

Ethical Guidelines for our project

We compiled questions that every iGEM team should answer before starting their work to make sure they are doing their best possible work. Here we split these questions into two parts for simplicity sake. Part one are general questions. These work topics like lab safety, team cooperation etc. This part would be answered for every project in the same way as we work in the same lab. You might notice that these question overlap a little with the safety forms. The second part of the questions is project specific and deals with different social implications of said project. Here we excluded question of personal opinion (such as an opinion about patenting organisms etc.). We included also assessment for three other project ideas that we talked about in our team. In the end after discussion ethical issues of each project the team democratically decided to continue with the Crating Crocin option.

Part 1

a) Safety in the lab

Does your iGEM team know the rules of the lab?

Our team has access to a document stating rules of the lab, cleaning rules and equipment rules. Each member of the team has read these rules and signed a document stating that they did so and understood these rules.

Does your iGEM team know how to behave in the lab?

Our team had a safety briefing with the lab technician to make sure we all know how to work safely.

Does your iGEM team know how to dress in the lab?

We made sure each member of the team has their own lab coat and knows when and where to wear it. We also have access to disposable gloves, safety goggles and other safety equipment and each member of the team was taught when and how to use these.

b) Emergency in the lab

How should your iGEM team act in case of an emergency?

Our team had a meeting to learn how to behave in case of a fire. We also talked about different kinds of medical emergencies and how to handle these. We have injury forms ready in case something happens and we know how to report those. In case of lab breach emergency, we had a thorough seminar on how to handle those and where to report any kind of leakage. We also established that one of the project leaders, whom had gotten more training, needed to always be present in the lab when lab work was done.

Do you have all the equipment available to handle any emergency? Do you know how the equipment works?

We have access to fire extinguisher, fire blankets, eye showers, medical kit,

emergency shower, eye wash, defibrillator and other equipment in case of emergency. Members of the team were educated on how to use these.

c) Work ethics:

Does your iGEM team have any rules or guidelines for respecting? If not, what do you think would be good guidelines to introduce?

In the modern world we want to be inclusive and respect each other and not exclude people based on their gender, skin colour, religion or sexual orientation. Our team takes pride in that over half of our members are female. Our members this year come from 8 different countries from inside and outside of Europe. This creates an amazing hub for ideas. However, we also need to think about how to make the creative space safe and welcoming for everyone. Therefore, our team had a talk about how we should treat each other in the team. Upon the talk we created a suggestion box for rule suggestions. From this we compiled a list of rules that we agreed on and everyone signed them.

Are you aware of the rules that govern patent applications in your country?

Yes. After meeting with the IPR lawyers at our university we are confident that we know the basic rules of patenting in Sweden. We also know who to turn to in case we need to pursue this in more detail.

Part 2

Choosing between four project ideas. Which of them would bring the minimal amount of risk when working with recombinant microorganisms.

Idea 1 - Affibodies

Today a lot of our residual contraceptives and hormones are reintroduced into drinking water and there are concerns that this might be causing problems world-wide. The idea for the project was to use affibodies to bind hormones and clear water with them. Two main hormones that are used in contraceptive pills are estrogen and progesterone. Both of these are steroid hormones.

Questions

a) Conceptual ethics and genetic engineering:

Can we anticipate how our product would behave if released? What would have to be growing conditions and could they potentially be met? Can we anticipate any interactions with any form of wildlife?

In this case we want a bacteria producing affibodies to be released in the wild in the first place. We could introduce some sort of resistance but bacteria mutate quite fast. We would try to make the binding specific. However, there is a potential that our affibodies would bind the same hormones in other organisms as well which potentially could meddle in their hormone balance. It could do the same to humans if they would be released in drinkable water to clean it.

Can we think some steps ahead and imagine a potentially harmful usage with our open-source project?

Probably not. But maybe this system could be used to manipulate hormonal levels in different organisms which could be considered unethical.

What potential economic influence does our GEM have in its late stages of development and implementation? Do the economic and social benefits change if the GEM is applied in different continents or countries? Are there potential sources of global injustice coming from our GEM?

The contraceptives released to water is a widely talked about problem. However, there is not much of a progress in trying to clean waters from the residual hormones. Potentially the water cleaning facilities and government would be the end-users of this product. But the social benefits could be of a larger scale with people being more interested in the environment. We believe that there would be more use of the product in the western world as it is the part of the world that uses contraceptives the most. On the other hand, we do not see larger social injustice coming from this as it would solve a problem only existing in the western world.

b) Social responsibility

How can we responsibly and accurately report our project in media and inform public about the science we are doing?

In this case we would need to inform the general public about the issue at hand and how our solution can solve it. This issue is not very well known to people so we would have to inform first and then offer our solution. We would need to establish trust and be honest about possible risks of the product but convince people that the benefit has a greater value. This might a bit difficult as people do not really feel every day consequences of hormones in water.

Who do we want to report to? Is it other iGEM teams, journalists or general public? What is our niche?

For affibodies we would need to report to general public to create trust and engagement. We would also need to talk to officials, politicians and business people to try to sell our product to a water cleaning company.

What kind of media and language should we use while talking about our project to reach our niche of the public?

To create buzz in the general sphere using articles in less science oriented media seems like a good choice. We could also try to engage people on Facebook. To try to catch eye of more business oriented people publishing articles via LinkedIn seems like the obvious choice. As far as the language goes we should choose probably more formal language trying to ensure people know we are serious about this and we are here to help.

Is patenting something your team has considered? Do you think that seeking patents is appropriate within the context of the iGEM competition?

It seems that patenting here would be the obvious choice. This kind of system would need a lot of development and testing. We would need to provide insurance for our investors which would be really hard without a patent. This is obviously more difficult in iGEM that is mostly open source. We would need to leave some parts outside of the competition and work with them for the patent.

Idea 2 – Cannabinoids

Cannabinoids are traditionally used for anti-palliative effects in diseases such as multiple sclerosis and some cannabinoids have shown promise treating epilepsy seizures. Others may have antipsychotic effects and when usual treatments are ineffective, cannabinoids have also been recommended for anorexia, arthritis, migraine, glaucoma, etc. Most potential uses, however, are not enough researched. Two problems with using cannabinoids are that production requires plant farming and that some cannabinoids are psychoactive, such as THC (Tetrahydrocannabinol). Synthetic production of cannabinoids in suitable micro-organisms might alleviate these problems since one can choose to only produce selected species of cannabinoids.

Questions

a) Conceptual ethics and genetic engineering

Can we anticipate how our product would behave if released? What would have to be growing conditions and could they potentially be met? Can we anticipate any interactions with any form of wildlife?

If released to the environment the oil producing bacteria would hardly find suitable environment to live in as it would need specific environment to produce the cannabinoids. In case it would produce them it might have an effect on the organisms in the environment as suggested in the idea description.

Can we think some steps ahead and imagine a potentially harmful usage with our open-source project?

Even if we only produce certain type of cannabinoid we are introducing the same pathway that lead to THC. It would be easier for someone to produce THC in bacteria using our product and that is still illegal in many countries.

What potential economic influence does our project have in its late stages of development and implementation? Do the economic and social benefits change if the project is applied in different continents or countries? Are there potential sources of global injustice coming from our project?

Potentially there would be a number of medical uses for the product. It would need development in the medical community and a lot of research to start usage but it could have great effects on numerous diseases. Most of these are quite similar in all countries so people could benefit worldwide. However, the potential of misuse in the drug trafficking would have a negative social impact on either some social group or on some developing countries.

b) Social responsibility

How can we responsibly and accurately report our project in media and inform public about the science we are doing?

We would need to talk about the stigma surrounding everything that comes from the cannabis plant. Maybe a friendly campaign focused on younger people that are usually more friendly toward cannabis would be successful. Also publishing articles about our product and its effects on the human body.

Who do we want to report to? Is it other iGEM teams, journalists or general public? What is our niche?

We would need to target general public to convince them about the good this could bring. Next we would also need to convince medical experts to actually use and develop the product. This might be easiest done by actually publishing the findings in a peer review article.

What kind of media and language should we use while talking about our project to reach our niche of the public?

We would need to be honest in what we are doing but in the same time reduce the fear factor of cannabis. Therefore, social media campaign targeted on younger audience seems obvious. However, we would need to be really careful not to get into the lazy stoner niche. Keep it playful and informative but not in a mocking way.

Is patenting something your team has considered? Do you think that seeking patents is appropriate within the context of the iGEM competition?

In this case we believe patenting would do more harm than good. We would try to interest medical researchers to take on the project and develop it further and patenting could limit our options.

Idea 3 - Parasite sensing

The main goal with our project idea is to use a parasite to sense and secrete effectors. One option could be the sensing of glucose and the secretion of insulin. This could maybe be done by the parasite schistosoma. Schistosoma spp. is a dioecious (separate sexes), with distinct male and female phenotype, flatworm that infects its host by penetrating the intact skin. After this they enter the circulation and end up in the venules of the bowel/rectum/urinary tract. There they produce eggs which cause the symptoms of Schistosomiasis. The advantages of using this parasite is that it can stay in the blood system and evade the immune system.

Questions

a) Conceptual ethics and genetic engineering

Can we anticipate how our product would behave if released? What would have to be growing conditions and could they potentially be met? Can we anticipate any interactions with any form of wildlife?

The parasite would be impaired in its reproduction and would reside mostly in blood vessels. By this its spread would be very unlikely. In case of a release from the bloodstream, there are no reported cases of adult Schistosoma that infected humans. Normally the Cercaria are infectious.

The release of Cercaria which would be used for treatment could cause problems depending on which drug they would secrete. In our idea, which we based on the secretion of Insulin, no harmful effect would be likely since we intended to couple the expression/secretion to the concentration of Insulin or glucose. Allergies and autoimmune diseases of the host could also cause potential problems.

Can we think some steps ahead and imagine a potentially harmful usage with our open-source project?

Since we thought of our modified parasite as a general platform for long term drug administration it could be misused by letting the parasite produce morphine or other addictive/harmful compounds.

What potential economic influence does our project have in its late stages of development and implementation? Do the economic and social benefits change if the project is applied in different continents or countries? Are there potential sources of global injustice coming from our project?

Our project could have reduced the treatment costs for long term illnesses by a large amount. It would be one parasitic infection approximately per 5-10 years. This one injection could, depending on how the parasitic expression platform is produced be relatively pricey. Further there would be overtime a potential cost reduction for long term insulin patients.

The patient's life quality would improve drastically. They would not need to inject themselves once or several times per day with insulin. Further each injection of conventional insulin leads to a high initial dose which slowly

reduces till the next injection. This does not mimic the normal course of insulin production and may lead to follow up problems for the patient.

b) Social responsibility

How can we responsibly and accurately report our project in media and inform public about the science we are doing?

Main concern here is that parasites are generally regarded as unsafe. We would need to make clear how we are working with them to make it safe for human use and educate people about potential benefits. However, we should not simplify the danger that comes from different parasites.

Who do we want to report to? Is it other iGEM teams, journalists or general public? What is our niche?

Again we would have to tackle multiple groups. In this case probably even the scientific community to let us make progress in this. We would also need to communicate to public about safety of our research.

What kind of media and language should we use while talking about our project to reach our niche of the public?

It might be a good idea to talk to journalists or start a blog to inform about what we are doing. This could ensure a more serious and still informative impression. A couple of articles in more serious journals or science blogs could help to reach the science community. We could also consider informative YouTube videos for more general public.

Is patenting something your team has considered? Do you think that seeking patents is appropriate within the context of the iGEM competition?

We are not sure if patenting would be possible in this case.

Idea 4 -Crafting Crocin

We are planning to make Alpha crocin in *E.coli*. Alpha-crocin, an apocarotenoid found in *Crocus* and *Gardenia*, is responsible for the red color of Saffron. Recent studies suggest that crocin may have several medicinal properties. Due to its colour, it could also be potentially used as a dye. It being a powerful antioxidant with interesting and not yet fully studied medicinal capabilities, large scale mass production of crocin would be of interest to further study its effects on the human body. Our team from 2013 already did the groundwork for us by developing zeaxanthin accumulating strain of *E.coli*. This year's project is building up on that. We identified three enzymatic steps leading from zeaxanthin to crocin.

a) Conceptual ethics and genetic engineering

Can we anticipate how our product would behave if released? What would have to be growing conditions and could they potentially be met? Can we anticipate any interactions with any form of wildlife?

The main idea is to use the crocin producing bacteria for laboratory purposes and to use the bacterium only for production not for the use itself. If the bacterium would get to environment the production is still under inducible promoter so the expression is regulated and secured with antibiotic resistance. Also crocin as a compound is not toxic.

Can we think some steps ahead and imagine a potentially harmful usage with our open-source project?

The only thinkable miss-use of crocin pathway would be continuation of it and ultimately creating saffron as a whole. This could potentially influence the market for saffron which brings livelihood to people in Iran and surrounding countries.

What potential economic influence does our project have in its late stages of development and implementation? Do the economic and social benefits change if the project is applied in different continents or countries? Are there potential sources of global injustice coming from our project?

We see potential of saffron as either supplement or a medicine in which case it would have economical potential. However, our primary focus is giving a cheaper way to get crocin for researchers so we can fully understand potential of crocin. Since crocin is now only produced from a plant *crocus sativum* which only grows in a small part of the world there is a potential negative economic impact for the local business there.

b) Social responsibility

How can we responsibly and accurately report our project in media and inform public about the science we are doing?

As producing crocin does not feel risky we can probably get away with a little more playful narrative. Since there is a lot of possible applications we most likely would have to focus on one or only several to not disperse the interest too broadly.

Who do we want to report to? Is it other iGEM teams, journalists or general public? What is our niche?

We would like to interest the general public as the applications are quite compelling and we could use the exposure. We would also need to attract sponsors to make more research and application possible.

What kind of media and language should we use while talking about our project to reach our niche of the public?

Making warm and informative YouTube videos or informing about our project via a blog and Facebook seems like the easiest narrative. We would probably use different events available in Uppsala and LinkedIn to get attention from potential sponsors.

Is patenting something your team has considered? Do you think that seeking patents is appropriate within the context of the iGEM competition?

Yes, it might be a good idea to patent our way of making crocin so we can attract sponsors.