

About this course

- Medical Microbiology is about micro-organisms that cause disease in humans.
 - Concerning the different diseases, you must learn:
 - Biology of the disease agent
 - Pathogenesis
 - Symptoms
 - Treatments
 - Epidemiology
- You will have to learn a **new vocabulary**
- You will have to be in class to take **detailed notes**
- **Exams questions** will be based more on notes than on your book
- The only “dumb” questions are those not asked

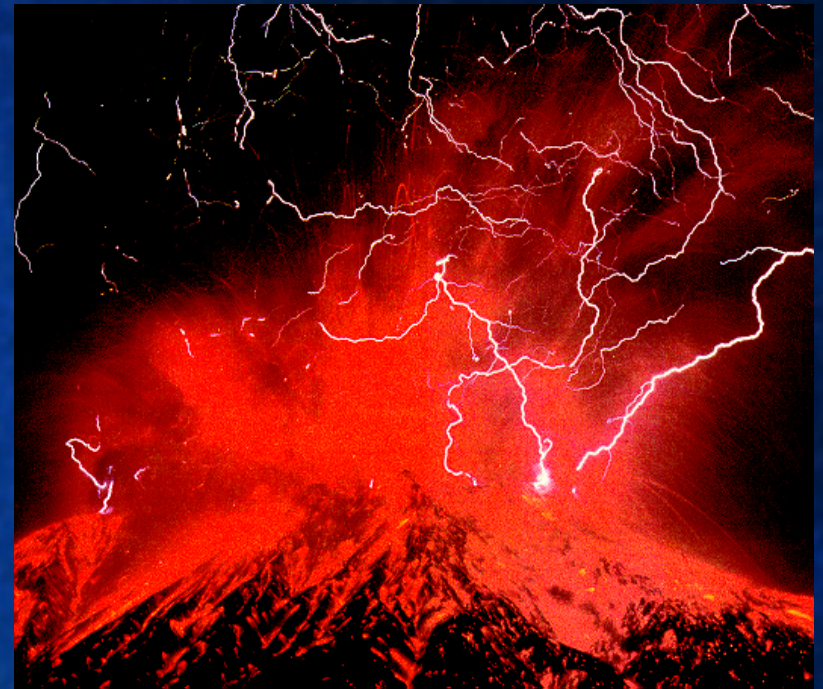
Origin of Species

- Life on Earth is tremendously diverse
- Species is a man-made criterion
- How this diversity arose is the question



Age of the Earth--Age of Life

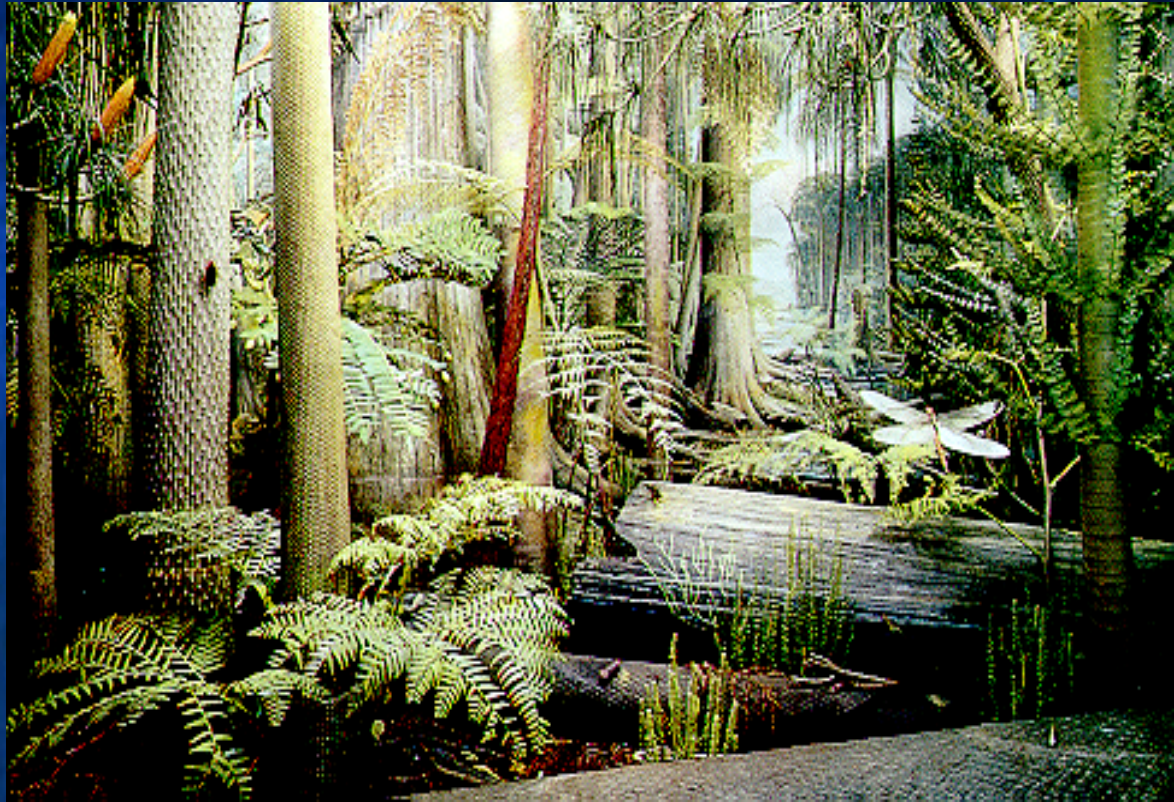
- Age of the Earth:
 - 4.5 - 4.6 Billion years
 - radioactive decay
- Oldest rocks
 - 3.9 Billion years
- Age of Life
 - 700 M, no life
 - cosmic bombardment
 - radioactive short-lived isotopes
 - volcanism
 - 3.5 Billion years ago
(life appeared as soon as it could)



Hot and Fiery Beginning

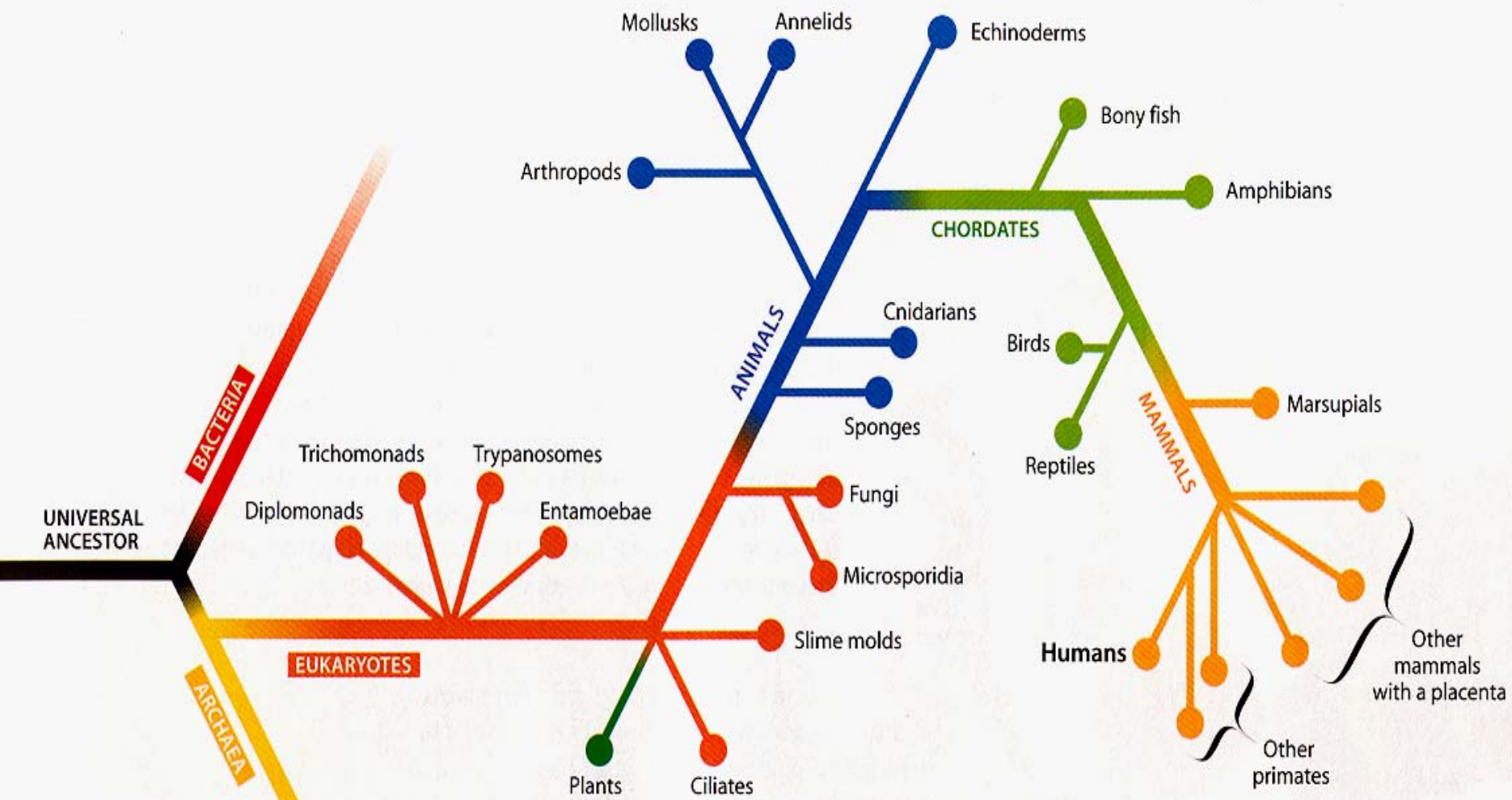
Ages of Life on Earth

- 5/6 Earth's history was unicellular
- Prokaryotic Life
 - arose 3.5 BYA
 - 1.5 BY, all prokaryote
- Eukaryotic Life
 - arose 2.0 BYA
- Multicellular Life
 - Cambrian Explosion
 - 530 MYA
 - All modern Phyla



Classification of Microbes:

- Three Domains of Life:
 - Prokarya
 - Archae
 - Eukarya
 - based on 16s rRNA sequences.
 - Viruses = acellular forms of life; obligate intracellular parasites.



Tree of life illustrates

Basic Cell Types:

- Prokaryotes:
- no membrane-bound organelles; simple structure:
 - Bacteria
 - Archae
- Eukaryotes:
- Membrane-bound organelles; complex structure
 - everything other than bacteria
 - Trees, insects, worms, amoebae, humans, etc.

Today, 13.6 M living species

8 M Insects

1.5 M Fungi

1.0 M Bacteria

750 K Arachnids (spiders, etc.)

400 K Viruses

320 K Plants

200 K Protozoa

200 K Mollusks

150 K Crustaceans

50 K Vertebrates

250 K Others (Why so Many?)

Binomial System of Taxonomy

Kingdom

Phylum

Class

Order

Family

Genus

Species

FOR HUMANS: Animalia

Chordata

Mammalia

Primates

Hominidae

Homo

Homo sapiens

Using the Binomial System

Originally 12 Words

Now only two

This is a species:

Generic name

Always Capitalized

Homo

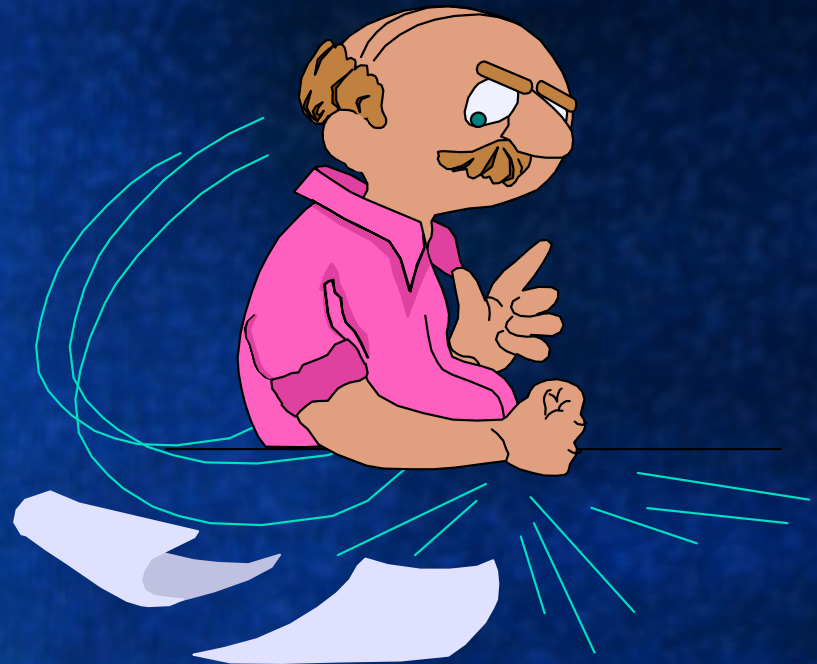
Specific name

Always lower case

H. sapiens

Always underlined or
italicized

Homo sapiens



Examples of species names (always in Latin)

They may be descriptive:

Entamoeba histolytica

Named after people:

Eimeria ninakohlyakimovae

Named after places:

Isospora utahensis

Or mixtures:

Yersinia pestis



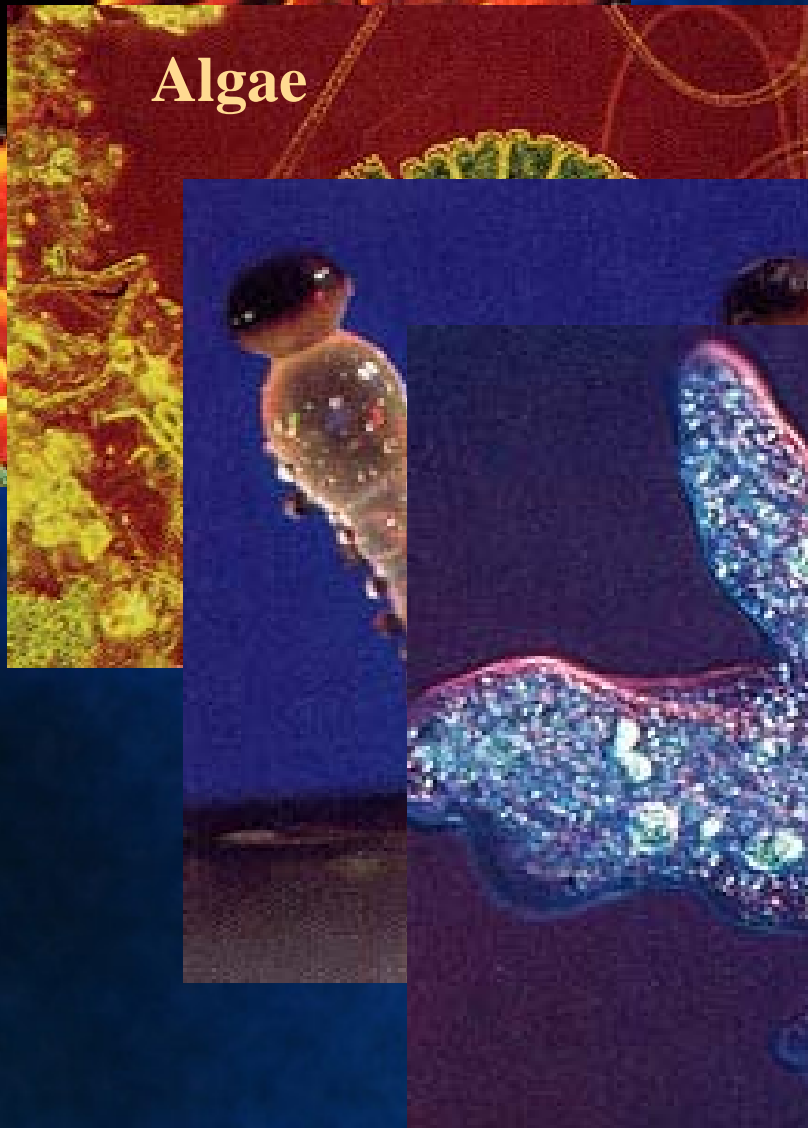
Major Groups of Microbes:

- **Fungi**- Free-living and pathogenic
 - Example of diseases: ring worm, candidiasis
- **Algae**- Almost all are free-living; no parasites
 - Ex: paralytic shell-fish poisoning
- **Protozoa**- Free-living and pathogenic
 - Ex: malaria, giardiasis, amebiasis
- **Prokaryotes**- Free-living and pathogenic
 - Ex: diphtheria, TB, whooping cough, tetanus
- **Viruses**- Obligate intracellular parasites
 - Ex: influenza, polio, measles, mumps, Ebola

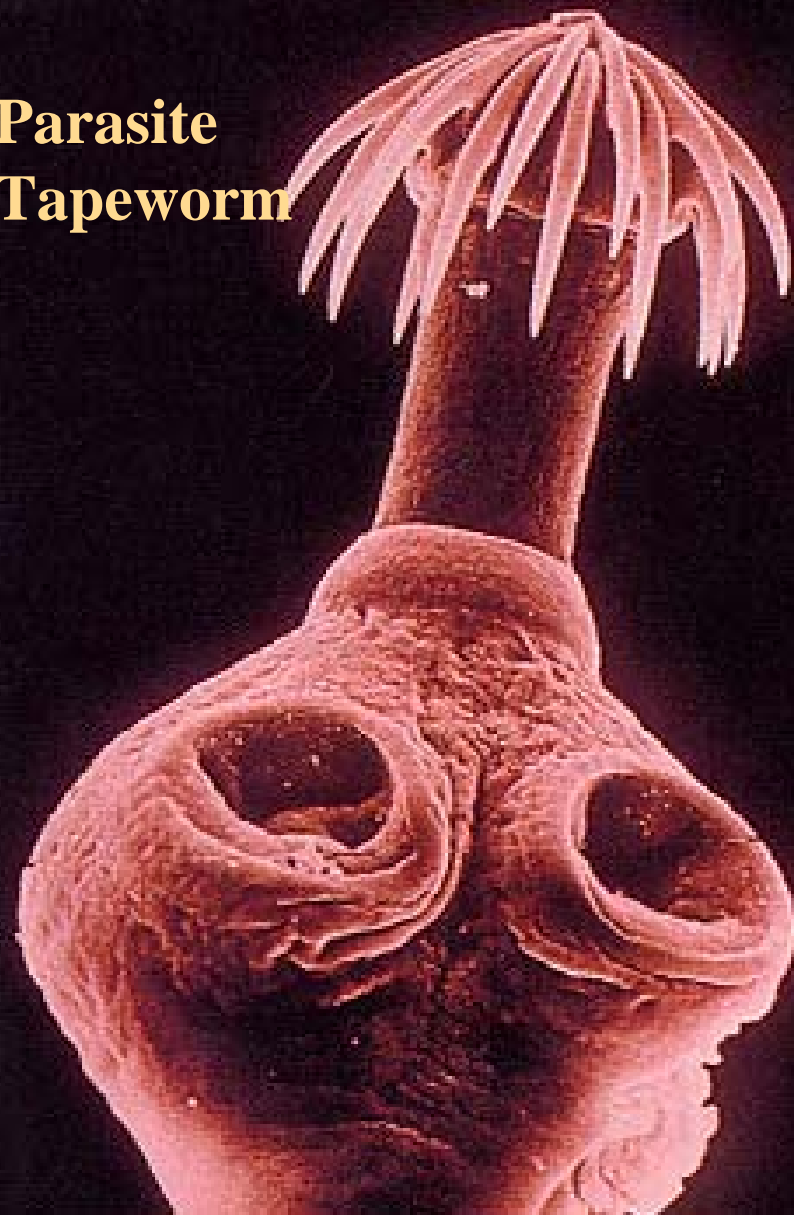
Bacteria



Algae



**Parasite
Tapeworm**



The Bacteria

- All prokaryotic organisms
- We are outnumbered:
 - we are composed of 10 trillion cells, but we are host on skin, in gut or orifices, to more than **100 trillion bacteria!!**
- It is difficult for many to appreciate size and scope of the bacterial world
- Some examples follow:

Kingdom Monera

- Monera means “alone”, or singular
 - Prokaryotes (more later)
- Not primitive, but rather the great success story of biology
 - have been around for 3.5 billion years
 - were alone for 2 billion years
 - changed the Earth significantly
 - created the soil, oxygen atmosphere, recycled life-dependent elements, tremendous genetic diversity
 - These are the bacteria

Monera, continued

- Metabolically diverse, but relatively simple in cellular organization
 - Small, lack membrane-bounded organelles, single DNA molecule for genome,
- Dominate the biosphere, outnumbering all Eukaryotes combined,
 - more bacteria on skin than humans have ever lived
 - all other life forms depend on bacteria, and life would rapidly disappear without them
 - only a small minority are associated with disease

Cellular Anatomy

- A. Shapes and arrangements:

- 1. Spheres

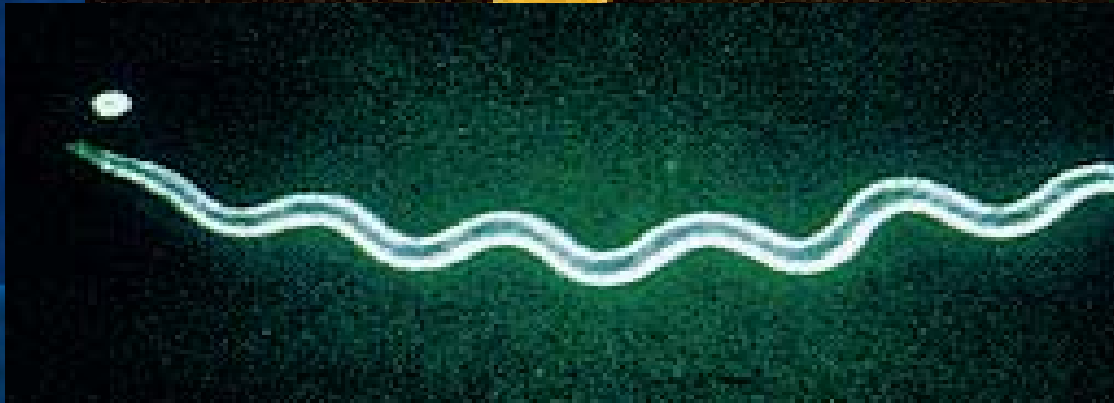
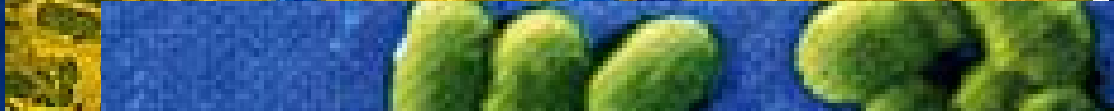
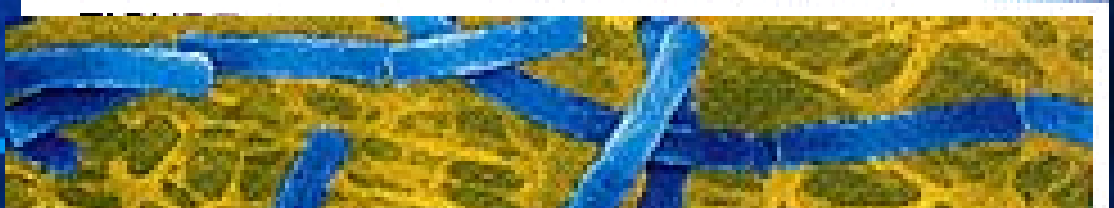
- cocci

- 2. Cylinders

- bacillus

- 3. Curved or helical

- spirilla or
spirochetes



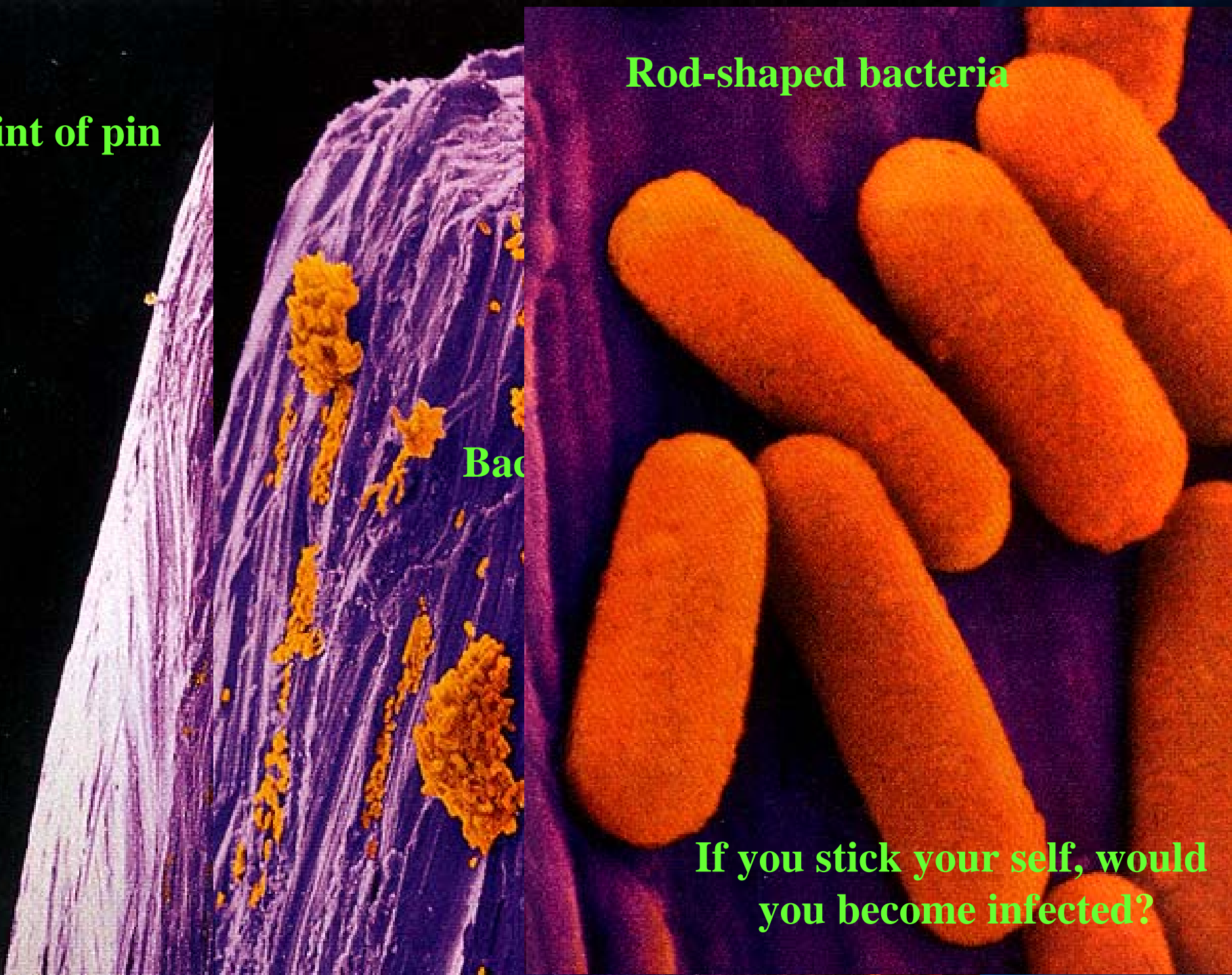
Spirochetes

Point of pin

Rod-shaped bacteria

Bac

**If you stick your self, would
you become infected?**

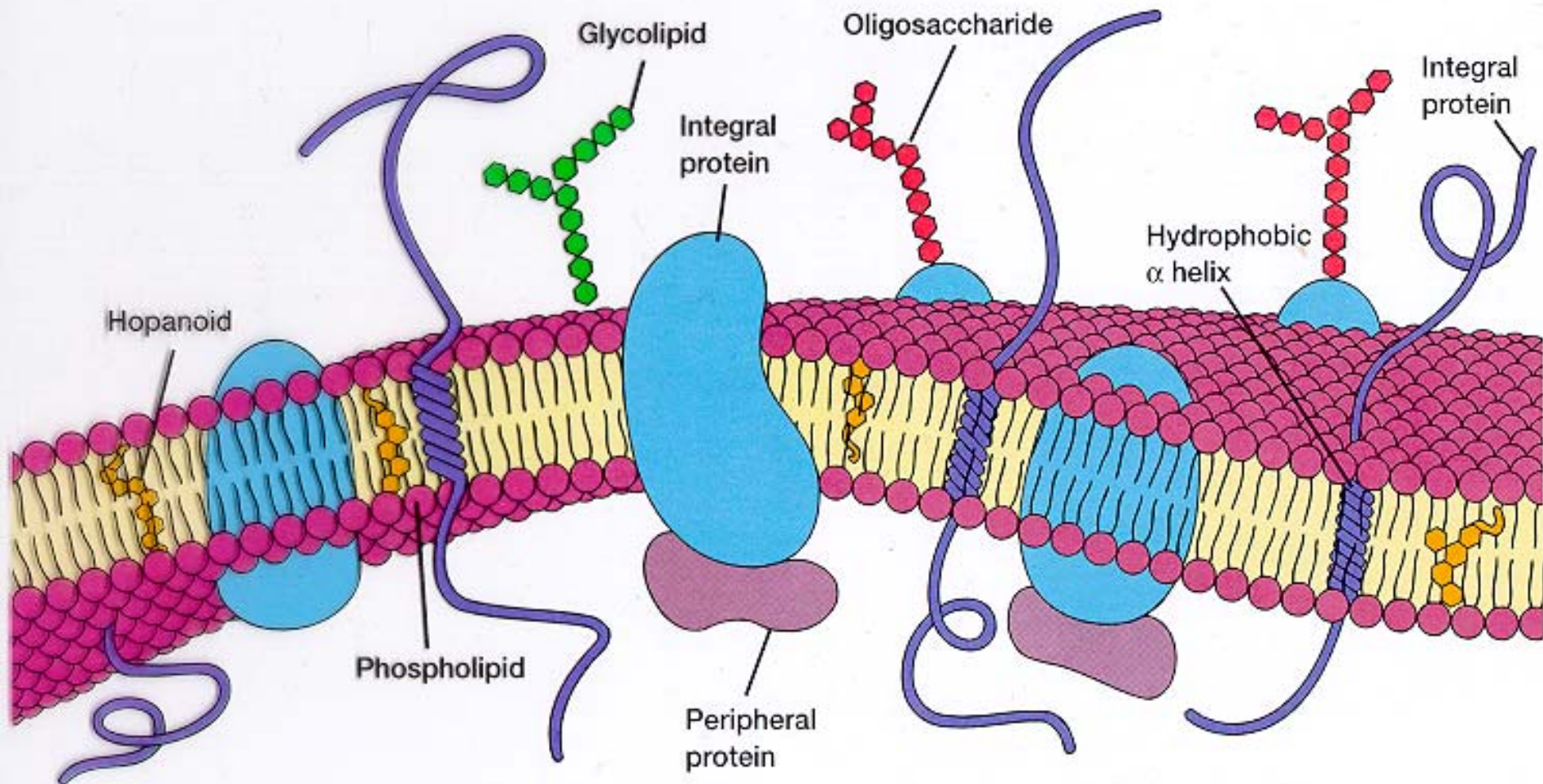


The Cell Surface

- Cell envelope:

- **Cytoplasmic membrane**- lipid bilayer; barrier
- **Cell wall**- support and protection
- **Glycocalyx**- protection and attachment; most made of polysaccharide
 - capsule, well organized not easily removed
 - slime layer, zone of diffuse unorganized material, easily washed off
 - aids attachment to surfaces
 - formation of biofilms
 - resists phagocytosis, a virulence factor

Cytoplasmic membrane:



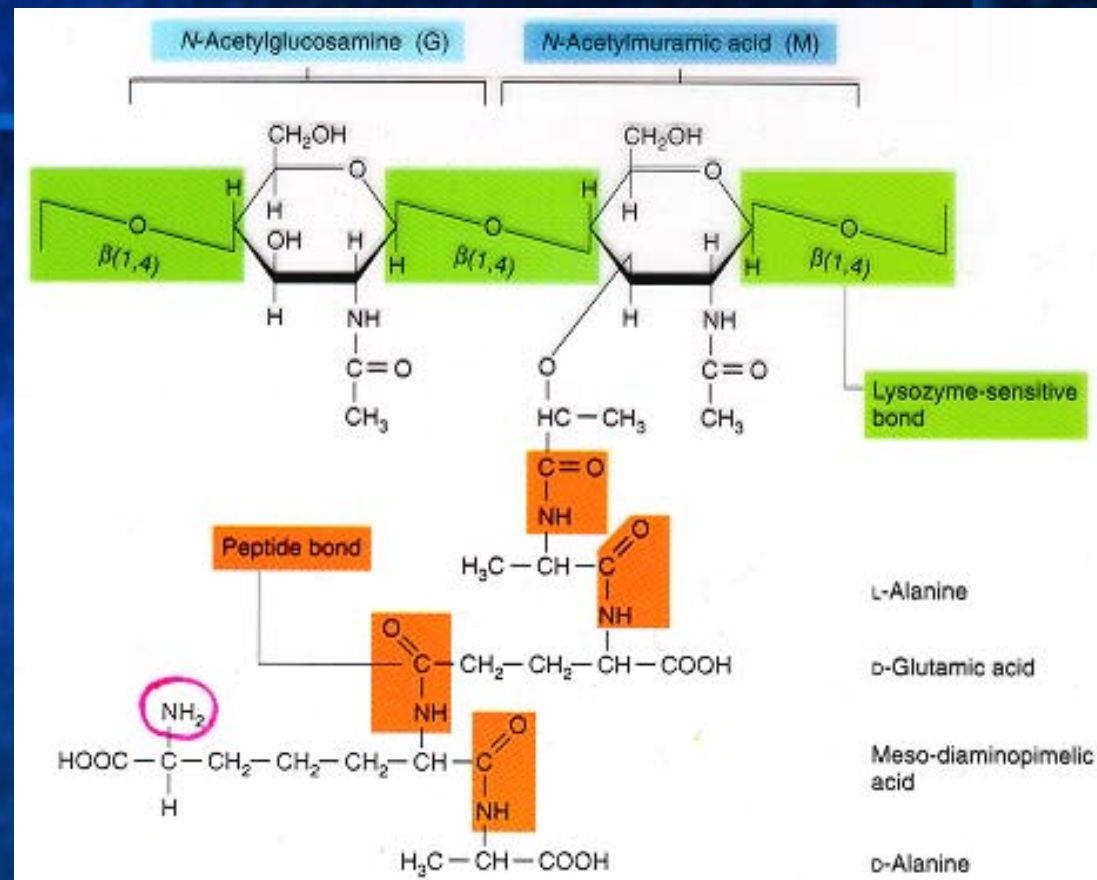
Cellular Anatomy

- Cell walls

- external to membrane
- nearly all have CWs
- offer protection from:
 - osmotic pressure
 - prevents lysis
 - but not plasmolysis
 - preserves, salt & sugar

- Peptidoglycan

- not cellulose
- sugar polymers linked by short polypeptides
- basis for gram stain

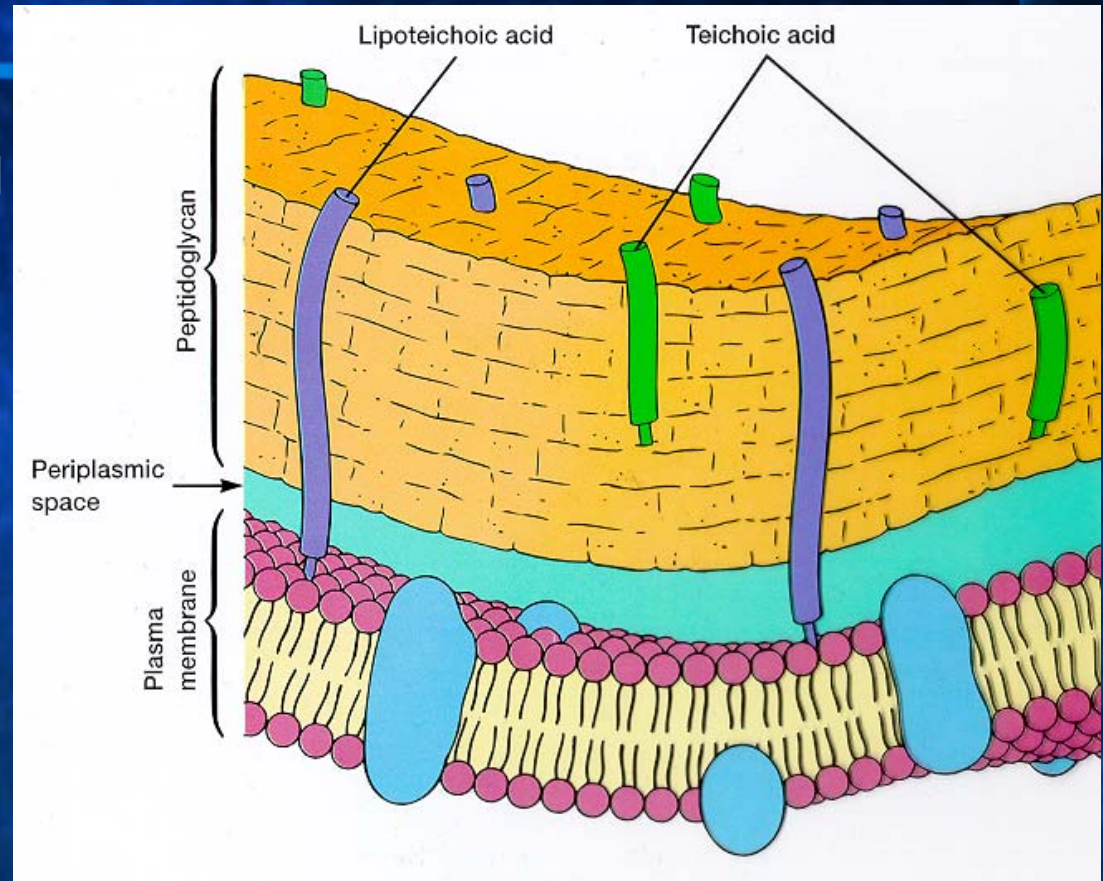


N-acetylglucosamine & N-acetylmuramic acid with poly peptide linkages

Gram-positive cell walls:

- **Peptidoglycan (POG):**

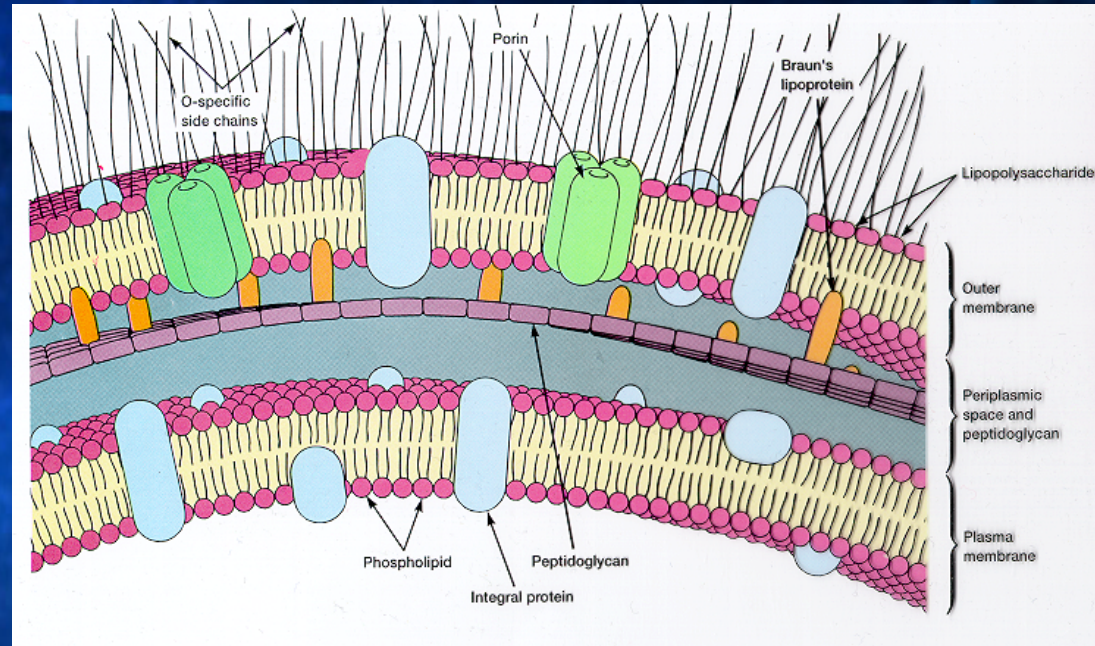
- POG, alternating polysaccharide chains N-acetylglucosamine and N-acetylmuramic acid, linked by short peptides = rigid mesh.
- About 40 layers deep (90% of cell wall)
- Also contain teichoic acids--polymers of glycerol or ribitol and phosphate



Gram-positive surface components

Gram-negative cell walls:

- multi-layered
 - Composed of a thin POG layer (1-2 layers deep),
 - A periplasmic space
 - Outer lipid membrane
 - Outer-most layer--
 - Lipopolysaccharide (LPS)
 - endotoxin (more later)
 - a sugar-lipid complex



Gram-negative surface components

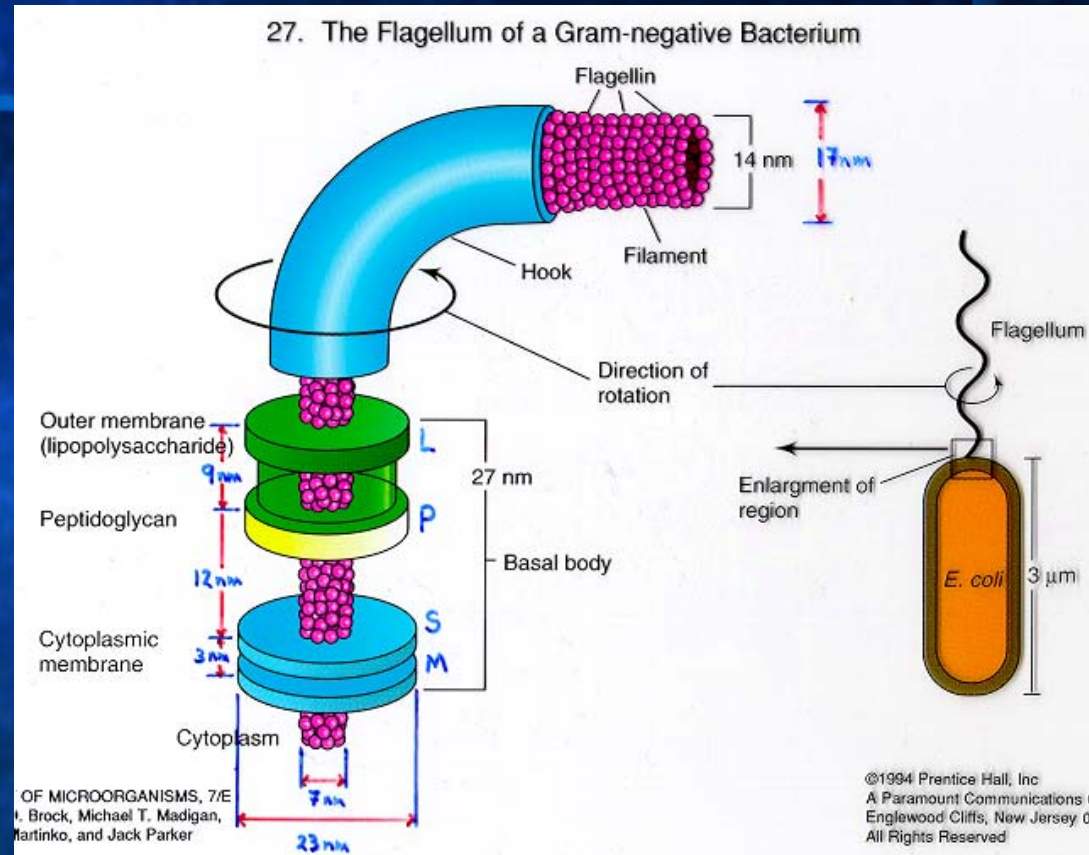
External Appendages:

● Flagella:

- flagellin protein subunits
- forms a rigid helix
- can vary in placement
 - all around, tuft at each end or one at end

● Pili:

- pilin protein subunits
- conjugation-genetic exchange=**sex pili**
- attachment=**fimbriae**



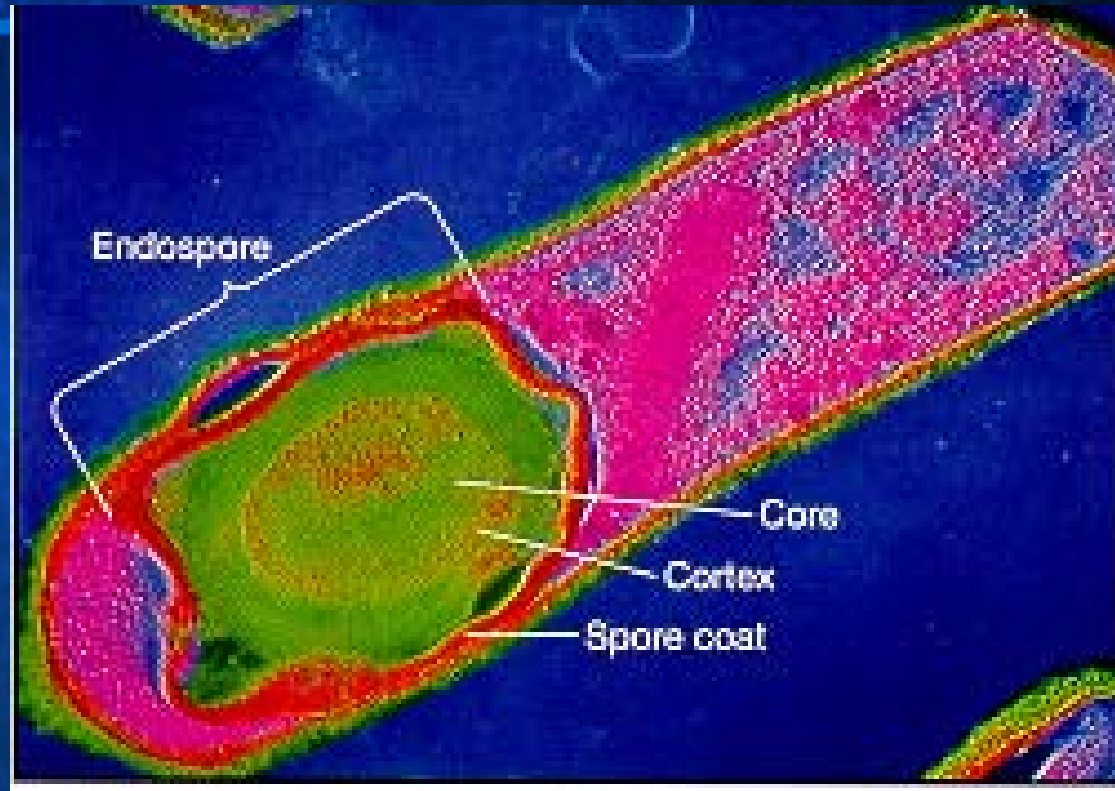
Flagellar motor

Cytoplasmic Contents:

- **Ribosomes** = composed of 2 major subunits; each composed of both RNA and protein.
 - For Prokarya: 50s + 30s = 70s
 - For Eukarya: 60s + 40s = 80s
- **Nucleoid region** = chromosome = 1 circular DNA molecule organized into looped domains.
- **Cytoplasmic inclusion:**
 - glycogen granules (carbon & energy), gas vacuoles, storage granules, phosphate, nitrogen, etc.

Bacterial Endospores:

- Found in *Bacillus* and *Clostridium spp*
- Extremely dehydrated (<15% water)
- Formed inside the cell (“endospores”)
- Proteins extensively cross-linked (S-S)
- Many protective layers of protein
- Almost completely ametabolic
- The most resistant forms of life to environmental factors on the planet



Endospore within bacterium

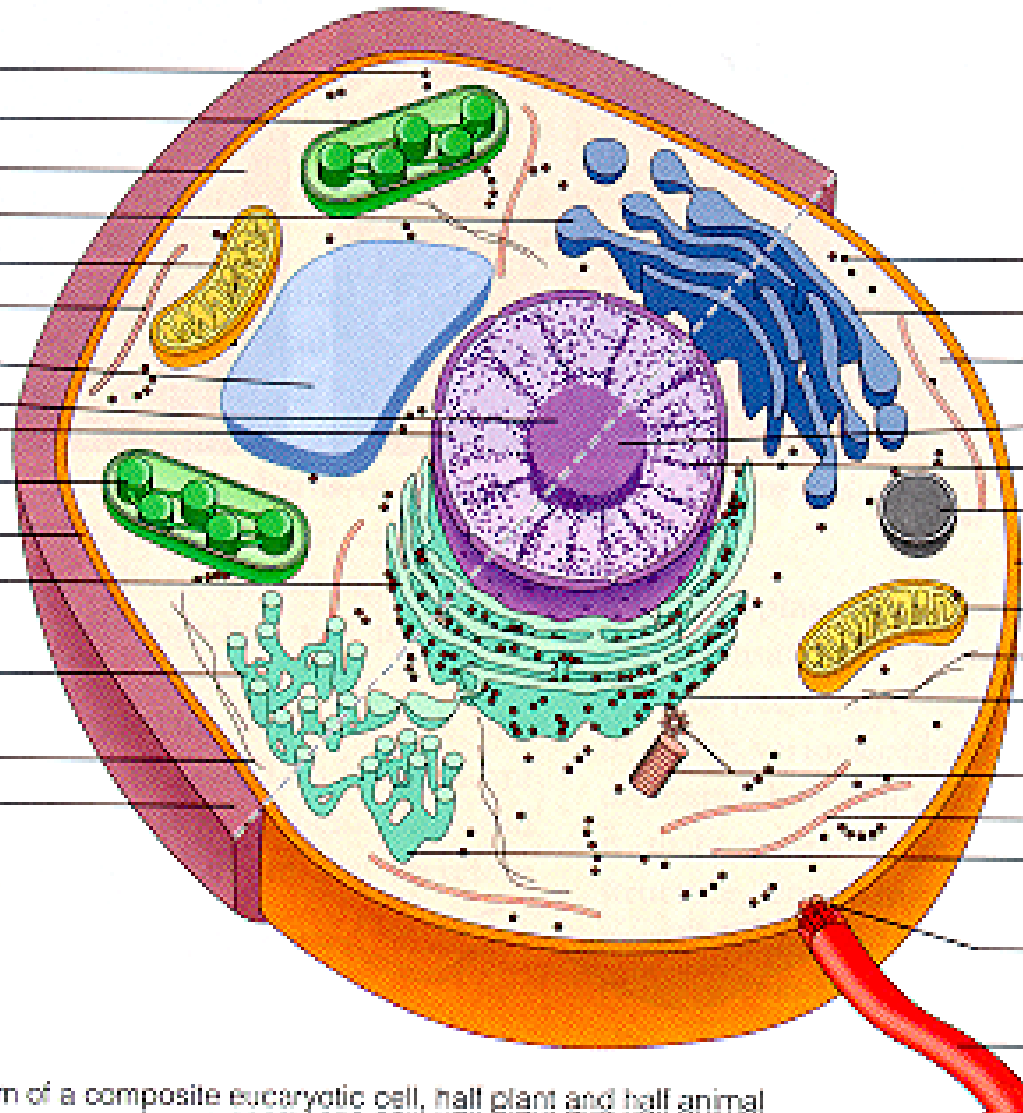
A Eukaryotic Cell

PLANT CELL

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

ANIMAL CELL

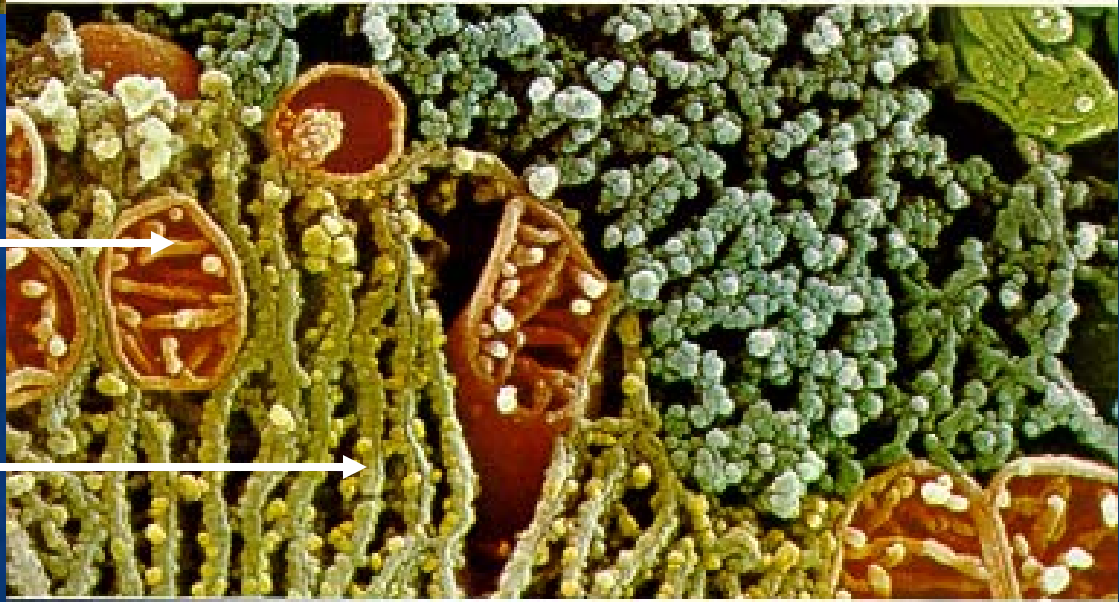
Ribosome
Golgi complex
Cytoplasm
Nucleolus
Nucleus
Lysosome
Plasma membrane
Mitochondrion
Microfilament
Rough endoplasmic reticulum
Centrioles
Microtubule
Smooth endoplasmic reticulum
Basal body
Flagellum



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

Eukary- otic Cell





Golgi
Mitochondria
Rough
Endoplasmic
Reticulum

