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Unit 2: DNA Replication

Module Name: Models of Replication in Prokaryotes and Eukaryotes : Linear

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Notes:

Eukaryotic DNA: Organization and Replication

The large amount of genomic DNA in a eukaryotic cell is tightly packaged in chromosomes contained within a specialized organelle, the nucleus. DNA is highly organized in eukaryotic chromatin; this DNA when gently isolated from chromatin looks like a 'string of beads'; each repeating bead-like unit =called a **nucleosomes**, consisting of DNA wrapped around **histone** proteins. Nucleosomes pack into condensed, super coiled **chromatin** fibers, which further loop into **chromosomes**.

DNA Replication in eukaryotes shares similarities with the process and enzymes in prokaryotes. As with prokaryotes, DNA replication in eukaryotes occurs in three stages: initiation, elongation, and termination, which are aided by several enzymes.

- During initiation, proteins bind to the origin of replication while helicase unwinds the DNA helix and two replication forks are formed at the origin of replication.
- During elongation, a primer sequence is added with complementary RNA nucleotides, which are then replaced by DNA nucleotides.
- During elongation DNA polymerase synthesizes the leading strand in 5' to 3' direction continuously, while the lagging strand is synthesized discontinuously i.e. in pieces, called Okazaki fragments.

- During termination, RNA primers are removed and replaced with new DNA nucleotides and the backbone is sealed by DNA ligase.

Eukaryotic Chromosomes have multiple Origins.

The process of replication of eukaryotic DNA is more complex due to: Large linear chromosomes, multiple origins of replication per chromosome and tight packaging of DNA around histone proteins. The DNA Replication rate is thus lower in eukaryotes.

Eukaryotic DNA is bound to proteins known as histones to form nucleosomes. During initiation, the DNA is made accessible to the proteins and enzymes involved in the replication process. There are specific chromosomal locations called origins of replication where replication begins. Eukaryotic chromosomes have multiple origins of replication. Considering the size of eukaryotic chromosomes, this is necessary to increase the rate of replication. Each of these origins defines a **replicon**, or the stretch of the DNA that is replicated from a particular origin.

Linear Model of Replication in Eukaryotes

1. To replicate eukaryotic DNA in short time, there are many replicons (1 replication origin every 10-100μm along DNA).
2. Replication begins at the origin, forms 2 replication forks (bidirectional replication) that move in opposite directions; forming a “replication bubble”.
3. Replication bubbles ‘grow’ in size and adjacent bubbles fuse.
4. Parent linear double stranded DNA molecule is copied semi-conservatively to form 2 linear double helical daughter DNAs.