DNA to Protein

Grade-Level Expectations

The exercises in these instructional tasks address content related to the following science grade-level expectations:

LS-H-B1 Identify the basic structure and function of nucleic acids (e.g., DNA, RNA) (GLE 7)
LS-H-B1 Describe the relationships among DNA, genes, chromosomes, and proteins (GLE 8)

Contents

- These instructional tasks contain a set of document- or resource- based exercises about *composition of nucleic acids and processes involved in composing proteins from the genetic code.*
- Teachers may choose to use or modify the tasks as part of an instructional lesson or as a formative or summative assessment.
- The printable student version excludes teacher directions.

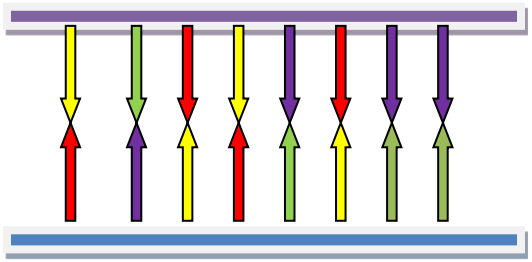
	Objective(s)
Scaffolding Exercise 1	– Describe what occurs in DNA replication – Develop a model of a chromosome and describe its composition – Explain the alteration made in genetic modification – Summarize the pros and cons of genetic modification of food crops
Scaffolding Exercise 2	– Explain the transcription process – Sequence complementary bases for a segment of DNA – Sequence bases for RNA from the same segment of DNA
Scaffolding Exercise 3	– Arrange terms in the correct order in which they occur or are activated during the process of translation
Culminating Exercise	– Summarize processes included in protein production – Explain the consequences of an incorrect base in a strand of DNA
Scoring Rubric	
Scoring Notes	
Printable Student Version	

Scaffolding Exercise 1

Teacher Directions:
Show the video, *The Double Helix*, to students to introduce the topic of DNA and provide historical background information.
Access *The Double Helix* at: http://media.hhmi.org/biointeractive/films/Double_Helix.html.

Ask students to consider the structure of DNA and products produced by DNA to respond to the prompts below.

Segment of Uncoiled DNA



1. Explain what occurs during DNA replication.

2. Develop a model of a chromosome and describe its composition.

Scaffolding Exercise 2

Teacher Directions: Have students explore the information found on the websites provided and respond to the prompts.

One of the technological advances in molecular biology is modification of DNA, also called genetic engineering. Read or listen to the article found at http://www.omaha.com/money/a-tale-of-two-nebraska-farmers-one-grows-genetically-modified/article_c323c398-cbd2-5753-bd1e-7dccd7ccd1f3.html. Then explore the information on genetically modified crops from one or more of the following websites:

- http://agbiosafety.unl.edu/education/summary.htm
- http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=957879329&topicorder=2&maxto=9&minto=1
- http://www.csiro.au/Outcomes/Food-and-Agriculture/WhatIsGM.aspx#

A. Briefly describe the type of genetic change made when modifying food crops.

B. Summarize the pros and cons of producing genetically modified foods.

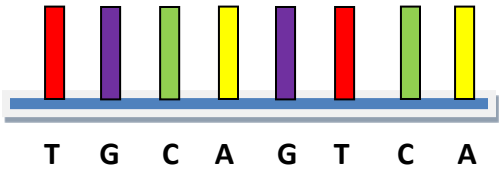
Pros	Cons

C. Research the conclusions drawn by scientists found at http://www.greenfacts.org/en/gmo/index.htm. What does the scientific evidence presented indicate regarding the safety in consuming genetically modified foods?

Scaffolding Exercise 3

Teacher Directions: Have students respond to the prompts below.

1. Identify and describe the process whereby RNA is created from a strand of DNA.



Portion of Single Strand of DNA with Unpaired Bases

Above is a sequence of unpaired bases found on a single, unwound strand of DNA. The bases are labeled with the first letter of the name of each.

2. Record the sequence of bases in a strand of mRNA that can be produced from the same DNA code.

3. Explain the function of mRNA.

4. What is the final product produced by a sequence of RNA codons?

Scaffolding Exercise 4

Teacher Directions: Have students complete the sequence. Follow up with a classroom discussion to reach consensus on the correct sequence.

Below is a set of cards with terms associated with translation. Arrange the cards in the order in which they occur or are activated during the process of translation. Upon completion, record the correct order for the terms.

Codons	**Proteins**	**mRNA**
Enzymes	**Ribosomes**	**Polymers**
tRNA		

Correct Order of Terms:

Culminating Exercise

Read the scenario below to respond to the prompt.

As a writer for a scientific journal, you have been asked to conduct an educational presentation to an audience of reporters who are not scientists. For the presentation on molecular biology, you are asked to inform the audience about the three major processes that are involved in the use of the genetic code to produce proteins. These processes dictate the structure and control the functions of living organisms.

In preparation for developing the slides and script for your presentation, summarize the three processes that are involved in the development of proteins from the DNA code and explain the possible consequences of an incorrect base being included during DNA replication.

Record your explanations in the following sequence:

A. DNA Replication

B. Transcription to RNA

C. Translation to protein

D. Describe the logical consequences of an incorrect base being paired up in the production of DNA or RNA.

Rubric	
Key Elements: **A**: Response summarizes the DNA replication process accurately. **B**: Response correctly summarizes the process of transcription of DNA into RNA. **C**: Response summarizes the translation process that converts RNA into proteins accurately. **D**: Response correctly explains a possible result of incorrect pairing of bases in transcription.	
4 Points	Response includes all four key elements. Response contains no scientific errors.
3 Points	Response includes three of the four key elements. Response may include scientific errors.
2 Points	Response includes two of the four key elements. Response may include scientific errors.
1 Point	Response includes one of the four key elements. Response may include scientific errors.

A well-developed response should demonstrate a correct and thorough understanding of the composition of nucleic acids and the processes involved in composing proteins from the genetic code. The response should be clear, include specific details, show a higher level of reasoning skills where appropriate, and address the key elements of the task.

Scoring Notes

Student responses will not be an exact imitation of the responses below. These responses are given as examples.

A. **DNA replication** is the process of producing two identical replicas from one original DNA molecule. DNA consists of two individual complementary strands of linked nucleotides coiled around each other in a double helix. Nucleotides in DNA contain a deoxyribose sugar, a phosphate, and a base. The bases pair up and bond to each other with hydrogen bonds. Before replication can occur, these two intertwined strands have to be separated. The strands can't be separated simply by pulling them apart; they must be broken to relieve the double helix thermodynamic strain. This allows a point of rotation as the two halves of the DNA are separated by weakening the hydrogen bonds. The double strands are then pulled apart, creating a Y formation called the replication fork.

At the replication fork, the sequence of bases is unpaired and exposed. Enzymes (DNA polymerases) match up the exposed bases with their complementary bases on free nucleotides: A with T and G with C. The sequence of bases on the original DNA strand is therefore the template for the order of bases on each newly created strand. New DNA chains can only be paired and restored in one direction on each strand. Also at the replicating fork, one of the forming DNA strands grows and elongates continuously as more of the original DNA molecule unwinds. This continues until the DNA replication process is complete for the leading strand. The lagging strand is the strand of nascent DNA whose direction of synthesis is opposite to the direction of the growing replication fork. The lagging strand is paired up in short sections. When one section stops forming, another section begins to form. This process is repeated until all sections are replicated. Later the tiny gaps between the sections are sealed together by DNA ligase enzymes to make the second newly formed strand of DNA.

B. In transcription, a section of a single strand of original DNA code is used as a template for matching complementary bases to form an mRNA strand in a process similar to the replication process. The process of transcription pairs the base adenine with uracil and cytosine is paired with guanine. Start and stop codons begin and end the forming of mRNA.The RNA strand then moves from the nucleus to the ribosomes.

C. During the process of translation, an mRNA segment engages with a ribosome in which sets of three bases (codons) are transcribed into amino acids with the assistance of tRNA. Each codon on the mRNA and tRNA is specific to an amino acid.The amino acids are bonded in the sequence they are transcribed. The bonded amino acids form a chain (polymer) that is a specific protein.

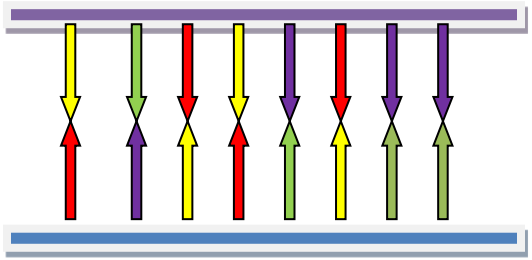
D. A mutation would occur. If an incorrect base is paired up in the production of RNA, it would change the sequence of bases that codes for a specific amino acid. A code for an ineffective or wrong amino acid would result. An essential protein would no longer be

produced. This type of mutation is one of the causes of genetic disorders in which an essential protein can't be produced resulting in metabolic disorders or mutations in body structures such as cancer, sickle-cell anemia, color blindness or cystic fibrosis.
Alternative Response: Occasionally, incorrectly paired bases in strands of nucleic acid survive and are incorporated into the next round of replication or transcription. These mutations may have no consequence, result in the death of the organism, result in a genetic disorder or cancer, or give the organism a competitive advantage over its neighbors, which leads to evolution by natural selection.

Printable
Student Version

Following the viewing of the video, *The Double Helix, c*onsider the structure of DNA and products produced by DNA to respond to the prompts below.

Segment of Uncoiled DNA



1. Explain what occurs during DNA replication.

2. Develop a model of a chromosome and describe its composition.

Explore the information found on the websites provided and respond to the prompts.

One of the technological advances in molecular biology is modification of DNA, also called genetic engineering. Read or listen to the article found at http://www.omaha.com/money/a-tale-of-two-nebraska-farmers-one-grows-genetically-modified/article_c323c398-cbd2-5753-bd1e-7dccd7ccd1f3.html. Then explore the information on genetically modified crops from one or more of the following websites:

- http://agbiosafety.unl.edu/education/summary.htm
- http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=957879329&topicorder=2&maxto=9&minto=1
- http://www.csiro.au/Outcomes/Food-and-Agriculture/WhatIsGM.aspx#

A. Briefly describe the type of genetic change made when modifying food crops.

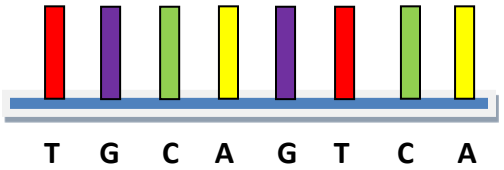
B. Summarize the pros and cons of producing genetically modified foods.

Pros	Cons

C. Research the conclusions drawn by scientists found at http://www.greenfacts.org/en/gmo/index.htm. What does the scientific evidence presented indicate regarding the safety in consuming genetically modified foods

Respond to the prompts below.

1. Identify and describe the process whereby RNA is created from a strand of DNA.



Portion of Single Strand of DNA with Unpaired Bases

Above is a sequence of unpaired bases found on a single, unwound strand of DNA. The bases are labeled with the first letter of the name of each.

2. Record the sequence of bases in a strand of mRNA that can be produced from the same DNA code.

3. Explain the function of mRNA.

4. What is the final product produced by a sequence of RNA codons?

Below is a set of cards with terms associated with translation. Arrange the cards in the order in which they occur or are activated during the process of translation. Upon completion, record the correct order for the terms.

Codons	**Proteins**	**mRNA**
Enzymes	**Ribosomes**	**Polymers**
tRNA		

Correct Order of Terms:

Read the scenario below to respond to the prompt.

As a writer for a scientific journal, you have been asked to conduct an educational presentation to an audience of reporters who are not scientists. For the presentation on molecular biology, you are asked to inform the audience about the three major processes that are involved in the use of the genetic code to produce proteins. These processes dictate the structure and control the functions of living organisms.

In preparation for developing the slides and script for your presentation, summarize the three processes that are involved in the development of proteins from the DNA code and explain the possible consequences of an incorrect base being included during DNA replication.

Record your explanations in the following sequence:

E. DNA Replication

F. Transcription to RNA

G. Translation to protein

H. Describe the logical consequences of an incorrect base being paired up in the production of DNA or RNA.