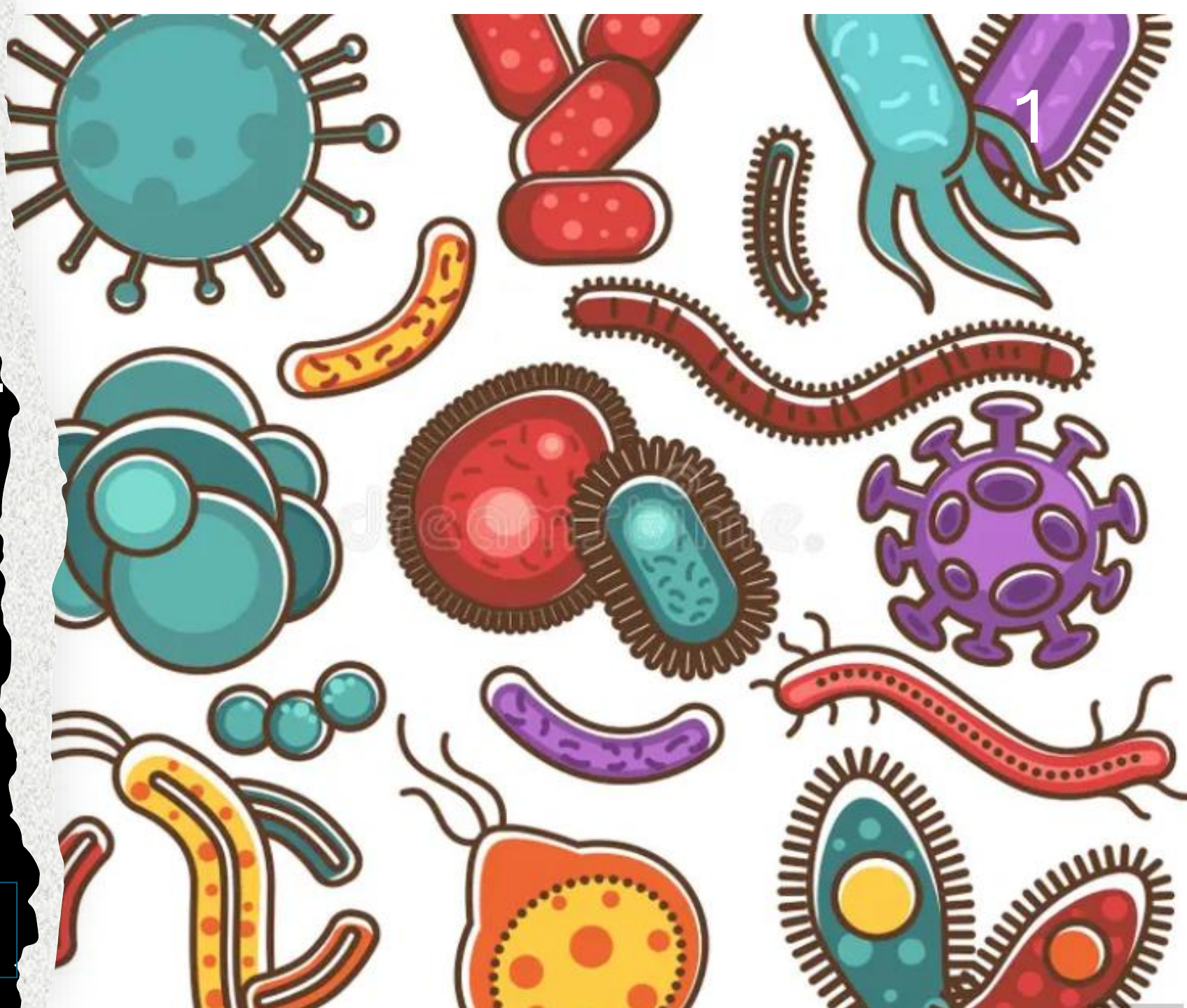




Classification and grouping of bacteria

Prof.Dr. LAMYAA KADHIM
MEDICAL BACTERIOLOGY



Learning objectives

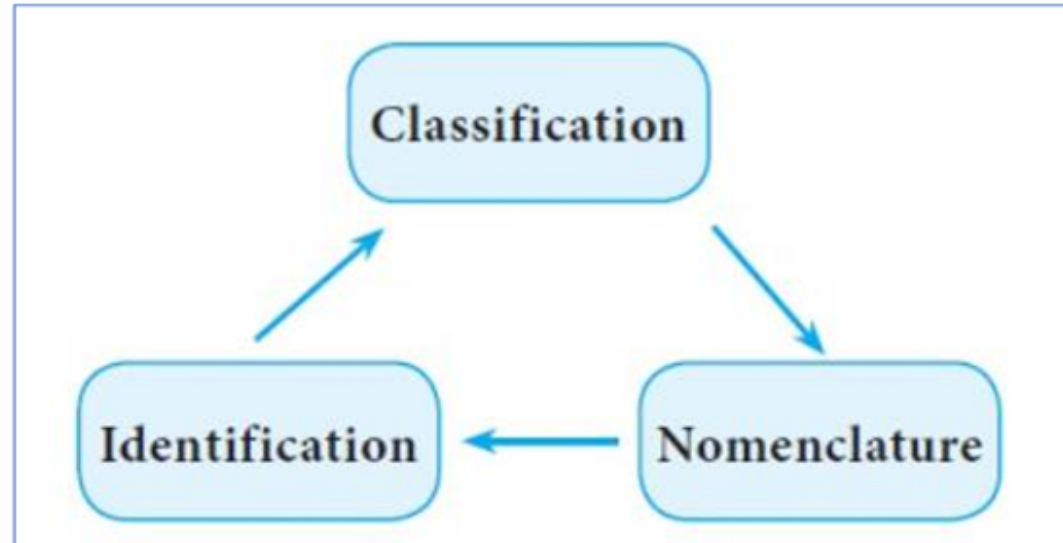
The learning Objectives of this lecture are:

- 1-Define the taxonomic models**
- 2- Explain grouping of bacteria**
- 3-Clarify the taxonomy techniques**
- 4- Determine the classification systems**

What is **TAXONOMY**?

Taxonomy:

Science of biological classification which include of three separate but interrelated parts:



Classification: Grouping organisms based on similarities or evolutionary relationships



Nomenclature: Naming taxonomic groups using specific rules, following the binomial (two-name) system



Identification: Determining the taxon to which an organism belongs

Why taxonomy is important

**Organizes
data**

**Supports
predictions**

**Standard
names**

**Ensures
accurate ID**

Is classification and identification important in medical practice ?



Medical practitioner needs to isolate, identify and find antibiotic susceptibility of a certain pathogen patients with infections.

Microbiology treatment often is exceptionally difficult when the pathogen is unknown .



What are the basis of classification?

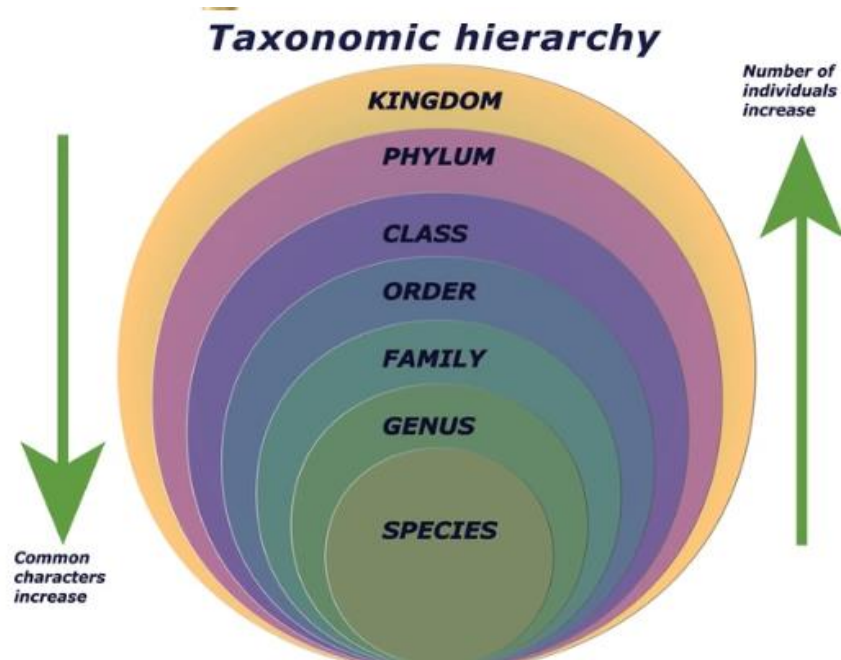
Morphological characteristics of the organisms



similarities and dissimilarities among organisms

Interrelationships of the organisms

Who is known as the father of taxonomy?



Invented binomial nomenclature

- Carolus Linnaeus is known as the father of taxonomy.

-introduced 'Binomial Nomenclature'

What is 'Binomial Nomenclature' ?

Binomial means 'Two Names'.

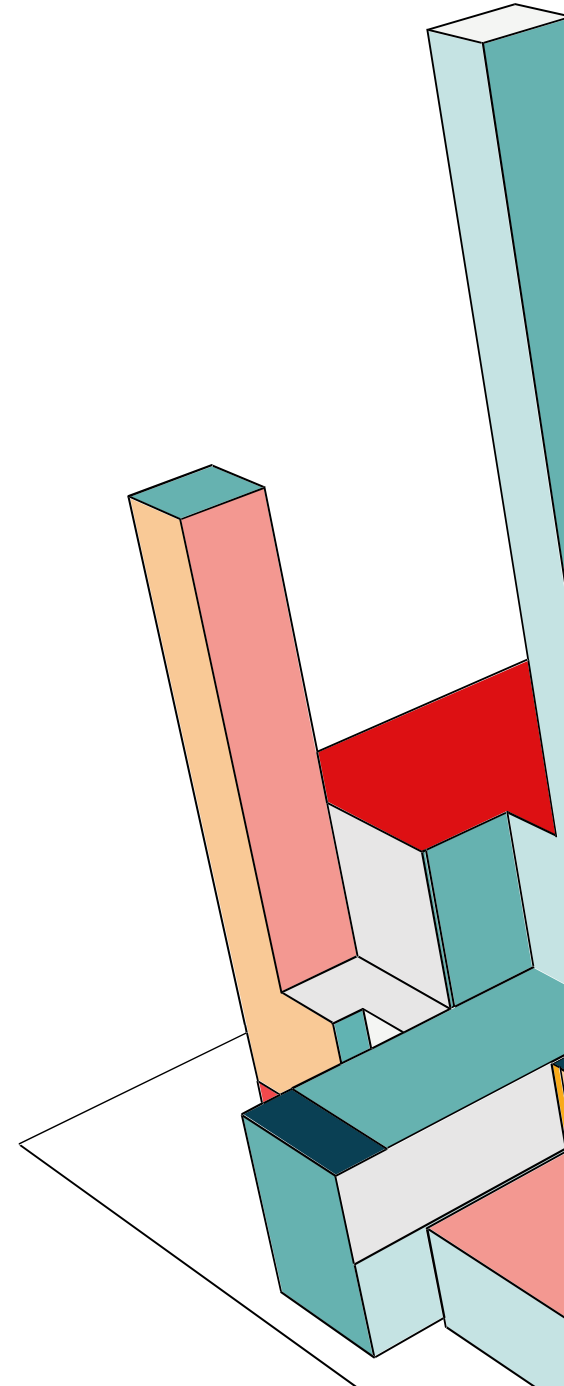
Binomial Nomenclature is the system of giving every living thing a two-part scientific name.

- **The first part is the genus name (written with a capital letter).**
- **The second part is the species name (written with a small letter).**
- **Both names should be underlined or should be written in italic form. For example:**

<i>Escherichia</i>	<i>coli</i>
↓	↓
Genus	Species

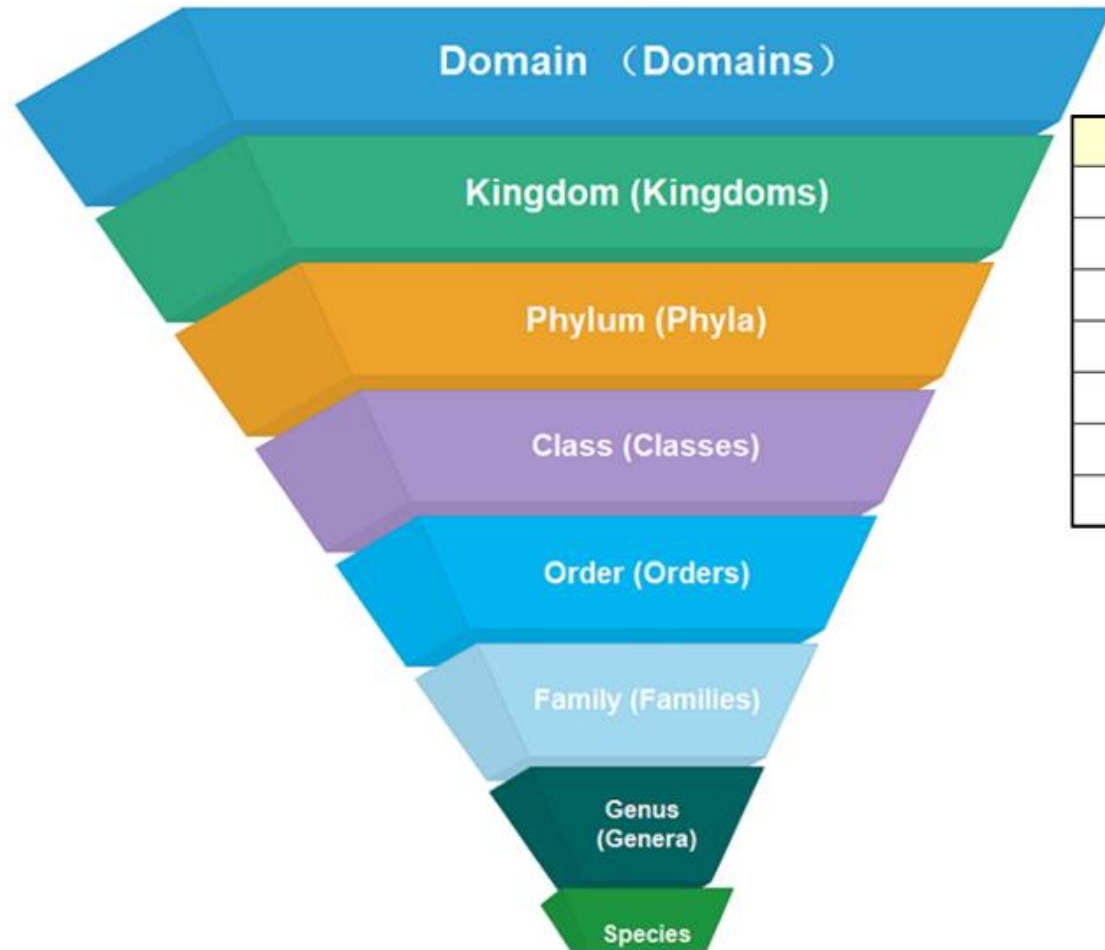
OR Escherichia coli

E. coli



Bacteria are classified using hierarchical systems

- The **hierarchical classification** system consists of the following taxa designations:

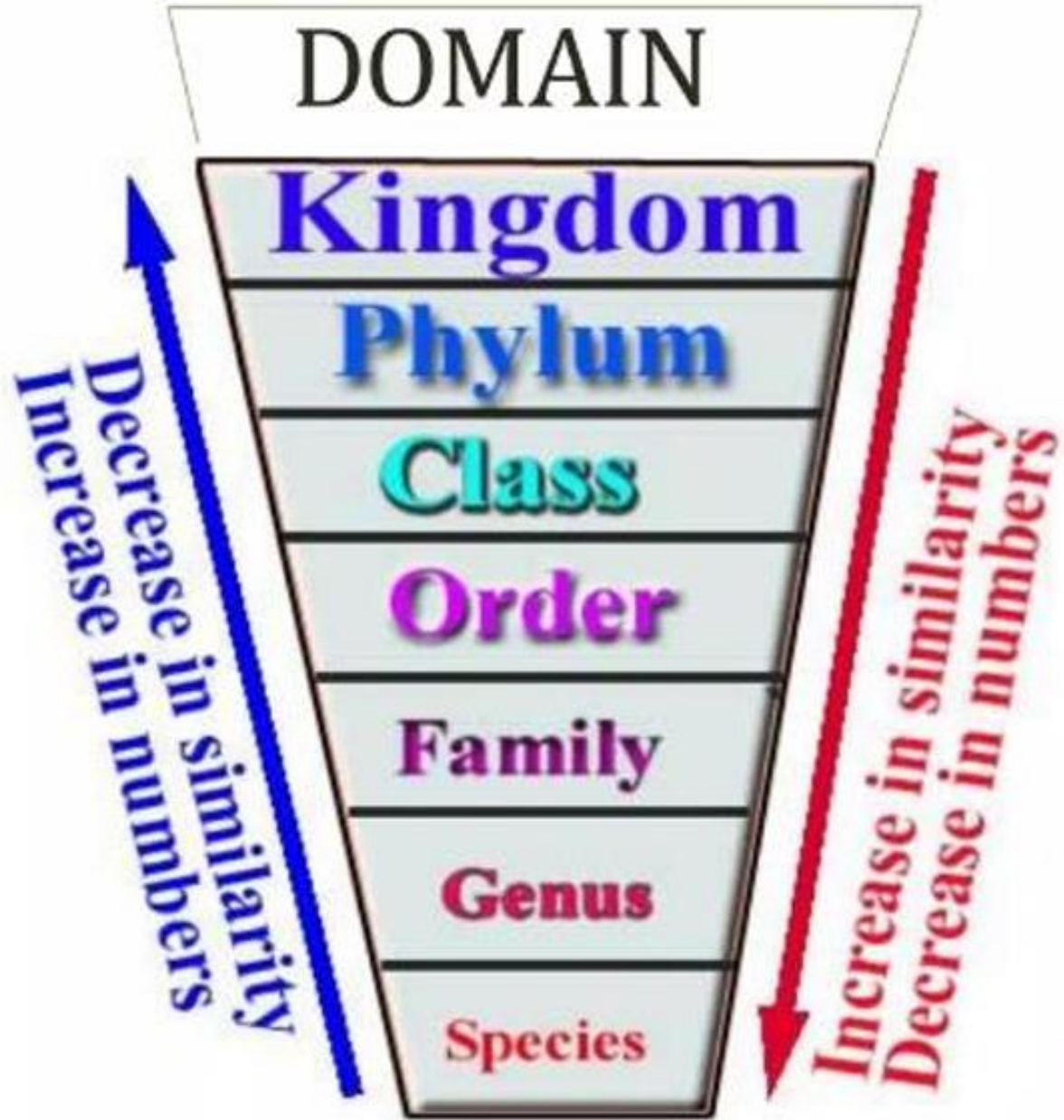


Formal Rank	Example
Domain	Bacteria
Phylum	Proteobacteria
Class	<i>Gammaproteobacteria</i>
Order	<i>Enterobacteriales</i>
Family	<i>Enterobacteriaceae</i>
Genus	<i>Escherichia</i>
Species	<i>coli</i>

Example: Taxonomic Ranks of the bacterium
Escherichia coli

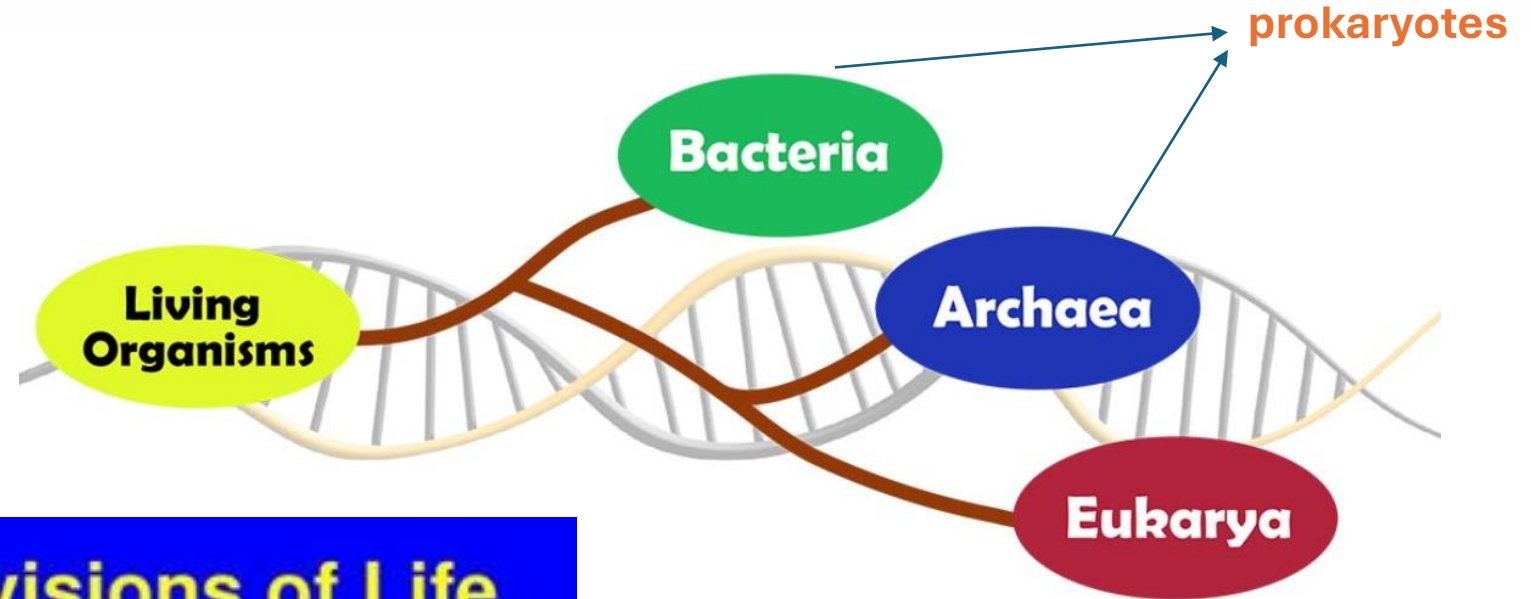


8 taxa of classification



Prokaryotes evolved before eukaryotes

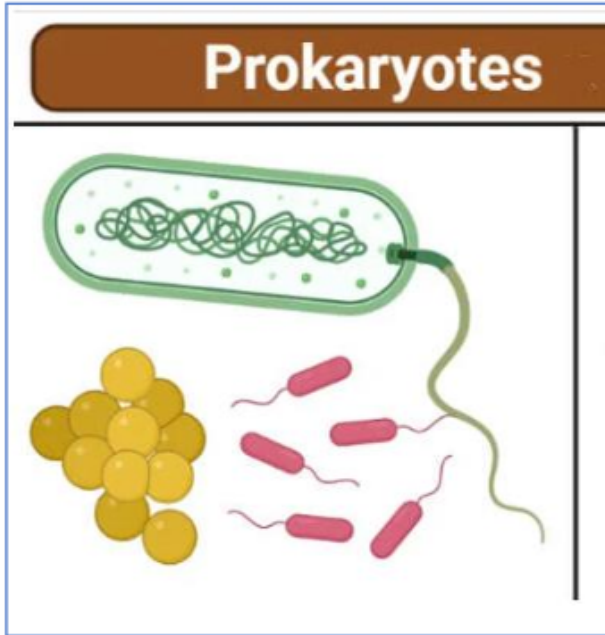
The three –domain system , based upon molecular analysis ,prokaryotes are divided into two domains bacteria and Archaea



The Major Divisions of Life

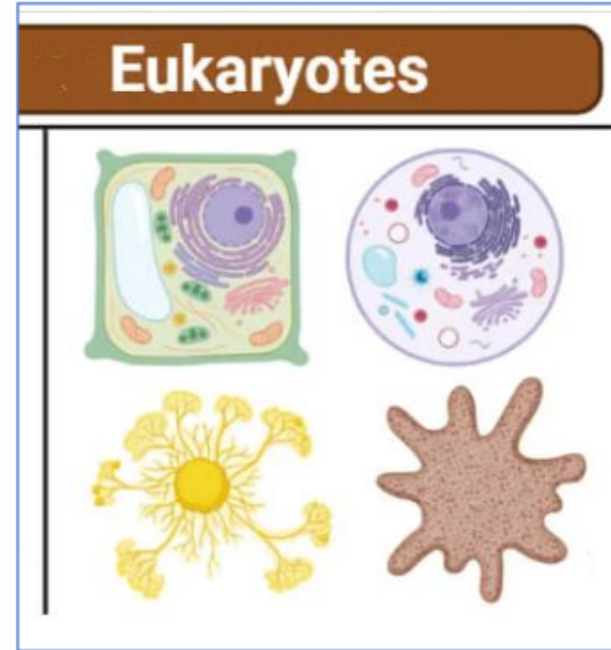
- based primarily on rRNA analysis
- currently held that there are three domains of life

What are the differences between Prokaryotes & Eukaryotes?



- Are single-celled organisms**
- Genetic material is not contained in a distinct nucleus**
- Have no membrane-bound organelles**

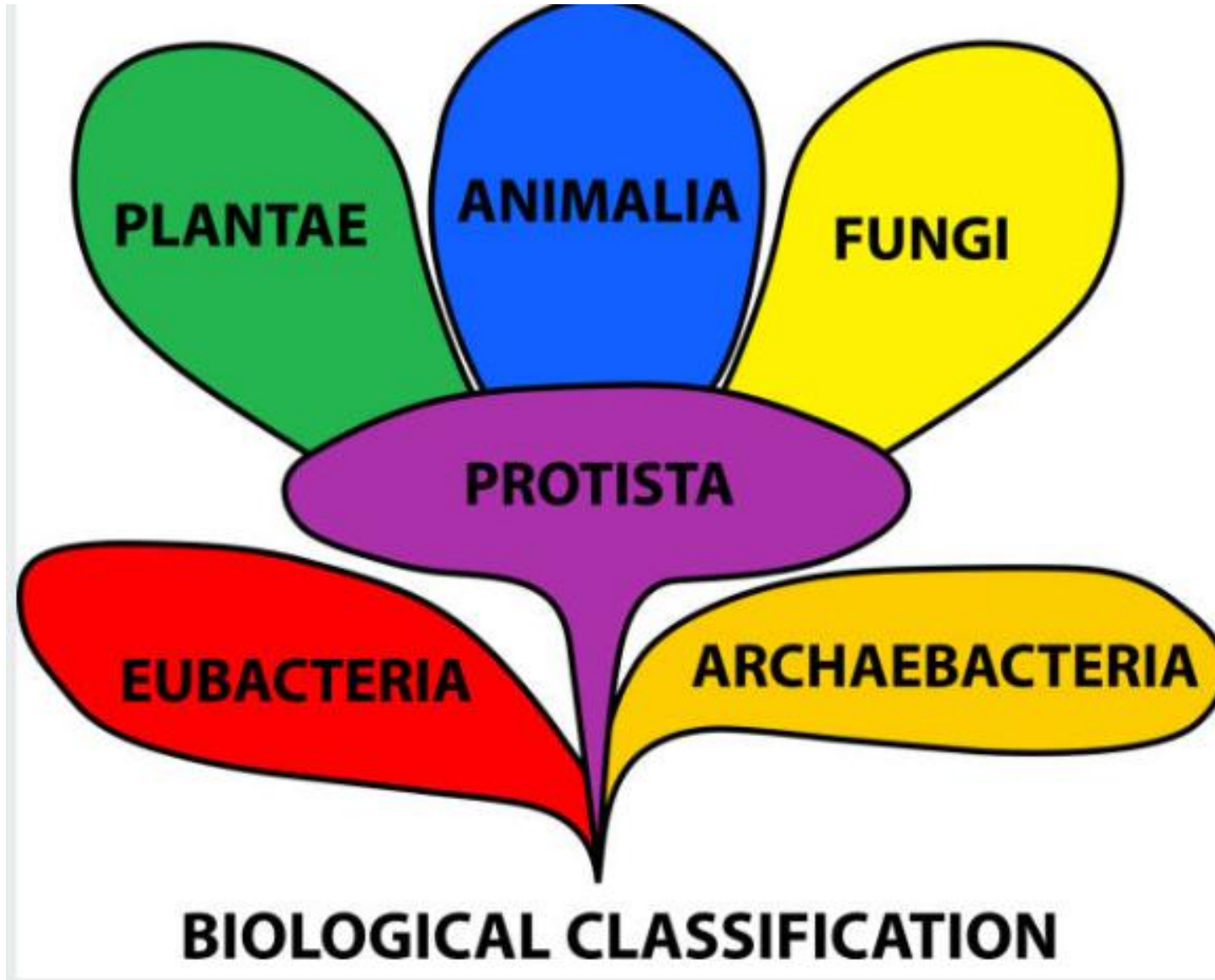
Examples:
Bacteria are prokaryotes



- May be single-celled or multicellular organisms**
- Genetic material is contained inside a distinct nucleus**
- Have membrane-bound organelles, which carry out specific cell functions.**

Examples:
All multicellular organisms including human

THE MAIN KINGDOM CLASSIFICATION SYSTEM :



There are over 1.5 million different organisms identified to date.

How to put them in groups?

This will be based on differences and similarities of **several major properties** among living organisms to put them into different groups .

Genotype and Phenotype

The genotype

is **a set of genes in DNA** responsible for unique traits or characteristics



The phenotype

is the physical appearance or characteristic of an organism



Basis of Classification of Microorganisms

Microorganisms are classified based on:

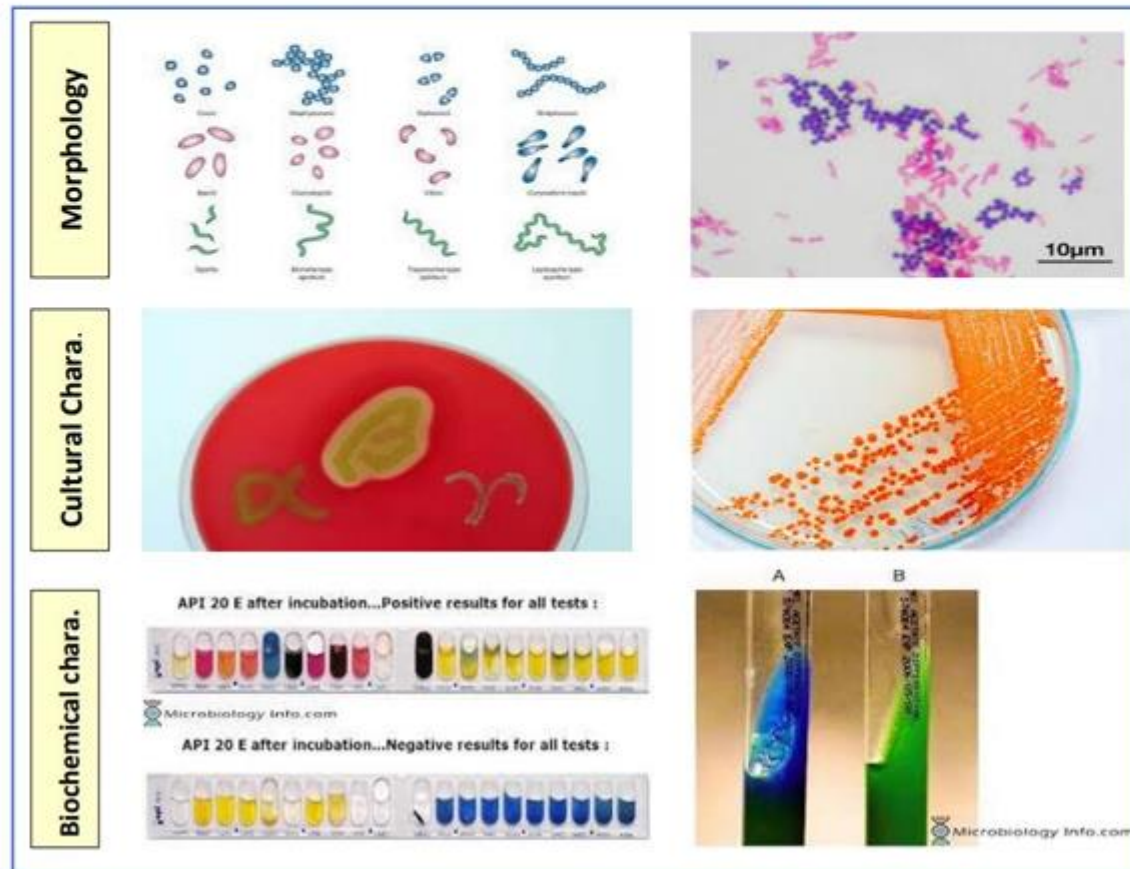
1- Phenetic characteristics

2- Genotypic

3- Phylogenetic

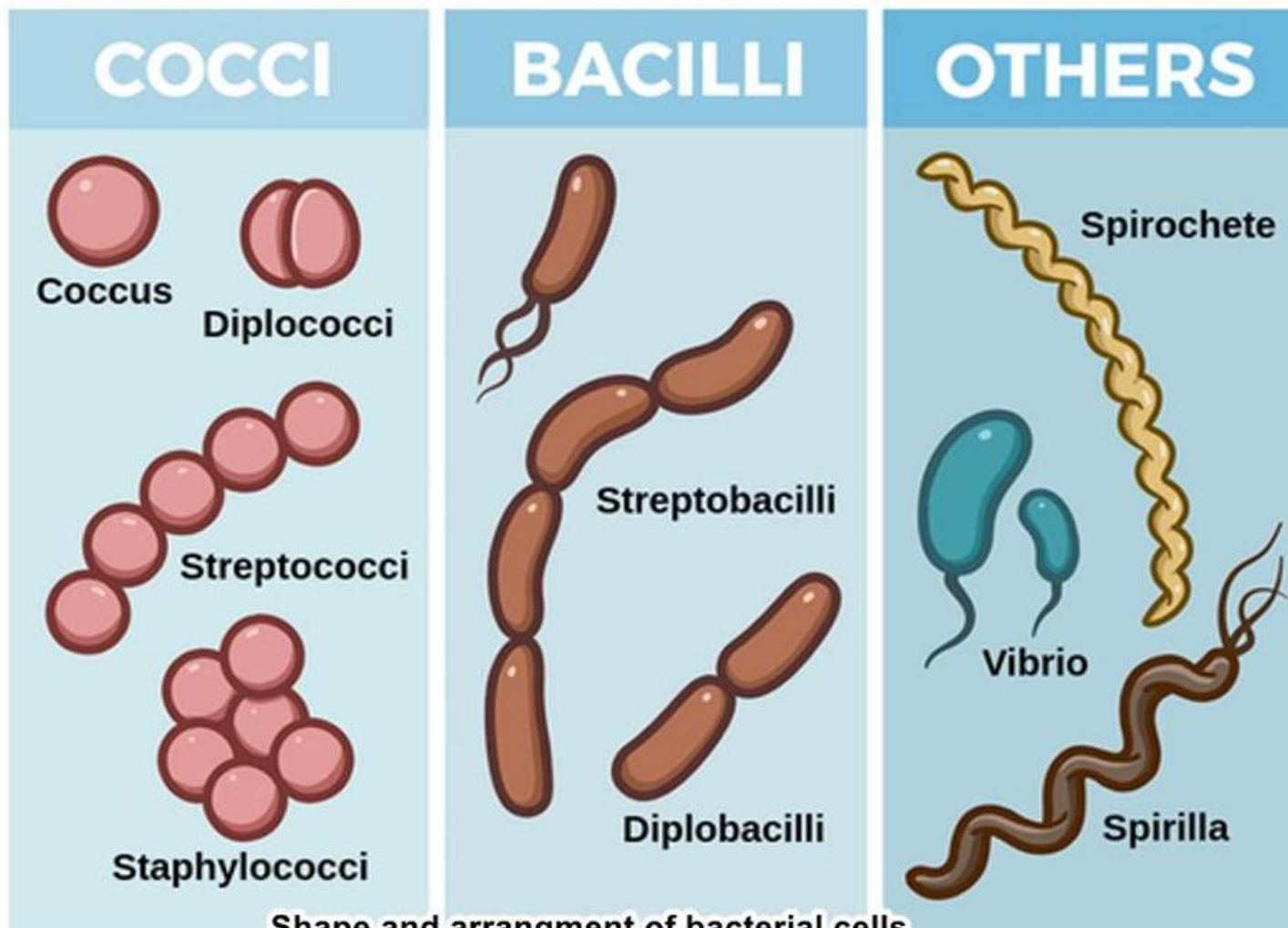
1- Phenetic characteristics

Is the classical approaches to taxonomy that make use of morphological , physiological, ecological, and genetic characteristics .



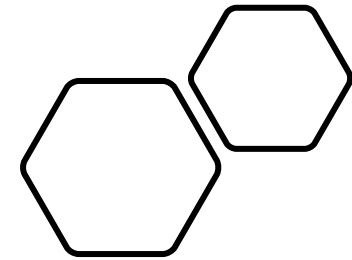
❖ **Classification Based on Several Major Properties of Bacteria**

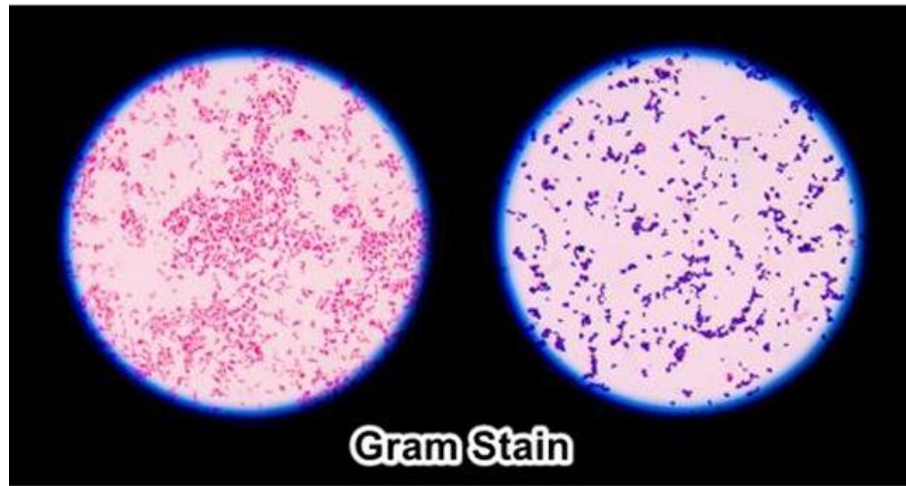
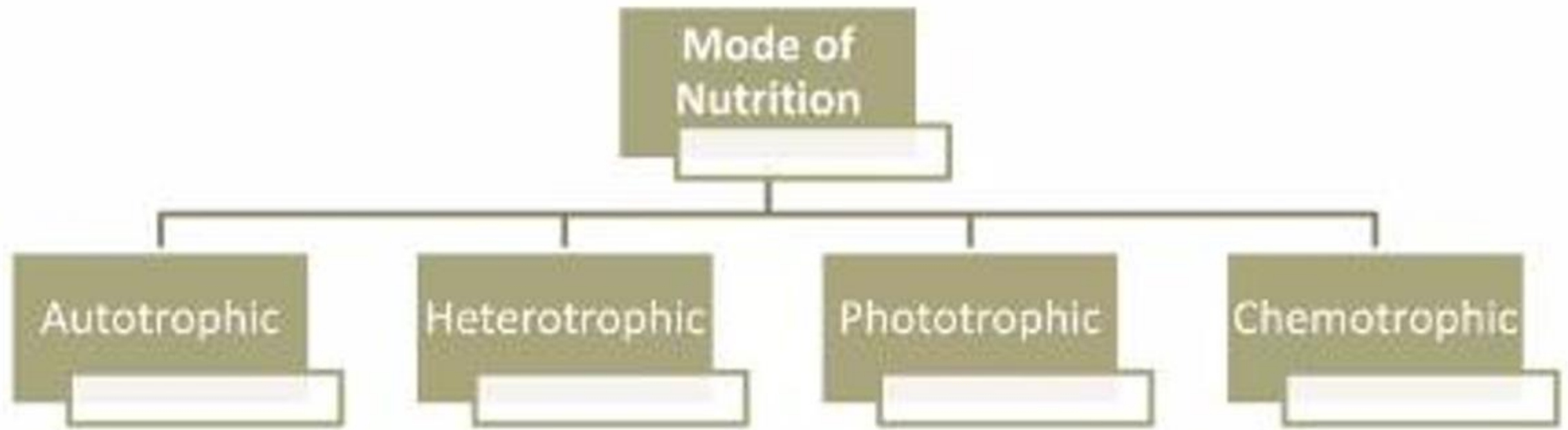
- A. Based on Morphological Characteristics
- B. Based on Anatomical Features
- C. Based on Staining Reaction
- D. Based on Pathogenicity
- E. Based on Cultural Characteristics
- F. Based on Nutrition
- G. Based on Environmental Factors
- H. Based on Presence of Flagella
- I. Based on Motility
- J. Based on Spore Formation



Shape and arrangement of bacterial cells

Morphological characteristics





Gram negative & gram positive

◉ GRAM'S STAIN

- Gram-positive cocci - *Staphylococcus aureus*
- Gram-negative cocci - *Neisseria gonorrhoeae*
- Gram-positive rods - *Clostridium* spp.
- Gram-negative rods - *E. coli*

◉ ACID FAST STAIN

- Acid-fast bacilli - *Mycobacterium tuberculosis*

Bacterial Classification as per Presence and Number of Flagella

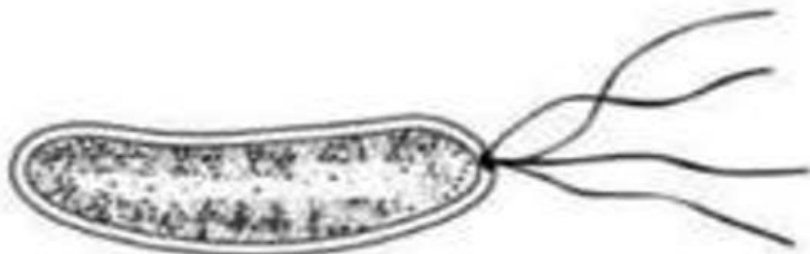
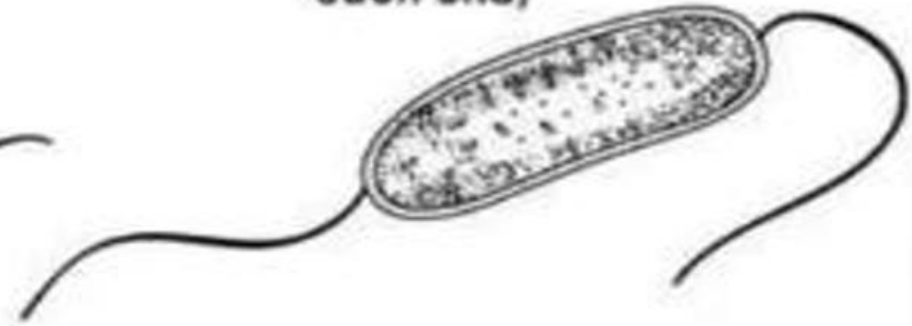
Atrichous
(no flagella)



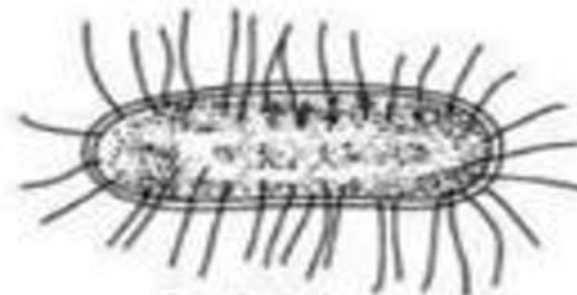
Monotrichous
(one flagellum at one end)



Amphitrichous
(flagella at each end)



Lophotrichous
(tuft of flagella
at one end)



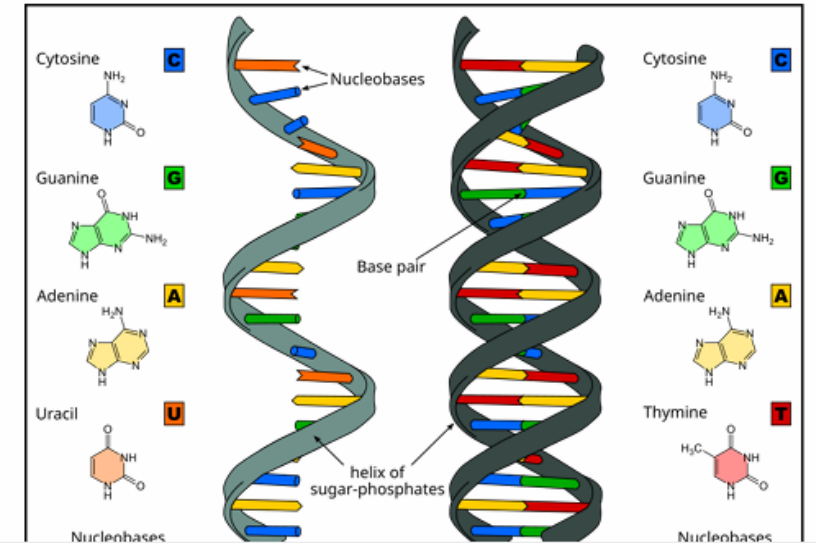
Peritrichous
(flagella all over)

2- Genotypic(Molecular Characteristics):

This is the **most powerful approaches** to taxonomy through the **study of proteins and nucleic acids** which are the direct gene products or the genes themselves, yielding considerable information about true relatedness.

The more recent molecular approaches in prokaryotic taxonomy are:

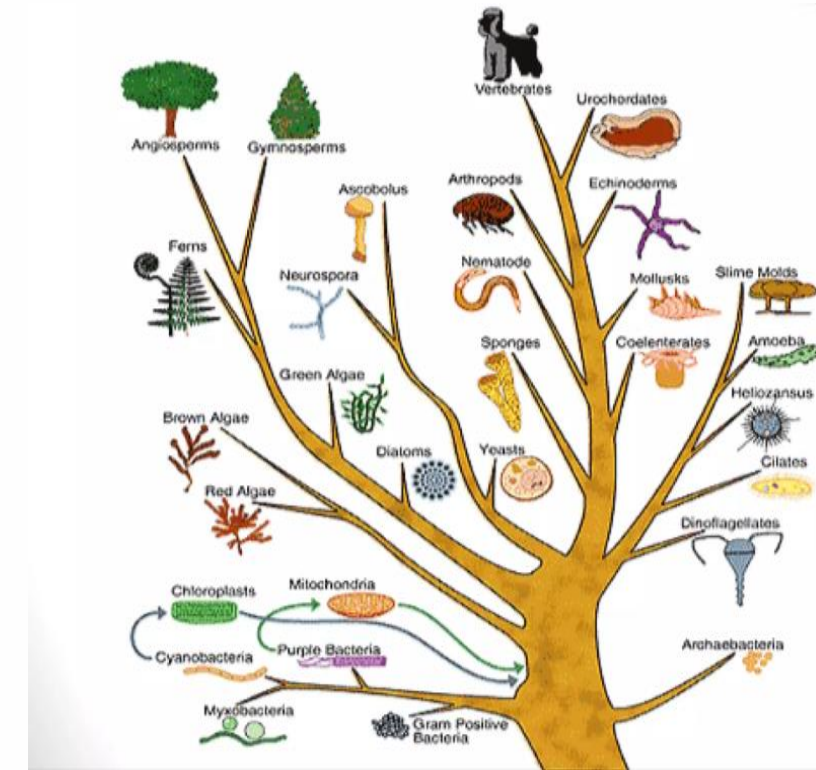
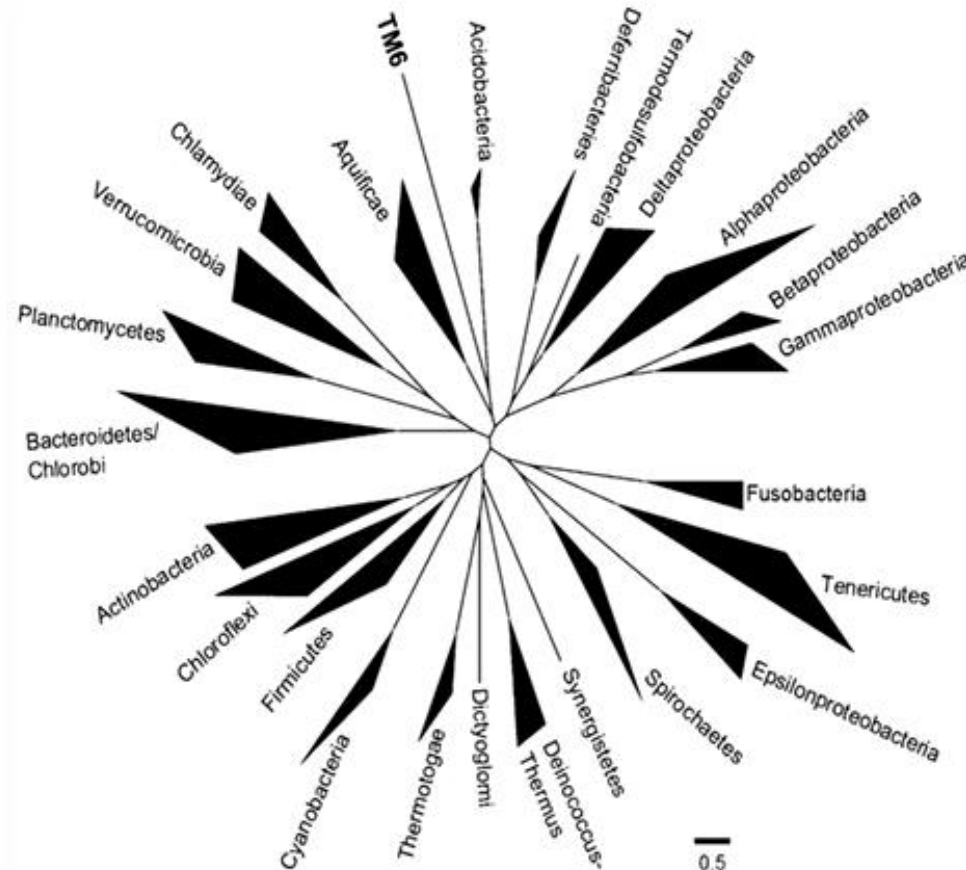
- 1- Comparison of Proteins
- 2- Nucleic Acid Base Composition
- 3- Nucleic Acid Hybridization
- 4- Nucleic Acid Sequencing



3- Phylogenetic

is the studying of evolutionary distance and evolutionary relationships rather than general resemblance

a “family tree” that classifies organisms by their evolutionary history



Classification Systems :

Phenetic system

grouping organisms together based on overall similarity

1 - Phylogenetic classification

grouping organisms together based on probable evolutionary relationships rather than general resemblance (the **direct comparison of genetic material and gene products such as RNA and proteins solves many of these problems.**

2- Molecular or Genetic classification

This is based on the degree of genetic relatedness of different organisms. DNA relatedness can be tested by studying the nucleotide sequences of DNA and by hybridization or recombination methods.

3 - Adansonian or Numerical classification

Is the analysis of various types of taxonomic data by mathematical or computerized methods

The process begins with a determination of the presence or absence of selected characters in the group of organisms under study.

Score 0 or 1

If character present : Score 1

If character absent : score 0

Characters studied

- 1- Flagella
- 2- Gram stain positive
- 3- Negative catalase test
- 4- Aerobe

Organism A

1

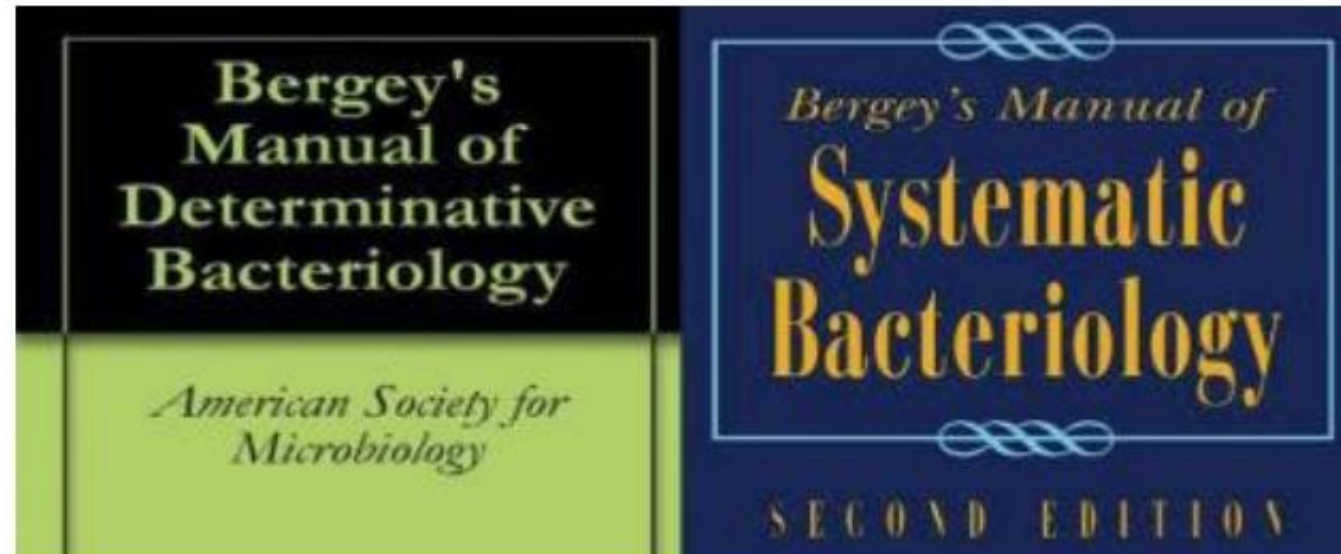
0

Organism B

The data are analyzed using mathematical or computerized method using specific equations to evaluate the similarity coefficient between the organisms

Bergey's Manual of Determinative Bacteriology

In 1923, **David Bergey**, professor of bacteriology at the University of Pennsylvania, and four colleagues published a classification of bacteria that could be used for identification of bacterial species, the ***Bergey's Manual of Determinative Bacteriology*** as well as the ***Bergey's Manual of Systematic Bacteriology*** (The first edition), a more detailed work that contains descriptions of all prokaryotic species currently identified. This manual is now in its ninth edition.





THANK YOU