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Med lab sci

BCH 204

Answers to Q1

What is DNA replication

DNA, short for deoxyribonucleic acid, is the self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes. It is the fundamental carrier of genetic information, present in virtually every cell in your body.

Double-helix DNA is made of two asymmetrical strands. Each strand is made of nucleotides lined up one after the other, and these nucleotides are bound to corresponding ones on the other strand to create a ladder-like structure. DNA is made up of four nucleotides — the building blocks of nucleic acids — which are composed of a nitrogenous base, a five-carbon sugar (ribose or deoxyribose), and at least one phosphate group.

Adenine (A), Thymine (T), Guanine (G), and Cytosine (C) are called nucleotides. A and G are called Purines while T and C are called Pyrimidines. According to the rules of base pairing, A always pairs with T, and C always pairs with G.

Before a cell duplicates or divides, through either mitosis or meiosis, DNA must be replicated to ensure that each new cell receives the correct number of chromosomes. This process occurs in all living organisms and

is the basis for biological inheritance.

DNA replication occurs in several steps that involve multiple proteins called replication enzymes, as well as RNA. DNA replication is vital for cell growth, repair, and reproduction in organisms.

Replication depends on the pairing of bases between the two strands of DNA. The A base can only bind to a T, and a C can only bind to a G. In the DNA double helix, the bases of one strand face across and bind to those of the other strand. Therefore, the base sequence of each strand complements that of the other -- the sequences are antiparallel and serve as templates for each other's replication. The two strands are labelled by the location of certain chemical bonds in the DNA backbone. The cell can replicate the "leading strand" as a single unit, but must replicate the "lagging strand" in small pieces.

STEP 1: INITIATION

Replication begins at a location on the double helix known as "oriC" to which certain initiator proteins bind and trigger unwinding. Enzymes known as helicases unwind the double helix by breaking the hydrogen bonds between complementary base pairs, while other proteins keep the single strands from rejoining. The "topoisomerase" proteins surround the unzipping strands and relax the twisting that might damage the unwinding DNA. The cell prepares for the next step, elongation, by creating short sequences of RNA called primers that provide a starting point of elongation.

STEP 2 : ELONGATION

With the primer as the starting point for the leading strand, a new DNA strand grows one base at a time. The existing strand is a template for the new strand. For example, if the next base on the existing strand is an A, the new strand receives a T. The enzyme DNA polymerase controls elongation, which can occur only in the leading direction. The lagging strand unwinds in small sections that DNA polymerase replicates in the

leading direction. The resulting small “Okazaki fragments” can contain 1,000 to 2,000 bases in bacteria, but eukaryotes -- organisms having cells with nuclei -- have fragments of only 100 to 200 bases. The fragments terminate in an RNA primer that is subsequently removed so that enzymes can stitch the fragments into an elongating strand.

STEP 3: TERMINATION

After elongation is complete, two new double helices have replaced the original helix. During termination, the last primer sequence must be removed from the end of the lagging strand. This last portion of the lagging strand is the telomere section, containing a repeating non-coding sequence of bases. Enzymes snip off a telomere at the end of each replication, leading to shorter strands after each cycle. Finally, enzymes called nucleases “proofread” the new double helix structures and remove mispaired bases. DNA polymerase then fills in the gaps created by the excised bases.

Answers to Q2

Important Enzymes in DNA Replication

ENZYMES	FUNCTION
Topoisomerase	Relaxes the super-coiled DNA
DNA helicase	Unwinds the double helix at the replication fork

Primase	Provides the starting point for DNA polymerase to begin synthesis of the new stand.
DNA polymerase	Synthesizes the new DNA strand; also proofreads and corrects some errors
DNA polymerase III	main DNA synthesis enzyme
DNA polymerase I	replaces RNA primers with DNA
DNA ligase	Re-joins the two DNA strands into a double helix and joins Okazaki fragment of the lagging strand
Helicase	unwinds the DNA double helix
Gyrase	relieves the buildup of torque during unwinding