

Protein synthesis: transcription and translation

Name _____

Date _____

Period _____

Part 1 · Vocabulary

1. Write the letter of the matching description next to each term.

- | | |
|-------------------------|---|
| _____ Promoter | A Machine of rRNA and proteins that links amino acids in the order the mRNA codes |
| _____ Template strand | |
| _____ RNA polymerase II | B Complex of proteins and small nuclear RNAs that removes introns |
| _____ Exon | C Three tRNA bases that base-pair with a codon |
| _____ Intron | D Part of the pre-mRNA that is cut out in the nucleus before translation |
| _____ Spliceosome | E Enzyme in the nucleus that makes all protein-coding pre-mRNAs |
| _____ 5' cap | F DNA sequence near the start of a gene where transcription factors and RNA polymerase bind to start transcription |
| _____ Codon | G Part of a gene that stays in the mature mRNA after splicing |
| _____ Anticodon | H 7-methylguanosine added to the RNA's 5' end; protects it and helps ribosomes recognize it |
| _____ Ribosome | I The one DNA strand that is read to choose each base of the new RNA |
| | J Three mRNA bases that specify one amino acid or a stop |

Part 2 · Transcription and RNA processing

2. In which direction does RNA polymerase build a new RNA strand?

- | | |
|--|--|
| A 3'→5', reading the template 5'→3' | C 5'→3', reading the template 5'→3' |
| B 5'→3', reading the template 3'→5' | D In both directions at once |

3. In a eukaryotic cell, where does transcription happen? Where does translation happen?

4. A template DNA strand reads 3'-TACGGA-5'. Write the mRNA made from it, 5'→3'.

5. The first three codons of HBB's coding sequence have the template strand 3'-TAC CAC GTA-5'. Write the mRNA they code for, 5'→3'.

6. Besides splicing, name the two changes made to the ends of the pre-mRNA before it leaves the nucleus, and give one job of each.

7. Introns begin with the bases _____ and end with the bases _____.

8. The HBB gene spans 1,608 nucleotides from the start site to the end of exon 3. How long is its mature mRNA, not counting the cap and poly-A tail?

- | | |
|------------|----------|
| A 1,608 nt | C 628 nt |
| B 980 nt | D 444 nt |

9. Put the start of HBB gene expression in order. Number them 1–5.

- _____ DNA at the start site is unwound (transcription bubble)
- _____ RNA is made 5'→3' from the template strand
- _____ The finished mRNA leaves through a nuclear pore
- _____ TFIID (with TATA-binding protein) binds the promoter
- _____ RNA polymerase II binds, forming the initiation complex

Part 3 • Translation

10. How many codons are there in the genetic code, and how many of them specify amino acids? Write the three stop codons.

11. In which direction does the ribosome read the mRNA? Which end of the polypeptide is made first?

12. Codon 2 of the β -globin mRNA is GUG. Which amino acid will the next tRNA bring into the A site?

- | | |
|--------------|-------------|
| A Methionine | C Glutamate |
| B Valine | D Histidine |

13. Match each ribosome site with what happens there.

- | | |
|--------------|---|
| _____ A site | A Releases the empty tRNA |
| _____ P site | B A charged tRNA arrives |
| _____ E site | C Holds the tRNA with the growing chain |

14. What catalyzes the formation of each peptide bond in the ribosome?

- | | |
|---|----------------------|
| A An aminoacyl-tRNA synthetase | C The mRNA |
| B RNA in the large subunit (the ribosome is a ribozyme) | D The release factor |

15. An mRNA reads 5'-AUG UUU GGC UAA-3'. How many amino acids does the ribosome add?

Part 4 · From gene to protein: β-globin

These are the first 7 codons of the human β-globin gene (HBB), the gene changed in sickle-cell disease.

16. Fill in the template strand, the mRNA and the amino acids (three-letter abbreviations; use a codon chart).

	Codon 1	Codon 2	Codon 3	Codon 4	Codon 5	Codon 6	Codon 7
Coding strand (DNA) 5'→3'	ATG	GTG	CAT	CTG	ACT	CCT	GAG
Template strand (DNA) 3'→5'							
mRNA 5'→3'							
Amino acid							

17. In sickle-cell hemoglobin, codon 7 of the coding strand changes from GAG to GTG. Write the new mRNA codon and the amino acid it codes for. What kind of mutation is this?

Part 5 · Compare the two processes

18. Complete the table.

	Transcription	Translation
Where (in eukaryotes)		
What is read		
What is made		
Main machine		