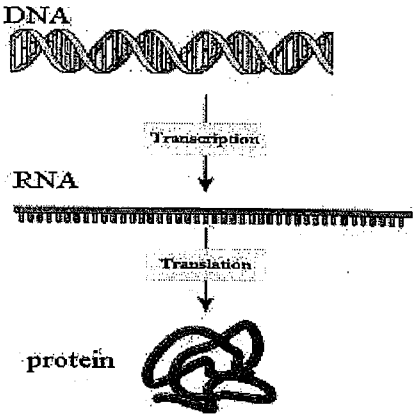
_____ Period _____ Date _____

Protein Synthesis Simulation Lab

. Introduction

.A is a very long, thin molecule located in the nucleus. The DNA in one chromosome has ₁0s of millions of base pairs and hundreds or thousands of genes. Yet an individual cell will only use a small portion of those genes in its lifetime. Imagine a mechanic who spends a lifetime fixing nothing but cars, but he or she is required nonetheless to carry around an entire library of repair manuals for everything from kitchen sinks to washing machines to light fixtures to computers and so on – all information the mechanic will never be able to use because s/he's busy fixing cars.

Another peculiar thing about DNA is that it is located inside the nucleus, and pretty much stays inside the nucleus, yet the proteins that DNA helps to make are produced OUTSIDE of the nucleus. So how does the cell solve this problem? It sends a "messenger" from the nucleus to the ribosomes in the cytoplasm.



In a process called transcription, the DNA code is transcribed (copied) into mRNA, following rules similar to DNA replication we saw earlier (see below). mRNA moves out of the nucleus into the cytoplasm where it links up with ribosomes and begins churning out proteins.

Recall that DNA consists of a sugar-phosphate backbone with a nitrogenous base. There are 4 different bases in DNA abbreviated with the letters A,T,C, & G. The code contained in DNA derives from these 4 bases. We can think of them as letters in an alphabet that will spell different words. In a real language, words can be anywhere from 1 letter long (a, I) to an upper limit of 10-15 letters for functional, non-compound words.

In DNA code, a "word" is always 3 letters long and is called a "codon." Consider the following DNA segment:

A	T	C	G	T	C	C	A	A	A
T	A	G	C	A	G	G	T	T	T

"ATC" is a codon. "GTC" is a codon. "CAA" is a codon. Etc.

In transcription, the DNA code is transcribed (copied) into RNA code, following rules similar to DNA replication we saw earlier EXCEPT that:

DNA RNA
Matches with
A.....U
T.....A
C.....G
G.....C

1. Transcribe the following DNA sequence into mRNA. Draw a line separating each codon:

A T C G T C C A A A....

_____

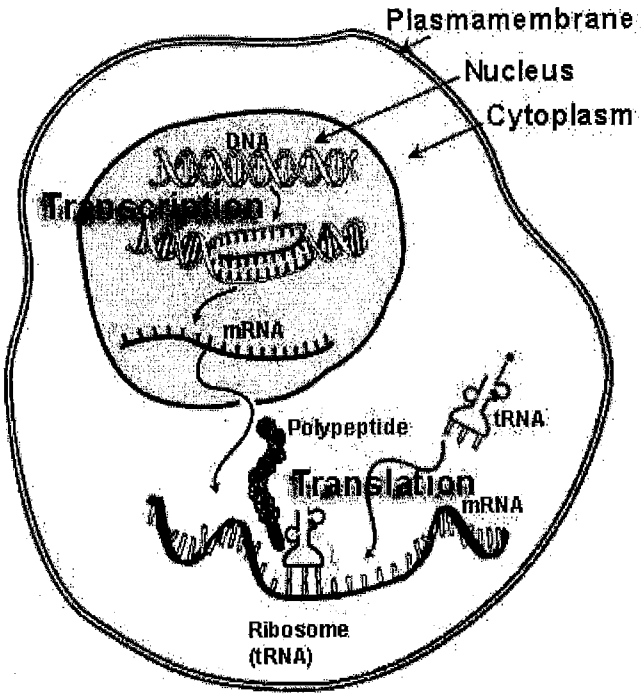
Name _____ Period _____ Date _____

2. Transcribe the following DNA sequence into mRNA. Draw a line separating each codon::

T A G C A G G T T T....

_____

Each mRNA codon corresponds to an amino acid that is transported to the RNA/ribosome complex by another special nucleic acid called tRNA. "T" stands for transfer. The ribosome essentially "reads" the RNA code and facilitates the linking of appropriate amino acids to make proteins. Summary diagram:



DNA (in nucleus) transcribed to mRNA

↓

mRNA leaves nucleus

↓

mRNA to cytoplasm

↓

mRNA hooks up with ribosomes.

↓

Ribosomes scroll through mRNA

↓

tRNA delivers amino acids to mRNA/ribosome complex

↓

Enzymes link amino acids together to form a protein

Activity: There are 4 letters of the mRNA code: U-A-C-G. How many possible combinations are there? In other words, how many "words" can you make with those 4 letters if any combination of letters is possible but all "words" are only 3 letters long? Hint – start with a single letter, how many codons can be produced that start with, for example, the letter "A?" You can infer the rest. I'll get you started…

AAA
AAC
AAU
AAG

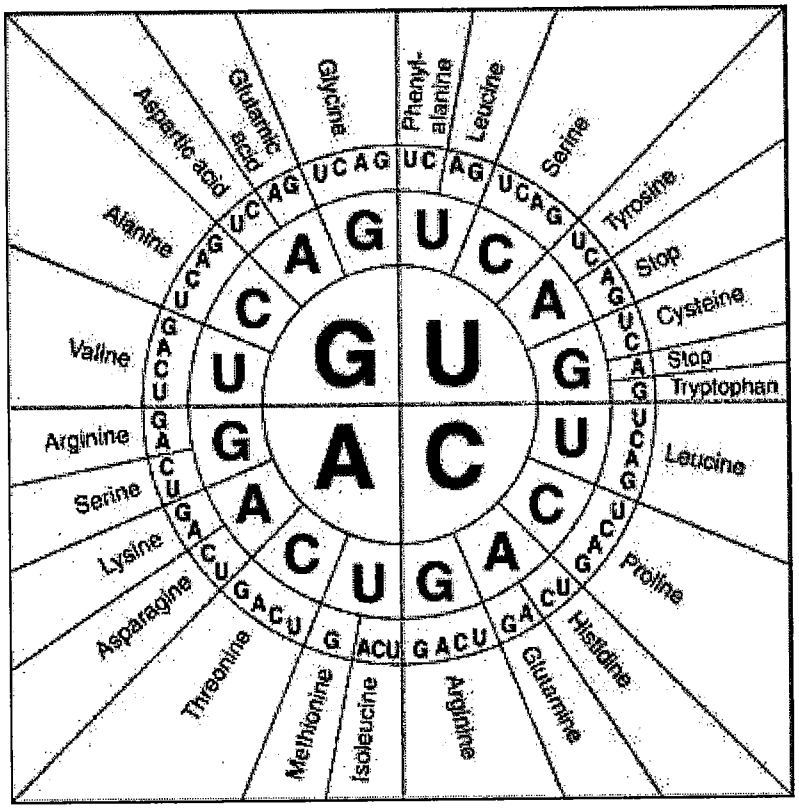
Name _____ Period _____ Date _____

Part 2: Questions

1. At this point, you should have figured out that there are _____ possible codons using 4 letters with 3 letters per codon in any order. However, there are only 20 amino acids, and each codon "codes" for one amino acid – so what does this mean?

_____

The table below shows which amino acid corresponds with which codons.



2. What does UAC code for?

_____

3. CAG? _____

4. AGG? _____

5. GAU? _____

6. UUU? _____

7. List the codons for Valine:

_____

8. Stop? _____

9. Methionine is a "Start" signal. What is its codon?

_____

Each amino acid is matched with one or more 3-letter "words." The **words** are analogous to an amino acid. When the words are put together they make a sentence. The **sentence** is analogous to a protein. So, let's break the following code.

10. Given the following DNA code, how would this segment be transcribed into mRNA?

T A C C C G A T A C T C C C T T C A A T T

_____

11. Give the 3-letter abbreviation (*see p. 4*) for the amino acids coded for in that sequence:

_____

12. What is the silly little sentence that this codes for (*see p. 4*)?

_____

Name _____ Period _____ Date _____

Amino Acid – English word Table

MET START	GLY THE	ALA SAD	VAL RAT	ILE MET
PHE RAN	HIS OLD	TRP FOE	PRO SLY	SER CAT
THR WHO	GLU SAW	CYS MAD	ARG ATE	TYR DOG
ASN AND	GLN HIS	ASP FOR	LEU DAY	LYS BIG
		STOP		

Abbreviation Table

NAME	CODE
Alanine	ALA
Cysteine	CYS
Aspartic Acid	ASP
Glutamic Acid	GLU
Phenylalanine	PHE
Glycine	GLY
Histidine	HIS
Isoleucine	ILE
Lysine	LYS
Leucine	LEU
Methionine	MET
Asparagine	ASN
Proline	PRO
Glutamine	GLN
Arginine	ARG
Serine	SER
Threonine	THR
Valine	VAL
Tryptophan	TRP
Tyrosine	TYR

In the remaining space, create your own messages and, working backwards, determine what the DNA sequence would be:

Your message: _____

Amino acid (3 letter): _____

mRNA sequence: _____

DNA Sequence: _____

Your message: _____

Amino acid (3 letter): _____

mRNA sequence: _____

DNA Sequence: _____