Module *(Estimated time to cover module sections)*	**Where can I cover this in my Biology curriculum?** **Highlights?**	**Next Generation Science Standards**	**Other Resources** *(Websites, related activities, etc.)*
RNA Sequencing: Up Close with the Data	RNA plays an important role in biological systems as the intermediary between DNA and proteins. By measuring the RNA in a cell or tissue, we gain insight into the cell/tissue's function. RNA-sequencing (RNA-seq) is a relatively new technology that allows us to measure RNA in a sample with a high degree of accuracy. In this module we are going to discuss the data generated by an RNA-seq experiment.	**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. **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.** **HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** **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) **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) **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.** **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** **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. **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. *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)	

		HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. **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)	
RNA-seq Data *Readings, short video and discussion - 20 min* **Gene expression** **Find new genes** **Detect changes in RNA splicing**	This section could be done in your DNA & Protein Synthesis unit or a DNA Technologies unit. It has good basic core content. Great gene expression graphic Nice video on RNA splicing (introns/exons)		mRNA Processing Case Study: http://sciencecases.lib.buffalo.edu/cs/collection/detail.asp?case_id=849&id=849
RNA-seq Analysis	This section could be done in your DNA & Protein Synthesis unit or a DNA Technologies unit. It has		

10-15 min reading and discussion	good basic core content.		
Read Alignment / Mapping **Basic alignment** **Multimappers (repeated sequences)** **Spliced alignment** *Reading and discussion 15-20 min*	This section and those that follow in the rest of the module may be more suited for AP Biology level courses or in an elective course on Genetics/Genomics, etc. They could also be used to help differentiate instruction in an Honors Biology classroom. It has clear graphics and explanations and ends with creative and challenging activities.		
Gene quantification **Simple quantification** **Alternative**			

splicing *Reading and discussion 10-15 min*			
RNA-seq in the World *Reading and discussion 10-15 min*	These examples and the accompanying information in the teacher section would be of interest in any level Biology class when covering DNA and gene expression		
Activities *10-20 min each* **RNA-seq Activity 1 – 4, Advanced Activity**	The questions that accompany the activities would be great to do in small groups and then as a whole class, using the diagrams in the slideshow to help lead the discussion.		