Ch 17 HW

The Genetic Code

DNA is transcribed to messenger RNA (mRNA), and the mRNA is translated to proteins on the ribosomes. A sequence of three nucleotides on an mRNA molecule is called a codon. As you can see in the table, most codons specify a particular amino acid to be added to the growing protein chain. In addition, one codon (shown in blue) codes for the amino acid methionine and functions as a "start" signal. Three codons (shown in red) do not code for amino acids, but instead function as "stop" signals.

	U		C		A		G	
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC		UCC		UAC		UGC		C
	UUA	Leu	UCA		UAA	Stop	UGA	Stop	A
	UUG		UCG		UAG	Stop	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	Gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG	Met or start	ACG		AAG		AGG		G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	Glu	GGA		A
	GUG		GCG		GAG		GGG		G

Part A - Understanding the genetic code

Use the table to sort the following ten codons into one of the three bins, according to whether they code for a start codon, an in-sequence amino acid, or a stop codon.

Drag each item to the appropriate bin.

Hint 1. How to interpret the table of codons

The table of codons shows the start codon in blue and the three stop codons in red. All other codons (shown in black) appear in the middle of the amino acid sequences that make up proteins.
To read the table, locate the first letter in the codon on the left side of the table, then locate the second letter along the top, and the third letter down the right side of the table. Follow those letters across and down to identify the amino acid associated with that three-letter codon.

Hint 2. What is the start codon?

Identify the start codon.

ANSWER:

AUG

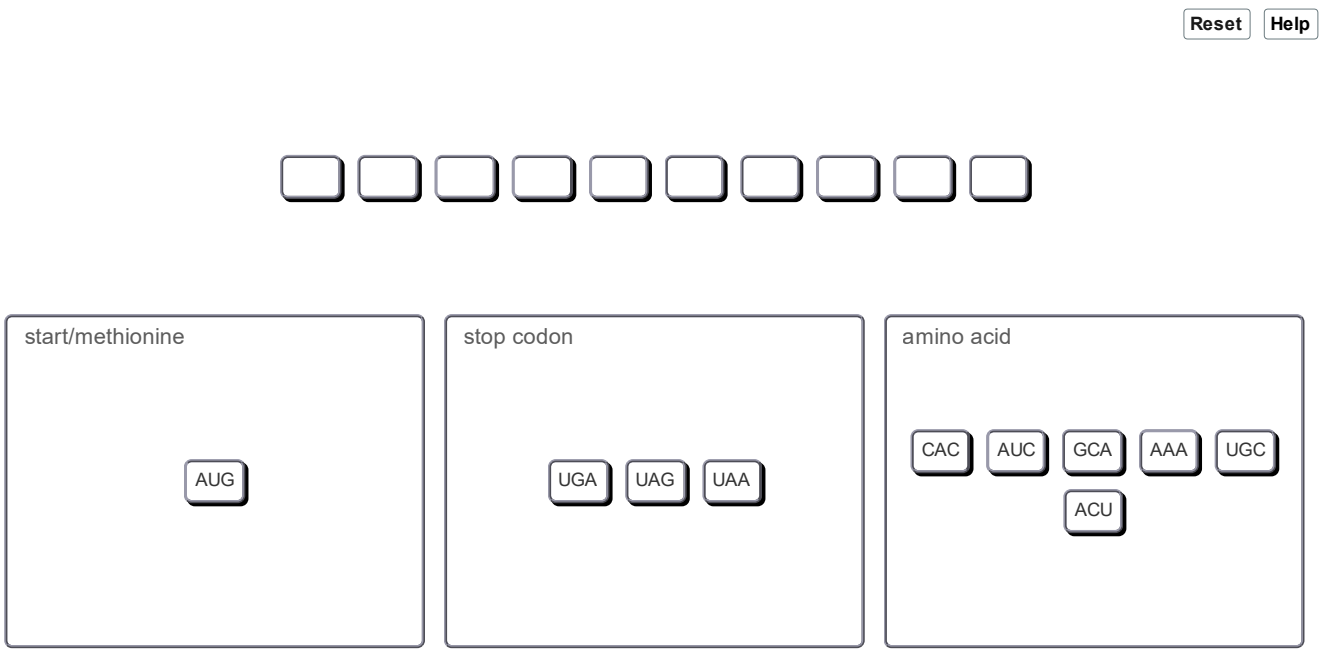
Hint 3. What are the stop codons?

Enter the three stop codons, separated by commas.

ANSWER:

UAG, UGA, UAA

ANSWER:



Correct

Nearly every mRNA gene that codes for a protein begins with the start codon, AUG, and thus begins with a methionine. Nearly every protein-coding sequence ends with one of the three stop codons (UAA, UAG, and UGA), which do not code for amino acids but signal the end of translation.

Part B - Translation of mRNA

During translation, nucleotide base triplets (codons) in mRNA are read in sequence in the 5' → 3' direction along the mRNA. Amino acids are specified by the string of codons. What amino acid sequence does the following mRNA nucleotide sequence specify?

$$5' - \mathrm{AUGGCAAGAAAA} - 3'$$

Express the sequence of amino acids using the three-letter abbreviations, separated by hyphens (e.g., Met-Ser-Thr-Lys-Gly).

Hint 1. How to approach the problem

First, subdivide the sequence into the individual three-letter codons. Then, refer to the table of codons to find the three-letter abbreviation for the amino acid that corresponds to each codon.

Hint 2. An example problem

This chart shows how to decode an example mRNA sequence. Labels indicating directionality (for example, 5' → 3') are not needed when writing amino acid sequences.

Example mRNA sequence	$5' - \mathrm{AUGUCGACUAAGGGA} - 3'$				
Codon sequence	AUG	UCG	ACU	AAG	GGA
Amino acid sequence (three-letter abbreviation)	Met	Ser	Thr	Lys	Gly

Hint 3. Can you identify the individual codons in the mRNA sequence?

To identify the amino acids specified by the mRNA sequence, you first need to subdivide the sequence into codons of three nucleotides each. This can be done by placing a space between each codon. Which of the following is the correct division of the codons for the sequence given? Look for the correct placement of spaces.

ANSWER:

- $5' - \text{A UGG CAA GAA AA} - 3'$
- $5' - \text{AU GGC AAG AAA A} - 3'$
- $5' - \text{AUG GCA AGA AAA} - 3'$
- $5' - \text{AUGG CAA GAA AA} - 3'$
- $5' - \text{AU GGCA AGAA AA} - 3'$

Hint 4. Can you decode GCA?

Which amino acid does the codon GCA code for?

Express your answer using the three-letter abbreviation of the amino acid.

ANSWER:

Ala

ANSWER:

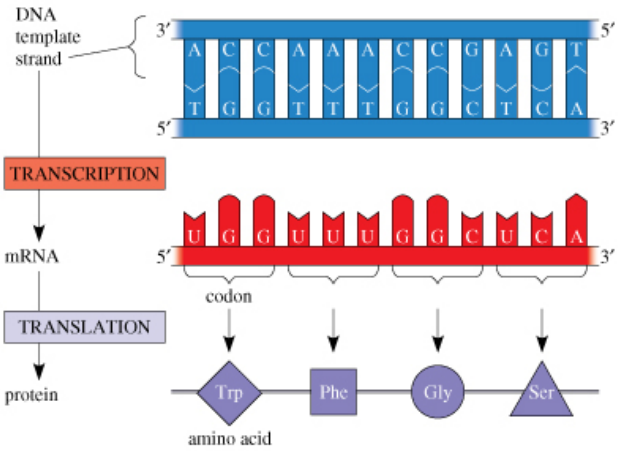
Met-Ala-Arg-Lys

Correct

An amino acid sequence is determined by strings of three-letter codons on the mRNA, each of which codes for a specific amino acid or a stop signal. The mRNA is translated in a 5' → 3' direction.

Part C - The role of DNA in determining amino acid sequences

Before a molecule of mRNA can be translated into a protein on the ribosome, the mRNA must first be transcribed from a sequence of DNA.



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What amino acid sequence does the following DNA nucleotide sequence specify?

$$3' - \text{TACAGAACGGTA} - 5'$$

Express the sequence of amino acids using the three-letter abbreviations, separated by hyphens (e.g., Met-Ser-His-Lys-Gly).

Hint 1. How to approach the problem

Follow these steps to convert a DNA sequence into an amino acid sequence.

1. First, transcribe the DNA sequence to determine the mRNA sequence. Be sure to remember the following:
   - The mRNA strand is complementary to the DNA strand.
   - Uracil (U) takes the place of thymine (T) in RNA to pair with A on the DNA.
   - The RNA is assembled in an antiparallel direction to the template strand of DNA. A 3'→ 5' direction in DNA is transcribed in a 5' → 3' direction in RNA.
2. Next, subdivide the mRNA sequence into the individual three-letter codons in the 5' to 3' direction.

3. Then, refer to the table of codons to identify the three-letter abbreviation for the amino acid that corresponds to each codon.

Hint 2. An example problem

This chart shows how to decode an example DNA sequence. Remember to first determine the mRNA sequence that is complementary to the DNA template strand's sequence. Be sure to write the mRNA sequence in a 5' to 3' direction, and to use U to pair with A.

Example DNA sequence (template strand)	$3' - \text{TACGAATCAGCTGTA} - 5'$
Complementary DNA sequence	$5' - \text{ATGCTTAGTCGACAT} - 3'$

mRNA sequence	$5' - \text{AUGCUUAGUCGACAU} - 3'$				
Codon sequence	AUG	CUU	AGU	CGA	CAU
Amino acid sequence (three-letter abbreviation)	Met	Leu	Ser	Arg	His

Hint 3. What mRNA sequence is transcribed from the DNA sequence?

What mRNA nucleotide sequence would be transcribed from the DNA sequence in this problem?

$3' - \text{TACAGAACGGTA} - 5'$

ANSWER:

- $5' - \text{ATGTCTTGCCAT} - 3'$
- $3' - \text{TACAGAACGGTA} - 5'$
- $3' - \text{AUGUCUUGCCAU} - 5'$
- $5' - \text{AUGUCUUGCCAU} - 3'$

ANSWER:

Met-Ser-Cys-His

Correct

Before mRNA can be translated into an amino acid sequence, the mRNA must first be synthesized from DNA through transcription. Base pairing in mRNA synthesis follows slightly different rules than in DNA synthesis: uracil (U) replaces thymine (T) in pairing with adenine (A). The codons specified by the mRNA are then translated into a string of amino acids.

Chapter 17 Pre-Test Question 4

Part A

What is the function of RNA polymerase?

Hint 1.

Compare RNA polymerase to DNA polymerase.

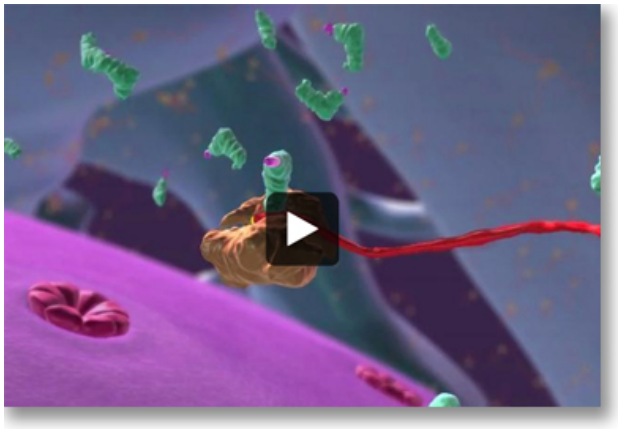
ANSWER:

- It adds nucleotides to the 5' end of the growing mRNA molecule.
- It relies on other enzymes to unwind the double helix.
- It proceeds slowly along the DNA strand, requiring about a minute to add two nucleotides to the growing mRNA molecule.
- It unwinds the double helix and adds nucleotides to a growing strand of RNA.
- All of the above.

Correct

RNA polymerase has several functions in transcription, including unwinding the DNA double helix and adding RNA nucleotides.

Protein Synthesis (1 of 3): Overview (BioFlix tutorial)



In eukaryotic cells, the nuclear DNA codes for the synthesis of most of the cell's proteins. Each step of protein synthesis occurs in a specific part of the cell. In addition, various forms of RNA play key roles in the processes of protein synthesis.

Before beginning this tutorial, watch the Protein Synthesis animation. Pay particular attention to the cellular locations where the various steps of protein synthesis occur in eukaryotic cells, as well as the different types of RNA and how they function.

Part A - Locations of the processes involved in protein synthesis

In eukaryotic cells, the processes of protein synthesis occur in different cellular locations.

Drag the labels to the appropriate targets to identify where in the cell each process associated with protein synthesis takes place.

Hint 1. Some cellular components involved in protein synthesis move through the nuclear pores

The nuclear pores are holes in the nuclear envelope that permit many types of large molecules or aggregates of molecules to move between the nucleus and the cytoplasm. Two cellular components that pass through the nuclear pores are ribosomal subunits and fully processed RNA. What can you infer about where these cellular components are made?

Hint 2. What occurs during some key processes of protein synthesis?

Match these key processes involved in protein synthesis to descriptions of what occurs at each step.

ANSWER:

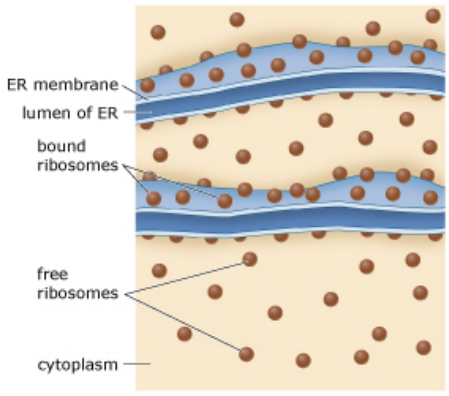
Reset Help

	1. The formation of a strand of RNA that is complementary to one strand of the nuclear DNA is called **transcription** .
	2. The attachment of a free amino acid to a specific RNA molecule is the key step in **charging of tRNA** .
	3. In **translation** , the nucleotide sequence of a piece of RNA is converted into a sequence of amino acids in a polypeptide.
	4. The final RNA template for protein synthesis in eukaryotes is different from the RNA that was produced from the DNA template because of **RNA processing** .

Hint 3. Where are cytoplasmic and secreted proteins made?

In a eukaryotic cell, most proteins remain in the cytoplasm after they are synthesized (for example, the enzymes involved in glycolysis). However, some proteins, such as insulin, must be exported (secreted) from the cell to function.
Both cytoplasmic and secreted proteins can only be synthesized in the presence of a ribosome. This diagram shows the two kinds of ribosomes:

- free ribosomes, which are found in the cytoplasm
- bound ribosomes, which are found on the membrane of the rough endoplasmic reticulum (ER)



Which statement correctly describes where cytoplasmic and secreted proteins are synthesized?

ANSWER:

- Cytoplasmic proteins are synthesized on ribosomes bound to the rough ER, whereas secreted proteins are synthesized on free ribosomes.
- Cytoplasmic proteins are synthesized on free ribosomes, whereas secreted proteins are synthesized on ribosomes bound to the rough ER.
- Both cytoplasmic and secreted proteins are synthesized on ribosomes bound to the rough ER.
- Both cytoplasmic and secreted proteins are synthesized on free ribosomes.

ANSWER:

Correct

Part B - Roles of RNA in protein synthesis in eukaryotes

RNA plays important roles in many cellular processes, particularly those associated with protein synthesis: transcription, RNA processing, and translation.

Drag the labels to the appropriate bins to identify the step in protein synthesis where each type of RNA *first* plays a role. If an RNA does not play a role in protein synthesis, drag it to the "not used in protein synthesis" bin.

Hint 1. The role of RNA primers

DNA synthesis (replication) and RNA synthesis differ in their needs for primer molecules.

- In DNA replication, DNA polymerase cannot initiate the formation of a new strand of DNA directly from DNA nucleotides alone. Instead, the process requires an RNA primer to which the nucleotides of the new DNA strand attach.
- In RNA synthesis, in contrast, RNA polymerase *can* initiate the formation of a new strand of RNA without any primers.

This information should help you sort the "RNA primers" label in this problem.

Hint 2. How do tRNA and rRNA function in protein synthesis?

Both tRNA (transfer RNA) and rRNA (ribosomal RNA) play essential roles in protein synthesis.

Which *two* statements correctly describe the roles of tRNA and rRNA in protein synthesis?

ANSWER:

- [x] rRNA is the major structural component of ribosomes and is involved in binding both mRNA and tRNAs.
- [x] tRNAs implement the genetic code, translating information from a sequence of nucleotides to the sequence of amino acids that make up a protein.
- [ ] rRNA has many variations, each of which binds a specific amino acid.
- [ ] tRNA transfers a nucleotide sequence from the DNA in the nucleus to the site of protein synthesis in the cytoplasm.

Hint 3. What is the role of mRNA in protein synthesis?

mRNA (messenger RNA) plays a key role in protein synthesis as the intermediate between the information encoded by a sequence of bases in DNA (a gene) and the sequence of amino acids that make up the protein product.

Which *three* statements correctly describe the role that mRNA plays in protein synthesis in eukaryotes?

ANSWER:

- [x] mRNA is the template for protein synthesis in translation.
- [x] mRNA carries genetic information from the nucleus to the cytoplasm.
- [ ] mRNA links together amino acids, forming a polypeptide chain.
- [ ] mRNA is the immediate product of transcription.
- [x] mRNA is produced only after the steps of RNA processing.

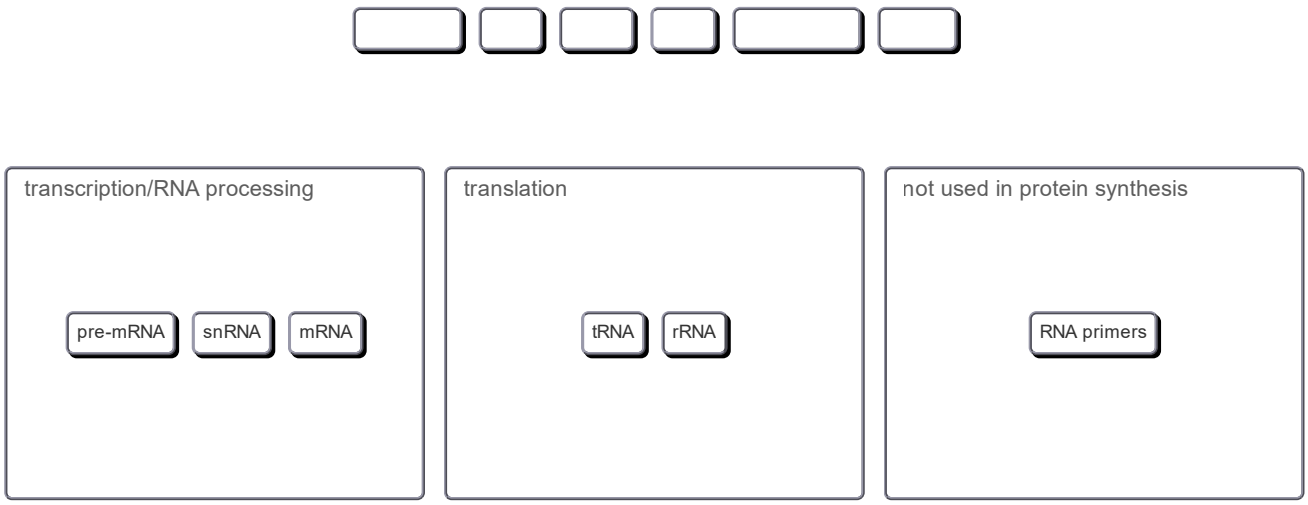
Hint 4. snRNAs and RNA processing

One stage of RNA processing in eukaryotes involves the removal of introns--non-coding regions interspersed within the coding regions of the pre-mRNA. In this RNA splicing process, the machinery that catalyzes the removal of introns (called the spliceosome) is composed of proteins and snRNAs (small nuclear RNAs).
The snRNAs (and associated proteins) have two functions in the splicing process:

- to bind to specific sequences of RNA that specify the location of the intron in the pre-mRNA, and
- to catalyze the splicing process itself.

ANSWER:

Reset Help



Correct

In eukaryotes, pre-mRNA is produced by the direct transcription of the DNA sequence of a gene into a sequence of RNA nucleotides. Before this RNA transcript can be used as a template for protein synthesis, it is processed by modification of both the 5' and 3' ends. In addition, introns are removed from the pre-mRNA by a splicing process that is catalyzed by snRNAs (small nuclear RNAs) complexed with proteins.
The product of RNA processing, mRNA (messenger RNA), exits the nucleus. Outside the nucleus, the mRNA serves as a template for protein synthesis on the ribosomes, which consist of catalytic rRNA (ribosomal RNA) molecules bound to ribosomal proteins. During translation, tRNA (transfer RNA) molecules match a sequence of three nucleotides in the mRNA to a specific amino acid, which is added to the growing polypeptide chain.

RNA primers are *not* used in protein synthesis. RNA primers are only needed to initiate a new strand of DNA during DNA replication.

Part C - Codon size and the genetic code

Life as we know it depends on the genetic code: a set of codons, each made up of three bases in a DNA sequence and corresponding mRNA sequence, that specifies which of the 20 amino acids will be added to the protein during translation.
Imagine that a prokaryote-like organism has been discovered in the polar ice on Mars. Interestingly, these Martian organisms use the same DNA → RNA → protein system as life on Earth, *except* that

- there are only 2 bases (A and T) in the Martian DNA, and
- there are only 17 amino acids found in Martian proteins.

Based on this information, what is the minimum size of a codon for these hypothetical Martian life-forms?

Hint 1. What mathematical equation can you use to solve this problem?

A simple mathematical equation can correctly express the maximum number of codons that can be constructed from *x* different bases, with a codon length of *y* bases. Recall that for life on Earth,

- there are 4 different bases (A, T, G, and C),
- a codon is 3 bases long, and
- there are a total of 64 possible codons that specify the 20 different amino acids (some amino acids are specified by more than one amino acid). This chart shows this redundancy in the genetic code for life on Earth.

	U		C		A		G		
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC		UCC		UAC		UGC		C
	UUA	Leu	UCA		UAA	Stop	UGA	Stop	A
	UUG		UCG		UAG	Stop	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	Gln	CGA		A

A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG	Met or start	ACG		AAG		AGG		G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	Glu	GGA		A
	GUG		GCG		GAG		GGG		G

Which of the following equations can be used to calculate the maximum number of codons (*N*) that can be constructed from *x* different bases when there are *y* bases per codon?

ANSWER:

- $N = 16(3x/y)$
- $N = x^y$
- $N = 4x(y+1)$
- $N = x\ y$

Hint 2. How can you solve this problem without using a mathematical equation?

It is possible to solve this problem by simply listing all the possible combinations of bases for a given codon length. In the hypothetical Martian example there are only 2 different bases (A and T). For a codon length of 1 base, there would only be 2 possible codons:
A or T

For a codon length of 2 bases, there would be 4 possible codons:

AA; TA; AT; or TT

How many different Martian codons are possible if the codon length is 4 bases?

ANSWER:

- 12
- 16
- 32
- 64

ANSWER:

- 2 bases
- 3 bases
- 4 bases
- 5 bases
- 6 bases
- The answer cannot be determined from the information provided.

Correct

In the most general case of x bases and y bases per codon, the total number of possible codons is equal to x^y .

In the case of the hypothetical Martian life-forms, is the minimum codon length needed to specify 17 amino acids is 5 (2^5 = 32), with some redundancy (meaning that more than one codon could code for the same amino acid).

For life on Earth, x = 4 and y = 3; thus the number of codons is 4^3, or 64. Because there are only 20 amino acids, there is a lot of redundancy in the code (there are several codons for each amino acid).

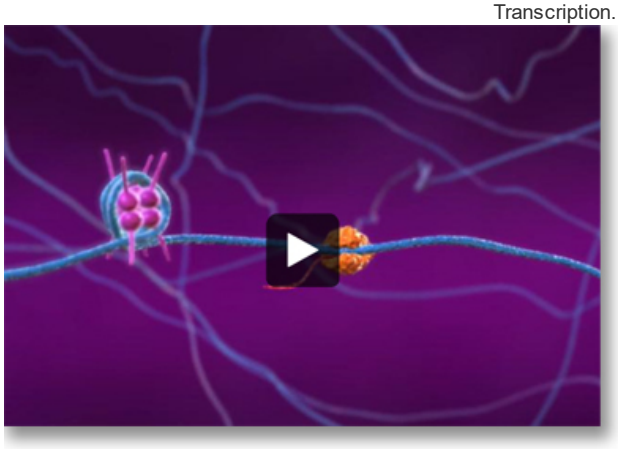
Protein Synthesis (2 of 3): Transcription and RNA Processing (BioFlix tutorial)

In the process of transcription, the genetic information encoded in the sequence of bases that makes up a gene is "transcribed," or copied in the same language, into a strand of RNA bases. The enzyme that catalyzes this reaction is called an RNA polymerase.

In eukaryotes, before the resulting strand (called pre-mRNA) leaves the nucleus, it is processed in several ways. The product of this processing is the mRNA that functions as the template for protein synthesis outside the nucleus.

Before beginning this tutorial, watch the Transcription and RNA Processing animations. Pay particular attention to the base pairing that occurs during transcription and the various steps involved in RNA processing.

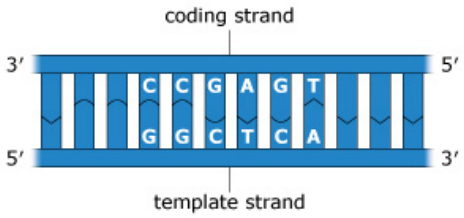
Transcription.



RNA Processing.

Part A - Transcription of the DNA base sequence to RNA

Suppose that a portion of double-stranded DNA in the middle of a large gene is being transcribed by an RNA polymerase. As the polymerase moves through the sequence of six bases shown in the diagram below, what is the corresponding sequence of bases in the RNA that is produced?



Enter the sequence of bases as capital letters with no spaces and no punctuation. Begin with the first base added to the growing RNA strand, and end with the last base added.

Hint 1. DNA-to-RNA base-pairing rules

Though the four nucleotide bases used to construct DNA are adenine (A), thymine (T), guanine (G), and cytosine (C), in RNA, the base uracil (U) is substituted for thymine.
Thus, the base-pairing rules in transcription are A→U, T→A, C→G, and G→C, where the first base is the coding base in the template strand of the DNA and the second base is the base that is added to the growing mRNA strand.

Hint 2. What are the coding strand and the template strand?

Double-stranded DNA is composed of two complementary strands of DNA. “Complementary” means that the bases on one strand pair in a specific way with the bases on the other strand: A with T and G with C. In a given gene, one strand of the DNA functions as the template strand, and the other is the coding strand.

Which *two* statements correctly describe the template and/or coding strands?

ANSWER:

- [ ] The four types of bases that are used in the coding strand are different from the types that are used in the template strand.
- [ ] As the RNA polymerase moves along the DNA, the DNA bases on the coding strand are copied, producing the identical sequence of bases in the RNA transcript.
- [x] The template and coding strands are always antiparallel; that is, if one strand has its 3' end on the left and its 5' end on the right, the other strand has the opposite orientation.
- [x] During transcription, the DNA bases on the template strand are paired with their complementary RNA bases to form the RNA transcript.

Hint 3. Does RNA polymerase move in a set direction along the DNA during transcription?

RNA polymerase produces an RNA molecule from one of the two strands of DNA by transcribing the DNA base sequence to a complementary RNA base sequence.

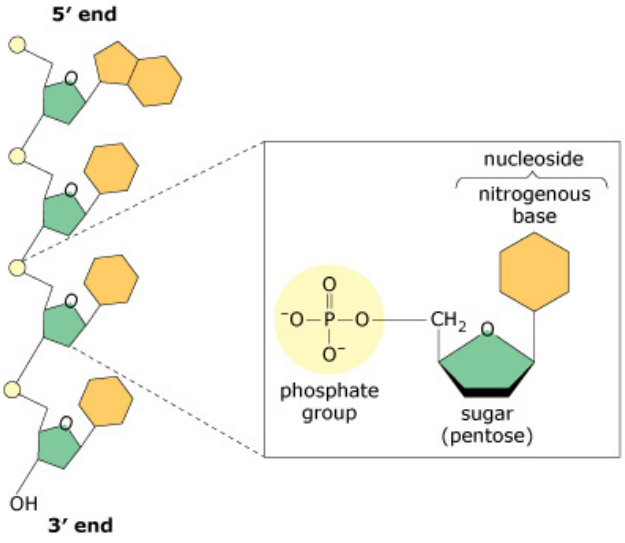
Does RNA polymerase move in a set direction along a strand of DNA during transcription?

ANSWER:

- (•) Yes, the RNA polymerase moves in a direction that reads the bases of the DNA sequence from the 3' end toward the 5' end.
- ( ) No; the RNA polymerase can move in either direction along the DNA strand because the same sequence of bases in the RNA will be produced regardless of direction.
- ( ) Yes, the RNA polymerase moves in a direction that reads the bases of the DNA sequence from the 5' end toward the 3' end.

Hint 4. The 3' and 5' ends of DNA and RNA

DNA and RNA molecules are very similar in structure. Both nucleic acids have a backbone composed of sugar molecules (deoxyribose in DNA; ribose in RNA) alternating with phosphate groups. A single base is attached to each sugar. The 3' end of each molecule has an exposed hydroxyl group (-OH) from the sugar; the 5' end has a phosphate group.



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ANSWER:

UGAGCC

Correct

There are three principles to keep in mind when predicting the sequence of the mRNA produced by transcription of a particular DNA sequence.

1. The RNA polymerase reads the sequence of DNA bases from only one of the two strands of DNA: the template strand.
2. The RNA polymerase reads the code from the template strand in the 3' to 5' direction and thus produces the mRNA strand in the 5' to 3' direction.
3. In RNA, the base uracil (U) replaces the DNA base thymine (T). Thus the base-pairing rules in transcription are A→U, T→A, C→G, and G→C, where the first base is the coding base in the template strand of the DNA and the second base is the base that is added to the growing mRNA strand.

Part B - The template strand

During transcription in eukaryotes, a type of RNA polymerase called RNA polymerase II moves along the template strand of the DNA in the 3'→5' direction. However, for any given gene, either strand of the double-stranded DNA may function as the template strand.

For any given gene, what *ultimately* determines which DNA strand serves as the template strand?

Hint 1. The role of the promoter in transcription

In eukaryotes, transcription is initiated at the point where the RNA polymerase II binds to the DNA. The specific DNA sequence to which the RNA polymerase II binds is called the promoter. A number of other DNA-binding proteins (transcription factors) are required for the RNA polymerase II to bind to the promoter.

Hint 2. What is the role of transcription factors in transcription?

In eukaryotes, the initiation and regulation of transcription involve DNA-binding proteins called transcription factors.

Which of the following statements correctly describe the role of transcription factors in the initiation of transcription? Select all that apply.

ANSWER:

- [x] Some transcription factors must bind to the promoter before RNA polymerase II can bind.
- [x] Some transcription factors bind to both strands of the DNA, whereas others bind specifically to either the template or coding strand.
- [x] Binding of a transcription factor to DNA requires a specific sequence of bases in the DNA binding region.
- [ ] Binding of transcription factors to the DNA causes the DNA to unwind, exposing the template strand to RNA polymerase II.

Hint 3. Comparing DNA polymerases and RNA polymerases, and their need for RNA primers

Both DNA polymerases and RNA polymerases create new strands of nucleotides that are complementary to one strand of a DNA molecule. However, DNA polymerases and RNA polymerases differ in some important ways.

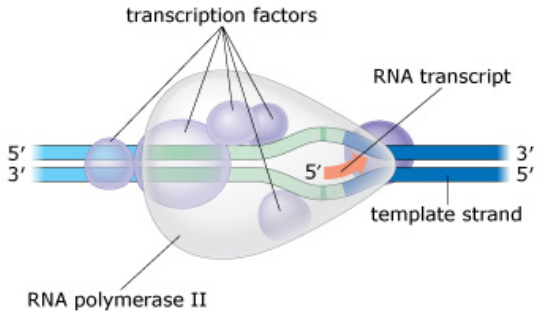
- DNA polymerases create a new strand of DNA (during DNA replication), while RNA polymerases create a new strand of RNA (during transcription).
- DNA polymerases cannot initiate a new strand of DNA on their own; instead they require the presence of an RNA primer (a short sequence of RNA nucleotides), which is added by a separate primase enzyme. RNA polymerases, in contrast, do not need a primer to initiate a new strand of RNA.

ANSWER:

- ( ) the location along the chromosome where the double-stranded DNA unwinds
- ( ) which of the two strands of DNA carries the RNA primer
- (•) the base sequence of the gene's promoter
- ( ) the location of specific proteins (transcription factors) that bind to the DNA

Correct

In eukaryotes, binding of RNA polymerase II to DNA involves several other proteins known as transcription factors. Many of these transcription factors bind to the DNA in the promoter region (shown below in green), located at the 3' end of the sequence on the template strand. Although some transcription factors bind to both strands of the DNA, others bind specifically to only one of the strands.
Transcription factors do not bind randomly to the DNA. Information about where each transcription factor binds originates in the base sequence to which each transcription factor binds. The positioning of the transcription factors in the promoter region determines how the RNA polymerase II binds to the DNA and in which direction transcription will occur.



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Part C - RNA processing

After transcription begins, several steps must be completed before the fully processed mRNA is ready to be used as a template for protein synthesis on the ribosomes.

Which *three* statements correctly describe the processing that takes place before a mature mRNA exits the nucleus?

Hint 1. What happens during RNA splicing?

Transcription of a typical eukaryotic gene initially produces a pre-mRNA molecule that contains more than 25,000 nucleotides. In contrast, the final mRNA for the same gene contains only about 1,200 nucleotides. Production of the final mRNA that is used in translation involves removing these "extra" nucleotides.

Drag the terms on the left to the appropriate blanks on the right to complete the sentences. Not all terms will be used.

ANSWER:

Reset Help

ribosomes

1. Regions of the RNA transcript that contain non-coding bases are called **introns** . These regions are not present in the mRNA that leaves the nucleus.

2. In a process called **splicing** , non-coding regions of the RNA transcript are removed.

3. Molecular complexes called **spliceosomes** carry out RNA splicing in the nucleus.

4. The completed mRNA contains the gene's **exons** joined together in the correct order.

ANSWER:

- [x] A poly-A tail (50-250 adenine nucleotides) is added to the 3' end of the pre-mRNA.
- [x] Noncoding sequences called introns are spliced out by molecular complexes called spliceosomes.
- [ ] Coding sequences called exons are spliced out by ribosomes.
- [x] A cap consisting of a modified guanine nucleotide is added to the 5' end of the pre-mRNA.
- [ ] A translation stop codon is added at the 3' end of the pre-mRNA.

Correct

Once RNA polymerase II is bound to the promoter region of a gene, transcription of the template strand begins. As transcription proceeds, three key steps occur on the RNA transcript:

- Early in transcription, when the growing transcript is about 20 to 40 nucleotides long, a modified guanine nucleotide is added to the 5' end of the transcript, creating a 5' cap.
- Introns are spliced out of the RNA transcript by spliceosomes, and the exons are joined together, producing a continuous coding region.
- A poly-A tail (between 50 and 250 adenine nucleotides) is added to the 3' end of the RNA transcript.

Only after all these steps have taken place is the mRNA complete and capable of exiting the nucleus. Once in the cytoplasm, the mRNA can participate in translation.

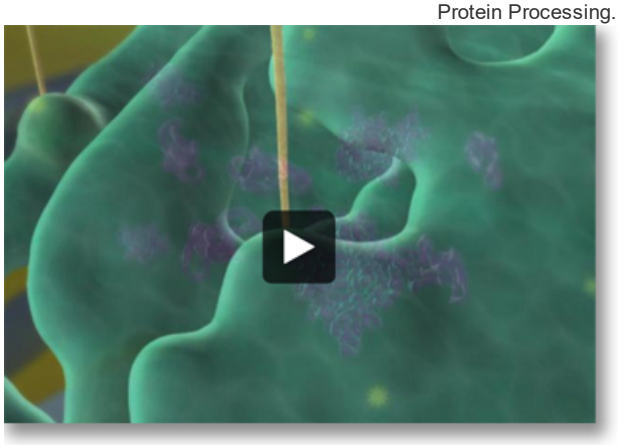
Protein Synthesis (3 of 3): Translation and Protein Targeting Pathways (BioFlix tutorial)

Translation is the mRNA-directed synthesis of polypeptides. In translation, the information encoded in a sequence of RNA nucleotides is converted into a sequence of amino acids according to the genetic code. Translation also includes the first stage of targeting proteins to their eventual cellular location.

Before beginning this tutorial, watch the Translation and Protein Processing animations. You may refer back to these animations at any time during the tutorial.

Translation.

Protein Processing.



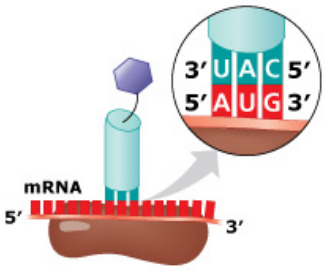
Part A - tRNA interactions with mRNA and the ribosome

Ribosomes provide the scaffolding on which tRNAs interact with mRNA during translation of an mRNA sequence to a chain of amino acids. A ribosome has three binding sites, each of which has a distinct function in the tRNA-mRNA interactions.

Drag the appropriate tRNAs to the binding sites on the ribosome to show the configuration *immediately before* a new peptide bond forms. Note that one of the binding sites should be left empty.

Hint 1. Binding of tRNAs to mRNA

The binding of each tRNA to the mRNA-ribosome complex is dictated by complementary base pairing between the codon of the mRNA and the anticodon of the tRNA. Each codon and anticodon consists of three nucleotides. Recall that in RNA the complementary base pairs are A -- U and G -- C; thus for the mRNA codon illustrated here (AUG), the complementary anticodon of the tRNA is UAC.



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Hint 2. What are the functions of the three tRNA binding sites on a ribosome?

Each of the three tRNA binding sites on a ribosome serves a specific function in translation.

Drag the terms on the left to the appropriate blanks on the right to complete the sentences.

ANSWER:

Reset Help

1. The **E site** is empty except immediately after the mRNA and bound tRNA translocate, or move through the ribosome.

2. The **A site** is the location in the ribosome where codon recognition occurs.

3. After formation of the new peptide bond, the **P site** holds a tRNA that is no longer linked to an amino acid.

Hint 3. Just before peptide bond formation, which sites contain tRNAs carrying amino acids?

Which of the following statements correctly describe the configuration of the tRNA binding sites *immediately before* the formation of a new peptide bond? Select all that apply.

ANSWER:

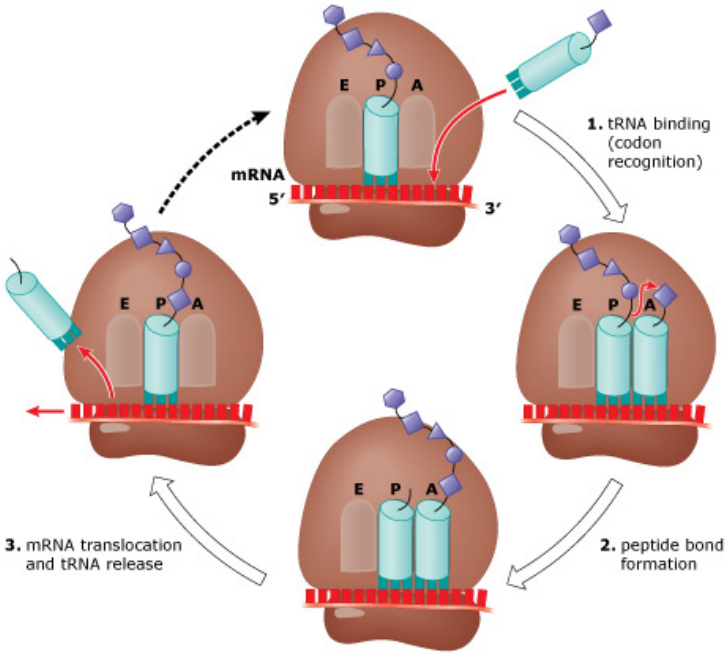
- [x] The E site has no tRNA (either with or without an attached animo acid).
- [ ] The A site has a tRNA with no attached amino acids.
- [x] The P site has a tRNA with an attached chain of amino acids.
- [x] At least two sites have tRNAs with one or more attached amino acids.

ANSWER:

Correct

During translation, new amino acids are added one at a time to the growing polypeptide chain. The addition of each new amino acid involves three steps:

1. **Binding of the charged tRNA to the A site.** This step requires correct base-pairing between the codon on the mRNA and the anticodon on the tRNA.
2. **Formation of the new peptide bond**. In the process, the polypeptide chain is transferred from the tRNA in the P site to the amino acid on the tRNA in the A site.
3. **Movement of the mRNA through the ribosome.** In this step, the discharged tRNA shifts to the E site (where it is released) and the tRNA carrying the growing polypeptide shifts to the P site.



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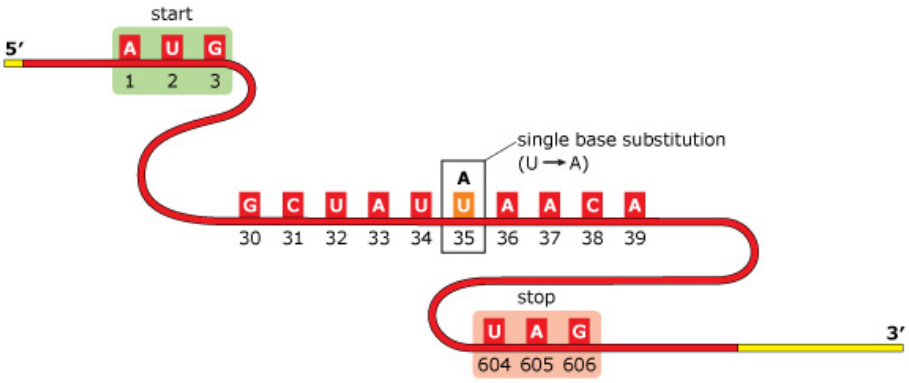
Part B - Predicting the effect of a point mutation

The diagram below shows an mRNA molecule that encodes a protein with 202 amino acids. The start and stop codons are highlighted, and a portion of the nucleotide sequence in the early part of the molecule is shown in detail. At position 35, a single base-pair substitution in the DNA has changed what would have been a uracil (U) in the mRNA to an adenine (A).



	U		C		A		G	
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
	UUC		UCC		UAC		UGC	
	UUA	Leu	UCA		UAA	Stop	UGA	Stop
	UUG		UCG		UAG	Stop	UGG	Trp
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
	CUC		CCC		CAC		CGC	
	CUA		CCA		CAA	Gln	CGA	
	CUG		CCG		CAG		CGG	
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
	AUC		ACC		AAC		AGC	
	AUA		ACA		AAA	Lys	AGA	Arg
	AUG	Met or start	ACG		AAG		AGG	
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
	GUC		GCC		GAC		GGC	
	GUA		GCA		GAA	Glu	GGA	
	GUG		GCG		GAG		GGG	

Based on the genetic code chart above, which of the following would be the result of this single base-pair substitution?

Hint 1. Identifying the codons in an mRNA sequence

The genetic code, which converts a sequence of bases in mRNA to the sequence of amino acids in a protein, is written in codons, each consisting of three bases. These codons are read sequentially beginning at the start codon (AUG), which establishes the proper “reading frame,” or sets of three bases. The codons do not overlap, and there are no unused bases between the codons.

Hint 2. What is a frameshift mutation?

Frameshift mutations alter the reading frame of the genetic message encoded in the mRNA and typically have disastrous effects on the resulting protein.

Which of the following mutations would result in a frameshift mutation? Select all that apply.

ANSWER:

- [x] deletion of two sequential nucleotides in the coding region of the gene
- [x] insertion of a single nucleotide in the coding region of a gene
- [ ] substitution of a single nucleotide in the coding region of a gene
- [ ] insertion of a single nucleotide in the 5' UTR (untranslated region) of the gene
- [ ] deletion of three sequential nucleotides in the coding region of a gene

Hint 3. What are nonsense, missense, and silent mutations?

Nonsense, missense, and silent mutations can all be caused by a single base-pair substitution in the coding region of a gene.

Drag the terms on the left to the appropriate blanks on the right to complete the sentences.

ANSWER:

Reset Help

1. A **nonsense** mutation occurs when a single base-pair substitution results in the formation of a stop codon and early termination of translation.

2. The substitution of one base-pair for another can cause a **missense** mutation that results in a single amino acid change in the protein.

3. A substitution in the third base of a codon that does not change the amino acid specified is called a **silent** mutation.

ANSWER:

- a nonsense mutation resulting in early termination of translation
- a frameshift mutation causing a single amino acid change in the protein
- a missense mutation causing a single amino acid change in the protein
- a frameshift mutation causing extensive change in the amino acid sequence of the protein
- a silent mutation (no change in the amino acid sequence of the protein)

Correct

The effect of a single base substitution depends on the new codon formed by the substitution. To identify the new codon, it is first necessary to determine the reading frame for the amino acid sequence. The first codon starts with base 1, the second codon with base 4, the third with base 7, and so on.
In this problem, the codon that contains the single base substitution begins with base 34. The original codon (UUA, which encodes the amino acid leucine) is converted by the single base substitution to UAA, which is a stop codon. This will cause premature termination of translation, also called a nonsense mutation.

Part C - Protein targeting pathways

The DNA in a cell's nucleus encodes proteins that are eventually targeted to every membrane and compartment in the cell, as well as proteins that are targeted for secretion from the cell. For example, consider these two proteins:

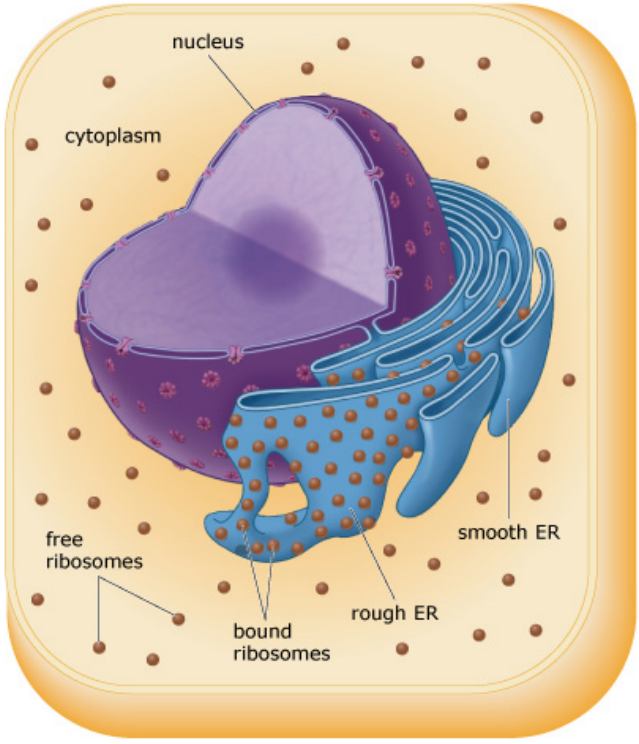
- Phosphofructokinase (PFK) is an enzyme that functions in the cytoplasm during glycolysis.
- Insulin, a protein that regulates blood sugar levels, is secreted from specialized pancreatic cells.

Assume that you can track the cellular locations of these two proteins from the time that translation is complete until the proteins reach their final destinations.

For each protein, identify its targeting pathway: the sequence of cellular locations in which the protein is found from when translation is complete until it reaches its final (functional) destination. (Note that if an organelle is listed in a pathway, the location implied is inside the organelle, not in the membrane that surrounds the organelle.)

Hint 1. Comparison of free and bound ribosomes

Eukaryotic cells contain two classes of ribosomes: those that float free in the cytoplasm and those that are bound on the cytoplasmic side of the rough ER. The ribosomes in these two classes are structurally identical. The only difference is that free ribosomes target the proteins they translate to the cytoplasm, whereas ribosomes bound to the rough ER target their proteins to the endomembrane system or to the exterior of the cell.



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Hint 2. How do proteins that will function in a cell's endomembrane system and proteins that are secreted from the cell compare?

Proteins that are secreted from the cell and proteins that function in compartments of the endomembrane system (such as lysosomes or vacuoles) share some common features in their synthesis and/or targeting to their final destinations.

Which of the following statements are true about these two types of proteins? Select all that apply.

ANSWER:

- [x] Both types of proteins are translated on ribosomes that are bound to the ER.
- [ ] The Golgi apparatus modifies and sorts proteins to be delivered to the endomembrane system, but does not modify and sort proteins to be secreted from the cell.
- [x] Proteins to be secreted are released from the cell when the vesicles containing them fuse with the plasma membrane.
- [x] Transport between the membranes and compartments of the endomembrane system, including the plasma membrane, is via small vesicles that bud from one compartment and fuse with the next.

Hint 3. What is the eventual (final) cellular location of proteins translated on free ribosomes?

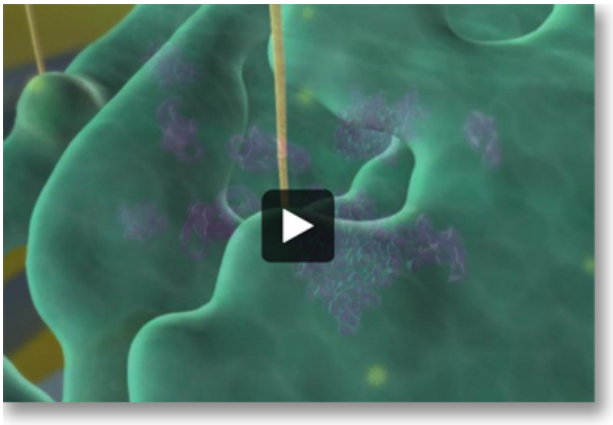
Proteins may either be translated on free ribosomes or on ribosomes bound to the ER.

What is the cellular destination of the majority of proteins that are translated on free ribosomes?

ANSWER:

- ( ) any membrane of the endomembrane system
- ( ) outside the cell (secreted)
- ( ) any compartment of the endomembrane system
- (•) the cytoplasm
- ( ) anywhere in the cell

Hint 4. Review the animation showing the translation and secretion of insulin



ANSWER:

Correct

There are two general targeting pathways for nuclear-encoded proteins in eukaryotic cells.

- Proteins that will ultimately function in the cytoplasm (PFK, for example) are translated on free cytoplasmic ribosomes and released directly into the cytoplasm.
- Proteins that are destined for the membranes or compartments of the endomembrane system, as well as proteins that will be secreted from the cell (insulin, for example), are translated on ribosomes that are bound to the rough ER.

For proteins translated on rough ER, the proteins are found in one of two places at the end of translation. If a protein is targeted to a membrane of the endomembrane system, it will be in the ER membrane. If a protein is targeted to the interior of an organelle in the endomembrane system or to the exterior of the cell, it will be in the lumen of the rough ER. From the rough ER (membrane or lumen), these non-cytoplasmic proteins move to the Golgi apparatus for processing and sorting before being sent to their final destinations.

AP Exam Prep Question 33

Part A

	SECOND BASE				
	U	C	A	G	

FIRST mRNA BASE						THIRD mRNA BASE
U	UUU, UUC — Phe UUA, UUG — Leu	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr UAA, UAG — Stop	UGU, UGC — Cys UGA — Stop UGG — Trp	U C A G	
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His CAA, CAG — Gln	CGU, CGC, CGA, CGG — Arg	U C A G	
A	AUU, AUC, AUA — Ile AUG — Met or Start	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn AAA, AAG — Lys	AGU, AGC — Ser AGA, AGG — Arg	U C A G	
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp GAA, GAG — Glu	GGU, GGC, GGA, GGG — Gly	U C A G	

The template strand of a gene contains this sequence: 3'-TAC TAG GCT AGT TGA-5'. A mutation occurs that changes the gene sequence to 3'-TAC TAG ACT AGT TGA-5'. How does this mutation affect the resulting amino acid sequence?

ANSWER:

- The mutation changes a single amino acid to another amino acid.
- The mutation eliminates the stop codon in the third triplet.
- The mutation does not affect the amino acid sequence.
- (●) The mutation introduces a stop codon.

Correct

Misconception Question 81

Part A

Which of the following molecules are produced by transcription?

Select all that apply.

ANSWER:

- ☐ Ribosomal proteins
- ☑ Messenger RNA
- ☑ Ribozymes

Correct

Messenger RNA and ribozymes are both produced by transcription. Read about transcription and ribozymes.

Misconception Question 82

Part A

Which of the following molecules is/are produced by translation? Include molecules that are subject to further modification after initial synthesis.

Select all that apply.

ANSWER:

- [x] RNA polymerase
- [x] Aminoacyl-tRNA synthetase
- [ ] The amino acid glycine

Correct

RNA polymerase and aminoacyl-tRNA synthetase, like other proteins, are produced by translation of mRNA, when amino acids such as glycine are linked to form polypeptides. Read about translation.

Misconception Question 83

Part A

Which of the following mutations would likely be most dangerous to a cell?

ANSWER:

- (•) Deletion of one nucleotide
- ( ) Substitution of one nucleotide for another
- ( ) Deletion of three nucleotides

Correct

Deletion of one nucleotide would shift the reading frame, altering the coding for all subsequent amino acids. In most cases, this would destroy the function of the protein produced from this gene. Read about the genetic code and point mutations.

Misconception Question 84

Part A

The average length of a transcription unit along a eukaryotic DNA molecule is about 27,000 nucleotide pairs, whereas an averaged-sized protein is about 400 amino acids long. What is the best explanation for this fact?

ANSWER:

- (•) Most eukaryotic genes and their RNA transcripts have long noncoding stretches of nucleotides that are not translated.
- ( ) Many genes are subject to alternative RNA splicing.
- ( ) Each amino acid in a protein is encoded by a triplet of nucleotides.

Correct

Most of these noncoding sequences are interspersed between coding segments of the gene and thus between coding segments of the pre-mRNA. Read about split genes and RNA splicing.

Misconception Question 85

Part A

Which of the following statements about ribozymes is/are correct?

Select all that apply.

ANSWER:

- [x] A ribosome can be regarded as one large ribozyme.
- [x] In some genes, intron RNA functions as a ribozyme and catalyzes its own excision.
- [x] Ribozymes are RNA molecules that function as enzymes.

Correct

Read about ribozymes.

Chapter 17 Question 3

Part A

The anticodon of a particular tRNA molecule is

ANSWER:

- ( ) changeable, depending on the amino acid that attaches to the tRNA.
- ( ) the part of tRNA that bonds to a specific amino acid.
- ( ) complementary to the corresponding triplet in rRNA.
- (•) complementary to the corresponding mRNA codon.
- ( ) catalytic, making the tRNA a ribozyme.

Correct

Chapter 17 Pre-Test Question 10

Part A

Which of these is currently considered the best definition of a gene?

Hint 1.

How has our view of the gene evolved over the past century?

ANSWER:

- (•) A gene codes for either a polypeptide or an RNA molecule.
- ( ) A gene codes for a single enzyme.
- ( ) A gene codes for a single polypeptide.
- ( ) A gene codes for a single protein.
- ( ) A gene codes for a particular ribozyme.

Correct

As our understanding of protein synthesis has expanded, we have seen that one gene may code for several polypeptides. We have also discovered many RNA molecules with diverse but important functions in the cell.

Chapter 17 Pre-Test Question 9

Part A

What does a mutagen cause?

Hint 1.

Consider the meaning of the prefix "muta-."

ANSWER:

- (•) a change in the sequence of DNA
- ( ) problems with mitosis
- ( ) a reduction in the number of tRNA molecules available for protein synthesis
- ( ) decreased permeability of the nuclear envelope
- ( ) decreased enzyme activity throughout the cell

Correct

Mutations are changes in the genetic material of the cell.

Chapter 17 Question 4

Part A

Which of the following is *not* true of RNA processing?

ANSWER:

- ( ) A primary transcript is often much longer than the final RNA molecule that leaves the nucleus.
- ( ) Ribozymes may function in RNA splicing.
- (•) Exons are cut out before mRNA leaves the nucleus.
- ( ) Nucleotides may be added at both ends of the RNA.
- ( ) RNA splicing can be catalyzed by spliceosomes.

Correct

Chapter 17 Question 5

Part A

Which component is *not* directly involved in translation?

ANSWER:

- mRNA
- tRNA
- ribosomes
- GTP
- DNA

Correct

Chapter 17 Question 7

Part A

Which of the following mutations would be *most* likely to have a harmful effect on an organism?

ANSWER:

- a single nucleotide deletion in the middle of an intron
- a deletion of three nucleotides near the middle of a gene
- a nucleotide-pair substitution
- a single nucleotide deletion near the end of the coding sequence
- a single nucleotide insertion downstream of, and close to, the start of the coding sequence

Correct

Activity: The Triplet Nature of the Genetic Code

Click here to view this animation.

Then answer the questions.

Part A

True or false? A codon is a group of three bases that can specify more than one amino acid.

Hint 1.

What is a codon?

ANSWER:

- True
- False

Correct

A codon is a group of three bases that can specify only one amino acid.

Part B

Which of the following statements about mutations is *false*?

Hint 1.

What types of mutation can occur in a gene sequence?

ANSWER:

- A deletion mutation results in the loss of a base in the DNA sequence.
- An addition mutation results in an added base in the DNA sequence.
- Addition and deletion mutations disrupt the primary structure of proteins.
- A knock-out mutation results in a total absence of the mutated protein.

Correct

A knock-out mutation refers to the loss of a protein's function but not necessarily to its complete absence.

Part C

If a DNA sequence is altered from TAGCTGA to TAGTGA, what kind of mutation has occurred?

Hint 1.

Determine how the two sequences differ.

ANSWER:

- Addition.
- None.
- Both addition and deletion.
- Deletion.

Correct

The original sequence has lost the base C.

Part D

Which mutation(s) would not change the remainder of the reading frame of a gene sequence that follows the mutation(s)?

Hint 1.

Think about how the genetic code is organized into "words."

ANSWER:

- One addition mutation.
- One deletion mutation.
- One addition and two deletion mutations.
- One addition and one deletion mutation.

Correct

This combination results in no net change in the number of bases, so the reading frame would eventually be restored.

Part E

If the sequence ATGCATGTCAATTGA were mutated such that a base were inserted after the first G and the third T were deleted, how many amino acids would be changed in the mutant protein?

Hint 1.

Determine the reading frame of the codons in the mutated sequence.

ANSWER:

- Three.
- Two.
- None.
- One.

Correct

The second and third codons in the new sequence are different from the original codons.

Part F

If a mutated DNA sequence produces a protein that differs in one central amino acid from the normal protein, which of the following kinds of mutations could have occurred?

Hint 1.

Think about the effects of different mutations on a codon sequence.

ANSWER:

- A deletion mutation.
- An addition mutation and a deletion mutation.
- None.
- An addition mutation

Correct

If the mutations occur within the same codon, only that codon (amino acid) will be altered.

Types of RNA

Living organisms make and use three main types of ribonucleic acids (RNA) for their biological functions:

- ribosomal RNA (rRNA)
- messenger RNA (mRNA)
- transfer RNA (tRNA)

Part A - Properties of RNA

Sort each description by the type of RNA it describes.

Drag each item to the appropriate bin.

Hint 1. What are the properties of tRNA?

Which of the following statements accurately describe(s) tRNA?

Select all that apply.

ANSWER:

- [x] It is often drawn as a cloverleaf shape.
- [x] It carries amino acids to the ribosome.
- [ ] It contains exons.
- [x] It recognizes the codons in mRNA.

Hint 2. What are the properties of rRNA?

Which of the following statements accurately describe(s) rRNA?

Select all that apply.

ANSWER:

- [x] It is a primary component of ribosomes.
- [x] It is involved in protein synthesis.
- [ ] It contains an anticodon.
- [x] It is the most abundant form of RNA.

Hint 3. What are the properties of mRNA?

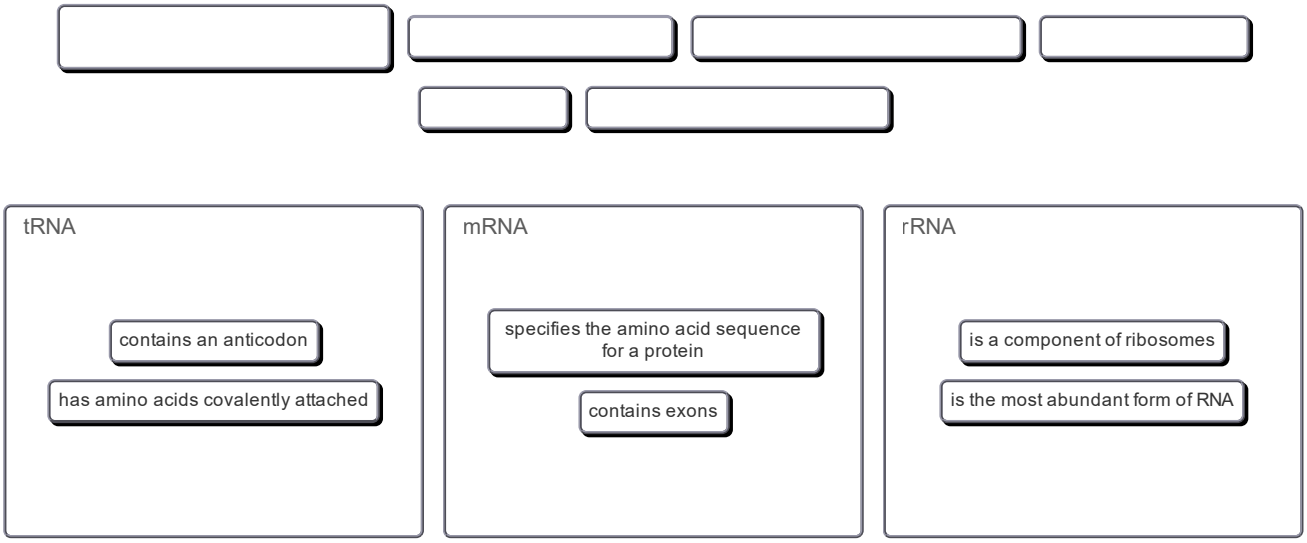
Which of the following statements accurately describe(s) mRNA?

Select all that apply.

ANSWER:

- [x] It carries the genetic information needed to specify a protein.
- [x] It is produced in the nucleus.
- [x] It contains codons.
- [ ] In its activated form, it attaches covalently to amino acids.

ANSWER:



Correct

The cell uses three different types of RNAs to build proteins. rRNA is part of the ribosome, which is the site of protein synthesis. mRNA carries the genetic information from the DNA; the information specifies the sequence of amino acids in the new protein. tRNA interprets the information from the mRNA and brings the appropriate amino acids to the ribosome.

Part B - The role of RNA in the flow of genetic information

Indicate at which step of the replication-transcription-translation process each type of RNA *first* plays a role.

During which step of the replication-transcription-translation process does each type of RNA *first* play a role? Drag each item to the appropriate bin. (Not every bin has to be filled.)

Hint 1. What role does RNA play in replication?

Replication is the process by which an exact copy of a DNA molecule is made. In this process, each DNA strand serves as a template for the synthesis of a new complementary strand.

Which type of RNA is either created during or participates in replication?

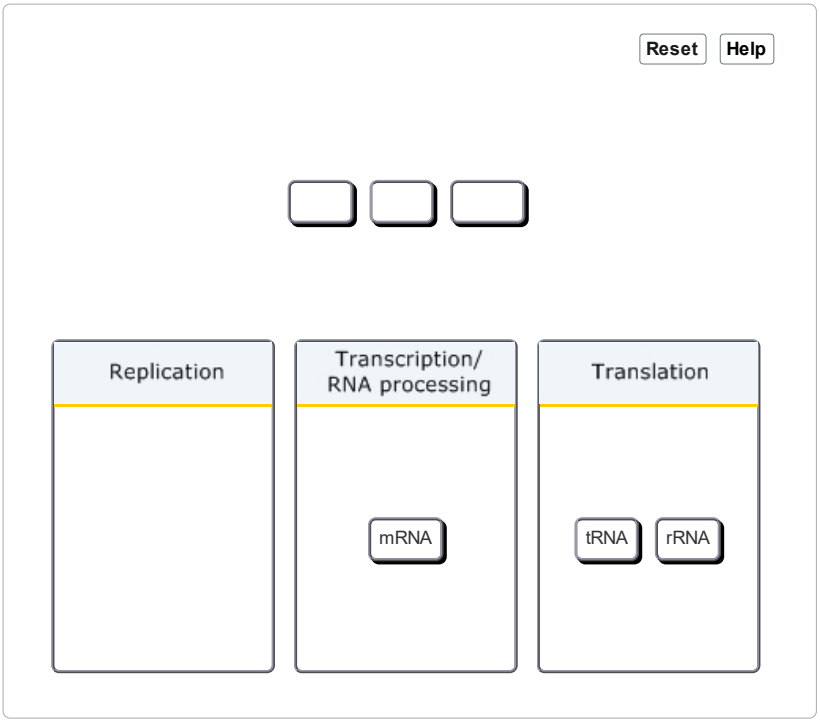
ANSWER:

- tRNA
- rRNA
- mRNA
- Neither tRNA, nor rRNA, nor mRNA is created during or participates in replication.

Hint 2. The role of RNA in translation

Translation is the process by which proteins are produced under the direction of mRNA. In this process, tRNA interprets the genetic information carried by mRNA and transfers the amino acids needed for protein synthesis at the ribosomes. The ribosomes add each amino acid to form a polypeptide chain. rRNA, a major component of ribosomes, carries out catalytic functions during translation.

ANSWER:

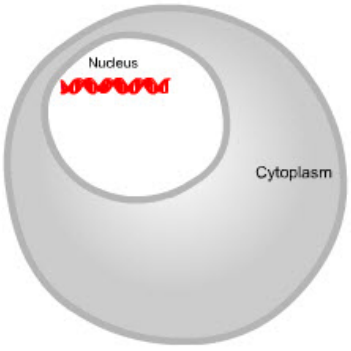


Correct

The understanding that genetic information flows in one direction, from DNA to RNA to protein, became known as the central dogma of biology. The replication-transcription-translation pathway is connected with the DNA→RNA→protein flow of information.

- During replication, a faithful copy of a DNA molecule is made.
- During transcription, the DNA “message” is copied onto a molecule of mRNA.
- During translation, the information carried in the mRNA is transferred to molecules of tRNA to build a protein on the ribosomes.

Activity: Synthesizing Proteins



Click here to view this animation.

Then answer the questions.

Part A

Where does translation take place?

Hint 1.

Consider the processes that occur at each organelle.

ANSWER:

- Ribosome
- Golgi apparatus
- Nucleus
- Endoplasmic reticulum

Correct

Translation, or protein synthesis, occurs at the ribosome.

Part B

Which nucleic acid is translated to make a protein?

Hint 1.

Which nucleic acid serves as the message that is decoded into a series of amino acids to make a protein?

ANSWER:

- DNA
- mRNA
- rRNA
- tRNA

Correct

mRNA is the message that is translated to make a protein.

Part C

Which of the following processes is an example of a post-translational modification?

Hint 1.

Which process occurs after a protein is synthesized on the ribosome?

ANSWER:

- Initiation
- Phosphorylation
- Elongation
- Peptide bond formation

Correct

Enzymes can phosphorylate proteins to alter their activity.

Part D

Which of the following steps occurs last in the initiation phase of translation?

Hint 1.

The initiation phase involves both the recognition of the start codon in the mRNA molecule and the formation of a ribosomal complex.

ANSWER:

- The small subunit of the ribosome binds to the 5' cap on the mRNA.
- An aminoacyl tRNA binds to the start codon.
- A peptide bond is formed between two adjacent amino acids.
- (•) The large ribosomal subunit joins the complex.

Correct

This step occurs after the 5' mRNA is bound by the ribosome and the start codon is bound by an aminoacyl tRNA.

Part E

At which site do new aminoacyl tRNAs enter the ribosome during elongation?

Hint 1.

Think about how tRNAs move through the different positions of the ribosome during elongation.

ANSWER:

- E-site
- (•) A-site
- P-site
- B-site

Correct

This is the site at which new aminoacyl tRNAs that are complementary to the mRNA codon enter the ribosome.

Part F

What is meant by translocation?

Hint 1.

Translocation occurs during the elongation phase of translation.

ANSWER:

- The completed polypeptide is released from the ribosome.
- (•) The ribosome slides one codon down the mRNA.
- The two ribosomal subunits are joined in a complex.
- The polypeptide chain grows by one amino acid.

Correct

Translocation is the process by which the ribosome slides down the mRNA so a new cycle of elongation can begin.

Part G

True or false. A tRNA with an anticodon complementary to the stop codon catalyzes the reaction by which translation is terminated.

Hint 1.

Release factors are involved in translation termination.

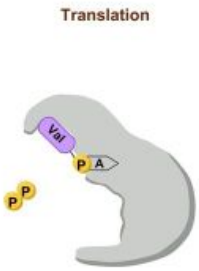
ANSWER:

- True
- False

Correct

There are no tRNAs complementary to the three stop codons; termination occurs when release factors recognize the stop codon in the A-site and catalyze the release of the polypeptide from the tRNA in the P-site.

Activity: Translation

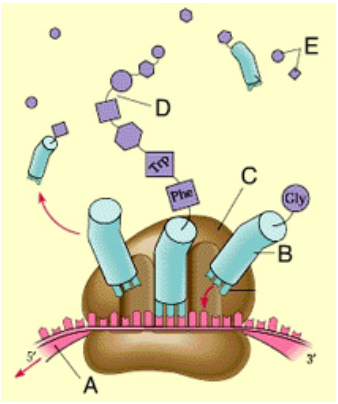


Click here to complete this activity.

Then answer the questions.

Part A

Which of these is a tRNA?



ANSWER:

- A
- B
- C
- D
- E

Correct

This is a tRNA.

Part B

What enzyme catalyzes the attachment of an amino acid to tRNA?

ANSWER:

- aminoacyl-tRNA synthetase
- rubisco
- dextrinase
- argininosuccinate lyase
- nuclease

Correct

This enzyme matches a particular tRNA with a particular amino acid.

Part C

The tRNA anticodon, GAC, is complementary to the mRNA codon with the sequence _____.

ANSWER:

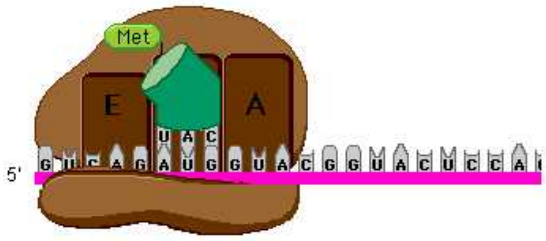
- CAG
- CTG
- GAC
- CUG
- TCG

Correct

In RNA uracil replaces thymine.

Part D

What is the name of the process shown in the diagram?



ANSWER:

- initiation (of transcription)
- RNA processing
- initiation (of translation)
- elongation
- termination (of translation)

Correct

The diagram illustrates the initiation of translation.

Part E

The initiator tRNA attaches at the ribosome's _____ site.

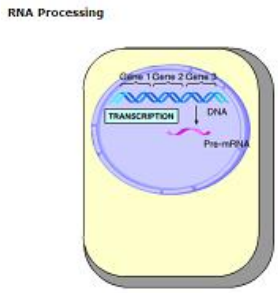
ANSWER:

- A
- translocation
- E
- P
- Q

Correct

The initiator tRNA attaches to the ribosome's P site.

Activity: RNA Processing



Click here to complete this activity.

Then answer the questions.

Part A

During RNA processing a(n) _____ is added to the 5' end of the RNA.

ANSWER:

- 3' untranslated region
- a long string of adenine nucleotides
- 5' untranslated region
- coding segment
- modified guanine nucleotide

Correct

The 5' cap consists of a modified guanine nucleotide.

Part B

During RNA processing a(n) _____ is added to the 3' end of the RNA.

ANSWER:

- 3' untranslated region
- a long string of adenine nucleotides
- 5' untranslated region
- coding segment
- modified guanine nucleotide

Correct

A poly-A tail is added to the 3' end of the RNA.

Part C

Spliceosomes are composed of _____.

ANSWER:

- snRNPs and other proteins
- polymerases and ligases
- introns and exons
- the RNA transcript and protein
- snRNPs and snurps

Correct

These are the component of spliceosomes.

Part D

The RNA segments joined to one another by spliceosomes are _____.

ANSWER:

- caps
- exons
- snRNPs
- tails
- introns

Correct

Exons are expressed regions.

Part E

Translation occurs in the _____.

ANSWER:

- cytoplasm
- lysosome
- nucleus
- Golgi apparatus
- nucleoplasm

Correct

Ribosomes, the sites of translation, are found in the cytoplasm.

Chapter 17 Pre-Test Question 5

Part A

After an RNA molecule is transcribed from a eukaryotic gene, what are removed and what are spliced together to produce an mRNA molecule with a continuous coding sequence?

Hint 1.

This RNA processing does not occur in bacterial cells.

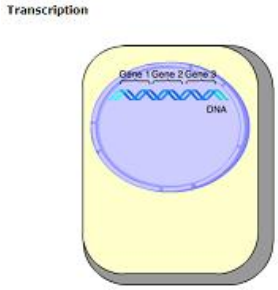
ANSWER:

- introns ... exons
- silencers ... enhancers
- exons ... introns
- operators ... promoters
- promoters ... operators

Correct

Introns, intervening sequences, are removed and the exons, expressed sequences, are spliced together.

Activity: Transcription



Complete this activity. Then answer the questions.

Part A

In the diagram below, the gray unit represents _____.

ANSWER:

- RNA
- DNA
- transcription factors
- RNA polymerase
- the promoter

Correct

RNA polymerase untwists a portion of the DNA double helix.

Part B

In the diagram below, the green unit represents _____.

ANSWER:

- RNA
- DNA
- transcription factors
- RNA polymerase
- the promoter

Correct

The promoter is the region of DNA at which the process of transcription begins.

Part C

In the diagram below, the two blue strands represent _____.

Hint 1.

RNA is not a double helix.

ANSWER:

- RNA
- DNA
- transcription factors
- RNA polymerase
- the promoter

Correct

DNA is a double helix.

Part D

Which of these correctly illustrates the pairing of DNA and RNA nucleotides?

ANSWER:

- GTTACG
  CAATCG
- GTTACG
  CAAUGC
- GTTACG
  GTTACG
- GTTACG
  ACCGTA
- GTTACG
  UAACAU

Correct

In RNA, uracil takes the place of thymine.

Part E

The direction of synthesis of an RNA transcript is _____.

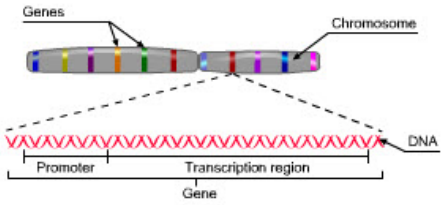
ANSWER:

- 1' —> 5'
- 5' —> 3'
- 1' —> 3'
- 3' —> 5'
- 2' —> 4'

Correct

Nucleotides are added to the 3' end of RNA.

Activity: RNA Synthesis



Click here to view this animation.

Then answer the questions.

Part A

What is the process called that converts the genetic information stored in DNA to an RNA copy?

Hint 1.

Most of these terms describe part of the gene expression process. One describes the process of making two identical copies of DNA from one parental DNA molecule.

ANSWER:

- Translation
- Translocation
- Transcription
- Replication

Correct

DNA is transcribed to give an RNA copy.

Part B

DNA does *not* store the information to synthesize which of the following?

Hint 1.

DNA contains the code to make specific types of products, including copies of itself.

ANSWER:

- Organelles
- DNA
- Messenger RNA
- Proteins

Correct

Synthesis of organelles is not directly coded in the DNA.

Part C

Transcription begins at a promoter. What is a promoter?

Hint 1.

A promoter is an essential part of a gene.

ANSWER:

- A site in DNA that recruits the RNA Polymerase
- A site found on the RNA polymerase
- Part of the RNA molecule itself
- The same as a start codon

Correct

This is the site where the RNA polymerase must bind to initiate transcription.

Part D

Which of the following statements best describes the promoter of a protein-coding gene?

Hint 1.

Transcription of a gene is initiated by its promoter.

ANSWER:

- The promoter is a nontranscribed region of a gene.
- The promoter is a site at which only RNA polymerase will bind.
- The promoter is a site found on RNA polymerase.
- The promoter is part of the RNA molecule itself.

Correct

The promoter is the regulatory region of a protein-coding gene at which RNA polymerase must bind to initiate transcription—it is not transcribed into the RNA.

Part E

What determines which base is to be added to an RNA strand during transcription?

Hint 1.

Consider the purpose of the template.

ANSWER:

- The previous base
- The order of the chemical groups in the backbone of the RNA molecule
- Base pairing between the two DNA strands
- Base pairing between the DNA template strand and the RNA nucleotides

Correct

Transcription involves the formation of an RNA strand that is complementary to the DNA template strand.

Part F

Which of the following terms best describes the relationship between the newly synthesized RNA molecule and the DNA template strand?

Hint 1.

The relationship between the RNA strand and the DNA template strand is similar to that of the two strands of a DNA double helix.

ANSWER:

- Covalently bound
- Permanently base-paired
- Complementary
- Identical

Correct

Because the template strand determines the nucleotides to be added to the RNA strand, using the same complementarity rules of the DNA, they will be complementary to each other.

Part G

What happens to RNA polymerase II after it has completed transcription of a gene?

Hint 1.

In eukaryotes, RNA polymerase II can transcribe any protein-coding gene, depending on the presence of regulatory proteins.

ANSWER:

- It joins with another RNA polymerase to carry out transcription.
- It is free to bind to another promoter and begin transcription.
- It is degraded.
- It begins transcribing the next gene on the chromosome.

Correct

The enzyme is free to transcribe other genes in the cell.

Chapter 17 Pre-Test Question 3

Part A

Where does RNA polymerase begin transcribing a gene into mRNA?

Hint 1.

Remember that RNA polymerase is an enzyme.

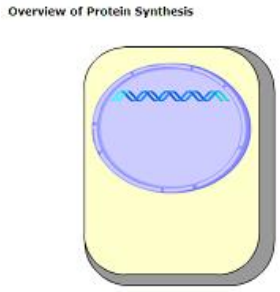
ANSWER:

- It looks for the AUG start codon.
- It starts at one end of the chromosome.
- Transfer RNA acts to translate the message to RNA polymerase.
- It starts after a certain nucleotide sequence called a promoter.
- The ribosome directs it to the correct portion of the DNA molecule.

Correct

In both eukaryotes and prokaryotes, RNA polymerase binds to the gene's promoter and begins transcription at a nucleotide known as the start point, although in eukaryotes the binding of RNA polymerase to the promoter requires transcription factors.

Activity: Overview of Protein Synthesis



Click here to complete this activity.

Then answer the questions.

Part A

What name is given to the process in which a strand of DNA is used as a template for the manufacture of a strand of pre-mRNA?

ANSWER:

- RNA processing
- gene expression
- polypeptide formation
- transcription
- translation

Correct

Transcription is the process by which a DNA template is used for the manufacture of several different types of RNA.

Part B

What name is given to the process in which the information encoded in a strand of mRNA is used to construct a protein?

ANSWER:

- RNA processing
- gene expression
- polypeptide formation
- transcription
- translation

Correct

Translation is the process by which information encoded in RNA is used to manufacture a polypeptide.

Part C

What name is given to the process in which pre-mRNA is edited into mRNA?

ANSWER:

- RNA processing
- gene expression
- polypeptide formation
- transcription
- translation

Correct

RNA processing edits the RNA transcript that has been assembled along a DNA template.

Part D

Polypeptides are assembled from _____.

ANSWER:

- hexoses
- glycerol
- nucleotides
- proteins
- amino acids (selected)

Correct

Proteins are composed of amino acid monomers.

Part E

RNA processing converts the RNA transcript into _____.

ANSWER:

- a protein
- DNA
- a eukaryotic cell
- mRNA (selected)
- a polypeptide

Correct

The editing of the RNA transcript produces mRNA.

Chapter 17 Pre-Test Question 1

Part A

The flow of information in a cell proceeds in what sequence?

Hint 1.

This is known as the central dogma of biology.

ANSWER:

- from protein to RNA to DNA
- from DNA to protein to RNA
- from RNA to DNA to protein
- from DNA to RNA to protein (selected)
- from RNA to protein to DNA

Correct

Chapter 17 Pre-Test Question 2

Part A

A codon consists of _____ bases and specifies which _____ will be inserted into the polypeptide chain.

Hint 1.

What is the essence of the genetic code?

ANSWER:

- two ... nucleotide
- three ... amino acid
- four ... amino acid
- three ... nucleotide
- four ... fatty acid

Correct

Three nucleotide bases make up a codon and specify which amino acid comes next in the sequence.