

Chapter 9 Study Guide Chemistry Of The Gene

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1 DNA The Molecule of Life

DNA is a double helix composed of two polynucleotide chains wound around each other Each chain consists of nucleotides each containing a deoxyribose sugar a phosphate group and one of four nitrogenous bases adenine A guanine G cytosine C and thymine T The bases pair specifically A with T and G with C held together by hydrogen bonds

Function DNA carries the genetic code that directs the synthesis of proteins essential for all cellular functions The sequence of bases in DNA determines the sequence of amino acids in a protein ultimately influencing an organisms traits

The Double Helix Model

The groundbreaking discovery of DNAs double helix structure by Watson and Crick revolutionized our understanding of genetics The model elucidates how DNA replicates ensuring the transmission of genetic information from one generation to the next

2 DNA Replication Copying the Code

SemiConservative Replication DNA replication is semiconservative meaning each new DNA molecule contains one original strand and one newly synthesized strand

Steps of Replication

- 1 Unwinding The double helix unwinds by the action of the enzyme helicase breaking the hydrogen bonds between the base pairs
- 2 Primer Binding A short RNA primer binds to the origin of replication providing a starting point for DNA polymerase
- 3 Elongation DNA polymerase adds nucleotides to the primer using the original strand as a 2 template
- 4 Leading and Lagging Strands DNA synthesis occurs continuously on the leading strand but discontinuously on the lagging strand forming Okazaki fragments
- 5 Proofreading DNA polymerase possesses proofreading activity ensuring high fidelity in replication
- 6 Joining DNA ligase seals the gaps between Okazaki fragments creating a continuous DNA molecule

3 Gene Expression From DNA to Protein

Central Dogma of Molecular Biology This principle states that genetic information flows from DNA to RNA to protein

Transcription The process of copying DNA into RNA RNA polymerase binds to the promoter region of a gene and transcribes the DNA sequence into a complementary RNA molecule mRNA

Translation The process of translating the genetic code in mRNA into a sequence of amino acids forming a protein Ribosomes bind to mRNA and move along it reading the codons threebase sequences Each codon specifies a particular amino acid brought to the ribosome by tRNA molecules The amino acids are linked together by peptide bonds forming a polypeptide chain

4 Genetic Code The Language of Life

Codons Threebase sequences in mRNA that specify a particular amino acid There are 64 possible codons but only 20 amino acids meaning some amino acids are coded by multiple codons

Start and Stop Codons The start codon AUG initiates translation Stop codons UAG UAA UGA signal the termination of translation

Universality The genetic code is nearly universal meaning the same codons specify the same amino acids in most organisms

5 Mutations Changes in the Genetic Code

Definition Any permanent change in the DNA sequence

3 Types of Mutations

Point mutations Changes in a single base pair

Insertions Addition of one or more base pairs

Deletions Removal of one or more base pairs

Effects of Mutations

Silent mutations No change in the

amino acid sequence Missense mutations Change in the amino acid sequence potentially affecting protein function Nonsense mutations Change in the amino acid sequence creating a stop codon resulting in a truncated protein Causes of Mutations Spontaneous mutations Occur randomly due to errors in DNA replication Induced mutations Caused by environmental factors like radiation or chemicals 6 Gene Regulation Controlling Gene Expression Importance Gene regulation is essential for proper development function and adaptation of organisms Mechanisms of Regulation Transcriptional regulation Controlling the rate of transcription Posttranscriptional regulation Modifying the mRNA molecule after transcription Translational regulation Controlling the rate of translation Posttranslational regulation Modifying the protein after translation 7 Applications of Gene Technology Recombinant DNA Technology Techniques for manipulating and recombining DNA molecules enabling the production of genetically modified organisms GMOs Gene Therapy Replacing or correcting defective genes to treat genetic diseases DNA Fingerprinting Identifying individuals based on their unique DNA profiles used in forensic science and paternity testing Conclusion This chapter provided a comprehensive overview of the chemistry of the gene highlighting the structure function and replication of DNA We explored the processes of gene expression from DNA to protein and delved into the concept of mutations and gene 4 regulation The applications of gene technology were also discussed demonstrating the immense impact of this field on human health agriculture and society Key Terms DNA Deoxyribonucleic acid RNA Ribonucleic acid Nucleotide Building block of DNA and RNA Base pairing Specific interactions between nitrogenous bases AT GC Replication Process of copying DNA Transcription Copying DNA into RNA Translation Translating mRNA into protein Codon Threebase sequence in mRNA specifying an amino acid Mutation Permanent change in the DNA sequence Gene regulation Controlling gene expression Recombinant DNA technology Manipulating DNA molecules Gene therapy Replacing or correcting defective genes DNA fingerprinting Identifying individuals based on their DNA Study Tips Draw diagrams Visualizing the structure of DNA and the processes of replication transcription and translation can be helpful Practice writing out sequences Transcribing and translating DNA and RNA sequences can solidify your understanding Relate concepts to realworld examples Connect the information to practical applications like genetic diseases GMOs and forensic science Review key terms and definitions Ensure you understand the meaning of all the important concepts discussed in the chapter Complete the chapter exercises and practice questions Test your knowledge and identify any areas that need further review

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