Now you see me: How we can use reporter genes to light up the cellular world
By Melanie Rose

Jellyfish, fireflies and mushrooms: What do they all have in common? They come from different environments and have wildly different lifecycles, but they all have a secret hidden away where nobody can see it. That is, until they want you to. Light! Bioluminescence, to be exact, or the production of light by living organisms! Some members of these groups are able to produce light through a chemical reaction, while others simply produce a protein that glows on its own. Scientists have been quick to harness these unique properties for their own research purposes. When bioluminescence is taken and used in another organism it is referred to as a **reporter gene.** Reporter genes are valuable tools as they can illuminate cells and allow for visual assessments such as cell tracking or morphological analysis.

Similar to bioluminescence, fluorescent proteins can serve as useful indicators of gene expression and protein distribution in living cells. With the development and discovery of multiple fluorescent proteins from many organisms there has been a change in how cellular functions are being studied.

The most commonly used reporter is a fluorescent protein which glows green when exposed to a specific wavelength of light. This reporter is called green fluorescent protein, or GFP. The protein originally came from the jellyfish *Aequorea victoria*, however, researchers have artificially reproduced it in the lab with enhanced brightness and function. GFP has been joined with many proteins/ genes of interest without hindering how the protein functions.

The biggest advantage of GFP is that it can be heritable, depending on how it is introduced into the cell. Methods which permanently incorporate the GFP within the host allow researchers to visualize the gene for many generations as the GFP will be passed on to cellular progeny. One of these methods is called transduction. Transduction uses a viral particle as a shuttle for genetic information. When the shuttle gets to the cell it unloads the genetic passengers and they make their way into the host genome. The host cell is unable to recognize that these passengers are foreign, and it will express them as if they were there all along. The organism now has a measurable fluorescent signal which can be used as an indicator of a desired biological process.

We are also able to selectively place these reporter genes next to a desired gene to visualize when our gene of interest is being read by the cellular machinery. When the gene is read, the reporter is too, which produces a fluorescent protein. We can then measure the amount of fluorescence as an indicator of gene activity.

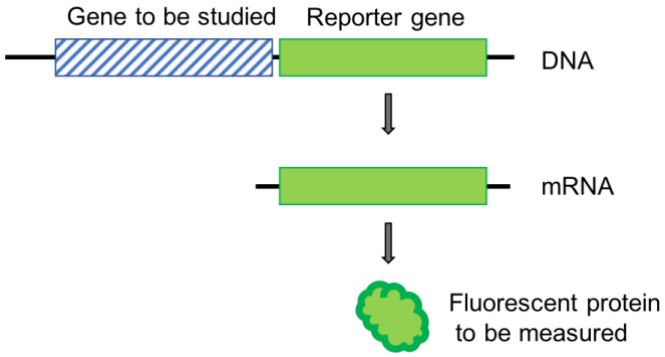

Figure 1: A graphical depiction of how we can use reporter genes to measure expression of a gene of interest

In the field of cellular research this becomes an important technique for studying genetic manipulations. We can now introduce multiple new genes into cells and measure how they are expressed simply by observing the amount of fluorescence given off by the cells. For instance, if a red fluorescent

protein and a green fluorescent protein are attached to separate genes and you want to see which gene is active after a treatment you would simply observe which color was being expressed.

For my work in the field of liver research we transduced stem cells from a patient with a clotting disorder called hemophilia A. This disorder causes a vital clotting protein to malfunction due to a genetic mutation. We were able to introduce a GFP-labeled functional copy of the mutated gene into the cells. We could then observe if the clotting protein was being produced, and at what rate.

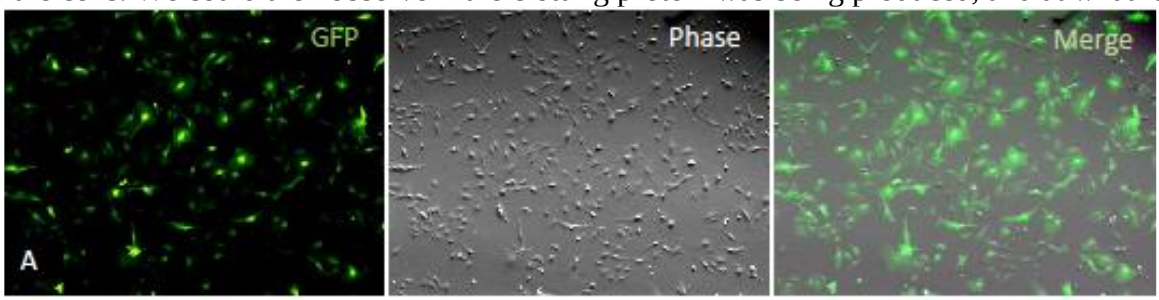

Figure 2: Hemophilia A patient stem cells are transduced with a virus containing the functional gene tagged with GFP. The cells glowing green have produced the functional protein.

Being able to visualize gene expression and track protein production are invaluable tools for scientific discovery. These chemical reactions and bioluminescent proteins have truly changed how cells can be studied and illuminated our minds.