Capstone Project: Gene Editing Digital Story

"Gene editing" refers to the introduction of specific changes in an organism's genome. Gene editing strategies have long been used in scientific discovery, health and medicine, and agriculture. We've all heard of Genetically Modified Organisms ("GMO's"). A new technology, called the CRISPR-Cas9 system, broadens and simplifies gene editing capabilities, enabling precisely targeted, heritable genetic alterations in any organism, including humans. CRISPR-engineered bone marrow stem cells are in clinical trials to treat sickle cell disease and beta-thalassemia (*NPR*).

Gene editing generates enormous public scrutiny and skepticism, especially when performed in people. In 2019 a scientist was sentenced to prison for the illegal use of CRISPR-Cas9 to genetically modify human embryos and deliver HIV-resistant babies (*Scientific American*). But the impressive progress in gene editing technology means that the frequency and scope of its use will undoubtedly expand. Understanding the mechanisms and strategies of gene editing has become crucial for even beginning students of the life sciences. As students in the spring 2021 iteration of BIOL 116, you will take this challenge to heart in a creative capstone project that will enable you to apply fundamental knowledge of molecular biology, genetics, and evolution to the development of a genome editing strategy to ameliorate a heritable human disease.

Small teams will present genome editing strategies in the form of a *digital story*--a brief video that will highlight the chosen trait/disease, characterize a gene involved in its development, and present an argument for whether and why and how gene editing could be an effective and practical strategy for solving the related medical problem. Contrary to popular stereotype, science is a creative endeavor. Prepare to step into the shoes of not only the scientist, but also the artist and even the playwright, as you develop your genome editing strategy and present your digital story to the world.

I. Project Overview:

Throughout the semester, you will work in small teams to develop short (3-4 minute) digital stories that explore the biological mechanisms underlying gene editing. These digital stories will be developed progressively by creating and submitting a series of "storyboards." The content of each storyboard will be directly aligned with a corresponding course module.

II. The Storyboards:

Each storyboard will include two elements: an image (or two) that adequately communicates the idea or strategy plus an accompanying narrative. In-class workshops will be held preceding submission of every storyboard. Through these workshops, you will gain hands-on experience with the bioinformatics tools and databases needed to explore your gene of interest. Completed storyboards will be submitted via Moodle as Powerpoint documents on the due date outlined below.

Storyboard #1:
Due date: *Monday,* March 8*, 11:59 pm*
During the first course module, you will explore the fundamentals of genetics by examining the transmission of genetic material and how that genetic material contributes to visible traits and/or disease. Armed with this knowledge, you will select a human trait or disease that piques your interest. In your storyboard, you will describe the trait/disease and why its genetic manipulation could be necessary or beneficial.

In-class Workshop: We will explore the NIH's *Online Mendelian Inheritance in Man* (OMIM) database, to determine what gene(s) dictate the chosen trait/disease and indicate a suitable gene target for development of a gene editing strategy.

Storyboard #2:
Due date: *Monday, March 29, 11:59pm*
The second step in developing a gene targeting strategy is to understand the gene structure and its protein product. In the second module of this course, you will explore the molecular mechanisms that govern gene expression, including the production of the functional unit of gene expression – the protein. In this storyboard, you will depict the structure of your chosen gene at the DNA and RNA level. You will then describe the sequence and structure of the resulting protein product. Finally, based on your analysis, you will suggest a part of the gene that would be a good candidate for gene editing.

In-class workshop: We will explore the gene and protein databases available through the National Center for Biotechnology Information to analyze gene structure and resulting mRNA and protein products.

Storyboard #3:
Due date: *Monday, April 19, 11:59pm*
In most cases, gene expression is finely regulated. In class, you will learn about the mechanisms by which genes are regulated to ensure proper timing and location of production within the body. This is an important consideration for developing effective gene editing strategies. For this storyboard, you review primary research literature to find evidence of regulation of your gene of interest. You should incorporate a figure from the primary literature, provide an interpretation of the data and discuss how the data inform their gene editing strategy.

In-class workshop: We will learn to search for and identify primary literature using Pubmed, a search engine covering journals in biomedical sciences.

III. The Digital Story:
Due Date: Corresponds with scheduled time for the final exam.
BIOL 116.01 (Powell): Monday, May 17 at 11:30 AM
BIOL 116.02 (Smith): Saturday, May 15 at 4:30 PM

The project will culminate in the production of a short video (3-4 minutes) assembled from the storyboards. The stories should highlight your chosen trait/disease, characterize a gene involved in development of the trait/disease and present an argument for why and how gene editing could be an effective strategy for solving the related medical problem. The final digital story should include the collection of images and narrative from each storyboard and will be constructed using voice-over presentations in PowerPoint.

IV. Training and Assistance Resources:

Peer-led bioinformatics help sessions:

In conjunction with the deadline for each storyboard, bioinformatics help sessions will be provided and staffed by peer instructors. Multiple 2-hour sessions will be scheduled on different evenings as the due date approaches. Workshops will be conducted using GoogleMeet. The dates and times of these sessions will be shared as the deadline nears.

Peer-led technical support sessions:

Digital stories are due during Finals Week. Peer-led help sessions for developing and/or troubleshooting voice-over PowerPoint videos will be held as we get closer to the end of the semester, in early May.

V. Grading:

Detailed instructions and advice for each storyboard will be presented at each in-class workshop.

The Digital Story project represents a total of 20% of the course grade.

Storyboard 1:	3.0%
Storyboards 2 and 3:	4.5% each
Final digital story:	8.0%
Total:	20.0%