

Discovering the Genome: What Makes a Nerve Cell Different? Module – For Teachers

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Module <i>(Estimated time to cover module sections)</i>	Where can I cover this in my Biology curriculum? Highlights?	Next Generation Science Standards	Other Resources <i>(Websites, related activities, etc.)</i>
<p>What Makes a Nerve Cell Different from a Skin Cell? A Bioinformatics Experiment</p> <p><i>Introductory video and discussion - 15-20 min</i></p>	<p>The same genome is in every cell of your body. Yet different cells in different parts of your body look and act very differently. The activity explores several databases that are used by bioinformaticians and other scientists for their research. The activity, organized by topics, is presented such that students progress from more simple to more complex database exploration. The topics expose students to human health-related databases as well as to databases for multiple species, which can be used for comparative genomics.</p> <p>Watch a video that describes one way a bioinformatician could approach the question: How does the same genome produce different types of cells? The video introduction fits well in a unit on DNA and Protein Synthesis or Reproduction & Development when talking about differentiation of cells during embryonic development. You could use this to start off a cell unit but it does require some knowledge/language of DNA and gene expression.</p>	<p>ETS1.B: Developing Possible Solutions *When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.</p> <p>HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.</p> <p>HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.</p> <p>LS1.A: Structure and Function *Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) *All cells contain genetic information in the form of DNA molecules. *Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which</p>	<p>Stem Cells unit: http://learn.genetics.utah.edu/content/stemcells/</p>

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		<p>carry out most of the work of cells. (HS-LS1-1)</p> <p>LS1.B: Growth and Development of Organisms *In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. *The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. * Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)</p> <p>HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.</p> <p>HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors</p> <p>LS1.A: Structure and Function *All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.</p> <p>LS3.A: Inheritance of Traits * Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA.</p>	
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		<p>*All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. *Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) LS3.B: Variation of Traits *In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. *Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. *Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)</p> <p>HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.</p> <p>LS4.A: Evidence of Common Ancestry and Diversity *Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)</p>	
<p>Sickle Cell Disease 20 min. Minimum, including discussion -</p>	<p>This could be done in a unit on genetics or when talking about DNA and protein synthesis and mutations. It could also be done as part of population genetics and evolution. Students utilize the 1000 Genomes database for this activity. “The</p>	<p>HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population</p> <p>HS-LS4-1.</p>	<p>Students learn how a mutated gene results in sickle cell anemia: Transcription and Translation – From Gene to Protein – hands-on or analysis and discussion</p>

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<p>60 minutes if more questions added using graphics on the site</p>	<p>1000 Genomes Project ran between 2008 and 2015. The goal of the 1000 Genomes Project was to find most genetic variants with frequencies of at least 1% in the populations studied” from around the world. (http://www.1000genomes.org/about)</p>	<p>Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.</p>	
<p>Genome Size</p> <p>25-45 min, including discussion, questions and whether you have students do the calculations and any additional searching.</p>	<p>This is a great short activity to do with your class when you first start talking about DNA and protein synthesis or when you first mention chromosomes before Mitosis. Students utilize the Animal Genome Size database, “a comprehensive catalogue of animal genome size data”(great images of different animals and C values flash by on top left!) http://www.genomesize.com/</p>	<p>HS LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.</p> <p>*All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)</p>	
<p>Huntington’s Disease</p> <p>40-50 minutes with introduction and discussion</p>	<p>The OMIM website is a treasure chest of information about genetic traits and genetic disorders and is great to use during Genetics, after the students have some background on DNA and gene expression. This site has a ton more to offer and is connected to the National Center for Biotechnology Information’s (NCBI website http://www.ncbi.nlm.nih.gov/) You could definitely expand this to a full period or more activity.</p>	<p>HS LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.</p> <p>HS LS1.A: Structure and Function *Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) *All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)</p>	<p>Tutorial for OMIM available at: http://www.openhelix.com/OMIM</p>

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<p>Cystic Fibrosis</p> <p><i>40-60 minutes with introduction and discussion.</i></p>	<p>This could be done at many places in the year - during discussions of protein structure during DNA & protein synthesis or during Genetics. The Uniprot site that students will use is amazing - it contains almost everything that is known about the structure and function of every protein that has been catalogued! It is well worth spending time to learn what is there and spend a day or two there with your class.</p>	<p>HS LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.</p> <p>HS LS1.A: Structure and Function *Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) *All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)</p> <p>*Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)</p>	<p>Uniprot tutorials: https://www.youtube.com/channel/UCkCR5RJZCZZoVTQzTY92aw</p>
<p>Breast Cancer</p> <p><i>20-30 minutes with introduction and discussion</i></p> <p>BRCA1</p> <p><i>30-40 minutes with introduction and</i></p>	<p>This can be done during Cell Cycle and Cancer / Mitosis unit, during DNA & Protein Synthesis or during Genetics. You could also do this during a Biochemistry unit when covering Protein Structure and include the concept of “domains”. The NCBI Gene site that students will use and its various linked sites is another amazing resource for everything connected to DNA, genes and proteins. Again, it is well worth spending time to learn what is there and spend a day or two there with your class.</p> <p>The HomoloGene database that students will also use allows you to see what species share genes that are thought to be “homologs” - similar in structure and</p>	<p>HS LS1.A: Structure and Function *Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) *All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)</p> <p>HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.</p>	<p>NCBI tutorials available at: http://www.ncbi.nlm.nih.gov/guide/training-tutorials/</p> <p>Watch video clip, NOVA: Cracking The Code (8 min) http://www.pbs.org/wgbh/nova/body/cracking-the-code-of-life.html (Select- Watch the Program. Select segment 11- Family Disease)</p> <p>After watching the clip, discuss the following questions with the whole class or in small groups: (5-10 min)</p>

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<i>discussion</i>	evolutionary origin. Try looking at the Protein information - it is especially interesting to see which domains are conserved between species.		<p>Should Alana get BRCA genetic testing for breast/ovarian cancer susceptibility genes? If she tests positive, what options are available to her? If she tests negative, does that mean that she will never develop breast or ovarian cancer?</p> <p>Minds-on activities for your students to learn more about cancer:</p> <p>Understanding the Biology of Cancer</p> <p>UV, Mutations, and DNA Repair</p>
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