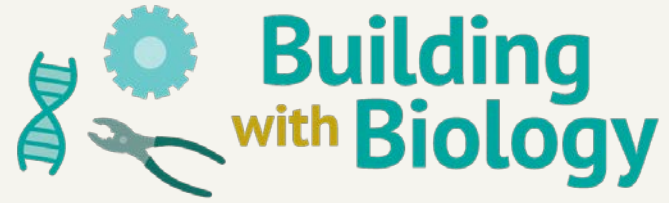


Engaging Audiences in Science through Building with Biology Public Forums



Activities and Conversations about Synthetic Biology

Welcome!

Thursday, April 28th – Today’s presenters are:

Caroline Lowenthal, Kayla Berry and Elizabeth Kollman, Museum of Science, Boston

As we wait to get started with today’s discussion, please:

Introduce yourself! Type your name and institution into the Chat Box

Call into the phone line (optional) at (877) 898-0037 (if using the phone line please make sure to mute your phone when not talking and also your computer’s microphone)

Questions? Feel free to type your questions into the Question pod at any time throughout the webinar

Today’s discussion will be recorded and shared on www.buildingwithbiology.org at:

<http://www.buildingwithbiology.org/blog/online-project-orientations-and-workshops>



This presentation is based on work supported by the National Science Foundation under Grant No. DRL 1421179. Any opinions, findings, and conclusions or recommendations expressed in this presentation are those of the author(s) and do not necessarily reflect the views of the Foundation.



Activities and Conversations about Synthetic Biology

Forums Webinar

April 28, 2016



This project is funded by the Advancing Informal STEM Learning (AISL) program in the Education and Human Resources Directorate of the National Science Foundation through award no. DRL-1421179



Presenters



Caroline Lowenthal
Forums



Kayla Berry
Stipends



Liz Kollmann
Evaluation



Agenda

- What is a forum?
- Why should you hold a forum?
- How this fits into BWB project goals
- Your options for forums
- Stipend details
- Evaluation requirements
- Resources
- What to think about now
- Q&A and how to get in touch with questions

Poll #1

What is a forum?

- Event for groups of 2-100+ where participants:
 - Learn about an emerging technology
 - Engage in a guided conversation
 - Share their views
 - Make a plan of action
- A longer, more in-depth conversation targeted at ages 16+
- Scientists are participants, rather than facilitators



What is a forum?

- A forum has 4 main parts:
 - Welcome and introduction
 - Speaker or video presentation
 - Participant conversation
 - Report out and wrap up
- A forum usually takes around an hour and a half



Why should you hold a forum?

For your institution

- Attract and engage adult audiences with various backgrounds and ages in in-depth learning experiences
- Develop your ability to engage the public in conversations about societal issues raised by emerging technologies
- Start to define a new role for your museum in your community, as a neutral place to talk about controversial science and technology issues

For your participants

- Share their perspectives with scientists and policy-makers who want public input on their work
- Increase scientist and public understanding of diverse points of view
- Gain confidence in making decisions about new technologies
- Practice considering different perspectives and sources of information for problem-solving
- Learn about a new technology and get the chance to discuss its impacts

How this fits into BWB project goals

- The aim of this project is to foster activities in science museums through which **public audiences can engage with scientists and** in conversations about what synthetic biology is, how research in the field is carried out, and the potential products, outcomes, and implications for society of this work.
- Researchers and publics **will explore personal and societal values and priorities** as well as research outcomes **so that both groups can learn from each other.**

Your options for forums

- **Should We Engineer the Mosquito?**
 - The materials for this forum are provided in your kit and you can print more from the Building with Biology website if needed
- **Editing the Genome: Now We Can. Should We?**
 - You will need to print all of the materials for this forum yourself from the Building with Biology website, available by the end of May

SHOULD WE
ENGINEER
THE **MOSQUITO?**



Your group is going to decide whether to release genetically engineered (GE) mosquitoes in Mombasa, Kenya, and how to go about it. Follow the steps below to learn about options, then draft your proposal on the back of this sheet. You can find more in-depth information about the mosquito life cycle, malaria and traditional control methods, and engineered mosquitoes in the Supplemental Information Sheets.



STEP 1: INTRODUCTIONS AND MALARIA PROFILE

1 card, 5 minutes

Introduce yourselves. Share your name and your connection to the topic. Then read the malaria profile card aloud to the group.



STEP 2: ENGINEERED MOSQUITO PROFILE

1 card, 5 minutes

The technology card provides information on one genetic engineering method that could be used to engineer mosquitoes so they would not transmit malaria as well. Engineers are working on other methods but this is one of the more promising options. Read the technology profile card aloud to the group.



STEP 3: GENE DRIVE PROFILES

2 cards, 8 minutes

The gene drive cards provide information about a technology that can be added to GE mosquitoes. Gene drives raise ethical considerations, but can improve the success of the GE mosquito strategy. Take turns reading the gene drive profile cards.



STEP 4: RELEASE OPTIONS

1 card, 2 minutes

The release options card provides some possible options for how your group can choose to release genetically engineered mosquitoes. As part of your conversation, you can choose one of these options or make up your own. Read the release options card aloud to the group.



STEP 5: PERSONAL PROFILES

5 cards, 10 minutes

Take turns reading the personal profile cards. You don't need to play the roles of these people, but rather, consider their perspectives as you make decisions.



STEP 6: DISCUSS AND MAKE A PLAN

30 minutes

Discuss whether your group would like to release the GE mosquitoes in Mombasa. As you discuss, consider the personal profiles. How might each of these people feel about introducing GE mosquitoes to help control malaria? For more background information on mosquitoes, refer to the Supplemental Information Sheets. Flip to the other side of this paper to write your plan as a group. **Your group will need to decide:**

1. Will you release GE mosquitoes in Mombasa? Why or why not?
2. If you choose to release GE mosquitoes, will you use a gene drive? If so, which type?
3. If you choose to release GE mosquitoes, who should handle the release? At what scale?
4. What were the reasons behind your group's decision?
5. If the community in Mombasa cannot agree about whether to release the GE mosquitoes, who should have the power to decide?

STEP 7: REPORT OUT

10 minutes

Each group presents their plan in 2 minutes or less. Then participants can comment on each other's plans.

YOUR PLAN

Write down your group's proposal for managing mosquitoes that transmit malaria.

If your group chooses to release GE mosquitoes in Mombasa, decide:

Whether you will use a gene drive and if so, which one? (targeting the malaria parasite or targeting mosquitoes), and

A method for release from the options below, or make your own:

Who should release the GE mosquitoes?

- A. Local Mombasa government
- B. Governmental authorities such as the Kenyan Ministry of Health
- C. Companies who developed the mosquitoes
- D. A nonprofit/NGO that developed the mosquitoes in collaboration with academics and government.
- E. Other

At what scale?

- A. Group releasing the mosquitoes determines the scale
- B. Limited local release followed by a one year study period (if using gene drives, this is only possible for the technique targeting mosquitoes)
- C. Large scale release
- D. Other

1. Will you release GE mosquitos in Mombasa? Why or why not?

2. If you choose to release GE mosquitoes, will you use a gene drive? If so, which type?

3. If you choose to release GE mosquitoes, who should handle the release? At what scale?

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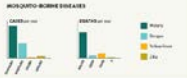
If you have time, consider this: How would your answers change if this were in your own city?

Be ready to present your plan in a 2-minute summary!

Malaria in Mombasa, Kenya



DISEASE OVERVIEW AND IMPACT
Malaria is one of the deadliest, world's most lethal diseases. It is caused by a parasite that is transmitted by the bites of infected mosquitoes. People with malaria are typically very sick with high fevers, shaking chills, and flu-like illness. Over 400,000 people die from malaria in 2015, and about 734 million cases were identified globally. Nine out of every 10 cases and deaths from malaria occurred in Africa, and the impacts fall disproportionately on children and people living in extreme poverty. Malaria is currently entirely treatable. If treatment starts within 24 hours of the first signs of fever, however, malaria drug resistance is already widespread in southeast Asia and is likely to spread to Africa. If this happens malaria will become harder to treat. For more information, see the Supplemental Information sheet on Malaria and Traditional Control Methods.



MALARIA PROFILE

CURRENT SITUATION
Malaria is a constant concern in Mombasa, the second largest city in Kenya, especially at the end of the rainy season. Nearly a quarter of very young cases infected with malaria in 2015, in 2009 Kenya began a 10-year plan to reduce the incidence of malaria and the number of deaths associated with it. Part of this plan involves distributing insecticide-treated bed nets, but still less than half of Kenyan households own them, and those that own them sometimes use them for fishing instead of sleeping.

CHALLENGES
Certain strains of malaria are becoming increasingly resistant to the antimalaria drugs that are currently available, and the mosquitoes that transmit malaria are becoming resistant to insecticides.

Source: World Health Report 2014, World Health Organization

Engineered Mosquito

These male engineered mosquitoes carry a gene that means their offspring will die during development unless they are fed a necessary chemical that is only available in the lab. The engineered male mosquitoes are released to mate with wild females. The offspring inherit the lethal gene from the engineered male. If a male mosquito is engineered because they don't take humans, the next generation of mosquitoes dies before they are mature enough to mate. This reduces the number of mosquitoes in the following generation because only females that mated with wild males will produce fertile offspring.

PROS:
Fewer mosquitoes enter the area means less transmission of malaria. This means mosquito gene loss may be irreversible, impossible to spread naturally, and the population will stay small.
Genetically engineered mosquitoes do not bite humans, but they and their offspring, which are becoming less effective as mosquitoes and the means to distribute them.

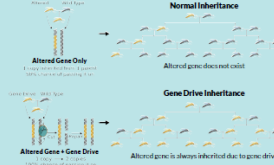
CONS:
Insecticides can make mosquitoes resistant to the lethal gene, so population reduction might not occur and it could spread without killing the humans. In the lab, a small number of mosquitoes with the lethal gene were able to live and reproduce without the necessary chemical. In the field, the chemical that kills the GEM mosquitoes also might be present in the environment, so they might be able to survive and reproduce. Engineered males are not as good at mating with wild females as the population.

For more information, see the Supplemental Information Sheet on Engineered Mosquitoes.

TECHNOLOGY PROFILE

Gene Drive Part 1: Overview

Some genes found in nature are more likely to be passed on to offspring. By using elements of these genes, engineers have developed gene drive systems. Genes with gene drives spread through a population quickly over just a few generations.



CONSIDERATIONS:

Some scientists suggest that we could release a second gene drive that would reverse the first gene drive if something went wrong. This strategy would not completely return the population to "normal" because the genes from the second gene drive would still be present.

Gene drives have been tested successfully in the lab but no mosquitoes with gene drives have ever been released in the wild.

OPTIONS:

One possible gene drive could target the malaria parasite that can live inside mosquitoes.

Another gene drive could target the mosquito itself.

For more information, see the Supplemental Information Sheet on Engineered Mosquitoes.

TECHNOLOGY PROFILE

Gene Drive Part 2: Targets



TARGET: Malaria Parasite
The gene drive targeting the malaria parasite makes mosquitoes unable to carry the malaria parasite.

TARGET: Mosquito
The gene drive targeting mosquitoes causes sterility to spread through the mosquito population, which reduces the number of mosquitoes.

PROS:

This is not likely to have many unexpected effects on animals besides mosquitoes.

The mosquitoes would still be present in the ecosystem.

CONS:

The malaria parasite might evolve resistance and return in a few years.

Scientists do not know whether the altered gene might spread to other related species of mosquitoes.

PROS:

This is likely to permanently reduce the mosquito population. With a small enough mosquito population, malaria cannot be transmitted.

CONS:

This might affect species that eat or interact with that species of mosquito.

This might wipe out Mombasa's entire population of this species of mosquito, which might impact the ecosystem and food chain.

For more information, see the Supplemental Information Sheets on Engineered Mosquitoes and Malaria and Traditional Control Methods.

TECHNOLOGY PROFILE

Release Options

Who should release the GE mosquitoes?

At what scale?

A. Local Mombasa government

B. Governmental authorities such as the Kenyan Ministry of Health

C. Companies who developed the mosquitoes

D. A nonprofit/NGO that developed the mosquitoes in collaboration with academics and government

E. Other

A. Group releasing the mosquitoes determines the scale

B. Limited local release followed by a one year study period (if using gene drives, this is only possible for the technique targeting mosquitoes)

C. Large scale release

D. Other



RELEASE OPTIONS

Matthew Bioengineer



Army Medical Research Center/AFMRL

My name is Matthew. I'm a bioengineer at the company producing these mosquitoes. I truly believe our company is doing great work for the greater good. The mosquitoes we engineer combat diseases which sicken and kill many people every year. Our product means that people no longer need to rely on dangerous chemicals in insect repellent or insecticides to stay safe from mosquito-borne diseases. With strict guidelines, plenty of rigorous testing, and the best scientists on our team, this is a sound product for reducing a public health issue. I want to get public input because I know that there are social and ethical questions about their release. We also know that our mosquitoes won't be as good at mating as wild ones, which is why we're considering gene drives.

PERSONAL PROFILE



Editing the Genome: Now We Can. Should We?

You are a group of citizens brought together to advise the city council on a research project at a local university. Scientists at the university have developed a new application using CRISPR, and local biotech companies are showing interest. The city council is interested in what local citizens think about the future use of this technology.



STEP 1: INTRODUCTIONS AND BACKGROUND INFORMATION

1 page, 10 minutes

Introduce yourselves. Share your name and your connection to the topic. Then take turns reading the background information aloud to the group.

STEP 2: APPLICATION CARDS

8 cards, 20 minutes

CRISPR is being used for a wide variety of applications. Take turns reading the application cards aloud to get a sense of their range.

STEP 3: CHOOSE AN APPLICATION

5 minutes

Choose one of the applications to discuss in more depth.

STEP 4: DISCUSS AND MAKE A RECOMMENDATION

30 minutes

Flip to the other side of this paper to write your recommendation as a group. City council is specifically interested in the answers to the following questions:

1. **Would you like this technology to be used? If so, how? If not, why not?**
 - Restricted to research use? Commercialized? Used in clinical applications, if applicable?
 - What benefits do you hope will result from the use of this technology?
 - What concerns do you have about its use?

2. **Should the university should bring this technology to market/the world? If so, how?**

Generally, filing a patent is the first step whether an inventor wants to charge for the use of their discovery or allow people to use it freely.

- Charge people who want to use it? If so, should the price be low or high?
 - Or allow people to use it freely? If so, should they insist on some restrictions on profits for companies who make products that use it?
3. **What restrictions, if any, would you like to see implemented to maximize the benefits and safety of editing this genome? Who should regulate/oversee the use of this technology?**
 - The scientists themselves? The city council? The state government? The federal government or a federal agency (e.g. FDA)?

STEP 5: REPORT OUT

10 minutes

Each group presents their recommendation in 2 minutes or less. Then participants can comment on each other's plans.

Application: _____

1. **Would you like this technology to be used? If so, how? If not, why not?**

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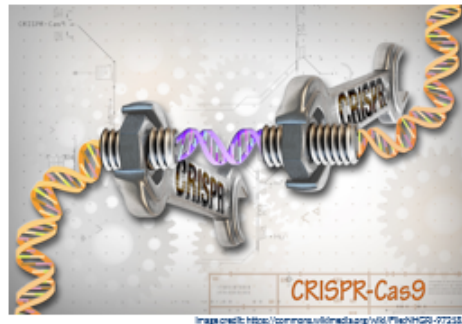
If you have time, consider this: How would your answers change if it were a company developing this technology rather than a university?

Background info (2 pages)

Building
with Biology

Background Information

Throughout history, humans have strived to create better versions of existing plants and animals through selective breeding. Since the 1970s, scientists have been able to genetically modify living things by "cutting and pasting" DNA. In 2013, scientists developed a new technique for



genetic modification that uses repeating patterns in the DNA of many species. This new technique is called the CRISPR/Cas9 system (called CRISPR, pronounced "crisper," for short). CRISPR works like a search-and-replace function in a word processor and allows scientists to edit genomes with much more precision, efficiency, and flexibility than they had with prior techniques. It is also faster, lower cost, and easier to use.

The CRISPR technique is only useful where the connection between genes and the desired or undesired characteristic is well understood. For example, scientists have identified the mutated gene that causes the deadly disease cystic fibrosis. On the other hand, a mosquito's ability to find humans has not been mapped to specific genes and likely involves a combination of genes. Using CRISPR to remove the mutated cystic fibrosis gene and replace it with an unmutated one should be much simpler than changing the mosquito's sense of smell.

8 application cards

Application Card: Bees



Illustration: Max Decker / iStockphoto.com, 2012/2/13/14

Problem

Bees are an important part of ecosystems all over the world. They play a critical role in agriculture, with 35% of global crops depending on pollinators like bees. Over the last 10 years, more and more bees have been lost. In February 2016, the UN released a report that included bees on a list of pollinator species that are at risk of global extinction.

Possible Solution

It is not clear yet what is causing so many bees to die, but possibilities include disease, parasites, and pesticides. Scientists have been studying the genomes of 'hygienic' bees, which obsessively clean their hives and remove sick and infested bee larvae. Hygienic colonies are less likely to die out from disease or parasites. If scientists can identify the hygienic genes, they can use CRISPR to copy them to other types of bees to help the bees survive.

Pros

- Many people, including scientists, the Environmental Protection Agency, and the Department of Agriculture, as well as their counterparts all over the world, have been trying for years to combat the loss of bees with little success. Modification with CRISPR may give the bees a way to survive.

Cons

- **Early stages/may be complicated:** No hygiene-associated genes have been definitively identified, and the combination of genes driving the behavior may turn out to be complex. It is not clear whether changing the hygienic genes might cause other behavior changes in the bees.
- **Reason not to do genetic modification:** If hygiene-associated genes are identified, conventional breeding may be enough to spread resistance to new populations, potentially making CRISPR unnecessary.

Discussion

STEP 4: DISCUSS AND MAKE A RECOMMENDATION

30 minutes

Flip to the other side of this paper to write your recommendation as a group. City council is specifically interested in the answers to the following questions:

1. Would you like this technology to be used? If so, how? If not, why not?

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- The scientists themselves? The city council? The state government? The federal government or a federal agency (e.g. FDA)?

Poll #2

New Opportunity

Building with Biology Forum Stipend

Stipend discussion –

- Stipend overview
- Budget and expenses
- Application and selection process
- Timeline



Forum Stipends

Application deadline: May 31st

One-time stipends in the amount of \$1,200 are intended to:

- help support the planning and implementation of a Building with Biology forum, in connection with your planned Building with Biology event
- to engage public audiences and create conversations among publics and scientists about synthetic biology and its societal implications

Stipend Overview

Building with Biology Forum Stipend Overview – provides details on stipend criteria and eligibility, the evaluation and reporting requirements, allowable expenses, and application and selection process

Eligibility

- Only recipients of Building with Biology physical kit can apply for a forum stipend
- The forum stipend is designed for institutions (e.g., museums, universities, and industry and professional organizations) within the United States

Stipend Budget and Expenses

Eligible expenses	Ineligible expenses
Staff time – planning meetings, recruiting forum participants	Cannot be used to pay for indirect costs (overhead)
Audio/Visual, space rental	Cannot be used for alcohol
Subsistence (participant food only)	Cannot be used to pay participants to attend the forum
Honorarium for outside presenters	Cannot be used for any prizes or entertainment costs
Other – parking and incidental expenses for guest presenters	

Application & Selection Process

Application deadline is Tuesday, May 31st

- Application must be filled out and submitted online through SurveyGizmo - <http://www.surveygizmo.com/s3/2657162/2016-Building-with-Biology-Forum-Stipend-Application>
- Applications will undergo review process by Building with Biology project team
- Applicants will be informed of their award status in early June 2016; stipends issued in June



Stipend Timeline

May 31st: Deadline to apply for forum stipend

June 2016: Applicants informed of award status in early June; stipend received in late June/early July

June 23rd: Evaluating Building with Biology Forums (required for those awarded stipend) webinar; 2:00 – 3:00 PM EST

June 24th – September 30th: Host a Building with Biology forum



Poll #3

The logo for 'Building with Biology' features three icons: a teal DNA double helix on the left, a teal gear in the upper center, and a pair of teal pliers on the right. The text 'Building with Biology' is positioned to the right of the icons, with 'Building' in a large teal font, 'with' in a smaller yellow font, and 'Biology' in a large teal font.

Building with Biology

Activities and Conversations about Synthetic Biology

Forum Stipend
Evaluation Requirements

Forum Evaluation Questions

- What do scientists and publics learn from the forum and from each other?
- Does participation increase publics' and scientists' interests in PES or synthetic biology? If so, how?
- What do scientists and publics value about their participation in the forum?
- What follow-up behaviors does participation prompt in scientists and publics?
- What are scientists' and publics' viewpoints about synthetic biology?

Data Collector Requirements

- Provide documentation of human subjects training completion
- Attend a 1-hour webinar: “Evaluating Building with Biology Forums”
- Collect surveys and discussion materials on the day of the forum
- Mail the surveys and discussion materials back to the Museum of Science



Pilot Events – Summer 2015

Data Collected from Forum Participants

Document contents

Introduction 2

 Data collection 2

 Data analysis 3

 Themes within the data 3

 Questions to consider 4

 Authorship 4

Presentation of data 5

 Forum participants represented various backgrounds, ages, genders, and group types. 5

 In some cases, volunteers and visitors experienced the forums differently. 6

 Forums increased participant—especially visitor—interest in future synthetic biology activities. 7

 Participants learned from interacting with one another and from the forum experience overall. 7

 Participants valued a number of things about their experience, especially aspects of the discussion. 10

 Participants offered some suggestions for improving the forums. 11



Data Collector Initials: _____ Su

Fo

Are you 18 or older? if so
Participation is volun

1. Thinking about your experience at this f
the statements below? (Please check)

- I shared my views about synthetic biology.
- I considered the benefits of synthetic biology.
- I considered the risks of synthetic biology.
- My group's final plan reflected my personal vie
- I learned about viewpoints different from my c
- I enjoyed this event.

2. What, if anything, did you learn from pi

3. Did both scientists and non-scientists pi
 Yes No I

4. What, if anything, did you learn from ot

5. How much did you know about the folk
know AFTER the forum? (Check one 'BE

	BEFORI
	Nothing
Facts about synthetic biology	<input type="checkbox"/>
Applications of synthetic biology	<input type="checkbox"/>
Societal aspects of synthetic biology	<input type="checkbox"/>
What other people think about synthetic biology	<input type="checkbox"/>

Questions?

<http://www.buildingwithbiology.org/project-evaluation>

Contact: Elizabeth Kollmann (ekollmann@mos.org)



Resources

- Guides
 - Mosquito guide available now
 - Editing the Genome guide coming soon!
- Training video coming soon!
- Forums manual available now
- BWB website:
<http://buildingwithbiology.org/forums>
- Introduction to Synthetic Biology and Society video available now
- Me!



Building with Biology

Should We Engineer the Mosquito?

Introduction

We regard you as thinking of joining the "Should We Engineer the Mosquito?" Forum as an opportunity to engage in thoughtful conversations about the potential societal and ethical implications of synthetic biology. Forum discussions take approximately an hour and a half, are targeted at older audiences (16+), and are often most successful as a separate event marketed to adults in a quiet space. Facilitated by educators, Building with Biology forums are adaptable and allow scientists to participate alongside members of the public to promote conversations about synthetic biology.

This document contains information for leading the Forum, including tips on how to make facilitating and engaging in thoughtful conversations the most enjoyable experience.

Introduction	1
Forum to Do It Quick Start Guide	2
Lead the Workshop	3
Facilitate	4
Facilitator's Toolkit	5
Facilitator's Toolkit	6
Facilitator and Event Checklist	7
Event Script	8
Closing Script	10
Forum Resources	11
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Credits and Acknowledgments	14



Building with Biology

Forums

Building with Biology forums provide an opportunity to engage in thoughtful conversations with scientists about important issues regarding the potential societal and ethical implications of synthetic biology. Forum discussions take approximately an hour and a half, are targeted at older audiences (16+), and are often most successful as a separate event marketed to adults in a quiet space. Facilitated by educators, Building with Biology forums are adaptable and allow scientists to participate alongside members of the public to promote conversations about synthetic biology.

- For an overview of the educational and professional materials provided in the Building with Biology physical kit, view the Kit Contents PDF.
- Forums Manual - This manual (PDF) is a great resource tool for planning and organizing a forum at your own institution.



What to think about now

- The parts of your forum that need the longest lead time are:
 - Choose a date, and find and reserve a location
 - Decide which forum you want to host
 - Find and confirm a speaker, if you want to have one
 - Publicize the forum
 - Create a registration list for participants to sign up
- This will also take a while and needs to be done in advance:
 - Find synthetic biologists and other scientists to attend as participants
 - You may also want to run a practice forum with volunteers or staff to familiarize yourself with the process and content

Q&A

To get in touch with questions, email
clowenthal@mos.org

Upcoming Webinars

Host site staff

We have a number of webinars and project orientations designed to help prepare host site staff for hosting their Summer 2016 Building with Biology events and forums.

- 5/16: Host Site Overview: Communicating Synthetic Biology (12PM EDT)
- 6/14: Evaluating the Public's Experience at Building with Biology Events (1PM EDT)
- 6/21: What's in Your Building with Biology Kit (2PM EDT)
- 6/23: Evaluating Building with Biology Forums (2PM EDT)

Scientist Volunteers

Online project orientations led by our project partner, AAAS, target your scientist volunteers. These three webinars will take place throughout the month of May.

