



Welcome everyone – thank you for volunteering your time to attend this orientation session for the Building with Biology event  
We could not have this event without you!

**Note:** This project and PowerPoint presentation use the free Google font Lato. To correctly use and view this presentation you will need to download the font and install it on your computer. Lato: <https://www.google.com/fonts/specimen/Lato>. You can download from here: <https://www.google.com/fonts#UsePlace:use/Collection:Lato> The more common fonts Calibri or Arial are fine substitutions.

## Presentation Overview

### Introduction to Building with Biology:

- About the project
- What is synthetic biology?
- Conversations with visitors

### Our Building with Biology Event

- Hands-on activities
- Logistics



Here is our agenda for the orientation today.  
We'll start out with a project overview and then spend most of our time going over the hands-on activities.

## Presentation Overview

### Introduction to Building with Biology:

- About the project
  - What is synthetic biology?
  - Conversations with visitors

### Our Building with Biology Event:

- Hands-on activities
- Logistics



We'll start by discussing the project.

# Public Engagement



## Project Goals:

- Multi-directional conversations between scientists and the public

## Target Audiences:

- Scientists and informal science educators, and the public



One of the primary goals of this NSF-funded project is to encourage back-and-forth conversation and dialogue between scientists and public audiences.

The activities and programs we're doing during our event are designed to share some basic scientific information, and to solicit people's own ideas. Public audiences will benefit from knowing about this field of research and researchers will benefit from hearing public perspectives directly from event participants.

You, scientists and volunteers, are an important target audience for this project! By participating in this event, and in this kind of outreach experience, we hope that you will learn through your conversations with the public and share what you learn back with your colleagues in the field. The field, as a whole, benefits from many voices including scientific and public.



Hands-on activities	Forums
	
<ul style="list-style-type: none"><li>• Facilitated</li><li>• Shorter experiences + back-and-forth discussions</li></ul>	<ul style="list-style-type: none"><li>• Longer conversations</li><li>• Focus on societal and ethical issues</li><li>• Science content + personal experiences and values</li></ul>
	

In order to encourage multi-directional conversations between scientists and the public, the Building with Biology project team has created 1) hands-on activities and 2) longer conversational forums.

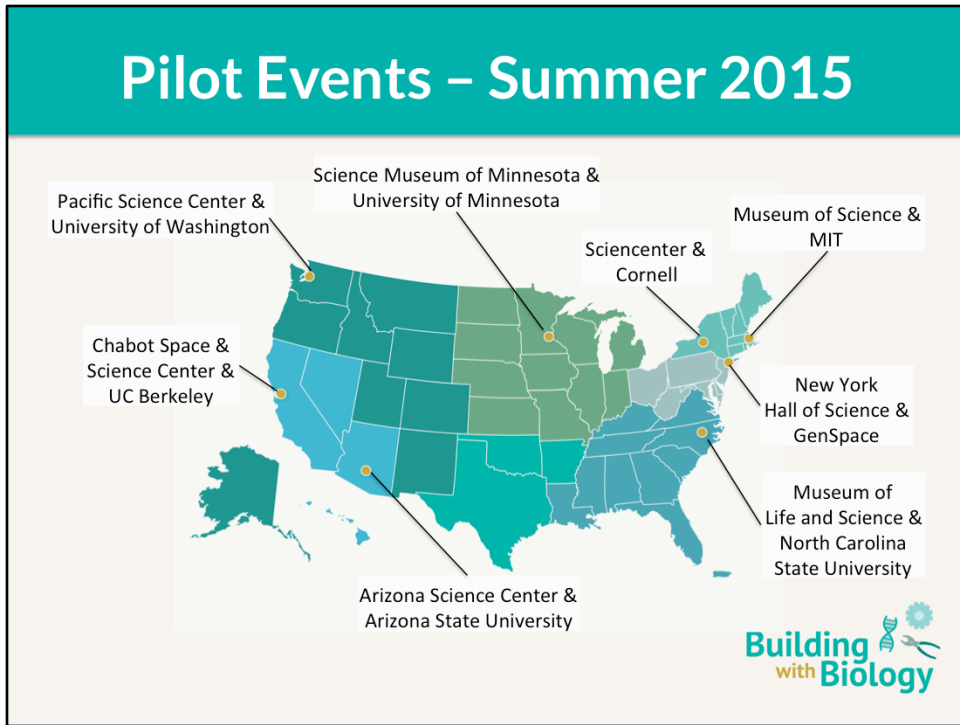
## Partners

*The Multi-Site Public Engagement with Science – Synthetic Biology* project is led by the Museum of Science, Boston in collaboration with:

- American Association for the Advancement of Science (AAAS): [www.aaas.org](http://www.aaas.org)
- BioBuilder Educational Foundation: [www.biobuilder.org](http://www.biobuilder.org)
- National Informal STEM Education Network: [www.nisenet.org](http://www.nisenet.org)
- Science Museum of Minnesota: [www.smm.org](http://www.smm.org)
- Sciencenter (Ithaca, NY): [www.sciencenter.org](http://www.sciencenter.org)
- Synthetic Biology Engineering Research Center (Synberc): [www.synberc.org](http://www.synberc.org)



“Building with Biology” is the public facing event of the *MultiSite Public Engagement with Science-Synbio* project, led by Museum of Science, Boston in collaboration with a number of scientist and informal learning partners.



The Building with Biology pilot events in the Summer of 2015 brought scientists and members of the public together at 8 science centers and museums across the U.S. to have conversations about synthetic biology.

The materials and activities for Building with Biology have been developed by both informal science educators (the event host sites and the regional hubs) and scientists. In the summer and early fall of 2016, these conversations will take place at about 200 sites around the nation.

## Evaluation Findings from Pilot Year

During the pilot events, we conducted surveys and found that:

- Visitors enjoyed the events
- Participating in events increased visitors' interest in synthetic biology
- Volunteers increased their skills in engaging the public in science



In the pilot year of the project, we conducted evaluation.

- 97% of visitors who filled out surveys “agreed” or “strongly agreed” that they enjoyed their participation
- 85% of visitors who filled out surveys said that the event increased their interest in learning about how synthetic biology is connected to their daily lives “somewhat” or “a great deal”
- 95% of volunteers “agreed” or “strongly agreed” that participating in Building with Biology increased their skills in engaging the public in science

## Presentation Overview

### Introduction to Building with Biology:

- About the project
- What is synthetic biology?
- Conversations with visitors

### Our Building with Biology Event:

- Hands-on activities
- Logistics



Now we're going to move onto sharing some very quick and basic information about the emerging field of synthetic biology.

## Synthetic Biology

**Biologists** study life, specifically organisms and their relationship to their environment.

**Engineers** solve problems using science and math. They use an engineering design process, which is a series of steps towards solving a problem.



First, a very quick introduction to synthetic biology... Many visitors may be more familiar with the fields of biology and engineering. **Biologists** study life, specifically organisms and their relationship to their environment. **Engineers** solve problems using science and math. They use an engineering design process, which is a series of steps towards solving a problem.

# Synthetic Biology

**Synthetic biologists** solve problems by applying engineering principles to biology.



**Synthetic biologists** solve problems by applying engineering principles to biology.

## Synthetic Biology

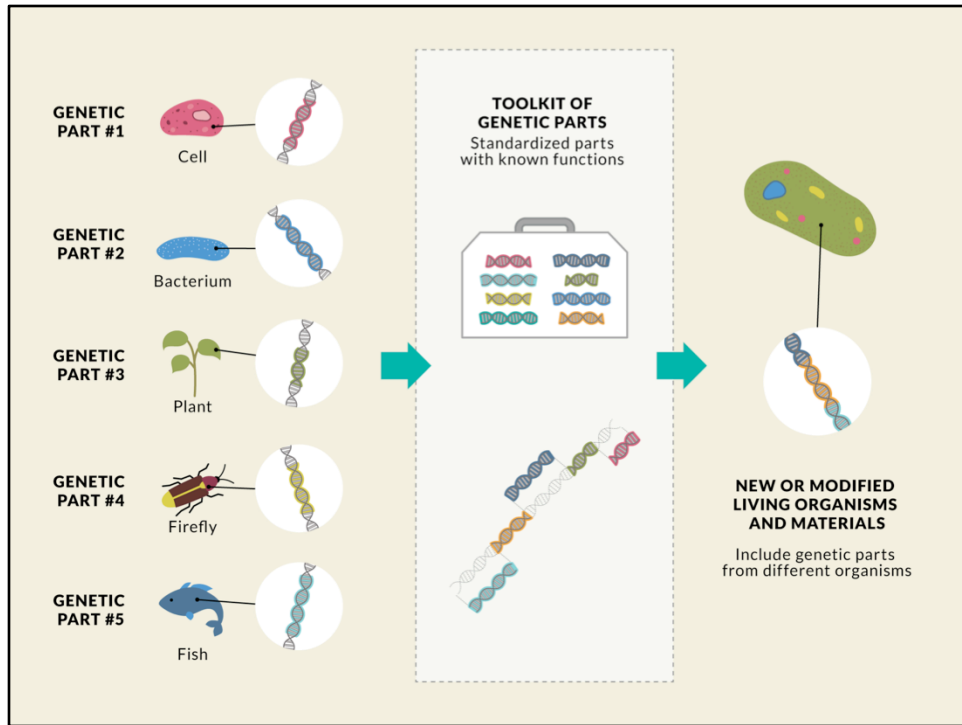
Researchers in this emerging field redesign existing organisms and make new ones.

Synthetic biology may provide solutions to problems in areas such as food security, healthcare, energy, and the environment.



Many visitors may find the new and emerging applications from this field most accessible and interesting. Researchers in this emerging field redesign existing organisms and make new ones. Synthetic biology may provide solutions to problems in areas such as food security, healthcare, energy, and the environment.





Using tools from genetics and biology, scientists and engineers mix and match pieces of DNA to make modified or new living systems. They design, build, and test these new systems in an iterative cycle (engineering design process).

Synthetic biologists are developing a library of standard biological parts. These genetic parts act like instructions that can be put together in different combinations to do and make new things.

## What is Synthetic Biology?



We'd like to show you 3 short videos designed for public audiences to help you think about ways to share information about synthetic biology and have a conversation with visitors.

First:

## How does synthetic biology work?

~2 minutes, <http://youtu.be/ZTBI5NJagNg>

created by MindFuel Canada

**Note: to play the video, you will need to use the file on the USB drive or go to YouTube (The video is not embedded in the slide show)**

## What is Synthetic Biology?



Second:

## Synthetic Biology Explained

~4 minutes

<https://www.youtube.com/watch?v=mIOFE9-3CNO>

created by Grist

**Note: to play the video, you will need to use the file on the USB drive or go to YouTube (The video is not embedded in the slide show)**

## What is Synthetic Biology?



Now, we'd like to show you a short video designed for public audiences. This video focuses on the ways that synthetic biology is interconnected with society, and shares some specific examples of how to talk about this complex content with our guests.

English Version:

<https://vimeo.com/160802115>

<https://vimeopro.com/nisenet/buildingwithbiology/video/160802115>

Spanish Version:

<https://vimeo.com/160802114>

<https://vimeopro.com/nisenet/buildingwithbiology/video/160802114>

**Note: to play the video, you will need to use the file on the USB drive or go to Vimeo (The video is not embedded in the slide show)**

## Presentation Overview

### Introduction to Building with Biology:

- About the project
- What is synthetic biology?

→ Conversations with visitors

### Our Building with Biology Event:

- Hands-on activities
- Logistics



Now we're going to move onto a brief overview of public engagement with science and conversations about synthetic biology.

## Conversations with Visitors



The focus of this project is to encourage scientists and volunteers to engage in conversations with visitors.



In these activities, we take a neutral position on synthetic biology. We are not “selling” it – and we are also not trying to discourage it.

We are creating a space for museum visitors to ask questions, share their ideas, and explore this emerging technology as it applies to their lives. We want scientists to have a conversation with the public.

Public understanding	Public engagement
<p><b>Demonstration</b></p> <ul style="list-style-type: none"> <li>• Scientist/educator has knowledge and expertise to share</li> <li>• Visitors discover phenomena and laws of nature</li> <li>• The facilitator communicates facts</li> <li>• Visitors ask questions and receive answers</li> </ul>	<p><b>Conversation</b></p> <ul style="list-style-type: none"> <li>• Everyone has their own values and perspective to share</li> <li>• Visitors form opinions and explore ideas</li> <li>• The group considers facts and values</li> <li>• Facilitators and visitors ask questions and receive responses</li> </ul>



This project is focused on increasing opportunities for public engagement with synthetic biology rather than public understanding. With the hands-on activities and the forum this engagement comes from having back-and-forth conversations between scientists and volunteers and the public.

READ NOTES FROM SLIDE

**Note:** Additional resources about Public Engagement with Science, specifically about synthetic biology, have been created for this project by AAAS. Links to resources and archived webinars can be found online at [buildingwithbiology.org/orientations](http://buildingwithbiology.org/orientations)

## Making the Content Accessible

You can use **analogies and examples** to help make synthetic biology concepts accessible.

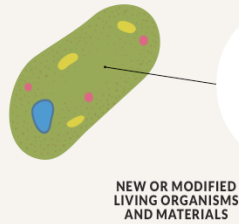


We have a few suggested strategies for having conversations with the public that involve using different analogies and concrete examples.



# Using Analogies

Making cells into factories . . . to make new things



- ➔ Medicine
- ➔ Foods
- ➔ Energy
- ➔ Materials



Analogy: Cells are like tiny factories.

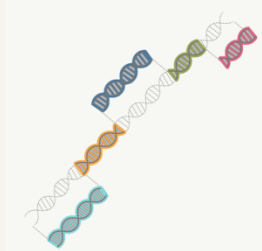
With synthetic biology, modified bacteria, algae, and yeast cells can be programmed to become tiny “factories” that produce new materials. Synthetic biology may provide solutions to problems in areas such as food security, healthcare, energy, and the environment.

## Using Analogies

Synthetic biology is like mixing and matching interchangeable parts and pieces.

Each part has a different biological function.

**TOOLKIT OF  
GENETIC PARTS**  
Standardized parts  
with known functions



Analogy: Pieces of genes can be assembled like blocks.

Genetic engineering has traditionally focused on swapping out single genes at a time. Rather than cut-and-paste, synthetic biologists hope to create entirely new genetic code assembled from an open-source repository of snippets of working genes called "BioBricks." Assembling them like blocks, the new sets of custom genetic code can then be re-inserted into bacteria or other organisms, modifying their fundamental behaviors and life cycles. This opens the door for scientists to engineer entirely new living organisms.

# Using Examples



Having concrete examples of synthetic biology products is another good way to talk about synthetic biology. All of the hands-on activity boxes include a reference with a few examples. This can be a good way to prompt visitors when discussing ways in which these technologies are interconnected with society.

Examples:

Medical applications are interesting and important to many visitors

Consumer products help connect synthetic biology to their everyday lives

Surprising inventions can spark their curiosity

## Presentation Overview

### Introduction to Building with Biology:

- About the project
- What is synthetic biology?
- Conversations with visitors

### Our Building with Biology Event:

- Hands-on activities
  - Logistics



We'll give you an opportunity to try out the hands-on activities, but, first, here's an overview of all the activities.

# Hands-on Activities



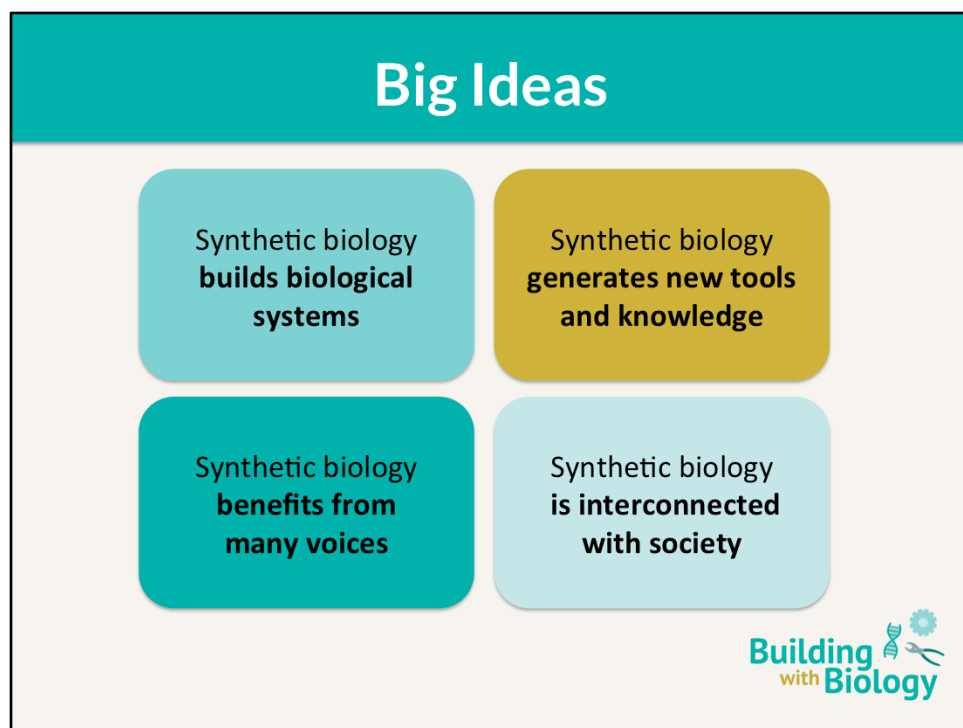
In every hands-on activity box:

**Activity guide** - with language to help you interact with visitors

**Facilitator guide** – with learning objectives and suggestions for conversation starters

Background **reference sheets** with information about the science behind your activity.

All **the hands-on activity materials** you'll need to run the activity, including a sign stand and colorful table cloth.



This project has 4 “big ideas” that we use to talk to the public about the emerging field of synthetic biology. The activities in the kit are meant to provide opportunities for conversations about synthetic biology and these ideas.

# Hands-on Activities

## Synthetic biology builds biological systems

Synthetic biologists apply engineering principles to the life sciences to solve problems.

The image shows two activity cards from the 'Building with Biology' series. The top card is titled 'Bio Bistro' and includes a 'Try this!' section with instructions on how to use different foods to represent different parts of a cell. The bottom card is titled 'VirEx Delivery' and includes a 'Try this!' section with instructions on how to use string and tape to create a model of a virus. Both cards have a 'Talk about it...' section at the bottom with discussion questions.

**Bio Bistro**

**Try this!**

1. These cards show different foods made using biotechnology. Some of these already exist, while others are future possibilities. ... which ones would you eat? ... which ones would you not eat? ... which ones would you eat only if you had a special diet? ... which ones would you eat only if you had a special diet? ... which ones would you eat only if you had a special diet?

**VirEx Delivery**

**Try this!**

1. Think of a disease that you want to cure and write it on an index card. You're going to make a model of a virus to help deliver a cure for that disease. To do this, you'll need special instructions (engineered genetic material) and insert them into a container (a virus).

2. Make engineered genetic material using yarn. Take two pieces of yarn (one purple and one orange). Each strand of yarn represents a strand of DNA that carries a specific set of genetic instructions (a gene). Use scissors to snip each strand of yarn into two pieces. Then use tape to attach a purple and an orange piece of yarn together. This engineered genetic material will provide instructions for how to cure your disease.

3. Place the strand of engineered material into a labeled box along with your index card. The labeled box represents the capsid or external shell of a virus. You're making a model delivery system to help transport your cure.

4. On a sticky note, write down where in the body this cure should go. Use more sticky notes to write down specific instructions for your modified virus to follow. Attach them all to the cardboard box.

**hat best fits your opinion?**

**some of these foods?**

**trying to solve you like or dislike different solutions?**

**How did you choose which disease you wanted to cure? Is it surprising to think about using a virus to treat a disease? How could you test your cure to be sure it was as safe as possible? Can you imagine other uses for "pre-programmed" viruses, beyond fighting diseases?**



The activities: “Bio Bistro” and “VirEx Delivery” focus on the idea that “Synthetic biology builds biological systems”

# Hands-on Activities

**Synthetic biology  
generates new tools  
and knowledge**

Using tools from genetics and biology, scientists and engineers are mixing and matching pieces of DNA to program living systems, in a way that is like computer programming.



The activity “Kit of Parts” focuses on the idea that “Synthetic biology generates new tools and knowledge”



# Hands-on Activities

## Synthetic biology benefits from many voices

Synthetic biology is an interdisciplinary field. People from many different fields participate. The work can take place in university labs, companies, and DIY maker spaces.



The activity “See DNA” introduces visitors to this essential biological material, and explores the idea that many people can participate in synthetic biology.

# Hands-on Activities

## Synthetic biology is interconnected with society

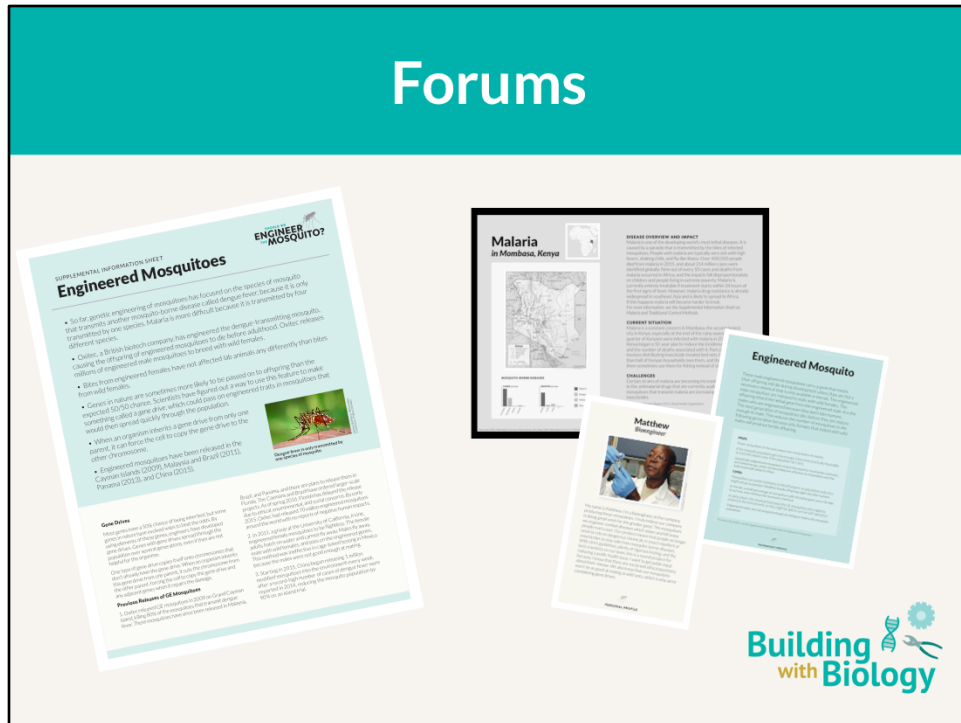
Technologies and societies are interconnected. People's values determine which new technologies are developed and used. Synthetic biology scientists are doing research that might affect all of us.

The image shows two activity cards from the 'Building with Biology' program. The top card is titled 'Tech Tokens' and includes a 'Try this!' section with a numbered list of instructions for an activity involving cards and technology. The bottom card is titled 'Super Organisms!' and includes a 'Try this!' section with a numbered list of instructions for an activity involving a human figure and tape, and a 'Now try this!' section with a numbered list of instructions for an activity involving a microorganism. Both cards also feature a 'Talk about it...' section with a discussion prompt.



The activities “SuperOrganism” and “Tech Tokens” explore how synthetic biology and society are interrelated.

# Forums



The forum touches on all four of the big ideas, and encourages thoughtful and deliberative conversation between scientists and the public about ways synthetic biology and these new technologies are interconnected with society.

Note: In the forum box, you will find a detailed manual on how to host a forum-style program. Additional forum programs and resources can be found online at [Buildingwithbiology.org](http://Buildingwithbiology.org).

# Passports

- Each facilitator will need to be prepared to stamp visitors' passports if guests ask them a question and/ or share what they think about synthetic biology.
- Facilitators who are scientists should wear "I'm a scientist" stickers at the event and should be ready to stamp passports if guests talk to them.
- The person at the graffiti board will need to stamp passports if a guest adds a post-it note to the graffiti board about how they think synthetic biology will change our lives in the future.



Each staff or volunteer will need to be prepared to stamp visitors' passports if:

Guests ask the facilitator a **question**

Guests **share what they think** about synthetic biology

Facilitators who are scientists should wear "I'm a scientist" stickers at the event and should be ready to stamp passports if:

Visitors **talk to the scientist** facilitator

The person at the graffiti board will need to stamp passports if:

Visitors **add a post-it** note to the graffiti board about how they think synthetic biology will change our lives in the future

Note: You may or may not choose to use the Building with Biology passports at your event, and that's fine. The physical kit include 100 copies (in English and in Spanish) but you are free to print more of your own from the digital file. Every activity box include a marker stamp for facilitators to use.

## Presentation Overview

### Introduction to Building with Biology:

- About the project
- What is synthetic biology?
- Conversations with visitors

### Our Building with Biology Event:

- Hands-on activities

➔ Logistics



We'd like to go over a few logistics for today's event.

## Event Logistics

- Event schedule
- What else is going on
- Location of bathrooms
- Emergency procedures



Note: Here are some common logistical points you'll probably want to cover. You can add any logistics that you would like to share for your institution.

# Thanks for volunteering!



## We couldn't do this without you!



This presentation was created as a collaboration of the Multi-Site Public Engagement with Science—Synthetic Biology project. This project was supported by the National Science Foundation under Award Number 1421179. Any opinions, findings, and conclusions or recommendations expressed in this program are those of the authors and do not necessarily reflect the views of the Foundation.

