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	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 how to measure RNA and how to perform an RNA-seq experiment.	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. <u>LS1.A: Structure and Function</u> *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.)* 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.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) 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)	
Why look at RNA instead of DNA? ***5-15 minutes depending on previous background***	This brief section of background material and discussion question could be done in your DNA & Protein Synthesis unit or when studying Gene Regulation or Development. In AP Biology, you could jump right into this when studying Cells.		

Measuring RNA ***10-40 minutes depending on previous background***	This brief section of background material and discussion questions, and those that follow, are probably best suited for an Honor Biology class or AP Biology or for differentiating instruction with the top of your regular Biology class. PCR and microarrays use fundamental concepts of DNA so they may be worth a try if you have the time. They could also be used during a DNA Technology unit or in an elective course.		Great virtual PCR and Microarray labs/animations: http://learn.genetics.utah.edu/content/labs/
Sequencing RNA ***5-10 min.***	This brief section of background material and discussion question focuses on which techniques to choose depending on what aspects of genomics you want to study.		
Preparing and Sequencing RNA **- Fragment RNA** **- Convert RNA into cDNA** - **Make second strand of DNA** - **Attach DNA Adapters** - **Perform Sequencing Reaction** ***20-30 minutes***	This series of images and accompanying text and questions apply principles of DNA replication and DNA/RNA structure in explaining RNA-seq library.		

Activity: RNA-seq data on the GTEx portal **- How to Browse the Data** **- Gene Expression Across Tissues** ***30-50 min.***	The Genotype-Tissue Expression (GTEx) portal is an online resource containing RNA-seq data from thousands of human donors across many different tissues. Researchers are using these data for many different purposes, like trying to figure out how changes in DNA and gene expression lead to various diseases. This activity uses GTEx to examine the expression of several genes across various human tissues and is a great addition to your DNA/Gene Expression unit or your Reproduction and Development unit. Be sure to do **Why look at RNA instead of DNA?** before doing this activity. Also be sure to check the number in the Entrez Gene ID box in order to get more amazing information about the gene.		