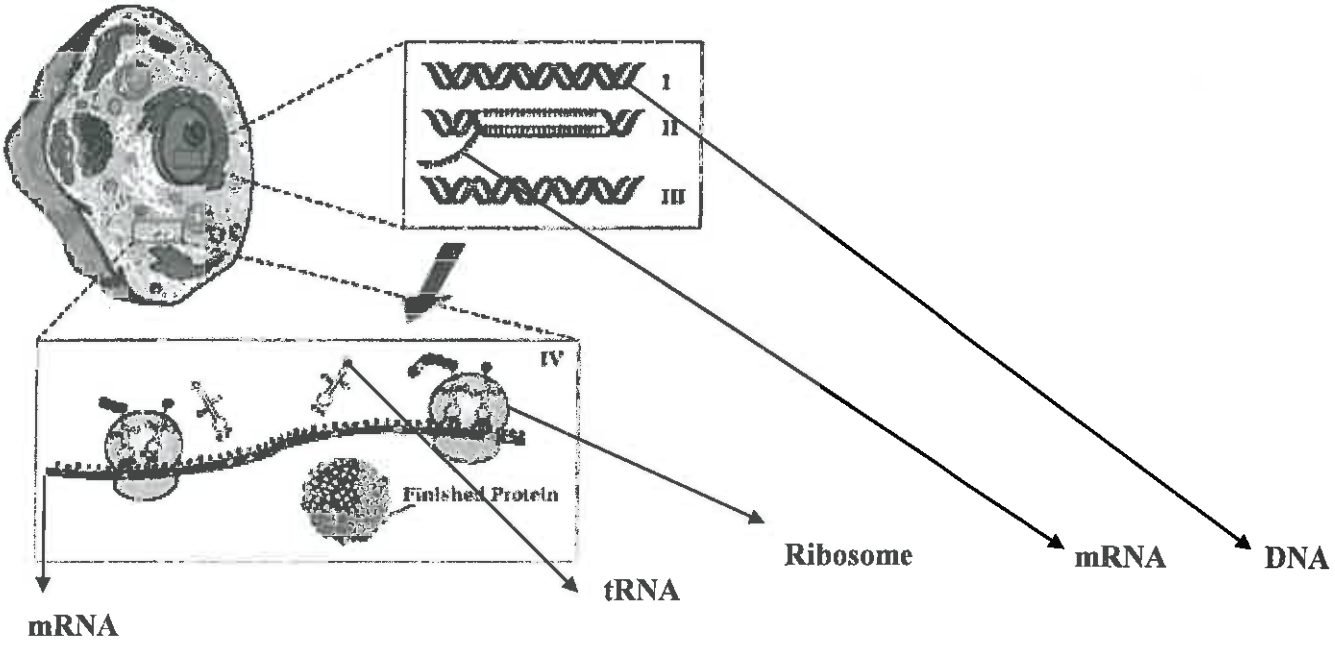
CODON TABLE

1st Base	2nd Base: U	2nd Base: C	2nd Base: A	2nd Base: G	3rd Base
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine (F)	Serine	Tyrosine (Y)	Cysteine (C)	C
	Leucine	Serine (S)	Stop	Stop	A
	Leucine (L)	Serine	Stop	Tryptophan (W)	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine (L)	Proline	Histidine (H)	Arginine	C
	Leucine	Proline (P)	Glutamine	Arginine (R)	A
	Leucine	Proline	Glutamine (Q)	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine (I)	Threonine	Asparagine (N)	Serine (S)	C
	Isoleucine	Threonine (T)	Lysine	Arginine	A
	Methionine (M)	Threonine	Lysine (K)	Arginine (R)	G
G	Valine	Alanine	Aspartic acid	Glycine	U
	Valine (V)	Alanine	Aspartic acid (D)	Glycine	C
	Valine	Alanine (A)	Glutamic acid	Glycine (G)	A
	Valine	Alanine	Glutamic acid (E)	Glycine	G
	U	C	A	G	

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
acid 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 -
Acid Acid 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 -
Acid 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 -
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 -
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 -
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 -
Acid Acid Acid Acid

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-CUU

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

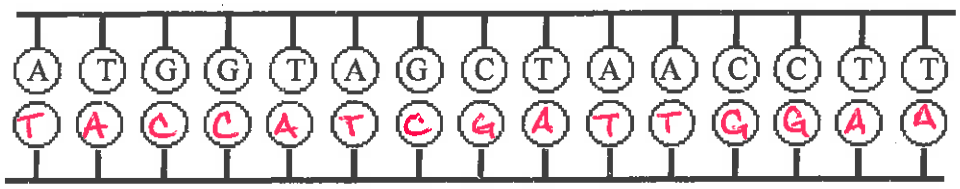
DNA triplets	mRNA codon	tRNA anticodon
CGG	GCC	CGG
CTA	GAU	CUA
TTC	AAG	UUC
GAC	CUG	GAC
CCT	GGA	CCU
TAC	AUG	UAC
GGT	CCA	GGU
ATT	UAA	AUU
GGG	CCC	GGG

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. 

DNA

2. 

mRNA

3. 

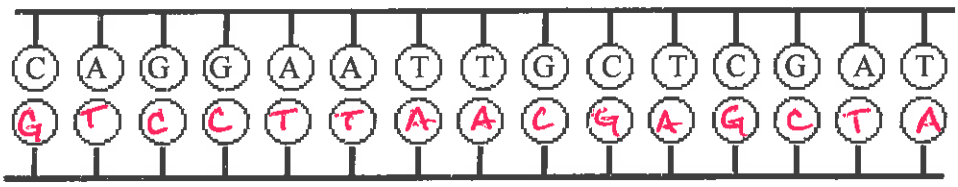
tRNA

4. 

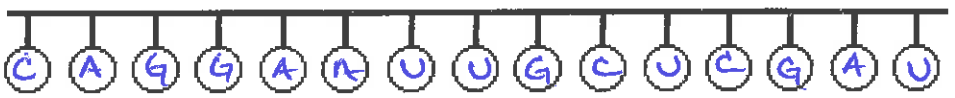
Amino Acids

5. mRNA is synthesized in translation or transcription?

6. mRNA has codons or anti-codons?

7. 

DNA

8. 

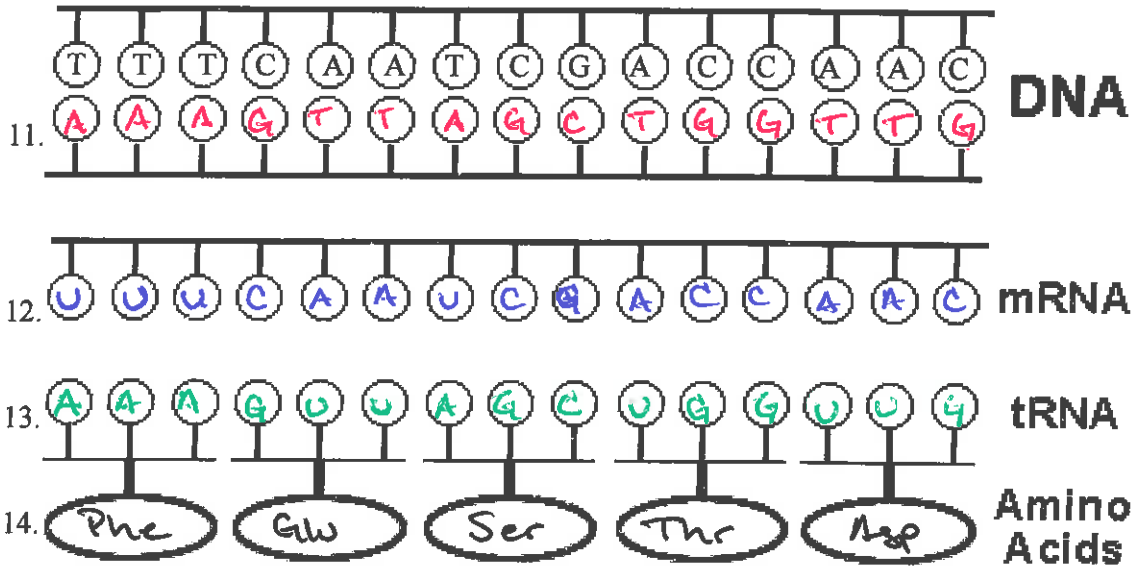
mRNA

9. 

tRNA

10. 

Amino Acids



15. 1 or 3 codons equal one amino acid?

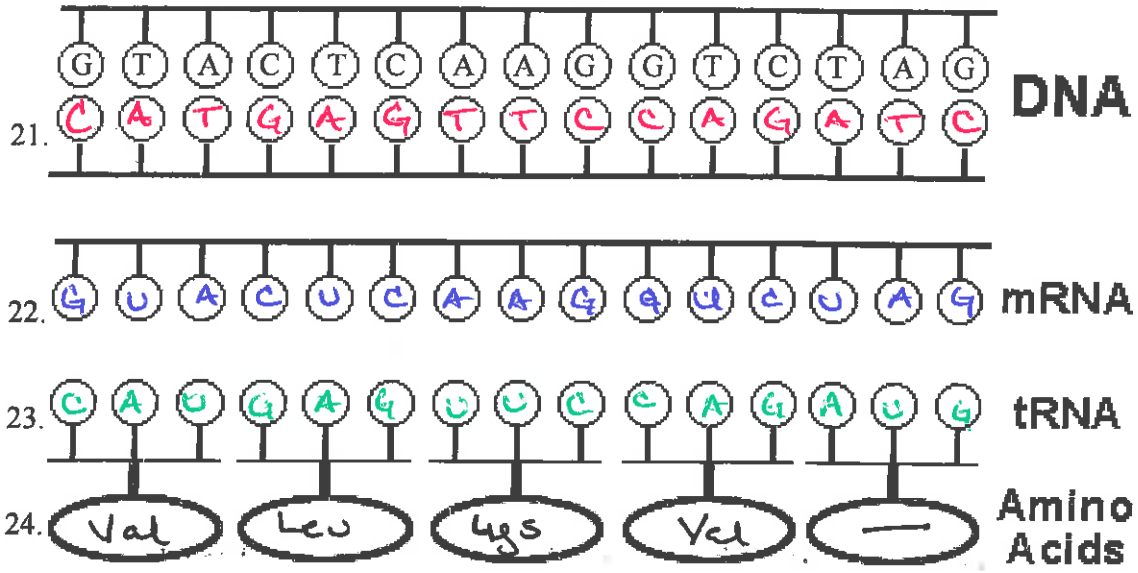
16. tRNA brings amino acids to the nucleus or ribosome?

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?



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

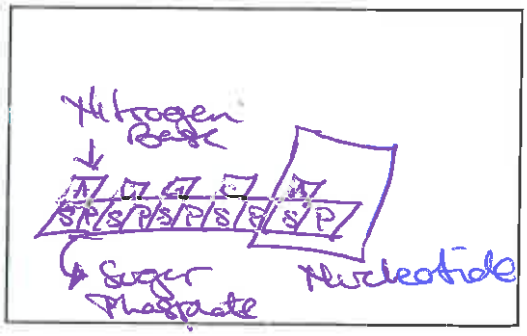
Messenger RNA

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

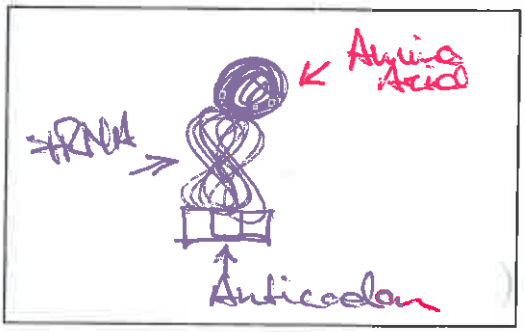
19. tRNA stands for transfer RNA.

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.



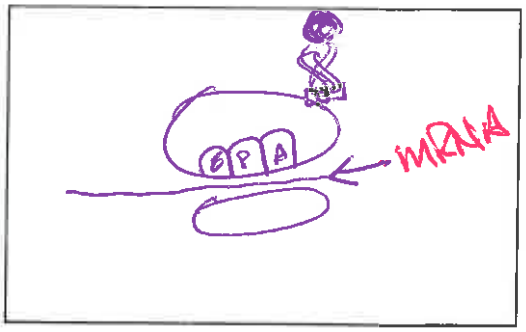
Ribosomal RNA

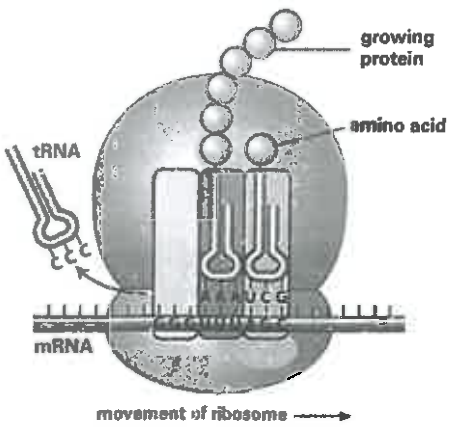
24. rRNA stands for Ribosomal RNA.

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

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

27. Draw a labeled diagram of a ribosome.



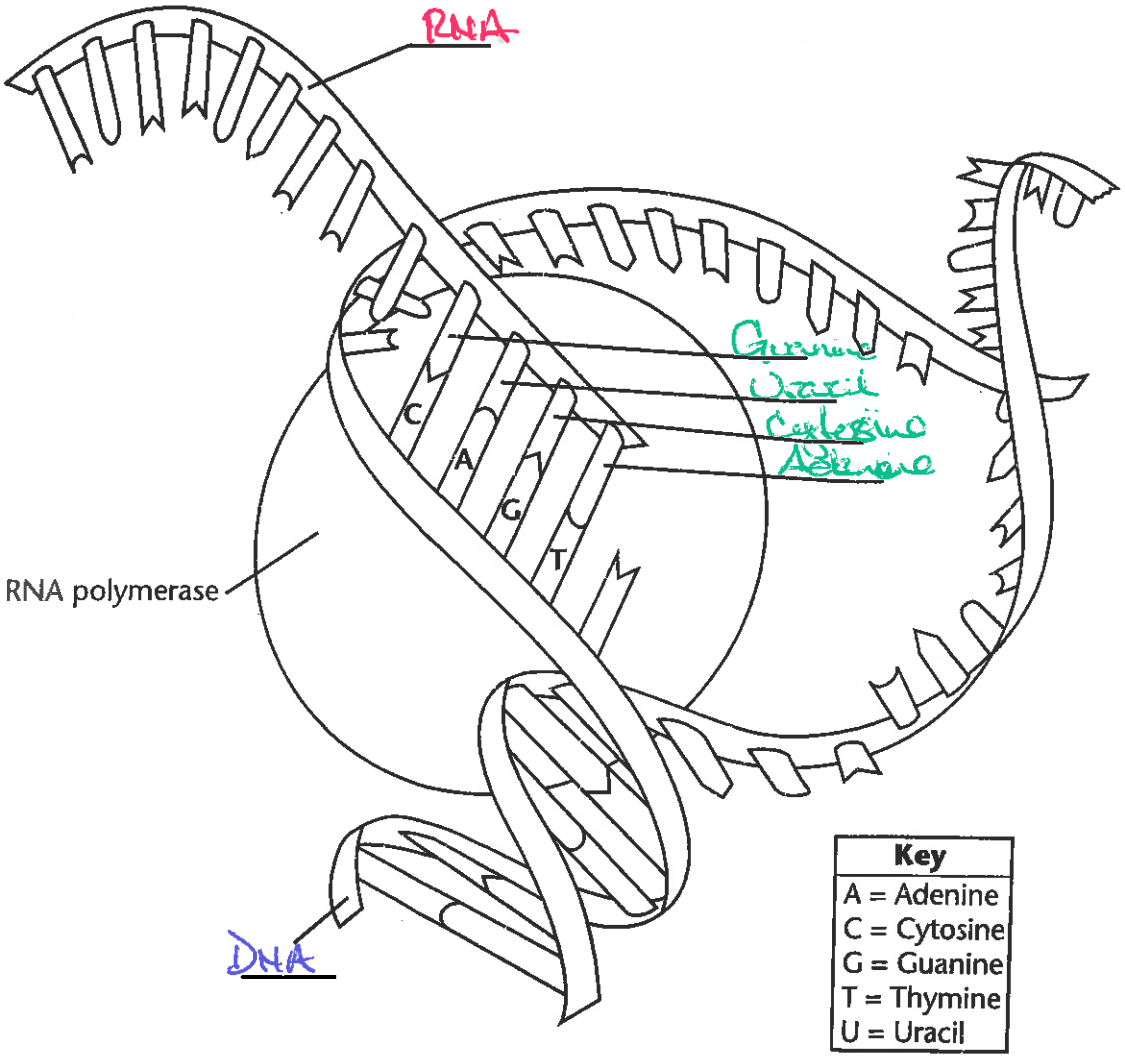


Name Key Class _____ Date _____

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

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	Single 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? Single Stranded

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:

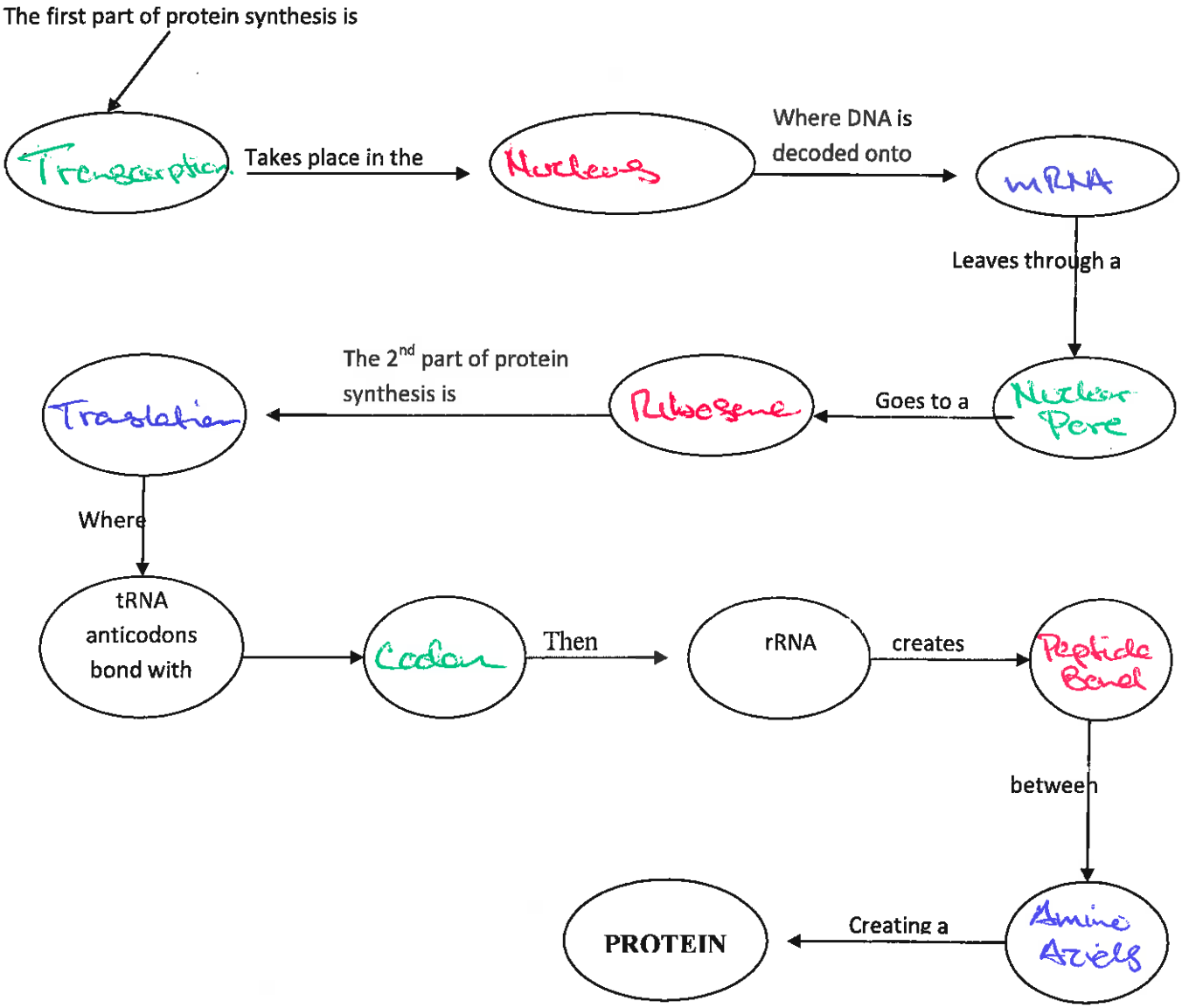
5. Name and describe the three types of RNA's involved in protein synthesis?
mRNA → Temporary copy of DNA transported to ribosome
tRNA → Brings AAs to Ribosome
rRNA → Combines with proteins to make ribosomes.

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? AUCGAUAGUUUA
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.**



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: UAUGCUUAGCGCUAGCGCGCGUAAGCC

   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: AAAUGCCGGUAGUCGGUAUGACC

   Codon: AUG-CCG-GUA-GUC-CGG-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 - threominene

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