

COURSE - M.SC. BOTANY, PART-II PAPER-VII

TOPIC- NUCLEOSOME(CELL BIOLOGY)

Prepared by- Dr.Premlata Mehta

Co-ordinated by-Prof.(Dr.) Shyam Nandan Prasad

Nucleosome

A nucleosome is the basic repeating unit of eukaryotic chromatin. In a human cell, about six feet of DNA must be packaged into a nucleus with a diameter less than a human hair. A single nucleosome consists of about 150 base pairs of DNA sequence wrapped around a core of histone proteins.

The shape of nucleosome arrangement of histone including H1 were also studied. The diameter of nucleosome is 11 nm and its height is 6 nm. The length of DNA around it is 70 nm which is equivalent to 200 base pairs. The length of DNA varies not only in different organisms but also in different tissue or even in different region within the same cell of an organism. The length of DNA, however, suggested that DNA should be coiled around nucleosome core particle. Enzyme DNase1 also led to cleavage of DNA suggesting that DNA lies on the surface of nucleosome. It was, therefore, suggested that histone do not cover DNA, but DNA is wrapped around histone core particle. In other words, it was suggested that it will be more appropriate to describe chromatin as string on beads rather than as beads on string. Neutron scattering technique was also used to find out distances of histones and DNA from centre of nucleosome. So that DNA is not covered by histones, but is wrapped around histone protein.

The packaging of DNA in chromatin is facilitated by associated protein, which in eukaryotes could be associated protein, which in eukaryotes, could be histone or non histone. More stable protein in chromosomes are histone and are classified into five type called H1, H2A, H2B, and H4. Another histone protein H5 has also been often described, although it may not be involved in packaging. It was thus known that chromatin consists of DNA, 5 different but stable protein and a variety of non histone protein.

Core particle:

When nucleus treatment was prolonged beyond the cleavage between nucleosome, the DNA was removed from both the free ends, yielding particles containing DNA of only 146 nucleotide pairs, instead of 200 nucleotide pairs. This reduced form of nucleosome is called core particle.

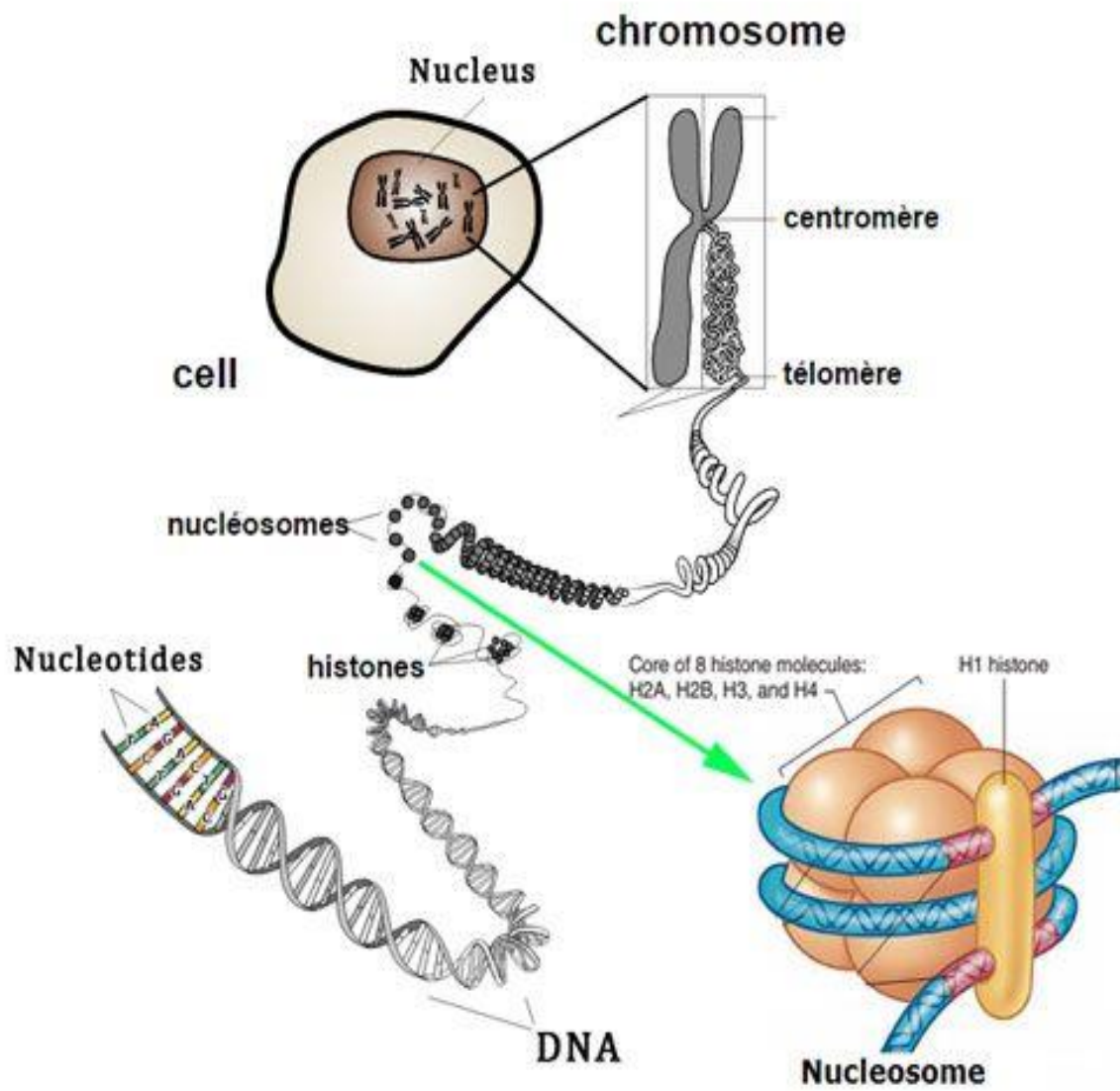
Nucleosome model:

Nucleosome model is a scientific model which explains the organization of DNA and associated proteins in the chromosome. It also further explains the exact mechanism of the folding of the DNA in the nucleus. The model was proposed by Roger Kornberg and J.O Thomas in 1974 and is the most accepted model of chromatin organization

They suggested that DNA interacts with tetramer (H3-H4) and two molecule of an oligomer(H2A-H2B) so that a tetramer involving two molecules each of the histone H3 and H4, is associated with two molecules each of the histone H2A and H2B and with 200 base pair of DNA . This make a repeating unit, 12.5 nm in diameter. One molecule of H1 is also associated with each repeating unit, P. Oudet et al.1975 proposed the term nucleosome for repeating unit which were observed as beads on strings under electron microscope .A nucleosome, along with the molecule of linker histone H1, and the linker DNA together make a chromatosome or chromatin particles. Thus a chromatosome consists of 166 base pair DNA, histone octamer and one molecule of H1.

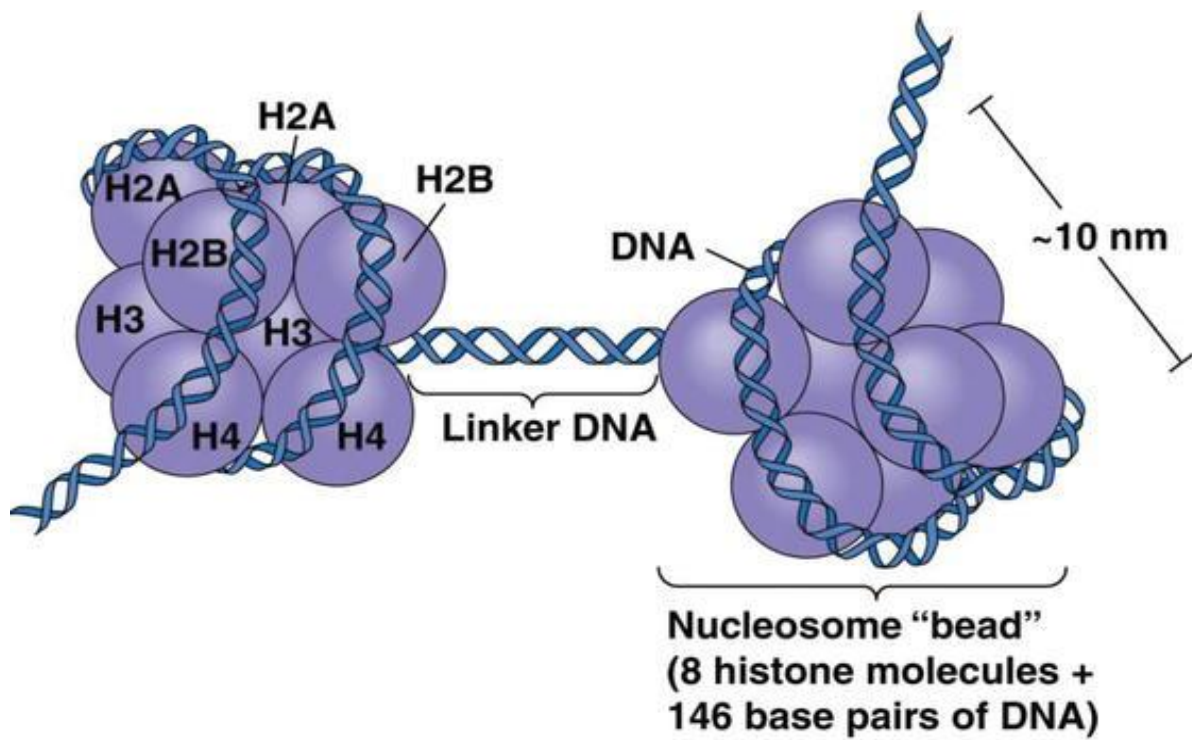
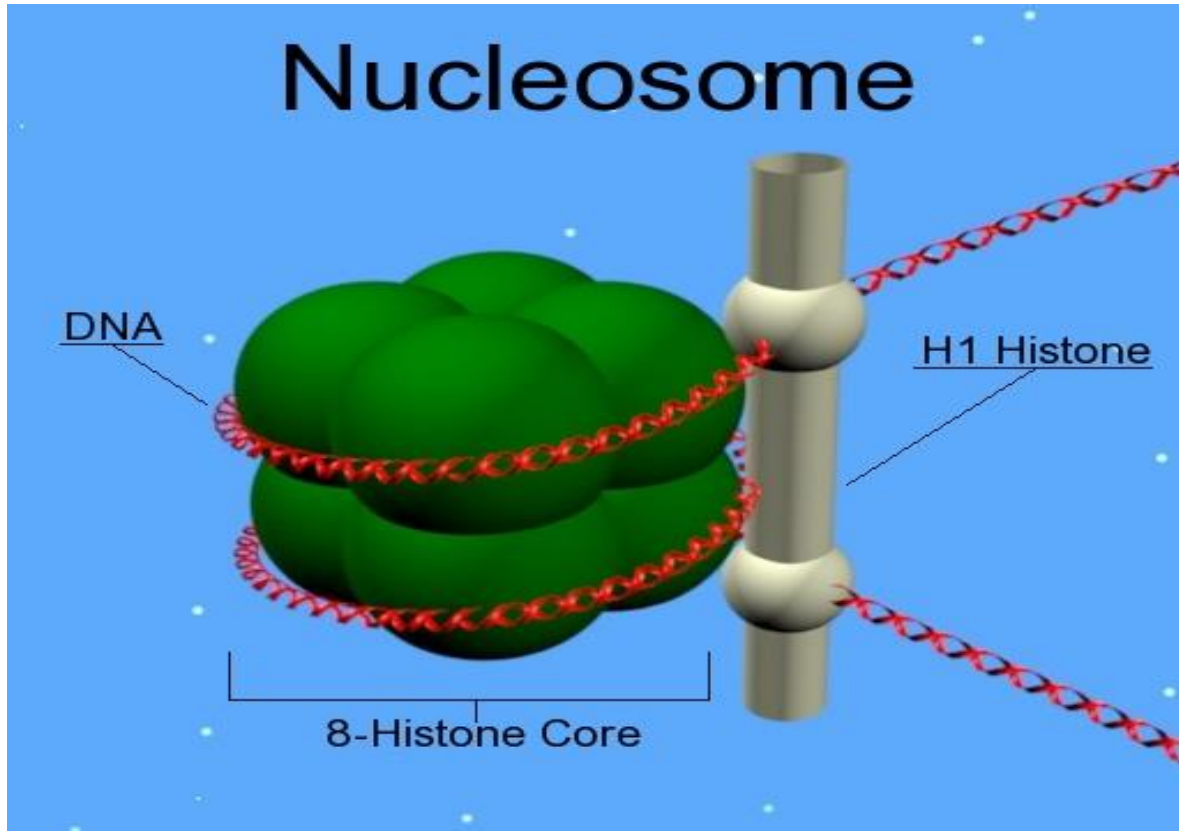
Level of DNA compaction - nucleosome provide the first level of organisation with a compaction rate of 5 to 10 fold (with diameter, 2-11 nm). Thus second level of organisation is the folding of nucleosomes into chromatin fibres with a diameter of 30nm, thus providing another 10 fold compaction in highly condensed regions (consisting of repetitive sequences). Another level of compaction yield structure with diameter of 300 to700 nm.

Telomere and telomeric repeats - The structure of telomere in a wide variety of organism has been studied to demonstrate that telomeres highly conserved elements across all eukaryotes, both in structure and function.



Nucleus with nucleosome

Nucleosome



Arrangement of Histone protein

Function:

Nucleosomes are the basic packing unit of DNA built from histone proteins around which DNA is coiled. They serve as a scaffold for formation of higher order chromatin structure as well as for a layer of regulatory control of gene expression.

It helps in reducing the length of chromatin fibre, because the nucleosome is the structure of DNA that is formed when the DNA is wrapped around a positively charged histone octamer.

These are the structural unit of chromatin.

It is said that around 220 base pairs are wrapped around 1 histone molecule which reduces the size of DNA. These nucleosomes are a structural subunit of chromatin and it has a shape of a bead. The nucleosomes are then attached by linker DNA and both of the structure of collectively known as a chromosome.

