NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

# Glowing Plants on Kickstarter: The Ethics of Synthetic Biology

*by*

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## Introduction

Synthetic biology (synbio) is a rapidly growing field that applies engineering approaches such as modularity, standardization, and modeling to build new combinations of biological parts that can accomplish specific tasks (GCAT, 2011). Current applications of synthetic biology range from producing an anti-malarial drug precursor in yeast (Ro et al., 2006) to building a completely synthetic genome for a cell that can self-replicate (Gibson et al., 2010). Many more potential applications are being dreamed up and at least partially developed by high school and college students every year through the International Genetically Engineered Machine (iGEM) competition (<http://www.igem.org>).

Synthetic biology goes beyond traditional molecular biology in that it uses Lego-style assembly logic, where many different kinds of DNA "building blocks" can be assembled by a few common steps. While recombinant DNA technology (being able to manipulate DNA and combine different pieces to create new or more efficient outcomes) has been around since the 1970s (Judson, 1979), this streamlining of the assembly process allows scientists (or anyone else with access to some basic equipment and reagents) to greatly speed up the process of building recombinant pieces of DNA. Thus, recombinant DNA technology is now accessible to many more people and the process of creating new DNA-based products can be much faster and more efficient. This has raised excitement over potential technologies that benefit the environment, human health and industrial applications, but also raises concerns about potential misuse or dangers of the technology.

In Part I of this case study we will examine a specific synbio project involving plants engineered to glow in the dark. We'll use this to get an understanding of the basic technology as well as some associated applications and concerns. In Part II we'll look more closely at the ethical issues associated with this technology and the thought processes that help us analyze what might be appropriate outcomes of synbio.

### *Preparation for Part I*

Before beginning Part I of the case, read the article and view the video below:

- Cha, A.E. 2013. Glowing plant project on Kickstarter sparks debate about regulation of DNA modification. *The Washington Post* October 3, 2013. Available at <https://www.washingtonpost.com/national/health-science/glowing-plant-project-on-kickstarter-sparks-debate-about-regulation-of-dna-modification/2013/10/03/e01db276-1c78-11e3-82ef-a059e54c49d0_story.html>. *Hunkered down in a converted shipping container stationed in a San Francisco parking lot, three young entrepreneurs are tinkering with the DNA of ordinary plants in the hopes of being able to mass produce a variety that glows in the dark ...*
- *Glowing plants to light your home? Here they come.* Running time: 2:28 min. Produced by W*all Street Journal* May 14, 2014. Available at: <https://youtu.be/AM1q0ifx91A> *A faint, green glow is starting to light the offices of San Francisco startup Glowing Plant. The* WSJ's *Deborah Kan speaks to CEO Antony Evans on the DNA sequencing tech that makes this happen and when we'll see them in stores.*

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## Part I – Interest Groups

In 2013, Genome Compiler Corporation launched The Glowing Plant project, a crowdfunding campaign on Kickstarter. Supporters were promised t-shirts, stickers, and light-bulb vases. Thousands of supporters would also receive seeds for a plant that would glow in the dark and the blessings of the project leadership to plant them. Perhaps unsurprisingly, there is a fair bit of demand for glow-in-the-dark plants. The campaign ultimately raised well over seven times its fundraising goal. Although the Glowing Plant project would ultimately push Kickstarter to issue rules banning the use of genetically modified organisms as payment to investors, the questions the project raised about the future of synthetic biology were not so easily answered.

Your instructor will assign you to a small group representing one of several different parties potentially affected by this case. These interest groups include:

- Glowing Plant scientists
- Investors in the Glowing Plants project
- Kickstarter (the fundraising platform)
- Environmental groups
- Consumers who might consider buying a glowing plant
- Government regulators from the EPA, FDA or USDA-APHIS

### *Step 1*

In your group, begin by considering what you would most want to know about the Glowing Plant project, from the perspective of your assigned role. Make a list of these items.

### *Step 2*

Using whatever internet resources are available to you, see what answers you can find to your group's questions. Summarize your key findings, being sure to note the sources of your information.

### *Step 3*

Each group will report back, framing your information around any of the following key questions that your findings help you to address. The questions below represent content areas that will help us address later ethics questions. Some of the questions most important to your assigned role may fall under one of these categories. If your group identified additional questions that don't fit easily under one of the areas below, feel free to add additional questions or topics to the list provided.

- How are the glowing plants made?
- What are the potential applications and advantages of glowing plants? What parties would benefit most?
- What are the potential dangers of glowing plants? What parties (not just humans) would be most affected?
- What are the limitations of the technology?
- What are the relevant regulations? Are they enough? Too much?

### *Step 4*

With respect to the potential dangers or concerns, what reasons would your particular role (the one your group is representing, not necessarily you yourself) list for supporting and/or opposing this technology? Of these reasons, which would your assigned role consider to be the most relevant to determining whether to go forward with commercializing this project? List the top three in rank order. Your list may include a mix of reasons for and against the technology; your job is to determine why one might view one particular reason (for or against) as more important than another.

1.

2.

3.

(How could you support and oppose an issue at the same time? It's possible that you might find reasons to support some applications of the technology but not others. Or you might find that the act of genetic engineering itself is ethically troubling, but might result in good consequences (or vice versa). The point here is to begin to explore the complexity of the issue, rather than responding with a gut reaction.)

### *Step 5*

As a class, we will determine the key unaddressed questions for which we would like more information. List those here. Each group will be responsible for gathering more information on one of these lingering questions.

### *Preparation for Part II*

Before beginning Part II of the case, complete the following:

- Read "Our Synthetic Future" by Cameron and Caplan in *Nature Biotechnology* 27, 1103–1105 (2009).
- Take a look at the Glowing Plant website (<http://www.glowingplant.com>) and other resources as needed to address the question assigned to your group.
- Prepare a brief summary of your findings with respect to the question you were assigned to investigate, being sure to cite your sources. Each student should respond individually to your group's assigned question, and you should use credible sources to support the answers you provide.

## Part II – Regroup

We'll begin as a whole class with a report-back from each group on the information they were able to find. You'll then be assigned to a new small group, comprised of students who represented different roles in our previous class. Note that in your new group, you will continue to represent your originally assigned role, but you will now be interacting with students representing each of the other roles. This combination of perspectives should help your group to more thoroughly evaluate the issue.

### *Step 1*

As a group, determine how or whether this new information affects any of the reasons that were raised previously. Does it invalidate any of them? Make some more important than others?

### *Step 2*

What moral obligations does someone in your role have? How are those different from the obligations someone in another role might have? How do one's circumstances shape one's obligations? What counts as a good reason for doing or not doing something?

### *Step 3*

Part of what has many people interested in or concerned about synthetic biology is the fact that it's so approachable, it can literally be done in someone's garage. In fact there is now a whole do-it-yourself (DIY) movement using synthetic biology principles. The Glowing Plant Project is planning to sell a kit allowing customers to make their own glow-in-the dark plants (http://www.glowingplant.com/maker ), and there are now public places where anyone can rent lab space to do this kind of work (such as Biocurious and Genspace; Kean, 2011). Whereas historically, DNA modification was only done in specialized lab spaces run by the government or large universities, now many more people have access. What does it mean that someone can now manipulate DNA in their own garage (or in a re-fitted shipping container, as in the case of the Glowing Plant project)? What are the moral obligations of the DIY scientist, and what reasons count as good reasons for this person?

## References

Cameron, N., and A. Caplan. 2009. Our synthetic future. *Nature Biotechnology* 27:1103–1105.

GCAT. 2011. Genome Consortium for Active Teaching. What is synthetic biology? [Web page]. <http://www.bio.davidson.edu/GCAT/Synthetic/What_Is_SynBio.html>. Accessed 3 October 2016.

Ro, D.-K., E.M. Paradise, M. Ouellet, K.J. Fisher, K.L. Newman, J.M. Ndungu, K.A. Ho, et al. 2006. Production of the antimalarial drug precursor artemisinic acid in engineered yeast. *Nature* 440 (April): 3–6. doi:10.1038/nature04640.

Gibson, D.G., J.I. Glass, C. Lartigue, V.N. Noskov, R.-Y. Chuang, M.A. Algire, G.A. Benders, et al. 2010. "Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome." Science (New York, N.Y.) 329 (5987): 52–56. doi:10.1126/science.1190719.

Judson, H.F. 1979. *The Eighth Day of Creation: The Makers of the Revolution in Biology.* Simon & Schuster.

Kean, S. 2011. A lab of their own. *Science* 333: 1240–42. <http://www.sciencemag.org/content/333/6047/1240.full.pdf>.