



SeaWorld/Busch Gardens Genetics

9-12 Classroom Activities

Translation Activity

OBJECTIVE

The student will identify the steps involved in the translation process.

ACTION

1. Divide the class into groups of four or five.
2. Define the process of translation and give a brief explanation using the background information.
3. Pass out one set of Translation Funsheets and an Amino Acid and Protein table to each group.
4. Explain that the activity is divided into two sections. The students will correlate the description of each translation step (listed on the second page of the translation Funsheets) with the illustration on the first page of the Translation Funsheets. There are blank spaces incorporated into the translation illustration for students to label each step with the titles listed above the descriptions on the second page.
5. Explain that every animal species is composed of various types of proteins necessary for life. Each group will represent a certain type of protein that is necessary for an animal to survive. Since each student group is representing a different protein, each group will be given different mRNA sequences. Assign each group one of the mRNA sequences listed below MATERIALS on page 23. The students will have to determine which protein they represent by utilizing the translation process.
6. Instruct students to complete the first section of the activity (correlating the illustration with the translation step descriptions on the second page). Review the correct answers as a class by using the Teacher's Guide. The first step to take in completing the second portion is to divide the given mRNA sequence into codons (three base-pairs). Next, the students will correlate each codon to the specific amino acid it codes for by using the Amino Acid Table. Finally, the students will determine which protein their group represents by observing the polymer of amino acids and correlating them to the specific protein they code for. This can be accomplished by utilizing the Protein table. Additionally, students should define the protein type they represent. I.E. How does the animal utilize that particular protein in their body? The answers may be checked for accuracy by using the Teacher's Guide.

TRANSLATION VOCABULARY

- Amino Acid:** An organic molecule possessing both carboxyl and amino groups. Amino acids serve as the monomers of proteins.
- Antibody:** An antigen-binding immunoglobulin, produced by B cells, that functions as the effector in an immune response.
- Anticodon:** A specialized base triplet on one end of a tRNA molecule that recognizes a particular complementary codon on an mRNA molecule.
- A-Site:** Aminoacyl-tRNA site; the binding site on a ribosome that holds the tRNA carrying the next amino acid to be added to a growing polypeptide chain.
- Codon:** A three-nucleotide sequence of DNA or mRNA that specifies a particular amino acid or termination signal and that functions as the basic unit of the genetic code.
- Enzymes:** A class of proteins serving as catalysts, chemical agents that change the rate of a reaction without being consumed by the reaction.
- Genetics:** The science of heredity; the study of heritable information.
- Gene:** One of many discrete units of hereditary information located on the chromosomes and consisting of DNA.
- Hemoglobin:** An iron-containing protein in red blood cells that reversibly binds oxygen.
- Hormone:** One of many types of circulating chemical signals in all multicellular organisms, that are formed in specialized cells, travel in body fluids, and coordinate the various parts of the organism by interacting with target cells.
- Myosin:** A type of protein filament that interacts with actin filaments to cause cell contraction.
- Protein:** A three-dimensional biological polymer constructed from a set of 20 different monomers called amino acids.
- P-Site:** Peptidyl-tRNA site, the binding site on a ribosome that holds the tRNA carrying a growing polypeptide chain.
- Ribosome:** A cell organelle constructed in

MATERIALS

Per student group:

- one Amino Acid Table
- one Protein Table
- one set of Translation Funsheets (2 pages)

Per class:

- one Teacher's Guide (per class)
- library or Internet access

mRNA SEQUENCES FOR GROUPS:

Student Group 1:

AUGGCCAUUUCAGAGUGGGUUUUCAGCACUGA

Student Group 2:

AUGCCGUUUUGCCGAACUAAAGACGUGCAAUAA

Student Group 3:

AUGCUGAAGAGCGGGGAGCCUUUUUAAUUAG

Student Group 4:

AUGCUCGUGCGGGGUUGAACCGAAGUGGUAA

Student Group 5:

AUGGACGCGGUUAUAGAACUUAUCUGUUAG

Student Group 6:

AUGCACUCCGAAUGGAUUACCAACUGGUGUGA

the nucleolus, consisting of two subunits and functioning as the site of protein synthesis in the cytoplasm.

RNA: (Ribonucleic acid) A single-stranded nucleic acid molecule involved in protein synthesis, the structure of which is specified by DNA. **Transcription:** the transfer of information from DNA molecule into an RNA molecule.

Transfer RNA: (tRNA): An RNA molecule that functions as an interpreter between nucleic acid and protein language by picking up specific amino acids and recognizing the appropriate codons in the mRNA.

Translation: The transfer of information from an RNA molecule into a polypeptide, involving a change of language from nucleic acids to amino acids.

Triplet Code: A set of three-nucleotide-long words that specify the amino acids for polypeptide chains.

Amino Acid Table

Amino Acid Table:

| Alanine | Arginine | Cysteine | Glutamine | Glycine |
|---------|----------|----------|-----------|---------|
| GCA | AGA | UGC | CAA | GGA |
| GCC | AGG | UGU | CAG | GGC |
| GCG | CGA | | | GGG |
| GCU | CGC | | | GGU |
| | CGG | | | |
| | CGU | | | |

| Asparagine | Aspartic Acid | Glutamic Acid | Histidine | Isoleucine |
|------------|---------------|---------------|-----------|------------|
| AAC | GAC | GAA | CAC | AUA |
| AAU | GAU | GAG | CAU | AUC |
| | | | | AUU |

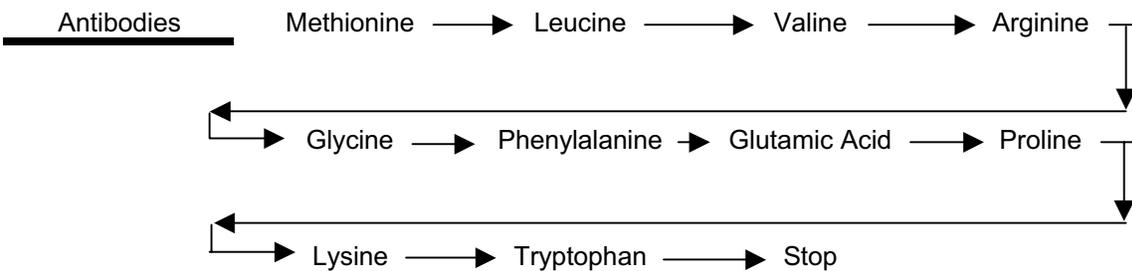
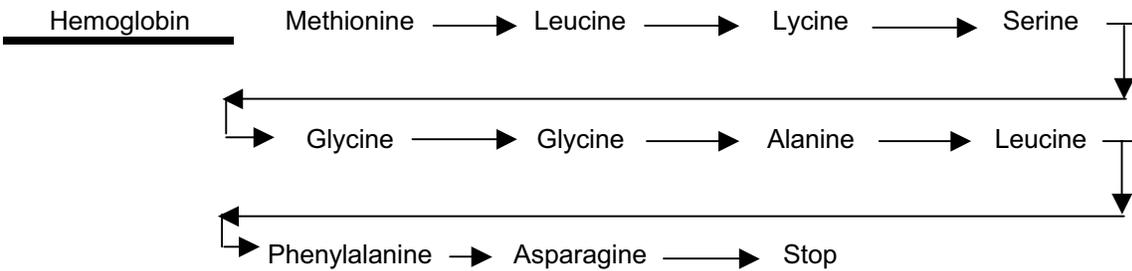
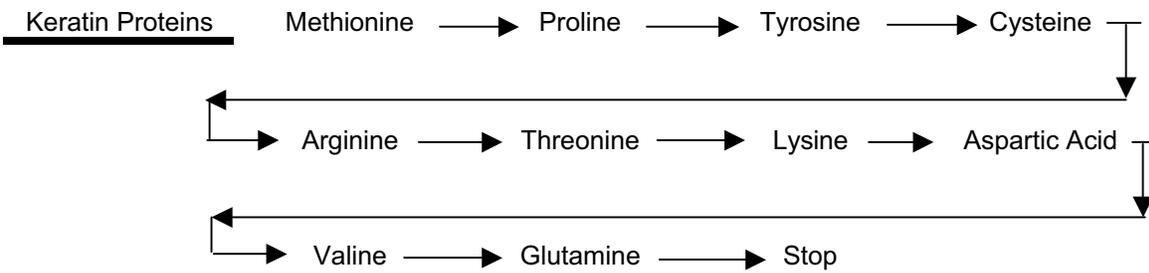
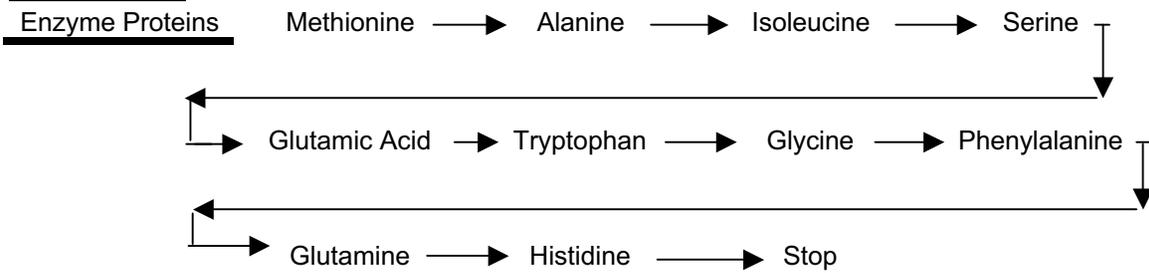
| Leucine | Lysine | Methionine | Phenylalanine | Proline |
|---------|--------|------------|---------------|---------|
| UUA | AAA | AUG | UUC | CCA |
| UUG | AAG | | UUU | CCC |
| CUA | | | | CCG |
| CUC | | | | CCU |
| CUG | | | | |
| CUU | | | | |

| Serine | Threonine | Tryptophan | Tyrosine | Valine |
|--------|-----------|------------|----------|--------|
| AGC | ACA | UGG | UAC | GUA |
| AGU | ACC | | UAU | GUC |
| UCA | ACG | | | GUG |
| UCC | ACU | | | GUU |
| UCG | | | | |
| UCU | | | | |

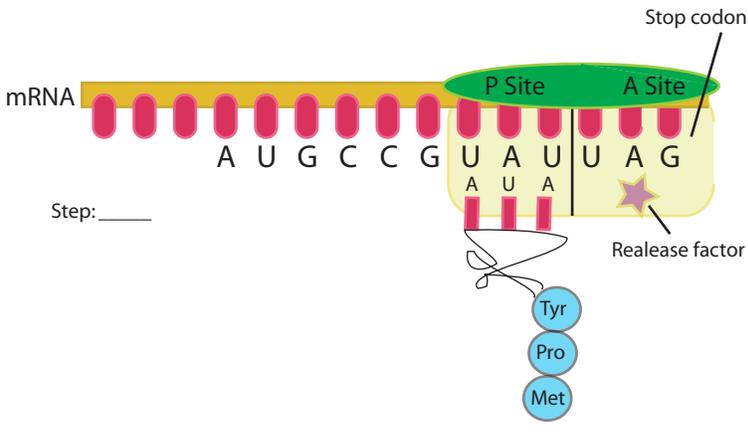
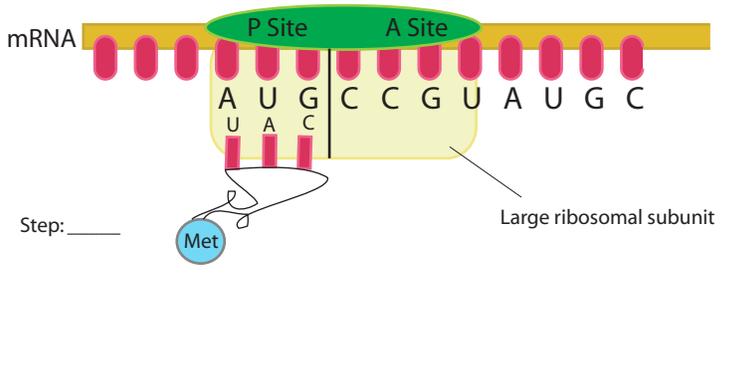
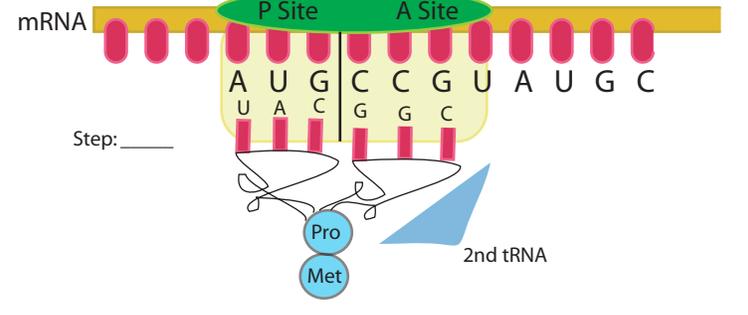
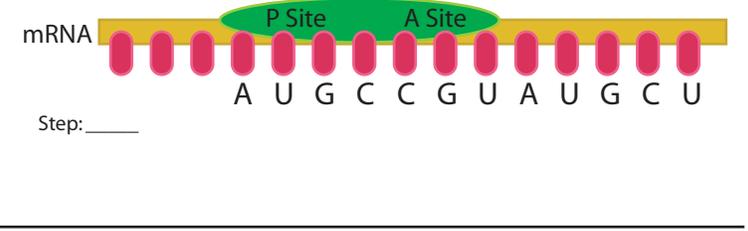
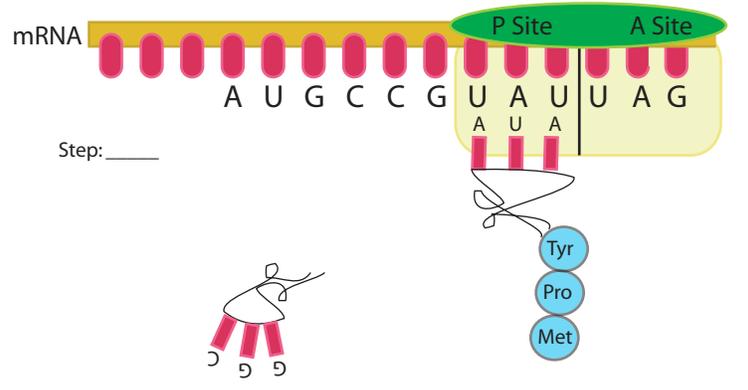
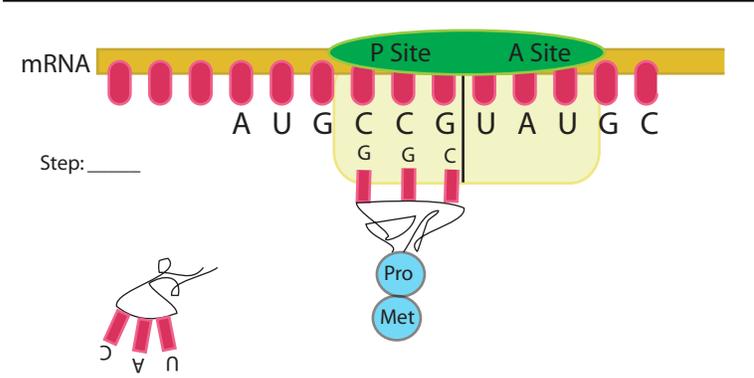
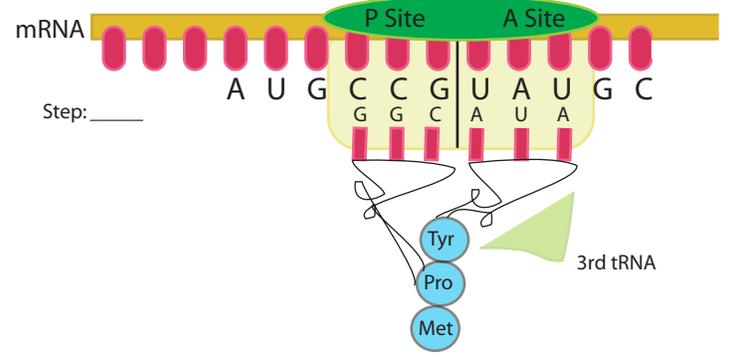
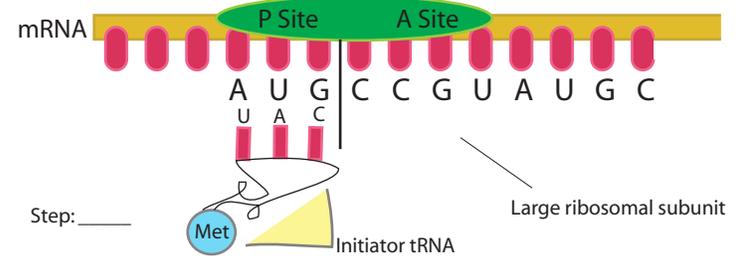
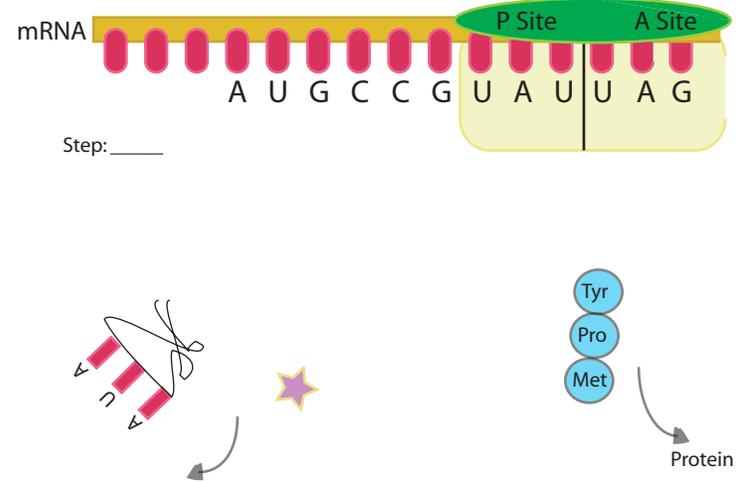
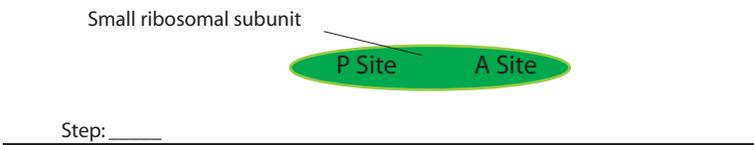
| Stop |
|------|
| UAA |
| UAG |
| UGA |

Protein Table

Protein Table:



Translation Funsheet 1



Translation Funsheet page 2

1. There are two parts to a ribosome; a large and small subunit. The small subunit has two binding sites for the mRNA molecule. They are called the p-site and the a-site.
2. The small ribosomal subunit binds to the mRNA molecule.
3. The third step in translation is when an initiator tRNA (a tRNA that contains an anticodon UAC and carries the amino acid Methionine) binds to the start codon of the mRNA AUG. Therefore, AUG is not only the start codon, it also corresponds to the amino acid Methionine. When the initiator tRNA binds to the mRNA, it occupies the p-binding site. Leaving the a-binding site empty.
4. The large subunit of the ribosome then combines to the entire complex (small ribosomal subunit, mRNA, and initiator tRNA). The mRNA is sandwiched between the small and large ribosomal subunits and has the initiator tRNA bound to its start codon.
5. A second tRNA carrying an amino acid approaches the complex and enters into the empty a-binding site. The anticodon of the second tRNA binds to the second codon of the mRNA at this site. The first amino acid (Methionine) and the second amino acid are bound together by a peptide bond.
6. The initiator tRNA that was in the p-binding site is released (leaving the amino acid Methionine bound to the second amino acid) and both ribosomal subunits move along the mRNA until the second tRNA is in the p-site. This leaves the a-binding site open again.
7. A third tRNA binds to third codon of the mRNA at the vacant a-binding site of the small ribosomal subunit. The third tRNA's corresponding amino acid becomes bound by a peptide bond to the growing chain of amino acids.
8. The second tRNA molecule is released leaving its amino acid bound to the growing chain. Both ribosomal subunits move along the mRNA molecule until the third tRNA is in the p-site, leaving the a-binding site open again.
9. The translation process is terminated when the ribosomal subunits come to a stop codon (UAA, UAG, and UGA) on the mRNA molecule. At this point many amino acids have been bound together forming a polypeptide chain. When a stop codon is encountered the a-binding site accepts a protein called a release factor instead of another tRNA. This factor breaks the bond between the tRNA and the polypeptide chain.
10. The polypeptide chain and tRNA (from the p-site) are released and the polypeptide goes on to form a protein.

Teacher's Guide

student group 1:

| | | | | |
|------------|---------|------------|--------|---------------|
| AUG | GCC | AUU | UCA | GAG |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Methionine | Alanine | Isoleucine | Serine | Glutamic acid |

| | | | | | |
|------------|---------|---------------|-----------|-----------|------|
| UGG | GGU | UUU | CAG | CAC | UGA |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Tryptophan | Glycine | Phenylalanine | Glutamine | Histidine | Stop |

student group 2:

| | | | | | |
|------------|---------|----------|----------|----------|-----------|
| AUG | CCG | UAU | UGC | CGA | ACU |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Methionine | Proline | Tyrosine | Cysteine | Arginine | Threonine |

| | | | | |
|--------|---------------|--------|-----------|------|
| AAA | GAC | GUG | CAA | UAA |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Lysine | Aspartic acid | Valine | Glutamine | Stop |

student group 3:

| | | | | | |
|------------|---------|--------|--------|---------|---------|
| AUG | CUG | AAG | AGC | GGG | GGA |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Methionine | Leucine | Lysine | Serine | Glycine | Glycine |

| | | | | |
|---------|---------|---------------|------------|------|
| GCC | CUU | UUU | AAU | UAG |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Alanine | Leucine | Phenylalanine | Asparagine | Stop |

student group 4:

| | | | | | |
|------------|---------|--------|----------|---------|---------------|
| AUG | CUC | GUG | CGG | GGG | UUU |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Methionine | Leucine | Valine | Arginine | Glycine | Phenylalanine |

| | | | | | |
|---------------|---------|--------|------------|------|---|
| GAA | CCG | AAG | UGG | UAA | |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Glutamic acid | Proline | Lysine | Tryptophan | Stop | |

student group 5:

| | | | | | |
|------------|---------------|---------|--------|------------|---------------|
| AUG | GAC | GCG | GUU | AUA | GAA |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Methionine | Aspartic acid | Alanine | Valine | Isoleucine | Glutamic acid |

| | | | | |
|---------|---------------|----------|----------|------|
| CUA | UUC | UAC | UGU | UAG |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Leucine | Phenylalanine | Tyrosine | Cysteine | Stop |

student group 6:

| | | | | | |
|------------|-----------|--------|---------------|------------|------------|
| AUG | CAC | UCC | GAA | UGG | AUU |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Methionine | Histidine | Serine | Glutamic acid | Tryptophan | Isoleucine |

| | | | | |
|-----------|-----------|---------|--------|------|
| ACC | CAA | CUG | GUG | UGA |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| Threonine | Glutamine | Leucine | Valine | Stop |