ARCHAEA

ARCHAEA:

The word archaea is comes from the ancient Greak means "*ancient things*".

The Archeae are a group of single celled micro organism. A single individual or species from this domine is called an *archaeon*. They have no cell nucleus or any other organelles with in their cells.

In the past they were viewed as an unusual group of bacteria and named Archaea bacteria but since the Archaea have an independent evolutionary history and show many differences in their bio chemistry from others form of life.

CLASSIFICATION:

They are now classified as a separate domine in the three –domine system.

In 1980's C.R.Whose , works on the basis of rRNA studies proposed that "five kingdom concept". Which do not accurately show the evolution or relationship among living things

So they proposed 3 kingdom systems

1) Eubacteria
2) Archeae bacteria
3) Eukaryotes

Generally, archaea and bacteria are quite similar in shape, size although a few archaea have very unusual shapes such as flat &square shaped cells.

Ex. *Haloquadea walsbye* .

Despite this visual similarity to bacteria, archaea possess genes and Several metabolic path ways that are most closely related to those of Eukaryotes, notably the enzymes involved in transcription (DNA to RNA) & translation (RNA to Protein). Other aspect of archaean biochemistry are unique, such as their reliance on ether lipids in their cell membranes.

The archaea exploit a much greater variety of sources of energy than eukaryotes, ranging from familiar organic compounds such as sugars, to using ammonia, metal ions or even hydrogen gas as nutrients.

Salt tolerant archaea (Halobacteria) use sun light as source of energy and other species of archaea fix carbon.

Archaea reproduce asexually and divide by binary fission, Fragmentation or budding in contrast to bacteria & eukaryotes. No spices of

archaea are known that form spores.Archaea were seen as extremophiles that lived in harsh environments such as hot springs and salt lakes but they have since been found in a broad range of habitats such as soils, oceans and marsh lands .

Archaea are now recognized as a major part of life on earth and may play an important role in both carbon & nitrogen cycles. No clear example of archaeal that inhibit the gut of humans and ruminants, they are present in vast numbers and aid in the digestion of food.

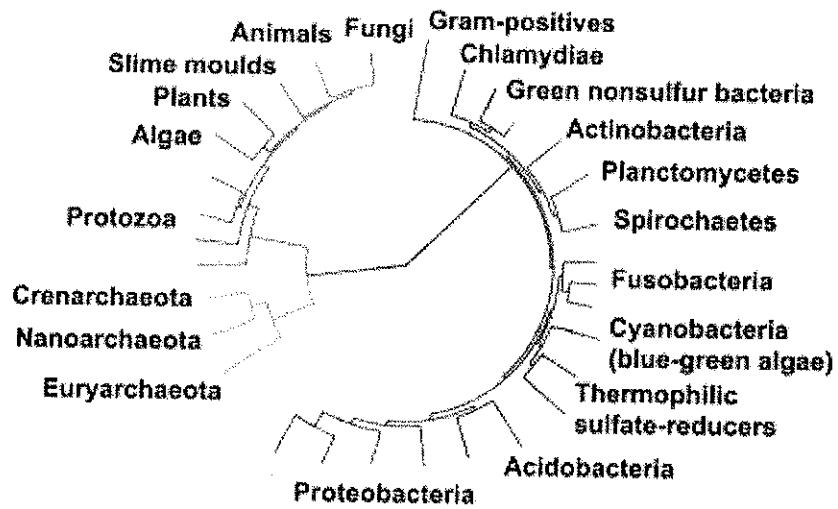
Archaea have some importance in technology with methane gas used to produce biogas and part of sewage treatment and enzymes from extremaphile archaea that can resist high temperature and organic solvents are exploited in biotechnology.

Current knowledge of Archaea classification:

Current knowledge on the diversity of archaea is fragmentary and the total number of archaean species cannot be estimated with an accuracy. Even estimates of total number of phyla in the archaea range from 18-23 of which only 8 phyla have representing that have been cultured and studied directly.

Many of these hypothetical groups are known from only a single rRNA sequence indicates that the vast majority of the diversity among these organisms remains completely unknown.

Evaluation:



Morphology:

Individual archaea ranges from 0.1 μm -15μm in diameter. Occurs various shapes and commonly.

Spheres
Rods
Spirals
Plates

Other morphologies:

1) Irregular shaped lobed cells -- Sulfolobus
2) Needle like filaments that are less than half a micrometer diameter – Thermofilum
3) Rectangular rods – Thermoproteous , pyrobaculum
4) Flat, square archaea – Haloquadra walsbyi

The unusual shapes are probably maintained both by their cell walls and a prokaryotic cytoskeleton. Proteins related to the cytoskeleton components of other organisms exist in the archaea and filaments are formed with in their cells.

The thermoplsma & ferroplasma the lack of cell wall means that the cells have irregular shapes and can resemble amoebae. Some spices of arechaea from aggregates or filments of cells to 200 μm long .

Ex : Thermococcus coalescens.

Cell structure:

Archaea are similar to bacteria in their general cell structure, but the composition and organization of some of this structure set the archaea apart. Like bacteria archaea lake interior membrane so their cells do not contains organelles and their cell membrane is usually bounded by a cell wall and they swim by the use of one or more flagella.

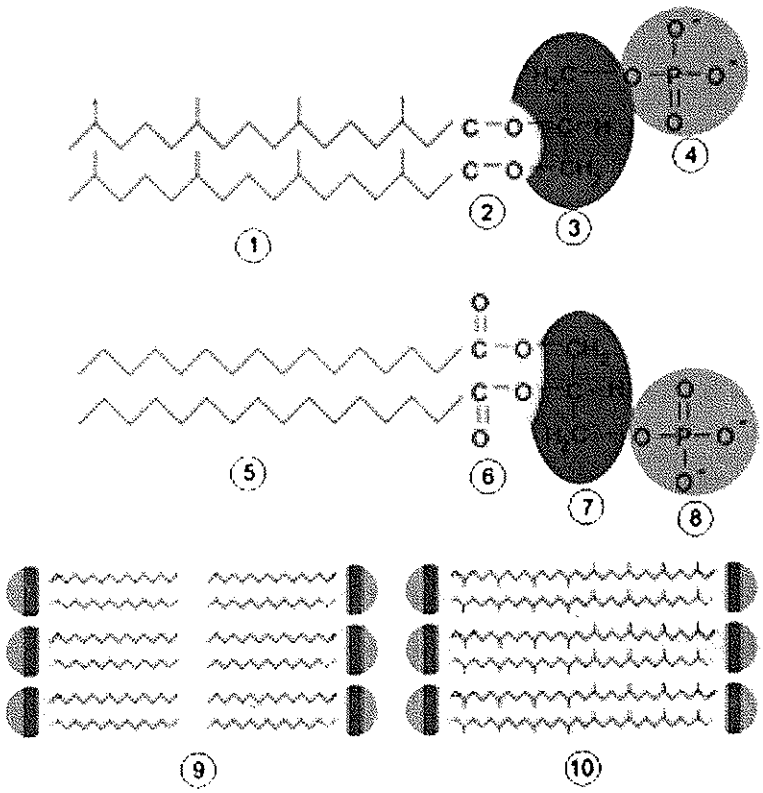
The overall structure of the archaea are most similar to G+ve bacteria, as most have single plasma membrane and cell wall, lack a periplasmic space .

Cell membrane:

Archaeas membrane is made of molecules known as phospholipids. These molecules possess both a polar part that will dissolve in water (the phosphate "head") and a greasy non polar part (the lipid tail). The major structure in cell membrane is a double layer of these phospholipids which is call a lipid bi layer.

The phospholipid the membrane of archaea was composed of glycerol-ether lipids. (In bacteria is a glycerol- ester lipid). Ether bonds are

chemically more resistant than ester bonds which might contribute to the ability of some archaea to survive at extremes of temperature and very acidic or alkaline environment.



Membrane structures. **Top**: an archaeal phospholipid, **1**isoprene sidechain, **2** ether linkage, **3** L-glycerol, **4** phosphate moieties. **Middle**: a bacterial and eukaryotic phospholipid: **5**fatty acid, **6** ester linkage, **7** D-glycerol, **8** phosphate moieties.**Bottom**: **9** lipid bilayer of bacteria and eukaryotes, **10** lipid monolayer of some archaea.

Some archaea, the phaspho lipid bilayer replaced by single monolayer. It is most rigid and better able to resist harsh environments.
Ex : Ferroplasma .

Cell wall:

Most of the Archaea possess a cell wall is assembled from surface layer proteins, which form an s-layer. An S-layer is made of rigid array of protein molecules that cover the outside of the cell like chain mail.

The layer provides both chemical & physical protection and can act as barrier preventing macromolecules from coming into contact with cell membrane.

Flagella:

Archaea also have flagella and those operate in similar way to bacterial flagella they are long stalk that are drivan by rotatory motors at the base of the flagella. These motors are powered by the protein gradient across the membrane.

Metabolism:

Archaea exhibit a great variety of chemical reactions in their metabolism and use many different source of energy. These forms a metabolism are classified into nutritional groups, depending on the source of energy and the source of the carbon.

On metabolism archaea use a modified form of glycolysis (the Enter – Doudroff pathway) and either a complete or partial citric acid cycle .

- Nutritional types in archaeas metabolism

Nutritional type	*Source of energy*	*Source of carbon*	*Examples*
Phototrophs	Sunlight	Organic compounds	• Halobacteria
Lithotrophs	Inorganic compounds	Organic compounds or carbon fixation	• Ferroglobus • Pyrolobus • Methano bacteria
Organotrophs	Organic compounds	Organic compounds or carbon fixation	• Pyrococcus • Sulfolobus • Methanosarcinales

Genetics:

Archaea usually have a single circular chromosome.

Size – largest 5741 kbp – Methanosarcina acetiwrans.

size -- smallest 490 kbp – Nanoarchaeaeum equitans .

It contains 537 protein encodings genes.

It also contain plasmid, it is transferred between cells by physical contact by Bacteria.

Reproduction:

Archaea reproduces by asexually by binory or multiple fission, Fragmentation, budding. Meiosis does not occur.

Ecology –Habitats:

Archaea exist in broad range of habitats and are a major part of global ecosystem and contribute up to 20% of the total biomass on earth.

Archaea are members of four main physiological groups

1. Halophiles – saline environment – halobacterium
2. Thermophiles – hot springs -- *Hyper thermphile*
3. Alkali philes -- -- *Methenopyrus kandles*
4. Acidophiles – (pH –o) -- *Picrophilus torridus*

Role in chemical cycling:

Archaea are part of the system on earth that recycle element such as carbon, nitrogen and sulphur through the various habitats in eco systems. Although these activities are vital for the normal function of ecosystems, archaea can also contribute to the changes that human have made in the environment and even cause pollution.

Significance:

1. Archaea helps in ammonia oxidation in soils this produce nitrite, which is oxidized nitrate by microbes and this was takes by plants.
2. In sulphur cycle is produce sulphur compounds (H2So4) as a biproduct in the metabolise by elements in rocks.
3. In carbon cycle methanogen archaea produce methane products.
4. The thermostable DNA polymer is used in PCR. ex. Thermus aquaticus.
5. Some archaea produce antibiotic, it is completely differs from bacterial antibiotic.
   Ex : *Hallow archaea, sulfolubus* .