

DNA Replication

2.1 INTRODUCTION

DNA is a molecule made up of two strands twisted around each other in a double helix shape. Each strand is made up of a sequence of four nitrogen bases like Adenine, Guanine, Thymine, and Cytosine. Adenine and Guanine are purines while Thymine and Cytosine are pyrimidines. Adenine always pairs with Thymine with double H-bonds while Guanine always pairs with Cytosine through three H-bonds. This means that two strands are complementary to each other. The two strands of DNA run in opposite direction.

DNA replication occurs during interphase of the cell cycle. Interphase of cell-cycle includes G1, S, G2 phases.

Interphase is the largest phase of the cell-cycle and it occurs during S-phase of interphase.

It is the biological process of producing two identical copies of DNA from one original DNA molecule is replicated only once during the life-cycle of a cell, and each time cell divides resulting to produce two daughter cells which must contain same genetic information or DNA as the parent cell. This type of DNA replication is semi-conservative in nature because it replicates double-stranded DNA molecule in such a way that two DNA molecule has one original parental DNA strand and one newly synthesized daughter strand. This newly synthesized DNA is identical to parent DNA molecule. This model of semi-conservative mode of DNA replication was proposed by Watson and Crick who gave the double helical model of DNA.

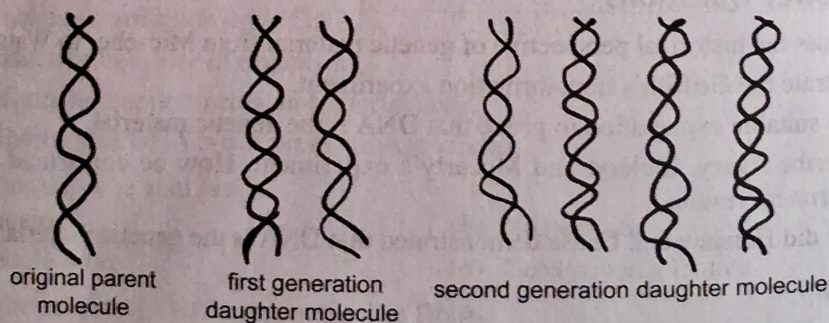


Fig. 2.1. Semi-conservative model of replication.

Each of two DNA strands is used as template to synthesize a new complementary strand and on each template new DNA is synthesized in 5' to 3' direction. The process of replication begins at a point called as origin of replication or 'ORI site' and it occurs in both the direction so, bidirectional. When both the strands are separated for the process of replication to begin, a 'Y-shaped' structure is formed and is called as replication fork. This replication fork moves in both the directions. So, when DNA untwist there is formation of two replication fork and this

two Y-shaped structure are joined together to form a replication bubble which contains locally denatured segment of DNA.

Prior to the discovery of enzymes which are involved in replication, three general mechanism have been proposed. These are as follows-

- (i) Conservative model
 - (ii) Semi-conservative model
 - (iii) Dispersive model
- (i) **Conservative model:** A conservative model of replication proposes that both strands of parent DNA or original DNA is used as template and it is not incorporated into a new double-helix or daughter strands.
- (ii) **Semi-conservative model:** It is one of the most important concepts of DNA replication. This is only the acceptable model of DNA replication. This replication model proposes that every double helix in the new generation of an organism consists of one complete "old or parent strand" and one complete "new or daughter strand".
- (iii) **Dispersive model:** This replication model proposes that every double helix in the new generation consists of a mixture of fragments of old and new DNA. This model is not acceptable because as a result, every cell division produces two cells with varying amount of old and new DNA

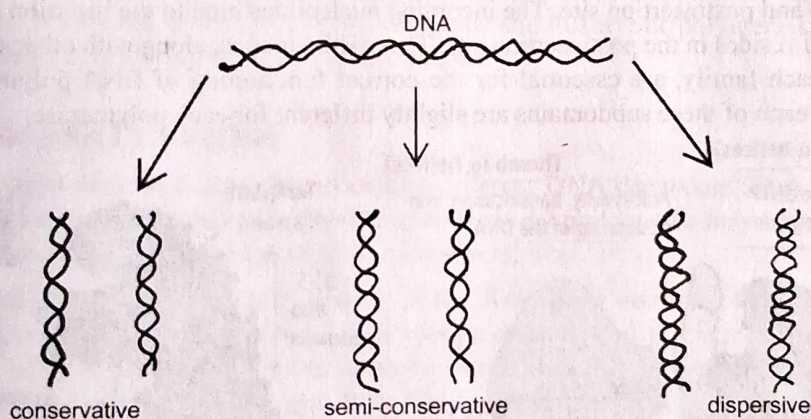


Fig. 2.2. Three proposed model of DNA replication.

In the early 1960s, English molecular biologist John Cairns performed an experiment of autoradiography to demonstrate that *E.coli* and other bacteria and archaea with circular chromosomes. In circular DNA there are three types of replication models: providing evidence of rolling circle, strand displacement and "Theta replication". The name is given because the structure generated resembles the Greek letter Theta (θ). This method of replication occurs in bacteria, *E. coli* and chloroplasts and mitochondria. There are certain terms which one should understand before learning about the whole replication process.

Replication fork: It is formed by a point of which a double stranded DNA molecule separates into two single strands that serve as templates for replication.

Replication bubble: Replication bubble is formed where replication occurs in both the direction and new strand is formed only in 5' to 3' direction.

Origin of replication or ORI: This is the region on the DNA strand where origin of replication begins.

- In prokaryotes, DNA is double-stranded circular in shape. As prokaryotes does not possess a well developed nucleus and undergo theta replication
- (I) Steps of Theta (θ) model of replication- There are three phases of the replication of circular DNA found in *E. Coli*, chloroplasts and mitochondria.