bind ferric ion and supply it to the cell when the iron uptake is difficult

Bacterial Cell Wall

What are the types of bacteria based on Gram Stain?

Gram-positive bacteria and Gram-negative bacteria

What is Peptidoglycan?

Rigid structure outside the cell membrane

Gram-positive bacteria

- Stain purple
- Thick peptidoglycan
- Contain large amount of teichoic acids(negatively charged)
- Small periplasmic space

Gram-negative bacteria

- Stain red/pink
- Thin peptidoglycan
- No teichoic acids but have lipopolysaccharides
- Bigger periplasmic space

Functions of cell wall

- Maintain bacteria shape
- Protect cell from osmotic lysis and toxic materials
- Contribute to pathogenicity

Bacterial Cell Wall (cont)

Peptidoglycan structure are composed of what identical subunits?

1. Two alternating sugars - NAG and Nam
2. Amino acids - Alternating L- and D- amino acids

Three amino acids not found in proteins of other organism

- D-glutamic acid
- D-alanine
- Meso-diaminoplemic acid
- Help to protect the cell wall against degradation by most peptidase

Peptidoglycan chains are crossl-inked by peptides for strength

- Composed of alternating D- and L-amino acids
- Gram-positive bacteria have more cross-linking
- Gram-negative bacteria have lesser crowss-linking

Lipopolysaccharide consist of and its functions?

1. Lipid A - Endotoxins which is harmful
2. Core polysaccharide - Contributes to negative charge on cell surface
3. Side O chain- Helps bacteria to escape human immune system by changing the O side chain

What are the function of Teichoic acids?

- Help maintain cell envelope
- Protect from environmental substances
- May bind to host cells

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External Structures

What are the external structures of bacteria and archaea?

- Pili/Fimbriae
- Flagella

Function of Fimbriae

Attachment to surface

Functions of Type IV Pili

- Motility
- Twitching

Function of Sex Pili

Transfer of DNA from one bacterium to another

What is Flagella?

Threadlike, locomotor appendages extending outward from plasma membrane and cell wall

Functions of Flagella?

- Motility
- Swarming
-Attachment to surfaces

Each bacterial flagellum is composed of?

- Filament
- Hook
- Basal body

What is self-assembly? Why this make sense in flagellum?

- A system's components organize into a functional structures as the result of interactions between the components without external directions
- Because many components of the flagellum lie outside the cell envelope and must be transported out of the cell for assembly

Components Outside of the Cell Wall

What are the outermost layers of bacterial cell and its function?

- Glycocalyx (Capsules/Slime Layers)
- S Layers

Glycocalyx

- Consist of a network of polysaccharides extending from the surface of the cells
- Capsules and Slime Layer

Capsule

- Well organized
- Not easily removed
- Resistance to phagocytosis

Slime Layer

- Unorganized
- Easily removed
- AId in motility

S Layer

- Structured layers of proteins/ glycoproteins that self-assemble
- Adhesion to surface

How does an S-Layer differ from a proteinaceous capsule?

Monomer of S-Layer have the ability to self-assemble

Bacterial Motility and Chemotaxis

What are the types of motility?

1. Swimming - Flagella
2. Swarming - Flagella
3. Spirochete motility
4. Twitching motility
5. Gliding motility

Bacterial Motility and Chemotaxis (cont)

Bacterial Flagellar Movement

- A rigid helix that rotates like a propeller to push the bacterium through the water
- CCW- Froward motion
- CW- Cell stop and tumble

Mechanism of Flagellar Movement

2 parts of motor producing torque - Rotor and Stator
1. Rotor - C ring and MS ring turn and interact with stator
2. Stator- Mot A and Mot B proteins produce energy through PMF

What are the power used by most flagellar motors?

- Difference in charge
- Difference in pH

Swarming

- Occur in group
- Mediated by flagella
- Occurs on moist surfaces

Spirochete

- Flagella located around the cell and remain within periplasmic space
- Rotate when the outer membrane rotate

Myxococcus spp. exhibit both twitching and gliding motility

1. Twitching - Jerky movement brought by the type IV pili
2. Gliding - Smooth

Bacterial Motility and Chemotaxis (cont)

What is chemotaxis?

Movement towards a chemical attractant or away from a chemical repellent

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