ORGANELLE DNAs

Although the vast majority of DNA in most eukaryotes is found in the nucleus, some DNA is present within the mitochondria of animals, plants, and fungi and within the chloroplasts of plants.

MITOCHONDRIAL DNA(mtDNA)

The important features of **mt. DNA** are as follows:

(a) Mitochondria contain multiple mt DNA molecules which can be detected by fluorescent microscopy. The mt DNA molecules are present inside the region of mitochondria known as matrix. As represented by the number of yellow fluorescent dots of mt DNA, a *Euglena gracilis* cell contains at least 30 mt DNA molecules.

(b) Mitochondrial DNA is cytoplasmically inherited. The inheritance is biparental. In mammals and most other multicellular organisms, however, the sperm contributes little cytoplasm to the zygote, and all the mitochondria in the embryo are derived from those in the egg, not the sperm. Studies in mice have shown that 99.99 percent of mt DNA is maternally inherited. In plants, mtDNA is inherited exclusively in uniparental fashion through the female parent (egg), not the male (pollen).

(c) Mitochondrial DNA from all the sources has been found to encode rRNAs, tRNAs, and essential mitochondrial proteins. All proteins are synthesized on mitochondrial ribosomes. All mitochondrially synthesized polypeptides are not complete enzymes but subunit of multimeric complexes used in electron transport or ATP synthesis.

(d) The size and coding capacity of mt DNA vary considerably in different organisms.Human mt DNA is among the smallest known mt DNAs, containing 16,569 base pairs. It encodes the two rRNAs found in mitochondrial ribosome and 22 t RNAs used to translate mitochondrial mRNAs. Mammalian mt DNA in contrast to nuclear DNA is lack of intron. Plant mitochondrial DNA is of several types, much larger and more variable. Long non coding regions and duplicate sequences are largely responsible for the greater length of plant mtDNAs.

(e) Differences in the size and coding capacity of mt DNA from various organisms most likely reflect the movement of DNA between mitochondria and the nucleus during evolution. Direct evidence for this movement comes from the observation that several proteins encoded by mtDNA in some species are encoded by nuclear DNA by others.It thus appears that entire genes moved from the mitochondrion to the nucleus, or vice versa, during evolution. The most striking example is COXII gene which encodes subunit 2 of cytochrome oxidase. This gene is found in mtDNA in all organisms studied except mung bean where the same gene is nuclear in nature.

(f) Products of mitochondrial genes are not exported.

(g) Reflecting the bacterial ancestry of mitochondria, mitochondrial ribosomes resemble bacterial ribosomes and differ from eukaryotic cytosolic ribosomes in their RNA and protein composition, their size, and their sensitivity to certain antibiotics. For instance, chloramphenicol blocks protein synthesis by bacterial and mitochondrial ribosomes from most organisms, but cycloheximide does not. Conversely, cytosolic ribosomes are sensitive to cycloheximide and resistant to chloramphenicol. In cultured mammalian cells the only proteins synthesized in the presence of cyclohexamide are encoded by mtDNA and produced by mitochondrial ribosome.

(h) Mitochondrial genetic code differs from the standard nuclear code. UGA , for example, is normally a stop codon, but is read as tryptophan by human and fungal mitochondrial translation system. AGA and AGG, the standard nuclear codons for arginine, used as stop codon in mammalian mtDNA. CGG, in plant mitochondrial DNA could code for either arginin or tryptophan. This apparent non specificity of plant mitochondrial code is explained by editing of mitochondrial RNA transcripts, which can convert cytosine residue to uracil residues. CGG, actually codes for arginine, but when Cytosine is converted to Uracil by editing of mt DNA transcript, it will code for tryptophan.

(i) Mutation in mitochondrial DNA causes several genetic diseases in humans. Generally when mutations in mtDNA are found, cells contain mixtures of wild type and mutant mtDNA- a condition known as **heteroplasmy.** The segregation of mutant and wild type of mtDNA occurs randomly in daughter cells. Mutations in mtDNA affects those tissues that have high requirement of ATP produced by oxidative phosphorylation and tissues that require most of or all the mtDNA in the cell to synthesize sufficient amounts of functional mitochondrial proteins. ***Laber's Hereditary optic neuropathy*** (degeneration of optic nerve accompanied by increasing blindness), for instance, is caused by missense mutation in the mtDNA gene encoding subunit 4 oft eh NADQ-CoQ reductase.

Characters of cpDNA

The characteristic features of chloroplast DNA are as follows:

1) Cloroplast contains multiple copies of organellar DNA and ribosomes, which synthesize some chloroplast encoded proteins using the standard genetic code.
2) Chloroplast DNAs are circular molecules of 120,000-160,000bp, depending on the species. Of the 120 genes in chloroplast DNA, about 60 are involved in RNA transcription and translation, including genes for r RNAs, tRNAs, RNA polymerase subunits, and ribosomal proteins. About 20 genes encode subunits of the chloroplast photosynthetic electron –transport complexes

and the F0F1 ATPase complex. Also encoded in the chloroplast genome is the larger of the two subunits of ribulose 1,5-bisphosphate carboxylase, which is involved in the fixation of carbon dioxide during photosynthesis.

3) Reflecting the endosymbiotic origin of chloroplasts, some regions of chloroplast DNA are strikingly similar to the DNA of present day bacteria. For instance, cpDNA encodes four subunits of RNA polymerase that are highly homologous to the subunits of *E.coli* RNA polymerase. One segment of cpDNA encodes eight proteins that are homologous to eight *E.coli* ribosomal proteins.
4) Some difference in gene composition of cpDNA occurs in different species. For instance, liverwort cpDNA has some genes that are not detected in chloroplast DNA of tobacco. Since the chloroplast in both the species contain same set of proteins, these data suggest that some genes are present in chloroplast DNA of one species and in the nuclear DNA of the other, indicating that some exchange of genes between chloroplast and nucleus occurred during evolution.
5) Methods have been developed to introducing foreign DNA into the chloroplast of higher plants. The large number of chloroplast DNA per cell permits the introduction of thousands of copies of an engineered gene into each cell, resulting in extraordinarily high levels of foreign protein production. ***Chloroplast transformation*** has recently led to the engineering of plants that are resistant to bacterial and fungal infection, drought and herbicide.