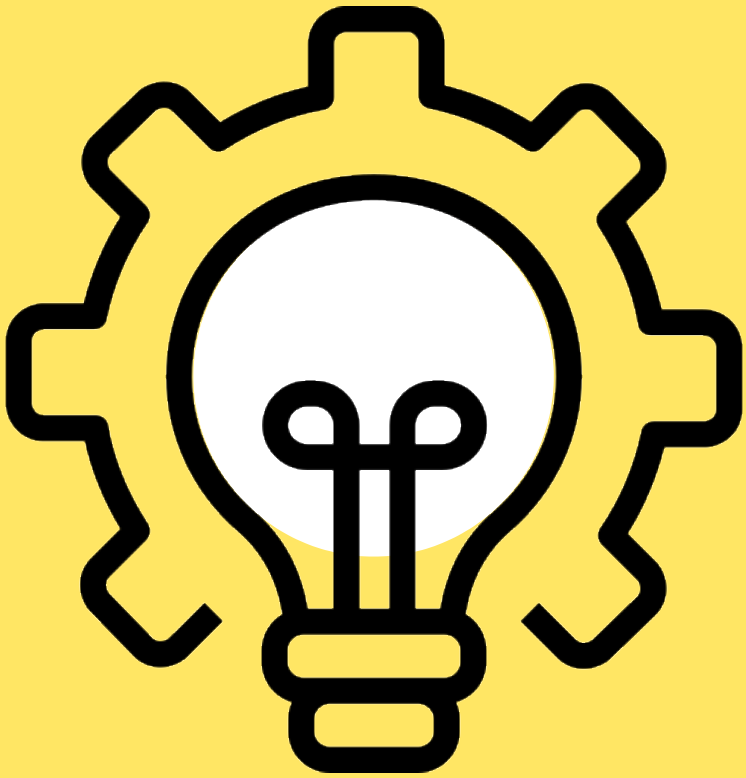

IGEM TAU PRESENTS

ASYV-IGEM COLLABORATION GUIDEBOOK

A GUIDE FOR RECREATION AND CONTINUATION OF THE VIRTUAL SYNTHETIC BIOLOGY CLUB AT AGAHOZO-SHALOM YOUTH VILLAGE, RWANDA

Preface

In the 2021 iGEM season, a few teams came together in collaboration for an educational virtual synthetic biology club for the students of the Agahozo-Shalom Youth Village in Rwanda. The club was a success, and both the village and the teams were determined to make this a repeating project for iGEMers to take on and build upon. Because you're only an iGEMer once, the same participating teams will not be composed of the same people in the next years. Therefore, this guidebook was written in order to help instruct and guide future iGEM teams to continue this very special project we had the pleasure of beginning. Most of this guidebook summarizes our experiences of planning, developing, and running the project this year.

The final section is how we recommend for teams to take this project forward and improve it and is based on the valuable feedback of both the staff and teachers at ASYV. It is therefore **crucial** not to skip this information, and understand that everything that was done this year, and everything that should be attempted in the future, should be focused on being for the good of the child. We should remember that we are privileged to be where we are, and that we have been accepted by the large ASYV family to take part in something as unique and special as this.

It is also important to keep in mind that we do not understand local problems and our goal is not to try and solve them, but rather to do our best to introduce students to tools that will allow them to think about and tackle local and global problems in new dimensions.

We truly hope future teams will take on this incredibly rewarding project and collaboration!

Any further questions, comments, edits to the guidebook, etc., can be sent to iGEM TAU 2021 at: igem.tau.21@gmail.com

Credit to canva.com for the front page, SBTS2018 user on flaticon.com for the image, and photographers at ASYV for the pictures of the students throughout this book.

Acknowledgments

We'd like to thank the teachers, staff and administration at ASYV for giving us the opportunity to attempt this project.

We'd also like extend gratitude to all the teams that were interested in this collaboration, and especially those who took part, brainstormed, built, and ran with us: **TU Delft, Vilnius Lithuania, MTU-CORK, BOKU Vienna, HKU, and Concordia Montreal.**

We'd like to give a special thanks to the Head of the ASYV Science Department **Ian Mukasa** for being an ardent supporter of this idea from the beginning and an incredible partner to work with. We appreciate you enabling this entire project and acting as both a partner and a guide to us in this process.

And of course, thank you to the spectacular students at ASYV who took part in this project for the first, and hopefully not last, time! You are the whole inspiration for this project.

Sincerely,

iGEM Tel Aviv University (TAU) 2021

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Introduction

What is ASYV?

The **Agahozo-Shalom Youth Village (ASYV)** is a youth village in Rwanda which was originally opened by Anne Heyman in 2008 for orphans of the 1994 Genocide Against the Tutsi in Rwanda. Today, the village serves as both a home and high school for vulnerable youth in Rwanda. Agahozo means "a place where tears are dried" in Kinyarwanda, and Shalom means "peace" in Hebrew.

ASYV provides an encompassing framework for the youth, which are still affected by post-trauma of the genocide[1], by using an approach which focuses on parental wholeness, formal education, health and wellness, and life enrichment programs.

There are currently about 500 students at ASYV and more than 1,500 graduates.

How did iGEMers become involved?

In 2021, our iGEM team of Tel Aviv University in Israel ("iGEM TAU") considered running an educational project together with ASYV. One of our members had a relationship to the village, having visited several times in the past, and we began discussing the possibility of starting a synbio club virtually for the students.

Due to the COVID-19 pandemic, the students had been home for some months within the school year, and like the rest of the world, became more accustomed to virtual learning. We thought, therefore, that the infrastructure to hold virtual meetings might already be in place at the village. After several meetings with the teachers and staff at the school, we had a plan in place for bi-weekly after-class meetings with the students (who were now back at the village).

The plans and ideas for the club grew quickly, and we realized that the more iGEMers we had helping us, the better the planning and execution could take place. After publishing the request for collaboration on the iGEM Global Slack, several teams turned to us, and a collaborative educational initiative was born.

How did the project develop?

Together with the teachers and staff at ASYV and Liquidnet Family High School, we came up with a general plan for the club. Since our project (as do many other projects) combines the fields of biology and engineering, we thought it would be fit to have a mix of students from both backgrounds.

[1] C. Mutuyimana, V. Sezibera, E. Nsabimana, L. Mugabo, C. Cassady, C. Musanabaganwa, and Y. Kayiteshonga, "PTSD prevalence among resident mothers and their offspring in Rwanda 25 years after the 1994 genocide against the Tutsi," *BMC Psychology*, vol. 7, no. 1, 2019.

We were very lucky to have the ongoing support of ASYV and Liquidnet High School staff, including **Aloys Kagimbura**, Special Projects Coordinator, **Julius Kaboyo**, Deputy Academic Director, **Ian Mukasa,** Head of the Science Department, **Justin Mutangana**, IT Officer and Python Programming Trainer, and **Jill Elias,** Engagements and Operations Manager, throughout this process.

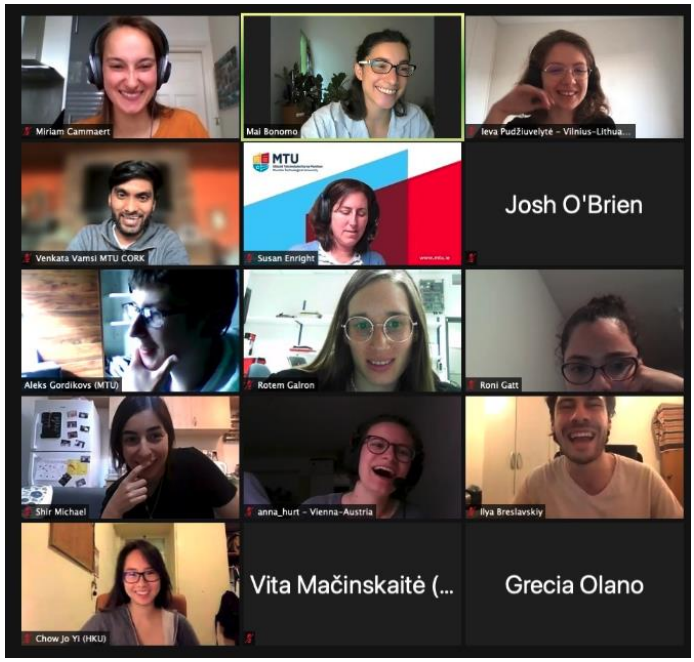


Fig. 1 Zoom screenshot from collaborative meeting between participating iGEM teams

The teachers helped put together a group of 16 enthusiastic students from the Senior 5 grade[2], half who major in Biology and the other half who study Python, among other things. The teachers also took the initiative to split the students up into teams of four, with two Python and two biology students in each team. Therefore, we had to devise a plan that would speak to students of both educational backgrounds, as well as find a way to combine the two subjects in an engaging manner. The "teams" of students would allow us to hold activities that engage the abilities of students of both backgrounds. We thought of a general format for the meetings: either a mix of a lesson and activity, or an activity that would take up the whole hour-long timeframe we had. The goal would be to combine the knowledge and expertise of both groups of students to solve biology-based problems, while at the same time introducing them to iGEM and the world of synthetic biology.

As a team, we soon realized that we needed extra help to bring this club to fruition, and so we put out a message in the Global iGEM Slack in search of teams who would be willing to collaborate with us. We soon had teamed up with the following iGEM teams: **BOKU-Vienna**, **Vilnius-Lithuania**, **TU Delft**, **Hong Kong HKU**, **Concordia-Montreal**, and **MTU-CORK Ireland**.

We started by holding several meetings together with the participating teams, to both introduce them to ASYV and which students they'd be working with, discuss the idea for the club, and to brainstorm further ideas for how we can take the project even further than we at iGEM TAU had originally imagined. We were privileged to have an enthusiastic and creative bunch of teams to work with.

In total, we were able to run seven meetings with the students. Originally, another final meeting was planned, however, the National Exam dates in Rwanda were moved up, obviously taking priority over after-school clubs. We had continued planning a Phase II of the project to occur after exams, however in June, another wave of COVID-19 hit Rwanda and the students were sent back home for the remainder of the school year (and iGEM season). Therefore, we hope that future teams can apply some of the ideas we had for Phase II.

In the next section, we will share with you the details of the logistics and planning of the club so that it can be recreated and built upon in coming years, as well as some information detailing each meeting to serve as a reference for future planning. Of course, this was a massive learning

[2] *Students go through four grades at ASYV: Enrichment year, Senior 4 ("S4"), S5, and S6. S5 would be the equivalent of a junior in high school.*

process, and the section afterwards will deal with lessons learned, advice, tips, and ideas to take the project even further.

After great feedback from the teachers and students who participated from ASYV, we truly hope that future iGEM teams will take the initiative to run this program again and take it even beyond our original vision.

iGEM TAU

The ASYV iGEM/SynBio club

Planning

Representatives from each participating iGEM team met and we ran an informational session about ASYV, the upcoming schedule for the club, the meeting structure, and tips on presenting to the students.

Goals

These were the goals we had in mind when we began this project:

1. To introduce Biology and Python students at ASYV to the world of synthetic biology and iGEM
2. To engage and interact with the students in a meaningful way
3. To introduce students to tools that would allow them to assess and think of solutions to their own local and global problems
4. To produce a sustainable and replicable club program that future teams could recreate, continue, and expand upon.

Plan

The overarching idea was to hold between eight to ten meetings, which would each be an hour and a half, twice a week. The biweekly meetings were due to time constraints (weekly meetings would suffice as well if the club dates were planned further ahead of time.) We began the club a couple of weeks after the initial meeting with the ASYV staff and had only until the beginning of the students' exam season to run it, so we squeezed in more meetings in a shorter time frame than we would have liked.

Our plan for the club was to hold each meeting in the structure described below. Alongside these meetings, we planned for the "teams" of students to think of, develop, and present their own synthetic biology solutions to local or global problems. We believed that this would both encourage critical and scientific thinking, group collaboration and combination of skills, as well as presentation-building and public speaking skills.

We implemented this by giving them homework assignments once a week, to be completed with their teams, which included questions to guide their thinking towards a final problem-solution which they could present (*find the homework assignments in the* **Appendix***).* The assignments were meant to structure the thinking process they should take as well as the presentation outline. We tried to simplify as much as possible, as it's possible that it was the first time these students had been confronted with both the scientific critical thinking process and building a presentation in such a way.

Originally, we had two extra meetings planned; one of these would be a session in which we could sit with the teams of students personally and help them build their presentation, go over their synbio solutions, and help them further develop them. The final meeting would be the presentations themselves, together with feedback from the teachers and team members from the participating iGEM teams. Unfortunately, due to the unexpected shortening of the club due to National Exam dates changing, we had to cancel two meetings. We wanted each participating team to have a chance to present their projects and run their club meeting, and we didn't want the students to be too rushed in thinking of their synbio problems and solutions. Therefore, we cancelled the final two meetings.

Meeting Structure

Our original recommended meeting structure was as follows:

I. Introduction, present participating team members
II. Project presentation
III. Activity (joint or separate) – a creative biology or coding activity which would either include the two types of students working together or splitting the two groups up for separate and more directed activities.
IV. Conclusion

Each meeting would have an hour and a half of time, but we asked each group to prepare for an hour's worth of meeting (taking into account an extra half hour of possible technical or logistical difficulties). Of course, plans are meant to be changed, and each team had a slightly different lesson structure. Most of the meetings were a simplified presentation of the team's iGEM project, with engaging questions and problems throughout.

It's important to carefully plan out your meeting beforehand, including a presentation and "who will say what", as well as if you'll need one or two computer labs (more on this in the "Logistics" section), and roughly how long each part will take.

We made sure to record each meeting and hold a debriefing (to be found in the **Appendix**) immediately afterwards to summarize and discuss what went well, what didn't go well, and what the next presenting team could learn from the last.

Resources

We opened two shared Google Drives:

1. The "ASYV Resources" folder[3], which would be for use between the collaborating iGEM teams and included the weekly homework, logistical information, and a Kinyarwanda dictionary
2. The "ASYV Student" folder[4], which was shared with the students as well, and included all the recordings of the Zoom meetings which they could come back to, as well as the original presentation files (which we recommend future teams to go through). We also created a biology review booklet for the students to have both in preparation for the club and throughout it as a resource for strengthening their biology knowledge.

In addition, we opened a Slack channel on the Global iGEM Slack to stay in touch easily with one another throughout the project.

Logistics

The logistics of planning a virtual club over international time zones is difficult to say the least, but not impossible. It's important to be in close contact with the staff at ASYV in preparation and right before meetings to make sure everything runs as smoothly as possible. Of course, issues can and will still occur regardless of how good the planning.

First of all, it's important to close the dates and times of the club. As mentioned, we did biweekly meetings, but weekly would definitely suffice if there are enough weeks in the program. The ASYV

[3] https://drive.google.com/drive/folders/1A9bo9IqL33YEHuJo7ckyXhFFj0WWEiEL?usp=sharing
[4] https://drive.google.com/drive/folders/1EL9ZCoCOASOwF8_Hrc54PAkE07qnZ_68?usp=sharing

teachers offered us a couple of possible dates and times, and we voted on that which would be best for most.

We then assigned each iGEM team to one date on which they would present, with a few members of iGEM TAU at each meeting to act as moderators and central communicators with the staff. We do recommend one team taking charge of all communication and logistical planning with ASYV in order to avoid a "broken telephone" situation and have everything concentrated in one place.

Fig. 2 Zoom screenshot from our first meeting with the ASYV students

We wanted to have the option for the meetings to take place for all students together, or for biology and Python students to be in separate groups for more focused sessions and activities. Therefore, we would let the teacher know a few days ahead of time whether the presenting team would need one or two rooms.

Each room in which the students meet is a computer lab, where each student has access to the computer/internet, but Zoom is projected on a large screen in the front of the room. The camera in the computer room faces the room of students, but it can be quite hard to make out their faces and voices clearly. Therefore, when a student wanted to speak or ask a question, they would do one of two options: come up to the computer with the Zoom camera, or a teacher would open Zoom on their cellphone[5] and the students would pass it between them in order to ask a question. Both of these methods worked, and while the cellphone might be more convenient in some ways, it's important to ensure first the agreement and comfort of the teacher with letting their cellphone be used.

Technical Issues

There were often internet connectivity issues. It's therefore very important to ensure the presenting team has a strong internet connection. The connection at ASYV goes in and out, and it sometimes takes some trial and error for them to get connected to Zoom with good sound and visuals, therefore it's important to be patient. This is also the reason why we allocate an hour and a half per meeting but ask teams to prepare for one actual hour – the technical difficulties have often eaten away at a significant part of the meeting time. Communicating with the teachers via email or whatsapp during internet disconnectivity is also important.

Contacts

Our main contact for planning the sessions was with **Ian Mukasa,** Head of the Science Department. Ian helped us coordinate each meeting, sat in the classroom to clarify things for the students, gave us feedback from ASYV and the student body, and was overall the reason the whole project worked. To get in touch with him, please first email me at mai.bonomo@gmail.com.

It's also important to get in touch with **Jill Elias,** Engagements and Operations Manager. ASYV has very specific Child Protection Policies which the participating teams should review before beginning the project. Please note that these include a media policy, which requires that

[5] Students at ASYV are not allowed to have smartphones.

communications and media (e.g. any pictures which include the ASYV students) need to be approved by ASYV before publication.

Meeting Summaries

Below is a summary by each team of their meeting to help give the future iGEM teams an idea of what might be included in each meeting, including a short summary of the team project so you can see how it connects to their presentations. Below each summary are "tips and advice" for future teams, which are maybe most critical to pay attention to, as these will help future teams avoid mistakes we have made and learn from our experiences.

All presentations, meeting recordings, and additional files can be found in the "ASYV Resources" folder (linked above).

Meeting #1 – iGEM TAU – Introduction Meeting (May 9, 2021)

The idea of the first meeting was to introduce the students to iGEM and synthetic biology, as well as the club we were running.
We started by having the students introduce themselves and introducing ourselves and our team. We then did a short basic biology review to make sure that all of the students were starting on some common ground (remember that it's very possible that the Python students have never been exposed to this information, and everything should be introduced and reinforced on a basic level). From there we transitioned to talking about synthetic biology in particular, and making the connection for the students between engineering (or Python, computer science) with biology. In this section we made sure to ask a lot of questions, letting the students think of solutions before we presented the actual solutions. We found this as one of the best ways to engage the students. We then gave a little programming overview for the biology students, before continuing to a general introduction on the iGEM competition. We finished by discussing the plan for the rest of the meetings.

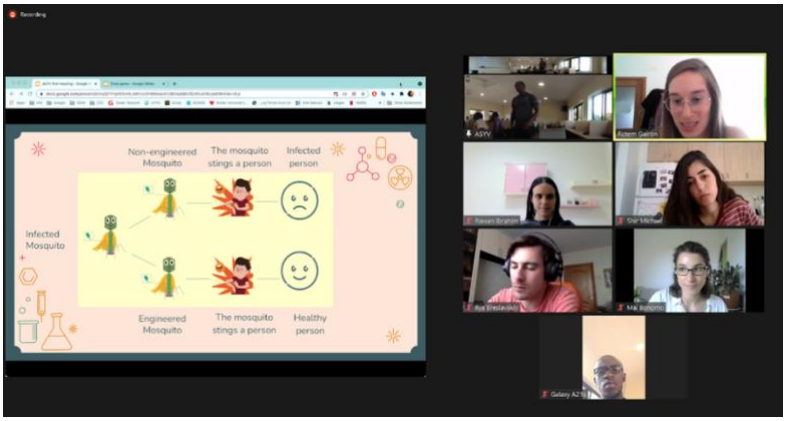


Fig. 3 Zoom screenshot from our first meeting with ASYV students

In our debrief after the meeting, we decided to incorporate future homework assignments after we realized some students wanted something to work on between meetings. This helped us devise the plan described above for the format of the homework and the final meeting plan. Overall, the meeting went very well, the students were enthusiastic about learning and were eager to do more.

Meeting #2 – iGEM TAU

The second meeting was much more of a learning experience after the first smooth meeting. The meeting format was planned to be more similar to that of the rest of the teams (as opposed to the initial introductory meeting). Our plan was to introduce our iGEM project and then split the group up in two and have an activity for each the biology and Python students separately. The Python activity was an exercise in classifying data, and the biology activity was a jeopardy-style trivia. Both can be found in the Google Drive folder.

Here we learned the very important lesson of how things can go very off plan. We started with half an hour of technical difficulties until we got a good connection with the students. We also packed the meeting with too much content and information, so we ended up rushing a bit and therefore losing some of the understanding of the students. We tried to get quickly to the activities we had planned, but we ended up having much less time planned for them and couldn't explain them in a slow and patient manner as we should have. Both activities ended up being rushed and cut short so we would have time for a conclusion and to give homework at the end.

The many tips and advice learned here will appear below in the advice section.

Tips and Advice

- Mind the culture gap – realize that these students grow up without a lot of the Western influences many of our teams did, and that certain references and examples that seem obvious to us may not be for them
- Try and give real-world, relatable examples (and mind the culture gap, e.g. malaria is a common disease that they are familiar and up-close with, while diabetes may not be known by everyone)
- Include often how Python can help solve biological problems; remember that half of the students are Python students, so it's important to relate things back to how engineering fits in and make sure everyone is included
- Ask many questions – this is the easiest way to be engaging and have an interactive lesson. Let the students come up with answers and solutions before you reveal them
- Stop often for questions – students won't necessarily stop you if they have questions, so it's important to stop after every slide or section to ask if everything was understood. It's not uncommon that they ask you to repeat something
- Ask frequently if everyone can understand ; it can be hard to hear and see the students sometimes, so I often would ask for a big "thumbs up" from everyone, which is easy enough to see on the screen, to make sure that I'm being heard and that everyone is following.
- Speak slowly and clearly, with relatively simple language – besides the culture gap, there is also a language and accent barrier. This can make you hard to understand and also them hard to understand. The English level of the students ranges and therefore try and avoid advanced terminology, and if you are saying a word that may not be understood by everyone, define it.
- Be flexible – often, the timing of the meetings doesn't go as planned. In our second meeting, we had too much information planned and had to decide on the spot what we would skip and what was too important. It's a good idea to plan ahead which slides are crucial and which are possibly skippable should you run out of time
- Be in touch with your team members throughout the lesson – this is a good way to communicate, for example, changing something last minute in the presentation, such as skipping a slide. We used Zoom chat or Whatsapp often to talk between ourselves during the actual meeting.

Fig. 4 ASYV SynBio club

- Be in touch with other teams and what they are presenting, as it may be something you don't have to repeat or even better, can build upon – for example, TU Delft was able to talk about GFP because we had already introduced it in the first meetings.

Meeting #3 – iGEM TU Delft

About TU Delft 2021: One in three people suffers from deficiencies in micronutrients, also known as hidden hunger. Vitamins are a class of micronutrients that play an essential role in a healthy pregnancy, cognitive function, and erythrocyte production. Deficiencies in vitamins are prevalent throughout the world, most noticeably in sub-Saharan Africa and South Asia. The 2021 TU Delft iGEM team develops AptaVita, a modular, cheap, and rapid vitamin detection test. We aim to provide an easy solution for improving the data available on vitamin deficiencies in low-income countries by testing at the point of care so that involved actors can develop more efficient strategies against vitamins deficiencies.

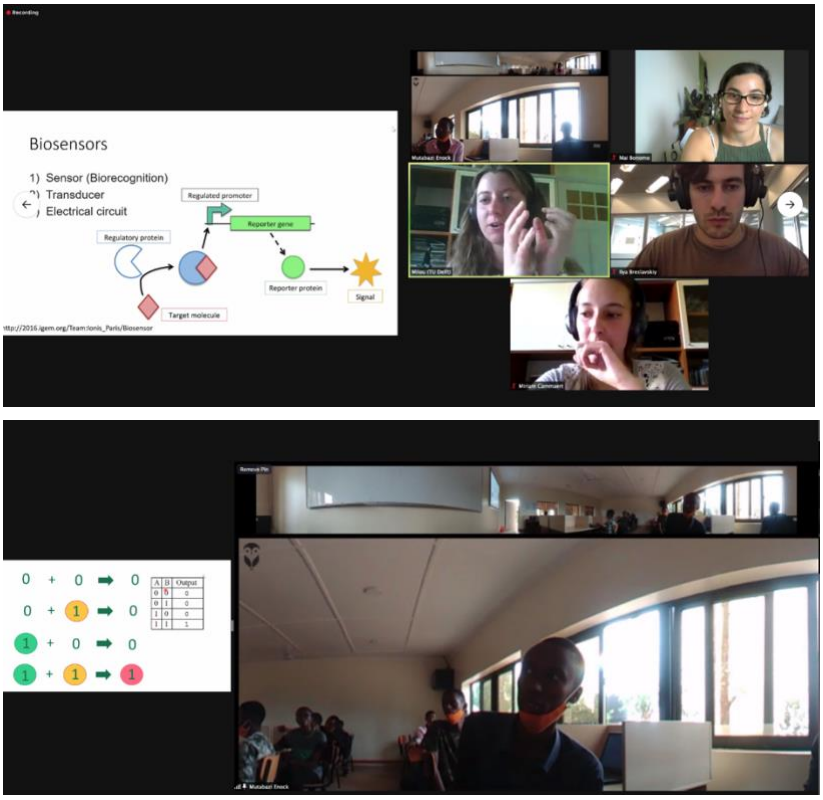


Fig. 5 Zoom screenshots from iGEM TU Delft ASVY meeting

How we planned and prepared the meeting: For planning and preparing the lecture, we took into account that there might be a language barrier. The English language is taught and mastered differently around the world. Therefore, we tried to use "easy" language. We also decided on lots of visuals because "A picture is worth a thousand words". Furthermore, we took into account that we wanted to have plenty of times for the students to ask questions, discuss amongst themselves, and solve potential technical issues. Therefore, we planned a presentation (with an average speed and without any of the interruptions mentioned above) of about twenty minutes, which did last the full one and a half hours with those interruptions.

About the lesson: In our lesson, we only included basic biology and some basics for programming. As the students of both biology and programming were present, we wanted to give them some aspects of their field of study. Our lecture covered the basics of biosensors, what components biosensors are made up of, and what and how we can detect something. The more programming aspect included introducing the concept of biological logic gates. Sometimes we introduced the students to more challenging examples, but only to show them what we can already achieve with a certain technology.

These basics helped to explain the idea behind our project: a vitamin biosensor. We did not dive into the complete technological background of our project; instead, we wanted them to know what aspects it requires and that such a biosensor can already be developed with relatively simple biological parts.

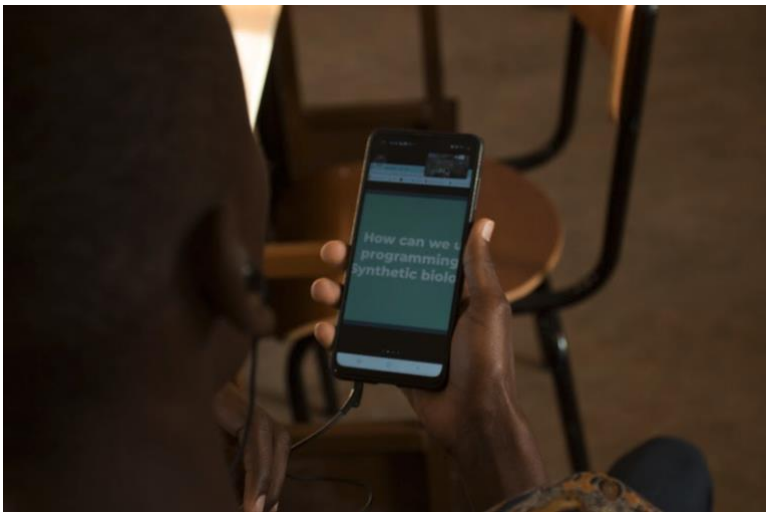
Finally, our lecture was a second lecture, and therefore we were able to build upon some principles that the students were already taught about. The TAU_Israel iGEM team already gave the students a lecture on their project and about some basics of biology. Hence, we wanted to build upon the newly learned principles to aid in the students' learning process. Therefore, we used some of these principles, such as the Green Fluorescent Protein, as components to build a biosensor.

How we made it interactive and engaging for the students: We tried to include various questions in our lecture and let them discuss amongst themselves before coming up to the computer to tell us their answers. Furthermore, we gave them multiple opportunities to ask their questions.

Tips and advice for future teams:

- Plan for a short meeting; it will stretch out over the hour due to taking time to ask and answer questions, giving the students time to think, speaking slowly, and technical difficulties.
- Plan for a presentation where you speak slowly, clearly, and with simple language.
- Use plenty of visual aids in your presentation, as this makes some complex principles easier to understand.
- Give the students enough time to ask their questions and make sure that they understood your answer (e.g., "Did that answer your questions?" "Is anything still unclear?")
- Give relatable examples, but also let them come up with their examples. They might amaze you with their great examples! Also, if possible, build on some of their examples to show them how technology can aid in a solution for their example.

Meeting #4 – iGEM MTU-CORK, Vienna, and Concordia Montreal



iGEM teams' Vienna and Concordia joined the collaboration after we already had set dates for when each team would present, therefore they teamed up to present together with iGEM MTU-CORK, with each team giving a section on their project.

Vienna Feedback:

About Vienna 2021: The iGEM 2021 team from Vienna is very diverse. We are a team of 27 students from all over the Life Science, IT and Bioengineering fields. In 2021, we are creating *Friendzyme*. We want to tackle various neglected gastrointestinal diseases by developing a novel therapeutic platform. The concept hopefully translates into medicine and provides symptom alleviation in affected patients in the future. Our therapeutic approach is based on oral enzyme therapy on the next level. We are creating a biocompatible scaffold containing probiotic transgenic Lactobacilli, that expresses and releases enzymes for the degradation of fructans.

Fructans are complex carbohydrates that cannot be broken down by human enzymes. They act as nutritional fiber and are metabolized by microbes that reside in the gut and comprise our

microbiome. In patients with Irritable Bowel Syndrome (IBS) and Non-Celiac Gluten Sensitivity (NCGS), this physiological process is perturbed and microbial fructan fermentation causes symptoms such as abdominal pain, bloating, headache and nausea. Fructans can be found in almost any food and were found to be a major contributor to the pathology of IBS and NCGS.

Up to 15% of the general population suffer from bowel disorders and the associated symptoms. The disorder severely limits the patient's choice of well-tolerated food. Our mission is to provide patients with a solution that allows the symptom-free consumption of fructan-containing foods. With a dose regimen of 1 pill for oral intake per day, our approach makes a carefree enjoyment of food with high fructan content possible. As we make use of continuous enzyme synthesis within the bioscaffold, *Friendzyme* offers patients a medium-term solution according to their demand.

How we planned and prepared for the meeting: Since our meeting with the students was done as joined together with the teams of Ireland and Canada, we first had a meeting to discuss the best way to go with our lesson and decided on giving them a short introduction to our teams followed by a presentation of the projects from Ireland and ourselves. I created the presentation so that anybody not having any clew about synthetic biology could understand our projects principle and target.
Here I tried to include as many drawings and pictures as possible especially since I was not sure how good the visibility will be and if they could make out any texts.

About the lesson: As said above I tried to focus on the main idea. Therefore, I let out the facts about the enzymes we use as well as the promoters and plasmid arrangements we thought about. Also, here I left out all the specifics about the capsule, its components and making process.
On the other hand, I put in the basics of what are enzymes, the microbiome and what does inflammatory bowl syndrome mean. What can those people eat and what causes them to have symptoms. To make them understand, why it was interesting for us to go in that direction .

How we made it interactive and engaging for the students: This part kind of did not go to well in our lesson, since they did not understand the game the team from Ireland wanted to play with them. But I was really happy to see that many questions about our project were asked. This also made me realize a lot of things.

Tips and advice:

- Give them questions to answer, like guessing questions, questions with a surprising answer or even funny one
- Do not make the mistake of underestimating their knowledge, create the presentation in a way that it gives all necessary info to understand it easily but also engages those who know more.
- Go into detail a little they are interested in some deep facts of your project and the process behind it
- Go through your process of coming to the idea and the parts of your project, so why did you chose that bacteria to produce your product, why is this not dangerous and what are you doing to minimize the dangers…

MTU-CORK Feedback:

About MTU-CORK 2021: Our team is the only Irish team this year to compete in iGEM. Our project name is BIOR.E.M (Bioremediation Earth Mars) and we are from Munster Technological

University. We aim to use engineered bacteria to bioremediate soil to cultivate vegetation on Mars.

We have spent many hours in the laboratory figuring out what works and what does not. We have created Biofrags (3D spherical housing units for bacteria) and a Biofrag Isolation Unit to help us create a simplistic yet effective system that will carry out bioremediation. Our team ranges from PHd students to second year business students! We have a range of talents and disciplines that bring multiple viewpoints and ideas to the table.

Planning and Preparation: We were really interested in the ASYV school and the greater community it is a part of. We were all wholeheartedly involved in creating a fun, insightful and interactive event for the students. We started preparations well in advance to give us time to make any adjustments and to ensure we delivered all relevant project information without over-burdening the students of ASYV. We delegated tasks to one another and began work promptly. Some prepared slides for the powerpoint, others did some research about some interesting facts or questions that may be suitable for the students to help make our presentation interactive.

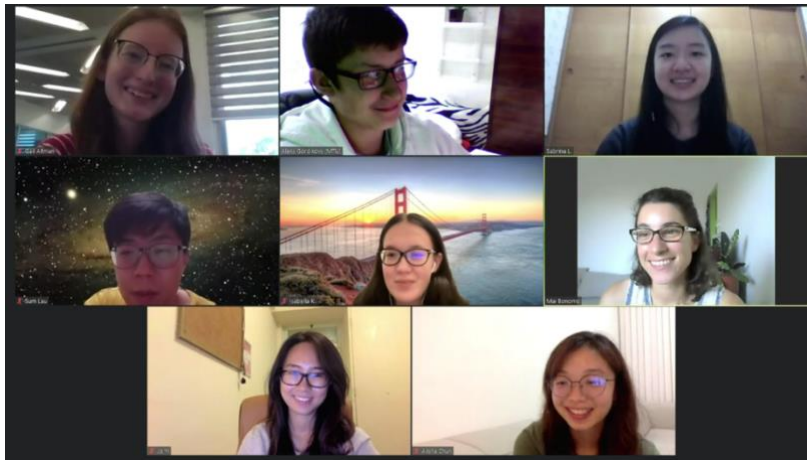
We then practiced the slideshow for someone who is outside of the scientific community to ensure the language was appropriate and easy to follow. Our team had to ensure we avoided the use of complex scientific jargon to make the experience understandable to everyone at all levels. We took the time to also research their school and community to have some prior knowledge about them so that we could ask them some questions and maybe learn something from them as science is all about sharing knowledge and learning together.

Tips and Advice for future teams: First and most important piece of advice would be, to have fun. Despite these students being from a different country and having a different language, they were extremely interactive and posed some great questions about our project after the presentation so don't be afraid to go a bit deeper into your project after someone asks a complicated question as it may spur an idea in them.

This event is symbiotic in nature, as undergraduates especially it is not often we get the chance to lecture or share ideas about scientific projects with other schools, so cherish the moment.

In regards to preparation, ensure you practice your presentation prior to the event and ensure the language used is scientific but not overly complex. Ensure the core elements of your project are included. We found that learning and incorporating there language into some of the slides really allowed us to solidify a connection with the students so this may be also something to consider.

Meeting #5 – iGEM HKU



About HKU: The University of Hong Kong (HKU) iGEM team is developing a self-sustaining solar-driven polyethylene terephthalate (PET) degradation system this year. Using an engineered E. coli that feeds on sucrose and produces enzymes to facilitate PET degradation, with S. elongatus which secretes sucrose, we are hoping to degrade PET into its monomers in a co-culture system.

How we planned and prepared for the meeting: In order to make our session as engaging for the students as possible, we decided on a topic that was relevant to the context in which ASYV students lived in. We chose malaria as this would be a topic students would be familiar with, since it is a prevalent issue in the region. This meant we would be able to allocate more time to the technologies and biology behind the issue, rather than trying to get students to understand the problem itself. We looked at gene drives in our session as a solution to malaria, as we felt the use of it to tackle malaria was controversial enough to pique students' interest.

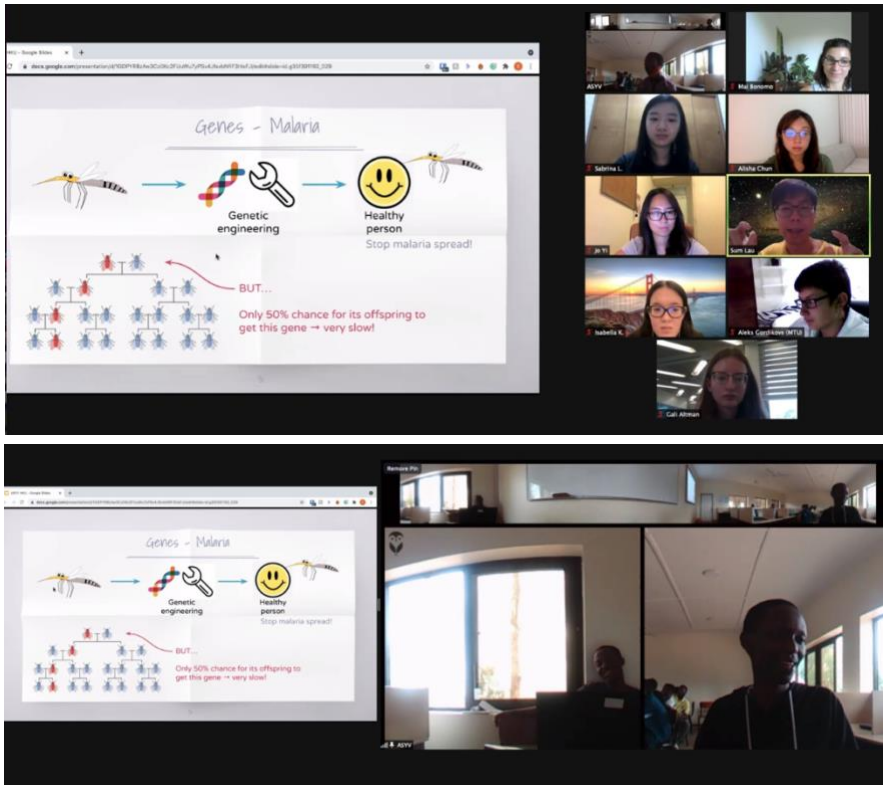


Fig. 6 Zoom screenshots from iGEM HKU ASYV meeting

We considered how we were going to present to students online, which can be less engaging than presenting in-person. This meant including interactive material such as quiz questions, and having small group discussions so students could discuss ideas and their understanding among themselves as well. We also included as many visuals as possible in our powerpoint to keep students engaged, and for them to be able to visualise what was discussed in the presentation. Additionally, we found that explaining the same concept in different ways, using a combination of analogies, videos, and verbal explanations, helped us overcome potential language barrier issues.

Tips and advice for future teams: Future teams working on the ASYV project should be aware that presenting online is a different environment from presenting in-person. It is not as convenient to gauge engagement online, nor is it as easy for students to ask questions. It is always best to

allocate buffer time for questions and technical difficulties. We tried to ensure that we enunciated words clearly in our presentation, and spoke slower than we would if we were presenting in-person. We also made frequent pauses throughout our presentation to see if there were any questions. This allowed for students to understand basic concepts before moving onto ones that built on previous knowledge. Given time constraints, we found we had to sacrifice content for clarity, but we thought this was in the students' best interest as it allowed everyone to be on the same page and have insightful takeaways. The ASYV project was very rewarding for us, and we hope future teams will find it to be too!

Meeting #6 – iGEM Vilnius Lithuania

About Vilnius: We are Vilnius Lithuania iGEM 2021 team and this year we are combating *Entamoeba histolytica* – a microorganism that causes an infectious disease called amoebiasis. It infects around 50 million people worldwide and causes up to 100 000 deaths every year. Our goal is to create a therapeutic compound that will diminish the virulence and viability of our target amoeba. In addition, we are developing specific low-cost and rapid diagnostic test for the detection of an invasive amoeba infection.

How we planned and prepared for the meeting / About our meeting: For the ASYV collaboration, we had a lecture for the Rwandan students about the concept and possibilities of probiotics. We planned out the lecture in a way that students firstly would be introduced to the concept of gut microbiota and why it is so important, afterwards we decided to dig into the topic of probiotics. We discussed the ways probiotics are nowadays used and how the tools of synthetic biology could be applied to develop new types of more effective probiotics. In the final part of our lecture, we introduced students to how we are engineering the probiotic strain to prevent the infection of Entamoeba histolytica. During the whole lecture, we were constantly asking students questions about how would they choose to solve the problems that we are facing in the laboratory or where they think the potential of probiotics could be used. We were pleasantly surprised to see how engaged students and their teacher were in our lecture since we received a lot of questions and ideas on this topic.

Tips and Advice: While talking about tips and advice for future teams, we would like to give advice to future iGEM teams to develop dialogue during the lecture, to encourage students to discuss and ask questions. This creates particularly enjoyable and productive learning and teaching experience.

Feedback and Moving Forward

We learned a lot throughout this process, of course made some mistakes and found many ways to improve, which will be summarized here.

The overall response to the project was positive – Ian and the other staff were happy we had taken this initiative directed at STEM-focusing students, and told us that the students were interested and very positive about the project overall. Throughout the program, the students were asking for assignments and tasks to do in between meetings, showing their enthusiasm, and would thoroughly fill out those assignments.

There were, however, some difficulties, some of which can be concluded from the "tips and advice" of the team summaries above, and some of which are summarized:

- The content was quite challenging at times for the students. As the students are both from biology and computer backgrounds, most things need to be explained first at a slow, simple, and basic level, to make sure everyone is on the same page. For this reason, **we recommend the following:**
    - **Splitting the students into two groups,** one for biology and one for Python. We did this for several of our meetings, and it worked well, as it allowed us to go more in depth on certain topics. This can be done in several formats:
        - Use the meeting time for two unrelated topics but valuable material for each to learn new skills or explore new fields
        - Keep the students on the same topic, but working on different angles of it, and maybe coming back together in the end
        - Have a bigger project going throughout the project and each group uses the time to move forward with it
    - **Simplifying the material to fit the course curriculum**. We had contact with Ian, the biology teacher, and Justin, the IT teacher, before we started the project, and they sent us the course curriculum. This helped us understand what the students might already know, and what would be totally new concepts to them. We also had the iGEM teams understand what the previous team had presented so that they could use the same examples or build upon them. However, we did lack communication, so some teams presented material that was too difficult, or moved to quickly. We therefore recommend also **keeping solid communication both between teams and getting feedback on lesson plans from the ASYV teachers.**
    - In addition, it's critical to **constantly get feedback from the students,** both during the lesson and between lessons. This will help you understand if you need to take it down a notch, slow down, or repeat something.
    - **Learn from our mistakes**. The Zoom recordings from most of our meetings are available in the ASYV Students folder we've shared, and we recommend you **rewatch** to **understand the level of the students, and how we simplified both successfully and unsuccessfully.**

- <u>The meetings should be more engaging.</u> While our original plan was to have the meetings be half lecture, half activity, most of the meetings ended up being a full lecture. While students found these meetings interesting and were engaged with questions and problem solving, we agreed with Ian that it would be much better to have more interactive meetings. We recommend trying some of the following:
    - **Build activities around the curriculum that the students are learning,** while trying to connect it to synthetic biology. Yes, it's pretty hard to think of just biology activities, or just Python activities, but hey – that's why we're iGEMers! Some ideas that we brainstormed with Ian include **manipulating data, making models, presentation skills, pitching ideas, turning ideas into something that can work.**
    - **Plan the club and activities ahead of time**. The vision that the teachers and ASYV have is to plan the whole club beforehand, in a way that would allow teachers to **run the club alone** with ideas and help from iGEMers, and biweekly or monthly meetings with iGEMers to get help, updates, more engagement and content, etc. **Outlining the objectives and every meeting of the club** before starting allows iGEM teams to prepare and make them as good as possible, and also allows for integration of each meeting with each other that can work towards a larger goal.
    - **Get the Python students coding**. The students follow the computer science curriculum of Carnegie Mellon University Computer Science Academy[6], and activities should be discussed with the IT teacher ahead of time in order to make sure it fits the level of the students. If there are meetings that are joint, or biology based, it's crucial to constantly include the Python students in the bigger idea and help them understand where they come into play. It's easy to lose these students when the conversation moves to only biology.
    - **Get the biologists in the lab.** We were too late on this idea, but there is some form of lab at ASYV that the students could do simple experiments in. Of course, reagents and materials are *expensive* and it's important to understand what state the lab is in and what is possible in terms of the village and teachers. Suggesting some simple experiments that require only few materials might be possible, but consider the limitations that might be faced (is there a way to get materials quickly to the village? how much can they afford? is there a fridge? is there safety equipment? etc.). Another idea we had was involved getting in touch with local Rwandan scientists and trying to help **organize a field trip** for the students and bring them to a local lab to see for themselves (and maybe, they'll even let them try things out there!) Of course, all of these ideas are entirely dependent on ASYV staff and teachers, which is why it is important to be in constant close communication with them. **Fundraising** might be a good way to raise transportation costs, lab equipment costs, etc.

    - **Bring local leaders to meet the students.** Yes, there is synthetic biology in Rwanda and Africa! We brought the idea up to Ian of bringing speakers (either live or virtually) who are leaders in the local scientific community to connect with the students and give a better idea of the possibilities, and allow them to see how pursuing STEM can be an option for them, give them opportunities to ask questions that pertain to local challenges and difficulties, etc.

[6] https://academy.cs.cmu.edu/

    - **Be in better communication with the students.** We had the idea to set up some type of communication methods we could have directly to the students, and ASYV tried to set up a student email which they would all have access to. This would have allowed the students to write us emails with questions, and for us to stay in touch with students and teams as well. However, we never got the email working. After discussing with Ian, he recommended in the next years trying a Microsoft Teams platform.
- Make a more comprehensive club plan. We really see the potential of a future high school iGEM team at ASYV, and Ian expressed wanting to move in that direction. Therefore, we recommend making a comprehensive club plan that requires students to understand synbio and think of a solution to a problem. Students could develop small projects on their own and use their teachers and iGEMers to help them develop them. iGEMers can create or bring materials that would help the students learn about more synbio methods on their own and progress independently. We **recommend getting iGEMers together with the teachers to discuss how the club should look** a while before starting, to give enough time to prepare, as one of our downfalls was that we rushed too quickly into starting the club with too little time to prepare.

If you've come this far, then you just might be ready to start your own ASYV Virtual club! Thank you for taking the time to read, and feel free to reach out to iGEM TAU 2021 or any of the participating teams for advice and tips on starting this collaboration. We wish you the best of luck!

Appendix

Homework Assignments

**Student names removed here to protect privacy.*

We had originally planned for

Homework Assignment #1:

Goal: Research different synthetic biology problems/solutions

TEAM 1*: Research iGEM Shanghai City: https://2020.igem.org/Team:Shanghai_city

TEAM 2*: Research iGEM BHSF: https://2020.igem.org/Team:BHSF

TEAM 3*: Research iGEM Xiamen City: https://2020.igem.org/Team:Xiamen_city

TEAM 4*: Research iGEM GDSYZK: https://2020.igem.org/Team:GDSYZX/Description

Instructions: Find two examples of synthetic biology projects (they can be iGEM projects!) and answer the following questions:

1. What is the problem the researchers are trying to solve?
2. How did they get to this problem, and why is it an important problem?
3. What is the solution that they came up with using synthetic biology?
4. What biological systems/methods did they use? (In your words)

Homework Assignment #2:

In this assignment, please get together with your team*.

You and your team need to think of a problem that needs solving! Think of a problem in your community, environment, or in the world that you think can possibly be solved with synthetic biology.

(Hint: for next week, you will need to think of a synthetic biology solution!)

1. What is a problem that you think can maybe be solved with the help of synthetic biology? Tell us about it.
2. Where is this a problem? (The whole world, your country, your village?)
3. Who does this problem affect?
4. Why did you choose this problem?

Homework Assignment #3:

Please complete the assignment by next week:) You are welcome to communicate with us via our group email igem.tau.21@gmail.com

In this assignment, you will try and think of a synthetic biology solution to the problem you thought of last week! Make sure you check out our feedback from the last assignment too, to help you with this one. Try your best and be creative! You can use the internet and all of the presentations from the last teams to help you.

1. What causes the problem you described last week? Note, if you want to specify your problem further, this is the place to write it!
2. What possible solution or solutions can be created with synthetic biology? Be creative! There are no crazy ideas :)

3. What resources would you need to find the solution?
4. Any thoughts/ wonders/ questions?

Debrief

It's crucial that you **debrief** after the meeting together with your teammates. Write them down in a note/doc, try and answer the following questions:

- What went well?
- What issues were there?
- What could have been done better?
- What advice could I give to the next group?
- What could have been planned better ahead of time?