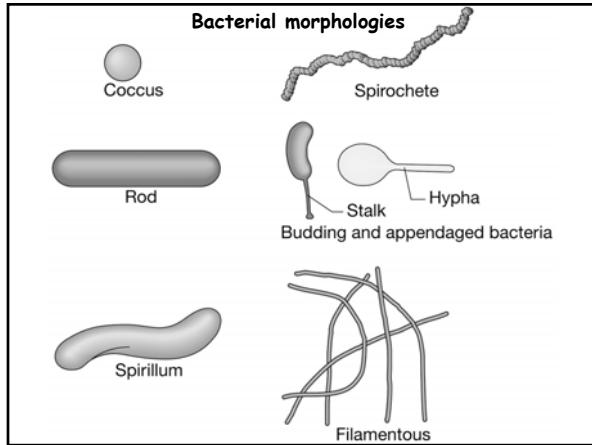
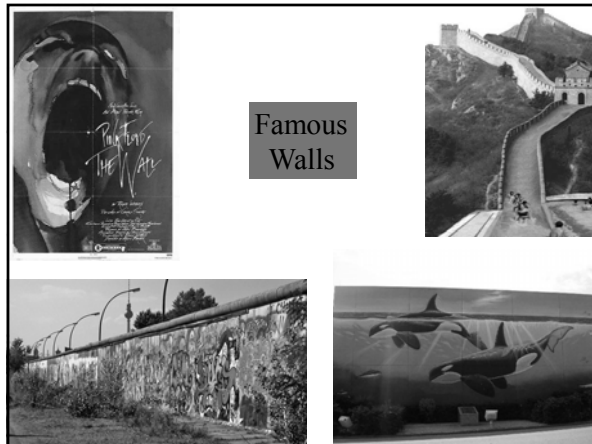


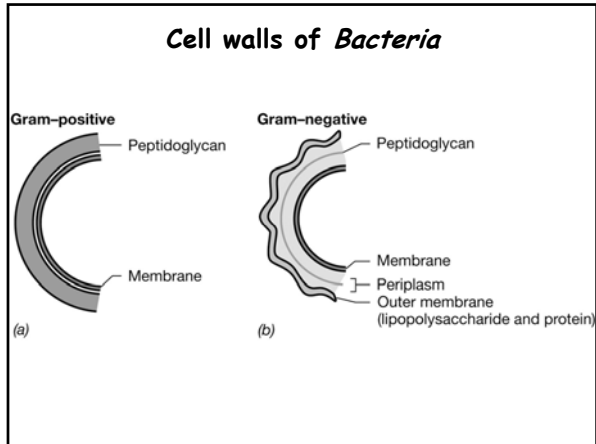
Comparing Bacteria, Archaea and Eucarya

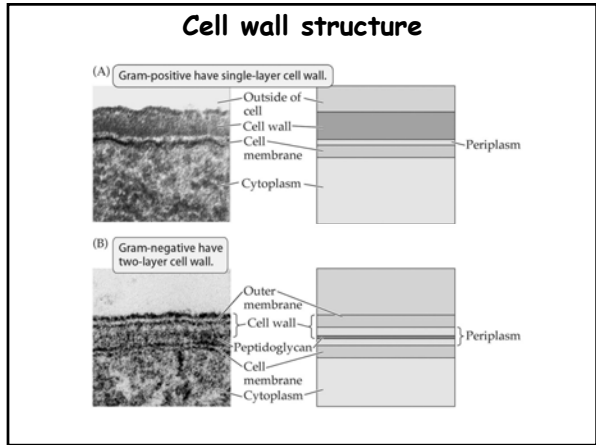
Classification of microbial cellular features: Variant (or NOT common to all)

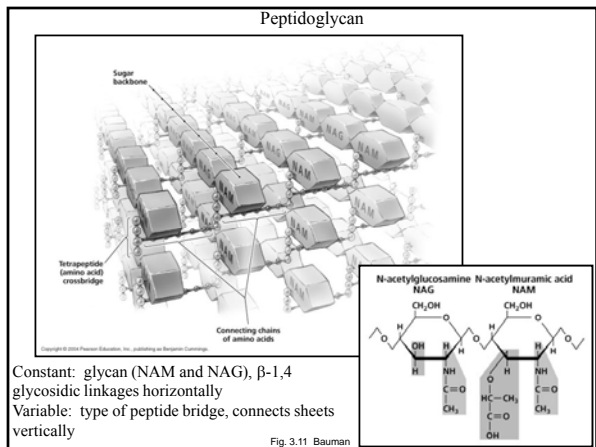
- Cell Wall (multiple barrier support themes)
- Endospores (heavy-duty life support strategy)
- Bacterial Flagella (appendages for movement)
- Gas Vesicles (buoyancy compensation devices)
- Capsules/Slime Layer (exterior to cell wall)
- Inclusion Bodies (granules for storage)
- Pili (conduit for genetic exchange)

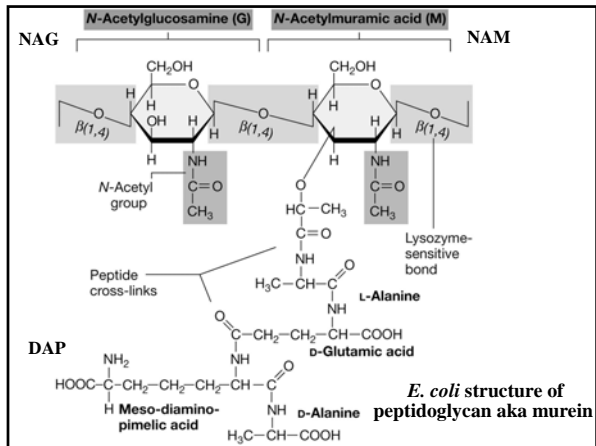


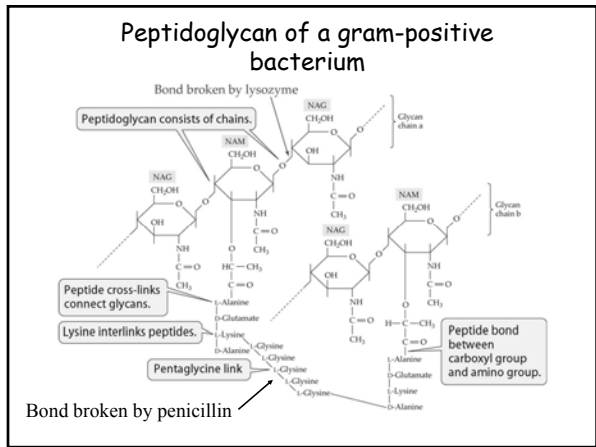


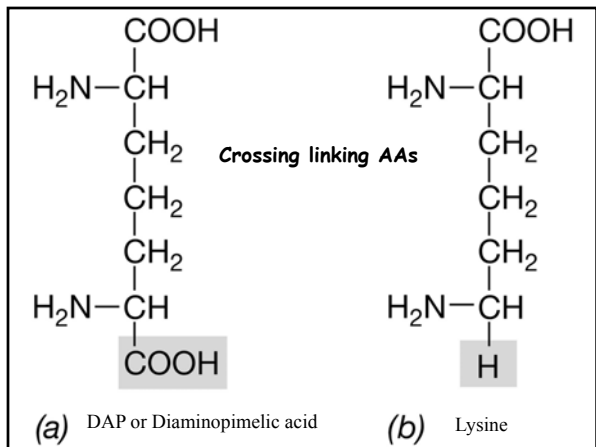


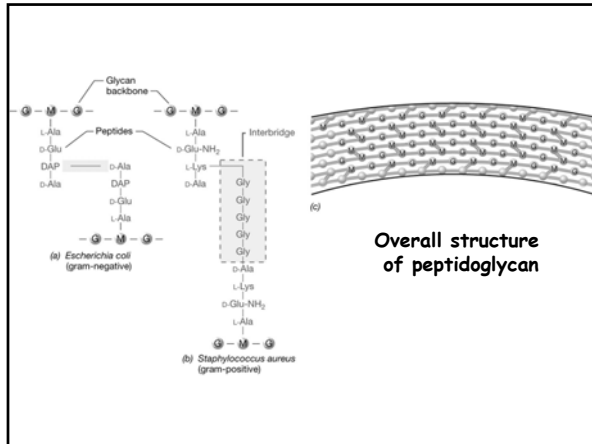


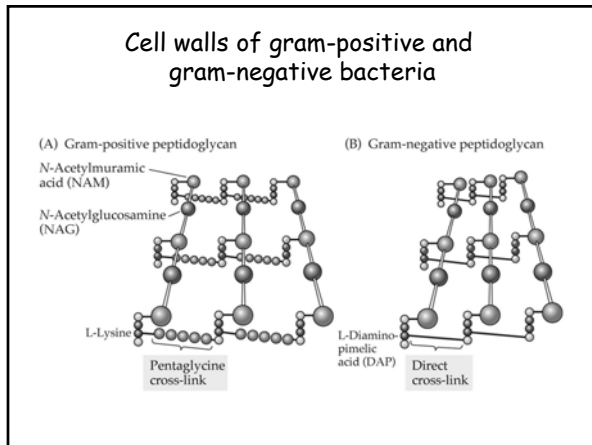


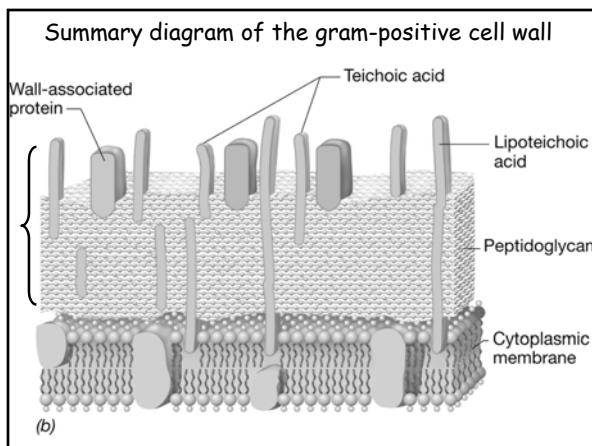


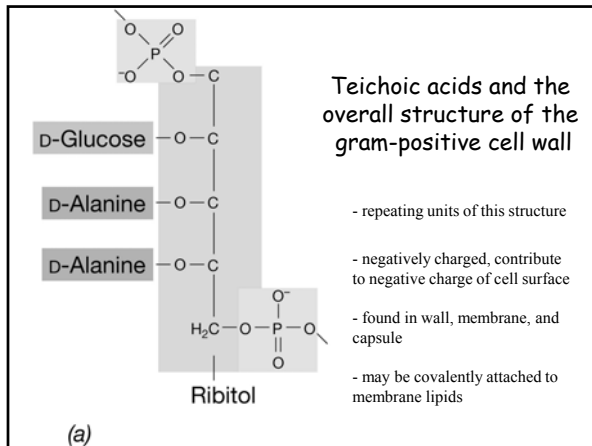


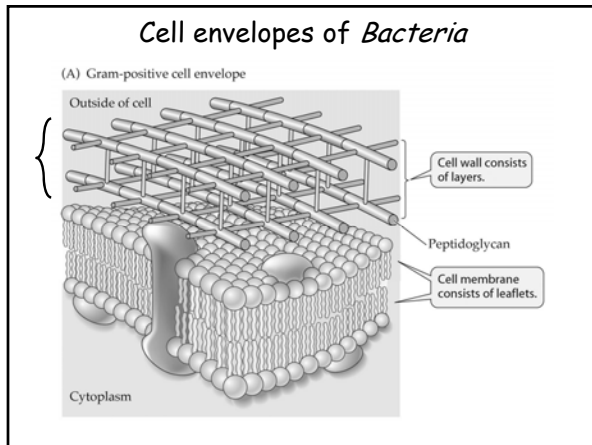


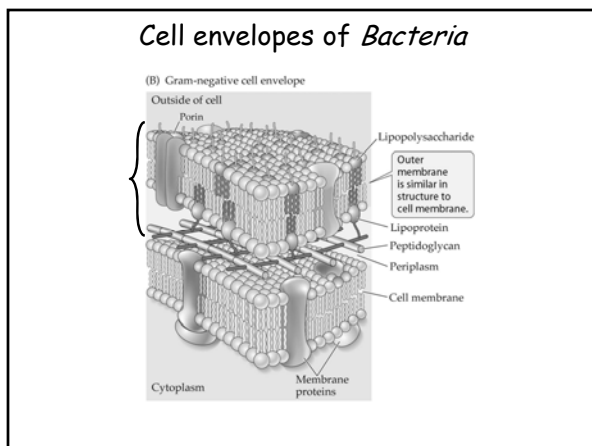




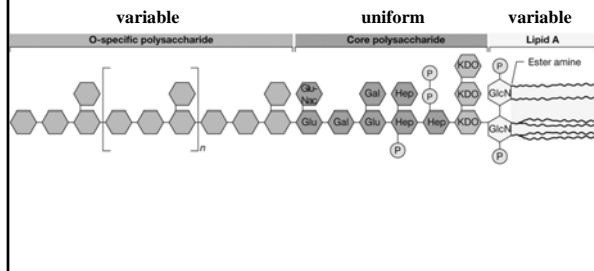








Structure of the lipopolysaccharide of gram-negative *Bacteria*



LPS chemical structure varies by species

-Hydrophilic, so exclude hydrophobic molecules like antibiotics and bile salts.

-Can be toxic

-Serve as an "epitope" or "antigen"

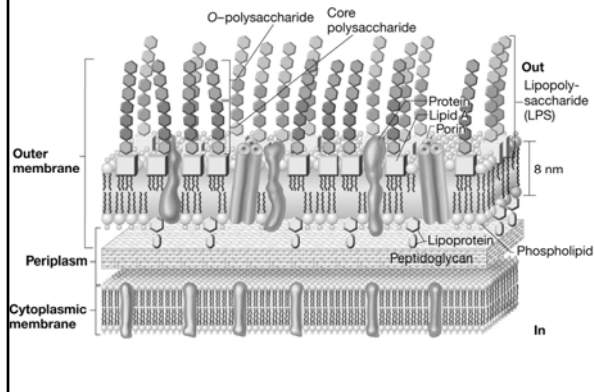
-Antibodies to intact cells' O-antigen are VERY strain-specific.

-Embedded in lipid layer.

-"Endotoxin", causes fever and shock in mammals if released from membrane (when bacteria lyse)

-Free (whole) LPS also triggers host defense by binding a receptor in macrophages

The gram-negative cell wall



Cell walls of Archaea:

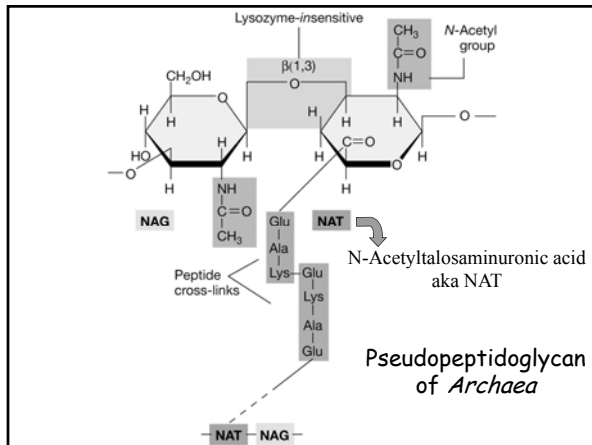
Some *Archaea* & *Bacteria* have a protein jacket outside the membrane called the "paracrystalline surface layer" or S-layer.

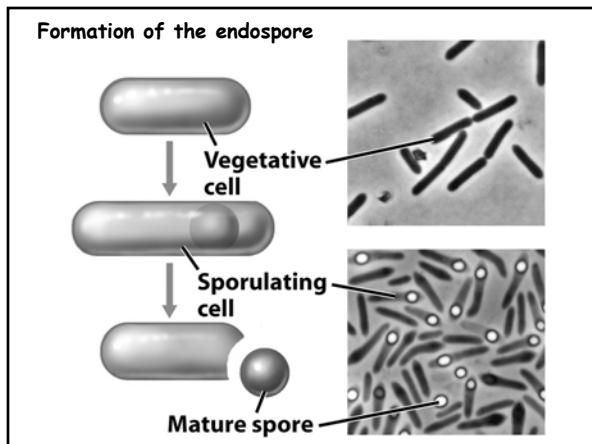
The S-layer sometimes serves as cell wall for *Archaea*.

It is a selective sieve, allowing the passage of low-molecular-weight substances while excluding large molecules and structures.



...other Archaea have polysaccharide cell walls

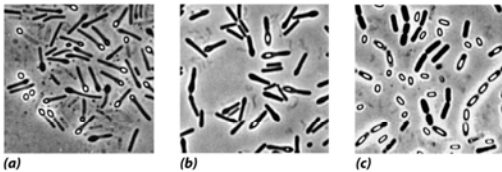




Spores remain viable in the environment after long periods of dormancy.

Extreme reports of endospore revival (successful germination from):

1. *Bacillus sphaericus* found in the guts of bees preserved in 40 million year old Dominican amber
2. *Virgibacillus* spp. found in salt crystals in the 250 million year old Salado Formation in New Mexico



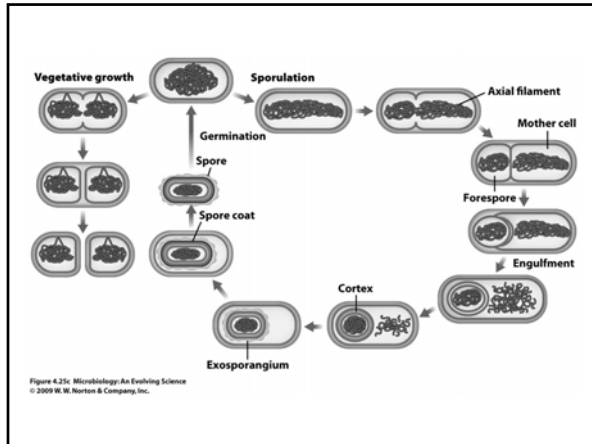
Morphology of the bacterial endospore
(a) Terminal (b) Subterminal (c) Central

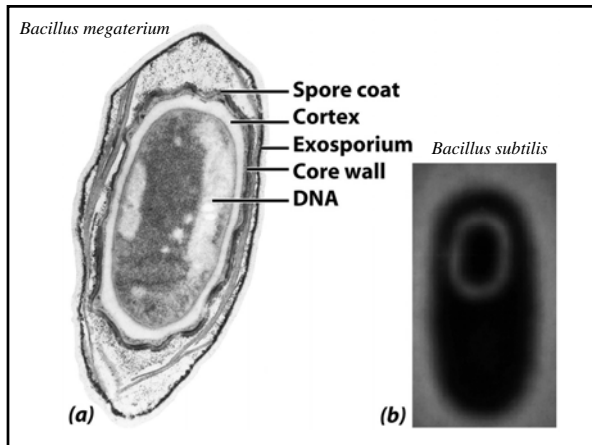
Endospores are a highly resistant differentiated bacterial cell produced by certain gram-positive *Bacteria*.

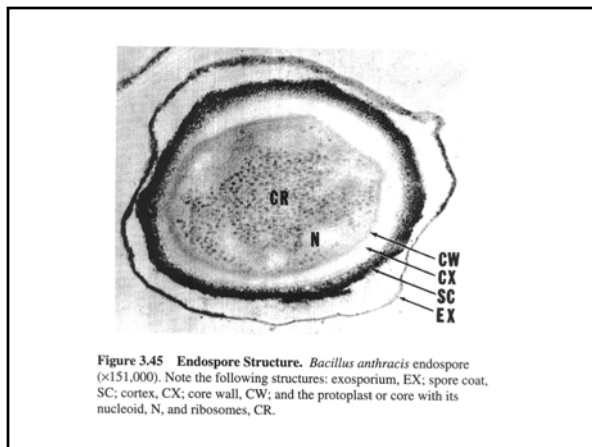
- mostly soil bacteria of phylum Firmicutes
- evolved just once
- most common in *Clostridium*, *Bacillus*
- agents of **survival**
- metabolically inert, highly dehydrated (10-15% water)
- most resistant biological structure known: heat up to 150°C, dryness, UV, strong acids, disinfectants
- can survive 100's (thousands? millions?) of years

Exospores are formed by pinching off of tips of filamentous bacteria (and of fungi)

- Streptomyces*, *Myxobacteria*
- agents of **dispersal**







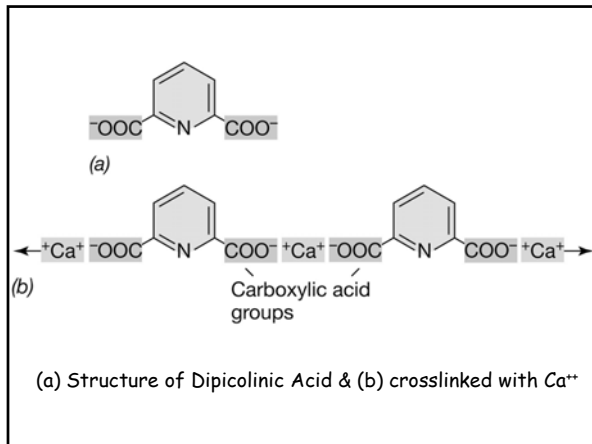
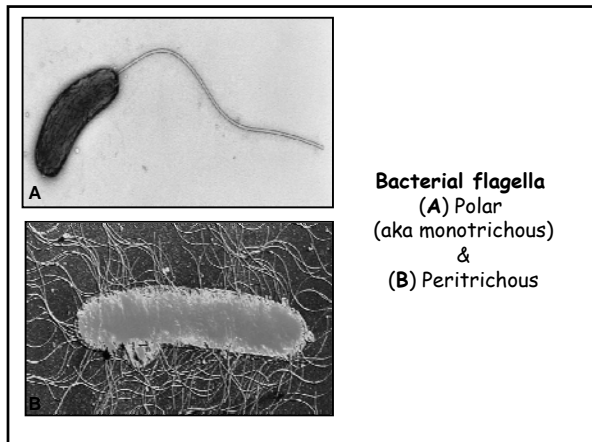


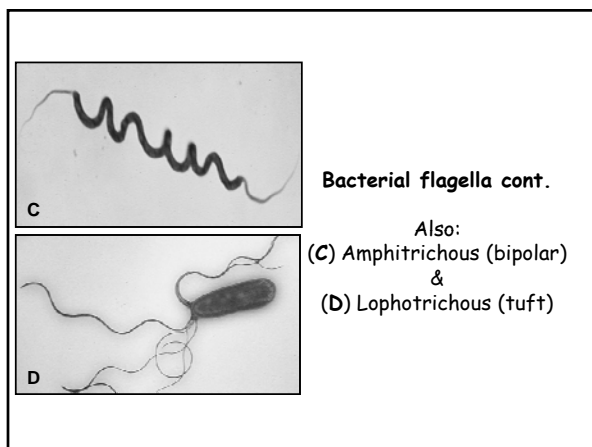
Table 4.3 Differences between endospores and vegetative cells

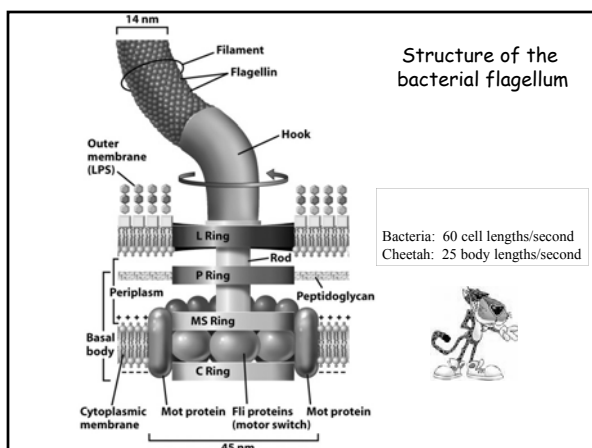
Characteristic	Vegetative cell	Endospore
Structure	Typical gram-positive cell; a few gram-negative cells	Thick spore cortex Spore coat Exosporium
Microscopic appearance	Nonrefractile	Refractile
Calcium content	Low	High
Dipicolinic acid	Absent	Present
Enzymatic activity	High	Low
Metabolism (O ₂ uptake)	High	Low or absent
Macromolecular synthesis	Present	Absent
mRNA	Present	Low or absent
Heat resistance	Low	High
Radiation resistance	Low	High
Resistance to chemicals (for example, H ₂ O ₂) and acids	Low	High
Stainability by dyes	Stainable	Stainable only with special methods
Action of lysozyme	Sensitive	Resistant
Water content	High, 80-90%	Low, 10-25% in core
Small acid-soluble proteins (product of <i>sap</i> genes)	Absent	Present
Cytoplasmic pH	About pH 7	About pH 5.5-6.0 (in core)

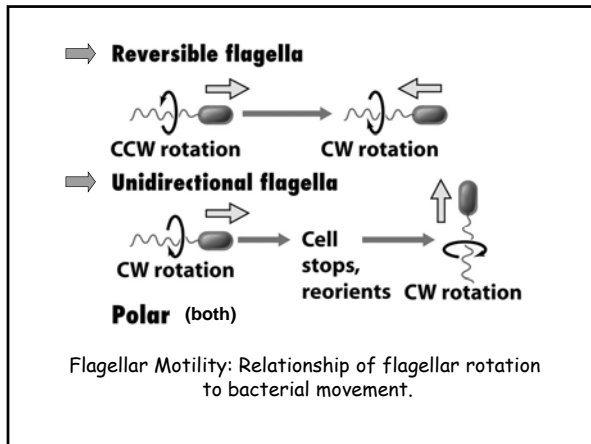
Characteristics of Endospore: Take Home Message

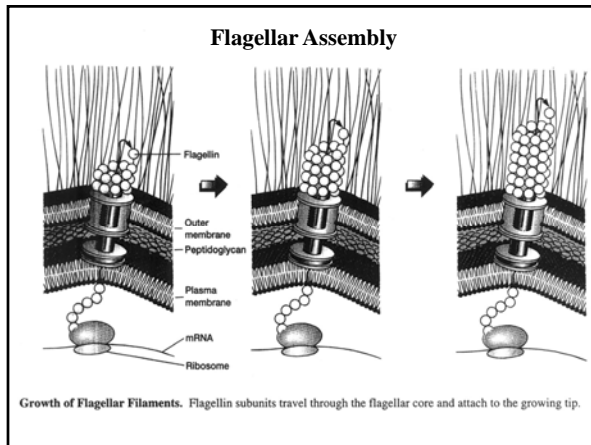
- The endospore is a highly resistant differentiated bacterial cell produced by certain gram-positive *Bacteria*.
- Endospore formation leads to a highly dehydrated structure that contains essential macromolecules and a variety of substances such as calcium dipicolinate and small acid-soluble proteins, absent from vegetative cells.
- Endospores can remain dormant indefinitely but germinate quickly when the appropriate trigger is applied.









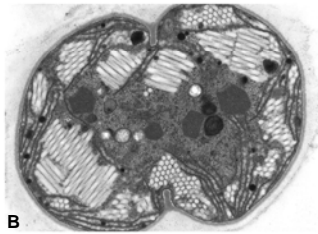
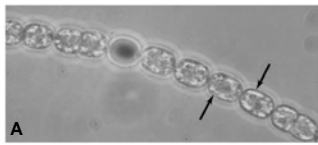


Flagellar Motility: Take Home Message

- Motility in most microorganisms is due to flagella.
- In bacteria the flagellum is a complex structure made of several proteins, most of which are anchored in the cell wall and cytoplasmic membrane.
- The flagellum filament, which is made of a single kind of protein, rotates at the expense of the proton motive force, which drives the flagellar motor.

Gliding Motility: Mechanism??





Gas Vesicles
(A) *Anabaena flos-aquae*
(B) *Microcystis* sp.

**The Hammer, Cork, and Bottle Experiment
(Before) (After)**

