1.89, Environmental Microbiology
Prof. Martin Polz
Lecture 3

Cell-wall Surface

- **Bacteria**
  2 types:
  - Gram negative (G^-)
  - Gram positive (G^+)

  All have "peptidoglycan" = murein in cell wall, capable of withstanding huge internal pressures.

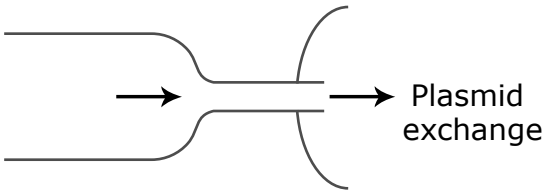
  G^+:
  - ~ 90% murein + teichoic acids (recognized by immune system) in cell wall
  - Cell wall is resistant to hydrophobic substances & dessication.
  - Abundant in soil because can withstand drying up & hydrocarbons released by plants. Present in gut bile salts.

  G^-:
  - ~ 10% murein, additional outer membrane
  - The murein layer sits between the cytoplasmic inner & outer membranes in a space called the periplasm.
  - The outer membrane has Lipopoly Saccharides (LPS) anchored to it. LPS's have O-specific side chains that are specific to strains of bacteria. These side chains are recognized by our immune system & are attached to a "core" → carbohydrate composition of core is relatively invariant.
  - Resistant to hydrophobic substances.
  - Can attach to surfaces.
  - Have porins = membrane tunnels which allow small molecules (600-700 Da) through.
  - Periplasmic space – provides "additional reaction volume" for cell; often contains enzymes & binding proteins.
  - Periplasmic space - enzyme & binding proteins (BPs) → allow for detoxification of specific substrates.

- **Archaea**: has pseudomurien

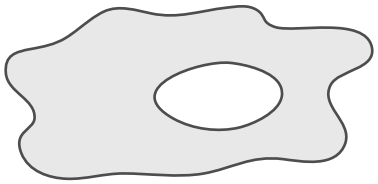
  - Additional cell surface structures

    - Fimbriae & pili – proteinaceous filaments that help mediate attachment to surfaces & allow for the exchange of genetic material ⇒ "Sex" pili



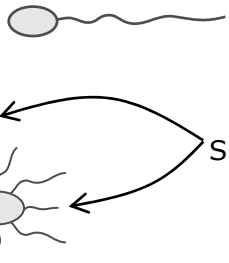
    - S-layers – crystalline protein layers on cell surfaces, act as filters

- Capsules – carbohydrate slimes exuded by bacteria; highly amorphous; protect against predation; capsules reduce growth → protect against predators, but makes it more difficult to obtain nutrients: example: tuberculosis.



- Flagella & motility: many motile, but not all
  - Flagella → swim at 50 μm/s (upto 300 μm/s)
  - Gliding
  - Gas vesicles

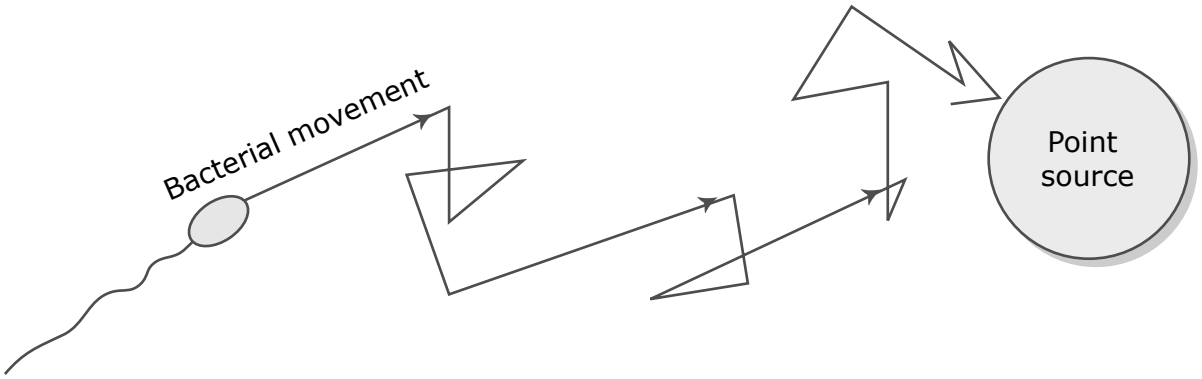
- Flagella: 1 or more/cell
  - Different from eukaryotic whip
  - Polar: at one end
  - Penitrichous
  - Single multiple → Protein gradient establishes power



Flagellum can turn in both directions:
Counter Clockwise Rotation → runs
Clockwise Rotation → tumbles backward

forward →

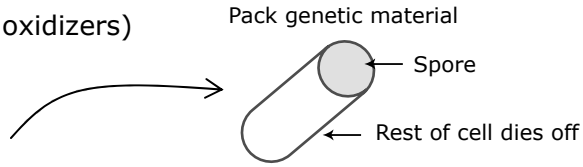
- Flagella: good because allows bacteria to quickly move towards a point source of nutrient so they can grow stronger than their competitors; can't sense gradient, so does a random walk, but goes in right direction because runs in right direction are longer



+ axis: chemo → sense chemicals
photo → sense light
magneto → sense magnetic field

Ecological Significance: μ gradients can determine global rate of biodegradation.
Refer to readings also (Fenchel)

- Storage Polymers
  - C: glycogen in form of granules
    Polyhydroxyalkanoates (natural plastic - biodegradable)
  - P: polyphosphates
  - S: elemental sulfur (S - oxidizers)
  - Fe: magnetosomes
- Endospores: endurance stages
  : allows bacteria to last for tens of thousands of years



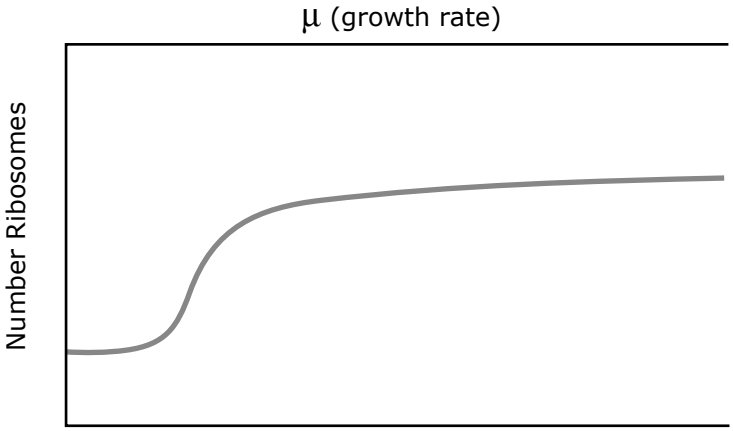
Internal Structures

- Ribosomes: turn mRNA into proteins (translation)

Evolutionary significance: highly conserved structure & function!

→ 2 subunits

52 proteins
- Large (50 S): 23 S Ribosomal RNA (rRNA) → 3,000 NT long, 5 S
- Small (30 S): 16 S tRNA ~ 1,500 NT



Numbers of ribosomes in a cell are tightly linked to growth rate:
- e.coli – fast ~ 1,000 ds
- e.coli – slow ~ 10-100 ds

When cell lacks nutrients, it eats its own ribosomes to survive (shrinks) because ribosomes make up much of all volume.