Topic: Protein Synthesis – Polypeptide Activity

Summary: Students will simulate transcription and translation and learn how proteins are built from the DNA code. Students will learn how mRNA, ribosomes, tRNA and peptide bonds are used in the formation of a polypeptide.

Goals & Objectives: Students will be able to model the process of transcription and translation in protein synthesis and explain the importance of amino acid sequences.

Standards: CA Biology *4a. Students know* the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA. 4b. *Students know* how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA. 4e. *Students know* proteins can differ from one another in the number and sequence of amino acids. 5b. *Students know* how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.

Time Length: 60 minutes

Prerequisite Knowledge: DNA base pairing, enzymes, amino acids, proteins, ribosomes.

Materials:
Two mRNA pieces of paper per group of students
DNA molecules – cut out each molecule
Photocopy many pages of the amino acids, cut out, each separated, and sorted
Photocopy many tRNA molecules for students
Scissors
Scotch tape - one per two students or group

Activity Setup:
Nucleus: On the white board, tape the cut out DNA molecules at a height easy read by the students. Tape the label "Nucleus" on top the board. You can chose to use the provided DNA code or make up your own on the provided empty DNA molecule.

Cytoplasm: Tape the cytoplasm label on the back tables of the room. Place the associated amino acids in an easy accessible tray or container to help with organization and prevent mixing of the amino acids.

Ribosomes: Tape the ribosome labels on each student's desk. Place scotch tape on their desks also.

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Procedures:
1. Group the student in pairs of two. It is better if they share a table or have them move single desks together to create one table. Explain the instructions to the students. Students are going to make two polypeptides.

2. One student in the group is to go to the nucleus with the mRNA paper and transcribe the DNA code from the nucleus to the mRNA molecule. He or she will write down the codons onto the spaces provided--three letters per underline space. He or she will then return to their desk and place the code onto the ribosome.

3. The other partner then translates the code and writes the anti-codon onto the bottom of the tRNA molecule. The mRNA student looks up the amino acid that the tRNA student is supposed to get from the cytoplasm. P.S. The ribosome is also in the cytoplasm but students are to go to an organized location to get the amino acids.

4. The tRNA student goes and retrieves the correct amino acids and then brings them both back to the ribosome and places the tRNA anti-codon at the A site.

5. The tRNA is then moved to the left and the amino acid is left at the P site.

6. The mRNA student looks up the next amino acid and the tRNA student transcribes the next codon and writes down the anti-codon onto a new tRNA molecule. The tRNA student then goes and gets the next amino acid and brings it back to the ribosome. The tRNA anti-codon matches with the corresponding codon.

7. The first amino acid is then taped to the next amino acid. The tape is to represent a peptide bond. The tRNA is moved to the left and the two amino acids are left at the P site. The amino acids should be vertical with the first amino acid being farther from the P site. The chain of amino acids should be perpendicular to the P site and the mRNA.

8. This process repeats until a stop codon is reached. The student brings the stop codon. The amino acid chain is released (called a polypeptide). Students do not tape the stop codon to the polypeptide.

Accommodations: Students who are not able to walk can stay at their seat and perform the duties at the ribosome, while the other student performs the walking duties. Students with an IEP can make one polypeptide or transcribe and translate one or two codons instead of the amount required for a polypeptide.

Evaluation:
The performance of the activity is worth 10 points. Each correct polypeptide is worth 10 points. The assignment is worth a total of 30 points.

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Teacher Key

mRNA Sequence

1. AUG – CCU – GUA – CGC – GGU – GUU – GCG – AUA - UGA
2. AUG – CUG – AGA – CCC- ACU – UCC – UAC – UAA
3. AUG – ACA – CUA - UUG – CCC – CCG – GAU – UCC – UUC - UAG
4. AUG – ACG - ACC – CUC - UCU – ACU – AGU – GGA – UAG

Amino Acid Sequence

1. Methionine – Proline – Valine – Arginine – Glycine – Valine – Alanine – Isoleucine - STOP
2. Methionine – Leucine – Arginine – Proline – Threonine – Serine – Tyrosine - STOP
3. Methionine – Threonine – Leucine – Leucine – Proline – Proline – Aspartic Acid – Serine – Phenylalanine - STOP
4. Methionine – Threonine – Threonine – Leucine – Serine – Threonine – Serine – Glycine - STOP

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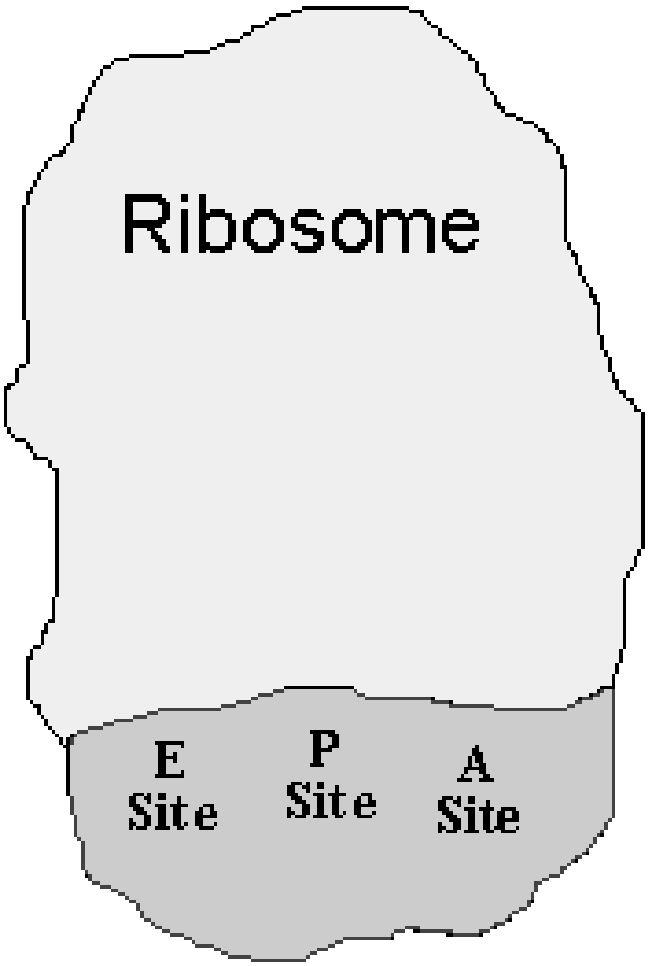
Found in the Cytoplasm



Amino Acid Alanine

Amino Acid Aspartic Acid

Amino Acid Arginine

Amino Acid Asparagine

Amino Acid Cysteine

Amino Acid Glutamic Acid

Amino Acid Histidine

Amino Acid Glutamine

Amino Acid Isoleucine

Amino Acid Lysine

Amino Acid Leucine

Amino Acid Methionine

Amino Acid Proline

Amino Acid Phenylalanine

Amino Acid Serine

Amino Acid Threonine

Amino Acid Tryptophan

Amino Acid Tyrosine

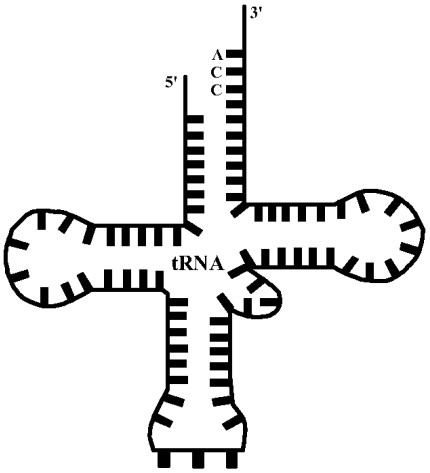
Amino Acid Valine

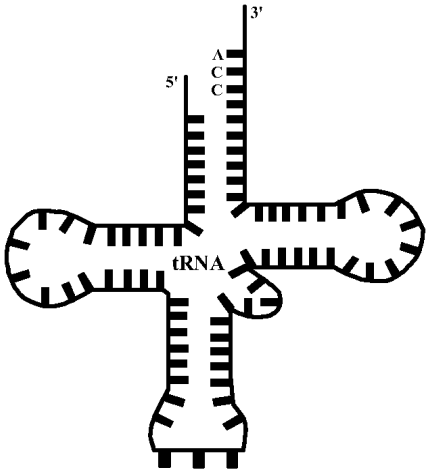
Amino Acid Glycine

STOP

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	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	Stop	Stop	A
	Leucine	Serine	Stop	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartic acid	Glycine	U
	Valine	Alanine	Aspartic acid	Glycine	C
	Valine	Alanine	Glutamic acid	Glycine	A
	Valine	Alanine	Glutamic acid	Glycine	G


3'
A
C
C
5'
tRNA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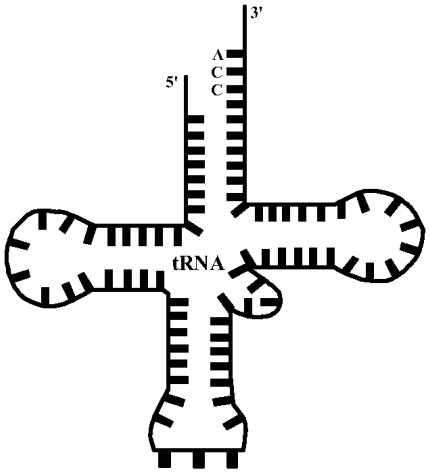
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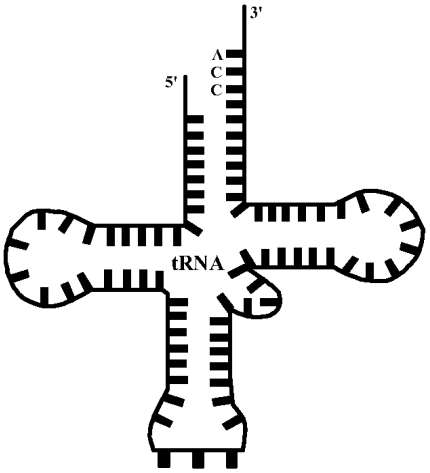
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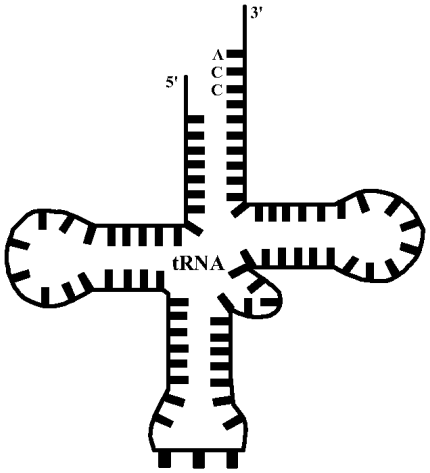
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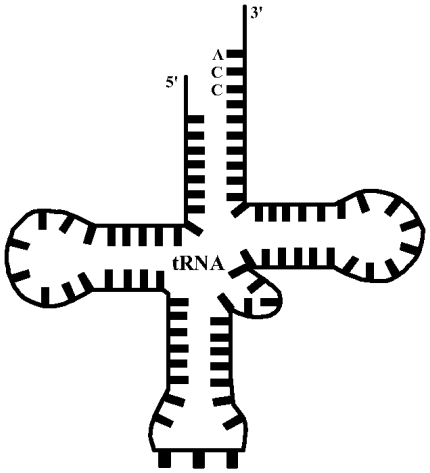
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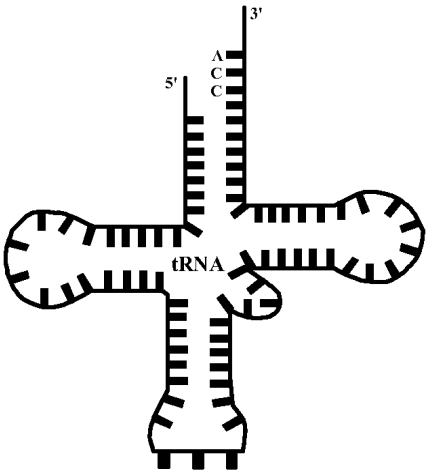
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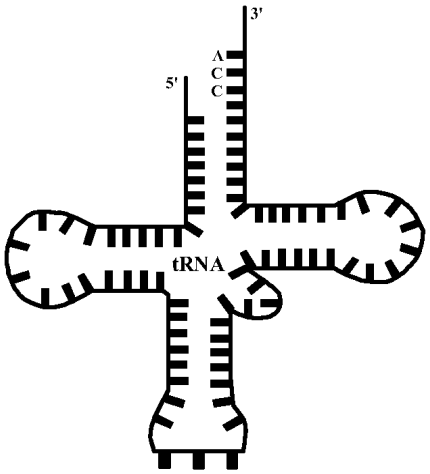
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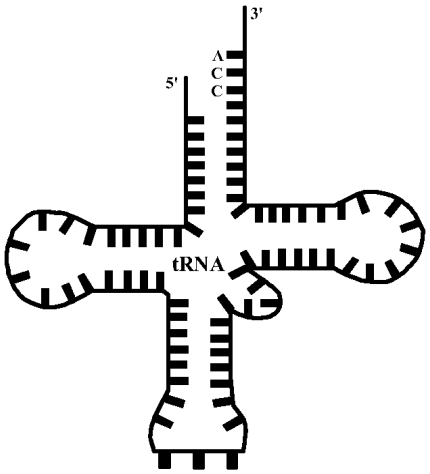
3'
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mRNA codons

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mRNA codons

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mRNA codons

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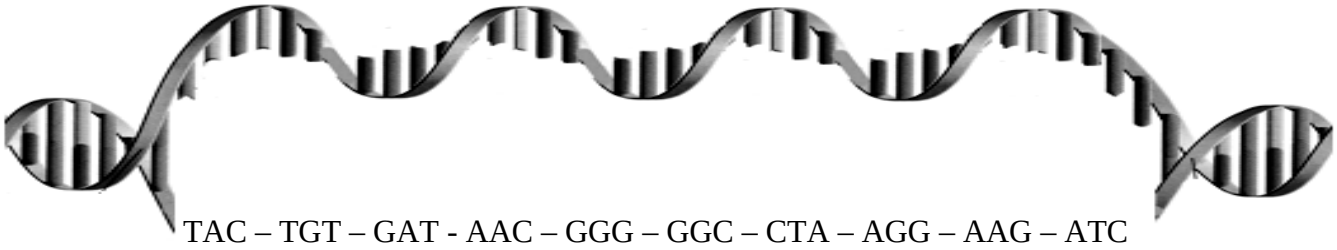
1

TAC – GGA – CAT – GCG – CCA – CAA – CGC – TAT – ACT

2

TAC – GAC – TCT – GGG - TGA – AGG – ATG – ATT

3



TAC – TGT – GAT - AAC – GGG – GGC – CTA – AGG – AAG – ATC

4

TAC – TGC - TGG – GAG - AGA – TGA – TCA – CCT – ATC

Cytoplasm

Nucleus