

Chapter 17 Ap Bio Reading Guide Answers

Chapter 17 Ap Bio Reading Guide Answers Chapter 17 From Gene to Protein How Information Flows in the Cell Reading Guide Answers This chapter delves into the central dogma of molecular biology exploring how the genetic information encoded in DNA is used to create proteins that carry out the functions of life We will dissect the process of gene expression which involves two major steps transcription and translation Section 1 The Genetic Code 1 What is the genetic code The genetic code is a set of rules that translates the nucleotide sequence of DNA into the amino acid sequence of proteins It consists of three nucleotide codons which each specify a particular amino acid or a stop signal for protein synthesis 2 Why is the genetic code considered redundant but not ambiguous The genetic code is redundant because multiple codons can code for the same amino acid For example UCU UCC UCA UCG AGU and AGC all code for Serine However the code is not ambiguous because each codon codes for only one specific amino acid This means that a single codon will not produce two different amino acids 3 Explain the concept of reading frame and how it affects protein synthesis A reading frame is a way of dividing the sequence of nucleotides in DNA or mRNA into three nucleotide codons each specifying an amino acid A single nucleotide change can shift the reading frame resulting in a completely different amino acid sequence and potentially a nonfunctional protein 4 What is a mutation and how can it affect protein function A mutation is a change in the nucleotide sequence of DNA Depending on the location and type of mutation it can have varying effects on protein function A point mutation changing a single nucleotide might have no effect silent mutation change a single amino acid missense mutation or introduce a premature stop codon nonsense mutation Larger mutations like deletions or insertions can significantly alter the reading frame and lead to 2 the production of a completely different or nonfunctional protein Section 2 Transcription 5 Describe the process of transcription Transcription is the process by which the genetic information in DNA is copied into a messenger RNA mRNA molecule Heres a breakdown Initiation RNA polymerase an enzyme binds to a specific DNA sequence called a promoter upstream of the gene This marks the beginning of the gene Elongation RNA polymerase moves along the DNA template strand using it as a guide to assemble a complementary RNA molecule Instead of thymine uracil is used in RNA Termination RNA polymerase encounters a specific DNA sequence called a terminator signaling the end of the gene The polymerase detaches from the DNA releasing the newly synthesized mRNA molecule 6 What is a promoter and what is its role in transcription A promoter is a specific DNA sequence located upstream of a gene that serves as a binding site

for RNA polymerase It acts as a switch to turn on and off gene transcription controlling the rate at which a particular gene is transcribed 7 Explain the difference between mRNA tRNA and rRNA mRNA messenger RNA Carries the genetic code from DNA in the nucleus to the ribosomes in the cytoplasm where proteins are synthesized tRNA transfer RNA Transports specific amino acids to the ribosomes during protein synthesis matching them with the appropriate mRNA codon rRNA ribosomal RNA Forms the structural and catalytic core of ribosomes the molecular machines that translate mRNA into proteins Section 3 Translation 8 Describe the process of translation Translation is the process by which the genetic information in mRNA is used to build a protein Heres a breakdown Initiation The small subunit of a ribosome binds to the mRNA and scans for the start codon AUG The initiator tRNA carrying methionine binds to the start codon The large subunit of the ribosome then joins the complex Elongation tRNA molecules carrying specific amino acids bind to the mRNA codons in the 3 ribosome one by one The ribosome moves along the mRNA bringing together amino acids in the order dictated by the codons forming a polypeptide chain Termination The ribosome encounters a stop codon UAA UAG or UGA on the mRNA This signals the end of the protein synthesis The polypeptide chain is released from the ribosome and the ribosome disassembles 9 What is a ribosome and what is its role in translation A ribosome is a cellular organelle that serves as the site of protein synthesis It consists of two subunits a small subunit that binds mRNA and a large subunit that holds tRNA molecules and facilitates the formation of peptide bonds between amino acids 10 What is the role of tRNA in translation tRNA molecules act as adapters during translation Each tRNA molecule has a specific anticodon that can base pair with a complementary codon on mRNA It also carries a specific amino acid which it delivers to the growing polypeptide chain at the ribosome 11 Explain how a polypeptide chain folds into a functional protein The primary structure of a protein the linear sequence of amino acids dictates its three dimensional structure The polypeptide chain folds and twists into a specific shape due to interactions between amino acids including hydrogen bonds ionic bonds hydrophobic interactions and disulfide bridges This complex structure allows the protein to perform its specific function Section 4 Mutations in Gene Expression 12 How can mutations affect the expression of genes Mutations can affect gene expression at various stages Transcription Mutations in promoter regions can alter the binding of RNA polymerase affecting the rate of transcription Translation Mutations in the coding sequence can alter the mRNA sequence leading to missense nonsense or frameshift mutations all of which can affect protein function Protein folding Mutations can alter the amino acid sequence disrupting the proteins folding pattern and rendering it nonfunctional 13 Explain the differences between basepair substitutions and insertionsdeletions Basepair substitutions A single nucleotide is replaced by another These can be silent no change in amino acid missense change in amino acid or nonsense introducing a 4 premature stop codon Insertionsdeletions Nucleotides are added or removed from the sequence These can lead to frameshift mutations altering the reading frame and drastically changing the amino acid sequence downstream of the mutation

14 Why are some mutations more harmful than others? The severity of a mutation depends on its location and effect on protein function. Mutations in critical regions of a gene such as those encoding active sites of enzymes can have more drastic effects than mutations in less important regions. Furthermore, mutations that alter the reading frame or introduce premature stop codons are generally more harmful than single basepair substitutions.

Section 5 Gene Regulation

15 Why is gene regulation essential for life? Gene regulation is the process of controlling which genes are expressed and at what level. This is crucial for ensuring that the correct proteins are produced at the right time and in the right amounts, allowing cells to respond to environmental cues, differentiate into specialized cell types, and maintain proper function.

16 Describe the different levels at which gene expression can be regulated. Gene expression can be regulated at multiple levels:

- Transcriptional control: Regulating the rate of transcription by controlling the accessibility of DNA to RNA polymerase.
- Posttranscriptional control: Modifying the mRNA transcript after it has been transcribed, affecting its stability, translation, or localization.
- Translational control: Regulating the rate of translation, impacting how much protein is produced from each mRNA molecule.
- Posttranslational control: Modifying the protein after it has been translated, affecting its activity, localization, or stability.

17 How can the environment influence gene expression? Environmental factors such as temperature, nutrient availability, and exposure to toxins can trigger changes in gene expression. These changes allow organisms to adapt to their surroundings and survive in various environments.

Conclusion 5 Understanding the intricate process of gene expression from the central dogma to the various levels of regulation is fundamental to comprehending how life functions. Mutations can disrupt this delicate process, highlighting the importance of genetic stability and repair mechanisms. Furthermore, environmental influences on gene expression demonstrate the adaptability and complexity of living organisms. This knowledge is not only crucial for understanding basic biological processes but also has implications for fields like medicine, agriculture, and biotechnology.

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