Topic: Protein Synthesis - Sentence Activity

Summary: Students will simulate transcription and translation by building a sentence/polypeptide from words/amino acids.

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:
Three mRNA strips of paper per group
DNA molecules – cut out each molecule
Photocopy the anti-codons on one side and on the backside photocopy the following amino acid / word page
Scissor to cut out the DNA, tRNA and mRNA cards
Paper and pencil to write the sentences
Scotch tape

Activity Setup:
Nucleus: On a table in the back of the room, tape the cut out DNA molecules to the table. Tape the label "Nucleus" on top of the table. You can chose to use the provided DNA code with the sentences in the teacher key or change the code around to make new sentences. You can also choose to write in your own words for the back of the tRNA cards.

Cytoplasm: Tape the cytoplasm label on the white board in the front of the room. Tape the tRNAs with the anti-codon facing the student onto the board. The word and associated amino acid should be facing the board so that the students cannot see the word.

Ribosomes: Tape the ribosome labels on each student desk.

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.

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 goes to the white board to get the tRNA with the corresponding anti-codon. The student takes the tRNA card from the board and brings it to the ribosome. The other student then writes the word on the back of the tRNA card onto their piece of paper. The tRNA student returns the card back to the white board.

4. The process repeats until a sentence is ended with the word STOP.

5. Students are going to make three sentences.

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 sentence or transcribe and translate one or two codons instead of the amount required for a sentence.

Evaluation:
Each correct sentence is worth 10 points each. The assignment is worth a total of 30 points.

1st Base	2nd Base: U	2nd Base: C	2nd Base: A	2nd Base: G	3rd Base
U	UUU = code	UCU = a	UAU = amino	UGU = eating	U
	UUC = learn	UCC = to	UAC = study	UGC = here	C
	UUA = do	UCA = are	UAA = STOP	UGA = STOP	A
	UUG = helix	UCG = for	UAG = STOP	UGG = college	G
C	CUU = genetic	CCU = I	CAU = acid	CGU = sequence	U
	CUC = have	CCC = is	CAC = read	CGC = learning	C
	CUA = double	CCA = be	CAA = your	CGA = studying	A
	CUG = protein	CCG = so	CAG = it	CGG = student	G
A	AUU = this	ACU = fun	AAU = life	AGU = summer	U
	AUC = what	ACC = can	AAC = DNA	AGC = sleeping	C
	AUA = school	ACA = the	AAA = from	AGA = synthesis	A
	AUG = START	ACG = you	AAG = want	AGG = teacher	G
G	GUU = science	GCU = all	GAU = cool	GGU = class	U
	GUC = enjoy	GCC = go	GAC = not	GGC = about	C
	GUA = think	GCA = my	GAA = bad	GGA = vacation	A
	GUG = will	GCG = in	GAG = best	GGG = today	G

Teacher Key

mRNA codons

1. AUG – CCU – GUC – CGC – GGC – 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
5. AUG – AUU – AUA – CCC – GAG- UCG – CGA - UCG – UGG – UAA
6. AUG – CCU – GUC – CGA - ACA – CUU – UUU – UAG
7. AUG – AAU – CCC- GCU – GGC – ACA –AAC – UUU – UGA
8. AUG – AGC - GCG – GGU – CCC- GAA – UCG – CGC – UAA
9. AUG – CGA - GUU – GUG - CCA – GAU – GCG – UGG – UAG
10. AUG – CCU – GUA – GCA – AGU – GGA – GUG – CCA - ACU – UAG

Sentences

1. START I enjoy learning about science in school STOP
2. START Protein synthesis is fun to study STOP
3. START The double helix is so cool to learn STOP
4. START You can have a fun summer vacation STOP
5. START This school is best for studying for college STOP
6. START I enjoy studying the genetic code STOP
7. START Life is all about the DNA code STOP
8. START Sleeping in class is bad for learning STOP
9. START Studying science will be cool in college STOP
10. START I think my summer vacation will be fun STOP

Anti-codon CUA

Anti-codon CGG

Anti-codon AUA

Anti-codon UGU

Anti-codon GUA

Anti-codon ACA

Anti-codon CGU

Anti-codon GCU

Anti-codon UCU

Anti-codon GGC

Amino Acid Alanine

GO

Amino Acid Aspartic acid

COOL

Amino Acid Threonine

THE

Amino Acid Tyrosine

AMINO

Amino Acid Cysteine

EATING

Amino Acid Histidine

ACID

Amino Acid Arginine

STUDYING

Amino Acid Alanine

MY

Amino Acid Proline

SO

Amino Acid Arginine

SYNTHESIS

Anti-codon GUG

Anti-codon UAC

Anti-codon UUU

Anti-codon UAU

Anti-codon ACC

Anti-codon ACG

Anti-codon AUG

Anti-codon GAG

Anti-codon AGG

Anti-codon CUC

Amino Acid Methionine

START

Amino Acid Histidine

READ

Amino Acid Isoleucine

SCHOOL

Amino Acid Lysine

FROM

Amino Acid Cysteine

HERE

Amino Acid Tryptophan

COLLEGE

Amino Acid Tyrosine

HAVE

Amino Acid Leucine

STUDY

Amino Acid Glutamic Acid

BEST

Amino Acid Serine

TO

Anti-codon CAU

Anti-codon CUU

Anti-codon UGC

Anti-codon UUA

Anti-codon UGA

Anti-codon AAA

Anti-codon UUG

Anti-codon CCC

Anti-codon GUC

Anti-codon GUU

Amino Acid Glutamic Acid

BAD

Amino Acid Valine

THINK

Amino Acid Asparagine

LIFE

Amino Acid Threonine

YOU

Amino Acid Phenylalanine

CODE

Amino Acid Threonine

FUN

Amino Acid Glycine

TODAY

Amino Acid Asparagine

DNA

Amino Acid Glutamine

YOUR

Amino Acid Glutamine

IT

anti-codon AAU

Anti-codon GAG

Anti-codon GAA

Anti-codon CCA

Anti-codon GGA

Anti-codon UAG

Anti-codon AGC

Anti-codon AAG

Anti-codon CAA

Anti-codon CAG

Amino Acid Leucine

HAVE

Amino Acid Leucine

___DO____

Amino Acid Glycine

___CLASS___

Amino Acid Leucine

___GENETIC___

Amino Acid Isoleucine

__WHAT__

Amino Acid Proline

___I____

Amino Acid Phenylalanine

__LEARN_

Amino Acid Serine

____FOR___

Amino Acid Valine

ENJOY

Amino Acid Valine

___SCIENCE___

anti-codon GGU

Anti-codon GAC

Anti-codon AGA

Anti-codon GGG

Anti-codon UCA

Anti-codon CAC

Anti-codon AGU

Anti-codon CCU

Anti-codon UAA

Anti-codon GCG

Amino Acid Leucine

PROTEIN

Amino Acid Leucine

BE

Amino Acid Glycine

IS

Amino Acid Glycine

A

Amino Acid Isoleucine

WILL

Amino Acid Isoleucine

SUMMER

Amino Acid Phenylalanine

VACATION

Amino Acid Serine

ARE

Amino Acid Valine

LEARNING

Amino Acid Valine

THIS

anti-codon AAC

Anti-codon ACU

Anti-codon UUC

Anti-codon AUU

Anti-codon CGA

Anti-codon AUC

Anti-codon UCG

Anti-codon GCC

Anti-codon CUG

Anti-codon GCA

Amino Acid Leucine

STOP

Amino Acid Leucine

HELIX

Amino Acid Glycine

STOP

Amino Acid Glycine

WANT

Amino Acid Isoleucine

STOP

Amino Acid Isoleucine

ALL

Amino Acid Phenylalanine

STUDENT

Amino Acid Serine

SLEEPING

Amino Acid Valine

SEQUENCE

Amino Acid Valine

NOT

anti-codon UCC

Anti-codon UGG

Anti-codon CCG

Anti-codon CGC

Anti-codon GAU

Anti-codon _____

Amino Acid Leucine

CAN

Amino Acid Leucine

TEACHER

Amino Acid Glycine

IN

Amino Acid Glycine

ABOUT

Amino Acid Isoleucine

_____

Amino Acid _____

DOUBLE

mRNA codons

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

mRNA codons

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

mRNA codons

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

mRNA codons

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mRNA codons

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mRNA codons

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

mRNA codons

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

mRNA codons

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

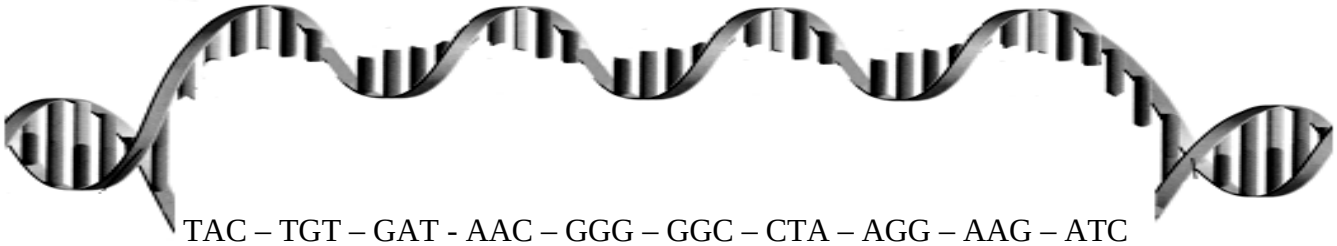
1

TAC – GGA – CAG – GCG – CCG – CAA – CGC – TAT – ACT

2

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

3

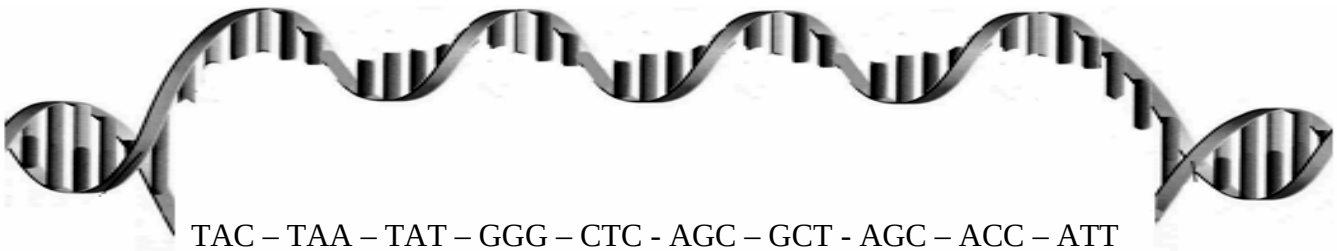


TAC – TGT – GAT - AAC – GGG – GGC – CTA – AGG – AAG – ATC

4

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

5



TAC – TAA – TAT – GGG – CTC - AGC – GCT - AGC – ACC – ATT

6

TAC – GGA – CAG – GCT - TGT – GAA – AAA – ATC

7

TAC – TTA – GGG - CGA – CCG – TGT – TTG – AAA – ACT

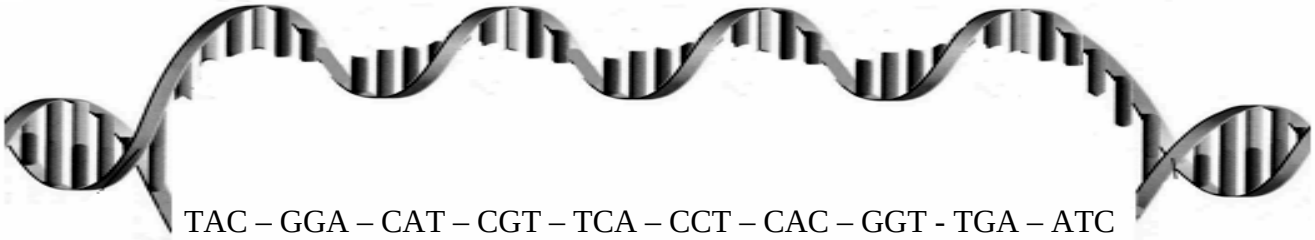
8

TAC – TCG - CGC – CCA – GGG - CTT – AGC – GCG – ATT

9

TAC – GCT - CAA – CAC - GGT – CTA – CGC – ACC – ATC

10



TAC – GGA – CAT – CGT – TCA – CCT – CAC – GGT - TGA – ATC

Found in the Cytoplasm