

Basics of Microbiology

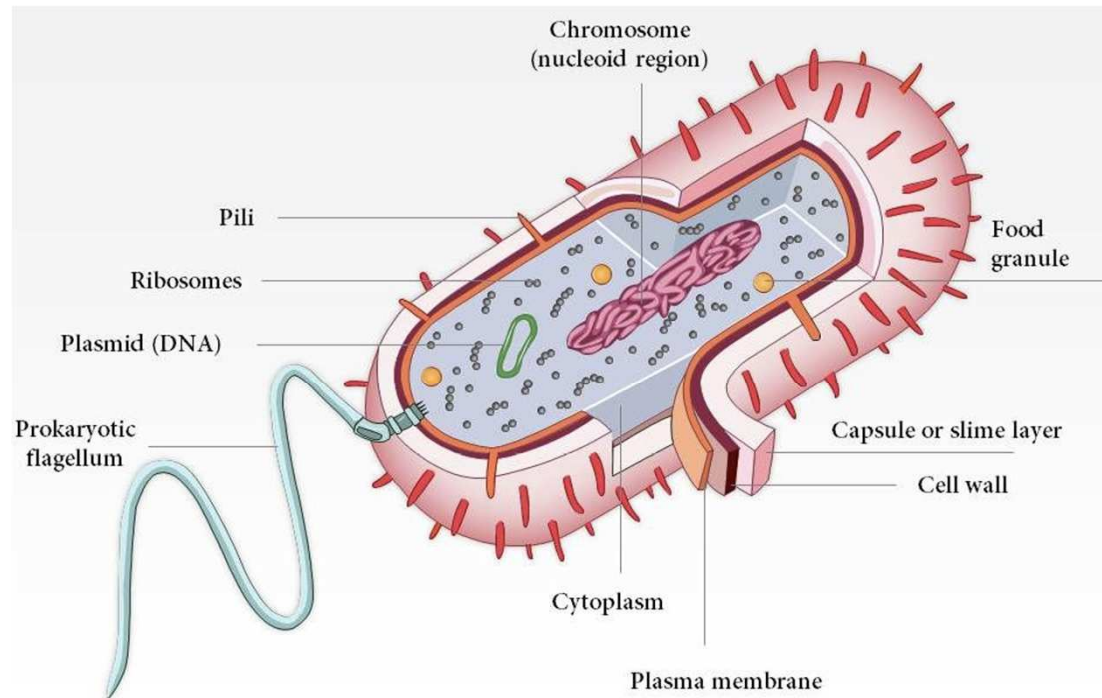
Today's class

- The Cell
- Genetic molecules
- Taxonomic and phylogenetic classification
- Horizontal gene transfer

The cell

- A building block of life
- Distinct features of a cell
 1. capable of growth and reproduction
 2. highly organized and selectively restrict what crosses their boundaries
 3. composed of major elements (C, N, O, S) that are chemically reduced
 4. self-feeding

Prokaryotic cell



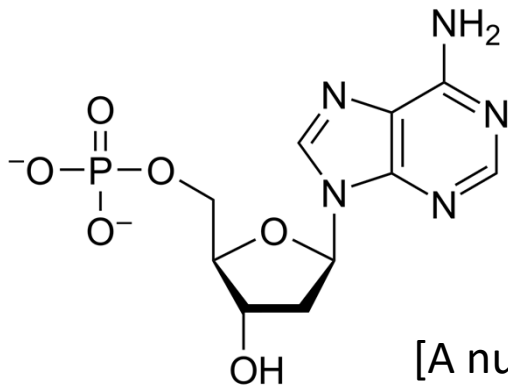
- Cell membrane
- Cell wall
- Pili & flagellum
- Cytoplasm
 - Nucleoid (contains chromosome)
 - Plasmid
 - Ribosome

Elements in a bacterial cell

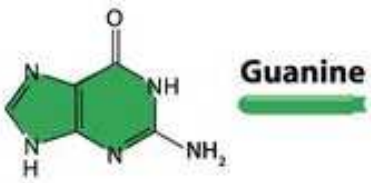
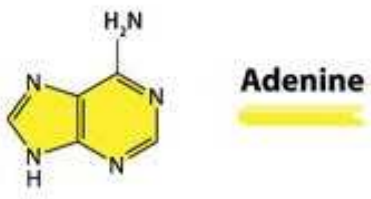
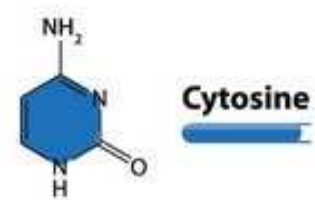
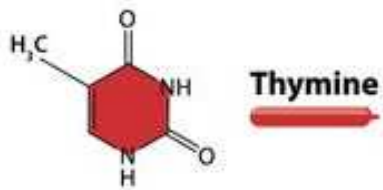
- Major: C, H, O, N, P, S
 - A bacterial cell is often represented as $C_5H_7O_2N$
 - P content typically assumed to be 1/5 of N (weight basis)
- Trace: Ca, Co, Cu, Fe, Mg, Mn, K, Se, Zn, (Mo, Ni, ...)
 - Involve in enzyme function or in other physiological activities

Genetic molecules

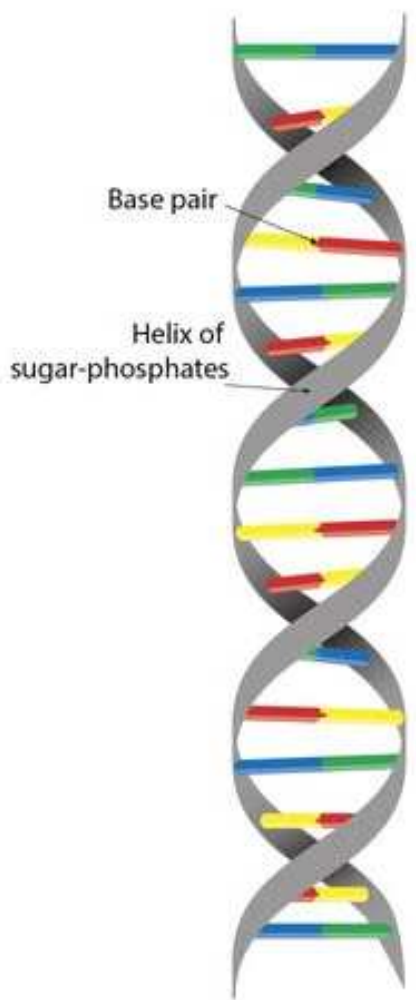
- DNA & RNA
- Composition
 - Nucleoside = nucleobase (nitrogenous base) + 5-carbon sugar
 - Nucleotide = nucleobase + 5-carbon sugar + phosphate
= nucleoside + phosphate
 - Nucleotide (monomer) -----> DNA or RNA (polymer)



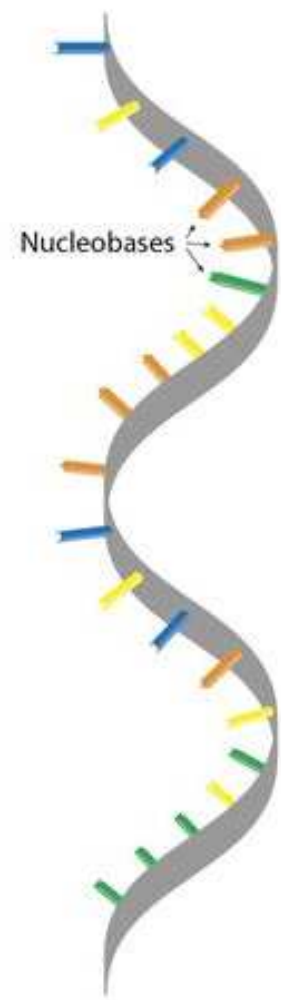
[A nucleoside of a DNA]



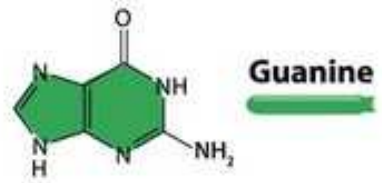
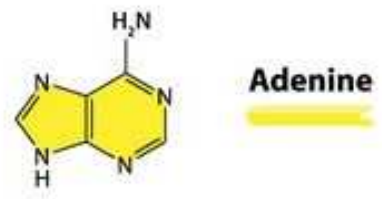
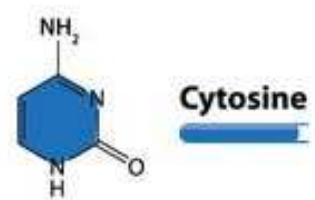
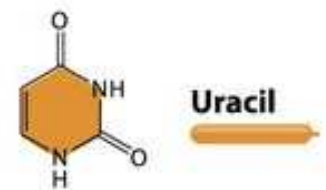
Nucleobases of DNA



DNA
Deoxyribonucleic acid



RNA
Ribonucleic Acid



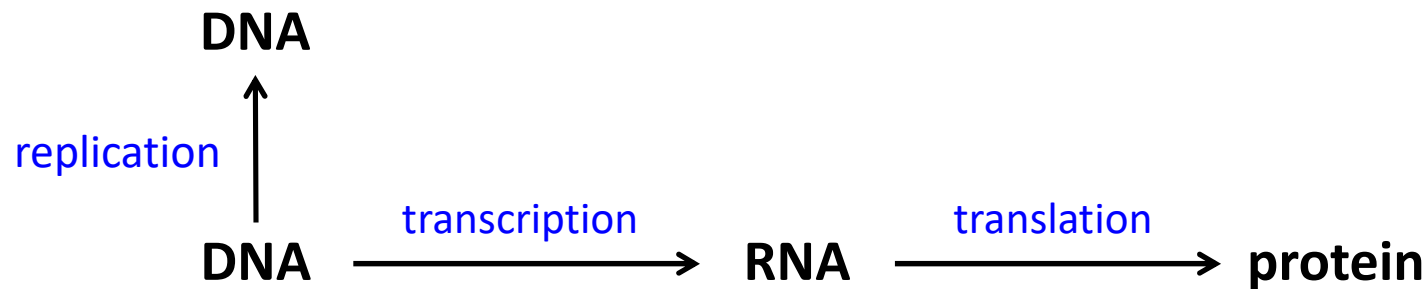
Nucleobases of RNA

DNA vs. RNA in structure

	DNA (deoxyribonucleic acid)	RNA (ribonucleic acid)
Sugar	deoxyribose	ribose
Strand	double-stranded	single-stranded
Base	adenine (A), thymine (T), guanine (G), cytosine (C)	adenine (A), uracil (U), guanine (G), cytosine (C)

DNA vs. RNA in function

- DNA: Long-term storage of genetic information; transmission of genetic information to other cells and new organisms
- RNA: Transfer the genetic code from the DNA to ribosomes to make proteins

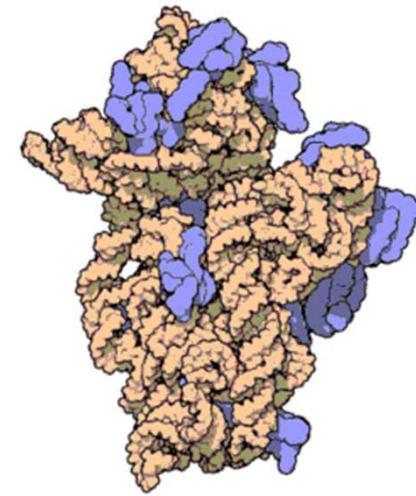


Taxonomy

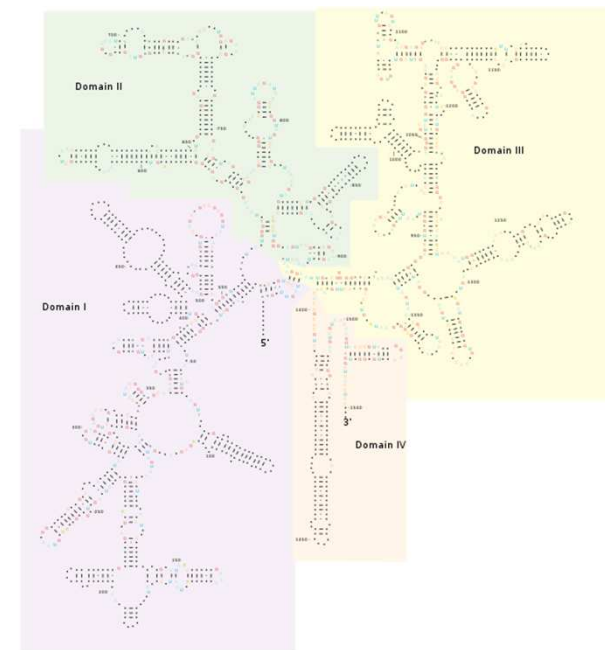
- Scientific study of naming, defining, and classifying groups of organisms
 - 1) Classification based on observable physical properties of organisms (phenotype)
 - ex) appearance, dye or strain characteristics, ability of chemical transformation
 - 2) Classification based on genetic characteristics (phylogeny)
 - Currently used to define domain/kingdom/phylum/class/order/family/genus/species
 - 16S rRNA gene used for prokaryotes

16S rRNA

- What's 16S rRNA?
 - Prokaryotic ribosomes have two subunits: 50S and 30S
 - 30S is composed of 16S rRNA and 19 proteins
- The gene that codes 16S rRNA
 - Slow rate of evolution
 - Highly conserved between different species of bacteria and archaea



30S subunit of a prokaryotic ribosome
orange: RNA, blue: protein



16S rRNA structure

Classification of organisms

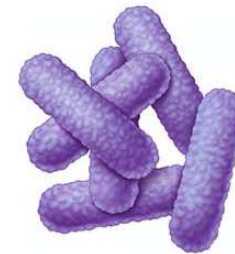
- By energy source: phototrophs & chemotrophs (organotrophs/lithotrophs)
- By carbon source: autotrophs & heterotrophs
- By growth in the presence/absence of O₂: aerobes & anaerobes
 - obligate anaerobes
 - aerotolerant anaerobes
 - obligate aerobes
 - facultative aerobes

Bacteria

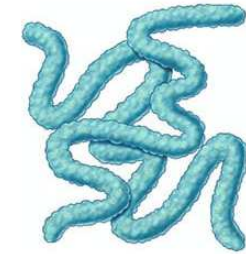
- Ubiquitous
- 0.5 – 5 μm size
- Can transform a great variety of inorganic and organic pollutants
- Plasmids
 - Small circular DNA that are physically separate from chromosomal DNA and replicate independently



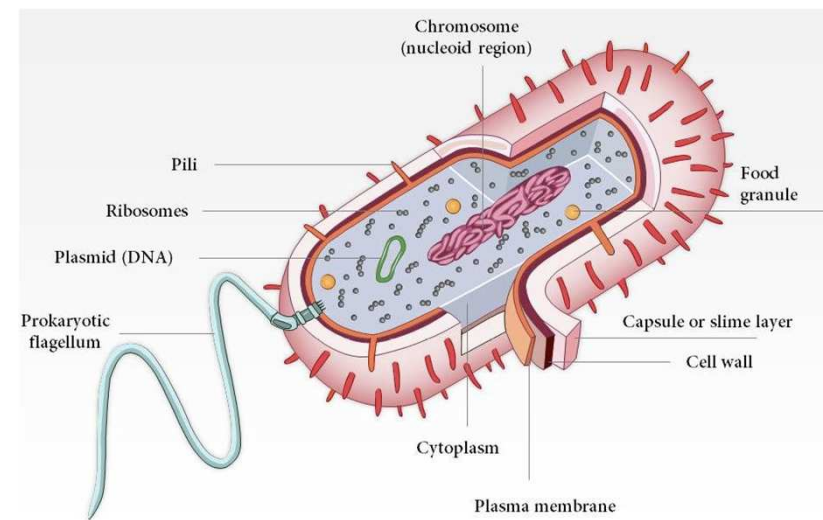
Sphere-shaped
(cocci)



Rod-shaped
(bacilli)



Spiral-shaped
(spirochetes)

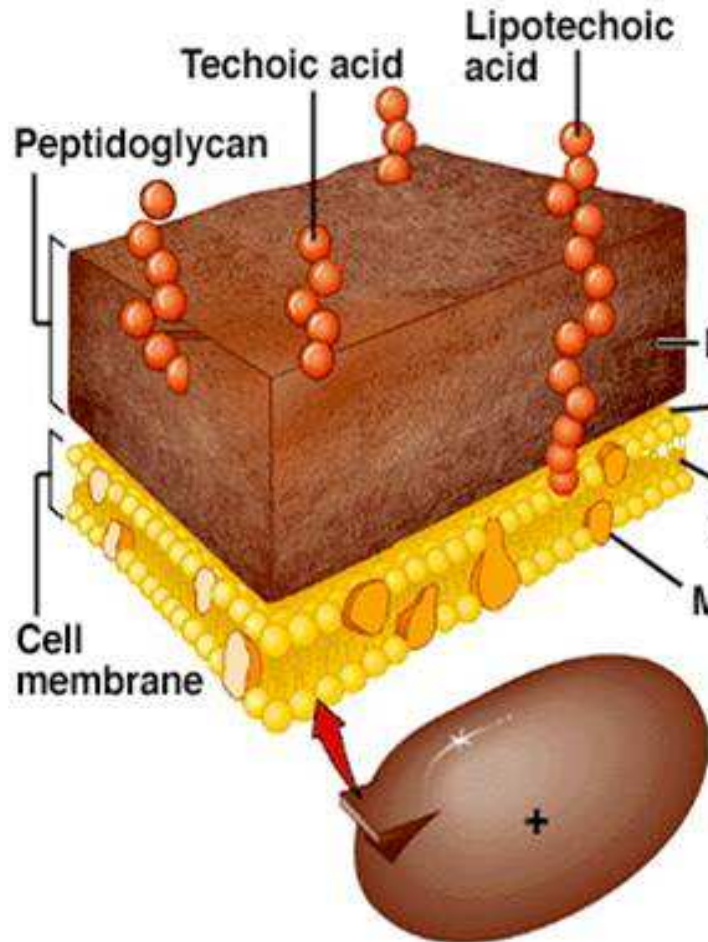


Classification of bacteria

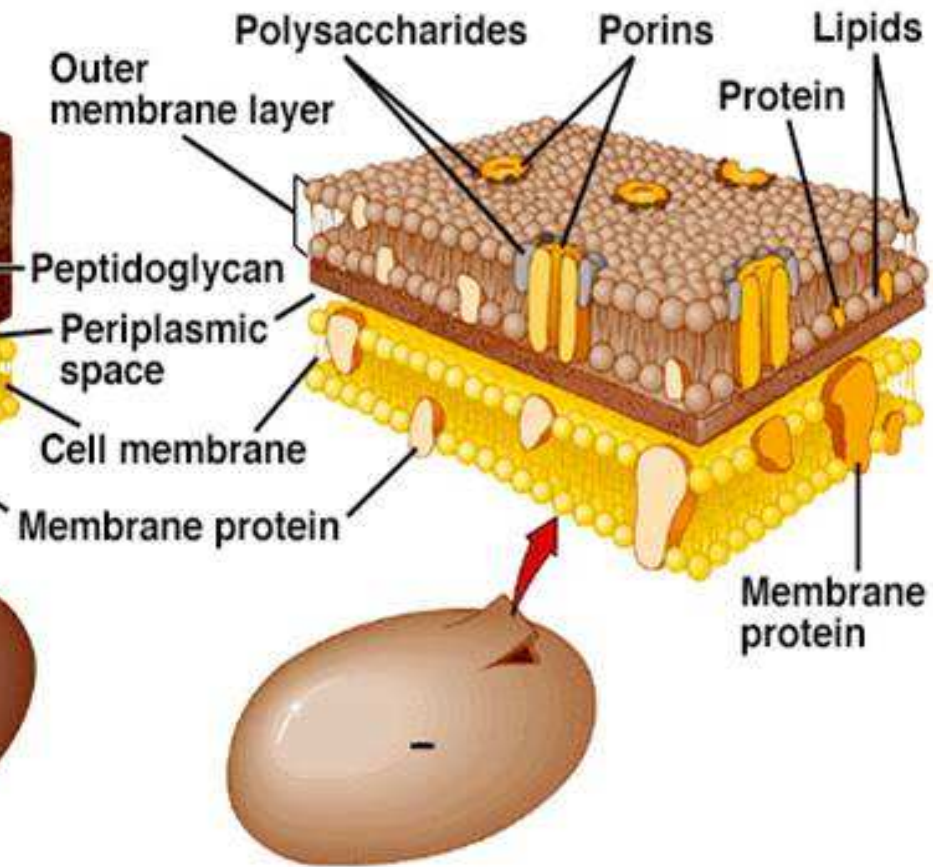
- By staining:
 - Gram positive & negative
 - Discovered by H. C. Gram in 1884
 - Gram(+): blue-purple / Gram(-): red
 - Based on cell wall characteristics

Classification of bacteria

Gram Positive



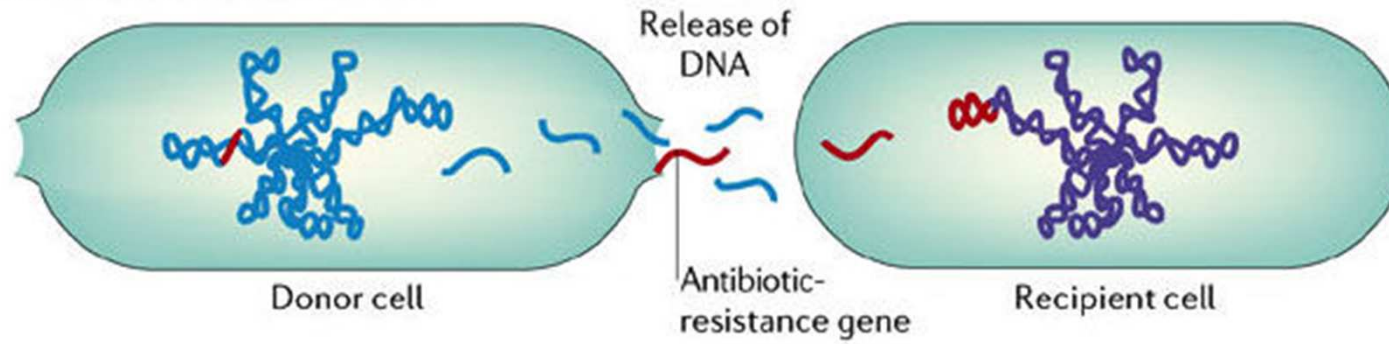
Gram Negative



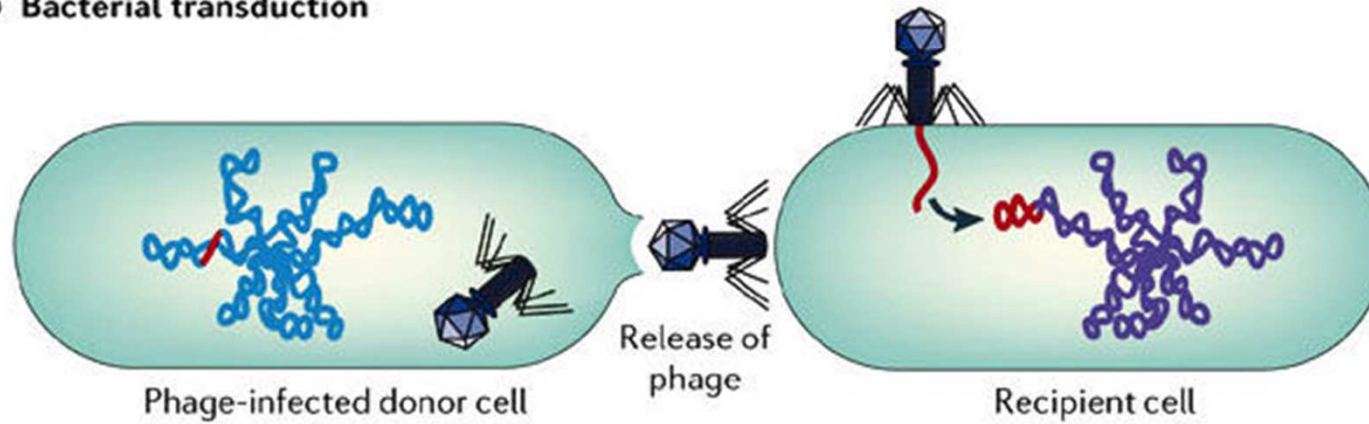
Horizontal gene transfer

- Movement of genetic material between organisms other than by vertical transmission of DNA
 - cf) Vertical gene transfer: from parent to offspring
- Mechanisms
 - Transformation: direct uptake and incorporation of exogenous genetic material
 - Transduction: introduction of foreign DNA into a cell by a virus
 - Conjugation: transfer of genetic material between bacterial cells by direct cell-to-cell contact or by a bridge-like connection

a Bacterial transformation



b Bacterial transduction



c Bacterial conjugation

