ARKAN
ACADEMY

MICROBIOLOGY 1

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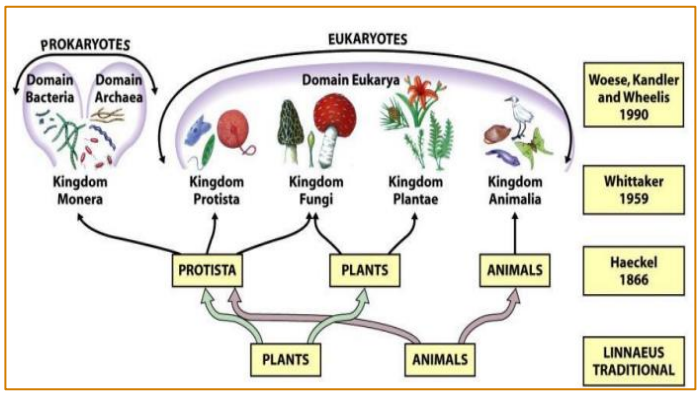
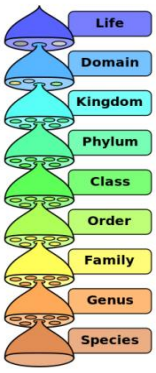
Study smarter, not harder!

Taxonomy and Bacterial Identification

- **Taxonomy**
  - The science of classification.
  - Grouping of related organisms together into categories(taxa)
  - Why do we need such classification?
    - ✓ To *arrange* related organisms into groups
    - ✓ To *establish* the criteria for identifying organisms
    - ✓ To *provide* important information on how organisms evolved
  - Organisms classified in any group have certain *common characteristics*.
    - ✓ A basic principle of taxonomy is that members of a *higher rank* category share *fewer characteristics* than those in a *lower rank* category (vertebrates: fish, humans, animals; mammals: human)

- **Classifications and Nomenclature**
  - Carl Linnaeus (the father of taxonomy) started a 2-kingdom classification and developed the 'binomial nomenclature' for naming organisms
  - Now we have 5-kingdom classification, which have been grouped *into 3 domains*
  - Binomial Nomenclature:
    - ✓ *First* name 'Genus' in *capital* letter, *second* name is specific epithet in *small* letter
    - ✓ The two names identify the species to which the organism belong
    - ✓ Both are *italic* or *underline*
      - E.g. *Escherichia coli*, Escherichia coli
    - ✓ The name of the organism *tells something* like shape, nutrient, disease, who discovered it, etc
  - Taxonomy and nomenclature of organisms are subject to *change* when *new* information is obtained.
    - ✓ i.e. organisms are sometimes moved from one category to another and their names may change





The Meaning of the Names of Some Microorganisms

Name of Microorganism	Meaning of Name
Entamoeba histolytica	*Ent*, intestinal; *amoebae*, shape and means of movement; *histo*, tissue; *lytic*, lysing, or digesting tissue
Escherichia coli	Named after Theodor Escherich in 1888; found in the colon
Haemophilus ducreyi	*Hemo*, blood; *phil*, love; named after Augusto Ducrey in 1889
Neisseria gonorrhoeae	Named after Albert L. Neisser in 1879; causes gonorrhea
Saccharomyces cerevisiae	*Saccharo*, sugar; *myco*, mold; *cerevisia*, beer or ale
Staphylococcus aureus	*Staphylo*, cluster; *kokkus*, berry; *aureus*, golden
Lactococcus lactis	*Lacto*, milk; *kokkus*, berry
Shigella etousae	Named after Kiyoshi Shiga in 1898; European Theater of Operations of the U.S. Army (final *e* gives proper Latin ending)

Table 9-1 Microbiology, 7/e
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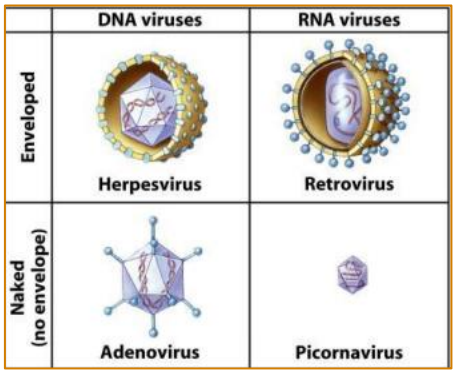
  - Members of a *species* have *common* characteristics that distinguish them from that of other species
  - A *subgroup* of a species (subspecies) with *one or more* characteristics that distinguish it from other subgroups of the same species is called '*strain*'.
    - ✓ i.e. when organisms in one pure culture of a species *differ* from the organisms in another pure culture of the same species in some characteristics such as antibiotic resistance, pathogenicity…
    - ✓ *Strains* are *identified by* a name, number, letters or combination of them; e.g. *E. coli K-12, E. coli ATCC 25922, E. coli NCTC 10418, E. coli 0157:H7* (causes haemorrhagic inflammation of the colon in humans)

- **The 5-Kingdom Classification**
  - One of the most *widely accepted* classifications
  - All living organisms regardless to the kingdom are composed of cells that carry certain functions
    - ✓ *Cell* is the basic structural & functional unit of living things
    - ✓ Regardless of the taxonomic classification of the organism, all cells have cell membrane, carry genetic information in DNA, have ribosomes to form proteins

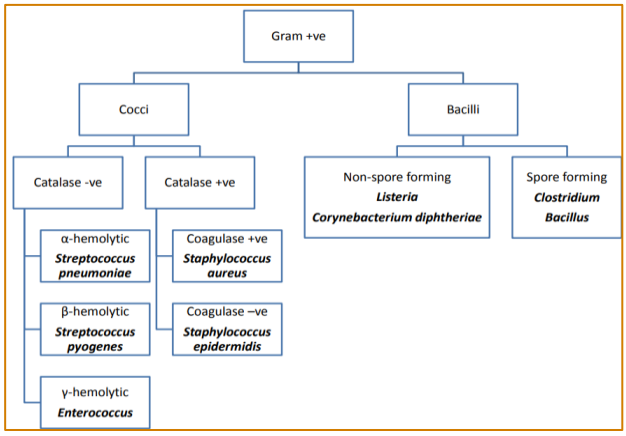
1. Monera or prokaryotae
   - ✓ Includes all *prokaryotes* (i.e. bacteria and archaea)
   - ✓ *Unicellular*, lack nucleus & lack membrane enclosed organelles
   - ✓ Reproduction mainly by *binary fission*
   - ✓ *Archaea*: live in extreme environments
     - e.g. thermophiles, halophiles, thermoacidophiles, methanogens (degrade organic compounds to methane)
2. Protista
   - ✓ Most are *unicellular*, some are organized into colonies
   - ✓ Some have *cell wall*, others don't
   - ✓ They are *eukaryotes*
   - ✓ They are *not* plants nor animals
3. Fungi
   - ✓ *Mostly* multicellular & *some* unicellular
   - ✓ Obtain nutrients by *absorption* of organic matter from dead organism.
     - They usually kill the cells then absorb nutrients.
   - ✓ *Some* cause *disease* to plants, animals & humans, some are used in food & industry
4. Plantae
   - ✓ *Macroscopic* green plants, live on land & contain chlorophyll
   - ✓ *Some* contain *medicinal* substances like quinine
5. Animalia
   - ✓ Most of the members are *macroscopic*, but several animal groups live on or in other organisms
   - ✓ Some serve as *carrier* to m.o., e.g helminths, and live inside the body
   - ✓ Certain *arthropods* live on surface of their host & some spread disease

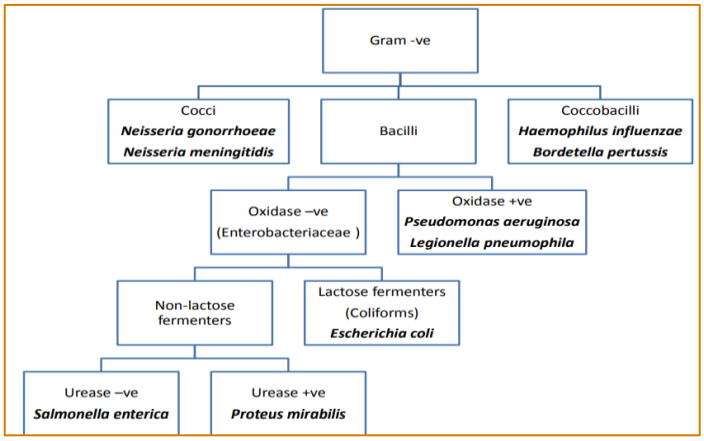
- **Classification of Viruses**
  - Viruses are *acellular* infectious agents that are *smaller* than cells, they contain *nucleic acids* (DNA or RNA) & are coated with *proteins*
  - They are *not assigned* to any of the 5 kingdoms since they have only few characteristics associated with living organisms
  - *Classified by* physical & chemical characteristics
    - ✓ e.g. *type* and *arrangement* of nucleic acid, shape, presence of envelope

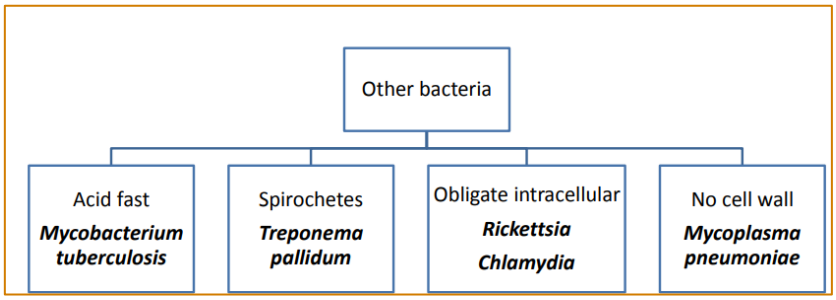


- **Identification of Bacteria**
  - *Criteria* for classifying bacteria:
    - ✓ *Morphology* of cells (size, shape, pili, capsule)
    - ✓ *Staining* (G+ve, G-ve)
    - ✓ *Nutrition*: autotroph, heterotroph
    - ✓ *Oxygen requirement*: aerobes, anaerobes, etc
    - ✓ *Biochemistry* (sugar fermentation, catalse, oxidase, H2 S, urease, etc)
    - ✓ *Genetics* (% similarity of DNA bases)
  - *Unusual Bacteria*
    - ✓ *Rickettsiae* & *Chlamydiae*: obligate *intracellular*
    - ✓ *Mycoplasma*: *no* cell wall & have various shapes
    - ✓ *Ureaplasma*: *unusual* cell membrane
  - *Molecular Methods*:
    - ✓ DNA Sequencing:
      - The process of determining the nucleic acid *sequence* (i.e. the order of nucleotides) in *DNA*
    - ✓ DNA Hybridization:
      - A molecular biology technique that measures the degree of *genetic similarity* between pools of DNA sequences
      - It is based on the percentage of annealing; high degree of annealing reflects high relatedness
    - ✓ Protein separation:
      - Commonly performed using *SDS-PAGE* (sodium dodecyl sulfate– polyacrylamide gel electrophoresis) which is an analytical technique to separate proteins based on their molecular weight
    - ✓ Phage typing:
      - A method used for identifying bacteria using specific *bacteriophages*
  - Biologists use taxonomy to identify organisms according to their characteristics
  - Most common is the *dichotomous key* which has paired statements describing characteristics of an organism.
    - ✓ i.e. By proceeding *step by step* through characteristics such as Gram type, shape, presence of enzymes or metabolic pathways (e.g. catalase, fermentation of certain sugars) a m.o. can be identified to species or even strain level

1a	Gram-positive	Go to 2
1b	Not Gram-positive	Go to 3
2a	Cells spherical in shape	Gram-positive cocci
2b	Cells not spherical in shape	Go to 4
3a	Gram-negative	Go to 5
3b	Not Gram-negative (lack cell wall)	Mycoplasma
4a	Cells rod-shaped	Gram-positive bacilli
4b	Cells not rod-shaped	Go to 6
5a	Cells spherical in shape	Gram-negative cocci
5b	Cells not spherical in shape	Go to 7
6a	Cells club-shaped	Corynebacteria
6b	Cells variable in shape	Propionibacteria
7a	Cells rod-shaped	Gram-negative bacilli
7b	Cells not rod-shaped	Go to 8
8a	Cells helical with several turns	Spirochetes
8b	Cells comma-shaped	Vibrioids







➢ Bergey's manual

- ✓ The widely accepted *reference* for the identification of bacteria.
- ✓ *1 st* edition published in *1923* by American society for microbiology (David Bergey was chairman of the editorial board)
- ✓ Bergey's manual of determinative bacteriology: for *bacteria identification*
- ✓ It is *internationally* recognized reference for bacterial taxonomy. Also serves as reliable source for identifying causative agents of infections
- ✓ Bergey's manual of *systematic bacteriology*: started in 1980 as a more comprehensive resource.
- ✓ It also provides *description* & *photographs* of species, tests to distinguish among genera & species DNA relatedness

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