Introduction to Bacteria: Classification, Morphology and Structures
Introduction

• Prokaryotic organisms.
• Vary in sizes, measure approximately 0.1 to 10.0 μm
• Widely distributed. It can be found in soil, air, water, and living bodies.
• Some bacteria can cause diseases for human, animals and plants.
• Some bacteria are harmless (i.e. live in human bodies as normal flora)
Size of Bacteria

- Unit of measurement in bacteriology is the micron (micrometre, µm)
- Bacteria of medical importance (0.2 – 1.5 µm) in diameter (3 – 5 µm) in length
Bacterial Morphology

- Rods – bacilli
- Coccoid shaped
- spirilla
Bacterial Morphology

- Cocci – spherical / oval shaped major groups
- Bacilli – rod shaped
- Vibrios – comma shaped
- Spirilla – rigid spiral forms
- Spirochetes – flexible spiral forms
- Actinomycetes – branching filamentous bacteria
- Mycoplasmas – lack cell wall
Reproduction

- Binary fission
Bacterial Structure

A. The envelope:
   1. Cytoplasmic membrane
   2. Cell wall (Peptidoglycan)
   3. Extracellular polysaccharides: capsules, microcapsules and loose slime
   4. Appendages
   5. Antigenic variation

B. Cytoplasmic components
Bacterial Structure

1. Cytoplasmic membrane
Bacterial Structure

2. Cell wall
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Gram-negative Bacteria</th>
<th>Gram-positive Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Structure</td>
<td>They have a thin lipopolysaccharide exterior cell wall.</td>
<td>The peptidoglycan layer is thick</td>
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<tr>
<td>Effect of Dye</td>
<td>do not retain the crystal violet dye, and react only with a counter-stain, generally stain pink.</td>
<td>retain the crystal violet dye, and change into purple during staining identification.</td>
</tr>
</tbody>
</table>
| Effect of Antibiotics | • resistant to penicillin  
• contain an endotoxin called LPS                                                              | susceptible to the enzyme lysozyme and to penicillin                                    |
| Flagellum             | If present, the flagellum has four supporting rings, namely 'L' ring, 'P' ring, 'M' ring, and 'S' ring. | The flagellum has two supporting rings, in the peptidoglycan layer, and in the plasma membrane. |
| Teichoic Acids        | absent.                                                                                 | present.                                                                               |
| Liproproteins         | They are attached to the polysaccharide backbone.                                       | absent.                                                                                |
| Periplasmic Space     | present.                                                                                | absent.                                                                                |
Bacterial Structure

**Gram Positive**

1. Fixation
2. Crystal violet
3. Iodine treatment
4. Decolorization
5. Counter stain (safarin)

**Gram Negative**
Bacterial Structure

3. Extracellular polysaccharides:
   – Capsules
   – Microcapsules
   – Loose slime

4. Appendages
   – Flagella
   – Pili

5. Antigenic variation
   – important in virulence & immunity
Bacterial Structure

B. Cytoplasmic components:

1. Cytoplasm
   - Contains chromosomal DNA, ribosomes and various type of nutritional storage granules.
   - Contains no organelles

2. Nuclear material (nucleoid or nuclear body)
   - Consist of one long, double-stranded, circular DNA molecule
   - R factor
   - binary fission
Bacterial Structure

B. Cytoplasmic components:

3. Ribosomes
   - function as the active center of protein synthesis

4. Cytoplasmic inclusion
   - Sources of stored energy
SPORES AND SPORULATION

• Highly resistant resting stages formed during adverse environment (depletion of nutrients)
• Endospores
  – Spore germination

• Medical significance of sporulation
  – Bacillus species
  – Clostridium species
Bacterial classification

Bacteria

- G+
  - Rod
  - Cocci
  - + spore -

- G-
  - Rod
  - Cocci
  - Spiral

- AF
- WL
- IC

- + +/- -O₂
Bacterial classification

A. Wall structure
   1. Gram +
      • *Staphylococcus, Streptococcus, Clostridium, Bacillus*
   2. Gram -
      • Enteric, respiratory and others
   3. Acid-fast
      • *Mycobacterium*
   4. Wall-less
      • *Mycoplasma*

B. Unusual
   – Obligate intracellular
      • *Rickettsia, Chlamydia*
Bacterial classification

C. Cell morphology

1. Shapes
   • Rod
   • Cocci
   • Spiral

2. Associations
   • Individual
   • Diplo-
   • Staphylo-
   • Strepto-
Bacterial classification

D. Growth characteristics

1. Oxygen requirement
   • Aerobic
   • Anaerobic, Microaerophilic, aerotolerant
   • Facultative

2. Spore formation

3. Intracellular/extracellular

4. Fastidious/non-fastidious
Bacterial classification

- Gram-positive rods
  - Sporeformers
    - Aerobic or facultative anaerobes: *Bacillus*
    - Obligate anaerobes: *Clostridium*
  - Non-sporeformers
    - Regular shape and staining properties: *Listeria, Erysipelothrix*
    - Irregular shape and staining properties
      - Non-acid-fast: *Corynebacterium, Propionibacterium*
      - Acid-fast: *Mycobacterium*
      - Filamentous, branching cells: *Actinomyces, Nocardia*
Medically important bacteria

**Oral site**
- Gram-positive bacteria (usually *Streptococcus* spp.)
- *Candida* spp.

**Respiratory-site ventilator and lungs**
- Gram-negative bacteria (*Pseudomonas* spp., *Acinetobacter* spp., *Enterobacteriaceae*, etc.)
- Gram-positive bacteria (*Staphylococcus* spp., etc.)
- Fungi (*Candida* spp., *Aspergillus* spp., etc.)

**Burn wound site**
- Gram-negative bacteria (usually *Pseudomonas* spp.)
- Gram-positive bacteria (usually *Staphylococcus* spp.)
- Fungi (usually *Candida* spp. but sometimes *Aspergillus* spp.)

**Cutaneous site and vascular catheters**
- Gram-positive and Gram-negative bacteria (usually *Staphylococcus* spp.)
- *Candida* spp.

**Intra-abdominal site**
- Gram-negative bacteria (usually *Enterobacteriaceae*)
- Gram-positive bacteria (usually *Enterococcus* spp.)
- *Candida* spp.

**Lower reproductive tract**
- Gram-negative bacteria
- Gram-positive bacteria
- Fungi (usually *Candida* spp. but sometimes *Cryptococcus neoformans*)

**Urinary site with catheters**
- Gram-negative bacteria (*Pseudomonas* spp. and *Enterobacteriaceae*)
- Gram-positive bacteria
- *Candida* spp.
Laboratory diagnosis

1. **Specimen:**
   - Pus from abscesses, wounds, burns
   - Sputum
   - Faeces or vomit
   - Blood
   - Mid-stream urine
   - Anterior nasal
Laboratory diagnosis

2. Culturing of specimens and Microscopy:
   – Blood agar and MacConkey agar
   – Mannitol salt agar
   – Incubation at 37 °C for 24-48 h

3. Biochemical Identification:
   – Gram stain
   – Catalase test, Coagulase test, DNAse test, Oxidase test

4. Rapid indirect identification:
   – Latex Agglutination
   – Quantitative (PCR)
   – Antibody reactions (ELISA)