

Should We Engineer the Mosquito?

Introduction

We're glad you're thinking of hosting the "Should We Engineer the Mosquito?" forum! A forum is an event where participants have a chance to learn about a topic and then engage in a guided conversation and make a plan of action. In this case, the participants are both scientists and members of the public, the topic is genetically engineered mosquitoes, and the plan is a decision about whether to release genetically engineered mosquitoes in Mombasa, Kenya. Participants get the chance to practice critical thinking skills and apply them to a real-world socio-scientific issue.

This document contains instructions for hosting the forum, including tips on how to make it welcoming and engaging to different types of participants. In this document, you'll find:

Introduction.....	1
How to Do It: Quick Start Guide	2
Learning objectives.....	5
Possible Variations	7
Preparation and Event Checklists.....	9
Intro Script	10
Closing Script	12
Related Resources	13
Appendix.....	13
Credits and Rights.....	14

How to Do It: Quick Start Guide

The following is a quick start guide for running this event. This section will give you the highlights, but it's best to read through the entire packet before getting started preparing to run the forum.

1. This forum is intended for audiences ages 16 and up. It is intended to take about an hour and a half.

2. The program is as follows:
 - a. Welcome, 10 minutes
 - b. (Recommended) Video or speaker presentation (see below), 15 minutes
 - c. Step 1: Introductions and Malaria Profile, 5 minutes
 - d. Step 2: Engineered Mosquito Profile, 5 minutes
 - e. Step 3: Gene Drive Profiles, 8 minutes
 - f. Step 4: Release Options, 2 minutes
 - g. Step 5: Personal Profiles, 10 minutes
 - h. Step 6: Discuss and Make a Plan, 30 minutes
 - i. Step 7: Report Out, 10 minutes

3. (Recommended) You may want to use a presentation to kick off your conversation and give your participants some background information. If so, your options are:
 - a. One or more videos chosen from the options below:
 - i. Option 1: Risk Bites video about gene drives (6 minutes):
<https://www.youtube.com/watch?v=KgvhUPiDdq8>
 - ii. Option 2: Dr. Rob Shaw speaking at the Museum of Science (9 minutes):
https://www.youtube.com/watch?v=N3E5aaf9Puo&index=3&list=PLxeUBLGfcIB_XY-WDF_Z7j5odcKcZsPWJ
 - iii. Option 3: Dr. Kevin Esvelt speaking at the Museum of Science (18 minutes):
https://www.youtube.com/watch?v=ensjAFm3eCI&index=5&list=PLxeUBLGfcIB_XY-WDF_Z7j5odcKcZsPWJ

If you want to use any of these or any other video, make sure you watch it before showing it to your participants.

 - b. Or recruit a local scientist to speak on the topic. If you want to invite a speaker, make sure to give them plenty of time to plan ahead. Give them some idea of what you'd like them to cover (e.g. an introduction to mosquito engineering, how it relates to malaria transmission, alternatives to mosquito engineering, etc.). When choosing a speaker, keep in mind not only their area of expertise,

but also their comfort and style in speaking to a group at a level appropriate for a general audience to understand.

4. The following materials should be placed at each table before the conversation gets underway:
 - a. Instructions Sheet (1 page, double-sided, 11"x17")
 - b. Profile Cards (all single-sided):
 - i. Malaria Profile (1 card, 8.5"x11")
 - ii. Engineered Mosquito Profile (1 card, 8.5"x11")
 - iii. Gene Drive Profiles (2 cards, 8.5"x11")
 - iv. Release Options (1 card, 8.5"x11")
 - v. Personal Profiles (5 cards, half sheet of 8.5"x11" each)
 - c. Supplemental Information Sheets that contain information about the following (1 page each, single-sided, 8.5"x11"):
 - i. Mosquito Information and Life Cycle
 - ii. Malaria and Traditional Control Methods
 - iii. Engineered Mosquitoes

It's nice to put at least 2 copies of the materials on each table to accommodate visual learners, so that more than one person can look at the materials at once. If you want to have more tables than the 10 sets included will allow, you can print more from <http://buildingwithbiology.org/forums> or make copies.

If you print more copies you should make sure to use the right size of paper and print single- or double-sided as specified above.

5. During the forum, you should follow this process:
 - a. Divide participants into groups of no more than eight (groups of six are ideal). Try to get a mix of scientists and members of the public at each table. Remind the scientists ahead of time that they are there to participate, not quiz the other participants.
 - b. Read the introduction script included in the guide. Feel free to use this as is or modify it.
 - c. (Optional) Share the agenda for the forum using the Agenda slide in the Conversation Countdown Slides.
 - d. (Recommended) Introduce the topic and the speaker, if applicable.
 - e. (Recommended) Show the video(s) or have the speaker speak.

- f. Have the groups start following the instructions on the instructions sheet (i.e. have the group members introduce themselves and read the cards, etc.). Once you've started the process, the groups should mostly be able to facilitate themselves. Start the Conversation Countdown Slides.
 - g. Help groups stay on time by reminding them to move on to the next step at the appropriate time. The Countdown Slides will advance automatically, but verbal reminders are still helpful.
6. At the end of the time, have each table report out to the rest of the group about their conversations and results. Ask each table to take no more than two minutes. If you have a speaker, he or she can share some final thoughts after the tables report out.

End of Quick Start Guide

Learning objectives

1. All new technologies present inherent risks, opportunities, and benefits for different people.
2. The introduction of new organisms into the environment raises many societal and ethical questions.
3. Everyone has valuable perspectives and views to add to the conversation.

Materials

- Included in the kit (10 copies of each):
 - Instructions Sheet
 - Profile Cards (10 total):
 - Malaria Profile (1 card)
 - Engineered Mosquito Profile (1 card)
 - Gene Drive Profiles (2 cards)
 - Release Options (1 card)
 - Personal Profiles (5 cards)
 - Supplemental Information Sheets (1 page each)
 - Mosquito Information and Life Cycle
 - Malaria and Traditional Control Methods
 - Engineered Mosquitoes
 - Conversation Countdown Slides (on flash drive)
 - Forums Manual (1 copy)
- Not included in the kit:
 - Pens
 - Paper for taking notes
- If your site is receiving a stipend, you will receive the following separately:
 - Evaluation information and instructions
 - Evaluation surveys
 - Envelope for mailing back the completed worksheets and evaluation surveys

Tips and Tricks

- General

- Designed for ages 16+.
- Many museums have found that it works best to hold the forum as a separate event from the rest of the hands-on activities, and evening often works well. It's a different target audience, and having it at a separate time means adults won't be there with their children.
- Preparation
 - Watch the videos yourself before the event, so that you are more familiar and comfortable with the topic and able to answer some questions. The videos are helpful to give background information to participants and give them some shared reference points. Using the videos (or a speaker) is strongly recommended and is generally worth the time it adds to the event.
 - It is helpful to do a practice run of the forum, whether or not you've run one before. You can do this by gathering a small group of staff and/or museum volunteers (even a group as small as 4 will work), in as little as an hour to an hour and a half. During the practice run, you can familiarize yourself with the format, materials, and goals of the forum. You will feel a lot more confident on the day of the event if you've had a chance to do a practice run.
- Recruitment
 - Marketing is important. Forums work best with a diverse audience with varied viewpoints. Make sure you spend time letting people know that the event is happening.
- Format and structure
 - Have people start by reading the background info on the profile cards for malaria, engineered mosquitoes, gene drives, release options, and personal profiles. This information will help inform the conversation, especially if you don't have a speaker or video to begin. Once they've read the cards, they can begin discussing the questions and making a plan. Participants can save the supplemental info pages for if and when they need them.
 - Things might take longer than planned. The overall event should take about an hour and a half, but if people have gotten engaged in the topic, they may want to continue their conversations after the event is over.
- Logistics
 - It's best to have the event in a room separate from the exhibit hall.
 - Round tables work well. Generally, the room setup has a number of round tables with chairs, a projector and a screen, and a podium for the host and the speaker, if there is one. For an example floorplan and photos, see the Forums Manual that is provided in your kit.
 - Make sure tables aren't too close together, so that people aren't distracted by each other's conversations or reading aloud. Six people per table is a

good number. Four to eight people works best. Fewer than four doesn't really work, and more than eight means that some people won't get to speak.

- Leave space at tables for latecomers, because there will be some.
- If possible, have refreshments for your participants.
- If possible, have a handheld microphone available for the reporters from each table to use during the report out, especially if your audience is older, or your group is large.
- Scientists
 - While recruiting scientists to help facilitate your hands-on activities, be sure to mention this opportunity as well – it's the easiest way to get scientists at your forum. However, not all of your scientists will be able to commit to both events, so you may need to recruit additional scientists to attend the forum. If scientists are only attending the forum, it's not necessary for them to attend the volunteer orientation. For suggestions about what to include in an email to scientists, see the Appendix at the end of this guide.
 - Tell the scientists that their role in the forum is different than their role in the hands-on activities. At the forum, they will be participants, rather than facilitators. They don't need to do anything to prepare for the forum, because they will participate on the same footing as members of the public.
 - Give scientists a button, sticker, or nametag to designate them as scientists, if you can. You can use the "I'm a Scientist" stickers that come in your kit, as one option.
 - It's best if you can get scientists who are not personally invested in the topic of mosquito engineering but are familiar with synthetic biology techniques. This way, they will be able to inform the conversation at a simple level but won't be put in a position of having to defend the idea of engineering mosquitoes. Many scientists were pleasantly surprised to see how thoughtful and respectful the public was about this topic.
 - Put scientists at each table, if possible. Don't have them all sit together.

Possible Variations

- Preparation
 - You may want to find a speaker to give a short presentation on the topic of mosquito engineering. If you are not able to host a speaker, we have provided 3 videos you can choose from. You can use any combination of the videos suggested, or find your own that are better targeted to the interests of your institution or audience. If your speaker is particularly specialized, you can supplement their talk with one or more of the videos.

- It can be helpful to have a facilitator at each table whose role is to make sure the conversation stays on track and proceeds smoothly. Facilitators are not necessary to host the forum, but they are a nice addition.
- If you had a chance to run a practice forum in advance, you may want your attendees from the practice run to facilitate at the tables of your event. They can help make sure the group stays on topic, that everyone gets a chance to speak, and that no one person dominates the conversation.
- Audience variations
 - For older or more hands-on participants, you can print extra copies of the materials so that each participant can have their own set.
 - For a vision-impaired group, you can print the materials scaled up on larger paper, available from <http://buildingwithbiology.org/forums>.
 - You may want to run the forum with a group of youth. It's a great opportunity for them to meet scientists. Keep in mind that this forum works best with participants ages 16+, although 14+ can work. If you are collecting survey data from your participants, remember that participants under 18 can't complete the surveys.
- Logistics
 - If you want to reuse the materials, it will help to laminate them.
 - You may want to hold your forum offsite, if your institution doesn't have a way to hold after-hours events. One idea is a local makerspace. Other options are a community center or a library.
 - If you choose to hold the forum as an evening event for adults, you may choose to serve alcohol as part of the event.
 - If you choose not to use the Countdown Slides, you will need to periodically let people know about how much time they have remaining, and which part of the process they should be working on.
 - If it's right for your audience, you can ask people who came together to split up among the tables so that they meet new people and share their views. Some groups will not like this, though, so be thoughtful about whether it makes sense for your group. You can also consider breaking up large groups of participants who know each other.
- Modifying Materials
 - You may modify any of the materials to better suit the needs or interests of your institution.
 - You may modify the timing of the forum, for example to give participants more or less time to talk or to give a speaker a longer time to speak and

answer questions. You can modify the Conversation Countdown Slides to fit your timeline.

- If you choose not to have a speaker or video, you should remove that line from the Conversation Countdown Slides. If you have a speaker or video, update the slide to reflect your choice.

Preparation and Event Checklists

Before the event:

- Choose a date, and reserve a location
- Find and confirm a speaker, if desired, and let him or her know logistical information
- Find synthetic biologists and other scientists to attend as participants
- Publicize the forum
- If desired, create a registration list for participants to sign up
- Make sure the space will be ready, including:
 - A/V equipment
 - Tables and chairs
 - Refreshments, if applicable
 - Lighting, climate control, and access to the room
- Make sure you have enough copies of the materials, and make more if needed
- Gather additional materials (pens and paper)
- Modify slides as needed
- Make buttons, stickers, or nametags for your scientists, if desired, or use the “I’m a Scientist” stickers provided in your kit
- Make signs to direct people to the location

Day of the event:

- Bring materials to the event location and put them on the tables, including:
 - Instructions Sheet
 - Profile Cards (10 total):
 - Malaria Profile (1 card)
 - Engineered Mosquito Profile (1 card)
 - Gene Drive Profiles (2 cards)
 - Release Options (1 card)
 - Personal Profiles (5 cards)

- Supplemental Information Sheets (1 page each)
 - Mosquito Information and Life Cycle
 - Malaria and Traditional Control Methods
 - Engineered Mosquitoes
- Pens and notepads for each table for taking notes
- Evaluation surveys (required for sites receiving a stipend, optional for others)
- Post signs directing people to where the event is being held
- Make sure the space is ready to use
- Test the A/V equipment and make sure the video plays with sound, if you're using one
- Put up the Countdown Slides
- Coordinate with the speaker to get his or her slides up, if applicable

After the event:

- Clean up the materials and collect your pens and paper
- If your site is receiving a stipend, collect the surveys and worksheets from each table and mail them to the Evaluation Team using the addressed, pre-paid mailing envelope provided in your box of evaluation materials
- Write a thank you note to your speaker(s), if applicable

Intro Script

(Speak Slowly!)

Have example materials with you to hold up.

[Slide 1]: “Hello and welcome to our ‘Should We Engineer the Mosquito?’ forum at _____. My name is _____ and I’m excited that you’re here today. We’re going to be talking today about an interesting topic, genetically engineered mosquitoes, and hopefully we’ll have some fun. For those who aren’t familiar with the format, a forum is a guided conversation that is informed by some scientific background information. At the end, we’ll be asking for your opinions! We’ll take your recommendations, combine them with those from other sites holding this same conversation, and share them with scientists who are working on this technology. [Recommended] *We’re going to [watch a video/hear from (speaker’s name)] to get an introduction to the topic, and then we’ll get started with our table conversations.* [Otherwise] *You’ll learn about the topic by reading the materials on your tables.*

[If applicable, introduce speaker or video, then have speaker speak or show video.]

[If applicable] Thanks [speaker's name] for an informative presentation. [Speaker's name] will be around during our conversation if you have any questions.

Now I'll explain the process for our conversation.

[Optional] If you're sitting with people you came with, I'd like to invite you to mix up your tables so that you're sitting with people you don't know. But you're welcome to stay with your friends if you prefer.

On your tables, you'll see:

- An **instructions sheet** [*hold up example*] that will tell you what to do at each stage in the process, and how long each part will take. I'll also help you stay on track by letting you know when it's time to move on to the next part, [if applicable] *and we'll have a countdown up on the screen as well.*
- Your table should have a **malaria profile** [*hold up example*] which will tell you about malaria, the disease we'll be talking about today. We're talking about malaria in Mombasa, Kenya, because it's a densely populated city heavily impacted by malaria.
- The **engineered mosquito profile** on your table [*hold up example*] will tell you about one way scientists and engineers are thinking of engineering mosquitoes to be worse at spreading malaria.
- The **gene drive profiles** [*hold up example*] will tell you about a technology you can add onto the engineered mosquitoes to make them more effective.
- The **release option card** [*hold up example*] suggests several options you can choose from to release the genetically engineered mosquitoes, if you choose to do so.
- The **personal profiles** [*hold up example*] will show you how different people think about the question of releasing these engineered mosquitoes.
- And finally, **three supplemental information sheets** [*hold up example*] have more information about mosquitoes, malaria and traditional control methods, and engineered mosquitoes. You can save this information for if and when you need it during your conversation.

The instructions will tell you when to read each of the materials on your table. You should read each of the materials aloud as you get to them in the instructions. Read all of the instructions to know what to do at each step.”

[Slide 2 – Agenda]: “Now we're going to get started. Take a look at your instructions sheet. You can see that we're going to start with:

- 5 minutes to do introductions at your table and review the malaria card.

- Then you'll review the engineered mosquito profile for 5 minutes, the gene drive profiles for 8 minutes, the release options for 2 minutes, and the personal profiles for 10 minutes.
- Once you've gone through the materials you'll spend 30 minutes discussing them and developing a plan. Your goal is ultimately to decide whether to release genetically engineered mosquitoes, and whether you want to use gene drives. There is no right or wrong answer here, and everyone's opinions are valid. Start this conversation by going around the table and having each person share their initial thoughts. Keep in mind that the scientists at your tables are participants, not facilitators.
- At the end, one person from your group will report back to the rest of us about what you decided.

This screen will count down the time until we'll do our report-outs. If you'd like to move ahead to the next step early or if you need more time at any stage, that's alright, but try to make sure you're ready to present at the end. If you have any questions at any time, please raise your hand and I will come over to help. Are there any questions before we begin? Alright, let's get started!"

[When groups have moved on to step 6] "Don't forget to choose someone to report out for your group. We'll all share our plans once we've finished our conversation."

Closing Script

(Speak Slowly!)

[Once groups have finished making their plans, when the Conversation Countdown Slides say "Time is up!"] "Hopefully you've all had enough time to write down your group's plan. Now we'll go around and share our plans, one table at a time. Please keep it short, no more than 2 minutes per group. Tell us your group's plan and some of the reasoning behind your group's decision. Once we've heard from all of the groups, we'll reflect together on what we've heard. Who would like to go first?"

[After all groups have shared] "Thanks to each of our reporters, and thanks to all of you for putting so much thought into your plans. Does anyone have any thoughts they want to share after hearing all of these plans?"

[If applicable] "Does our speaker have any thoughts he/she wants to share after hearing all of these plans?"

[When you're out of time or no one else has anything to say] "I want to thank all of you for coming to this "Should We Engineer the Mosquito?" forum and to [host institution's name]. *[If your site is receiving a stipend] Your tables have feedback surveys on them. If*

you're age 18 or older and you wouldn't mind filling one out, we'd love to hear your thoughts. I hope you all had a great time, and let me know if I can answer any questions."

[If there are any logistical details to mention (parking, getting out of the building, etc.), you can share them here, or whenever makes sense for your audience.]

Related Resources

Included in this kit is a general guide to public forums, called the Forums Manual. There are many more details there, including information on planning, preparation, setup, marketing, registration, facilitation, cleanup, and what to do after the forum is over.

The Building with Biology website (www.buildingwithbiology.org) has more resources for hosting this forum and other parts of the Building with Biology event, as well as evaluation resources and other project information.

The NISE Network website (www.nisenet.org) contains additional training resources to introduce participants to the relationship between technology and society and to have conversations with them.

Appendix

Sample points to mention in an email to scientists about the forum:

- A forum is an event where participants have a chance to learn about a topic and then engage in a guided conversation and make a plan of action. In this case, the participants are both scientists and members of the public, the topic is genetically engineered mosquitoes, and the plan is a decision about whether to release genetically engineered mosquitoes in Mombasa, Kenya. Participants get the chance to practice critical thinking skills and apply them to a real-world socio-scientific issue.
- This forum is an opportunity for people to discuss the way mosquitoes should be engineered to reduce malaria transmission. This is an opportunity for a more in-depth conversation that takes approximately an hour and a half. It's targeted at older ages (16+).
- During the forum, participants learn the basics about genetically engineering mosquitoes to fight malaria and the related ethical and societal issues. Then, through the forum conversation, they get the opportunity to consider the viewpoints of others on the topic of releasing these genetically engineered mosquitoes. Finally, participants form a plan about whether and how to release genetically engineered mosquitoes in Mombasa, Kenya using the information they learn, their background knowledge, and their values.

- Participating in the “Should We Engineer the Mosquito?” forum is a way to interact with people with various backgrounds, ages, and experiences in a conversation about malaria, the most widespread mosquito-borne disease, which affects about 200 million people per year. Despite its prevalence, malaria is a disease that is hard to fight.

Credits and Rights

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Card Images:

Anopheles mosquito: https://commons.wikimedia.org/wiki/File:Anopheles_stephensi.jpeg

Kenya: https://en.wikipedia.org/wiki/Outline_of_Kenya#/media/File:Kenya_Map.png

Africa map: https://commons.wikimedia.org/wiki/File:Kenya_in_Africa_%28undisputed_only%29_%28-mini_map_rivers%29.svg

Gene drive diagram: <http://blogs.scientificamerican.com/guest-blog/files/2014/07/mosquito-diagram.jpg>

Malaria parasite: <https://en.wikipedia.org/wiki/Malaria#/media/File:Malaria.jpg>

Personal Profile: Matthew: <https://www.flickr.com/photos/armymedicine/7170561482>

Personal Profile: Anna: https://commons.wikimedia.org/wiki/File:Ingeborg_Gjaerum.jpg

Personal Profile: Faraji: https://commons.wikimedia.org/wiki/File:Kenyan_mother_with_child_at_a_hospital_in_Lodwar,_Kenya.jpg

Personal Profile: Ahamed: https://commons.wikimedia.org/wiki/File:US_Navy_071019-N-4014G-380_Cmdr_Robert_Hall_Jr.,_commanding_officer_of_guided-missile_destroyer_USS_Porter_%28DDG_78%29,_presents_a_command_coin_to_the_Mayor_of_Mombassa,_Kenya,_Hamisi_Mwindani.jpg

Personal Profile: Sharon: https://commons.wikimedia.org/wiki/File:Future_families_-_Hope,_a_Community_Health_Worker_%287497778302%29.jpg

Mosquito release: https://commons.wikimedia.org/wiki/File:Future_families_-_Hope,_a_Community_Health_Worker_%287497778302%29.jpg

Mosquito release:

https://en.wikipedia.org/wiki/Dengue_fever#/media/File:Equipos_usam_t%C3%A9cnicas_de_combate_%C3%A0_dengue_em_Bras%C3%ADlia.jpg

Supplemental Info Sheet Images:

Mosquito Information and Life Cycle

Mosquito life cycle: https://commons.wikimedia.org/wiki/File:Culex_mosquito_life_cycle_en.svg

Mosquito laying eggs: <https://www.flickr.com/photos/deadmike/265023985>

Malaria and Traditional Control Methods

Symptoms of malaria: https://en.wikipedia.org/wiki/Malaria#/media/File:Symptoms_of_Malaria.png

Bed net: https://en.wikipedia.org/wiki/Mosquito_net#/media/File:Mosquito_Netting.jpg

Child with malaria: <https://www.flickr.com/photos/51868421@N04/6918113518>

Engineered Mosquitoes

Aedes aegypti: https://commons.wikimedia.org/wiki/File:Aedes_aegypti_during_blood_meal.jpg

Card Sources:

World Health Organization. World Malaria Report 2015. Accessed Jan 20, 2016 <http://www.who.int/malaria/publications/world-malaria-report-2015/en/>

Supplemental Info Sheet Sources:

Mosquito Information and Life Cycle

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Fang, Janet. Ecology: A world without mosquitoes, *Nature*, Jul 21, 2010
<http://www.nature.com/news/2010/100721/full/466432a.html>

American Mosquito Control Association. Life Cycle, accessed Jan 20, 2016 <http://www.mosquito.org/life-cycle>

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<http://www.cdc.gov/malaria/about/biology/mosquitoes/>

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<http://www.nytimes.com/2013/02/24/magazine/when-mutant-mosquitoes-attack.html?pagewanted=all>

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Engineered Mosquitoes

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