# CSIR NET Life Science Unit 9

## Three Kingdom Classification

### Three-Domain System (Carl Woese's Classification)

As knowledge in the field of microbiology increased about microbial diversity and DNA sequencing got introduced in classification systems, a big change occurred. An American microbiologist Carl Richard Woese introduces a new class of Archaea by the evidence of 16S ribosomal RNA technology in phylogenetic taxonomy. In this classification system, he adopted the term Domain, Carl Woese's classification system is mainly based on the 16S rRNA gene. In this classification, Domain denotes above the kingdom or "Super kingdom".

Carl Woese classification system also known as the six-kingdom system, this system is divided into three domains and six kingdoms.

In this system, he included all living organisms in three domains which are Archaea, Bacteria, Eukaryote, and it is also divided into six kingdoms which are Archaebacteria (ancient bacteria), Eubacteria (true bacteria), Protista, Fungi, Plantae, Animalia.

All organisms in this classification system are divided on the basis of 16S ribosomal RNA, the lipid composition of the cell membrane, and their sensitivity towards antibiotics. This system split archaea from bacteria. By the study of rRNA it becomes feasible the identification of organisms, their structure modifications very little over time, rRNA molecules also indicate associated or unrelated completely different cells and organisms. 16S ribosomal RNA (rRNA) is used as a 'Chronometer' because its universal distribution means its presence in all species, its similar functionality in all organisms, stability means it changes its sequence slowly and most importantly, rRNA sequence can be aligned, or matched up, between 2 organisms.
Three Domains: the three domains of Woese's classification are: -

- Domain Archaea
- Domain Bacteria
- Domain Eukarya

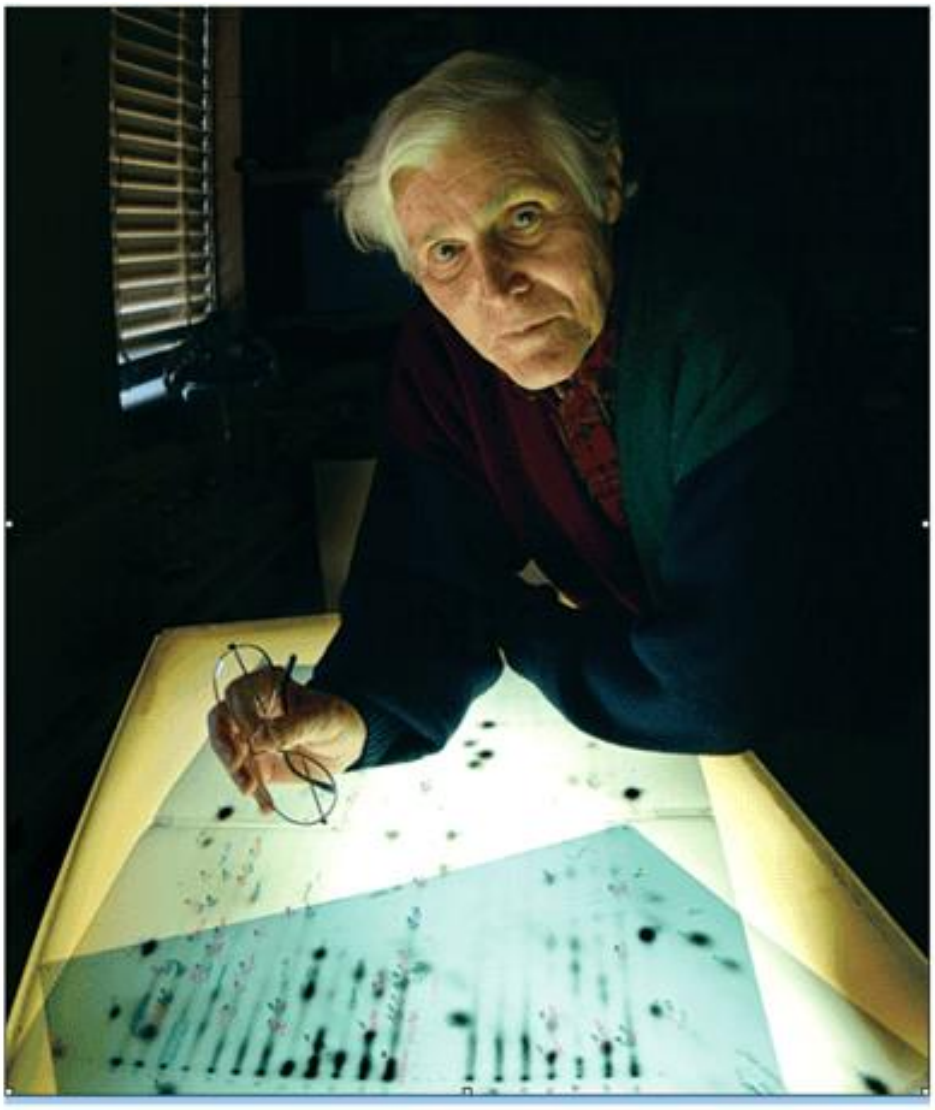

**Fig. Carl Woese**

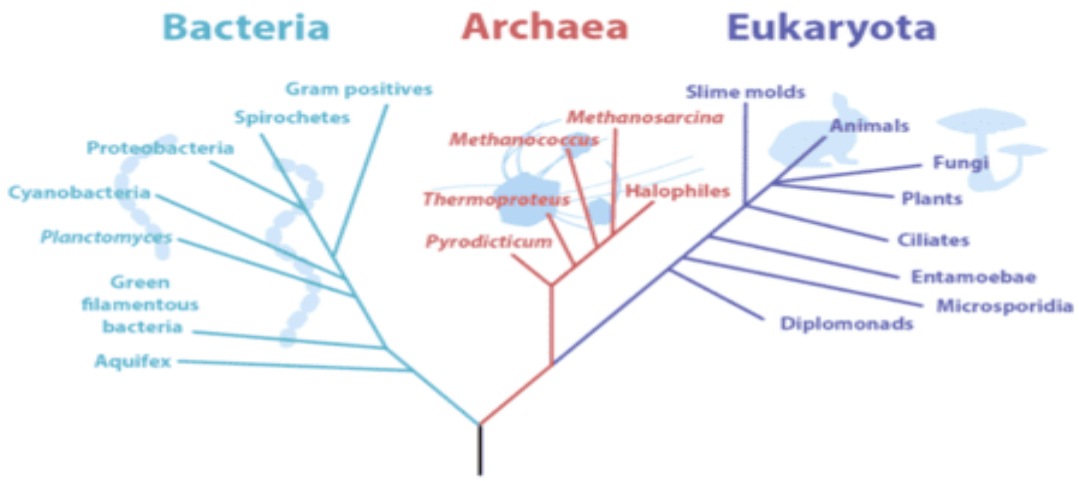


**Fig. The Three Domain System**

- **Domain Archaea:**

The domain archaea contain all prokaryote cells which have distinct biochemistry of cell wall. The cell wall of archaea is a semi-rigid structure that provides protection to the cell from the environment and from the internal cellular pressure. cell walls of normal bacteria are made up of peptidoglycan which is lacking in archaea. archaea show a wide variety of cell wall types, adapted for the environment of the organism. Some archaea lack a cell wall altogether. mostly their cell wall is made up of pseudomurein pseudomurein. Instead of NAM, the archaeal cell wall contains N-acetylalosaminuronic acid (NAT) linked to NAG, with peptide crosslinking which increases strength. in some archaeal cells, Methanochondroitin polymer is also found. And in the cell membrane of archaea, an ether-linkage is present between the glycerol and the side chain, instead of to the ester-linked lipids found in bacteria and eukaryotes, because of their structure They can survive in extreme, harsh environments that differentiated them from other domains. It is considered as the oldest species of organisms on Earth. Araceae are divided into three phyla;
• Crenarchaeota: membrane of this phylum is able to survive in extremely high temperatures and extremely low temperatures, Ex, Acidilobus saccharovorans. Aeropyrum pernix.

• Euryarchaeota: members of this phylum are known as halophiles, which can survive highly saline environments, Ex Methanogens.

• Konarchaeota; members of this phylum found in hot springs, Ex. Candidatus Methanodesulfokores.



- **Domain Bacteria:**

Domain bacteria contain prokaryotic cells also known as Eubacteria these bacterial cells have bacterial rRNA and contain diacyl glycerol diester lipids in their membrane with ester linkage. Cell walls of these bacteria are made up of peptidoglycan and Lipid these members are known as true bacteria, domain bacteria are further divided into 5 phyla;
• Proteobacteria: E. coli, Salmonella typhus, Legionella, Heliobacter pylori (cause of many ulcers), Neisseria gonorrhea (cause of gonorrhea).

• Cyanobacteria; blue-green algae or photosynthetic bacteria.• Eubacteria; Clostridium (tetanus, botulism), Bacillus, Mycoplasma (walking pneumonia).

• Chlamydias; Giardia, Chlamydia.

• Spirochaetes: Spiral bacteria that cause syphilis etc.

- **Domain Eukarya:**

In the three-domain classification domain, Eukarya has eukaryotic cells with a membrane-bound nucleus. Organisms of this domain have membranes that contain unbranched fatty acid chains and glycerol. They do not have peptidoglycans on their cell wall. Eukarya inhibits antibacterial antibiotics but is sensitive to antibiotics that affect eukaryotic cells. Eukarya was divided into four kingdoms:

• Protista: Ex. slime moulds, euglenoids, algae, and protozoans.

• Fungi: Ex. sac fungi, club fungi, yeasts, and moulds.

• Plantae: Ex. mosses, ferns, conifers, and flowering plants.

• Animalia; Ex sponges, worms, insects, and vertebrates. So, it is clear that in a three-domain system, three domains are Archaea, Bacteria, and Eukarya; domain Archaea have one kingdom Archaebacteria which is known as ancient bacteria, domain bacteria have also one kingdom Eubacteria which is known as true bacteria, and domain Eukarya which contain eukaryotic organisms divided into four kingdoms that is Protista, Fungi, Plantae and Animalia. domain Archaea and Bacteria have prokaryotic organisms that do not have a membrane-bound nucleus. The three-domain system is totally based on molecular evidence is the merits of the three-domain system include well established evolutionary relationship.