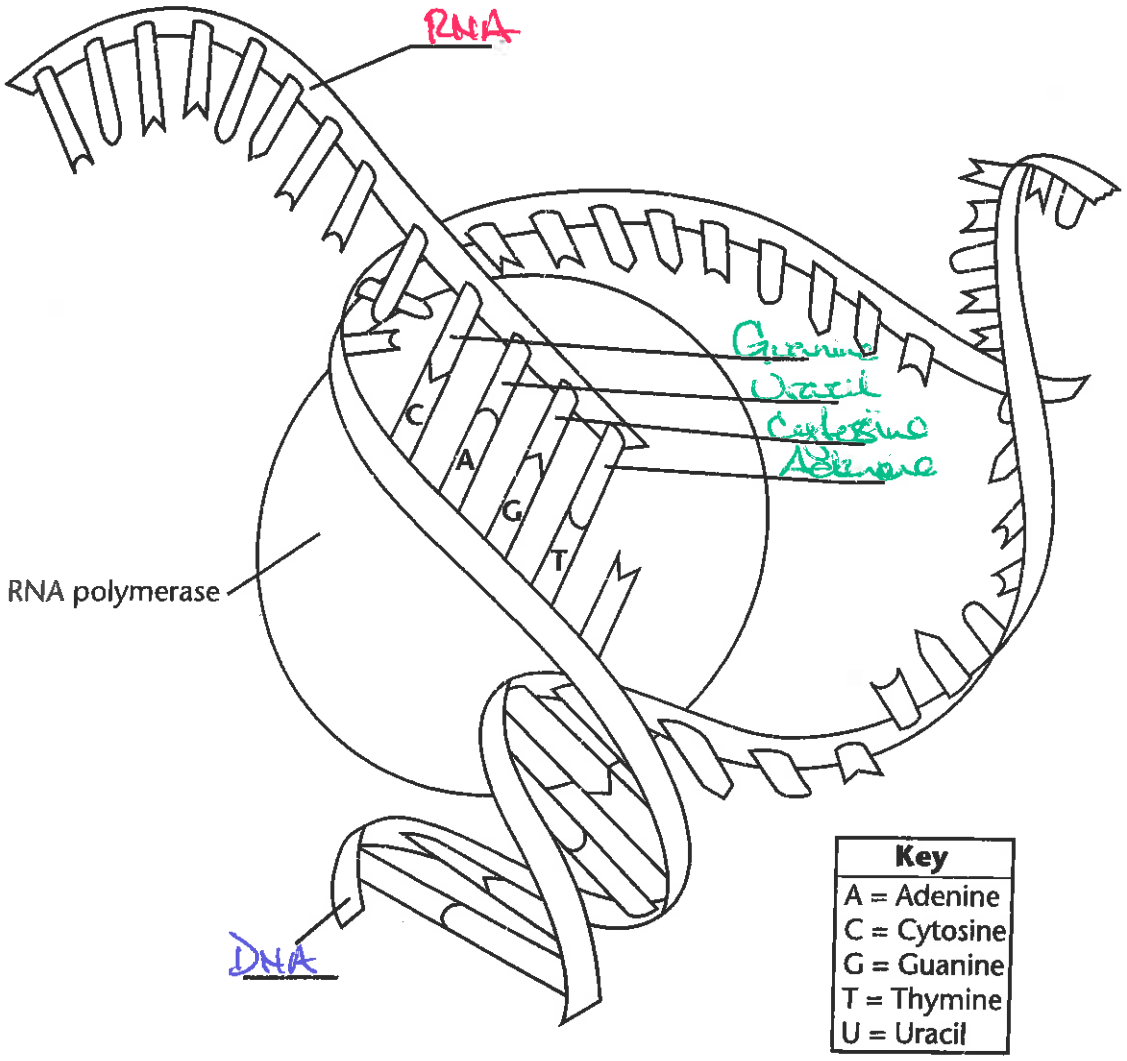
Name Key Class _____ Date _____

Transcription

In transcription, RNA polymerase splits the two halves of a strand of DNA. RNA then uses one half as a template to make a copy of the other half. RNA contains the nucleotide uracil instead of the nucleotide thymine.

Label the DNA *and* RNA. *Then, label the missing nucleotides marked on the diagram.*



Use the diagram to answer the question. Circle the correct answer.

1. In RNA, which nucleotide is always paired with uracil?

adenine guanine

Name_____ Class_____ Date_____

Comparing DNA Replication and Transcription

DNA replication is the process by which a cell copies its DNA. During replication, both strands of the double helix are used as templates to make complementary, or matching, strands of DNA. DNA transcription is the process by which a single strand of DNA is used as a template to generate a strand of mRNA.

Fill in the missing information. One row has been completed for you.

Template DNA	Complementary DNA	Messenger RNA (mRNA)
TTACG	AATGC	AAUGC
CCGCC	GGCGG	GGCGG
TGCATCG	ACGTAGC	ACGUAGC
AGACTC	TCTGAG	UCUGAG
CTATTGT	GATAAGA	GAUAAGA
GACCGATG	CTGGCTAC	CUGGCUAC

Use the table to answer the question.

1. Give another example of a template DNA code that is at least four base pairs long. Then give its matching complementary DNA and mRNA codes.

ATGC → CD= TACG → mRNA = UACG

Name Key Date _____ Period _____

RNA Worksheet

Objectives: Understand the differences between the two Nucleic Acids and types of RNA

Structure of RNA

1. The sugar in a nucleotide of RNA is Ribose.
2. The pyrimidine bases are Cytosine and Uracil.
3. The purine bases are Adenine and guanine.
4. In complimentary base pairing, A bonds with U and G bonds with C.
5. RNA is a Single-stranded polymer.
6. There are 3 types of RNA each with its only function.

Comparison of Nucleic Acids

7. The five-carbon sugar in RNA is Ribose whereas in DNA it is Deoxyribose.
8. In RNA the base Uracil is substituted for Thymine.
9. DNA molecules are double stranded and RNA molecules are Single stranded.
10. In terms of length, DNA molecules are much longer than RNA molecules.
11. DNA is only found in the Nucleus of a cell.

Transcription

12. Making a messenger RNA using DNA as a template is called transcription

13. In the cytoplasm, mRNA delivers the code to the Ribosome.

14. To the right, construct a messenger RNA molecule from a DNA strand. Use the correct complimentary base pairing. Use colored pencils to show the DNA and mRNA strands.

- ✓ Only one side of the DNA molecule is copied during transcription
- ✓ Remember that there is no thymine in RNA. You must substitute uracil.

DNA Strand 1 2	→	DNA Strand 1	mRNA Strand
A – T		A	– U
C – G		C	– G
T – A		T	– A
T – A		T	– A
A – T		A	– U
C – G		C	– G
G – C		G	– C
C – G		C	– G
G – C		G	– C
C – G		C	– G
A – T		A	– U
T – A		T	– A

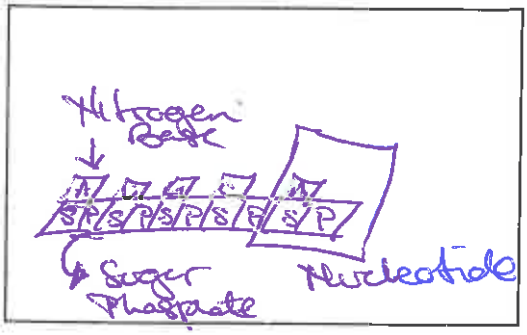
Messenger RNA

15. mRNA stands for Messenger RNA.

16. mRNA has the code for making Proteins.

17. mRNA is produced in the Nucleus.

18. Draw a labeled diagram of an mRNA strand.



Transfer RNA

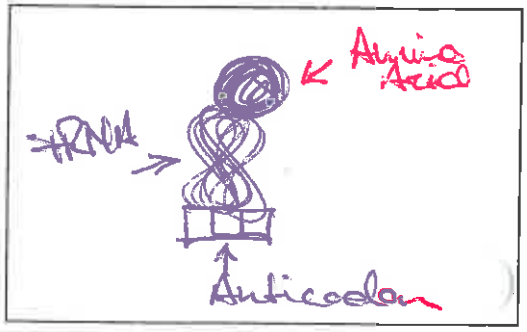
19. tRNA stands for transfer RNA.

20. tRNA carry Amino Acids from the cytoplasm to the ribosomes.

21. One end of the tRNA is specific for a single type of Codon.

22. The other end of the tRNA contains three unpaired bases called an Anticodon.

23. Draw a labeled diagram of the "cloverleaf" shape of a tRNA.



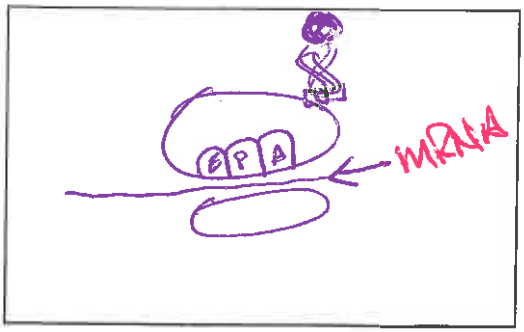
Ribosomal RNA

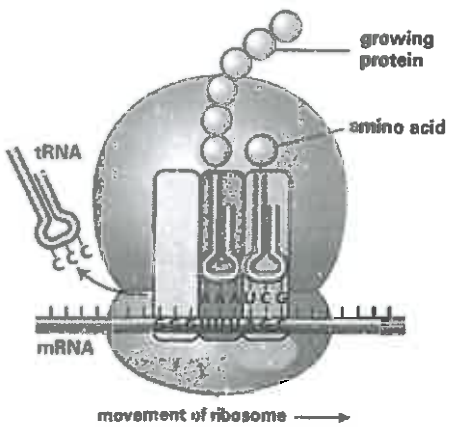
24. rRNA stands for Ribosomal RNA.

25. rRNA forms Ribosomes which are the sites of protein synthesis.

26. rRNA is produced in the Nucleus of the cell.

27. Draw a labeled diagram of a ribosome.





Protein Synthesis Review Worksheet

1. How are DNA and mRNA alike?
Both carry instructions on the production of proteins.

2. How are DNA and mRNA different? Fill in the table below.

DNA		mRNA
Double Helix	Shape	Simple Strand
Thymine	Nitrogen bases	Uracil
Deoxyribose	Sugars	Ribose
Nucleus	Location	Cytoplasm

Transcription: DNA to mRNA:

1. How many strands of mRNA are transcribed from the two "unzipped" strands of DNA? 1

2. If the following were part of a DNA chain, what mRNA bases would pair with it to transcribe the DNA code onto mRNA? G-G-A-T-C-G-C-C-T-T-A-G-A-A-T-C
CCUAGCGGAAUCUUAG

3. If DNA is described as a double helix, how should mRNA be described? Simple Strand

4. How are the accuracy of DNA and mRNA codes assured? Complementary base pairing and uses DNA as template for both.

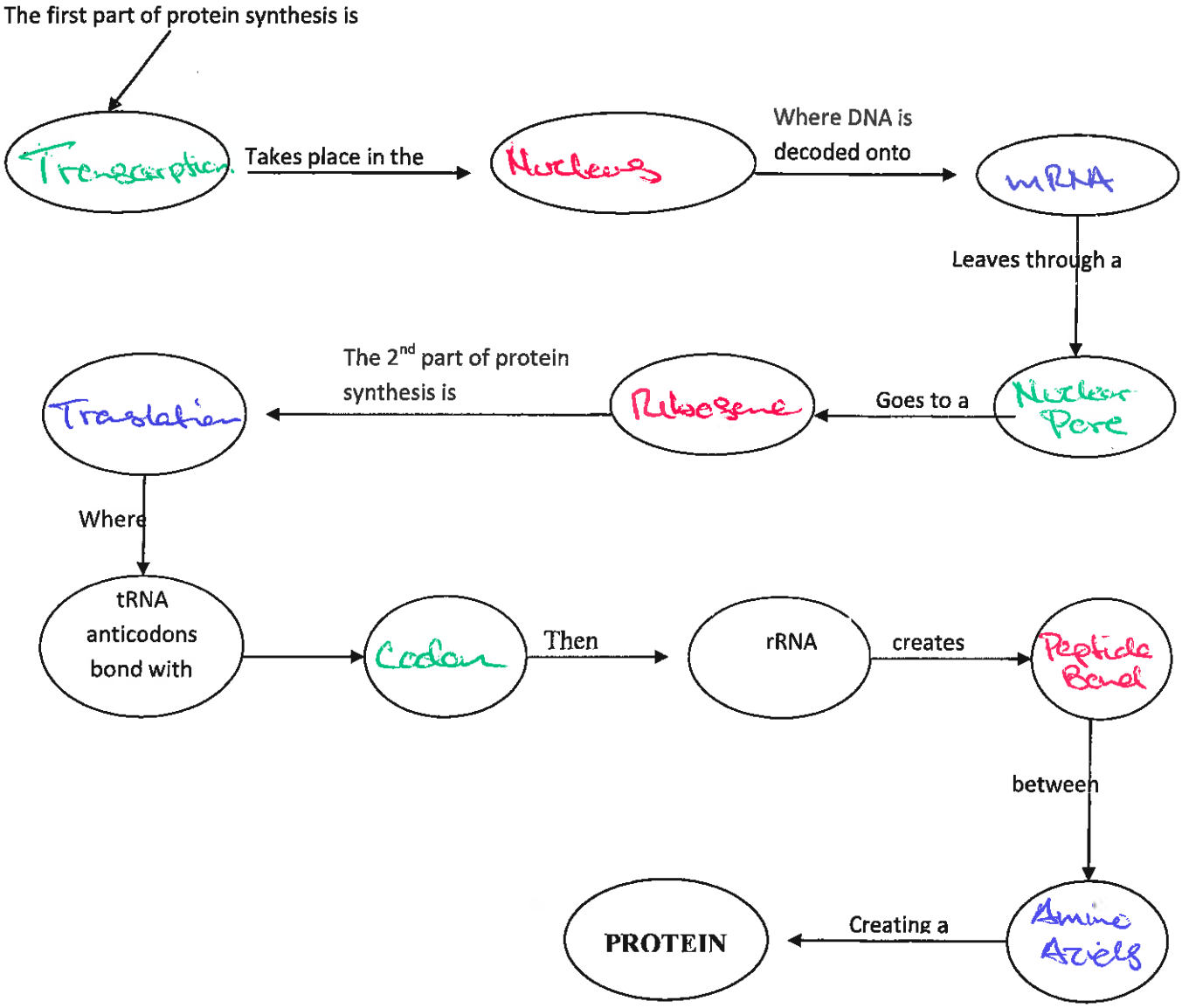
Translation: mRNA to PROTEIN:

5. Name and describe the three types of RNA's involved in protein synthesis?
mRNA → Temporary copy of DNA transported to ribosome
tRNA → Brings AAs to Ribosome
rRNA → Complex with proteins to make ribosomes.

6. What is located at EACH end of a tRNA molecule? Anticodon and AA
7. Where must an mRNA attach before protein production can begin? Ribosome
8. How many bases are needed to specify an mRNA codon? 3
9. If a strand of mRNA contain the sequence, U-A-G-C-U-A-U-C-A-A-A-U, what tRNA anticodons would be needed to translate the sequence? AUCGAUAGUUU
10. How does mRNA get out of the nucleus? Exits through Nuclear Pore
11. What is the difference between an amino acid and a protein? Amino acids are the monomer of proteins.
12. What type of bond is formed between amino acids? Peptide Bond

Protein Synthesis Flow Chart

Directions: Fill in the flow chart below, using the following words: **Amino acids, mRNA, mRNA codon, nucleus, nuclear pore, peptide bonds, ribosome, transcription.**



Name Key Date _____ Period _____

Worksheet: DNA, RNA, and Protein Synthesis

BIOLOGY: Chapter 6-9

Directions: *Use your notes and book to answer the following questions concerning Replication, Transcription, and Protein Synthesis.*

1. Define the following terms:

a. **Replication**- The copying of DNA with the use of proteins and enzymes specialized to copy, repair, and proofread DNA.

b. **Transcription**- The creation of mRNA from the DNA. This mRNA is made with RNA polymerase.

c. **Translation**- Producing polypeptides from the mRNA template.

2. Break the following DNA sequence into **triplets**. (Draw a line to separate triplets)

CCG/ATA/CGC/GGT/ATC/CCA/GGG/CTA/ATT/GAA

3. If the above code showed the bases on one strand of DNA, what would the **complementary strand** read?

GGC-TAT-GCG-CCA-TAG-GGT-CCC-GAT-TAA-CTT

4. What would the code in problem #2 be **transcribed** into (What would the mRNA sequence be?)

GGC-AUA-GCG-CCA-UAG-GGU-CCC-GAU-UAA-GUU

5. How many **codons** are there in the above problem? 10 codons

6. What is the three letter sequence on a **tRNA** molecule called? anticodon

7. How many different **amino acids** are there that make up all of the proteins in our body? 20 AAs

8. How many different **codons** are there? 64 codons

9. What would the **amino acid sequence** be translated from the mRNA sequence in problem #4? (Use the Genetic Code table below to translate)

Gly
Tyr
Ala
Pro
Stop
Gly
Pro
Asp
Stop
Leu

Codons Found in Messenger RNA

Second Base

First Base	U	C	A	G	Third Base
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

10. Complete the table below. Use the following DNA sequence.

CGGCTATTCGACCCTTACGGTATTGGG

DNA triplets	mRNA codon	tRNA anticodon
CGG	GCC	CGG
CTA	GAU	CUA
TTC	AAG	UUC
GAC	CUG	GAC
CCT	GGA	CCU
TAC	AUG	UAC
GGT	CCA	GGU
ATT	UAA	AUU
GGG	CCC	GGG

Transcription and Translation

Practice Worksheet

Example:

DNA : G T A C G C G T A T A C C G A C A T T C

mRNA: C A U G C G C A U A U G G C U G U A A G

Codons: AUG-CGC-AUA-UGG-CUG-UAA

Anticodons: UAC-GCG-UAU-ACC-GAC-AUU

Amino Acids: METHIONINE-ARGININE-ISOLEUCINE-TRYPTOPHAN-LEUCINE

Using the example above, transcribe the following DNA strand into mRNA and translate that strand into a polypeptide chain, identifying the codons, anticodons, and amino acid sequence.

1. DNA: A T A C G A A A T C G C G A T C G C G G C G A T T C G G

   mRNA: UAUGCUUUAGCGCUAGCGCGCGCUAAGCC

   Codon: AUG-CUU-UAGCGC-UAG-CGC-CGC-UAA-GCC

   Anticodon: UAC-GAA-AUC-GCG-AUC-GCG-GCG-AUU-CGG

   Amino Acids: Methionine- Leucine

2. DNA: T T T A C G G C C A T C A G G C A A T A C T G G

   mRNA: AAAUGCCGGUAGUCCCGUAUGACC

   Codon: AUG-CCG-GUA-GUC-CCU-UAU-GAC

   Anitcodon: UAC-GGC-CAU-CAG-GCA-AUA-CUG

   Amino Acids: Methionine-Proline-Valine-Valine-Arginine
   Tyrosine-Aspartic acid

3. DNA: T A C/G G G/C C T/A T A/C G C/T A C/T A C/T CA/T G G/A T C/G G

mRNA: AUG/CCC/GGA/UAU/GCG/AUG/AUG/AGU/ACC/UAG/CC

Codon: AUG - CCC - GGA - UAU - GCG - AUG - AUG - AGU - ACC - UAG

Anitcodon: UAC - GGG - CCU - AUA - CGC - UAC - UAC - UCA - UGG - AUC

Amino Acids: Methionine - Proline - Glycine - Tyrosine - Alanine
Methionine - Methionine - Serine - threaminene

4. DNA: G/T A C/G C G/T A T/A C C/G A C/A T T/C

mRNA: C/AUG/CGC/AUA/UGG/CUG/UAA/G

Codon: AUG - CGC - AUA - UGG - CUG - UAA

Anitcodon: UAC - GCG - UAU - ACC - GAC - AUU

Amino Acids: Methionine - Arginine - Isoleucine - Tryptophan
Leucine -

Transcribe the following DNA strand into mRNA and translate that strand into a polypeptide chain, identifying the codons, anticodons, and amino acid sequence.

DNA: C G A/T A C/A A T/G G A/C C C/G G T/A T G/C G A/T A T/C C

codon - AUG - UUA - CCU - GGG - CCA - UAC - GCU - AUA

Anticodon - UAC - AAU - GGA - CCC - GGU - AUG - CGA - UAU

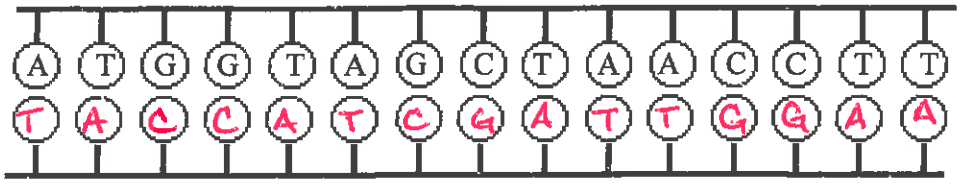
AAs - Methionine - Leucine - Proline - Glycine - Proline -
Tyrosine - Alanine - Isoleucine

Name: _____ Row: _____

Date: _____ Period: _____

Protein Synthesis Worksheet

Directions:
1st Fill in the complimentary DNA strand using DNA base pairing rules.
2nd Fill in the correct mRNA bases by transcribing the bottom DNA code.
3rd Translate the mRNA codons and find the correct amino acid using the Codon Table
4th Write in the amino acid and the correct anti-codon the tRNA molecule.
5th The answer to the questions about protein synthesis below the amino acids.

1. 

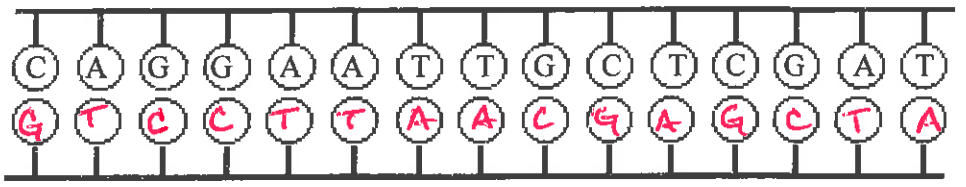
2. 

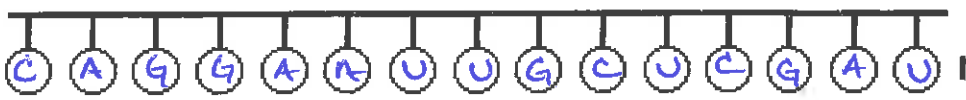
3. 

4. 

5. mRNA is synthesized in translation or transcription?

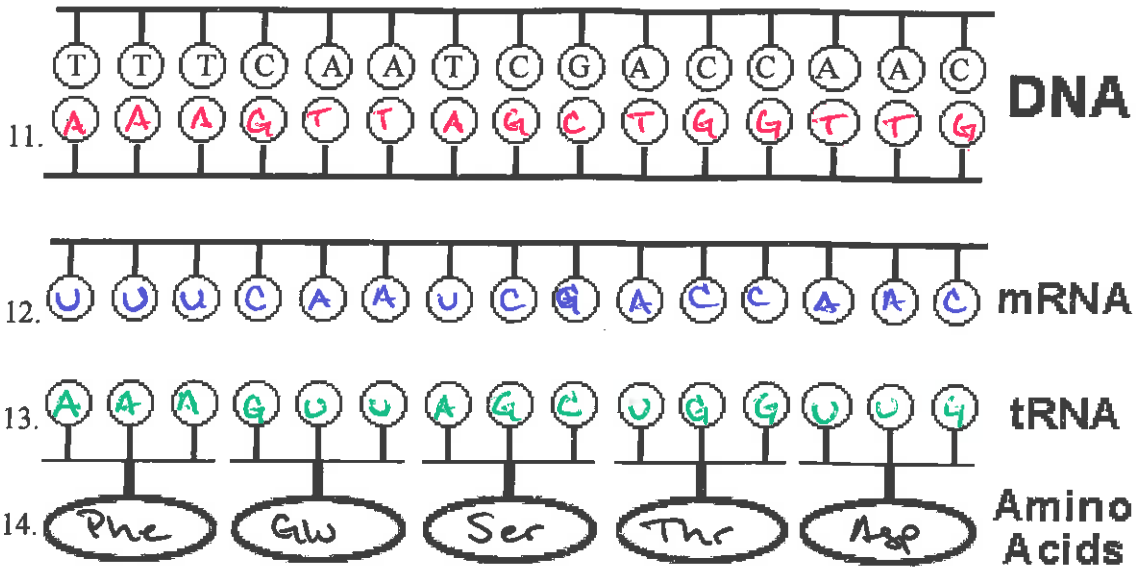
6. mRNA has codons or anti-codons?

7. 

8. 

9. 

10. 



15. 1 or 3 codons equal one amino acid?

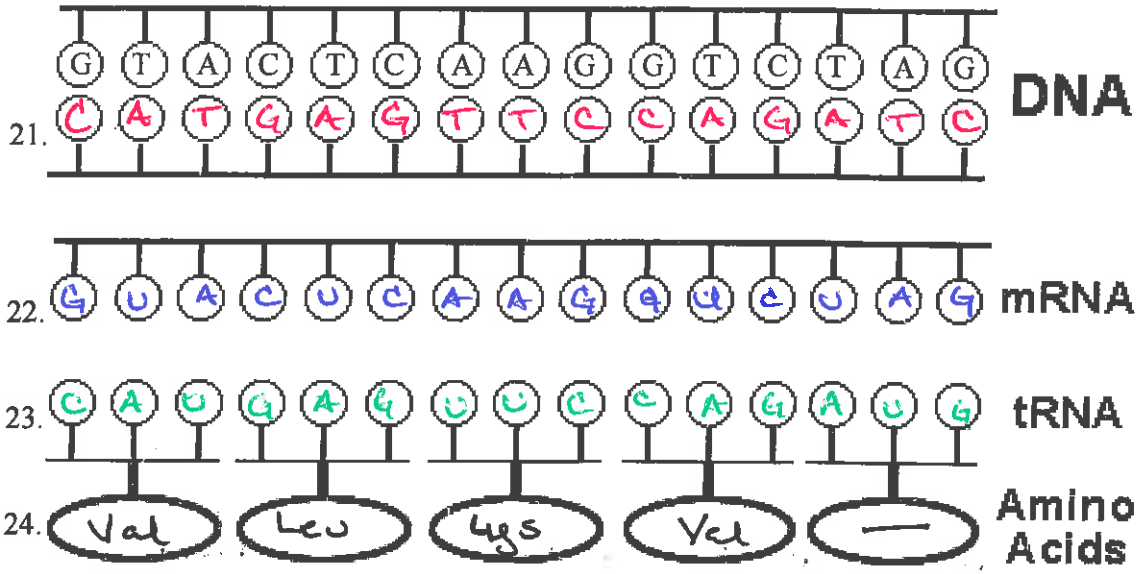
16. tRNA brings amino acids to the nucleus or ribosome?

17. A polypeptide is a sequence of proteins or amino acids?

18. tRNA has codons or anti-codons?

19. tRNA transfers amino acids during translation or transcription?

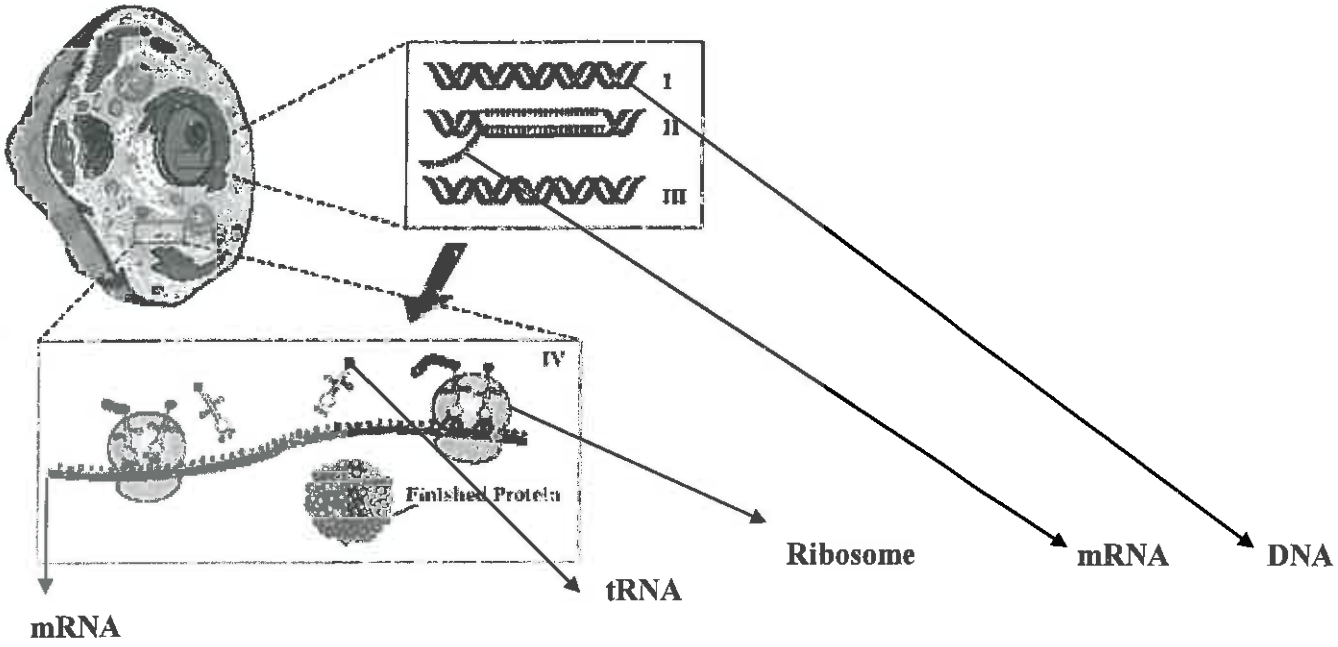
20. Ribosomes are the site where translation or transcription takes place?



PROTEIN SYNTHESIS WORKSHEET

PART A. Read the following and take notes on your paper:

Protein synthesis is the process used by the body to make proteins. The first step of protein synthesis is called Transcription. It occurs in the nucleus. During transcription, mRNA transcribes (copies) DNA. DNA is "unzipped" and the mRNA strand copies a strand of DNA. Once it does this, mRNA leaves the nucleus and goes into the cytoplasm. mRNA will then attach itself to a ribosome. The strand of mRNA is then read in order to make protein. They are read 3 bases at a time. These bases are called codons. tRNA is the fetching puppy. It brings the amino acids to the ribosome to help make the protein. The 3 bases on tRNA are called anti-codons. Remember, amino acids are the building blocks for protein. On the mRNA strand, there are start and stop codons. Your body knows where to start and stop making certain proteins. Just like when we read a sentence, we know when to start reading by the capitalized word and when to stop by the period.



PART B. Answer the following questions on your paper:

1. What is the first step of protein synthesis? Transcription
2. What is the second step of protein synthesis? Translation
3. Where does the first step of protein synthesis occur? Nucleus
4. Where does the second step of protein synthesis occur? Cytoplasm
5. Nitrogen bases are read 3 bases at a time.
6. The bases on the mRNA strand are called codon.
7. The bases on tRNA are called anticodon.
8. What is the start codon? AUG
9. What are the stop codons? UAA, UAG, UGA
10. A bunch of amino acids put together makes polypeptide

PART C. Use your codon chart to determine the amino acid sequence. Remember to read through the strand and <u>ONLY</u> <u>start on AUG</u> and <u>STOP</u> <u>when it tells you to stop</u>. Follow example below:

Example:

DNA → AGA CGG TAC CTC CGG TGG GTG CTT GTC TGT ATC CTT CTC AGT ATC

mRNA → UCU GCC AUG GAG GCC ACC CAC GAA CAG ACA UAG GAA GAG UCA UAG

protein → start - glu – ala –thre – hist – asp -glu-threo-stop
(glu: acid; asp: acid)

1. DNA → CCT CTT TAC ACA CGG AGG GTA CGC TAT TCT ATG ATT ACA CGG TTG CGA TCC ATA ATC

mRNA → GGA GAA AUG UGU GCC UCC CAU GCG AUA AGA UAG UAA UGU GCC AAC GCU AGG UAU UAG

protein → Met - Cys - Ala - Ser - Leu - Ala - Iso - Arg -

2. DNA → AGA ACA TAA TAC CTC TTA ACA CTC TAA AGA CCA GCA CTC CGA TGA ACT GGA GCA

mRNA → UCU UGU AUU AUG GAG AAU UGU GAG AUU UGU GGU CGU GAG GCU ACU UGA CCU CGU

protein → Met - Glu - Asp - Cys - Glu - Iso - Cys - Gly - Arg - Glu - Ala - Thr -
(Glu: acid; Glu: acid)

3. DNA → TAC CTT GGG GAA TAT ACA CGC TGG CTT CGA TGA ATC CGT ACG GTA CTC GCC ATC

mRNA → AUG GAA CCC CUU AUA UGU GCG ACC GAA GCU ACU UAG GCA UGC CAU GAG CGG UAG

protein → Met - Glu - Pro - Leu - Iso - Cys - Ala - Thr - Glu - Ala - thr -
(Glu: acid; Glu: acid)

4. DNA → TAA ACT CGG TAC CTA GCT TAG ATC TAA TTA CCC ATC

mRNA → AUU UGA GCC AUG GAU CGA AUC UAG AUU AAU GGG UAG

protein → Met - Asp - Arg - Iso -
(Asp: acid)

5. DNA → CTA TTA CGA TAC TAG AGC GAA TAG AAA CTT ATC ATC

mRNA → GAU AAU GCU AUG AUC UCG CUU AUC UUU GAA UAG UAG

protein → Met - Iso - Ser - Leu - Iso - Phe - Glu -
(Glu: acid)

6. DNA → TAC CTT AGT TAT CCA TTG ACT CGA ATT GTG CGC TTG CTG ATC

mRNA → AUG GAA UCA AUA GGU AAC UGA GCU UAA CAC GCG AAC GAC UAG

protein → Met - Glu - Ser - Iso - Gly - Asp -
(Glu: acid)

7. DNA → ACC CGA TAC CTC TCT TAT AGC ATT ACA AAC CTC CGA GCG

mRNA → UGG GCU AUG GUG AGA AUA UCA UAA UGU UUG GAG GCU CGC

protein → Met - Val - Arg - Iso - Ser -

8. DNA → TAC AGA CGG CAA CTC TGG GTG CTT TGT TCT CTT CTC AGT ATC

mRNA → AUG UCU GCC GUU GAG ACC CAC GAA ACA AGA GAA GAG UCA UAG

protein → Met - Ser - Ala - Val - Glu - Thr - His - Glu - Thr - Arg - Glu - Glu - Ser -
(Glu: acid; Glu: acid; Glu: acid)

Unit 5A:

Gene Expression Homework Packet

CP Biology **Name** Key

HW #1: DNA vs. RNA and the Triplet Code

1. Given the following sequence of DNA nucleotides in a strand of DNA, fill in the complimentary strand of DNA (cDNA):

TAC GCC CTA AAG GCG AGC TCG CGC AAA ATT

cDNA ATG CGG GAT TTC CGC TCG AGC GCG TTT TAA

2. What does a gene segment on a strand of DNA hold the code for? A gene segment holds the code for producing a specific protein

3. How many different types of amino acids are there? 20 Amino Acids

4. What did the Nobel Prize winner Francis Crick discover about the code in the DNA molecule? (triplet)

Francis Crick discovered the reading frame of the code

5. Is the DNA code for the amino acid lysine the same in a shark as it is in a bacterium? Yes

6. Use the following table to describe the differences and similarities between DNA and RNA.

Place an **X** in the column if the characteristic applies. Place a **O** in the column if the characteristic does not apply:

Characteristic:	DNA	RNA
type of nucleic acid	X	X
composed of nucleotides	X	X
contains deoxyribose sugar	X	O
contains ribose sugar	O	X
contains glucose	O	O
contains phosphate groups	X	X
single stranded	O	X
double stranded	X	O
contains guanine, cytosine and adenine	X	X
contains thymine	X	O
contains uracil	O	X
always found in the nucleus	X	O
found in the nucleus AND in the cytoplasm	O	X
made from a gene on the DNA molecule	O	X
copies or replicates itself	X	O
could be part of a messenger or transfer molecule or a ribosome	O	X
makes up your genetic material, genes and chromosomes	X	O

HW #2: Transcription

1. Place the following sequence of steps in transcription in the correct order:

___3___ mRNA separates from the DNA template.

___4___ Hydrogen bonds reform between the two strands of the DNA molecule.

___2___ Free-floating mRNA nucleotides match up with their complimentary nucleotides on the DNA strand.

___1___ DNA helix unwinds and hydrogen bonds between nitrogen bases break at the gene location.

___5___ mRNA moves into the cytoplasm and the DNA strands reform and rewind.

Given the following DNA strands, transcribe the DNA code into the mRNA codon. Using the chart in your notes, determine the amino acid sequence for the protein that the DNA codes for.

2. **DNA CODE:**

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

mRNA CODON:

A U G U G G C A U A C G G U A U A A

AMINO ACID SEQUENCE:

Met Trp His Thr Val —

3. **DNA CODE:**

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

mRNA CODON:

A U G U C G U G U G C C G G G U G A

AMINO ACID SEQUENCE:

Met Ser Cys Val Ala Gly —

4. Complete by filling in the blanks:

a) A gene is a segment of DNA that carries the ___Code___ for a ___Protein___.

b) During transcription, a molecule of ___mRNA___ will be used to act as the 'messenger' to carry the code for the protein from the ___DNA___ in the nucleus to the ___Ribosome___ in the cytoplasm or on the rough endoplasmic reticulum.

c) Proteins are made up of ___Amino___ ___Acid___.

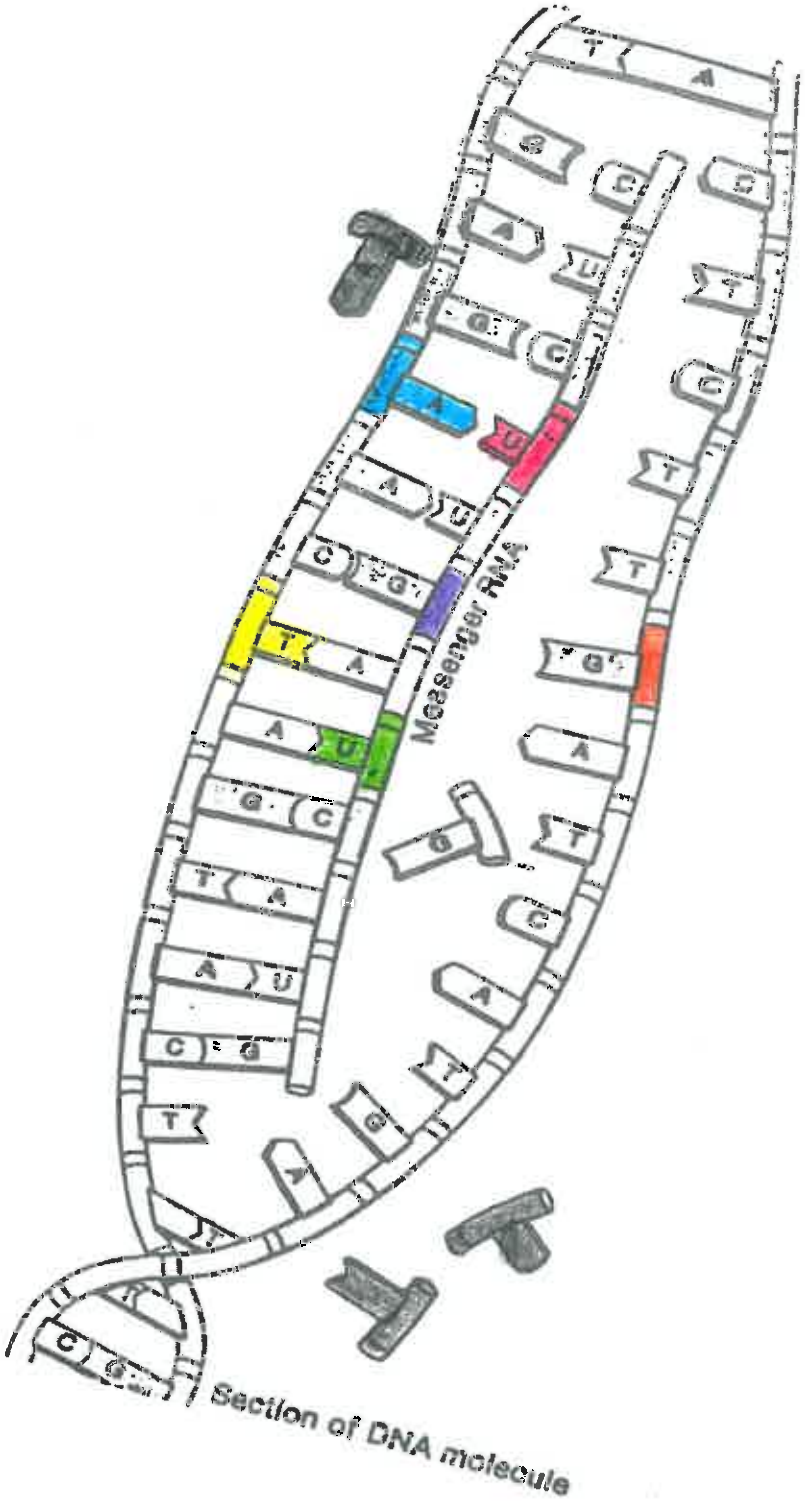
d) Each amino acid in DNA is represented by ___3___ nitrogen bases on one strand of the DNA molecule.

e) When mRNA is transcribed from the DNA template, three nitrogen bases on the strand of mRNA hold the code for a single ___Amino___ ___Acid___.

f) The code for an amino acid on the mRNA is called a ___Codon___.

5. Color the following picture of DNA in the process of transcription as follows.

1) Color a single DNA nucleotide blue.
2) Color a single mRNA nucleotide red.
3) Color a single thymine nucleotide yellow.
4) Color a single uracil nucleotide green.
5) Color a single deoxyribose sugar orange.
6) Color a single ribose sugar purple.
7) Color a free-floating mRNA nucleotide black.



HW #3: Summary of Transcription and Translation

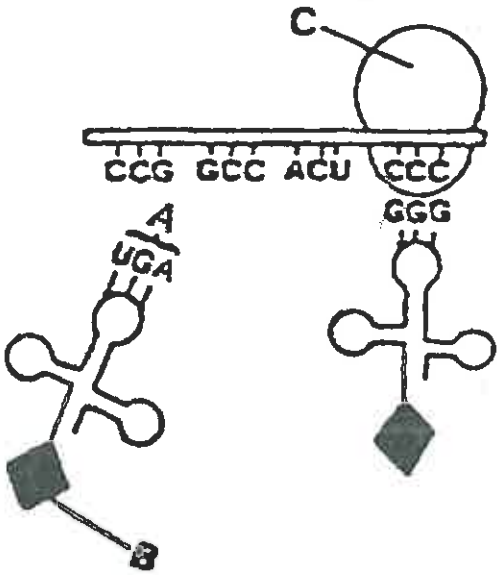
1. What is the name for a specific, three-base sequence on mRNA? Codon
2. What do we call the corresponding three-base sequence on tRNA? anticodon
3. Name the process of building protein molecule from information encoded on mRNA. translation
4. Where, in the cell, does translation occur? Cytoplasm
5. What is the three base sequence of the amino acid that is always at the start of a newly formed protein molecule? AUG
6. Using the chart in your note packet, determine the sequence of amino acids ***coded for by the mRNA shown below left***. Start from the top of the mRNA.

A
U
G
G
C
A
U
U
U
A
A
U
A
C
G
G
A
C
G
A
A
U
A
A

Codon:	Amino Acid:
1) AUG	Methionine
2) GCA	Alanine
3) UUU	Phenylalanine
4) AAU	Asparagine
5) ACG	Threonine
6) GAC	Aspartic Acid
7) GAA	Glutamic Acid
8) UAA	—

7. Amino acids are linked together by Peptide bonds.
8. The base pairs in codons and anticodons that join at the ribosome are Complementary (complementary, supplementary) to each other.
9. Each protein molecule is made up of one or more small units or monomers called Amino Acids
10. RNA differs from DNA in all of the following ways EXCEPT: (circle the correct answer)
    a. it is single stranded
    b. it is found inside the nucleus and out in the cytoplasm
    c. it contains uracil in place of thymine
    d. it is made up of nucleotides

Use the letters A, B and C, in the diagram below to answer questions 11-13.



11. Structure A in the diagram is an Anticodon

12. Structure B in the diagram is an Amino Acid

13. Structure C in the diagram is a Ribosome

14. The structure and function of a protein is determined by: (Circle one)
    a. the number of amino acids in its structure
    b. the types of amino acids in its structure
    c. both a and b

15. Describe the FUNCTION of the three types of RNA:
    a. messenger or mRNA Carries DNA's message from the nucleus to the ribosome.
    a. transfer or tRNA Carries Amino Acids from around cytoplasm to the ribosome.
    a. ribosomal or rRNA Assembles polypeptide by matching mRNA codons with tRNA anticodons.

16. Which nitrogen base takes the place of thymine in mRNA? Uracil

17. What is the name of the process of making a strand of mRNA from a strand of DNA? Transcription

18. Where, in the cell, does transcription take place? Nucleus

19. What is ribose? The sugar in Ribonucleic Acid

20. What molecule, similar to ribose, is found in DNA? Deoxyribose

Name: Key Date: Period: _____

Mutations Practice Worksheet

1. Define the following words:

Mutation	Change in DNA sequence
Gene	sequence of DNA that codes for protein

2. The basic 3 types of gene mutations are:

Substitution	Deletion	Insertion

3. Transcribe the following "normal" DNA sequence into mRNA. Then use your codon chart to translate the mRNA into amino acids. The normal DNA sequence represents a normal gene. Remember that a gene is a sequence of DNA that codes for a particular protein.

Normal DNA Gene Sequence

DNA	**T – A – C – G – C – T – T – C – G – A – A – G – C – T – C – A – A – C – G – G – C – A – C - T**							
mRNA	AUG	CGA	AGC	UUC	GAG	UUG	CCG	UGA
Amino Acids	Met	Arg	Ser	Phe	Glu	Leu	Pro	–

4. Mutation #1: Compare the mutated strand of DNA in the table below to the normal strand of DNA. What difference do you notice? T changes to A

Normal DNA	**T – A – C – G – C – T – T – C – G – A – A – G – C – T – C – A – A – C – G – G – C – A – C - T**							
Mutated DNA	**T – A – C – G – C – A – T – C – G – A – A – G – C – T – C – A – A – C – G – G – C – A – C – T**							
mRNA	AUG	CGU	AGC	UUC	GAG	UUG	CCG	UGA
Amino Acids	Met	Arg	Ser	Phe	Glu	Leu	Pro	–

1. This is an example of a Substitution mutation.
2. Base # 6 which was a T was substituted for a A.
3. How many Amino Acids were changed by this mutation? 0
4. Did this mutation change the gene and therefore the overall protein that would be produced? Explain why or why not.

No, although there is a mutation because it is on the 3rd base of codon it still gave the same Amino Acid

5. Mutation #2: Compare the mutated strand of DNA in the table below to the normal strand of DNA. What difference do you notice? Extra Nucleotide

Normal DNA	T–A–C–G–C–T–T–C–G–A–A–G–C–T–C–A–A–C–G–G–C–A–C-T								
Mutated DNA	T–A–C–G–C–T– T–C–G–A–A–A–G–C–T–C–A–A–C–G–G–C–A–C-T								
mRNA	AUG	CGA	AGC	UUU	CGA	GUU	GCC	GUG	A
Amino Acids	Met	Arg	Ser	Phe	Arg	Val	Ala	Val	—

1. This is an example of a(n) Insertion mutation (be specific).
2. A(n) A was inserted at position # 12.
3. How many Amino Acids were changed? 4
4. How did this mutation change the gene? Explain.

Yes, the gene is half different and no longer has a stop. Also it has extra AAs.

6. Mutation #3: Compare the mutated strand of DNA in the table below to the normal strand of DNA. What difference do you notice? Missing Nucleotide

Normal DNA	T–A–C–G–C–T–T–C–G–A–A–G–C–T–C–A–A–C–G–G–C–A–C-T							
Mutated DNA	T–A –G–C–T–T–C–G–A–A–G–C–T–C–A–A–C–G–G–C–A–C–T							
mRNA	AUC	GAA	GCU	UCG	AGU	UGC	CGU	GA
Amino Acids	Iso	Glu	Ala	Ser	Ser	Cys	Arg	—

1. This is an example of a(n) Deletion mutation (be specific)
2. A(n) C was deleted at position # 3
3. How many Amino Acids were changed? 7
4. How did this mutation change the gene? Explain.

Yes, its completely different and no longer has a start

Conclusion

What type of mutation has the least chance of changing a gene? Substitution

Which types of mutations have the best chance of changing a gene? Insertion and Deletion

In this activity, which mutation caused the most damage? Explain.

Deletion

Name Key Period _____ Date _____

Tales of the Mutant Jaguar- Untamed Science Video

Log in to the textbook website. Choose Unit 4, Chapter 13 Resources, Untamed Science Video

1. The effects of mutations can be Neutral, Harmful, or Beneficial.
2. Mutations hit a dead end if they are not passed on to the offspring.
3. Mutations that are beneficial and passed on to the offspring are really rare.
4. Some mutations are changes in a single base pair. These are called Point mutations.
5. Mutations that remove a part of the DNA sequence are called deletion mutations.
6. There are two general causes of mutations. One is due to errors that occur during replication. The other is external causes of change in the DNA sequence like exposure to toxic compounds and radiation.
7. What happens to cause beneficial mutations? To be beneficial the mutation must result in some adaptation that makes the organism better able to survive and reproduce in its environment.
8. From an evolutionary standpoint that mutation must be found in the DNA of the organism's sex cells in order to be passed along to its offspring.
9. An example of a beneficial mutation may be resistance to a certain bacteria or a disease.
10. Albinism and melanism are two genetic pigmentation variations found in nature. Albinism prevents the body from producing pigments. Melanism causes the body to produce excess black pigment.

11. What type of environment are golden pigmented leopards found in?

Deciduous Forest

12. The spot pattern of the golden leopard is beneficial in an environment of Sun and Shadow.

13. On the other hand, melanistic individuals have an advantage in environments where Dense Dark Forest.

14. Most mutations are Neutral and do not affect individuals.

15. The more dramatic "bad" mutations are somatic and (are / are not) passed on to the descendents.

16. The most rare mutations are beneficial which (are / are not) passed on to the descendents.

17. Over time, beneficial mutations can spread throughout an entire Population. This is what we recognize as the classic Species.

Timing and Frequency of Mutations

Mutations may occur at different times in the life cycle of an individual. Think about the effects of the following mutations at different times in the life cycle of an individual:

1. Mutations that occur during formation of gametes (sex cells), or just after fertilization are found in (all / some) cells of the organism.

2. Mutations that occur during the embryonic stage, when cells and tissues are differentiating, cause mosaicism, in which (all / some) cells of the organism have the mutation.

3. Mutations that occur after an organism is fully formed affect only the cells in which they occur and their daughter cells. (TRUE/ FALSE)

4. When mutations occur in sex cells, they may be inherited by the organism's offspring. (TRUE/ FALSE)

5. If mutations occur in somatic (body) cells, the mutations will remain in the gene pool after the organism dies. (TRUE/ FALSE)

Name: _____ Date: _____ Period: _____

DNA vs. RNA

1. Which of the following is paired correctly? **CHOOSE TWO**

DNA: Phosphate, Deoxyribose, Uracil	RNA: Phosphate, Deoxyribose, Adenine
DNA: Phosphate, Ribose, Thymine	RNA: Phosphate, Ribose, Cytosine
DNA: Phosphate, Deoxyribose, Guanine	RNA: Phosphate, Ribose, Thymine

2. How many strand(s) are present in RNA molecules?

a. 1 b. 2 c. 3 d. 4

3. How many strand(s) are present in DNA molecules?

a. 1 b. 2 c. 3 d. 4

4. Where is DNA found? Nucleus

5. Where is RNA found? Nucleus & cytoplasm

6. What structures are composed of RNA? (HINT: you should have 3 answers!!)

mRNA, tRNA, rRNA

7. Fill in the correct sequence for the Central Dogma of molecular biology.

DNA → RNA → proteins or polypeptides → Traits

8. Genes code for all the following, EXCEPT?

a. traits b. proteins c. polypeptides d. all of these are correct!

9. RNA and DNA are **both** in which organic compound category?

a. Carbohydrates b. Lipids c. Nucleic Acids d. Proteins

10. The monomer unit for **both** DNA and RNA is ...

a. monosaccharide b. triglyceride c. nucleotide d. amino acid

Name: _____ Date: _____ Period: _____

Transcription

1. Where does transcription occur? Nucleus

2. What molecules are **required** for transcription to occur correctly?

   a. DNA, RNA polymerase, DNA Nucleotides

   b. DNA, DNA Polymerase, RNA Nucleotides

   c. DNA, RNA Polymerase, RNA Nucleotides

   d. DNA, DNA Helicase, DNA Polymerase

3. Transcribe the following sequence

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

4. In the above sequence how many codons are present?

   a. 21 b. 6 c. 7 d. I don't know what a codon is ☹

5. What is the DNA sequence, given the mRNA stand below?

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

6. The pieces that get cut out from the mRNA sequence before going to the cytoplasm are known as...?

   a. Introns b. Exons c. Promoters d. Nothing gets cut out

Name: _____ Date: _____ Period: _____

Translation

1. Where does translation occur? Cytoplasm

2. What is an example of a **codon**? GCA

3. What molecules are **required** for translation to occur correctly?

   a. RNA polymerase, RNA Nucleotides, Ribosomes

   b. mRNA, tRNA, ribosomes, amino acids

   c. mRNA, DNA, nucleus, ribosomes

   d. DNA, DNA Helicase, DNA Polymerase

4. Translate the following mRNA sequence into a chain of amino acids.

A U G / A A A / C C C / G A A / U U U / C U C / A C G / U G A

M / K / P / E / F / L / T / —

5. How many codons are present in the above sequence? 8 Amino Acids? 7

6. What would be the tRNA sequence (anticodons) for the sequence given in question 4.

UAC UUU GGG CUU AAA GAG UGC ACU

7. What is the bond that forms between the amino acids? Peptide Bond

8. What is the one and ONLY start codon? AUG

9. What are the three stop codons? UAA - UGA - UAG

Name: _____ Date: _____ Period: _____

Mutations

1. Mutations are...

   a. heritable changes in genetic information

   b. spontaneous

   c. harmful, helpful, or neutral

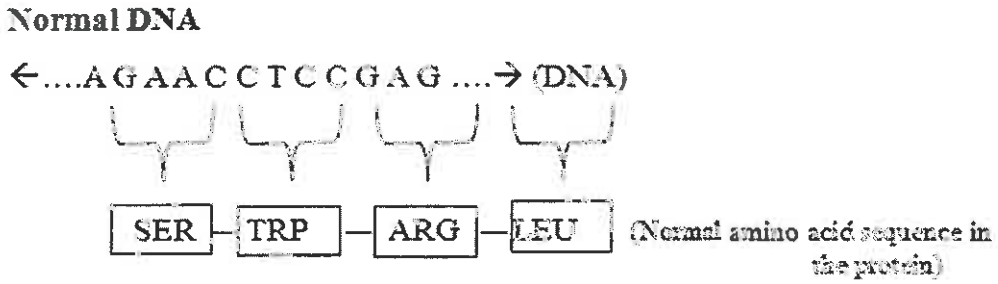
   d. All of the above are true

2. List four examples of **mutagens:**

Pesticides Tobacco Smoke UV rays X rays

Identify the following as Deletion, **Insertion/Addition, or Substitution** Mutation:

Here is the Normal Sequence



3. What is the mutation shown in the image to the right?

Insertion

Circle the mutation.

What happened due to this mutation?

3 AAs changes in the Poly Peptide

Over →

4. What is the mutation shown in the image to the right?

Substitution

Circle the mutation.

What happened due to this mutation?

Only 1 AA changed

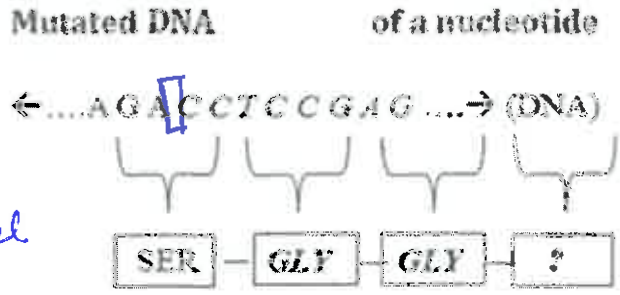
5. What is the mutation shown in the image to the right?

Deletion

Circle the mutation.

What happened due to this mutation?

1 AAs was lost and 2 changed



6. **Sickle Cell Anemia** is what type of mutation?

a. Insertion b. Deletion c. Substitution

CP Biology
2013-2014

Name_____

UNIT 5A: Gene Expression

WHAT IS A GENE?

Gene:

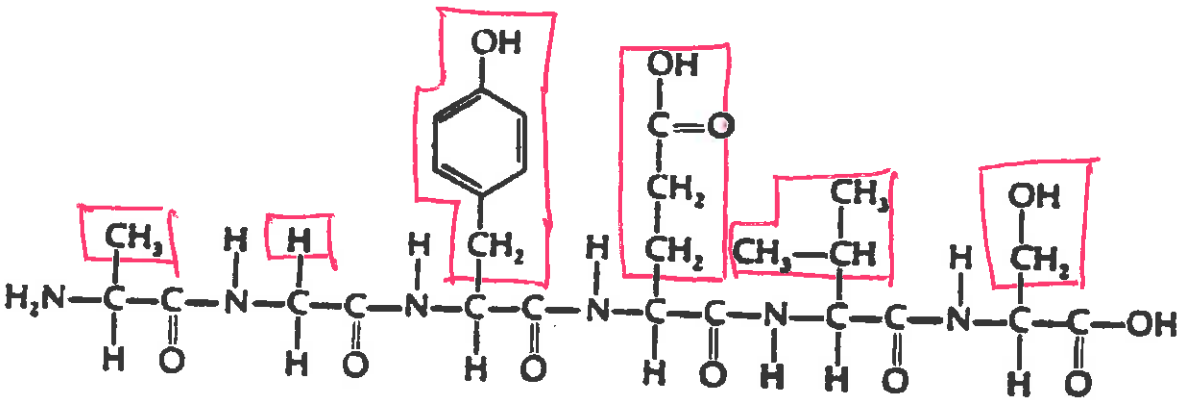
1) *A unit of hereditary information which can be passed on to future generations.*

2) *A **segment** of DNA on a chromosome which holds the **code** or **"recipe"** for a protein or polypeptide.*

Genes hold the code for the synthesis of:

1. Proteins
2. Polypeptides
3. Traits

Review of the amino acid structure of a protein:



1) Circle the R groups

2) How many different **TYPES of** amino acids could be used to form a single protein or polypeptide?
20*

3) How many **TOTAL** amino acids are shown in the diagram to the left?
6

Protein Synthesis – the building of proteins

- Proteins are synthesized by **ribosomes** in the *cytoplasm (on rough ER or floating freely in the cytoplasm),*
- The DNA is located in the nucleus of a eukaryotic cells.
- Additional molecules will be needed to carry the DNA code to the cytoplasm to form proteins. *This molecule is called RNA (Ribonucleic Acid).*
- RNA nucleotides are composed of:

1) Ribose Sugar
2) Phosphate Group
3) One of four Nitrogen Bases: Adenine, Guanine, Cytosine and **Uracil**

Proteins come in many forms. Due to the variety of different proteins, they serve many different functions that contribute to the growth, maintenance and replacement of cells.

Type of Protein	Name of Protein	Exact Function
Structural	Collagen	In structure of skin tissues
	Keratin	In structure of hair, bones, skin and nails
Contractile	Myosin, actin	In muscle contraction
Transport	Hemoglobin	In carrying oxygen in blood
Hormones	Insulin, glucagon	In control of blood sugars
Enzymes	Pepsin, amylase	In digestion of organic compounds
	DNA polymerase	Replication or duplication of DNA
Protective	Gamma globulin	In antibody formation
	Fibrinogen	In blood clotting
Toxins	Venom	Used for protection or to capture prey

- **Differences between DNA and RNA:**

Characteristic	DNA	RNA
Location in the cell	found only in the nucleus	Nucleus & cytoplasm
Type of sugar in nucleotide	deoxyribose	Ribose
Number of strands	2	One
Nitrogen bases	A,G,C, thymine--no uracil	A,G,C, Uracil-no thymine
Can be copied or replicated	yes	No
Different forms	only one form—DNA	mRNA, tRNA and rRNA

Three types of RNA necessary for the synthesis of proteins:

1) **mRNA – messenger RNA**: *carries an RNA "copy" of the DNA gene code from the nucleus to the cytoplasm.*

2) **tRNA – transfer RNA**: *transports amino acids from the cytoplasm to the ribosome so they can be joined to make a protein.*

3) **rRNA – ribosomal RNA**: *molecules of rRNA make up the ribosomes two units plus associated proteins (function is purely structural).*

Gene Expression

How the genes are *expressed* is a function of the protein produced.

Recall the Central Dogma:

DNA (Gene) → **mRNA** → **Protein** → **Trait** (Expression)

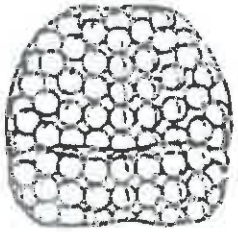
STEPS IN THE SYNTHESIS OF A PROTEIN:

1)**Transcription:** *mRNA strand is built from the code on the DNA strand (gene).*

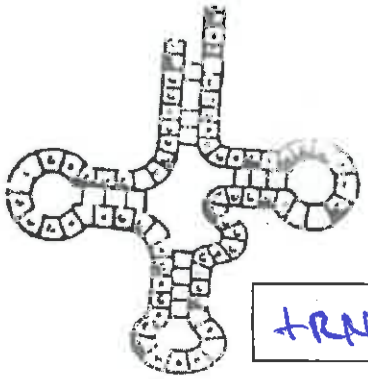
2) **Translation:** *mRNA strand is used at the ribosome to help join amino acids to form a protein.*

Label the following molecules as either mRNA, tRNA or rRNA.

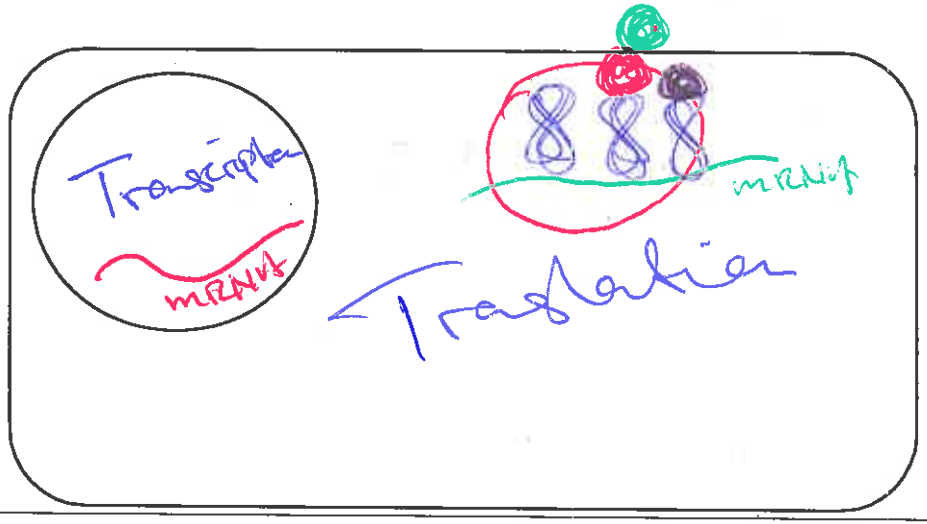
mRNA



rRNA



tRNA



Transcription

Requirements for Transcription:

1) a *gene segment* on the DNA.
2) many free floating *RNA nucleotides*
3) the *enzyme RNA Polymerase*

Steps in Transcription: (catalyzed by RNA polymerase)

1) DNA double helix unwinds at the area of DNA where the gene is located.
2) Weak hydrogen bonds break between the two DNA strands.
3) Free floating RNA nucleotides bond with complementary DNA nucleotides to form a one strand of mRNA.
4) When the mRNA is completely formed it breaks away from the DNA.
5) The DNA strands reconnect and the mRNA is free to travel to the cytoplasm.

A gene holds the code for a functional protein or polypeptide. The code is found *in the sequence of nucleotides on **one** strand of the DNA at a specific location on a chromosome.*

In 1961, Francis Crick and coworkers proposed a **triplet code** for the formations of **amino acids** from DNA.

Triplet Code: *a set of three nucleotides that codes for a single amino acid in the protein* = ***Codon***

Create a mneumonic device to remember the requirements for transcription:

(gene segment) G: Get

(RNA nucleotides) R: Really

(enzyme RNA Polymerase) E: Excited

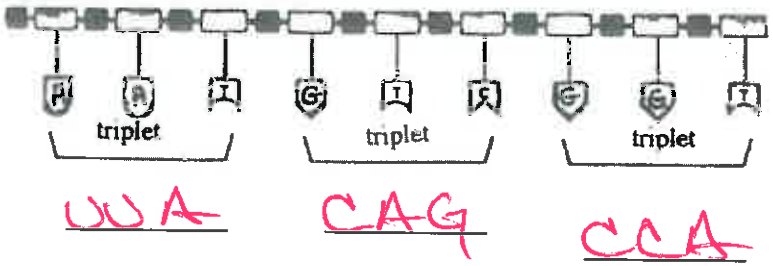
Example of Transcription:

The DNA code for a polypeptide is as follows:

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

AUG GGC AUC GAA UGA

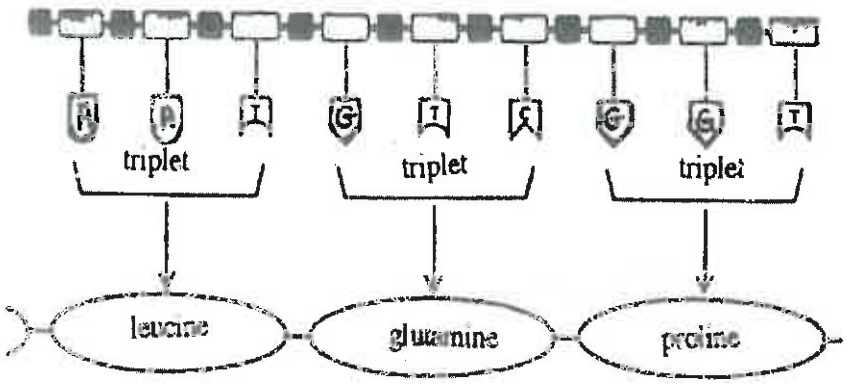
Fill in the nitrogen bases that are complementary to this DNA strand.



UUA CAG CCA

Fill in the triplet codes (codons) above on the complementary strand of mRNA.

Notice that **three** bases in the DNA code for a single amino acid.



(The gene is read from **one** of the two DNA strands.)

Each triplet code on a DNA molecule is transcribed into a triplet ***codon*** on the mRNA molecule.

Some codons have special functions:

- **Start codon**: *signals the ribosome that it is the beginning of the mRNA sequence.*
  - i.e **AUG** – codes for the amino acid methionine.

- **Stop codon**: *signals the ribosome that it is the end of the mRNA sequence and triggers the release of the mRNA from the ribosome.*
  - i.e. **UAA, UAG, UGA – *DON'T*** code for an amino acid!!!

1) Identify the ***phospate groups*** (PO_4), ***sugars***, ***nitrogen bases*** and ***amino acids*** in the picture to the left.

2) If a protein is made of 100 amino acids, how many bases in the DNA are needed to code for the protein?

   Hint: # of nitrogen bases = # of amino acids x 3 + 3 (to account for the stop codon)

   Answer: $(100\,AA \times 3) + 3SN = 303$ TN

Practice:

DNA Code: T A C C A T C C C A A A A C T

mRNA codons: AUG GUA GGG UUU UGA

*What does each letter in the code or codon represent?

*What does each codon represent?

*Because each base triplet on the mRNA stands for an amino acid, each mRNA molecule must contain 3 times the number of nucleotides as the number of amino acids making up the protein.

*A mRNA strand with 66 nucleotides codes for a polypeptide 21 amino acids in length.

*A protein 300 amino acids in length was made from an mRNA strand 903 nucleotides in length.

mRNA Codon Chart

We can use the following chart to determine the exact sequence of amino acids that will make up a protein.

In the genetic code, each amino acid is coded for by three mRNA bases arranged in a specific sequence.

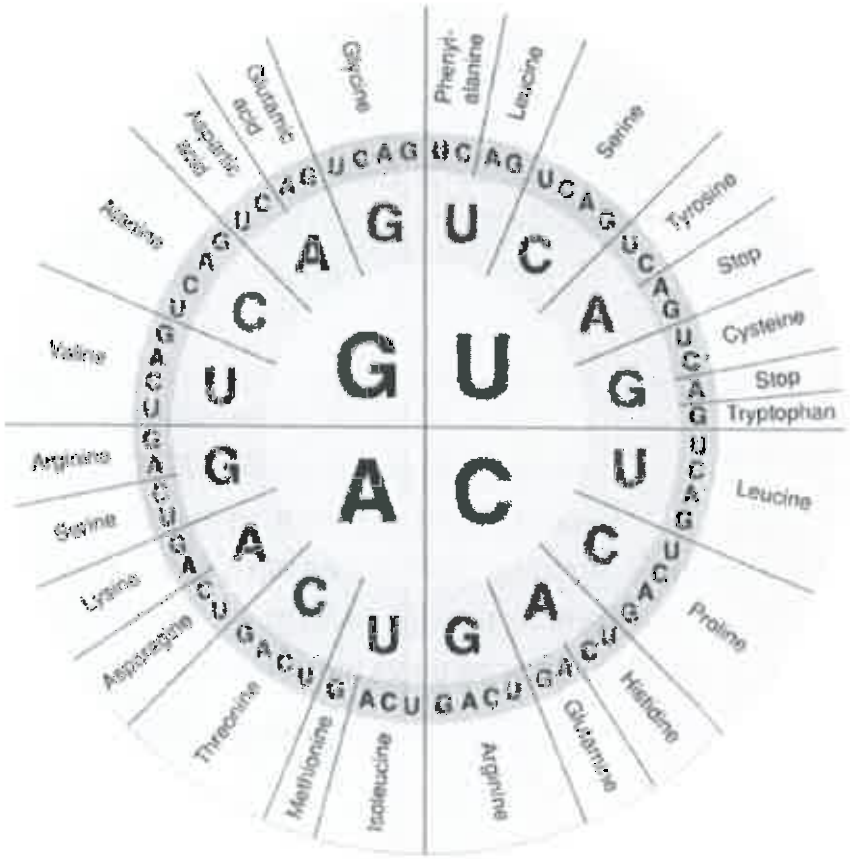
a The first base in a codon is found along the left side of the chart.

b The second base is at the top of the chart.

c The third base in the codon is found along the right side of the chart.

1st ↓ / 2nd →	U	C	A	G	
U	Phenylalanine Phenylalanine Leucine Leucine	Serine Serine Serine Serine	Tyrosine Tyrosine *Stop* *Stop*	Cysteine Cysteine *Stop* Tryptophan	U C A G
C	Leucine Leucine Leucine Leucine	Proline Proline Proline Proline	Histidine Histidine Glutamine Glutamine	Arginine Arginine Arginine Arginine	U C A G
A	Isoleucine Isoleucine Isoleucine Methionine	Threonine Threonine Threonine Threonine	Asparagine Asparagine Lysine Lysine	Serine Serine Arginine Arginine	U C A G
G	Valine Valine Valine Valine	Alanine Alanine Alanine Alanine	Aspartic acid Aspartic acid Glutamic acid Glutamic acid	Glycine Glycine Glycine Glycine	U C A G

If the chart on the previous page is too confusing then you can also use this codon chart:



Practice:

1) How many different mRNA codons are there on the chart? 64

2) How many different amino acids are there? 20*

3) With the exception of Methionine and Tryptophan, more than one nucleotide triplet codes for each amino acid. Give an example of an amino acid which has more than one codon.
Lysine

4) What do you notice about the codons that code for the same amino acid?
2 similar bases, 1st 2 of 3.

5) What is the only Start codon? AUG
What is the DNA code for the mRNA start codon? TAC

6) What amino acid does every polypeptide begin with?
Methionine

7) How many Stop codons are there? 3

8) What are the Stop codons? UAA, UAG, UGA
What are the DNA codes for the mRNA stop codons?
ATT, ATC, ACT

After transcription has taken place, the mRNA moves **OUT** of the nucleus to link with a ribosome in the cytoplasm.

Then **TRANSLATION** **will begin.**

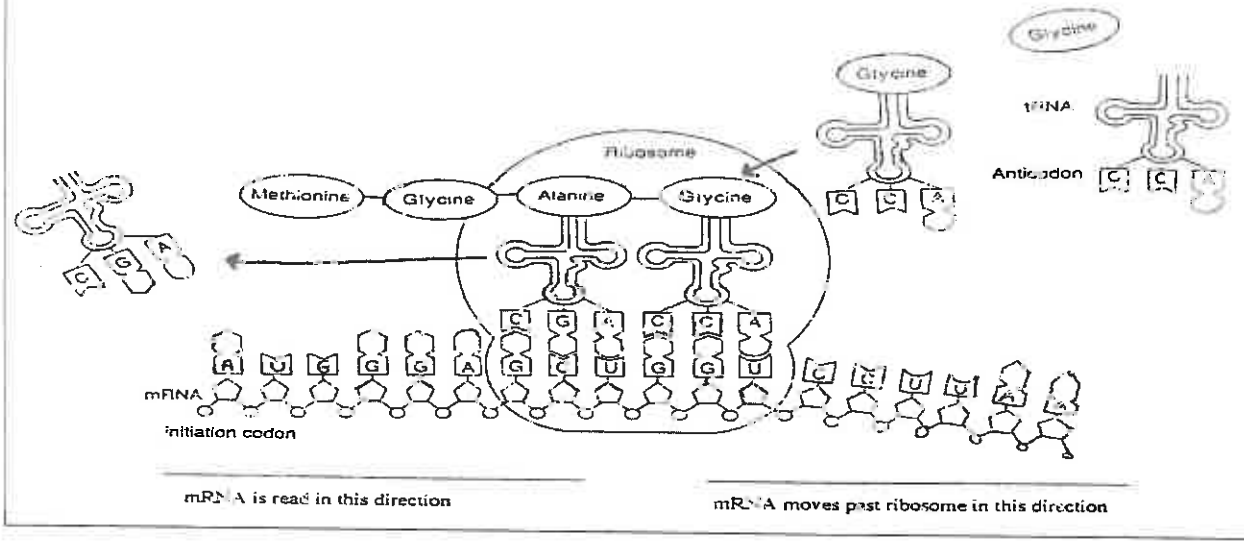
Translation: *the process of using mRNA codons to build proteins at the site of the ribosome in the cytoplasm or on the rough endoplasmic reticulum (rough ER).*

Requirements for Translation:

1) *mRNA* – it carries the DNA code as 'codons'.
2) *ribosomes* – 2 rRNA + protein subunits
3) *tRNA* – carry the amino acids from the cytoplasm to the ribosome to be joined to form proteins.
4) Many *amino acids* in the cytoplasm.
5) All the necessary *enzymes*.

Steps in Translation:

1) mRNA joins with the ribosome in the cytoplasm or the rough ER.
2) tRNA with an amino acid attached joins the mRNA codon to the anti-codon. (*the anticodon on the tRNA is complementary to the codon on the mRNA*)
3) A second tRNA with an attached amino acid joins the mRNA.
4) A *peptide bond* forms between the first 2 amino acids.
5) The first tRNA released from the mRNA and the amino acids stay bonded together.
6) The mRNA slides through the ribosome to expose the next codon.
7) The next tRNA with an amino acid joins the mRNA.
8) The sequence 2-7 is repeated **until a stop codon** is reached.



Notes: (Recommend making a mneumonic device for the requirements for translation.)

The Final Products of Protein Synthesis

- The final products of protein synthesis are either a *non-functional polypeptide* or a *functional protein*.
- Many times a protein must be *modified* after it is translated. This is done in the cytoplasm, the ER and/or the Golgi.
- Some proteins are coded for by a single gene, i.e insulin (which is later broken into 2 segments).
- Some proteins are composed of different genes, i.e. hemoglobin (2 genes, 4 segments).

This is directly from the USG section of what you should be ***able to do by the end of the unit (#1):***

Relate the terms DNA, chromosome, gene, RNA, protein, and trait.

DNA makes RNA
RNA makes Proteins
Proteins dictate Traits
DNA makes up Chromosomes
Chromosomes are made of genes

Gene Mutations

Gene Mutations: *any change in the normal sequence of nucleotides in a gene sequence*.

There are different variations of gene mutations.

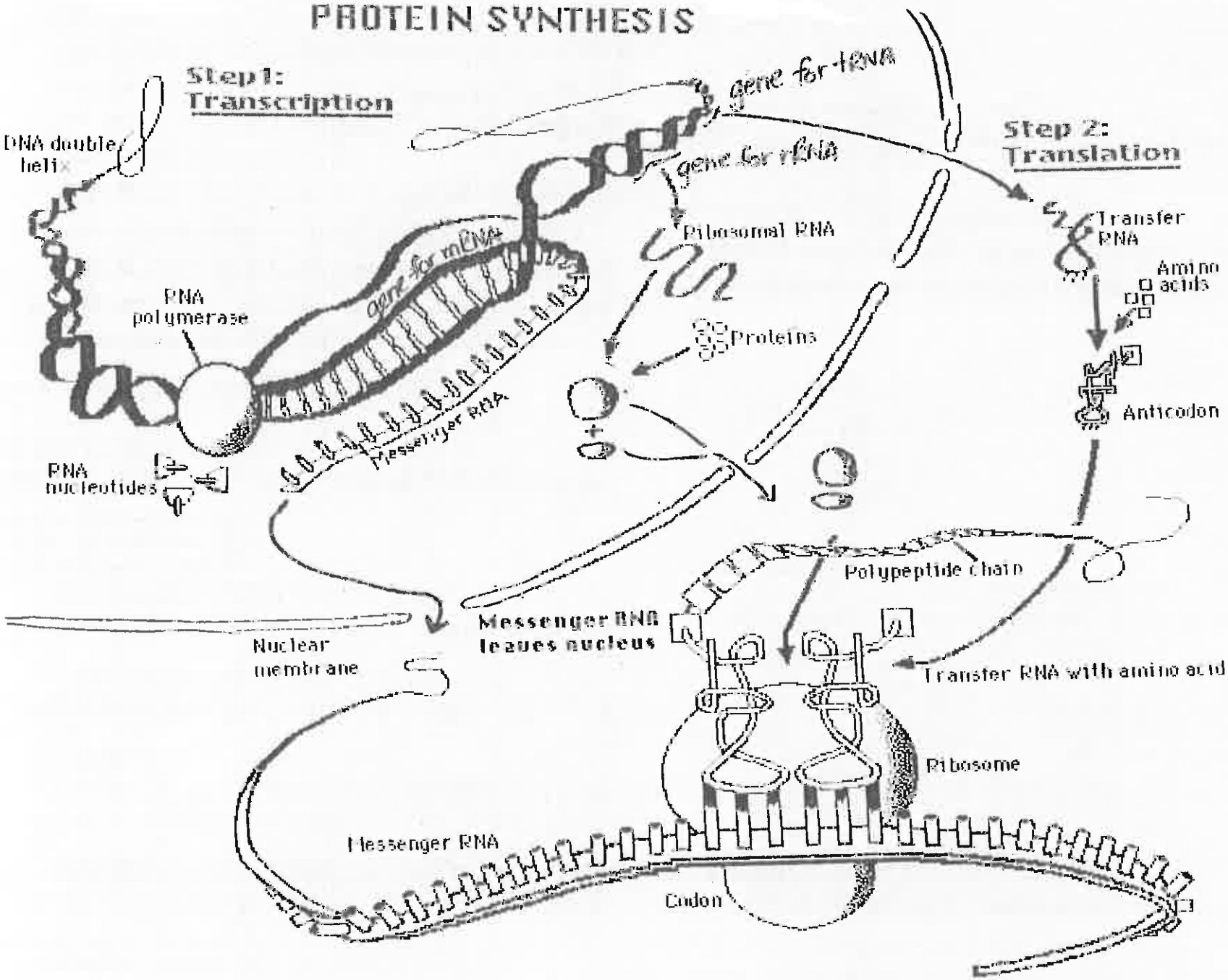
1) They can be *harmful*, *helpful* or have *no effect*.
2) They can occur spontaneously during DNA replication despite the enzymes that help to proof read the DNA.
3) Many of the mutations in the DNA are caused by **mutagens**: *any physical or environmental agent that can cause a genetic mutation*.
4) An altered gene may be passed on to every cell that develops from it BUT it will be carried on to the next generation only if the mutation takes place in a *sperm or egg cell*

Some mutagens are:

1) Pesticides
2) Tobacco smoke
3) X rays
4) UV rays

If a mutation occurs in a gene it is usually harmful. It can cause diseases such as cancer, and many hereditary diseases that are passed from parent to offspring.

If you inherit a disease such as hemophilia, what are you actually inheriting? Mutations


PROTEIN SYNTHESIS
Step 1:
Transcription
DNA double helix
gene for tRNA
gene for rRNA
gene for mRNA
Ribosomal RNA
RNA polymerase
Proteins
Messenger RNA
RNA nucleotides
Step 2:
Translation
Transfer RNA
Amino acids
Anticodon
Polypeptide chain
Messenger RNA leaves nucleus
Nuclear membrane
Transfer RNA with amino acid
Ribosome
Messenger RNA
Codon

There are several ways that the base sequence can be changed or mutated:

1) **Addition** of an extra nucleotide within the sequence.
2) **Deletion** of a nucleotide within the sequence.
3) **Substitution** of a different nucleotide for one normally present in the sequence.

Analogy:

Read the following sentence (remember, it's read in triplets.

The fat cat ate the rat.

- **Addition:**
  Add a b in front of the **f** in fat. Shift everything to the right.

  The bfa tca tat eth era t

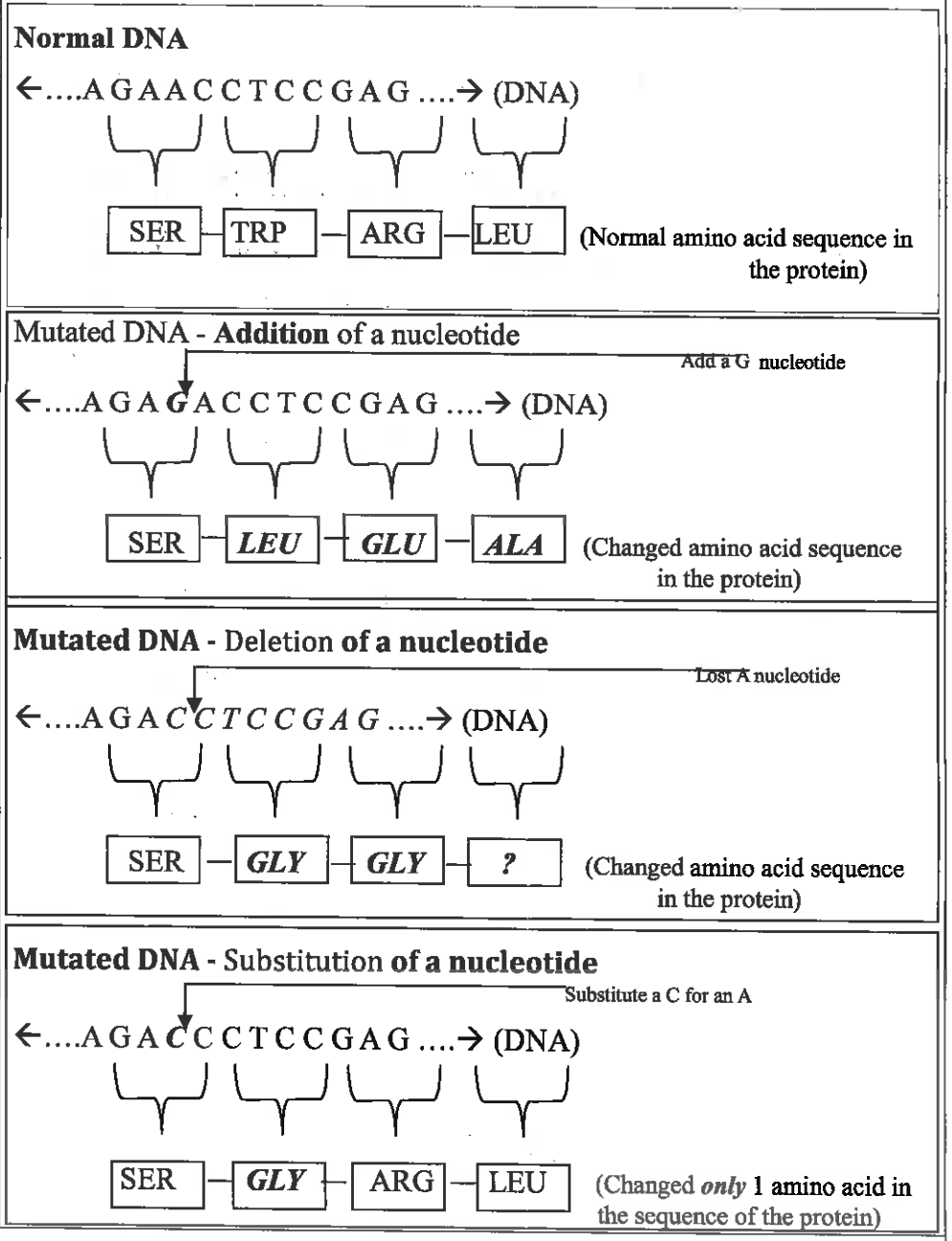
- **Deletion:**
  Delete the **f** in fat. Shift everything to the left.

  The atc ata tet her at

- **Substitution:**
  Substitute the letter **b** for the **f** in the word fat and read the sentence again.

  The bat cat ate the rat

Which change does the least damage to the sentence structure?



An example of a disease casued by a gene mutation is the disease **Sickle Cell Anemia**.

What is sickle cell anemia:

A nucleotide substitution which results in hemoglobin oleucles that become rigid, causing the red blood cell to assume a half-moon or "sickle" shape. The cells do not carry oxygen as effectively and can have difficulty moving through tiny capillaries due to their decreased flexibility and increased tendency to stick together. Causes debilitating pain, strokes, eye damage and shortened life span. Medictions treat symptoms as there is no cure. Bone marrow transplants and gene therapy are being used with some success.

Because the gene sequence is mutated, the gene expression is altered.