P. M. P. Power point 2

Principles of Microbial Physiology

Cont….

- **Archaea**
- The **Archaea** are a group of single celled microorganisms. A single individual or species from this domain is called an *archaeon* (sometimes spelled "archeon"). They have no cell nucleus or any other membrane-bound organelles within their cells. In the past they had been classed with bacteria as prokaryotes and named **archaebacteria**, but this classification is regarded as outdated. In fact, the Archaea have an independent evolutionary history and show many differences in their biochemistry from other forms of life, and so they are now classified as a separate domain in the three domain systems. In this system, the phylogenetically distinct branches of evolutionary descent are the Archaea, bacteria and Eukaryotes.

- Archaea are divided into four recognized phyla, but many more phyla may exist. Classification is still difficult, because the vast majority have never been studied in the laboratory and have only been detected by analysis of their nucleic acid in samples from the environment.
- Archaea and bacteria are quite similar in size and shape, although a few archaea have very unusual shapes, such as the flat and square-shaped cells of *Haloquadratum walsbyi*. Despite this visual similarity to bacteria, archaea possess genes and several metabolic pathways that are more closely related to those of eukaryotes,

- notably the enzymes involved in transcription and translation. Other aspects of archaeon biochemistry are unique, such as their reliance on ether lipid in their cell membranes. Archaea use a much greater variety of sources of energy than eukaryotes: ranging from familiar organic compounds such as sugars, to ammonia, metal ions or even hydrogen gas. salt-tolerant archaea (haloarchaea) use sunlight as an energy source, and other species of archaea fix carbon; however, unlike plants and cyanobacteria, no species of archaea is known to do both. Archaea reproduce asexually by binary fission, fragmentation, or budding and no known species form spores.

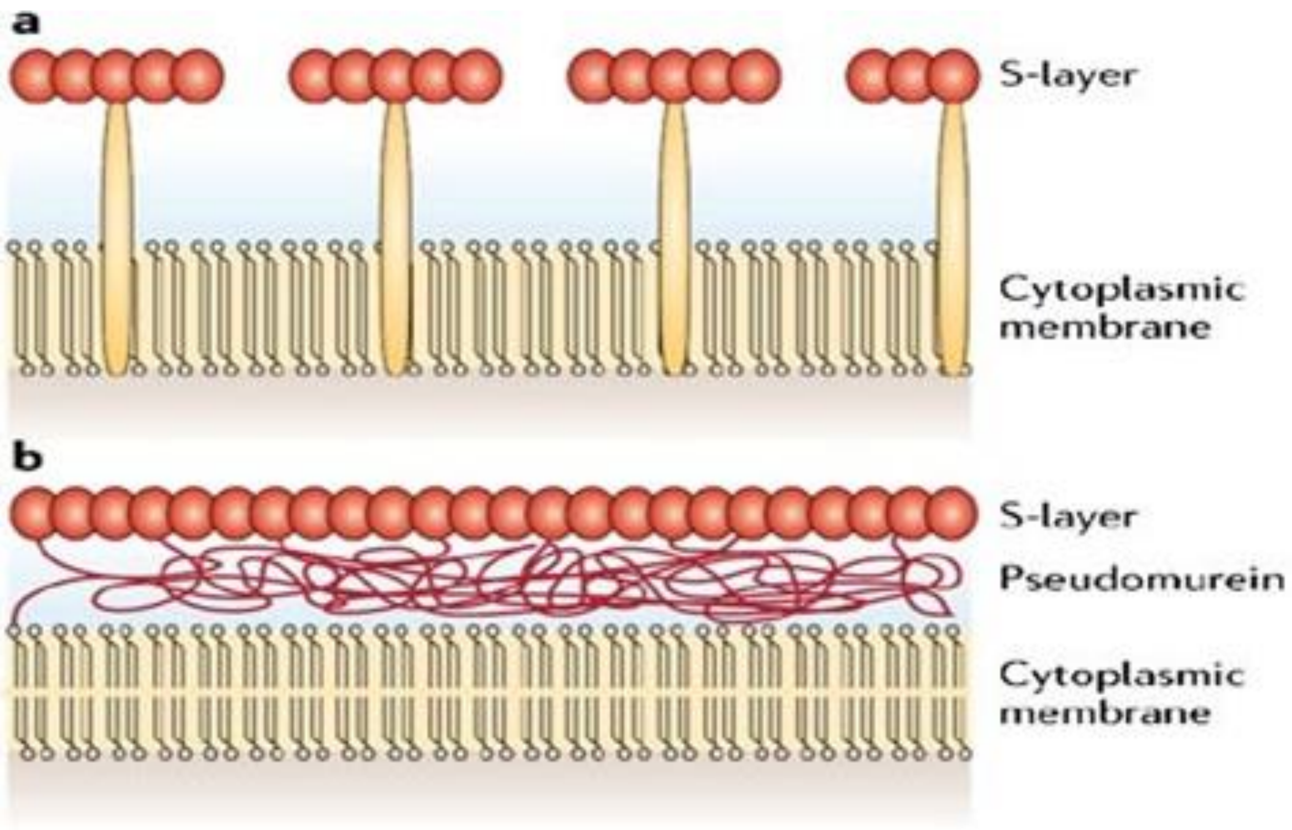
- **Archaeal Cell Walls:**
- Most archaea possess a cell wall. In most archaea the wall is assembled from surface-layer proteins, which form an S-layer. S-layer is a rigid array of protein molecules that cover the outside of the cell. This layer provides both chemical and physical protection, and can prevent macromolecuoles from contacting the cell membrane. Unlike bacteria, archaea lack peptidoglycan in their cell walls. Methanobacteriales do have cell walls containing pseudopeptidogycan, which resembles eubacterial peptidoglycan in morphology, function, and physical structure, but pseudopeptidoglycan is distinct in chemical structure; it lacks D- amino acid and N- Acetylmuramic acid.

- Archaeal cells have more variations in their cell wall chemistries, and some do not contain cell walls (eg *Thermoplasma* and *Ferroplasma*)
- *Methanobacterium* sp. *c*ontain glycans (sugars) and peptides in their cell walls:
  - Glycans: are modified sugars ,N-acetyl talosaminouronic acid (NAT or T) & N-acetly glucose amine (NAG or G)
    - T and G are linked to each other by a beta 1, 3 glycosidic bond & alternate to form the cell wall backbone.
    - Lysozyme (an enzyme produced by organisms that consume bacteria, cannot digest beta 1,3 glycosidic bonds.
    - Peptides: Short peptides attached to T.

Penicillin is ineffective in inhibiting the cell wall peptide bridge formation.

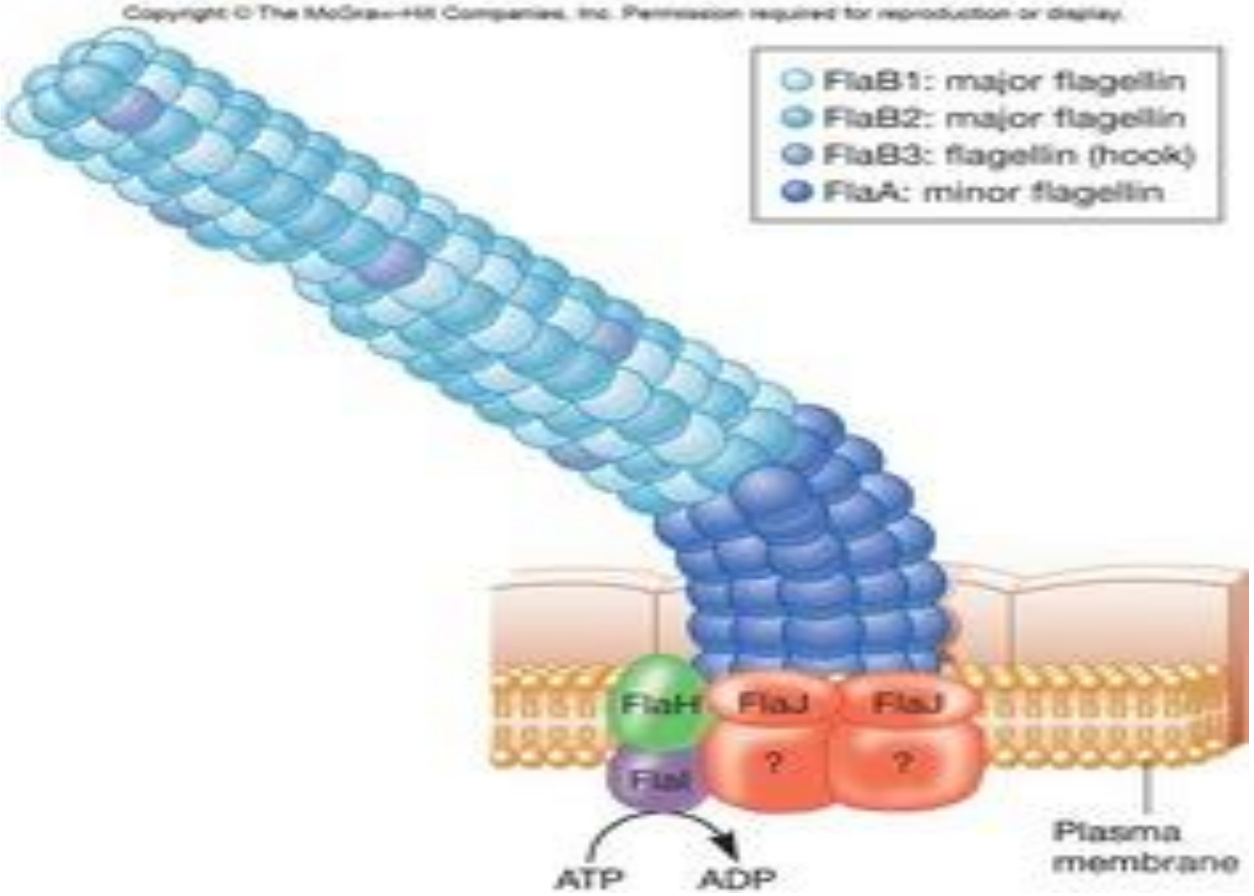
- *Methanosarcina* sp. cell walls contain non-sulfated polysaccharides
- *Halococcus* sp. contain sulfated polysaccharides
- *Halobacterium* sp. contain negatively charged acidic amino acids in their cell walls which counteract the positive charges of the high Na^+ environment. Therefore, cells lyses in NaCl concentrations below 15%.
- *Methanomicrobium* sp. & *Methanococcus* sp. cell walls are exclusively made up of proteins subunits.

Ultrastructure of archaeal of cell wall



- **Flagella**
- Archaea flagella operate like bacterial flagella—their long stalks are driven by rotatory motors at the base. These motors are powered by the proton gradient across the membrane. However, archaeal flagella are notably different in composition and development. The two types of flagella evolved from different ancestors. In contrast to the bacterial flagellum, which is hollow and is assembled by subunits moving up the central pore to the tip of the flagella, archaeal flagella are synthesized by adding subunits at the base.

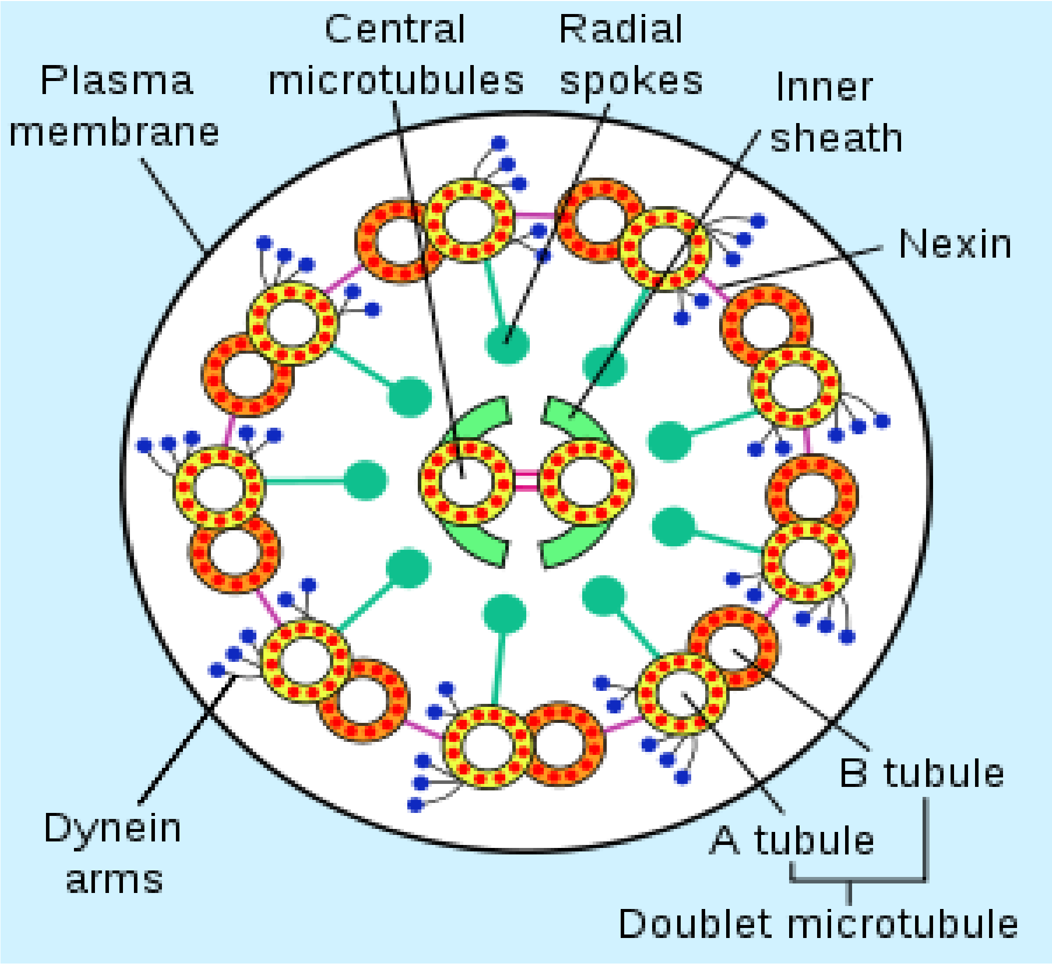
Ultrastructure of archaeal flagella



- **3-Eukaryal Cell Walls:**
- Cell walls of algae have a variety of different cell wall types and include cellulose, calcium carbonate, silicone dioxide, proteins and even polysaccharides.
- The cell walls of fungi are made up of chitin (a nitrogen-containing polysaccharide)
- The yeasts cell wall are made up of glycoprotein mainly glycan and mannan attached by glycosidic linkage with protein.

- **Eukaryotic flagella**
- **Structure**
- A eukaryotic flagellum is a bundle of nine fused pairs of microtubule doublets surrounding two central single microtubules. The so-called *"9+2"* structure is characteristic of the core of the eukaryotic flagellum called an **axoneme**. At the base of a eukaryotic flagellum is a basal body " blepharoplast" or kinetosome, which is the microtubule organizing center (MTOC) for flagellar microtubules and is about 500 nanometers long. Basal bodies are structurally identical to centroiles. The flagellum is encased within the cell's plasma membrane, so that the interior of the flagellum is accessible to the cell's cytoplasm.

Eukaryotic Flagellum Ultrastructure



- **Mechanism**
- Each of the outer 9 doublet microtubules extends a pair of dyneinin arms (an "inner" and an "outer" arm) to the adjacent microtubule; these dynein arms are responsible for flagellar beating, as the force produced by the arms causes the microtubule doublets to slide against each other and the flagellum as a whole to bend. These dynein arms produce force through ATP hydrolysis. The flagellar axoneme also contains radial spokes, polypeptide complexes extending from each of the outer 9 microtubule doublets towards the central pair, with the "head" of the spoke facing inwards. The radial spoke is thought to be involved in the regulation of flagellar motion, although its exact function and method of action are not yet understood.