Standard #: SC.912.L.16.5

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Explain the basic processes of transcription and translation, and how they result in the expression of genes.

Subject Area: Science

Grade: 912

Body of Knowledge: Life Science

Idea: Level 3: Strategic Thinking & Complex Reasoning

Standard: Heredity and Reproduction -
A. DNA stores and transmits genetic information. Genes are sets of instructions encoded in the structure of DNA.

B. Genetic information is passed from generation to generation by DNA in all organisms and accounts for similarities in related individuals.

C. Manipulation of DNA in organisms has led to commercial production of biological molecules on a large scale and genetically modified organisms.

D. Reproduction is characteristic of living things and is essential for the survival of species.

Date Adopted or Revised: 02/08

Content Complexity Rating: Level 3: Strategic Thinking & Complex Reasoning - More Information

Date of Last Rating: 05/08

Status: State Board Approved

Related Courses

Course Number	Course Title
2000310:	Biology 1 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2000320:	Biology 1 Honors (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2000430:	Biology Technology (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2002490:	Forensic Sciences 2 (Specifically in versions: 2014 - 2015, 2015 - 2017, 2017 and beyond (current))
2000440:	Genetics (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2002420:	Integrated Science 2 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2002430:	Integrated Science 2 Honors (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2000800:	Florida's Preinternational Baccalaureate Biology 1 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
7920015:	Access Biology 1 (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 and beyond (current))
2000315:	Biology 1 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2000500:	Bioscience 1 Honors (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2000510:	Bioscience 2 Honors (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
2002425:	Integrated Science 2 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 and beyond (current))

Related Access Points

Independent

Access Points Number	Access Points Title
SC.912.L.16.In.3:	Recognize that a substance called DNA carries genetic information in all organisms, and changes (mutations) in DNA can be helpful or harmful to an organism.

Supported

Access Points Number	Access Points Title
SC.912.L.16.Su.2:	Recognize that all organisms have a substance called DNA with unique information.

Participatory

Access Points Number	Access Points Title
SC.912.L.16.Pa.2:	Recognize similarities in characteristics of plants and animals of the same type (species).

Related Resources

Student Center Activity

Name	Description
	Use this resource as a follow up to the following video that explains RNAi

Acting Out Transcription and Translation (A Model):	http://www.pbslearningmedia.org/resource/lsps07.sci.life.gen.rnai/rnai-discovered/. This group activity can introduces two analogies to illustrate how RNAi interferes with specific gene expression and protein production. In the first model, students review protein synthesis. In the second model, the interference of RNAi with the protein production is illustrated. Throughout this process, students develop an understanding of transcription and translation.

Lesson Plan

Name	Description
Alien Encounters -- Transcription and Translation:	This is a 3-4 day lesson which focuses on the role of DNA and RNA in protein synthesis. It teaches students about the process of transcription and translation which makes the amino acid chains. This lesson has a variety of activities to engage students in learning, including virtual manipulatives, tutorials, videos and a summative lab to wrap up information learned.
Central Dogma Protein Construction Stem Challenge:	Proteins are essential for all functions necessary for life in organisms. Proteins are created by reading the sequence of nucleotides in genetic material (DNA). During cellular processes known as transcription and translation, the DNA code is read, transferred into a copy called mRNA, and then the copy is read to create specific amino acids bonded together. The amino acids and their interactions create the specific shapes of proteins. In this activity you will be translating strands of DNA to mRNA, and then into small sequences of amino acids. The amino acids will then be bonded together based on their properties. The proteins will be analyzed for correct bonding patterns since the shape of the protein is directly related to the amino acid sequence and the protein's function.
DNA Mutations:	In this lesson, students will learn the effect of DNA mutations on protein formation and phenotype. The students will convert a DNA sequence to an amino acid sequence and use color-by-number pictures to show the difference between an original and mutated sequence. Through comparisons with other students in the class, the students will learn that not all mutations will result in a change, while some may cause a great deal of change in a gene (and therefore the protein and/or phenotype).
Ice Cream Sundae Gene Expression:	This lesson allows students to visualize how genes are expressed by completing the process of transcription and translation of 10 ice cream sundae genes. After students have completed the transcription and translation they will be using the expression of each gene to assemble an ice cream sundae with their coded ice cream type and toppings. The students will be able to make a connection between how genes are expressed in an ice cream sundae and relate it back to human gene expression.
Modeling Transcription and Translation:	This lesson plan consists mostly of student-centered activities that involve learning and mastering the steps in DNA replication, transcription, and translation.
Protein Car Synthesis:	Students will use this hands on activity to work their way through Transcription and Translation. Students can work in small groups to first construct a complete code of mRNA, and then construct a protein by finding corresponding Anticodons from tRNA. The accurate Base Pairing will result in the accumulation of Amino Acids. Amino Acids will be represented with automobile parts. For the completion of this activity, students will be able to piece together a fully formed automobile (or protein). This activity is accompanied by a written analogy of Transcription and Translation using a library and a mechanic.
Protein Synthesis Math Relays!:	While working in cooperative groups, students will gain practice acting out DNA replication, transcription and translation! Instead of students creating a protein as their final piece, they will need to solve a math problem and supply the correct answer as their "protein"!
Protein Synthesis: Transcription & Translation:	Students will explore the process of protein synthesis, specifically transcription and translation, using a sequenced graphic organizer and an interactive simulation (Lesson 1 & 2). This resource contains 3 lessons: • Lesson 1: Transcription & Translation • Lesson 2: Lac Operon • Lesson 3: Proteins & Cancer As an extension (Lesson 3) the students will justify the applications of biotechnology that uses transcription and translation to synthesize proteins that target cancer cells or reason the possibilities of the amplification of antibodies using immortal cells. They will explore how mutations, genetic or epigenetic (lifestyle-chemicals, radiation, viruses), resulting in cancer. The student will connect changes that occur in the genetic code, during transcription and translation, to the deleterious impact on proto oncogenes that promote cell division and tumor suppressor genes that normally inhibit it.
RNA and Protein Synthesis Activity with Lab:	This lesson will clear misconceptions and probe student thinking by utilizing differentiated instruction and implementing meaningful learning. The educator will also be able to provide students with real world examples. Students are given multiple opportunities to excel and demonstrate their content knowledge throughout this lesson. By assessing their prior knowledge prior to the beginning of a new chapter students will make connections to complex concepts.
Super Power Proteins:	In this lesson the students will have the opportunity to explore the concept of transcription with a hands-on, easy to use model and also be able to create a super hero to apply the concept.
The Code of Life:	This is a basic lesson on DNA transcription, one of the two primary steps in protein synthesis. Students will learn about the role of messenger RNA (mRNA) in transcription and translation through teacher- and student-led activities.
	This lesson uses the fundamentals of protein synthesis as a context for investigating the closest living relative to Tyrannosaurus rex and evaluating whether or not paleontologist and dinosaur expert, Jack Horner, will be able to "create" live dinosaurs in the lab. The first objective is for students to be able to access and properly utilize the NIH's protein sequence database to perform a BLAST, using biochemical evidence to determine T rex's closest living relative. The second objective is for students to be able to explain and evaluate Jack Horner's plans for creating live dinosaurs in the lab. The main prerequisite for the lesson is a basic understanding of protein synthesis, or the flow of information in

The King of Dinosaurs or a Chicken Dinner?:	the cell from DNA to RNA during transcription and then from RNA to protein during translation. You will find downloadable handouts of the necessary documents for the lesson. To complete the lesson, you will need the handouts and ideally computers with Internet connections so that students can complete the BLAST on their own or in groups. The computers are not a requirement, however, because the video has an optional segment that goes through the BLAST step-by-step and shows students exactly what they would see if they were doing it themselves. There is an optional reading assignment from *WIRED* magazine at the close of the lesson, and the article can be accessed for free on-line at http://www.wired.com/magazine/2011/09/ff_chickensaurus/. The lesson should take somewhere around 90 minutes, a portion of which is group or classroom discussion based on prompts from the video or the handouts.
The Monster Mash: A Lesson About Transcription and Translation:	Students will model the process of protein synthesis and then model how those proteins result in phenotypic changes. Students will also be able to explain the function of models in science. Students will explore how variations in DNA sequences produce varying phenotypes. Students will complete transcription and translation of DNA and RNA and then determine phenotypes produced based on amino acid sequences while completing hands on activity. During this lesson, students will create a factious organism by rolling a dice to determine which DNA sequence it will receive. Students will then perform transcription and translation. Finally, students will determine the phenotype of the organisms by comparing its amino acid sequence to a key that will be provided. Lastly, students will create a picture of the fictitious organism.
Tissue Specific Gene Expression:	How is it that all cells in our body have the same genes, yet cells in different tissues express different genes? A basic notion in biology that most high school students fail to conceptualize is the fact that all cells in the animal or human body contain the same DNA, yet different cells in different tissues express, on the one hand, a set of common genes, and on the other, express another set of genes that vary depending on the type of tissue and the stage of development. In this video lesson, the student will be reminded that genes in a cell/tissue are expressed when certain conditions in the nucleus are met. Interestingly, the system utilized by the cell to ensure tissue specific gene expression is rather simple. Among other factors - all discussed fully in the lesson - the cells make use of a tiny scaffold known as the "Nuclear Matrix or Nucleo-Skeleton". This video lesson spans 20 minutes and provides 5 exercises for students to work out in groups and in consultation with their classroom teacher. The entire duration of the video demonstration and exercises should take about 45-50 minutes, or equivalent to one classroom session. There are no supplies needed for students' participation in the provided exercises. They will only need their notebooks and pens. However, the teacher may wish to emulate the demonstrations used in the video lesson by the presenter and in this case simple material can be used as those used in the video. These include play dough, pencils, rubber bands (to construct the nuclear matrix model), a tennis ball and 2-3 Meters worth of shoe laces. The students should be aware of basic information about DNA folding in the nucleus, DNA replication, gene transcription, translation and protein synthesis.
Transcription & Translation in Action:	In this lesson, students will use manipulatives to act out the processes of transcription and translation. Upon completion, students are asked to complete a One Pager, graphic representation/reflection of their learning.
Transcription and Translation:	This lesson will help students understand how DNA directs the making of proteins. This lesson will also assist students in understanding the relationship between DNA and RNA and how transcription produces a single-stranded RNA molecule.
Transcription and Translation Made Easy:	"Transcription and Translation Made Easy" is an interactive whole-class activity that follows the transfer of information from the DNA to protein formation. The activity uses letters as parts of words as an analogy for amino acids as parts of proteins to allow the students to observe the type of mutations that may occur and the level of damage that each can cause.
Understanding Translation:	In this lesson, the students will learn about the final step of protein synthesis through a series of activities. At the end of this lesson, the students will be able tie in translation and its role in protein synthesis.

Tutorial

Name	Description
Chromosomes, Chromatids, and Chromatin:	This Khan Academy video reviews the basic processes of DNA replication and protein synthesis. It then goes on to explain how the terms chromosome, chromatin, and chromatid, relate to each other.
DNA:	This Khan Academy video describes the structure of the molecule DNA in great detail. It also discuses the role DNA plays in the process of protein synthesis, explaining transcription and translation. The video discusses the relationship between DNA and chromosomes as well.
Protein Synthesis:	This tutorial is a full lesson on the process of protein synthesis. Transcription and translation are both explained in detail.
RNA Translation:	This tutorial will demonstrates the process of RNA translation through an interactive animation.
Transcription and Translation:	This Khan Academy video briefly describes DNA replication and then goes into a thorough explanation of both transcription and translation.

Original Student Tutorial

Name	Description
DNA to Genes to Proteins:	The focus of this tutorial is the first step of protein synthesis, transcription of DNA to RNA. Students are introduced to the concept of epigenetics as a mechanism to activate or inactivate gene expression.
Protein Synthesis: Your Personal Protein Factory:	Explore the basic processes of transcription and translation, and how they result in the expression of genes as you complete this interactive tutorial.

Virtual Manipulative

Name	Description

DNA to Protein:	This website contains many interactive activities that can be used by students to gain an understanding of translation and transcription.
Protein Synthesis:	This visual tutorial of the complex biochemical process helps the student to understand the process of protein synthesis. This manipulative gives the students detailed information starting with the basics of genetic codes called codons. Next, the lesson then leads the students towards detailed information of mRNA, tRNA and rRNAs. The final phase helps students by describing the complete process of protein synthesis from initiation, to elongation and then to termination. The tutorial offers check questions at every stage to ensure students are learning the important information.
Transcription and Translation Animation:	This interactive animation allows students to replicate the steps of protein synthesis from DNA. It coincides with the resource "DNA Replication Animation".
Translation: Making a protein from a messenger RNA:	The genes in DNA encode protein molecules. Expressing a gene means manufacturing its corresponding protein.Translation is the key process of making a protein from the genetic code expresses in the DNA. In translation, messenger RNA is read according to the genetic code, which relates the DNA sequence to the amino acid sequence in proteins. This virtual manipulative will allow the students to understand the process of translation. Students will also get a chance to observe, what happens when a new random mutation generates stop codons.

Video/Audio/Animation

Name	Description
DNA Tutorial:	This website has a nice graphic depiction of complementary base pairing, as well as a great video computer model of DNA replication, transcription, and translation. Additional links are provided for further study.
DNA: Animations:	The Howard Hughes Medical Institute makes available twenty-five short, narrated animations about DNA at this link. The animations are viewable as video clips and topics include, but are not limited to DNA structure, DNA replication, transcription and translation, mutations in DNA, polymerase chain reaction, DNA sequencing, and shotgun sequencing.
Photosynthesis animation and other cell processes in animation:	This site has fantastic short Flash animations of intricate cell processes, including photosynthesis and the electron transport chain.

Text Resource

Name	Description
Human DNA Is Not A Document, It's An App:	This informational text resource is intended to support reading in the content area. This article discusses the relevance of the new findings regarding DNA coding and uses seven technological metaphors (i.e. Apps and Zappos) to compare DNA coding to contemporary physics.
The Cell's Protein Factory in Action:	This informational text resource is intended to support reading in the content area. The ribosome, the site of protein synthesis, is the focus of this article. The text describes how a problem-some antibiotics are targeting the ribosomes of both harmful *and* beneficial bacteria-is being solved by studying the movement of ribosomes during translation.

Teaching Idea

Name	Description
Modeling Transcription and Translation :	In the lab "From Gene to Protein - Transcription and Translation," students learn how genes are involved in the process of protein synthesis, including exploring specific examples such as albinism and sickle cell anemia. Students use paper models to simulate the process of transcription and translation.
Translation Activity-SeaWorld Classroom Activity:	Students will identify the steps involved in the translation process.

Perspectives Video: Expert

Name	Description
Proteins and Secretory Pathways:	A cell has made a protein; now what? Learn more about protein secretion!

Educational Game

Name	Description
Transcribe and Translate a Gene:	See how cells "read" the information in a DNA sequence to build a protein, then build one yourself!

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Parent Resources

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