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Archae and its applications

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Introduction

The word *"Archaea"* derieved from Greek word, meaning *"Ancient things"*. Archae are prokaryotetic, single celled microorganisms that were first isolated from extreme environments like hot sulfur springs. Initially, *Methanogens* were the first representative of Domain Archaea. But in 1970, Archae was categorized as separate group of prokaryotes by Carl Woese & his colleagues. Later in 1977, the Woesian Revolution has divided the phylogenetic tree of life into "three separate domains- The Eukarya, The Bacteria & The Archae on the basis of sequence of 16SrRNA, certain biochemical characters, cell wall and cell membrane (Plate 1). Habitat diversification of archae ranges from growing at low pH (Acidophiles), high salt concentration (Halophiles), high alkalinity (Alkaliphiles) to the temperature of 40-70° C (Thermophiles). Recent studies have discovered *Nano archaeum equitans* belonging to the phylum Nanoarchaeota in 2003 followed by Archael Richmond Mine Acidophilic Nanoorganisms (ARMAN) in 2006. Archaea are most closely related than bacteria to most ancient forms of life that lived in harsh conditions on earth billions of years ago. They are prokaryotic, single celled microorganisms that can survive at extreme conditions. They exist in varied cell shapes ranging from sphere, rod, spiral as well as plates. Due to their diversified habitat, they are ubiquotus in mature. They are widely used for diagnosis and heredity studies, development of drugs and vaccines, sewage treatment, industrial applications such as detergents, bioremediation as well as biogeochemical cycles.

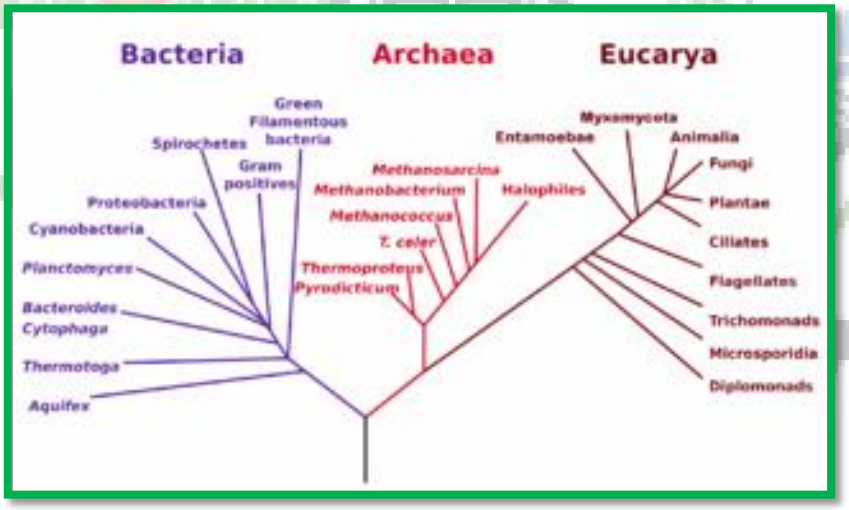

Plate 1: Phylogenetic tree of life

Classification of Archae

The Archaea are classified into two phyla: *Crenoarchaeota* and *Euryarchaeota,* each are further divided into:

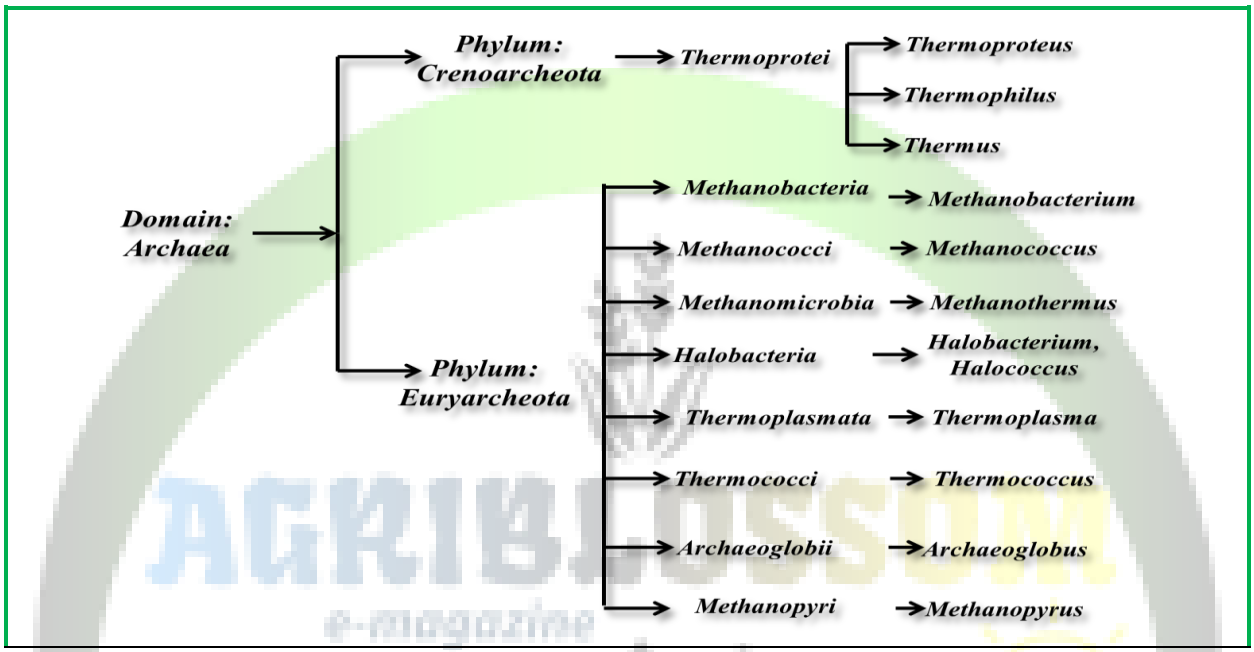

Plate 3: Classification of Archaea

Morphology of Archae

- Gram positive, prokaryote, does not have nucleus and any other membrane-bound organelles. Monoderm cell organization.
- Cell size ranges- 0.1 µm to 15µm in diameter as compared to bacteria (1 µm) and Eukarya (10 µm or larger).
- Cell wall consists of pseudo-peptidoglycan molecules, layer of glycoprotein, methano chondroitein and sulphated heteropolysaccharides, e.g. *Methanobacterium, Methanobacter*.
- Cell membrane consists of phosphate backbone of lipids i.e. glycerol-1-phosphate, phospholipid bilayers, saturated, branched and repeating isoprenoid sub-units that attach to glycerol by ether linkage forming ether bond.
- Various cell shapes- Spheres, Rods, Spiral, Plates (Cell wall & Prokaryotic cytoskeleton) namely *Thermophilus*, *Methanococcus*, *Halobacterium*, *Methanosarcina*, *Thermoproteus* and *Sulfolobus* (Plate 2) except *Thermoplasma* lacking cell wall are irregular in shape.
- Multi-species colonies exist as, "String of Pearls"
- Genetically, they consists of one circular chromosome, plasmids, no nuclear membrane, 70S ribosome size.
- Archaea reproduce asexually by binary fission,, fragmentation, or budding unlike bacteria and eukaryotes, no known species forms spores.
- They are phototrophic *(Halobacteria),* lithotropic *(Methanobacterium)* and organotrophic *(Methanosarcina)* in nature.

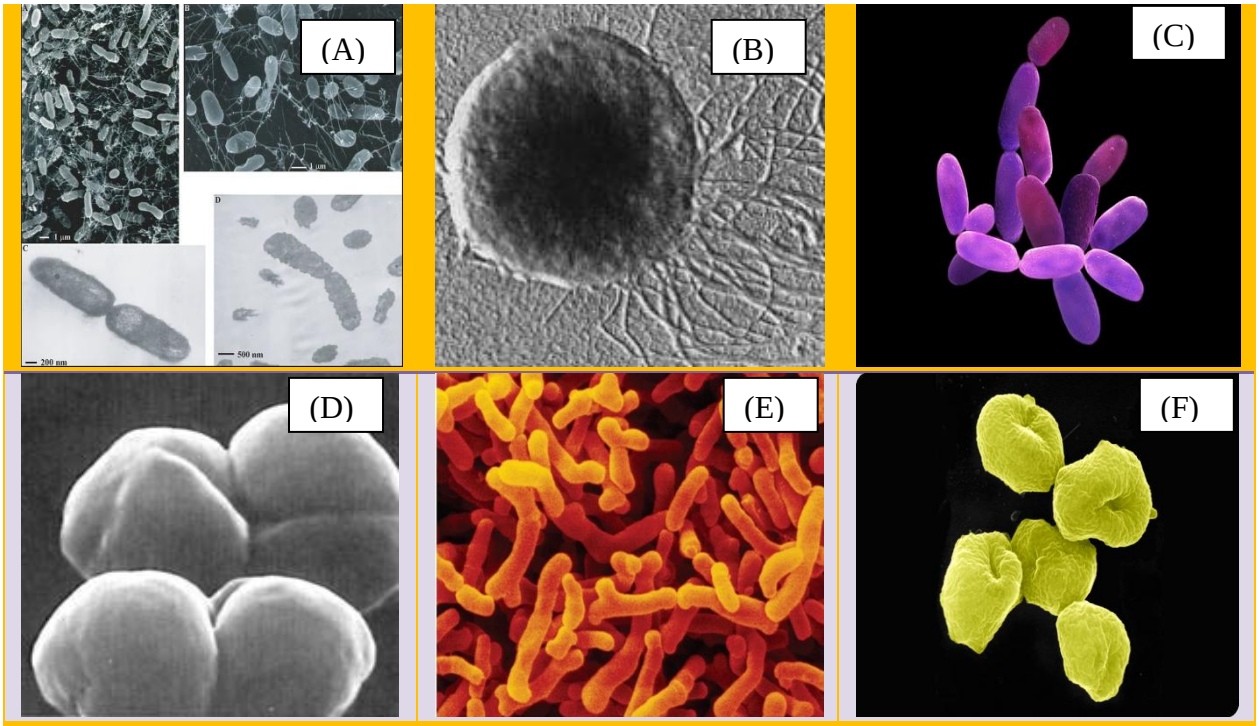

Plate 2: Morphology of Archae; *Thermophilus* (A), *Methanococcus* (B), *Halobacterium* (C), *Methanosarcina* (D), *Thermoproteus* (E) and *Sulfolobus* (F)

Applications of Archaea

- *Thermus aquaticus- Taq polymerase* used as component of Polymerase Chain Reaction (PCR) due to its thermostable nature at high temperature. Uses- Diagnosis hereditary diseases, phylogeny, Identifying DNA fingerprints.
- Extremozymes- Hyperthermophilic Proteases increases the cleaning ability of detergents at high temperature.
- Archaeosome Vaccines- using highly stable archaeal membranes to deliver drugs & vitilize immune response.
- Bioremediation- treating contaminated soil & waste water.
- Anaerobic decomposition- sewage treatment.
- S-Layer Glycoproteins- Nanotechnology & Self Filtration capacity.
- Biogeochemical cycles – large contribution in C, N & S cycles. E.g- Methanogens. Methanogens are global greenhouse gas emissions and global warming. They inhabit human and ruminant guts, where their vast numbers aid digestion. They are also used in biogas production and sewage treatment, and enzymes from extremophile archaea that can endure high temperatures and organic solvents are exploited in biotechnology.

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