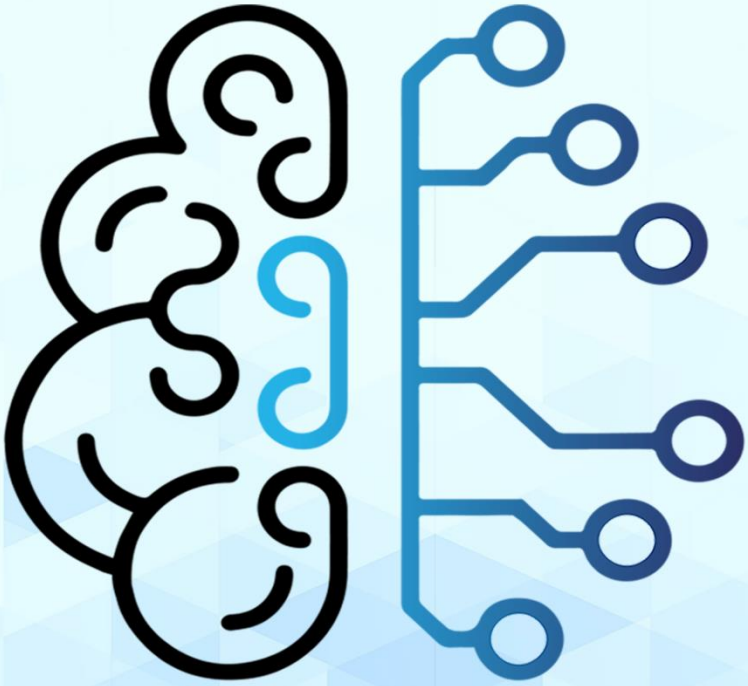
International Genetically Engineered Machine
Foundation iGEM Competition 2021

"HOW TO IGEM"

A short guide for anyone starting in iGem

A collaboration with KOREA_HS



iGEM NOUS GREECE

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Contents

Letter by the authors

While our iGEM year is coming to its end, we thought back to our very first moments as a team. To be honest, we had almost forgotten about the uncertainty and sense of disarray we felt at that time. iGEM is a complicated competition with many rules, deliverables that may cause feelings of confusion to any new team. In addition, explementary teams from past years can create fear instead of motivation when you don't really know what you are doing. Yet…

This is the purpose of this booklet. It is something we wish we had when we were starting our team. It's a compilation of the most important things you should know and do as a new team. In our course, we found ourselves in many situations that begged our response and immediate action. Now, having almost finished, we looked back and evaluated ourselves. The things we did then, and now appear to be correct and appropriate, will be presented in the following pages as advice and hopefully a guide to others.

This is a heritage to future teams that hope to participate in the iGEM Competition. We wish you the best of luck in the beginning of this amazing journey! We hope that you can learn from our experiences, avoid our mistakes, and excel. We would be delighted if you may have any feedback or if you wish to add to this booklet to enrich it or update it. Do not hesitate to contact us shall any questions or concerns arise.

Also, we would like to thank our partners "**KOREA_HS**" for helping us, and for making this guide whole by adding their own experience and advice as a High School team.

Sincerely,
the team "NOUS" (Greece_United)

!DISCLAIMER!: The iGEM Competition tends to change rules, fees, deadlines, and deliverables from year to year. While consulting this guide, make sure to check with the website of each year's competition for any changes!

1. THE iGEM COMPETITION

iGem or International Genetically Engineered Machine is a non-profit organization focused on advancing synthetic biology and education. It also encourages the creation of an open and collaborative community.

As described in their website (https://igem.org/), the main program of this organization is the iGEM Competition, an annual, world-wide synthetic biology event aimed at undergraduate university students, as well as high school and graduate students. The iGEM has 9 main tracks: diagnostics, energy, environment, food and nutrition, foundational advance, information processing, manufacturing, new applications, and therapeutics. Moreover, it has also 2 special tracks: open and software.

The iGEM organization began in January 2003 as an independent study course by the Massachusetts Institute of Technology (MIT) and gave students the opportunity to develop biological applications. The competition began in 2004 with 5 participating teams. In 2005 there were 13 teams, and eventually year 352 teams challenged each other in the competition in 2021.

The iGEM Competition gives students the opportunity to push the boundaries of synthetic biology by tackling everyday issues facing the world. Multidisciplinary teams work together to design, build, test, and measure a system of their own design using interchangeable biological parts and standard molecular biology techniques. In order for a team to qualify for a prize they have to recreate and present the experimental part of their project in the Giant Jamboree, the final event of the competition. Greece as a country has a strong presence in the competition with several teams gaining Awards and Medals since 2017.

Figure 1: iGEM logo

1.1. Why iGEM?

To our knowledge, iGEM is the only competition that gives young people the opportunity to play in the big-boys game. You have the chance to work in an environment exceptionally similar to that of a real research team. People from completely different fields have to cooperate to achieve a common goal, to tackle a problem they all care about. You learn to work in a team, to listen to different opinions and understand different points of view from yours. You have to manage a team, fundraise, communicate your work to the public, work in a lab or run a model.

All those skills you will learn in the harmless and (almost) responsibility-free environment of iGEM, you will certainly use in your future. Whether that is academic, scientific or anything else. It is the greatest of preparations for real life a student can have.

TRACKS

iGEM has many tracks, meaning many different categories in which a project can belong. It is solely up to each team to choose a project and decide in which track they think it belongs to. There are no constrains or rules. (Exception: Any High School ( ) team can only compete in the High School track.). It is in your hands to categorize your project correctly. For example, if you have a diagnostics project but you decide to select the therapeutics track, you will have the worst diagnostics project ever (!). It will not cure a disease at all, just diagnose. You don't want that if you are striving for an award!

Here we explain what each track is about to help you categorize your project correctly.

Therapeutics

Projects that aim to cure something e.g., Osteoarthritis 😉

Example Project

Energy

Projects that use synthetic biology to revolutionize energy as we know it or solve problems around it

Example Project

Hardware

Interaction of a hardware device with living organisms

Example Project

Software

Development of a program that aids experiments and solves biology problems

Diagnostics

Projects that try to revolutionize the diagnosis of an illness etc.

Example Project

Foundational Advance

Projects that are not competing to solve a practical problem but try to solve technical problems surrounding core synthetic biology
Example Project

Environment

Projects about environmental issues with solutions or with detection systems

Example Project

Open

For any team who may not fit in any of the other Track topics

Example Project

Information Processing

Projects that engineer ways to make biological systems perform computations

Example Project

Manufacturing

Basically, using synthetic biology to make a product. Sort of.

Example Project

Food and Nutrition

Projects about the problem of producing enough food and energy

Example Project

New Application

Projects that create novel, forward-thinking and innovative ideas

Example Project

Medals

In iGEM there are two ways to be judged. The first one, Medals, are independent of the work other teams do. It is kind of a competition within your team. In order to win a medal, you have to fulfil the criteria of this medal and of the previous one in rank. For example, you cannot win the gold medal if you do not fulfil the criteria for the silver and bronze and you have to fulfil at least 3 gold criteria. Below we have listed the criteria for bronze, silver, and gold medal and what they mean.

Beware! For a criterion to count you must present it in the appropriate page. If you write your attributions in the team page, even though you have done what you have to, it does not count. You must present it in the page "Attributions" (20xx.igem.org/Team:YourTeamName/**Attributions**) in your wiki.

Also, many criteria are similar to others, such as Collaboration and Partnership. They are not though. Your work should be distinct.

Medal	Criteria	Explanation
Bronze	Competition Deliverables	Complete the basic deliverables: Wiki, Presentation Video and Judging Form, before the respective deadlines
	Attributions	Descriptively write who helped and with what. Describe what work each team member did, what your PIs, advisors, instructors did and what people outside of the team helped you with. Not literature citations though!
	Project Description	Say everything about your project. Why you think its useful and meaningful, what are the future goals and how you came up with it.
	Contribution	Do something to help future iGEM teams. It could be anything! Like this guide for example! Better documentation in a Part, work to improve past work in software, or helpful documentation of your work.
Silver	Engineering Success	Demonstrate engineering success in a part of your project by going through at least one iteration of the engineering design cycle. Design → Build → Test → Learn → Design...
	Collaboration	Cooperate with another team to achieve a common goal. A good example is the iGEM Meet Up Conferences many teams co-organize. But there are many other ways to collaborate.

	Human Practices	Answer the question: "How does society affect my project and how does my project affect society?" and work to show that. (Should be in a positive way…)
	Proposed Implementation	Show how your project would work in its later stages (outside of the lab) for example as a product. Who would use it, how and why? What problems would arise and how would you solve them.
Gold	Integrated Human Practices	You should do things and let those things affect your project and then explain how what you did changed your project for the better. For example, if you ask your target patients what drug delivery method they prefer and change your project to match that answer. It is a tricky and difficult criterion.
	Improvement of an Existing Part	Make a new Part that improves the function of an existing Part.
	Project Modelling	Use modelling to gain insight into how your project works or should be implemented. Explain your model's assumptions, data, parameters, and results in a way that anyone could understand.
	Proof of Concept	A proof of concept usually consists of experiments or prototypes that demonstrate that your project is likely to work in a relevant context.
	Partnership	Collaborate throughout the year with at least one other 2021 iGEM team on a set of shared objectives related to both of your projects. Not just common events, but real and constant cooperation on your projects. It helps if your projects look alike or have common things.
	Education & Communication	Develop and implement education, science communication, and outreach materials related to synthetic biology. Find new and innovative ways to communicate science that are effective and thorough.
	Excellence in Another Area	Be really good in something that is not Wet Lab or Dry Lab. For example, entrepreneurship.

Awards

In our opinion, awards are the real thing. In awards you compete with other teams in multiple fields and only one is the winner. There are many many awards in different fields so you can have many opportunities to show your excellence. There are the **Grand Prizes** that are given to the overall best project of an age category, there are **Track Awards** that are given to the best project of a certain track, **Community-Awarded Prizes** that awarded based on iGEM teams' vote, and the **Special Prizes** listed below. (There are 3 winners in each, one for every age category). More info on: 20XX.igem.org/Judging/**Awards.**

Best Wiki

Prettiest and most functional wiki you can find.

Best Hardware

Best piece of hardware for synthetic biology but not from a Hardware-Track team

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Inclusivity Award

Be exceptionally inclusive. Go out of your way to be inclusive. Through H.P. or wiki or anything.

Best Integrated Human Practices

Do Integrated Human Practices better than anyone :). THAT SIMPLE!

Education

New and inventive ways to educate people. Use/make tools. Make it accessible.

Best Measurement

Designing great measurement approaches for characterizing new parts or developing and implementing an efficient new method for characterizing thousands of parts are good examples.

Best Model

Make a model that is actually helpful to your Wet Lab, before you get in the lab.

Best Software Tool

Best piece of software or addition in a software that somehow helps iGEM teams or is about synthetic biology. Not from a Software-Track team.

Best Supporting Entrepreneurship

Best plan and research to make as a start-up. Exceptional effort to build a business case and commercialize an iGEM project.

Best Sustainable Development Impact

Demonstrate how you have evaluated your project ideas against one or more of the Sustainable Development Goals.

Safety and Security Award

Do something that will make SB safer and more secure.

Best New Basic Part

Find new, cool, and important genetically encoded functions, and refine and convert the DNA encoding these functions into BioBrick standard biological parts.

Best New Composite Part

New BioBrick devices that are made by combining existing BioBrick Parts.

Best Part Collection

Many great parts or/and collections.

Best Plant Synthetic Biology

Build a project in a plant chassis, or submit plant parts or anything good regarding plants.

Best Presentation

Just do the best presentation or presentation video. Fun, understandable, and interesting.

Diffrences in online format

BEWARE! iGEM criteria, deliverables, fees, and other things may change each year, or even throughout a year. We are stating what was true in the year we participated. Please make sure you have the right information if you are planning to participate in an iGEM Competition.

Usual iGEM Competition	Virtual iGEM Competition	Notes
Presentation of project in Giant Jamboree	Team presentation video	The same thing as presenting your project in the usual format, but in a video.
-	Project promotion video	Something like a pitching of your project.
750$ per person: Giant Jamboree registration	2500$ per team: Giant Jamboree registration	Who knows why!
Poster	No poster needed	Used to be a basic deliverable, it is not necessary anymore.
Team Presentation	Team Presentation Video	Instead of presenting your project in front of the judges you send them a video.

2. How to search for the iGEM Competition: KNOW WHAT YOU ARE GETTING INTO

Before you decide to join an iGEM team, or create your own, it is important to understand at full extent what the iGEM competition is and how it works. This is important to demolish any misconceptions surrounding this eccentric competition.

For example, in Greece, few people would have thought that non-biologists could, would and should(!) participate in a Synthetic Biology competition. Inform people, it's important!

Another thing is that almost no one understands the extent of work and devotion you put in a project. You can't be having 4-week vacation during summer while your experiments are running! Make sure you and others are in the same page and that you all are fully committed to your common goal.

All in all, here are some basic things to cover in order to KNOW WHAT YOU ARE GETTING INTO!

Basic steps on understanding iGEM

Step 1 : Judging

Familiarize yourself with the judging system. To win, you have to know how you are going to be judged. Each year, iGEM updates the "questions" (20xx.igem.org/Judging/**Rubric**) judges ask about one's project, that correspond to medals and awards. Reading and understanding those questions will help you actively understand what is being asked of your team and what it is that you should do to win.

Step 2 : Team Requirements

It's important to know the basic rules surrounding team formation, team categories etc. There are age limits that may stop you from participating (20xx.igem.org/Competition/**Team_Requirements**). For example, in a Collegiate team, members used to have to be undergraduate students and not exceed the age of 23, while now there can even be postgraduates inside a team. In a High School team members must be only high school students, and there are Commercial and Community Lab teams as well with loose criteria. All this information will help you choose what kind of a team you want to be and who you can recruit.

Step 3 : Team Composition

If you are starting on your own iGEM team and plan on recruiting others, or even if you already have a team, you should look into what skillsets are important in an iGEM team. That can be done by analysing the basic sub teams a project contains: Wet Lab, Dry Lab, Human Practices, Web Development, Fundraising, Graphics Design.

These categories have a close corelation with the main deliverables the competition has, so it is important, if you want to have an adequate team, to understand what each one is. Also, do not look only for people who study exactly what a team needs. Many of us had, unrelated to our department, skills that helped in the project.

Categories	Use	Main Deliverables	What we did
Wet Lab	This team will do the bio-things. Protocols, experiments, literature research on the project etc.	Sort of the whole project :), Safety Form	Most of our team members studied in biology – related departments and had some prior lab experience.
Dry Lab	Responsible for simulations of the bio-things, development of applications, statistical analysis etc.	The rest of the project.	Not many of us studied computer science, though a lot of our members had coding skills, so we pulled through.
Human Practices	How your project interacts with the world.	Events, Integrated Human Practices, Education & Communication	Everyone did their part in Human Practices. No one knew anything. Kind of learned on the job…
Web Development	Well, you must have a wiki so….	Wiki	Our coders had a basic understanding of website development
Fundraising	Can't do anything without money. Lab consumables, travelling, registration and dissemination fees will come up.	Registration fees	There were always some finance-related people that orchestrated our fundraising efforts, but almost everybody worked on that. Our team also received help from outside partners.
Graphics Design	Anything pretty about your team. Social Media, Promotion templates, logos, brochures, banners, posters.	Project Promotion Video, Wiki design	One of us had awesome designing skills and studied on that.

Step 4 : Past Projects

Before you do anything, look up past successful projects. It is excessively helpful and will help you fully understand what an iGEM project is and how a team works. Read projects from all tracks and categories.

You will also see what has already been done, give you ideas about what can be done better and really open your eyes in the limits of synthetic biology (Spoiler: there are no limits).

Can't stress this enough. READ PAST PROJECTS!

Step 5 : Judging Book

If you ever find the time, you should read the 100+ – page Judging Book that is published to help judges. There you can find explementary past projects that are used as an example in each criterion and award to judge other projects. Again, if you know how you are being judged you know how to excel.

3. HOW TO BUILD A TEAM

As explained in "Step 3" in Section 2, a project can be analysed in 6 basic sub teams: Wet Lab, Dry Lab, Human Practices, Web Development, Fundraising, Graphics Design. Be sure to have skillsets withing your team that cover all of them. That is the most important thing.

Something else to have in mind is balance. The team members cannot be just boys or biologists. Make sure that your team supports diversity and aim for different voices and minds to join your team. It is only to your advantage.

Also, be sure that you are kinda compatible with everyone, and everyone with each other. You should be friends before becoming partners (of course it can happen and the other way around). Communication and cooperation play a major role in success. Even if you can't love everyone, you must learn how to work with them.

3.1. Recruitment

If you wish to recruit new members to your team, you can either approach people you already know or create an application asking for people with a certain skillset that would be interested in participating in the iGEM competition.

Through this process you should always have in mind that you have to show to the potential team members who you are and what you are looking for, without misleading them. It is not only them that have to show their best selves but you/your team as well. Think of it as a double way interview.

Also keep in mind that you will have to reject some people. Be sure to be kind, fair, use the right delivery method and offer feedback. A kindly written official email that both informs of the result, says something positive about the candidate and does not intimidate them, is the way to go.

Step 1: Application Forms

Our application forms had the following structure. First, we briefly explained what is iGEM and we talked about our team and what we are looking for. After the introductory text, there were all sorts of questions (starting with basic information such as name, birthday, email), that we had thoroughly chosen.

Remember through your questions to not only check for knowledge but also check for behaviour and character. Don't be afraid to be creative!

1. What will the participation in our iGEM team offer you?
2. Share three positive and three negative elements of your character.
3. Have you ever been a member of a scientific (student / non-student) team? If so, what kind of team was it and what was your role in it?
4. What special abilities do you think you can offer in our team?
5. In which sub team of our project (Wet Lab / Dry Lab / Human Practices / Web Dev & Graphics Design / Fundraising) would you like to apply to?
6. Share relevant university and online courses you have completed successfully.
7. Have you participated in any other projects or presentations?
8. Have you participated in any summer schools / workshops / conferences (share name and carrier)?
9. Have you had any research experience? Have you had any experience in biological or chemical laboratory techniques?
10. What programming languages do you know?
    Are you familiar with any numeric computing environment?
11. Are you familiar with any software for graphics design?

Apart from the technical questions we also asked more creative ones, to understand the applicant's way of thinking.

1. How would you describe blue to a blind person?
2. Which song would you like us to listen to while reading your application?
3. What is your favorite drink?

Last but not least, we asked from the applicants to send us their Curriculum Vitae if they wished to.

Step 2: Interviews

Once the applications were closed, interviews started to take place. Through the interviews we tried to be calm and friendly to help the interviewees be calm and themselves.

The interviews had the following structure:

Introduction

- Explain what is the iGEM competition.
- Analyse the basic timeline of our team
- How did you learn about iGEM?
- How did you choose our team?

Application Information

Analyse the answers of the technical part, e.g., projects, presentations, previous experiences, and discuss about their academic achievements. Let them show you their interests, if they actually did and liked what they said they did. Maybe you'll discover things that amaze you that were not included in the application. Give a lot of time in this part.

Character

- Elaborate on your positive and negative traits. (It's funny how some people will try to look good and include contradicting traits. Watch out for things like that. :))

- You notice that one of your teammates doesn't complete the tasks assigned to them and no one does anything about it (either because they have not noticed it, or because they are afraid to talk to that person, or because of indifference). How would you face this situation?

- You notice that two people on your team are constantly in conflict and as a result, the dynamics of the team decrease and no one does anything about it (either because they have not noticed it, or because they are afraid to face these people, or because of indifference). How would you face this situation?

iGEM team requirements

- State that the iGEM competition and the participation in it has to be top priority in accordance with anything else because the workload is huge.
- How much time are you willing to dedicate to iGEM?
- Explain that we have to be in continuous communication.
- During the summer all our team members (especially the Wet Lab members) have to be able to be at the place of the laboratory.

Out of the box thinking

Riddles and Problems (Solutions in the Appendix)

- In the Sombrero galaxy there are N planets that host intelligent life. Each planet has an astronomer on it who observes the planet closest to it. All distances between planets are different. Prove that if N is an odd number, then there is a planet that is not observed by any astronomer.

- Three friends, Mr. Red, Mr. Blue and Mr. Green, are chatting. One is wearing a red suit, the other a blue suit and the third a green suit. The one who wears the blue suit takes the floor and says: “Did you notice something? None of is wearing a suit with the same colour with our names". “Indeed, you are right," adds Mr. Red. What colour suit is everyone wearing?

- A robot from Japan answers "yes" with green light and "no" with red light. A robot from China answers "yes" with red light and "no" with green light. What question should you ask to get the two robots to answer with a red light?

- I have a bouquet of flowers. All flowers are roses except for two, all the flowers are carnations except for two and all the flowers are daisies except for two. How many flowers of each species does the bouquet have?

- A skier wakes up at dawn and gets ready to go skiing. In a drawer he has 4 black and 8 blue woollen gloves. Unfortunately, the room is too dark to distinguish their colours. How many gloves does he have to take with him at least to make sure he has two of the same colour, without turning on the light and waking up his wife?

- We have three closed baskets and an inscription hanging on each one. The first writes "ORANGES", the second writes "APPLES" and the third writes "ORANGES AND APPLES". We know that all three inscriptions are placed incorrectly. How can we take the fruit out of a single basket and put the signs in the right place without looking inside or searching?

Other Questions

- Explain what you study as if you were talking to a 3-year-old.
- Without necessarily knowing it already, why the sky is blue / why is the sun is red when it sets?
- You have 6 identical matches. How can you make 4 equilateral triangles without breaking the matches?
- How can you measure exactly 4 liters with jugs of 3 liters and 5 liters?

Closing

- If you were a colour, which colour would you be?
- What do you think is your greatest achievement?
- What do you want to be when you grow up?

Step 3: Assignments

During the interviews you should take notes on the people you’ve seen to decide whether they suit your team or not. Once you decide on a small number of people that might be eligible for joining your team, you should assign them a task to see how they work.

When we were one step before the end of the recruitment process, we chose an awarded past iGEM project and asked the candidates to read it and make a small presentation on what they understood, focusing on the sub team they had chosen. For example, if a candidate was going to be a wet lab member, they would talk to us about that part of the project.

Step 4: YOU MADE IT!

Hooray! You now have an iGEM team. Next on, you should get to know your teammates and build your team!

3.2. Team Building

Team building is one of the most important things in the process of creating an iGEM team. You are going to communicate and cooperate with each other for a long period of time, so you first have to lay the foundation for this collaboration.

Even if you know each other it is important to have certain activities in the start, to familiarize with each other's character, way of talking, etc. in a non-work and without stress and pressure environment.

Some ideas for ice breaking activities to get to know each other better are:

- We asked every team member to secretly answer us some questions. Then, during a meeting we read everyone's answers without knowing who wrote them, and we tried to guess who it was.

  The questions we asked were:

  1. If you were an animal, what animal would you be and colour would it have?
  2. What is your favourite season?
  3. What is your favourite means of transport?
  4. Which character (from movies/series/comic/cartoon etc.) do you admire the most?
  5. What is your favourite quote or life moto?

- While drinking our favourite drink, each of us share one or more personal stories, based on a question. For example, "What was your most embarrassing moment?" or "Tell us about your worst heartbreak". In this way we started to get to know each other a little bit more.

Another really important thing is **Role Assignments.** Make sure to append roles to every member. Almost all your team members should be responsible for something. Someone will be the Head of Web Development, meaning that they mainly will manage that field, someone else will be the Inclusivity Award Manager, and someone else will be responsible for ordering the bio – stuff you'll need for your experiment.

Don't be afraid to change those roles during the course of the project, as new things come up, people change and fit better other categories. This will make everyone feel useful and find they're place in the team. Also, by spending time for something you become more dedicated, it becomes a part of you that you want to see succeed. This is the most important thing in the Team Building process. For all members to believe in and be excited by what they do as a group.

Also, having people designated for long term tasks will help you stay in top of things and constantly have things running. For example, not everyone should engage in your team's social media. One or two people are enough. They know and constantly learn how to manage social media better than anyone else, strategies don't get mixed, posts are not repeated, and you have a stable aesthetic. If they need help or advice they can reach out to the rest of the team, but social media will not be everybody's constant problem. Other long – term tasks to look out for and have one person manage them from the start are certain H.P. (Human Practices) activities like co–organized conferences with other teams or communication with organizations.

For all this to be possible, you have to **COMMUNICATE WELL** with your team. What's better than a good communication system to help you keep on track? We personally used a combination of certain available platforms to cover all our needs. Mainly we talked through Discord, where we had multiple channels and roles about every running task that you can use to notify (tag) the right person. This helps because messages about a subject don't get mixed with other topics and if let's say you are a Dry Lab member you can go to the Dry Lab channel without having to read what happens in the Wet Lab channel.

Another thing we did after talking and coordinating things through Discord, was to add our main tasks in a shared board in a Task Managing App. That way we had a simpler to-do list at hand and could check at any moment the progress of everything. Moreover, we had shared calendars with notifications of upcoming calls and deadlines. (Oh yeah we had like 10 different weekly group calls about everything that went down at the time. Had to find a way to remember them.)

Feel free to try this system, but you should change things up to see what works best for you. Do it fast though and make it a habit. We did not manage to make a habit of using the task manager app and that idea died quickly even though it was super useful.

4. FIND YOUR PROJECT!

We can't stress enough the Importance of brainstorming. It has to be a group activity in order to find something that the whole team will like and be dedicated to. It's a wet lab or dry lab thing. Value each teammate's opinion irrelevantly of their field of study. Ask your graphics designers and your fundraising members too.

4.1. Brainstorming: Where to start

A nice way to start brainstorming is through games! (Also helps with team building.) You can find many examples online and be sure to find something that you like and fits your team, but we will tell you a few of the things we did.
The purpose of brainstorming in this case is to find an interesting problem and an innovative solution to it.

- So, we started by asking every member to write down many and any problems they face in their everyday life. We got things such as: "My hair gets in the way and I can't see when I study", "TOO MANY COACKROACHES", "I have loose joints and my hands are constantly powerless and hurt".

- Then we assigned one problem to each person, and they wrote down a solution (no judgement there. We craved for crazy, out-of-the-box thinking.)

- They passed the problem and the solution to the next person that tried to add to that solution by saying "Yes, and…."

- In the end we read out the whole solutions, discussed and voted the best problem-solution pair.

- Those pairs made it to the next phase where we discussed, defended, and attacked each one while enacting a character. The characters we chose were contrasting by nature, such as Tom & Jerry or Harry Potter & Voldemort.

  The results of this round looked like this:

  "My hair gets in the way and I can't see when I study": A hair gel that has small magnetic elements. You put it in your hair when you want to study and control the position of your hair with to large magnets around you.

"I have loose joints and my hands are constantly powerless and hurt": An exoskeleton powered by sound! You will wear it and use soundwaves to push things around so that you won't have to use your hands!

Not all were gems.

We had 2 whole and full weekends of brainstorming so many more activities happened and many more ideas popped up. That is just the gist.

Another place to look for interesting problems you may want to tackle is in your community, region, or country. What is the most common health issue there? Is there a serious agriculture problem that affects the economy?

Study sessions

After brainstorming, we voted and gathered the best ideas. Each one of us chose his favorite(s) and started furtherly researching them. Our goal was to make them more realistic, find the recent scientific advances around it, read past iGEM projects that relate to it and see what is state of the art. Then we met and discussed our findings in what we called "study sessions".

Another factor to consider is the appeal of an idea. Does your team like it? Will the world like it? Is it something helpful and interesting? But most importantly: Is it something that can be done by undergraduate students?

During this process we constantly eliminated projects for a variety of reasons. Then we asked experts in each idea's field about their opinion or any questions we may had. They helped us understand whether what we were planning was possible. Then and there, the need for the right question, at the right person, at the right time became evident.

4.3. Finding the one

While constantly eliminating ideas, reforming others, and asking questions we were left with 3 possible projects that we really loved. How do you choose?

We analysed the logistics behind every idea. How much time would it take? What is the rough cost? Do we have labs to support it in our city?

We discussed all that by playing "Devil's Advocate" with each other and then voted! After that, we concluded that our project would be an innovative, patient customized and unintrusive cure for Osteoarthritis!
What is interesting in our project is that it was inspired by the problem mentioned above. The soundwave exoskeleton turned into a simple exoskeleton with a soothing gel. The soothing gel became a regenerative one and then then project changed to fit a more common problem: Osteoarthritis!
The key takeaway is to always be ready to readjust your idea!

4.4. Finalization

Time to find PIs, advisors and instructors that fit your project! See below for more information.

Also, now that you have a better and more analytic picture of what you will be doing the next months, it's time to redistribute tasks. New things and responsibilities must have come up and someone has to take care of them. Also, a good time to see if your team has any shortages. Maybe you need more Dry Lab members than you thought, or someone that is familiar with hardware. All depends on the project you chose.

5. ORGANIZATION

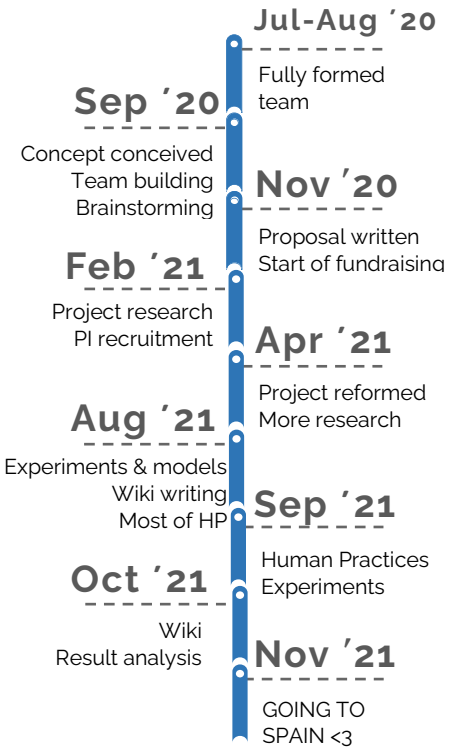
You have a team. You have found an idea. There are many tasks to be completed.

It's time to organize things and set deadlines through time up until the competition. The calendar in the iGEM website can help you with this process. Study each deliverable really closely and decide how much time you need to complete it. Add an extra 7 – 15 days for each of your deadlines, just to be safe. **Better be safe than sorry!**

Timeline

Among iGEM teams there are 2 common timelines. The first one, is for a team that forms and joins the upcoming competition, the one iGEM suggests. The other one, that we followed, was to form the team and join the competition approximately in 2 years. Let's explore both!

iGEM proposed timeline

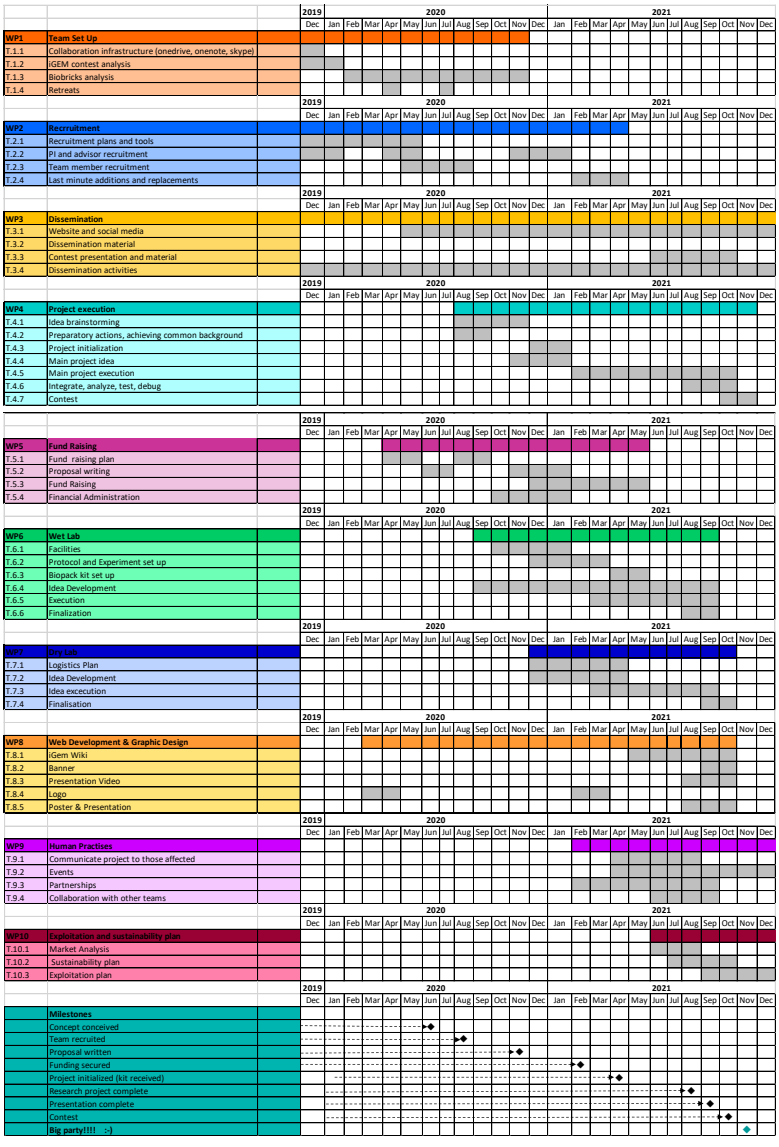


What we did

Gantt Chart

A Gantt chart in general, is a type of bar char that illustrates a project schedule. This chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis. The width of the horizontal bars in the graph shows the duration of each activity. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project.

Below you can see our Gantt Chart. Each different color section signals a different work package, and corresponds to the work packages of the diagrams above. The last section (turquoise) are the milestones set by our team and corresponds to the diagram on the right (above) explained before.



According to the time available ahead of you the tasks, work packages and milestones will change. In any case, the process of breaking down the things to be done, and organizing them in a timeline is crucial, because there lots of things to be done, and you most probably are going to lose track of time…

Criteria & Awards

After you have chosen a project it's time to make all the criteria and awards fit to it. It is important to do that early in the year, so you don't face any unpleasant surprises like: "Oh! It's October and we just realised we have not implemented anywhere an official Engineering Cycle!". Make sure all the main deliverables are doable with the project you have chosen, if not slightly change your project till they do.

Also, it is a good moment to choose which awards you'll go after. Choose plenty, brainstorm and let your minds run wild. You may end up ditching some of them in the process due to time limits, or generally everything going south but that's just part of the game. That's why you chose plenty after all. In this process you'll find helpful the definitions of awards we listed in the previous pages. Some awards will be, by definition, irrelevant to your project so you will eliminate them from the start. For example, our project about Osteoarthritis could not ever possibly compete for the "Best Plant Award".

6. REACHING OUT FOR HELP

iGEM is not simple. It takes a village to handle a project of these dimensions, and you can't do it alone. You will have to learn how to properly ask for help from experts in their field, professors, government officials, university people and a whole load of others. Don't be shy, don't be passive. Go out there and find who can give you what you need!

6.1. RECRUTING PROFESSORS

Look close, look far, look in unexpected places. Check CV's (fun to be on the other side) and evaluate who seems to be the best fit for your team. Consider mentoring skills but most importantly basic knowledge and research/teaching focus. Contact them with care when you find them. They frighten easily! :)

What you should decide early on is what kind of lab and lab equipment you are going to need and who can provide that for you. Find professors that manage labs that interest you and try to approach them to join your team as P.P.I.'s or S.P.I.'s. It is sensible to search for professors in the university of your area, or an area you can frequently and systematically visit.

It is important to remember that professors are grownups with real jobs that won't devote 100% of their day to your project. So, when you are finishing your safety form deliverable at 2 am, terrifyingly close to the deadline, and you need a PI's approval in order to submit, do not think that they will wake up for that….

Point is, find a professor you are closer and more familiar with, someone that you can annoy with ease. Someone that will help with your financial organization, check your important emails before they are sent and add their name so other people will trust you easier, someone who will bring you food and solve interpersonal problems of the team. (Mrs. Kaldoudi thanks a lot :))

Another thing to consider is the form of contact with your PI's. Establish something recurrent that suits everybody. Organize monthly calls or a weekly mail update so all your different professors can stay up to date in anything that goes on even if it doesn't really concern them. Be sure to keep everything professional and kind, even if you could break a wall with your anger about all those late replies, unanswered emails, rescheduled and missed meetings.

Good luck! Professors are a tough kind!

Outside partners

Have you thought of anyone that could help you with your project and you really want them to be a member of your team, but iGEM regulations on team composition forbid that (usually due to age)? That person could be an outside partner! No help should be wasted, and when someone is eager to help, why not find a way to let them?

Outside partners can help with the workload or consult on certain areas. It is better if they focus only on a certain aspect of the project (eg. only Entrepreneurship), so that there is no confusion and better communication. For example, only the Fundraising members will cooperate with the designated-for-Entrepreneurship outside partner. No need for wet lab members to get in their feet!

7. FUNDRAISING

Make a rough budget and start seeking ways to collect the money. Your budget should include:

- Lab consumables
- Dissemination material (leaflets, posters, T-shirts)
- Competition fees
- Travel expenses (if you are going to travel)

In order to ask for money and get sponsorships, create an impressive and inclusive presentation of your team and project, to show people you are serious and responsible. Other than that, you'll need an official bank account (e.g. university account) that can be trusted for money to go there.

How to present yourself

In the business world, you need to be a professional in order for companies and other carriers like you, trust you and therefore sponsor you. You can't just knock their door, call them and tell them "Hey! We are super good students! You'll like us. Give us money. NOW!!". No, it doesn't work like that. There are certain things you need to do for others to take you seriously.

Project Proposal: This is a document where everything must be included. It has to be something you'll give to someone who has absolutely no idea about who you are, what iGEM is, what you need. To get an idea, the table of contents of out project proposal is as follows:

Pitching Presentation

When in Rome, do like the Romans do…. It might seem a bit unnecessary to make a pitching presentation. Seems like something that a start-up asking for millions would do. But it's not! A pitching presentation is a nice way to show your work and why someone should believe in you. Show them you are not a charity, but money well spent! Show them you are serious and just as good as any businessperson they usually fund.

Promote your PI's

Professors are generally more trusted by everyone around you than students. So, use that! (With the approval of your PIs of course). You are not just a student team, looking for money to spend on a super hard and far-fetched project. You are an organized team that is guided by the opinion and knowledge of an esteemed professor in order to succeed with their innovative idea!

Do you see the difference it would make in the eyes of a possible sponsor?

Social Media

Social Media is your best chance of building a good image for your team. Try to be inclusive, post frequently & interesting things and engage with your followers. You should keep it formal to make a good impression on any sponsor checking out your social media, to show them that it would be in their benefit to be advertised by your team as sponsors. But don't forget you are a student team so send your fun vibes out there too and show them biology can be fun!

Sponsorship Packages

There are numbered people on this universe that would just give you money with nothing in return. Make sponsorship packages! A sort of reward for the money a sponsor will give you that is different according to the amount. Below you can see our sponsorship packages.

Figure 2: Sponsorship Packages by iGEM NOUS

Your University/School

The most obvious source of money for your project is the University that supports you. However, this can be a bit tricky. Universities have many expenses annually, and therefore it is difficult to spend money on every student team that wants to build something and participate in competitions (believe us, there are lots of student teams out there for every sort of competition).

So, in order to ask for money from your university, you first need to find the right person. Usually, universities have a team responsible for all the money stuff.

Next on, you should decide on the amount of money you are going to ask for. If you ask for too much money (according to the universities standards) they are going to kindly decline your request.

Concluding, you need to find someone you trust that knows how your university works to guide you through the process of asking money from the university.

Other places to look for money include government agencies, scholarships from foundations and scientific sponsorships.

Crowfunding

SUCH A LIFE SAVER! The love and support of the people was amazing! Relatives, friends and strangers helped as raise 3,160$!

Crowdfunding is the chance for your friends, aunts, grandparents, teachers etc. to finally help in this quirky thing you've been going on and on about for months now.

Find a platform that suits you and your country, promote it like crazy and hope for the best.

You can find more information on our short tutorial. Find it in our wiki!

Just a little tip: You may want to promote this page to the target audience of your project. Young people trying to change the world for something that affects them is a good motive to donate.

Companies

How to approach companies is super tricky! If you may know someone from the inside use them to give you the right person to talk to but also say a good word about you.

Irrespectively of that, gather all the companies you can think of. Pharmaceuticals, marketing or consulting companies, supermarkets, IT companies, random shops etc. Better if they have their origins in your country. Then call them! Use your nice voice, be kind and patient and try to get an email that does not end in @info …. Then, send them your proposal and propose a meeting where you will have the opportunity to pitch them your project and explain what it is that you are asking. Make sure to do follow up calls and have a detailed archive of when you called who and what they answered.

Good luck fundraising, it is not easy.

8. HIGH SCHOOL TEAMS

Before discussing "How To Start a High School iGEM Team," I [ML]'m more than happy to introduce and credit full co-authorship to Matthew Kaung. Matthew Kaung is a senior at the American School in Japan and leader of the 2021 Team ASIJ_Tokyo. As I lack experience with financial and business sectors concerning iGEM, he helped me to write up for "How To Start a High School iGEM Team," "How To Select a Research Topic," "How to Fundraise and Host Events," and "Legacy." I now let Matthew Kaung deliver words of advice from his end.

8.1. How To Start a High School iGEM Team

It is my [ML] assumption that most of you are interested in starting your own iGEM team, not joining an existing organization to seek opportunities in Synthetic Biology. This booklet may not be useful if the latter is the case. Thus, Matthew Kaung and I focused on the former case by extensively delivering the case of 2021 ASIJ_Tokyo (and comparatively little on 2021 Korea_HS) to suggest structural procedures to avoid and/or overcome financial, intellectual, or ethical barriers you may face during the exhaustive journey of starting an iGEM team.

Case Study: 2021 ASIJ_Tokyo

Figure 3: Team photo of 2021 AIJ_Tokyo.

At the high school level, there are two main ways to start an iGEM team. The first way is to start an iGEM team at your own school. In order to do this, you must first find a PI (principal investigator) who is willing to support the club and provide a space to conduct lab experiments. The big challenge that many high schools face is the lack of lab equipment or space, which is why you can always reach out to university or collegiate teams for help. For those who are unable to conduct experiments at schools, emailing institutions and universities is the best way to go! ASIJ_Tokyo has been able to loan equipment from other teams in the past!

With the help of school funding, ASIJ_Tokyo has been able to conduct experiments at school and attend the Giant Jamboree for the past 5 years. Therefore, when wanting to start an iGEM team, make sure to discuss this idea with the administration of the school. Getting their support and funding can often make participating in the Jamboree much easier.

With the financial backing and facilities ready, the next step is to recruit members interested in iGEM. iGEM is unique in that it encompasses many aspects, so make sure to recruit members of different backgrounds as you will need the combined talents to finish the project. It is important to note that iGEM requires a Wiki for a competition deliverable every year, so make sure you have someone to code on your team.

Once the members have been recruited, members need to learn about the core elements in synthetic biology. This is usually the role of the Primary Instructor or advisor, but in the case the primary instructor is just a supporting teacher, many iGEM teams are willing to help offer their knowledge and experience. The primary instructor should at least have a baseline knowledge of simple synthetic biology and be able to serve as a communication liaison between iGEM HQ and the team. Oftentimes, while the school can help fund iGEM, due to the expensive participation and lab fees, additional fundraising must be done. Some ideas for fundraising could include holding a bake sale, starting a GoFundMe page (see an example from the University of Tokyo who raised 6000 dollars), and looking for sponsors.

Overall, starting a team at your local high school poses many challenges such as funding and lab space, but once you start up a team, you can have a steady program that can last for many years. The first step for interested teams is to speak to the faculty or the administration about your idea and make the idea come true from there.

Case Study: 2021 Korea_HS

Figure 4: Team photo of 2021 Korea_HS.

The second way to start an iGEM team is through recruitment from already existing organizations (which is the case for Team Korea_HS). There are many iGEM teams that involve students from different schools living in the same country. These iGEM teams are usually run by institutions that already have solid financial backing and lab space. For students who are unable to start a team in their own high school, joining one of these iGEM teams run by the organizations may be a great way to get into the iGEM community.

High School vs Collegiate Teams

iGEM comprises three sections: high school, undergraduate, and overgraduate. Each section is evaluated separately for Grand Prize, Special Award(s), and Community-Based Award(s). However, each section is responsible for the same registration fee, Jamboree fee, deadlines, attendance dates, medal criteria, and judging. Hence, all information (e.g. medal criteria) on igem.org applies to high school teams.

Unique from the undergraduate or overgraduate section, high school teams do not register their projects to specific tracks (thus not awarded track-based awards) but fall under the “High School” track. There are approximately 97 teams competing in this track as of 2021 iGEM, and high school participation is projected to increase radically in the following years.

However, high school teams, due to the involvement of minors (18 years old or younger) in the team, are required to fulfill additional registration requirements. This includes the principal consent form for every school represented on the team, participant consent form from the primary PI of the team, and department head consent form (if the team is working at a laboratory outside of their high school).

How To Select a Research Topic

Case Study: 2021 ASIJ_Tokyo

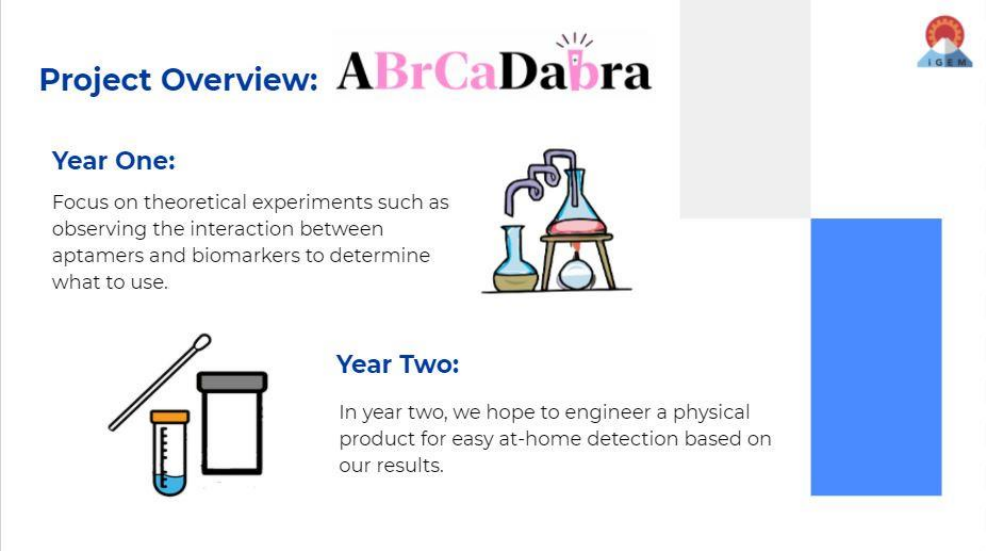


Figure 5: Research topic overview of 2021 ASIJ_Tokyo.

At ASIJ_Tokyo, we have a philosophy where the members of the current team will select the project focus for the year. This way, students can be working on a project that they are interested in and passionate about as iGEM requires a high level of dedication.

Having this independence does have its challenges, as it is often difficult to decide on a topic with everyone's diverse interests. Methods that ASIJ_Tokyo has used to narrow down project selection is to first select a track (ex. diagnostics, therapeutics, environment), then select a topic (ex. diabetes, breast cancer), before finally investigating a specific pathway that we want to investigate.

Deciding on a topic is often the most challenging part of an iGEM journey, and don't be afraid to ask other teams or people about their opinions when going through this ideation process.

Case Study: 2021 Korea_HS

➢ **Amino acid sequence modification**

Peptides	*Amino acid sequence*	*Charge*
Buforin IIB (BIIB)	RAGLQFPVGRLLRRLLRRLLR (21 aa)	+7
Modify Version 1 (MV1)	RAGLQFPVGRLLRRLLR (17 aa)	+5
Modify Version 2 (MV2)	RAGLQFPVGRLLR (13 aa)	+3

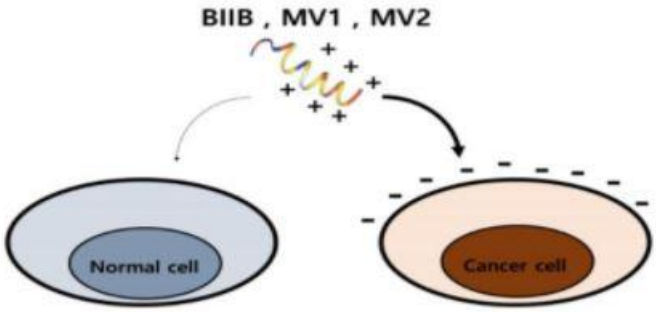


Figure 6: Research topic overview of 2021 Korea_HS.

iGEM opportunities at existing organizations are similar to those of science camps or internship programs: predetermined research topics amongst PI, primary/secondary instructor(s), and student advisor(s). This poses a distinct advantage that the team is already provided a roadmap to the iGEM journey, thus reducing the necessity to risk-take or fail the engineering process (most topics are often literature-validated before provided to the students). However, this structure may not be sufficient to pique students' interests in Synthetic Biology and miss the iGEM mission of the engineering cycle.

However, students are allowed to improve or modify several aspects of the project through student-guided wet/dry lab experiments, integrated human practices, and/or literature reviews. This serves as a critical process of students autonomously working beyond iGEM expectations, which is a valuable asset that can be recorded as "Contribution," "Description," "Engineering Success," "Improvement of an Existing Part," or "Proof of Concept." Hence, student body autonomy is relatively preserved under this form of team foundation, too.

Collaborating and Engaging in iGEM

Competing in a high school section does not mean that your team's collaborative sphere is limited to other high school teams. Let's assume Team Korea_HS plans to model biochemical networks of a certain cancer cell line but does not know which program to use and how to. This is when collaboration comes into effect: collaboration can be done by mentoring a team (or being mentored by a team), troubleshooting a project, hosting a virtual meetup, or modeling/simulating a system. Below are steps that your team can take to reach teams of your or other sections for technical/non-technical assistance.

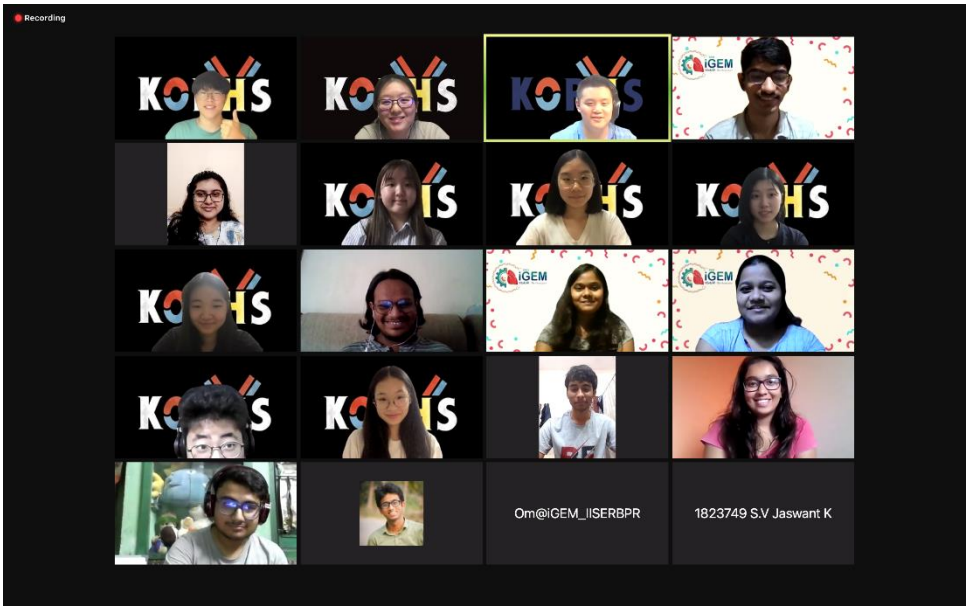


Figure 7: Collaboration meeting between Korea_HS and IISER_Berhampur.

Consolidate objectives: Even before finding a team, your objective must be to find a reason behind the collaboration. A simple, hour-long meeting with other teams with superficial discussion on each other's project, unfortunately, is not a collaboration! Discuss the following questions with your team: For what areas should we receive assistance? How can we assist them in return? How are we expecting to provide and receive assistance? Is this an area that can't be solved within the scope of our team's capabilities? This reflection should serve the important purpose of being objective-oriented throughout the meeting.

Find a team: If your team properly consolidated objectives, you now should have a strong idea of which type of team your team is willing to collaborate with. Most traditional ways to accomplish this are surfing through iGEM Global Slack (carefully read team introductions) or Instagram (carefully read a few of the feeds). A similar spectrum of information can also be found in 2021.igem.org/Teams/Collaborations. You should finalize your selection with 3~5 candidate teams. Do note that the similarity of the topics (not only methods) also matters!

Contact a team: After organizing contact information of the teams that you are willing to collaborate with, draft a collaboration request email, including the following: (1) introduction of team and project, (2) reason behind collaboration (a problem you're facing), (3) suggestion for collaboration (a solution you're requesting), and (4) method for communication (e.g. Zoom call). If teams do not respond via email, seek other contact information, such as Instagram DM or Slack private channels. It often takes 3~5 days for a team to review your request and respond after careful consideration, so be patient!

Prepare for a meeting: Before each collaboration meeting, you are highly encouraged to draft a pre-meeting note that details the agenda and objectives of the meeting. Moreover, prepare any documents or presentations that correspond to the agenda and objectives of the meeting. For instance, if you are willing to discuss dry lab during the meeting, create a presentation that explains your team's dry lab

objectives, problems, and possible solutions that you're seeking through collaboration. During the meeting, be sure to discuss and resolve all objectives of the meeting.

Debrief a meeting: Other teams, in most cases, won't be able to provide help on an intricate dry lab matter within an hour's worth of meeting time! They will likely suggest a second collaboration meeting to discuss the matter in detail (for them to review the information and prepare). Hence, after the meeting, keep yourself updated with the team to actively review each team's progress on collaboration and schedule for a 2nd round collaboration meeting. An interval of 1~2 months - with a total of 2~3 collaboration meetings per team - is highly recommended.

iGEM requires teams to actively engage in integrated human practices - that is, a humanistic approach to validate the product's effectiveness and accountability to the real world. This is often done by teams interviewing potential users, stakeholders, or experts of the topic and modifying/analyzing their products accordingly to their commentaries. Often, high school teams find it difficult to directly contact and source potential users, stakeholders, or experts due to stereotypical status as a high school research team, which is often overlooked in most cultures.

The common practice employed by most high school teams is the incorporation of a social sphere: for example, you might have a father whose friend is an oncologist. If your team still lacks a plausible interviewee even after reflecting on your social sphere, follow the protocols suggested for finding a possible collaborator for your project (just above this section), but expand the scope to different institutions of diverse contexts. Again, engage actively to find people of social or occupational status to provide an accurate review and advice on your product for real-world application.

How To Fundraise and Host Events

An important facet of iGEM is hosting events. Whether this is for human practice or fundraising, hosting events is a great way to show your team's image and spread your impact to the great community.

The first step to hosting an event, after planning out the details and purpose, is to find a venue. In light of the COVID-19 pandemic, there are many digital alternatives to physical events, such as having an online workshop or an online exchange. For teams that are encountering difficulty securing a physical venue, working online is a simple alternative! We recommend that teams speak to their local school or university if they want to hold a physical event.

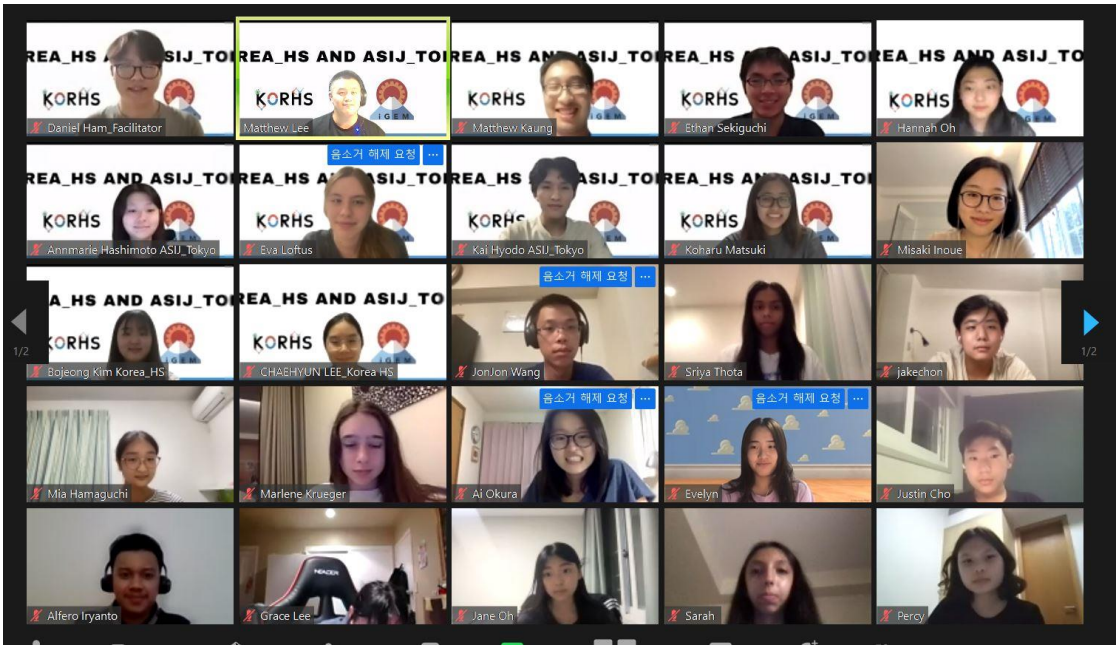


Figure 8: 2021 Autumn Dry Lab Bootcamp hosted by ASIJ_Tokyo and Korea_HS.

The next step is to find a target audience. If you want to host a good event, you need to have the right target audience to make an impact. For example, if you would like to spread synthetic biology and its usefulness, it may be useful to speak to a group of elementary or middle school students to pique their interest. Once you have decided on a target audience, you can start emailing relevant contacts and individuals.

These are the two main steps towards hosting an event for iGEM. With regards to hosting events between iGEM teams(virtually or in person), iGEM HQ usually organizes a few events throughout the year but if you contact teams you are interested in working with, teams will be more than happy to help coordinate and plan the event with you.

Responding to Concerns Regarding iGEM

If you're reading this, you're already a sleep-deprived high school student. There's a lot to deal with: school assignments, standardized tests, and high school dramas. You really don't have time to care what iGEM even is. Don't worry, we got your back. We've talked to many as hundreds of high school students across the globe, and below are some questions that we've come across most frequently (and you might be wondering about this, too).

- Will iGEM be a lot of work? How do I manage iGEM, along with other important things?
- What is the meaning of even doing iGEM during the high school year - for the resume?
- Won't the competition be too competitive for me, with basic knowledge of biology?
- Like most high school projects, what if I'm the only one who's working on it?

These questions, indeed, stem from our deep minds. However, keep a scientific attitude: take out emotions from the process and assess it with facts. Don't focus on what your mother's cousin's daughter's friend experienced with iGEM. Disregard outliers and look at what the general trend has to tell you about it - we're here to guide you through that process.

Will iGEM be a lot of work? How do I manage iGEM, along with other important things?

To iterate numbers than judgments, be prepared to devote at least an hour per day to iGEM. Some days more and some days less, but keep an hour per day as a general trend. However, during weekends or before deadlines (beasts like Wiki Freeze), expect hours of workload, or even sleepless nights. Concerned how you could possibly balance iGEM along with schoolwork and extracurricular activities? Don't worry: high school iGEMers ourselves, we have prepared several techniques you may use (thank us later) to guide you through the iGEM journey.

Plan ahead: Have a clear idea of what you want to accomplish each day. Create a small to-do list, reserved for iGEM, on your planner. Through the iGEM journey, things will start getting unorganized, random, and hectic (particularly from July, when most teams begin their collaborative meetings and events). You will feel lost in where to start (and even how to complete all the tasks) if you stay unorganized and do not plan ahead. Of course, complete the task each day! If not, tasks will pile up exponentially, and you will face learned helplessness.

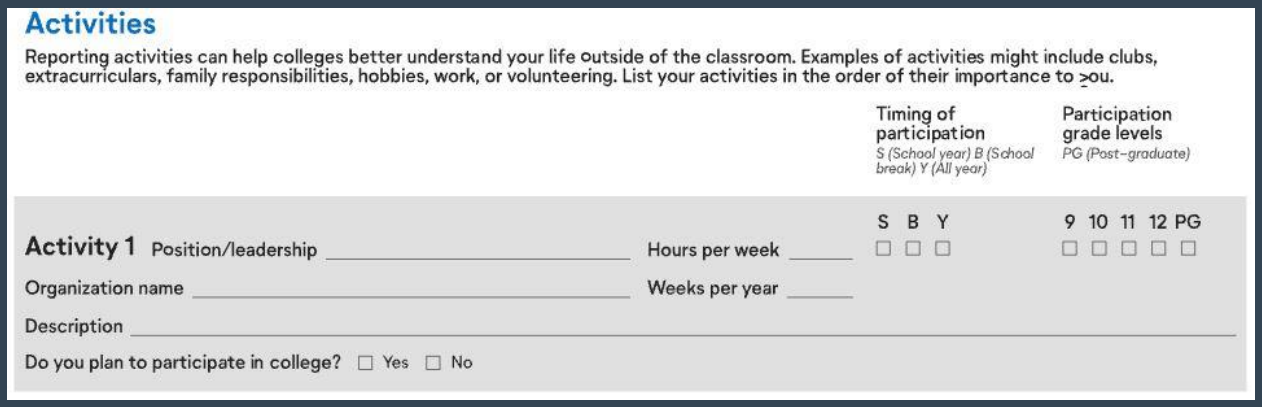
Use spacing effect: We all have an experience of pulling all-nighters before exam day. For iGEM, this simply does not work! Humans simply cannot pull all-nighters every day. Thus, space your work out throughout the day. An hour's worth of workload does not seem overwhelming when you divide it up to six sessions of ten minutes. Recall that you are wasting hours each day: playing games during recess, taking a nap on the school bus, etc. Why not begin utilizing these short bursts of time to get work done as early as possible? Doors to work-life balance start here!

Understand the power of 1/n: For 95% of the group projects, there always is that one student who does all the work. iGEM is a beast that a single student can't defeat by him/herself. On average, there are 15 members in each iGEM team. If role division is done effectively and fairly (1/n), the workload assigned to each member will not be overwhelming, seriously. Of course, team leaders have added responsibilities to administrative tasks, but workload, in general, must be unvaried amongst all members. This further expands to team dynamics - an iGEM factor that is critical to successfully leading the team throughout the year.

Active communication: Everything begins with proper communication. Set a standardized communication medium for the entire team (preferably Discord, allowing users to create channels for improved organization and share various files). Draft a code of conduct for communication: for example, checking Discord at least twice a day, reporting once the daily task is completed, etc. If members play in their own league without communicating, your team will face significant difficulties later compiling everything into good-looking deliverables.

What is the meaning of even doing iGEM during the high school year - for the resume?

Let's be honest with ourselves: doing iGEM in high school years has more to do with building your resume than falling in love with Synthetic Biology. We understand - we've also gone through that thought process. Hence, let's be realistic for a moment - discuss college applications and real-world demographics: we'll cover everything you can do to advertise your iGEM achievements to universities that you're applying to.



Activities

Reporting activities can help colleges better understand your life outside of the classroom. Examples of activities might include clubs, extracurriculars, family responsibilities, hobbies, work, or volunteering. List your activities in the order of their importance to you.

	Timing of participation S (School year) B (School break) Y (All year)	Participation grade levels PG (Post-graduate)
	S B Y	9 10 11 12 PG
Activity 1 Position/leadership _____ Hours per week _____	☐ ☐ ☐	☐ ☐ ☐ ☐ ☐
Organization name _____ Weeks per year _____		
Description _____		
Do you plan to participate in college? ☐ Yes ☐ No		

Figure 9: "Activities" section of the Common Application.

In the context of American universities (which most international students are aiming for), most of them require students to submit a Common Application (visit commonapp.org for more details). Students can list and order up to 10 activities (of any type - clubs, extracurriculars, family responsibilities, hobbies, work, or volunteering) of their highest significance. You can (and should) include your iGEM achievements under "Activities." You are only allowed to enter the information included in Figure 7.

***Gold Medal*, 2020 International Genetically Engineered Machine (iGEM) Competition** **2020 (9 hr/wk, 60 wk/2yrs)**

Team Captain & Modeling
Quantitative Data Analysis
Wiki & Poster Development and Organization Lead of Team KSA Korea

- The project aimed at the production of high-quality recycled paper through biodegradation of lignin that can decrease chemical byproducts and wastewater generated by existing paper production processes to the significant environmental and economic benefit
- Derived a system of differential equation using certain assumptions to take into account the time since the reaction started taking place – more precisely, the time since the phenolic compounds started to get produced by the degradation of lignin
- Identified the pain points in recycled paper usage by means of surveys and interviews; sought to integrate what we have learned into our project, designing our experiments and implementation plan around the identified pain points; sought to improve the overall experience with recycled paper, for purposes of sustainable development and expanding potential markets for our project
- Wiki link: https://2020.igem.org/Team:KSA_KOREA#
- Poster link: https://2020.igem.org/Team:KSA_KOREA/Poster
- Major Achievements done by me: shorturl.at/blruA
- The 2020 medal criteria can be found at https://2020.igem.org/Judging/Medals. Our team, *KSA Korea*, met all the criteria to receive bronze and silver medals, which was necessary for us to be considered for a Gold Medal. We met the additional Integrated Human Practices and Modeling criteria that earned us this award.

Figure 10: Example resume of a high school iGEMer.

Most universities also accept (but do not require) a resume, which is a document that allows you to enter any other information about yourself (e.g. activities or achievements) that you weren't able to include or elaborate on for Common Application. You can provide detailed explanations and external links to your iGEM accomplishments. We have attached an example resume of a student that was accepted into a dentist program at a prestigious university.

iGEM begins as iGEM but not ends as iGEM. What does this mean? Throughout the iGEM journey, you will establish a variety of initiatives and activities that exceed beyond expectations of iGEM and might want to continue those activities after iGEM. Although these activities are tied under the theme of iGEM, you can list them as separate activities and elaborate on them on Common Application and resume.

For example, I [ML] was introduced to a high school scholastic conference called Korea Scholar's Conference for Youth (KSCY) during iGEM. Even after iGEM, I still regularly submit student-composed research papers to KSCY, attend the main conference, and receive awards. Of course, I will be adding those accomplishments both on my Common Application and resume. I was able to compose advanced research proposals and presentations with strong scientific foundations by experiencing a full engineering cycle myself during iGEM.

Another member of our team [HO], having learned the potency of Synthetic Biology and the social necessity to advocate it, founded a student-led initiative called Korea International Synthetic Biology Society. It regularly invites high school students to partially iterate engineering cycles of iGEM and submits research papers to collegiate journals. Of course, this was recorded as a key core activity that she will elaborate on both on her Common Application and resume: she not only received credit for founding an initiative but also for receiving awards!

I have seen many high school students engaging in research programs through internships or summer camps. However, iGEM, by allowing students to experience the full engineering cycle of Synthetic Biology, surpasses all such programs, in terms of its dynamicity, integratedness, and creativity. With all unique experiences, from collaborating with other teams worldwide, communicating with the public, and designing life-changing machines, iGEM will mold your identity as an emerging bioengineering researcher.

Won't the competition be too competitive for me, with basic knowledge of biology?

Basic knowledge of biology in iGEM is encouraged but not required. However, most teams generally require their members to take introductory biology courses prior to joining them. Your Principal Investigator (PI) and instructors will ensure that what you've mastered in the pre-requisite course is sufficient enough to smoothly transition to advanced Synthetic Biology and biotechnology. However, what if this is not the case for your team?

Some high school teams open their spots for any students who may be interested in Synthetic Biology. This can be concerning for many students unfamiliar with biology. For example, assume the team's project is to design an antibody that targets a tumorous protein. Even before learning the dynamics of the project, a student must understand antibody-antigen interactions, which is the underlying mechanism

of the project. Students will also struggle to research further, particularly during the engineering cycle, literature review, and results analysis.

Fortunately, most teams that do not require a pre-requisite hold lecture series or discussion sessions led by PIs and instructors regularly to help students grasp the topic. However, you are highly encouraged to self-study the fundamentals of biology to distinguish yourself from others or to even understand the basics of lectures or discussions. Lest you are wondering how to prepare, we have provided study plans to sufficiently introduce yourself to biology at an introductory level for the essential topics below.

- Evolution and Themes of Biology
- The Chemical Context of Life
- Water and Life
- Carbon and the Molecular Diversity of Life
- The Structure and Function of Large Biological Molecules
- A Tour of the Cell
- Membrane Structure and Function
- An Introduction to Metabolism
- Cellular Respiration and Fermentation
- Photosynthesis
- Cell Communication
- The Cell Cycle
- Meiosis and Sexual Life Cycles
- Mendel and the Gene Idea
- The Chromosomal Basis of Inheritance
- The Molecular Basis of Inheritance
- From Gene to Protein
- Regulation of Gene Expression
- Viruses
- DNA Tools and Biotechnology
- Genomes and Their Evolution

1. **Study Plan A (Campbell Biology: 10th Edition):** You will need to teach yourself from Chapter 2 (Chemical Context of Life) to 21 (Genomes and Their Evolution). Campbell is a standard text to AP Biology and collegiate basis to introductory biology. Take three days to master one chapter. On Day 1, carefully read the chapter and mark confusion. On Day 2, carefully re-read the chapter and resolve the confusion. On Day 3, create a page-long note of the chapter that summarizes key ideas and highlights confusion of the chapter. Do note that Campbell is a highly detailed, wordy textbook: it is key to save your time by discriminating relevant information.

2. S**tudy Plan B (Oxford IB Diploma Programme Biology Course Companion: 2014 Edition):** You will need to self-study from Unit 1 (Cell Biology) to Unit 3 (Genetics). This book is a standard text for IB Biology. Take three days to master one chapter. On Day 1, carefully read the chapter and mark confusion. On Day 2, carefully re-read the chapter and resolve the confusion. On Day 3, create a page-long note of the chapter that summarizes key ideas and highlights confusion of the chapter. Do note that this textbook is relatively concise than Campbell: it is key to mark and resolve your confusion by incorporating external sources.

If you don't have enough time to fully read a significant portion of the textbook, prep books - books that summarize key concepts of each chapter (usually designed for AP exam preparation) - are available alternatives. "Cracking the AP Biology Exam: 2022 Edition," "Barron's AP Biology: 7th Edition," and "AP Biology Crash Course: 3rd Edition" are great alternatives. Visit PrepScholar Blog for a comparative review of all three prep books. If you are a video learner, visit Bozeman Science Youtube Channel (refer to "AP Biology Video Essentials" playlist and watch videos 12~13, 15~18, 23, 27~40, 42~46, 49, 53~54).

If you are able to fully guide yourself through one of the study plans, the topics you've studied will guide you through comprehension of complex, interactive Synthetic Biology concepts and constructs. You will further amplify your biological awareness by expanding your breadth of knowledge through wet and dry lab experimentations and analysis, which trains you for both the basic and applied fields of Synthetic Biology.

Like most high school projects, what if I'm the only one who's working on it?

Before joining large-scale competitions like iGEM, most students concern that they would be the ones who'll have to take burdens of the workload. Again, iGEM is a massive competition that a single member can't simply procrastinate the day before Wiki Freeze. In iGEM, you'll meet a diverse array of people with varying knowledge, interest, qualities, and opinions. You will often disagree with your teammates and quarrel over workload. By following the steps enumerated below, you will be able to build a team with healthy dynamics, where communication, integration, and understanding constantly occur.

1. **Balance the composition**: iGEM requires an asset of different skills. Hence, even before branching into sub-divisions, create a list of assets that you would expect members to have and engage in recruitment. For example, if all members are wet lab-immersed, your team will face difficulties in executing dry lab, human practices, and deliverables (promotion video, presentation video, and Wiki) design. We have created an idealistic model of team composition that will most likely lead to iGEM success.

   - Wet Lab Execution (3 members)
   - Dry Lab Execution (2 members)
   - Collaboration (2 members)
   - Human Practices (2 members)
   - Public Engagement (2 members)
   - Deliverables (2 members)
   - Marketing & SNS (2 members)

   The idealistic composition model allows each member to focus on one area (instead of heedlessly getting interfered with different areas) throughout the iGEM journey, thus rendering deep, delicate results. You can flexibly adjust the composition model based on your team's medal/award objective or interest dynamics: however, note that successful iGEM teams (receiving Grand Prize or Special Awards) have mass-recruited experts of many areas (not even related to Synthetic Biology) to display their excellence in iGEM.

2. **Utilize bureaucracy:** Now, with the idealistic model of team composition, create divisions (or sub-teams) to boost the efficiency of workload. Most teams (with 15 members on average) create 3~4 teams, commonly Wet Lab, Dry Lab, Human Practices, and Deliverables - again, feel free to flexibly adjust this system in line with your team's iGEM mission. Under this bureaucratic paradigm, sub-teams are provided the authority to manage their own members, tasks, and deadlines - instead of a centralized administration exhaustively overseeing affairs of all iGEM agendas.

3. **Be deadline/task-oriented**: A centralized administration must provide each division with a clear deadline and task. That is, each iGEM step must be defined with a clear task/objective and deadline: this is the main task of whole team leaders and co-leaders. Again, the constitution of active communicational media and regular meetings allow whole team leaders and co-leaders to effectively and efficiently convey these details to leaders of sub-teams. Then, the sub-team must further divide its objectives into clear tasks and deadlines and assign them to its members.

You might ask, "Aren't you [ML] simply rewording all common sense knowledge in jargon?" Yes, I. Everyone with sufficient high school experience knows the importance of team composition and bureaucracy to group projects. However, once tasks start to overwhelm you, you often will turn off-track, unorganized: thus, it is imperative that you recall the concept of healthy team dynamics consciously and judiciously implement it amid an exhaustive iGEM journey, although it may take some time at the start to get everything organized and written down physically.

I [ML], as a high school iGEMer, spent months surveying and organizing concerns that high school students had when they were conditionally asked to join a high school iGEM team. Based on my experience as a team leader (and after interviewing multiple high school iGEMers and instructors), I provided responses (and further actions) you can take to address your concerns to maximize your iGEM experience, taking into account pragmatic considerations that high schoolers these days might have.

8.7. Scrutinizing iGEM Legacy

After the iGEM season is over, it's not the end for your team and the entire journey! First, celebrate the wonderful progress you have made together. Getting through an iGEM season is challenging work!

For teams that are based in their local high schools, make sure to pass valuable information and lessons learned to your new set of members. With experience and advice from past years, your local team will get stronger and benefit a lot. If you have time, you can also help train and mentor the new team as an advisor and get some valuable experience.

For teams that are not school-based, depending on the structure of your program, your team may disband after the conclusion of the iGEM season. Many iGEM teams have decided to take their project further by publishing their findings in a paper, so this is something you may want to consider after finishing the project.

9. THE TEAMS

THE IGEM NOUS TEAM

The iGEM NOUS team participated in the iGEM 2021 competition.

"NOUS" is an ancient Greek word (νοῦς) translated as "brain".

A general definition describes "NOUS" as a set of cognitive abilities, such as, consciousness, perception, thought and memory. These abilities are the result of the different brains of the team members, that are brought together from a variety of disciplines including molecular biology and genetics, physics, computer science, medicine, business, and graphic design.

On the other hand, "NOUS" in French, literally means "we". We seek to act as a unity through communication, which is our keystone. So, the word "NOUS" apart from characterizing the strength of each one of us separately, also describes the spirit of the team as a whole. We are all fascinated with science and this has led us to a continuous strive for knowledge. Thus, we are eager to go beyond the university curriculum to gain more experiences, improve and build our career. In doing so, our vision is to contribute to science and help the world become a better place for everyone.

iGEM NOUS logo

THE KOREA_HS TEAM

Team Korea_HS is comprised of 16 enthusiastic high school student-researchers of Synthetic Biology, gathered under a common aspiration to build a better world through original engineering and meaningful collaboration. This year, Team Korea_HS is "Designing a Cancer-Specific Cell-Penetrating Peptide for the Efficient Delivery of siRNA into Cancer Cells."

Korea_HS participated in the 2019 iGEM (Gold) and 2020 iGEM (Gold, iGEMer's Prize). With completely new leaders, members, and mentors equipped for the year 2021, we aim to galvanize Synthetic Biology and its humanitarian integration by adjusting the paradigm of 2019 and 2020 Korea_HS to further integrate the team with a fast-paced generation.

"HS" is an acronym for "High School." Team Korea_HS is comprised of 16+ students with a common ethnic identity but different educational contexts (representing 9+ high schools). Thus, we aim to build an interdisciplinary, dynamic project for 2021 iGEM by bringing fresh, dynamic perspectives from varying backgrounds.

KOREA_HS logo

TEAM MEMBERS - NOUS

Pavlos **CHATZOUDIS** is a graduate student in Animation & Interactive Media at Akto - Middlesex University in Thessaloniki. During his studies he has attended multiple seminars including a live stream animation workshop by Disney animator Aaron Blaise in 2020, as well as a webinar by CG Master Academy called "Pursuing a C□+78areer in Animation" in 2020. In occasions he has worked in caricature events held by AddArt in Thessaloniki. Pavlos has also participated in "Draw The Can, Yes You Can" competition by Fanta in 2018, and was one of the five winners. Also worth mentioning, is his participation in "I have a dream" competition by PIERCE-American College of Greece in 2015, in which he was distinguished for his work. Pavlos has had 3-year comic lessons in 2014 and 1-year life drawing lessons in 2017. He is a native Greek speaker and holds an EDI Certificate of Proficiency in English.

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Jordi **KONTIS** is a 4th year undergraduate student in the in the department of Molecular Biology & Genetics at the Democritus University of Thrace. Complementary to his academic achievements, he has gained research experience during this semester as he is an intern at Zagoraiou laboratory at the Biomedical Research Foundation Academy of Athens and during a summer Internship at ELPEN's Experimental Research & Training Center in 2019, through his active involvement in several research programs and seminars such as the Panhellenic Conference of the Hellenic Society for Biochemistry and Molecular Biology in 2019. Also, worth mentioning is his participation at the 54th Summer School of the "NCSR DEMOKRITOS", in 2019. At a personal level Jordi has a passion for neuroscience and sailing, whilst currently holding the position of sailing instructor at the Alexandroupolis Nautical Club. He is a native Greek and Spanish speaker and holds a Michigan Certificate of Proficiency in English.

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Daniel **KOTSI** is a 4th year undergraduate student on the department of Molecular Biology & Genetics at the Dimocritus University of Thrace. He has participated in several seminars with biological interest, or without such as the "13th International Particle Physics Masterclasses 2017". However, his true passion is Molecular Biology and for that he managed to gain some research experience during a summer internship at IMBB FORTH Institute of Molecular Biology and Biotechnology Foundation of Research and Technology – Hellas. In the future he aims to work on unravelling the mysteries of Stem cells differentiation. He is a native Greek speaker, he holds a Michigan Certificate of Proficiency in English, a B2 certificate of language in French and a B1 certificate of language in Russian.

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Evangelia **MALESKOU** is a 5th year undergraduate student in the Department of Computer Science and Biomedical Informatics at the university of Thessaly. During these years she has volunteered to many conferences and science events such as FOSSCOMM (2019) in Lamia and Athens Science Festival (2018). She has gained both wet lab and dry lab experience by taking part in webinars and assisting in Biology lab at the university as well as workshops (TedX Lamia 2019). She is a native Greek Speaker and holds a Michigan Certificate of Proficiency in English.

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Christos **MANTIS** is a 4th year undergraduate student in the department of Molecular Biology & Genetics at the Democritus University of Thrace, where he was admitted at the 5th place of the overall accepted students through Panhellinic examinations in 2018. He is a graduate student of the American College of Greece, PIERCE. He has attended the Action Trial Researcher and the Conference on Modern Physics at "NCRS DEMOKRITOS" aswell as the Harvard Model Congress Europe in 2017. He also scored in the top 24 in the Panhellinic Biology Competition in 2018. He has also participated at the 54th Summer School of "NCRS DEMOKRITOS", in addition to the 70th Conference of the Hellinic Society of Biochemistry and Molecular Biology in 2019.Christos, apart from biology, has a great interest in computer science and chemistry. He is a native Greek speaker and holds a Cambridge Certificate of Proficiency in English.

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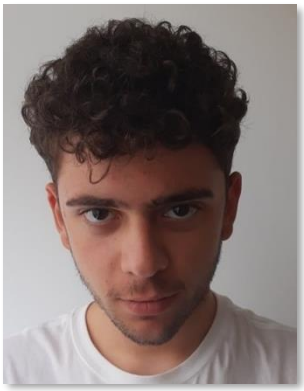

Nikolas **ROMANIDIS** is a 4th year student Department of Economics at the University of Macedonia. Greece. He is a native Greek speaker, while also holding a Certificate of Proficiency in English.

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Michalis **SARRIS** is a 3rd year student in the Medical School of the National and Kapodistrian University of Athens, Greece. He has successfully participated in National Mathematics, Physics, Programming, Astronomy and Biology Competitions and several scientific summer schools, such as summer programs on Biomedicine and Genetics organized by the Johns Hopkins Center for Talented Youth, Thessaloniki, Greece, 2016 and 2017 respectively, and summer schools on Mathematics and Physics. His passion of Physics is shown by the fact that he attended a course in NCSR Demokritos in addition to getting a degree on Astronomy by the University of Thessaly, Greece. He is an avid public speaker, having spoken in a variety of conferences, with his favorites being his speech for the Greek telecommunications company "Nokia" and his participation in the FameLab contest. In his free time he plays chess and writes poetry and short stories, some of which have been published. He is a native Greek speaker, while also holding the Cambridge Certificate of Proficiency in English and the DELF B2 Certificate in French.

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Giannis **THIMIANIDIS** is a 3rd year undergraduate student in the department of Molecular Biology & Genetics at the Democritus University of Thrace. He has attended several seminars and conferences such as the 11th Panhellenic Conference of Basic and Clinical Pharmacology, (Alexandroupolis, 2020) the Panhellenic Conference of the Hellenic Society for Biochemistry and Molecular Biology, (Athens, 2019), the Conference of the Panhellenic Association of Bioscientists. He has also participated in the 55th Summer School of the "NCSR DEMOKRITOS" (2020). Giannis has attended an entrepreneurship seminar from the American College of Thessaloniki (2019). He has participated in seminar from the European Parliament in Strasbourg, 2019 and in a simulation of the European Parliament in Thessaloniki, 2017. Giannis is actively involved with music and he has several certificates and an honorary praise in this field. He is currently interested in Genetics of Cancer. Giannis is a native Greek speaker and holds an MSU Certificate of Proficiency in English.

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Anastasia **TZIMA** is 4th year undergraduate student, majoring in Economics at Aristotle University of Thessaloniki (AUTH). She graduated from Anatolia College High school with distinctions and she participated twice in Johns' Hopkins Center for Talented Youth (CTY) summer programs in 2015 and 2016, taking the courses of Microeconomics and International Relations. Her work experience includes NATO, where she interned in Budget office and the logistics department. Anastasia has participated in multiple conferences regarding economics amongst them being the Delphi Economic forum 2019 and the Business Today International Conference 2020. She has also been trained by Epsilon Net on "IFRS and IPSAS" with a 100 hours seminar in 2019. She has been awarded with many times for her academic performance both in school and in university and she has won the second place in regional finals in P&G's CEO Challenge 2020. Her volunteering experience focuses on fundraising for NGOs and university clubs. In her free time, she likes playing tennis and swimming and also taking piano lessons.

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Alkmini **ZANIA** is a 5th year undergraduate student in the Department of Biology at National and Kapodistrian University of Athens, Greece. She has successfully participated in National Physics and Biology Science Competitions. In 2017 she contested in International Biology Olympiad and was awarded a bronze medal. In July 2020 she attended Neuromatch Academy, an online school for computational neuroscience. Alkmini enjoys programming and problem solving and is interested in bioinformatics. She is a volunteer Scout leader at her hometown. She is a native Greek speaker, holds a Cambridge Certificate of Proficiency in English and is currently learning Spanish.

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Melina **ZIKOU** is a 4th year student in the Computer Science Department of Aristotle University of Thessaloniki, Greece. She has successfully participated in National Mathematics, Physics and Programming Competitions and several scientific summer schools, such as a summer school in computer programming in the USA, 2017. She has presented a variety of student scientific conferences and seminars. In 2019 she became a member of Aristotle Space & Aeronautics Team, worked voluntarily as Lab Assistant in the Johns Hopkins Center summer program for Talented Youth, and was selected to participate in an internship on web developing in the Information Technology Center of Aristotle University of Thessaloniki. Melina has a great interest in artificial intelligence and data mining. She is a native Greek speaker and holds a Cambridge Certificate of Proficiency in English.

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Nefeli **ZIKOU** is a 3rd year student in the Physics Department of Aristotle University of Thessaloniki, Greece. She has attended multiple scientific summer schools, a program on Cryptology organized by the Johns Hopkins Center for Talented Youth, Thessaloniki, Greece, 2016 and a workshop on robotics, Institute of Technology, USA, 2017. She has successfully participated in National Mathematics, Physics and Computer Science Competitions, as well as the "Mission Space Lab" competition by European Space Agency, 2020. Nefeli has presented in several seminars, amongst them the Anatolia College Science and Technology Annual Conference, 2017. Nefeli is a member of the Amateur Astronomy Club of Thrace and has a passion for astrophysics and electronical manufacturing. She is a native Greek speaker and holds a Cambridge Certificate of Proficiency in English.

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TEAM MEMBERS - KOREA_HS

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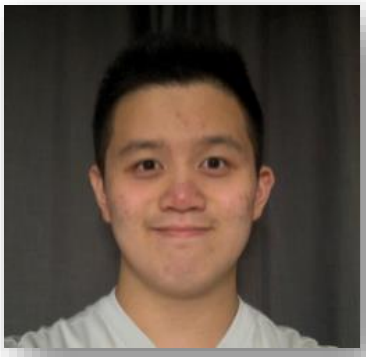

Matthew Lee

Matthew Lee – team leader of Korea_HS – is a sophomore at Daegu International School (Daegu, South Korea). Parallel to his academic accomplishments, he is actively involved in a Synthetic Biology research group developing non-invasive diagnostics of diabetes mellitus, regularly submitting his research and review to student journals. Along with Hannah Oh (co-author of this booklet), he founded the Korea International Synthetic Biology Society to galvanize research opportunities for high schoolers. In school, he fosters integrated, intellectual school dynamics through World Vision, National Honor Society, You Are Not Alone, Students Organizing Against Racism, Model UN, Jets Flyover, etc. Outside of school, involved in Rustic Pathways, Doctors Without Borders, and Korea Youth Work Agency, he brings his extensive community experience to envision humanistic Synthetic Biology. He is a proficient English and Korean speaker and a working Chinese speaker; at a personal level, he enjoys traveling and watching baseball games.

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Hannah Oh

Hannah Oh is a high school sophomore at Chadwick International, an international school in Songdo, South Korea. She has gained synthetic biology research experience working as team Korea_HS's co-leader and Human Practices member, participating in both wet and dry lab aspects of the team project. At school, along with other select Korea_HS members, she has established club KISBC, a multi-institutional network of clubs run by high-schoolers in Korea aiming to further awareness of synthetic biology. She has been a part of the school's Honor Council and Core Value Council since 2020, representing her class of 2024 at various levels throughout her high school career. She aims to pursue biomedical engineering in the future. At a personal level, Hannah has a keen interest in fine art and graphic design, hence why she has also partaken in the Korea_HS logo design process. She is a proficient English and Korean speaker and is currently learning Spanish.

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10.Contact

We put a lot of work in this guide, and we hope that is reflected in every chapter. It would mean a lot if you contacted us to inform us that you read it and maybe it helped you a bit! So, feel free to reach out, send us feedback, comments, questions, or anything else you want! Each and every one member would be delighted to hear about your progress or aid you in your iGEM course!

Happy iGEMing!

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 ASIJ_Tokyo x KoreaHS iGEM

11. Appendix

Riddle and problem solutions

In the Sombrero galaxy there are N planets that host intelligent life. Each planet has an astronomer on it who observes the planet closest to it. All distances between planets are different. Prove that if N is an odd number, then there is a planet that is not observed by any astronomer.

Since all the distances between the planets are different, there is a minimum distance, AB. So, the astronomers of planets A and B observe each other. Excluding these two planets, we are left with N-2 planets and N-2 astronomers. If one of these N-2 astronomers observes either the A or B planets, then there are not enough astronomers to observe the other N-2 planets, so there is a planet that no one is observing.

If one does not observe A and B, then in a similar way there will be a next minimum distance of DG planets with astronomers observing each other, and so on. So, excluding successive pairs of planets, if N is odd then there is necessarily a planet that no one observes.

Three friends, Mr. Red, Mr. Blue and Mr. Green, are chatting. One is wearing a red suit, the other a blue suit and the third a green suit. The one who wears the blue suit takes the floor and says: "Did you notice something? None of is wearing a suit with the same colour with our names". "Indeed, you are right," adds Mr. Red. What colour suit is everyone wearing?

After Mr. Red answered to the one in the blue suit, it means that he is not wearing blue. And since Mr. Red can't wear a red suit, it means that he is wearing green. Mr. Blue can neither wear the blue nor the green suit, so he wears the red. Finally, for Mr. Green, is wearing the blue suit.

A robot from Japan answers "yes" with green light and "no" with red light. A robot from China answers "yes" with red light and "no" with green light. What question should you ask to get the two robots to answer with a red light?

The green means NO? / Are you from China?

(There are more correct answers.)

I have a bouquet of flowers. All flowers are roses except for two, all the flowers are carnations except for two and all the flowers are daisies except for two. How many flowers of each species does the bouquet have?

A rose, a carnation and a daisy.

A skier wakes up at dawn and gets ready to go skiing. In a drawer he has 4 black and 8 blue woollen gloves. Unfortunately, the room is too dark to distinguish their colours. How many gloves does he have to take with him at least to make sure he has two of the same colour, without turning on the light and waking up his wife?

He has to take at least 3 gloves.

We have three closed baskets and an inscription hanging on each one. The first writes "ORANGES", the second writes "APPLES" and the third writes "ORANGES AND APPLES". We know that all three inscriptions are placed incorrectly. How can we take the fruit out of a single basket and put the signs in the right place without looking inside or searching?

We take a fruit from the basket with the inscription "ORANGES AND APPLES". If it is an orange, then this basket has the oranges inside. Because the basket with the inscription "APPLES" can't contain apples, it has oranges and apples. The basket with the inscription "ORANGES", has the apples inside. We do the same if the fruit we take out is an apple.

You have 6 identical matches. How can you make 4 equilateral triangles without breaking the matches?

A pyramid.

How can you measure exactly 4 liters with jugs of 3 liters and 5 liters?

You fill the 5, you empty it at 3, there are 2 liters left at 5. You put them in the 3. You fill the 5 and empty it to 3. Since it had only 2 liters it will take another 1, so the 5 are left with 4 liters.