

The information in DNA is coded in a particular sequence of \_\_\_\_\_ (nucleic acid monomers).

This chapter is about how this sequence is expressed as a specific t \_\_\_\_\_.

Did Gregor Mendel know about genes? \_\_\_\_\_ (Yes / No)

What makes pea stems long? A protein growth hormone named \_\_\_\_\_.

The DNA inherited by an organism leads to specific traits by dictating the synthesis of \_\_\_\_\_.

Francis Crick's Central Dogma was that information flows from \_\_\_\_\_ to \_\_\_\_\_.

*The Study Of Metabolic Defects*

That genes direct cellular metabolism was first suggested by British Physician \_\_\_\_\_ . Among his observations was that urine turned black when exposed to oxygen in persons afflicted with the condition named \_\_\_\_\_ . Do you suffer this condition? \_\_\_\_\_

During a metabolic pathway, each step is regulated by a(n) \_\_\_\_\_.

Beadle and Tatum's work supported the \_\_\_\_\_ hypothesis.

This hypothesis was not suitable because it did not account for the other important roles performed by p \_\_\_\_\_.

Because of this, molecular biologists modified the one gene – one enzyme hypothesis to the \_\_\_\_\_ hypothesis. But because some proteins are composed of several different polypeptides, each coded for by a single gene, the theory assumed a new name, the \_\_\_\_\_ hypothesis. BUT, for simplicity's sake, the book identifies the relationship as one \_\_\_\_\_ : one \_\_\_\_\_. So there.

*Transcription and Translation Are The Two Main Processes In Protein Synthesis*

Do genes build proteins directly?

\_\_\_\_\_ (Yes / No)

Are proteins made of genes?

\_\_\_\_\_ (Yes / No)

Do genes leave the nucleus to make proteins?

\_\_\_\_\_ (Yes / No)

The bridge between genes and protein is \_\_\_\_\_.

The four bases in RNA are:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

The sugar of RNA is \_\_\_\_\_.

Is RNA singly- or doubly-stranded?

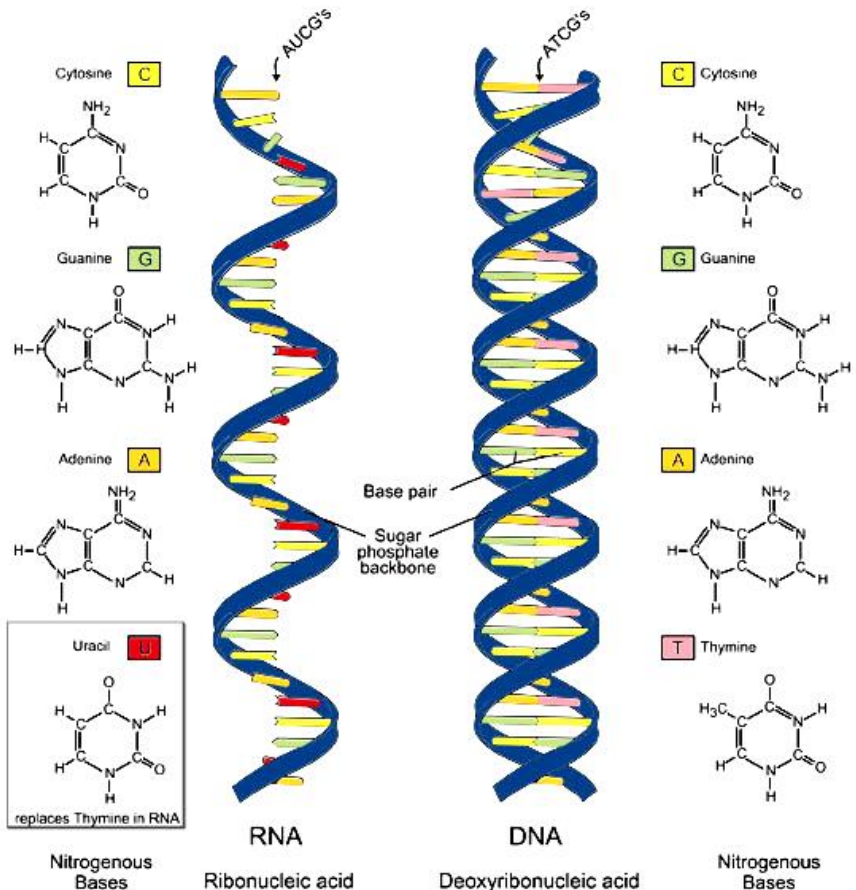
\_\_\_\_\_.

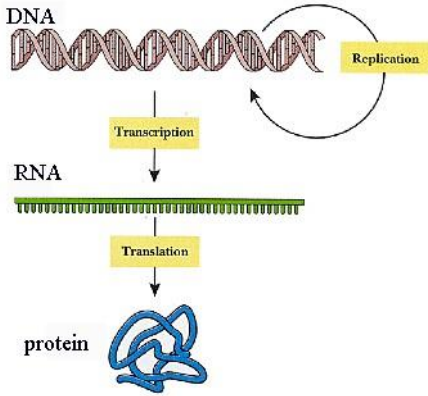
Is RNA's cellular existence *permanent* or *temporary*?

Which is a **larger** molecule, DNA or RNA? \_\_\_\_\_

The process of RNA synthesis is termed t \_\_\_\_\_.

Is RNA assembled in the 3' to 5' direction, or the 5' to 3' direction?

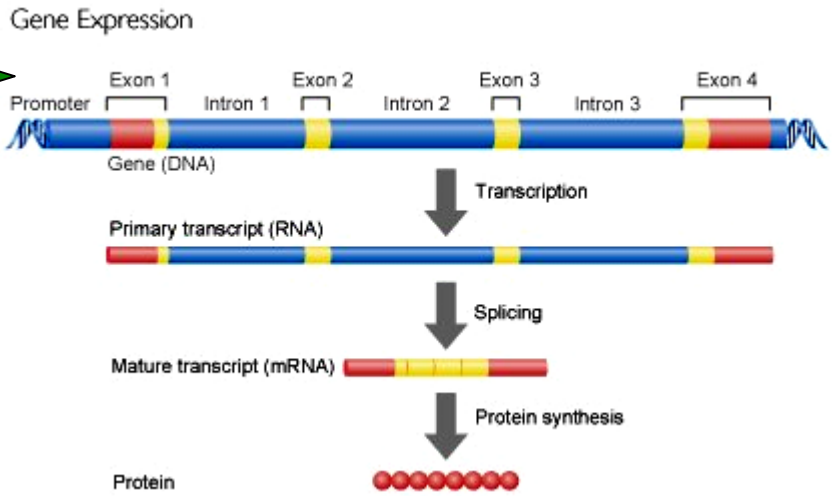




The type of RNA that is made during transcription is \_\_\_\_\_ - RNA.  
 The actual synthesis of the polypeptide in the cytoplasm (upon a ribosome) is titled \_\_\_\_\_.  
 During transcription, the genetic information is transcribed from one n \_\_\_\_\_ a \_\_\_\_\_ to another (DNA to RNA).  
 During translation, the information is translated from the language of n \_\_\_\_\_ a \_\_\_\_\_ to the language of p \_\_\_\_\_! (Thus, the name "translation")  
 Translation occurs upon the organelle called the \_\_\_\_\_.  
 In eukaryotes, the n \_\_\_\_\_ e \_\_\_\_\_ separates transcription from translation in space and time.  
 Transcription occurs within the \_\_\_\_\_.  
 Is transcribed RNA *modified* or *unmodified* before it leaves the safe haven of the nucleus? \_\_\_\_\_

**Gene Expression (View The Diagram)**

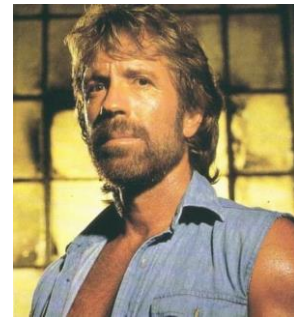
An initial m-RNA transcript is called a \_\_\_\_\_ transcript.  
 The final transcript is called a \_\_\_\_\_ transcript.  
 To make a mature transcript, the \_\_\_\_\_ are removed and the \_\_\_\_\_ are spliced together.  
 The "very beginning" of the transcript is called the \_\_\_\_\_



**In The Genetic Code, Nucleotide *Triplets* Specify Amino Acids**

There are \_\_\_\_\_ (#) different nucleotides in DNA. There are \_\_\_\_\_ (#) different amino acids in nature. In order to make all proteins, there must be a genetic code for each amino acid in order to make all proteins.  
 To illustrate the number of nucleotides that "carry the code" for the placement of one amino acid (remember, you need 20 codes), write out all of the different codes if:  
 Codes consist of one nucleotide: \_ \_ \_ \_ Are there enough? \_\_\_\_\_  
 Codes consist of two nucleotides: \_ \_ \_ \_ \_ \_ \_ \_ Are there enough? \_\_\_\_\_  
 Codes consist of three nucleotides: \_ \_ \_ \_ \_ \_ \_ \_ (You don't really have to do this, I think I've made my point) \_ \_ \_ \_ \_ \_ \_ \_ etc... Are there enough? \_\_\_\_\_

Because the codes consist of three nucleotides, they are called \_\_\_\_\_.  
 Are both sides of DNA transcribed? \_\_\_\_\_  
 This strand is called the t \_\_\_\_\_ s \_\_\_\_\_.  
 The "other side" is not a "loser side" or a "dork side". It is more like a "Chuck Norris" side, preserving and protecting the nucleotide sequence in the template strand.  
 Is the same side of the DNA molecule **always** the template strand? \_\_\_\_\_  
 Is the mRNA molecule that is transcribed *identical* or *complimentary* to the template strand? \_\_\_\_\_  
 During transcription: T pairs with \_\_\_\_, A pairs with \_\_\_\_, C pairs with \_\_\_\_, and G pairs with \_\_\_\_.  
 Three mRNA bases (a triplet) make up a \_\_\_\_\_.



Each codon specifies \_\_\_\_\_ (#) amino acid during polypeptide assembly.  
 If a mature transcript is 450 codons long, how many amino acids are there in the polypeptide? \_\_\_\_\_

*The Dictionary of the Genetic Code*

CGA is the codon for the amino acid \_\_\_\_\_.  
 UGG is the codon for the amino acid \_\_\_\_\_.  
 AAA is the codon for the amino acid \_\_\_\_\_.  
 How many codons are there for leucine? \_\_\_\_\_  
 The three "stop codons" are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.  
 The initiator codon is \_\_\_\_\_.  
 The first amino acid used in all polypeptide assembly is \_\_\_\_\_.  
 How many codons carry codes for specific amino acids? \_\_\_\_\_  
 How many codons do NOT carry codes for specific amino acids? \_\_\_\_\_

Note that in FIGURE 17.4 there is \_\_\_\_\_ but no \_\_\_\_\_.  
 The variability in redundant codons usually arises from the identity of the \_\_\_\_\_ (first / second / third) nucleotide.  
 Do base triplets and codons overlap? \_\_\_\_\_ (Yes / No)

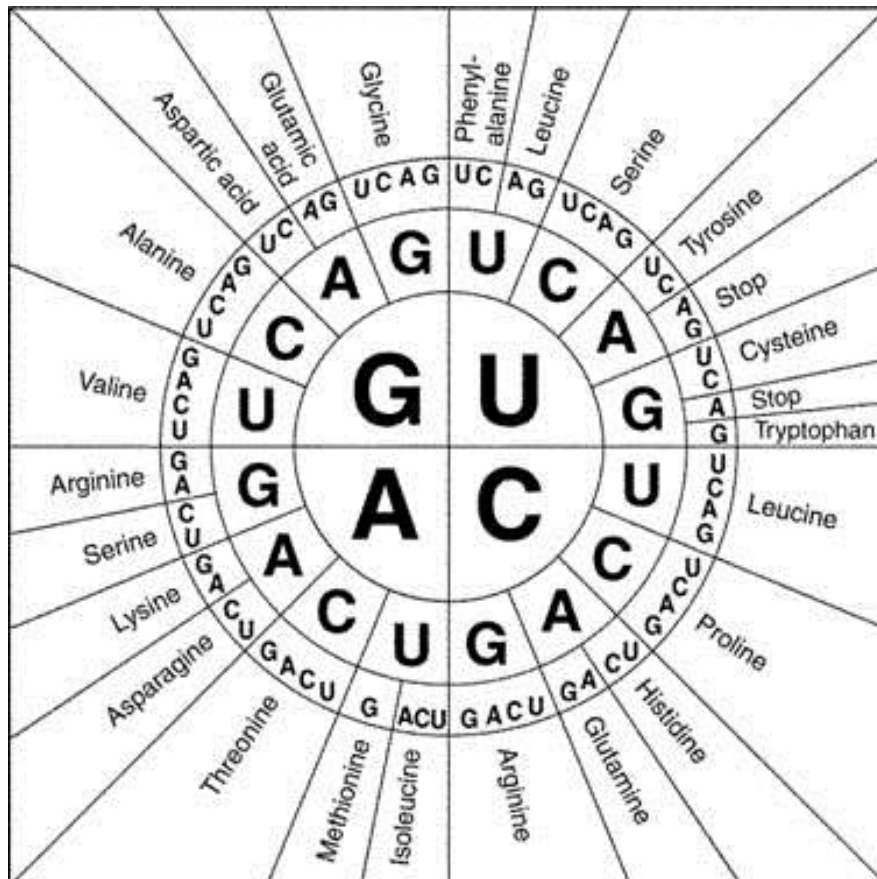
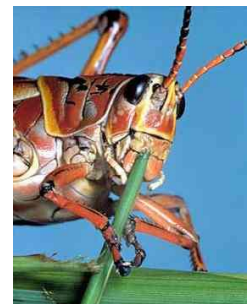
	U	C	A	G
U	UUU } Phe UUC } UUA } Leu UUG }	UCU } Ser UCC } UCA } UCG }	UAU } Tyr UAC } UAA } Stop UAG }	UGU } Cys UGC } UGA } Stop UGG } Trp
C	CUU } Leu CUC } CUA } CUG }	CCU } Pro CCC } CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } Arg CGC } CGA } CGG }
A	AUU } Ile AUC } AUA } AUG } Met	ACU } Thr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

*The Genetic Code Must Have Evolved Very Early In The History Of Life*

Do humans use the same genetic code as skunks? \_\_\_\_\_ as sea lamprey? \_\_\_\_\_ as black widow spiders? \_\_\_\_\_  
 as slugs? \_\_\_\_\_ as slime molds? \_\_\_\_\_ as Paramecia? \_\_\_\_\_  
 as chloroplasts and mitochondria? \_\_\_\_\_ as Chuck Norris? \_\_\_\_\_

This near universality is a reminder to us that all living things are genetically related to one another. I, for instance, share a common genetic ancestry with the sheep dog. Name one of your organism relatives! \_\_\_\_\_

Having a common biochemistry allows animals to \_\_\_\_\_ other living things.





*Transcription: The DNA-directed Synthesis of RNA*

The enzyme that regulates mRNA synthesis is, of course, \_\_\_\_\_.

RNA elongates in the \_\_\_' to \_\_\_' direction.

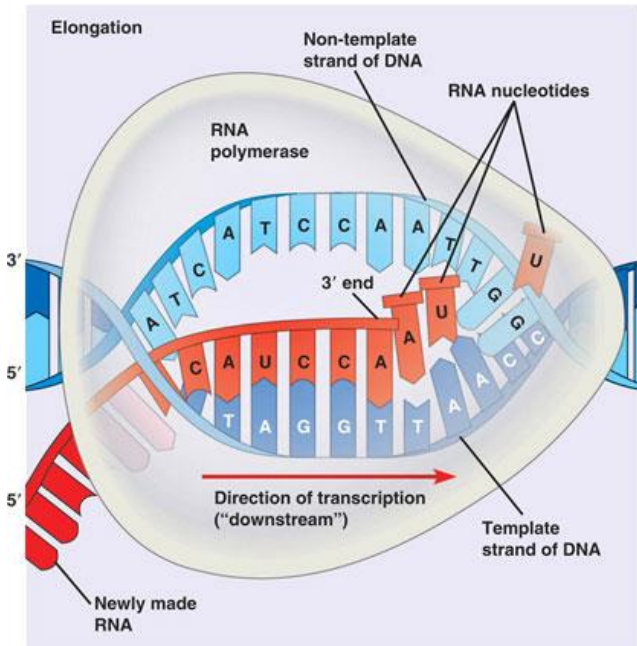
The site of RNA polymerase attachment is called the \_\_\_\_\_.

The nucleotide sequence at the end of the gene, where detachment occurs, is the \_\_\_\_\_.

The three "parts" of transcription are named:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

*Initiation, Elongation, and Termination*



The promoter is usually about \_\_\_\_\_ nucleotides long.

Are **both** sides of a gene used as a template? \_\_\_\_\_ (Yes / No)

In addition to RNA polymerase, a \_\_\_\_\_ is necessary to initiate transcription.

The initial base sequence in the promoter is known as the \_\_\_\_\_ box.

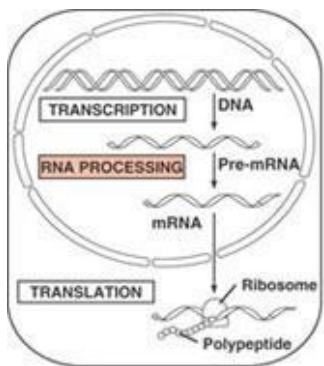
How quickly are DNA nucleotides transcribed?

What happens to the DNA molecule "behind" the advancing transcription complex?

Can a single gene be transcribed by more than one RNA polymerase molecule? \_\_\_\_\_ (Yes / No)

Does prokaryotic DNA transcription stop at the terminator sequence?

Does eukaryotic DNA transcription stop at the terminator sequence?



*Eukaryotic Cells Modify RNA After Transcription*

The newly-transcribed RNA molecule is called \_\_\_-RNA in eukaryotes.

Does modification occur *within* the nucleus or *outside* of the nucleus? \_\_\_\_\_

The 5' cap is a modified form of guanine called \_\_\_\_\_.

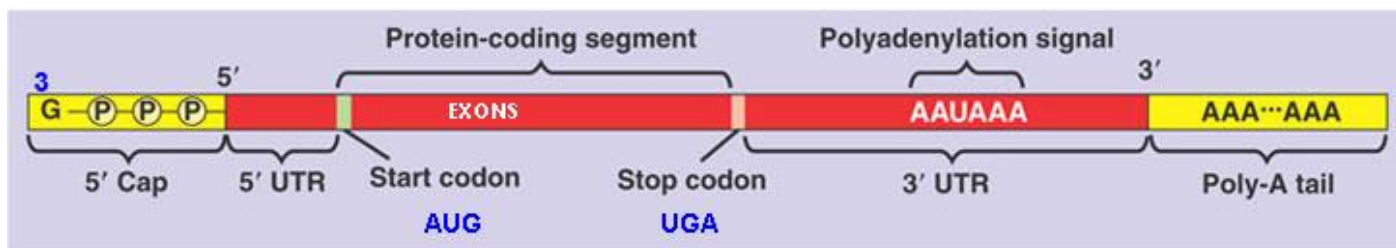
What are the two most important functions performed by the cap?

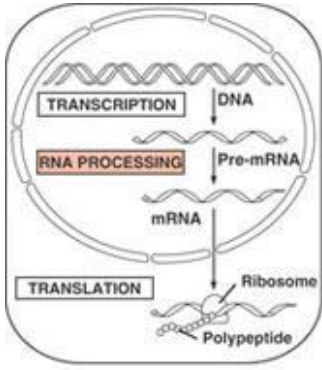
- 1.
- 2.

The tail is modified by adding repetitive \_\_\_\_\_ nucleotides to it.

What are the two most important functions of the poly(A) tail?

- 1.
- 2.





The average pre-mRNA molecule has \_\_\_\_\_ nucleotides, enough to code for a protein with \_\_\_\_\_ amino acids.

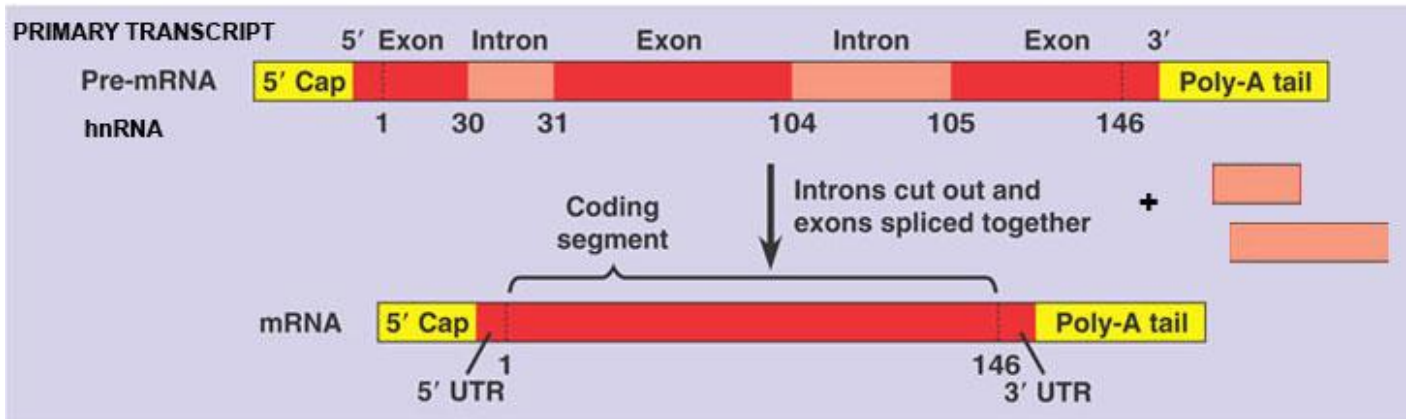
The average protein has \_\_\_\_\_ amino acids, so it requires an average of \_\_\_\_\_ nucleotides in modified RNA.

Is the greater quantity of pre-mRNA *left* or *spliced out*? \_\_\_\_\_

The “spliced out” nucleotide sequences are called \_\_\_\_\_, or \_\_\_\_\_ for short.

The “left in the mRNA molecule” nucleotide sequences are called \_\_\_\_\_ because they are eventually e\_\_\_\_\_.

**DNA is colinearly copied, nucleotide for nucleotide, into primary transcript RNA, & then processed.**



Introns are cut out by ribosome-like aggregations of RNA and proteins called \_\_\_\_\_.

Spliceosomes form when nuclear proteins unit with “\_\_\_\_\_”.

The role and structure of spliceosomes reveals that RNA can transfer genetic information AND function as an e\_\_\_\_\_.

RNA molecules that function as enzymes are named \_\_\_\_\_.

This is a revolutionary concept because it means that not all enzymes are p\_\_\_\_\_ molecules. Some of them are forms of RNA!

Is it true that pre-RNA is spliced in one way, and one way only? \_\_\_\_\_ (Yes / No)

Alternative RNA splicing means that some pre-mRNA molecules can be spliced in different ways, resulting in the ultimate synthesis of several different polypeptides. Does RNA splicing *increase* or *decrease* the number of genes needed by a species? \_\_\_\_\_

Do introns *increase* or *decrease* instances of crossing over? \_\_\_\_\_

Is there a greater chance for crossing over if a gene is **1200** nucleotides long or if a gene is **8000** nucleotides long? \_\_\_\_\_

### Translation – The Synthesis of Protein

At the end of transcription, a molecule of \_\_\_\_\_ is made.

At the end of translation, a molecule called a \_\_\_\_\_ is made.

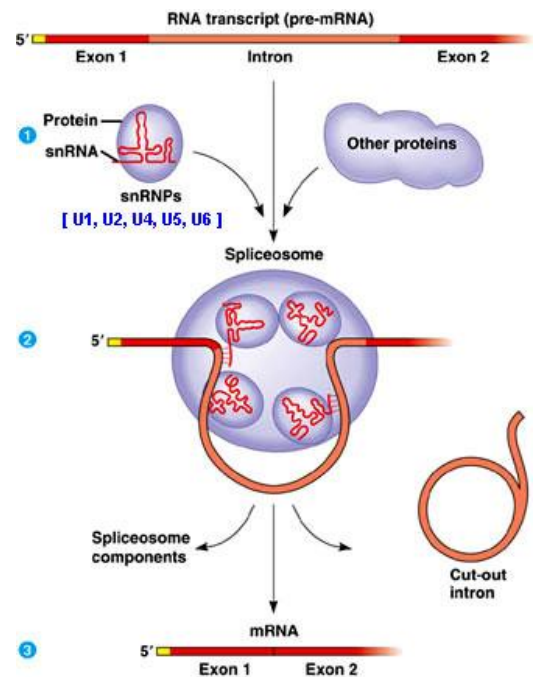
The function of tRNA is to shuttle around the \_\_\_\_\_ that are necessary for polypeptide formation.

How many amino acids are there in nature?

Is there tRNA specificity for amino acid transport? \_\_\_\_\_ (Yes / No)

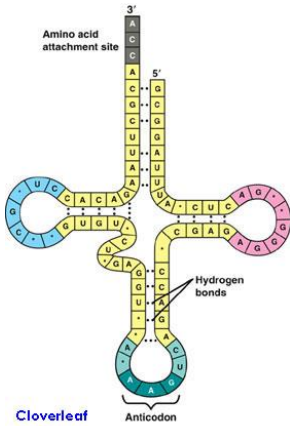
The codon of an mRNA molecule forms a temporary union with the \_\_\_\_\_ of a tRNA molecule.

The mRNA codon CGG would temporarily unite with the anticodon \_\_\_\_\_. What amino acid would the tRNA molecule carry with it? \_\_\_\_\_ (The chart is on page 308)



The Structure and Function of tRNA

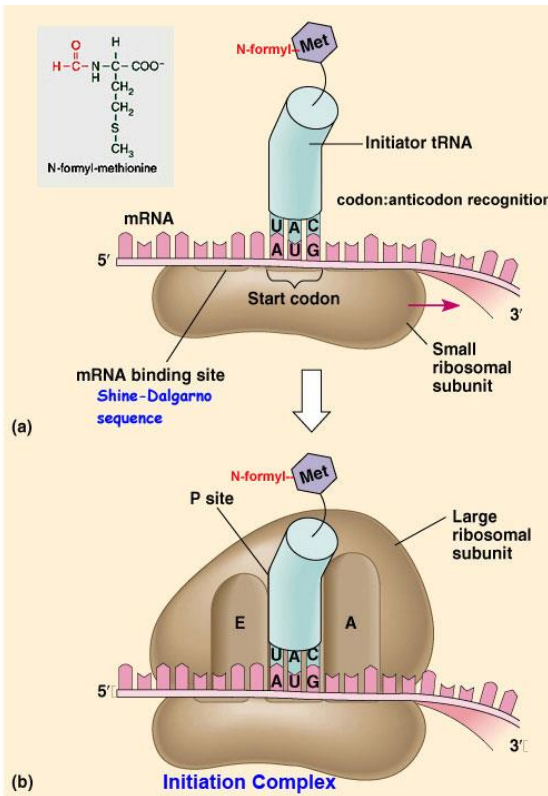
Where does tRNA come from? \_\_\_\_\_  
 Is tRNA used *once* or *over-and-over*? \_\_\_\_\_



The shape of a tRNA molecule is popularly likened to a \_\_\_\_\_.  
 tRNA is usually about \_\_\_\_ (#) nucleotides long.  
 The amino acid is attached to the \_\_\_\_\_ end of the RNA molecule.  
 The actual number of different tRNA molecules is \_\_\_\_\_. This is less than the number that we expect, \_\_\_\_\_. The mRNA-tRNA rules are lightly enforced when it comes to the identity of the 3<sup>rd</sup> codon nucleotide. This relaxation of the rules is given the somewhat unimpressive but entertaining name \_\_\_\_\_.  
 The enzyme that attaches the amino acid to the tRNA molecule must be specific and accurate. Its name is \_\_\_\_\_. You do not have to memorize this name, but you should say it out loud at least once in your life. Please do that now.

Ribosomes

Ribosomes are made of two parts named \_\_\_\_\_.  
 Ribosomes are made of \_\_\_\_\_ and \_\_\_\_\_.  
 The site of ribosome synthesis is the \_\_\_\_\_.  
 Do subunits unite before they exit the nucleoplasm? \_\_\_\_\_  
 Are the ribosomes of prokaryotes and eukaryotes the same? \_\_\_\_\_  
 What is the purple strand entering the ribosome in the drawing to the left? \_\_\_\_\_  
 What is the yellow dotted structure emerging from the ribosome? \_\_\_\_\_  
 What part of the ribosome plays an enzymatic role, the **RNA** or the **protein**? \_\_\_\_\_



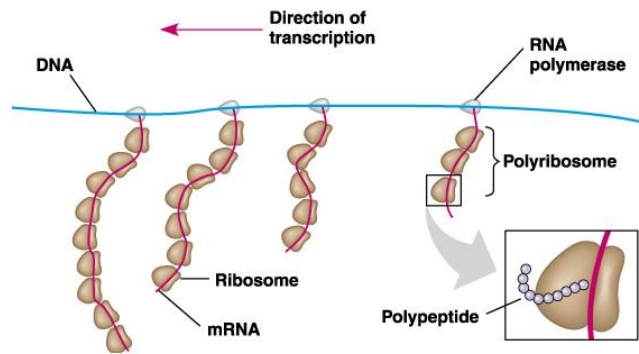
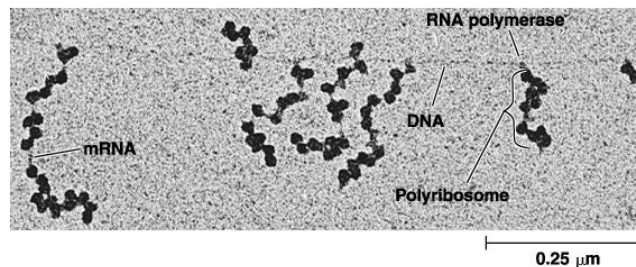
The P site holds the growing \_\_\_\_\_ chain.  
 The A site holds the “next” \_\_\_\_\_ to be attached.  
 The E site releases the tRNA molecule that has just lost its \_\_\_\_\_.

Translation may be viewed by using the following link:  
<http://www.dnai.org/lesson/go/19436>  
 The start codon is always \_\_\_\_\_.  
 The first amino acid in the growing polypeptide chain is always \_\_\_\_\_.



*Building A Polypeptide*

Translation is the synthesis of a \_\_\_\_\_ chain.  
 The energy for translation is provided by the hydrolysis of \_\_\_\_\_!  
 First mRNA binds to the \_\_\_\_\_ subunit at its \_\_\_\_\_' end (because that is where the \_\_\_\_\_ is). Farther downstream is the initiator codon \_\_\_\_\_. (This codon will pair with the tRNA anticodon \_\_\_\_\_ which carries \_\_\_\_\_ at the amino acid attachment site.) The \_\_\_\_\_ subunit joins the small subunit, completing the translation initiation complex. At this point, the initiator tRNA sits atop the \_\_\_\_\_ site while the \_\_\_\_\_ site remains unoccupied, preparing for the arrival of the next \_\_\_\_\_ molecule. The polypeptide begins to elongate as \_\_\_\_\_ are added one at a time to the chain. The bonds holding together the mRNA codon and tRNA anticodon are \_\_\_\_\_ bonds, so they are temporary and easily formed and broken. The bond that forms between adjacent amino acids is called a \_\_\_\_\_ bond. During translocation, the tRNA molecule moves from the A site to the \_\_\_\_\_ site, and finally to the \_\_\_\_\_ site. Elongation continues until a \_\_\_\_\_ codon is encountered in the A site. The three stop codons are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. A protein called a \_\_\_\_\_ binds directly to the stop codon in the A site. The release factor causes the addition of a molecule of \_\_\_\_\_ to the end of the polypeptide chain, hydrolyzing the completed polypeptide and separating it from the complex. The average time taken for polypeptide assembly is just about one \_\_\_\_\_ (if translation occurs singly). However, it is possible for an mRNA molecule to be translated simultaneously by several translation complexes. Such strings of ribosomes adhering to a single mRNA molecule are called \_\_\_\_\_.



The coiling and folding of the newly formed polypeptide occurs \_\_\_\_\_. (*spontaneously / under cellular direction*).

The primary structure of a protein is its \_\_\_\_\_.

The secondary structure of a protein is its \_\_\_\_\_.

The tertiary structure of a protein is its \_\_\_\_\_.

If the cell helps a protein fold, the assisting protein is called a \_\_\_\_\_ protein.

List three ways in which the protein *might* be further altered:

- 1.
- 2.
- 3.



What happens to proteins synthesized on free ribosomes in the cytosol?

What happens to proteins synthesized upon bound ribosomes?

- 1.
- 2.

Is there a structural difference between a “free ribosome” and a “bound ribosome”? \_\_\_\_\_ (Yes / No)

ALL ribosomes begin as \_\_\_\_\_ (free / bound) ribosomes. A ribosome binds to an internal membrane if it has a sequence of 20 ( or so) amino acids called a \_\_\_\_\_.

Is it found at the leading or trailing end of the growing polypeptide? \_\_\_\_\_

The signal peptide is recognized by a protein-RNA complex called a SRP or \_\_\_\_\_ - \_\_\_\_\_.

This complex “drags” the ribosome (and its growing polypeptide) to a receptor protein on the surface of the

R \_\_\_\_\_ E \_\_\_\_\_ R \_\_\_\_\_.

Instead of ending up within the cytosol, the growing protein enters the interior of the ER (called the c \_\_\_\_\_).

The signal peptide (those 20 amino acids) are usually \_\_\_\_\_ (left in / excised from) the polypeptide.

What if the polypeptide is going to turn into a membranous “iceberg”?

Polypeptides are also carried to the:

- 1.
- 2.
- 3.

If this is the case, is translation completed *within the organelle lumen* or *in the cytosol*? \_\_\_\_\_

### RNA: A Review

When I was a child, I thought there were only three types of RNA. It turns out that there are MORE than six. But the “BIG SIX” are shown below in the form of matching. Close your book and see if you can match RNA with function.

- |                             |  |
|-----------------------------|--|
| _____ 1. rRNA               | A. A protein-RNA complex that recognizes a signal peptide and drags the ribosome to an organelle membrane. |
| _____ 2. SRP RNA            | B. Plays an important role in the function of spliceosomes.  |
| _____ 3. mRNA               | C. Carries amino acids to ribosomes for polypeptide synthesis.   |
| _____ 4. snRNA              | D. Carries genetic information from DNA to ribosomes.  |
| _____ 5. Primary Transcript | E. Is a structural and functional part of a ribosome.  |
| _____ 6. tRNA               | F. RNA before introns are removed.   |

Can RNA.....

1. \_\_\_\_\_ Bond with DNA?
2. \_\_\_\_\_ Bind with other RNA molecules?
3. \_\_\_\_\_ Assume a permanent shape as a result of hydrogen bond formation?
4. \_\_\_\_\_ Pass genetic instructions from one organism generation to the next?
5. \_\_\_\_\_ Form, disperse, and reform?