Errors in dna replication essay sample

Science, Genetics

DNA replication is a biological process that occurs in all living organisms and copies their DNA; it is the basis for biological inheritance. The process starts when one double-stranded DNA molecule produces two identical copies of the molecule. The cell cycle (mitosis) also pertains to the DNA replication/reproduction process. The cell cycle includes interphase, prophase, metaphase, anaphase, and telophase. Each strand of the original double-stranded DNA molecule serves as template for the production of the complementary strand, a process referred to as semi-conservative replication. Cellular proofreading and error-checking mechanisms ensure near perfect fidelity for DNA replication.

While most DNA replicates with fairly high fidelity, mistakes do happen, with polymerase enzymes sometimes inserting the wrong nucleotide or too many or too few nucleotides into a sequence. Fortunately, most of these mistakes are fixed through various DNA repair processes. But some replication errors make it past these mechanisms, thus becoming permanent mutations. These altered nucleotide sequences can then be passed down from one cellular generation to the next, and if they occur in cells that give rise to gametes, they can even be transmitted to subsequent organismal generations. Moreover, when the genes for the DNA repair enzymes themselves become mutated, mistakes begin accumulating at a much higher rate. In eukaryotes, such mutations can lead to cancer. ERROR CORRECTION:

DNA replication errors include:
A) Adding nucleotides (more than that are supposed to be added). B) Removing nucleotides (from places they are supposed to be in). C) Putting nucleotides in wrong places. DNA polymerase enzymes are amazingly

particular with respect to their choice of nucleotides during DNA synthesis, ensuring that the bases added to a growing strand are correctly paired with their complements on the template strand (i. e., A’s with T’s, and C’s with G’s). Nonetheless, these enzymes do make mistakes at a rate of about 1 per every 100, 000 nucleotides. n humans, with our 6 billion base pairs in each diploid cell, that would amount to about 120, 000 mistakes every time a cell divides.

Fortunately, cells have evolved highly sophisticated means of fixing most, but not all, of those mistakes. Some of the mistakes are corrected immediately during replication through a process known as proofreading, and some are corrected after replication in a process called mismatch repair. When an incorrect nucleotide is added to the growing strand, replication is stalled by the fact that the nucleotide’s exposed 3′-OH group is in the “ wrong” position. During proofreading, DNA polymerase enzymes recognize this and replace the incorrectly inserted nucleotide so that replication can continue. Proofreading fixes about 99% of these types of errors, but that’s still not good enough for normal cell functioning.

After replication, mismatch repair reduces the final error rate even further. Incorrectly paired nucleotides cause deformities in the secondary structure of the final DNA molecule. During mismatch repair, enzymes recognize and fix these deformities by removing the incorrectly paired nucleotide and replacing it with the correct nucleotide. DNA repair, include, base excision repair, nucleotide excision repair, double-strand DNA break repair, and mismatch repair (MMR).