❖ Cytoplasmic Organelles (part3)

Proteasomes

- Proteasomes are very small abundant protein complexes composed of three subunits : two regulatory particles and one core particle
- Non membranous organelle that degrades some protein molecules that attached to **Upiquitin protein** by ATP dependent pathway.
- They function to degrade excess enzyme, denatured or otherwise nonfunctional polypeptides also remove proteins no longer needed by the cell and provide an important mechanism for restricting activity of a specific protein to a certain window of time. Destroy protein infected by viruses. Whereas lysosomes digest organelles or membranes by autophagy, proteasomes deal primarily with free proteins as individual molecules.

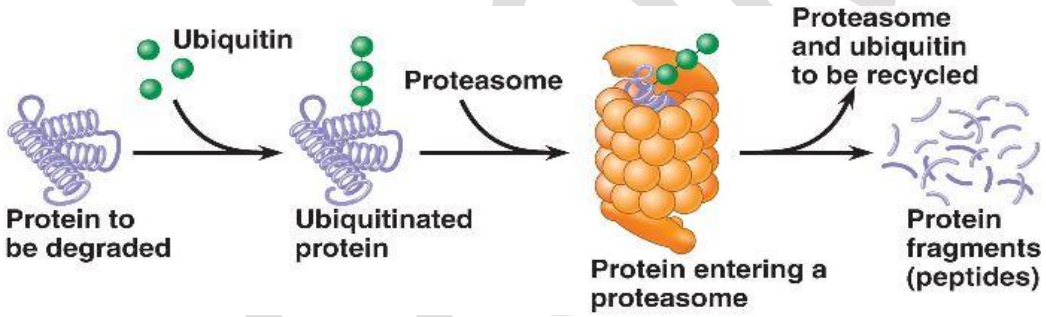
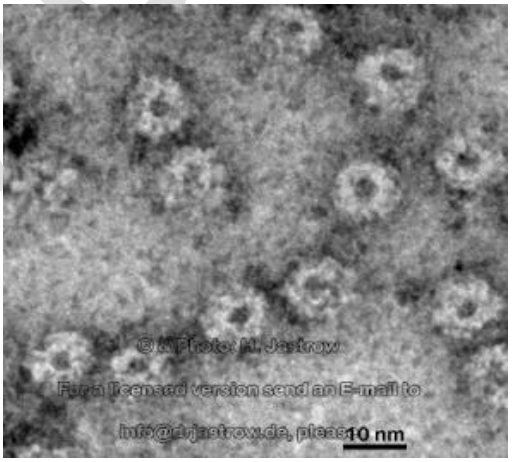


Figure: Diagram of proteasome and Upiquitin pathway

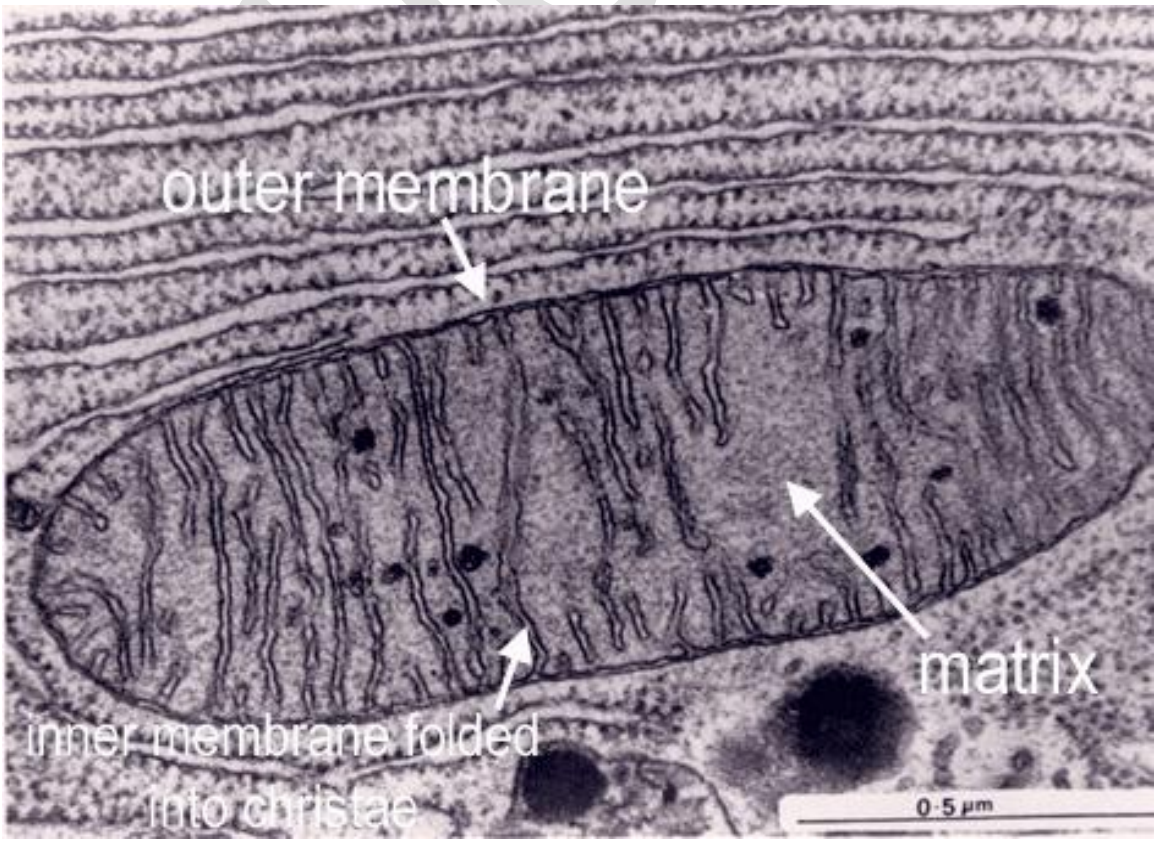


✓ *Failure of proteasomes or other aspects of a cell's protein quality control can allow large aggregates of protein to accumulate in affected cells. Such aggregates may adsorb other macromolecules to them and damage or kill cells. Aggregates released from dead cells can accumulate in the extracellular matrix of the tissue. In the brain this can interfere directly with cell function and lead to*

*neurodegeneration. **Alzheimer disease** and **Huntington disease** are two neurologic disorders caused initially by such protein aggregates.*

❖ Mitochondria

- Mitochondria (singular, **mitochondrion**) are membrane-bounded organelles
- They are usually elongated structures appears under L.M. as spheres, ovoids, or thread like bodies
- They are highly plastic, rapidly changing shape, fusing with one another and dividing, and are moved through the cytoplasm along microtubules.
- The number of mitochondria is related to the cell's energy needs: cells with a high-energy metabolism (eg, cardiac muscle, liver cells and cells of kidney tubules) have abundant mitochondria, whereas cells with a low-energy metabolism have few mitochondria such as small lymphocyte
- Mitochondria are often called the **powerhouses** of the cell. Just as a powerhouse burns fuel to produce electricity, the mitochondria convert the chemical energy of glucose products into the chemical energy of ATP molecules. In the process, mitochondria use up oxygen and give off carbon dioxide. Therefore, the process of producing ATP is called **cellular respiration.**



TEM of Mitochondria

The structure of mitochondria under E.M.: each mitochondrion consists of:

1. **Outer membrane:** is smooth membrane surrounded that allows entry of molecules and contain enzyme involved in mitochondrial lipid synthesis.
2. **Intermembrane space:** Because of channels in the outer membrane of the mitochondria, the content of the intermembrane space is similar to that of the content of the cytoplasm.
3. **Inner membrane:** exhibit numerous folds called **cristae** which maximize internal surface area of mitochondria and contain most of the respiratory chain enzymes and ATP synthase which is responsible for cell respiration (oxidative phosphorylation) and production of cell ATP.

✓ Shape of cristea different according type of cells;

1. In protein secreting cells cristea project into the interior of the organelle like shelve.
2. In steroid secreting cells such as the adrenal cortex or interstitial cells in the testes, the mitochondria cristea are tubular.

4. **Mitochondrial matrix:** the matrix is the space within the inner membrane; contain enzymes for Krebs cycle, mitochondrial DNA **(circular DNA),** special ribosome, tRNase and enzymes for gene expression.
   - *Mitochondrial DNA* is double stranded and has a circular structure very similar to bacterial chromosomes, mitochondrial DNA synthesis and duplication is independent of nuclear DNA replication.
   - *Mitochondrial ribosome* is smaller than cytosolic ribosome.
   - *tRNases* are enzymes that degraded the tRNA.

✓ The structure of a mitochondrion supports the hypothesis that they were originally prokaryotes engulfed by a cell ☺☺☺☺

➢ **Replication of mitochondria**

Mitochondria replicate similarly to bacterial cells, when they get large, they undergo **fission**. This involves furrowing of the inner and then the outer membrane as if someone was pinching the mitochondrion. The two daughter mitochondria must first replicate the DNA.

➢ **Function of mitochondria**

1. Mitochondria are primary sites for ATP synthesis (site of Krebs cycle**)** from organic material so that known as powerhouse of the cell.

2. Cell respiration.
3. Maintain body heat because some energy dissipated as heat.
4. They have key role in apoptosis programmed cell death.
5. Some mitochondrial functions are performed only in specific types of cells, e.g. mitochondria in liver cells contain enzymes that allow them to detoxify ammonia, a waste product of protein metabolism.
6. Heme synthesis occurs partly in the mitochondria and partly in the cytosol, Heme is an essential prosthetic group in proteins that is necessary as a subcellular compartment to perform diverse biological functions like hemoglobin and myoglobin. The major tissues for heme synthesis are bone marrow by erythrocytes and the liver by hepatocytes.
7. Other metabolic reactions happened in mitochondria include gluconeogenesis and ketogenesis

✓ *A maternally-inherited mutation in the mitochondrial genome is leading to defective synthesis of respiratory chain proteins which can produce structural abnormal in muscle fibers especially skeletal muscle fibers are very sensitive to mitochondrial defect (muscular dysfunction) and other cells. (**This called mitochondrial disorders**)*