

Tutorial 2: DNA Replication

Answer all questions below.

1. What is a gene, and why must it be duplicated before cell division?
A gene is the basic unit of heredity, made up of DNA, and it forms part of chromosomes. Gene must be duplicated before cell division to ensure that both daughter cells will receive identical sets of chromosomes.
2. Describe the basic structure of DNA as proposed by Watson and Crick.
Deoxyribonucleic acid (DNA), a type of nucleic acid, has a double helix structure as proposed by Watson and Crick. This structure consists of two complementary strands, each composed of a sugar-phosphate backbone and nitrogenous bases (A-adenine, T-thymine, G-guanine, C-cytosine). Adenine pairs with thymine (A-T) and guanine pairs with cytosine (G-C).
3. Explain the process of semiconservative replication in DNA replication.
In semiconservative replication, the two strands of the DNA double helix separate, and thus build a complementary strand on each of the two original strands. The sequence of each original (parent) strand dictates the sequence of its new complementary strand, as adenine (A) pairs with thymine (T) and guanine (G) pairs with cytosine (C). This process results in two double-stranded DNA molecules, each with one "old" (original) strand and one "new" strand, maintaining the original sequence. Thus, every DNA molecule produced is half "old" and half "new," ensuring accurate genetic information transfer.
4. What is the role of DNA helicase in DNA replication?
DNA helicase is an enzyme that unwinds the DNA double helix by disrupting the hydrogen bonds holding the base pairs together, without breaking the DNA chain. This separation creates two single strands of DNA that can serve as templates for replication.
5. What is the significance of Okazaki fragments, and how are they joined together?
Okazaki fragments are short DNA sequences synthesized on the lagging strand during DNA replication. These fragments are formed because the lagging strand is synthesized discontinuously in the 5' to 3' direction, resulting in a series of short pieces with gaps between them as the replication fork passed by. To create a continuous strand of DNA, the Okazaki fragments must be joined together, this process is carried out by the enzyme DNA ligase.
6. Why are RNA primers necessary during DNA replication?
RNA primers are essential to initiate the synthesis of a new DNA strand with a short stretch. RNA primers are made of primase which lays down a short RNA primer before DNA polymerase elongate the strand. Once the strand is extended, the RNA primer is then removed, and replaced with DNA to ensure the continuity of the DNA strand before replication is completed.