**DNA: A Look at the Replication Process**

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**Abstract:** Utilization of the DNA replication process of eukaryotic and prokaryotic cells is applied to many industries including food production, pharmaceuticals, and medical practices. This micro review takes a quick view into the replication machinery to provide a better understanding of the mechanical processes for developing modern application purposes. With this further insight we can better adapt current modalities for modification to fit the growing demand for these technological sciences. Some of the developing industrial purposes include: cancer treatments, xenotransplantation, medication production, and agricultural production of plants and animals.

**Key Words:**

DNA, Deoxyribonucleic Acid, RNA, Replication, Transcription

**Introduction:**

Deoxyribonucleic acid (DNA) is the genetic material that codes for life. The replication of DNA is a crucial step for continuing species evolution, medical advancements, industry, and quality of life. Continuing research into how to manipulate the genotypes of plants and animals to result in the desired expression of traits has applications in modern fertility clinics, plant/ animal production, and medical care applications. One revolutionary application is the utilization of genetically altered pigs, GALSAFE PIGS, to harvest organs for xenotransplantation in humans in need of donor organs. Before we can start to manipulate the Deoxyribonucleic Acid replication process, first we have to understand what makes up DNA, and how the process of replication naturally occurs according to the central dogma of molecular biology.

**Discussion:**

 Through decades of biochemical analysis of the cell’s process of replication we have gained vast insight about the replication and repair processes of DNA. During our expansion of knowledge through molecular exploration, we have derived that DNA is a double-helix comprised of two strands of sequenced sugars. These sugars consist of deoxyribose and phosphate bonds, aka Nucleotides. DNA strands are uni-directional and orientation is determined by the 5-prime end that has a phosphate group and a 3-prime end that has a hydroxyl group associated with the 5 and 3 carbon respectively. The leading strand runs in 5-prime to 3-prime direction and has phosphate backbones and hydrogen bonds between the nitrogenous bases and the lagging strand runs 3-prime to 5-prime. The replication process of both strands can only occur in the 5-prime to 3-prime direction. The nitrogenous bases that compose DNA are called Purines or Pyrimidines. Purines are two-carbon nitrogen ring bases, which are Adenine and Guanine. Pyrimidines have one-carbon nitrogen ring, and these are Thymine and Cytosine. Another pyrimidine to make note of is Uracil. Uracil is only utilized by RNA, ribonucleic acid, which is a critical component to replication. Purines and Pyrimidines bond with hydrogen bonds to create base pairs. Adenine bonds to Uracil and Cytosine bonds to Guanine. The linear sequence of the bonded base pairs is what codes for proteins. In RNA, Uracil replaces the thymine and bonds with cytosine.

The replication process is broke down into two processes, Transcription and Translation.

“All cells have enzymes called DNA Polymerases that use the base pairing property of DNA to produce a complementary DNA strand from a parent template strand, allowing a cell to replicate and to repair its genome Base paring also allows complementary DNA Strands to self-assemble into a double helix structure, keeping redundant copies of the genomic information in close proximity and protecting this information from chemical and enzymatic degradations by burying it in the interface of the base pairs” (Maffeo 2019).

Replication can begin once the initial protein mediated unwinding occurs and the DNA helicase protein attaches to break apart the hydrogen bonds between the bases on the DNA strands. This is often referred to as the DNA “un-zipping,” which results in two strands: the leading and the lagging strand. DNA polymerase adds new nucleotides down the leading strand continuously in 5-prime to 3-prime order. The lagging strand, however, is a little more complex since DNA polymerase only adds nucleotides in the 5-prime to 3-prime direction, and the lagging strand runs 3-prime to 5-prime. RNA primase signals the D­­­­­NA polyermerase to synthesize the nucleotides into several segments going from the opposite direction in short bursts, but staying with the 5-prime to 3-prime rule. The individual segments are called Okazaki fragments, and the addition process has to be repeated several times for the duration of the lagging strand. Next, another DNA polymerase replaces the RNA primers with DNA. Then DNA ligase repairs and seals the gap between the small Okazaki fragments creating an unbroken phosphate-sugar backbone.

Lastly, the production of DNA is not a perfect process. As a result the replication process ends with the disposal of less than ideal specimens. Deoxyribonucleic acid can be susceptible to damage resulting from errors during replication, oxidation by free radicals, radiation, or by general degradation. “The typical products of DNA damage include base pair mismatches, abasic or chemically modified nucleosides, single-stranded breaks, intra-ad-inter-strand cross links, and double-stranded breaks.” (Maffeo 2019) Once detection of these genetic mutations occurs, apoptosis is triggered to eliminate the continued existence of the flawed genetic material. Apoptosis is the programmed of the cell. When apoptosis signaling fails to terminate, it can result in forms of cancers.

**Conclusion:**

It is essential for the DNA replication process to be understood and studied. Not only does this knowledge help improve agricultural goals, but it also results in long term advancements in medicine and extension of life expectancies. When professionals understand the correct ways these processes work, they can identify solutions to when the process is less than ideal. To highlight a few advancements, just look at the genetics studies with food and rice production to feed poverty struck populations, or the production of genetically “GALSAFE” pigs to harvest genetically modified organs for xenotransplantation into humans. There are many compelling advancements in this field of study, leaving lots of room for professional and academic growth.

**References:**

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