**AP Biology Biology Exploration Guide**: Molecular Genetics #2

 Transcription and Translation

**Key Concepts**: 

* Genes specify proteins via transcription and translation
* Transcription is the DNA-directed synthesis of RNA
* Eukaryotic cells modify RNA after transcription
* Translation is the RNA-directed synthesis of a polypeptide
* Point mutations can affect protein structure and function
* While gene expression differs among the domains of life, the concept of a gene is universal

**Read:**

* Chapter 17

**Key Terms**: Here is a list of key terms and concepts you will hear about and see during the chapter readings. Get to know them!

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| --- | --- | --- | --- |
| *Gene expression* | *Reading frame* | *5’ cap* | *Point mutation* |
| *Transcription* | *RNA polymerase* | *Poly-A tail* | *Base substitution* |
| *RNA processing* | *Promoter*  | *Introns* | *Insertion* |
| *Translation* | *Terminator*  | *Exons* | *Deletion* |
| *Messenger RNA (mRNA)* | *Intiation* | *Spliceosome*  | *Frame shift* |
| *Transfer RNA (tRNA)* | *Elongation* | *snRNPs* | *Missense mutation* |
| *Ribosomal RNA (rRNA)* | *Termination* | *Alternative RNA splicing* | *Nonsense mutation* |
| *Ribosome* | *Transcription factors* | *P site (peptidyl-tRNA site)* | *Silent mutation* |
| *Codon* | *Transcription initiation complex* | *A site (aminoacyl-tRNA site)* | *Mutagen*  |
| *Anticodon* | *TATA box* | *E site (exit site)* |  |

**Questions for Your BILL:**

**The Connection between Genes and Proteins**

1. Define *gene expression*.
2. Explain how the “one-gene-one protein” hypothesis was derived by Beadle and Tatum.  Why has this hypothesis been refined to “one gene-one polypeptide,” and now “one gene-one (protein) domain?”
3. Explain THREE structural ways in which *RNA* differs from DNA.
4. Distinguish between the three types of RNA produced during transcription:
	1. *Messenger RNA (mRNA)*
	2. *Transfer RNA (tRNA)*
	3. *Ribosomal RNA (rRNA)*
5. Distinguish between *transcription* and *translation*.
6. Compare where transcription and translation occur in bacteria and in eukaryotes.
7. Francis Crick coined the term “central dogma” with regard to the relationship between DNA and RNA. Explain what Crick meant by this.
8. Explain the relationship between protein synthesis and an organism’s phenotype.
9. Define *“codon”* and explain the relationship between the linear sequence of codons on mRNA and the linear sequence of *amino acids* in a polypeptide.
10. Explain the significance of the *reading frame* during translation.
11. Explain the evolutionary significance of a nearly universal genetic code.

**The Synthesis and Processing of RNA**

1. Create a cartoon strip that illustrates how RNA is modified after transcription in eukaryotic cells. Add captions to help highlight key points and terms. Include the following in your diagram:
2. How does RNA polymerase identify where to begin transcription of a gene?
3. Explain the relationship between the promoter, enhancers, and transcription factors.
4. Diagram each of the following phases of transcription.
	1. initiation
	2. elongation
	3. termination
5. Create a cartoon strip that illustrates how RNA is modified after transcription in eukaryotic cells. Add captions to help highlight key points and terms. Include the following in your diagram:
	1. *RNA splicing*
	2. *5’ cap*
	3. *poly-A tail*
6. Define and explain the role of *ribozymes*.
7. Explain why, due to *alternative RNA splicing*, the number of different protein products an organism can produce is much greater than its number of genes.

**The Synthesis of Protein**

1. Draw a tRNA molecule and discuss how its structure enables its function. Explain the significance of the *anticodon* and *wobble* in your tRNA molecule.
2. Make a detailed diagram of a ribosome that illustrates the structures listed below. Describe the function of each component of the *ribosome*. Inlcude the following
	1. *small ribosomal subunit*
	2. *large ribosomal subunit*
	3. *P site, A site,* and *E site*.
3. Diagram the process of translation including the phases listed below and include the location (A, P, or E site) of incoming tRNA molecules, incoming amino acids, energy sources, the growing polypeptide chain, uncharged tRNA molecules and release factors as appropriate:
	1. Initiation
	2. Elongation
	3. Termination
4. Describe the significance of *polyribosomes*.
5. Explain the purpose of a *signal peptide* at the beginning of a newly synthesized protein.
6. Use the following DNA nucleotide sequence to create the appropriate codon sequence for a strand of mRNA, the appropriate series of tRNA anticodons, and ultimately the amino acid sequence that would be generated.

(DNA template strand) **T-A-C-T-C-A-G-T-G-G-G-G-C-A-C-T-T-A**

**Point Mutations**

1. Define “*point mutations*”.
2. Distinguish between the following types of mutations:
	1. Silent mutation
	2. Missense mutation
	3. Nonsense mutation
	4. Frameshift mutation
3. Why is an insertion or deletion more likely to be deleterious than a substitution?
4. Define the term ‘*mutation*’. Give an example of a physical and a chemical agent of mutation.

**Supplementary Resources**: Click the links below for more information to help you learn more about this lesson.

Interactives

* **McGraw-Hill 3D Animation**: [Molecular Biology of the Gene (Protein Synthesis)](http://www.mhhe.com/biosci/bio_animations/03_MH_MolBioGene_Web/index.html)
* **Pearson’s BioCoach Activity**: [Transcription](http://www.phschool.com/science/biology_place/biocoach/transcription/intro.html) and [Translation](http://www.phschool.com/science/biology_place/biocoach/translation/intro.html)
* University of Utah Genetic Science Learning Center: [DNA to Protein](http://learn.genetics.utah.edu/content/begin/dna/)
* McGraw Hill: [Transcription Animation](http://highered.mcgraw-hill.com/sites/0072507470/student_view0/chapter3/animation__mrna_synthesis__transcription___quiz_1_.html)
* McGraw Hill: [RNA Processing](http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120077/bio30.swf::How%20Spliceosomes%20Process%20RNA)
* McGraw Hill: [Translation Animation](http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120077/micro06.swf::Protein%20Synthesis)
* University of Nebraska: [Transcription Animation](http://www.cmbi.ru.nl/edu/VWO/4vwodag/gene2.swf)
* University of Nebraska: [Translation Animation](http://www.cmbi.ru.nl/edu/VWO/4vwodag/gene3.swf)

Lectures

* Bozeman Biology’s “[Transcription & Translation](http://www.youtube.com/watch?v=h3b9ArupXZg)” video.
* Bozeman Biology’s “[The Central Dogma](http://www.youtube.com/watch?v=yLQe138HY3s)” video.
* Bozeman Biology’s “[Genotypes and Phenotypes](http://www.youtube.com/watch?v=OaovnS7BAoc)” video.
* Crash Course Biology’s video: [DNA, Hot Pockets, & The Longest Word Ever](http://www.youtube.com/watch?v=itsb2SqR-R0&list=PL3EED4C1D684D3ADF&index=11&feature=plpp_video)
* Crash Course Biology:  [DNA Transcription and Translation](http://quietube5.com/v.php/http%3A//www.youtube.com/watch?v=itsb2SqR-R0)

 HYPERLINK "http://quietube5.com/v.php/http://www.youtube.com/watch?v=itsb2SqR-R0"