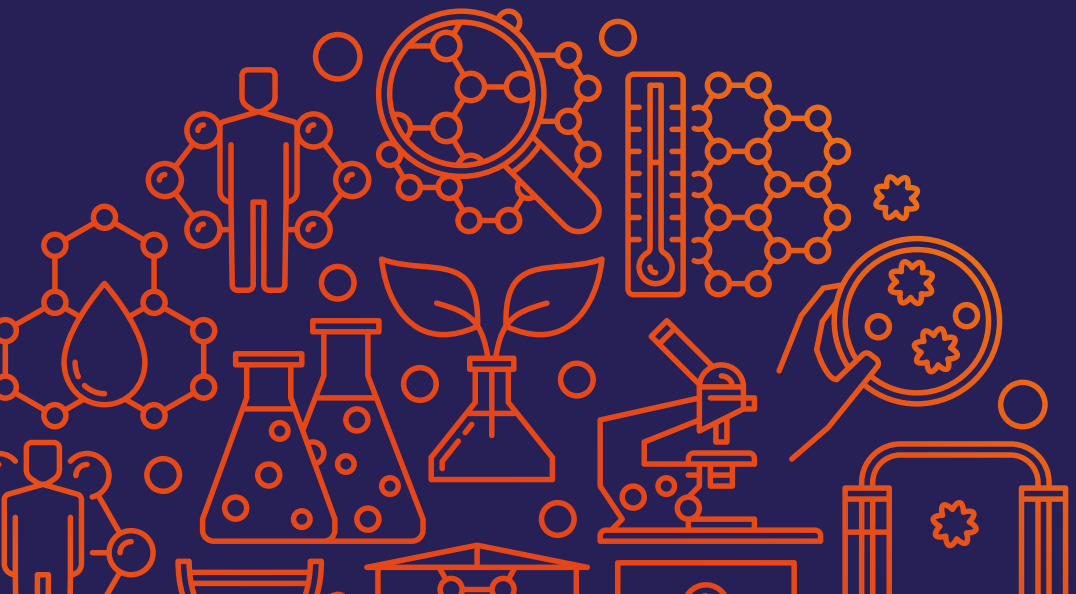
Minimalist BIOLOGY

BIOCHEMICAL SOCIETY

User Guidance Notes

Synthetic biology is a rapidly developing and interdisciplinary field. Bringing together knowledge from biochemistry and biology, chemistry and physics, engineering and computer science, synthetic biology aims to redesign – or ultimately create – biological entities and their inner workings, opening the door to new technologies and applications. As any field or tool that has the potential to tweak life, even if only in microscopic form, and result in significant societal impact, synthetic biology raises a wealth of ethical and practical questions that need to be tackled with open dialogue.

Minimalist Biology is a hands-on, Art&Science activity designed to engage varied publics with synthetic biology, its bases and applications, while fostering a conversation on this new field and its potential impacts on society.



Introduction

The arts and crafts nature of this activity will naturally attract an audience of young experimentalists keen on painting and decorating their own bacterial box. These young participants will typically be accompanied by adults, or your audience might consist of older teens with an interest in biology and engineering and a penchant for the arts. Depending on your audience, familiarity with synthetic biology and its underlying fields and principles will significantly vary. While some might be largely unfamiliar with the inner working of DNA and genetic engineering, others might have heard of genome editing and even be familiar with its mechanisms and implications.

Start the activity by finding out how familiar participants are with the basics: e.g., what cells, bacteria and genetic information are. Once those basic concepts are grounded, you can combine them in discussing how bacteria contain genetic information that can be engineered, edited and moved from cell to cell, changing the very functions that those cells can perform. You can do this by using a couple of pre-folded pieces of the origami DNA to illustrate two pieces of genetic information coding for two different functions, and how they can be extracted from a cell and moved to another. This is a good gateway for introducing what "synthetic biology" is all about, as many – if not most – participating in this activity might never have heard the term.

The information sheets that accompany the activity provide further background on synthetic biology across two levels of complexity – one aimed at younger audiences and another at older teens and adults.

Equipment

Model or picture of DNA (A template for an origami DNA model can be found here)

A big bowl/box/container (e.g., an inflatable baby pool) to contain paper origami DNA sequences

Origami DNA sequences labelled as coding for different biological functions

Printed stickers with proteins structures representing different biological functions

Small cardboard boxes

Assorted arts and crafts materials to decorate cardboard boxes (including paints, brushes and non-toxic glue sticks)

Lab coats or aprons and goggles

The "bacterial box" game

Set up three side-by-side areas or stations:

- Station 1: What are bacteria?
- Station 2: Pick a gene from the gene pool
- Station 3: Complete your bacteria

In each station you will take participants through a series of steps that facilitate understanding of – and engagement with – synthetic biology.

In Station 1 you should use some pieces of origami DNA to illustrate what genetic information is, how genes can be shuffled between organisms and how some of those organisms – e.g., bacteria – can be genetically manipulated.

In Station 2 you will be using a large container – e.g., an inflatable baby pool, which you can imaginatively call "The Gene Pool" – filled with origami DNA pieces, each with one of five different processes or functions

written on it (you can write these yourself or digitally adapt the existing origami DNA templates before printing; the end products, or functions, are: Biofuels; Biological Computers; Biomaterials; Biosensors; and Therapeutic Systems). Once the participant has selected the gene(s) with which they want to create their bespoke bacterium, they can move on to Station 3.

In Station 3 participants can insert the selected gene(s) in a small cardboard box which will be their bespoke bacterium, now bestowed with a unique function, or combination of functions. The participant should now be given stickers corresponding to their chosen function(s); these five stickers are available to be directly printed, each presenting a protein structure that stands in for the biological function that sticker signals (e.g., producing biofuels, making new medicines).

At this point, having inserted one or more gene segments into a box and glued the corresponding protein/function stickers on it, participants should be invited to decorate their bespoke bacterial box with the arts and crafts materials at their disposal.

Participants should be reminded throughout the activity that they are creating a bespoke box that represents a bacterial cell with a specific function or set of functions. It's easy, especially for younger participants, to get enthused with the arts and crafts aspect of this activity and forget that what they are creating represents a living organism. One idea to remind participants of this is to ask questions that help them focus on the task, such as: "What would you like your bacterium to do?" "How do you think you should decorate your bacterium so that it performs the function you chose?"

Remember, your role in this activity is to make sure that participants grasp the purpose of the task – i.e., to create a bespoke bacterial cell based on gene(s)/function(s) that they themselves choose – that they are engaged in creating this one-of-a-kind bacterium, and that they understand that what they were doing all along is called synthetic biology.

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Further reading

Kathryn L. Garner (2021) ***Principles of synthetic biology***. Essays Biochem 65 (5): 791–811: https://doi.org/10.1042/EBC20200059

An entire volume of The Biochemist dedicated to ***Synthetic Biology***. Volume 41, Issue 3, June 2019: https://portlandpress.com/biochemist/issue/41/3

Aaron J Dy, Emily R Aurand and Douglas C Friedman (2019) ***YouTube resources for synthetic biology education***. Synthetic Biology, Volume 4, Issue 1, 2019: https://doi.org/10.1093/synbio/ysz022

Synthetic Biology Media Resources: A collection of minimally-curated educational and informative videos and podcasts. Engineering Biology Research Consortium (EBRC): https://ebrc.org/resources/synthetic-biology-media-resources

Synthetic Biology. National Human Genome Research Institute: https://www.genome.gov/about-genomics/policy-issues/Synthetic-Biology