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À DNA REPLICAITON

DNA is the basic material for life. It is the DNA due to the presence of which anything can be called as living. It possesses the most important property of replication through which it can make exact copies of itself. This process of DNA replication is the very basis of life. Normally the two strands of DNA double helix are united by Hydrogen bonds between the purine and pyrimidine. When the H-bonds break the two strands separate and unwind. The nucleus contains free nucleotides. These free nucleotides pairs with the nucleotides of the two separated strand by H-bonds. In this way a new strand of DNA is formed around each old strand. Thus, there is formation of the two double helices, each identical to the original double helix. This process of DNA replication insures that the genes are present in identical sets in all cells of the body of an individual.

The process of DNA replication takes place during the interphase between two cell divisions. It is a semi conservative process in which each of the two double helix formed from the parent double strand has one old and one new strand; it means the 50% of the original DNA strand gets conserved.

REQUIREMENTS OF DNA REPLICATION

DNA replication requires the presence of the followings:-

1] DNA template – Both strands of DNA are utilized as template for the synthesis of new DNA strands.

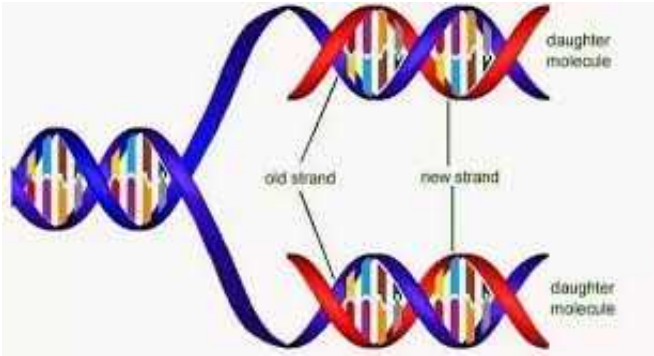
2] A Primer: - RNA functions as a primer for DNA replication.

3] Activated nucleosides:- DNA replication requires the presence of 4 different types of nucleoside tri-phosphates i.e., ATP, GTP, CTP and TTP.

4] Enzymes: - DNA replication requires the presence of various types of enzymes which includes unwindase, super helix relaxing enzyme, a modified RNA polymerase, DNA polymerase and polynucleotide ligase.

À MECHANISM OF DNA REPLICATION

In the presence of all the above mentioned requirements, DNA replication may easily strart. It starts at a specific point called the “Origin”. At the point of origin there is producton of nick or incision by the activity of the enzyme endonuclease. After incision at the point of origin the two DNA strands get unwind due to the activity of DNA unwinding enzyme known as unwindase. It combines with one of the two strands of DNA double helix & promotes the process of unwinding. At this point of unwinding the DNA double helix forms a Y shaped replication fork. About 200 molecules of unwinding proteins may be found at each fork. The DNA replication will starts only when the template DNA strand becomes longer than the 50 nucleotides.



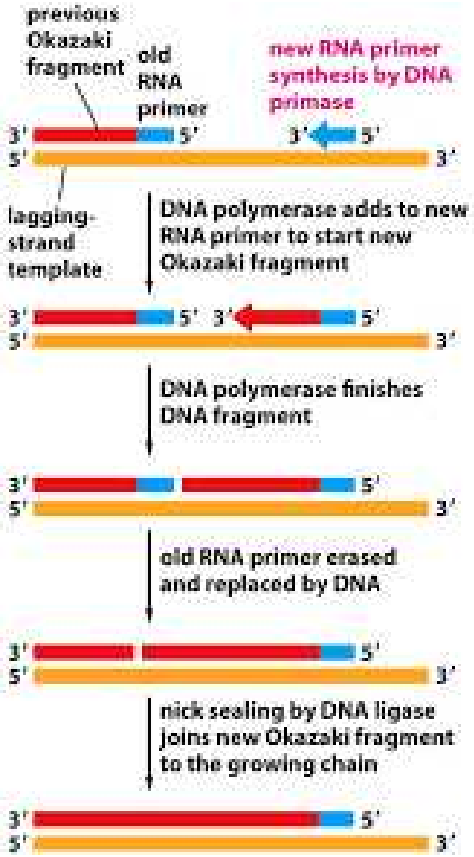
Replication of DNA

***Above diagram taken from Google**

The unwinding of DNA strand causes the development of strain in the DNA strand on the far side. This strain gets relieve by the action of another enzyme called super helix relaxing enzyme. This protein has nicking-closing enzymatic activity. It introduces nicks in the non-replicating region of DNA & one of the strands is made to rotate upon the other & relieves the strain. The break is then

closed by ligation & the replicating fork moves on. In this way the template DNA gets ready for the synthesis of new DNA strand.

The synthesis of DNA strand starts with the formation of a RNA primer. The DNA polymerase cannot initiate DNA chain denovo. Therefore, a pre-existing polynucleotide chain i.e., a primer is required to which polynucleotides are added. The primer is in the form of a short polynucleotide chain of RNA with a 5' tri-phosphate and 3' hydroxyl end (3'-OH end). The RNA primer is synthesized by the DNA template close to the origin of replication. This synthesis is probably catalyzed by modified RNA polymerase which may contain a starting factor. Thus, it involves a process of transcription but no translation.



Role of Polymerases & other enzymes in DNA replication

***Above diagram taken from Google**

After the synthesis of RNA primer elongation of the DNA chain takes place. It occurs by the addition of DNA nucleotides to the 3'-OH group of the last ribonucleotide of the RNA primer. This synthesis takes place in the 5'→3' direction & it catalyzed by the enzyme DNA polymerase-III. Thus the newly synthesized DNA chain possesses RNA attached to the 5' (primer) end. This RNA primer ultimately gets hydrolyzed by the exo-nuclease activity of DNA polymerase-I. The resulting gap is filled in by the DNA nucleotides by the catalytic activity of DNA polymerase-I. This new made DNA primer is joined to the longer DNA strand with the help of enzyme Ligase.

The formation of RNA primer before DNA synthesis is quite essential, so that during DNA formation no error takes place. Adding of nucleotides to an already existing polynucleotide chain removes the possibility of any error. However if a chain is synthesized from the beginning then initially there is a definite chance of certain error. It is why RNA primer is essential.

Reference books :-

1.Cytology by C.B.Power,

2.Cell & developmental biology by Prof.K.V. Sastry, Dr.B.S Tomar, Dr.S.P.Singh

3.Genetics by P.K.Gupta