

**I. The politician – Mr. Shum.**

*Q: What is your perspective of technology in general?*

A: I think technology is really a great thing. It really improves people's lives. In terms of medical technology, it elongates people's lives. You can see, a lot of electronic operators, like AC, make lives easier. It makes life really easier and convenient.

*Q: We know that Hong Kong has imported a lot of food from mainland China and overseas. Although Hong Kong itself has organic farming, the production is too low to meet the demand of the market. However, most of the imported food may be genetically engineered or modified. How do you think about Genetically Modified (GM) food?*

A: I stand for the residents. I think Hong Kong people generally accept GM food, as long as they are healthy, and not toxic. This is OK, because it is genetically engineering. I think it does not involve some moral issues, like hurting animal, no. I think if it is healthy, GM food is OK.

*Q: Most of people regard GM food as cheap. And GM food has passed various regulations and tests in scientific field. However, some people may think that genetic engineering is like human acting as God. Other people may also think that GM food may seem to be OK at this moment, but human knowledge is not comprehensive. GM food may become a new allergen, they claim. Like penicillin, we only find out recently that the bacteria grow resistant to it. If somebody challenges you by stating that you do not oppose GM food, what will you do?*

A: Actually, we are human beings and we need to improve our quality of life and life expectancy via various means. As long as there are reliable scientists, research papers and ready GM food proven by science, all the doubts related to GM food is not enough to reject the idea (of GM food). We have to address the issues of human beings. For example, like many African countries, some people are still under starvation. Every human trial is making human society move forward, but there is always risk. If we do not move, we stay. What is our choice? I think people would like move forward, cautiously.

*Q: Then we move to synthetic biology. Synthetic biology is actually putting a particular function of an organism to another organism we want, so that we can create an organism with various functions we want. In our project, we try to create a kind of bacteria that can specifically bind to colon cancer cells and after induction, it can kill it. After it releases too much drug, the bacteria will die, ensuring safety. It is like a well-trained soldier who can target at the bad guys and kill them upon receiving commends. After killing too much, he will commit suicide. If this drug passed all the animal tests, and now it is in the stage of human trial. Since it is a totally new technology and we are using an organism, how do you think about this kind of trial?*

A: A coin has two sides. The patient must consent. You must review all the potential risks. You know at this point to disclose the research to the patient. If the patient agrees with this and he is willing to do that, it is OK. You need to review all the potential moral issues. And you really need to ask for the feelings of the patient. I will not say I support this or not, but legitimate process must be undertaken.

*Q: Since the method is new, if one particular person consents to this and the result is not positive,*

*he/she then complains to you. He/She asks for your help. What will you say to this patient and scientists?*

A: I must identify clearly what is my role in this case. If this is the case, I will act as a role to seek some legitimate criteria. If I discover all the things are done correctly by scientists, it is OK. But I will at least listen to his/her complaints. If there is something hidden by the scientists, I will go through all the legal processes.

*Q: Now, allow me to introduce another scenario. Before the human trial, there are animal tests. Suppose there are a group of animal lovers, who love animals to the extent that they do not want animals to get any pain. However, in scientific world, there exists a standard of animal test ethic, but it may not be the same criteria with the animal lovers' one. If there are a group of animal lovers complain to you about this, how are you going to say?*

A: I think it is a really difficult situation, when some people have strong views on something, but there is something going on which is legally appropriate. I will not reject the complaints' ideas, because they are seeking a person to listen. I have the responsibility to respect their views. I will talk about how to propose their views to the government, because he/she seeks some method to do this. If the society as a whole takes the same view, then I think they will succeed. If they are just minority, I think they will not succeed.

## **II. The Journalist.**

Note: a voice recording was not made due to the interviewee's preference for an informal gathering in a coffee shop. Her responses to our questions and her suggestions were translated from Cantonese and recorded in note form below.

1. What have you heard about synthetic biology?

- Bacterial batteries.
- Defeating diabetes.

2. How do the media present science these days?

- There's not much chance for presentation in popular media.
- The media explain a little bit about science, but it will never be mainstream news.
- It is quite hard in HK to promote the latest technology because people don't have the background interest and knowledge to receive it.
- Few platforms exist that actually publish such information.

3. Should the public know about the latest technology?

- Personal opinion is yes. New technology is required for better and better treatment.
- The young seldom have interest in following the latest developments if they are not major-related.
- Any false or misleading ads cannot stand for long. Present information by fact.
- Understanding is important.

4. Suggestions to us for presenting synthetic biology to society.

- Clear and concise methods like animation will help to raise public interest.

- Reinterpretation of it into a simple and attractive form allows you to involve more people.
- Should the technology be applicable to more people it can garner more interest.

5. What are the prospects of synthetic biology technologies in HK?

- The public should be able to gradually accept it, since HK is developed.

### III. The University Student.

*Key*

S --> Sean Carim (HKUST iGEMer)

U --> Mr. Au (University Student)

S: So the first question I want to ask you is a pretty general question regarding science. So do you believe it is important for society to keep up with the latest knowledge in science and technology?

U: Yes I believe so. Because science is - let me think - is related to our daily lives. And I think it is important for us to know basically how things work. For biology, I think it is good for us to know briefly what we are made of, and how we can have a healthier life because we know more about ourselves.

S: Sure, and science relates to what the world is made of, and why the world behaves like it does.

U: So I think it is important to know, at least, some of the principles of science.

S: And what about in terms of the latest technology?

U: You mean in science, the technology in science?

S: Yes the technology that arises from the latest scientific research.

U: I think it is also important. Just like with other technologies, IT technology for instance. It is important to keep up with the latest technology. In physics we know that some of the theories in the past were not wrong but somehow did not cover the whole picture. And now scientists know more about the truth and they can more thoroughly understand the whole thing. And I think it is important to know more because the new principles are becoming more and more accurate. So I think it is good to know about the latest technology.

S: Then I'd like to take that question on further. If you take for example a place like Hong Kong. Hong Kong is a place where science and technology matters are not considered very prominent. One of the key reasons is that there is a lack of a strong science and technology industry here and people here don't consider that knowledge to be that

prominent. Do you think that Hong Kong's knowledge is good enough?

U: Actually it's quite good. Because for secondary school students, at the age of 10 or 12, they need to get those knowledge, no matter what subject they take. They need to have some basic knowledge. So I actually think it's quite good. In Hong Kong when we take science subjects in secondary school it is already quite rigorous I think. It is already quite sophisticated, but not to compare with those in university. I think it is quite advanced already. From this point of view, I actually think it's quite good.

S: Now, let's step away from Hong Kong. What do you think about the knowledge of people in your age group, and particularly regarding knowledge of the latest technology?

U: For my friends, they treat science as a hobby, and if they are really interested in it they will look for respective resources on the web and they will read by themselves. But they won't take it that seriously, because they think that, especially in Hong Kong, if they study science they don't really have good job prospectives, if they are working in Hong Kong. For most of my friends, they are interested in science, and they will find some science materials interesting, but they will only read them when they have leisure time. So I think most of them don't really have knowledge of the latest technology. Sometimes they just think they are too busy and they can't be bothered by those boring readings.

S: Sure, that makes sense. But from a consumer perspective, what do you think of Hong Kong as a consumption zone for the latest technology?

U: I think in Hong Kong...

S: We're stepping away from just knowledge and moving towards just consumption of technology.

U: Okay. I think in Hong Kong is quite a frequent user of these technologies. No matter with physics or chemistry, in Hong Kong we enjoy a higher living standard than other places in the world. We will put new technologies into practice to improve our living standards further, if we have a chance. We try to generate electricity, and Hong Kong has been one of the most advanced to move towards burning gas rather than coal. Governments and corporations have been actively incorporating those technologies into their production. It's just sometimes the consumers don't know they are inside the whole thing.

S: Great. Thank you for that. Now I'd like to ask you about the term genetic engineering. Have you heard this time before?

U: Yeah I heard it in high school in biology.

S: And so, when you hear the term genetic engineering, what do you associate it with

immediately?

U: It's quite frightening for me. I think it is amazing but it's frightening. Because if we have genetic engineering theoretically we can change every living thing in the world, in the way we want to.

S: That is theoretically correct, yes.

U: I think it is really amazing for a technology to be that advanced, you can control many things that you want to. But I found it quite frightening, because personally I think it is not good to intervene with the whole ecosystem just because you want it to be that way.

S: In fact what technology has allowed humans to do since we started investing in technology from prehistoric times, is that technology has allowed mankind to gain more and more control over their surroundings. That makes sense to you? What makes gaining more control over a living organism and living systems more frightening?

U: I think that is because we are in direct contact with that every day. I think there will be some side effects in some way, because we tried to manipulate things that we originally could not. For example, talking about genetic engineering, the GM foods, personally I would not purchase those kinds of foods if I can spot them, because I believe it is somehow not good for me. The living things were there, they had a role in the ecosystem, and it is not good for us to change their role, or change the way they live.

S: I see. Alright. It is the opinion of many technologists that our future will see us manipulating genes more often to generate living organisms with desirable properties. So GM foods for example are just the start. What do you think about the validity of this prediction? Do you think society will accept further manipulation of genes? And do you think people will allow this to continue?

U: I think eventually the whole trend will go that way. Maybe some people will be against the plans, but I think for example, this year it has been the worst harvesting year for many years, and the price of the crops is rising dramatically and while people want to enjoy better living standards they will exploit the environment more, and it will be worse for the natural resources to grow, no matter if a tree or other living things like animals. So if humans want to change the environment now, they only have two ways, one is to change their own living habits and their routine, but I don't think people will be willing to do so... some people somehow will be willing to do so because they know we are disturbing the whole ecosystem, because we are trying to get more and more resources, but I don't think many people will be willing to do so. Maybe the only cost for them to enjoy a higher living standard is paying more. If they want to enjoy air-conditioning, the cost of electricity may be higher in the future because of new technologies or methods to allow them to generate a larger amount of electricity for the larger consumption, but what an ordinary consumer needs to do is just pay more to sustain a higher living standard. Though I think people will

most probably go the second way, to try and change the environment more and they will try to use scientific ways to manipulate the whole world to make it more favourable for us to live in. I think GM will be predominating in the future. People will try to get more food by making GM. I think it is a trend and cannot be reversed.

S: Thank you for that, that was very insightful. Specifically about generating organisms for desirable properties. What do you think about that trend in technology?

U: I think it would be more and more widely used in the future. The crops that I mentioned just now, I think they will try to make crops more pest-resistant, more drought-resistant. Then it seems like the only way for us to increase food production in the future. Most of the natural resources we are relying on are getting less and less. I think the government will urge the scientists to try to find ways to increase food production with the same amount of resources or even less. So GM foods maybe, now we have tomatoes...

S: We have tomatoes that can survive - at least temporarily - icy conditions.

U: Yeah yeah so it will go that way.

S: Let's step away from predictions about the trend and go to your personal concerns, or the concerns of the society you represent about generating organisms with desirable properties. Do you have any specific concerns about that?

U: Yeah I think so. For me I'm actually quite concerned because although the scientists now they can make some GM foods, if they really want to generate a large variety of organisms that are genetically modified, I think the technology is not advanced enough in order to make sure that every production line will be 100% safe.

S: Reliability is also a potential concern.

U: Yeah so I think maybe in a 100 or 1000 species only 1 mistake can disrupt the whole ecosystem and then it will be disastrous. Also, the reason for me to choose not to take GM foods now is that I think it poses a potential threat on humans' health. At least for me I still don't know whether there will be side effects of taking in those organisms. Its genes have changed, and everything inside the organism has somehow changed. So I'm consuming the same thing but it's already a different thing, there are concerns with the usage of genetically engineered foods.

S: Thank you for that. I'm going to take us now into a new concept that is guiding the progression of genetic engineering. It is a concept in the life sciences and also bioengineering. We call it synthetic biology. Synthetic as in man-mind. And biology, living organisms. Man-made living organisms. Now I just want to explain a little bit about GM foods. Genetic engineering in the past was a kind of trial and error method. You introduced mutagens to the living organism to cause it to change. But you have no control

over how it will change, you just select from the changed individuals the ones with the desired properties you intend. There is no design aspect, there is only trial and error. But with synthetic biology we're introducing the design aspect. The idea behind synthetic biology is that we will be able to design organisms specifically to perform certain tasks. Now, how this has come about is because during the past few decades a lot of research has gone into connecting the gene with its function. Scientists believe they know the functions of many specific genes. They intend to move those genes around to confer the functions associated with them to organisms of their own design. That is the concept behind synthetic - man-made - biology. Obviously the pinnacle of such a kind of technology would be to design - fully - a brand-new living organism, from scratch. Nature didn't have it. It wasn't in nature, it was totally designed by a man, or a group of men, or women. So clearly this is controversial in many different ways. And I'm sure you can easily think of many ways it is controversial: ethical, moral. From what I have just told you do you have any immediate thoughts or comments about this topic synthetic biology?

U: I think it is putting technology into a more extreme position. For me it would be more dangerous to do so, because the potential hazard is more hazardous if it really happens.

S: One concern that people have is that things that people have engineered in the past they have been able to engineer because they understand all the parameters. And I'm going to give you an example. For example, in mechanical engineering we build bridges, we build tables and chairs, because we believe we understand the laws of physics. We believe we understand them well enough that we can predict accurately how an engineered system will behave. We can predict, for example, how much wind a bridge can withstand before it falls over. However a concern we have about biological engineered systems is that we don't know all the parameters. Because a living system is something that has developed over the course of - depending on your beliefs, some people believe in evolution, some people believe that all life was created by a higher power - that a living system operates by a set of parameters that are too complicated to fully understand, at least now. So do you follow that kind of concern?

U: Yes. For example engineering, a chair or a table, we know it won't fall when we sit on the chair. The principles of physics are not easier than the biological principles, but I think when we put them into practice they go in different ways, so that it can be somehow safer for us to apply those physics principles rather than those biological principles. For example, we know that metal is stronger than some other materials, so we use metal rather than those other materials when we are building certain buildings. But we can do it by trial and error, and we can do it in laboratories by using various materials and then we can test it many times so we can make sure that it will be 99.9% safe when we are using that material. But with GM things or synthetic things I think doing the experiment is already posing a threat. The experiment is much more complicated, because you need to create a whole new organism. When something goes wrong, it will go wrong. It will be quite undesirable. Everything needs to be done by trial and error when we are creating new things.

S: Are you saying you believe that when something goes wrong, with a biological engineered item, the risk is greater than if something went wrong with a mechanical engineered item?

U: Right.

S: That is actually a sentiment that many people hold. We're going to continue to move more about the potential of synthetic biology items. What the technology amounts to is the ability to modify living systems, because living systems are powerful, and the reason why they're powerful is because they can perform a variety of tasks that cannot be performed using other means. For example, manipulation of energy. Living systems are very efficient at manipulating energy. They transfer energy from one form to the other at very high efficiency that we ourselves cannot reproduce using chemical means and mechanical means. And also they have a wide range of capabilities for example pretty much all higher plants their leaves have the ability to sense the position of the sun in the sky. So the leaves can orientate themselves to receive the greatest amount of sunlight throughout the day as the sun travels from east to west. These capabilities can now be captured and controlled to revolutionize a lot of different fields including but not limited to energy - so we might revolutionize how we gain energy and how we produce energy for the rest of our industries to operate - medicine, and environmental management. But there are vast technical risks, one of which you have already raised, which is the potential to cause imbalance in the ecology because we are introducing something that never existed before. And we're also introducing it suddenly. Also there is the possibility new disease causing agents could be generated, because disease-causing agents are biological. When we create something new, if we do not know its full abilities, who knows what we could actually make - some people have this concern. Based on this knowledge, how do you as a future potential consumer of such technology, rate the viability of this technology? Understanding its potential benefits and also these potential risks, how viable do you think this technology will become?

U: I think it will be quite viable. Because...

S: You mentioned before that people will continue to find ways to improve their lives.

U: Yes, that's right. So I think people are trying to do more things with less resources. This is why they are trying to introduce new technology that gives them greater control over what's around them. It is true that there are many benefits of these technologies, because we can personalize a totally new organism to do a specific task for us. But I don't think it's a good idea to do so because one thing that people now forget about is that they are inside the ecosystem. They are having a position in the food chain. People now think that they are separated, the whole human being they are separated from the ecosystem. And whatever they do to the ecosystem, if they use the technology to make the environment change in the way they want they will only gain the benefits, but forgetting about the

potential risks of changing the ecosystem, because we are inside the ecosystem. So I think using the technologies, human beings may be harmed by the imbalance in the ecosystem. Some technologies are already used because of the fact that the ecosystem is now quite imbalanced. We are now trying to use more and more extreme methods to make the bomb not explode yet. But if we try to introduce more and more extreme technologies and maybe perhaps we can finally have control over the whole thing, maybe, I think at that time the bomb will explode. And finally we will be harming ourselves. So I think even if practically it is possible for us to create anything we want, I think it is still better to do so by engineering rather than using biological means. Because it is more controllable if something goes wrong.

S: Your points make a lot of sense. Now as this technology is further propagated, so will the skills to interact with this technology. So you actually gave an example yourself. You actually drew a comparison between IT and biological engineering. In IT, as information technology has spread, so has the ability for more people to interact directly with this technology. So more people have personal computers because personal computing becomes cheap. So people can write their own code, and write their own programs, and this skill is propagating to more and more people as well. Technologists predict this will be the same for biological engineering and this kind of industry, in that the future will see more and more people gaining the skills and equipment necessary to manipulate DNA. So what do you think about that?

U: Hmmm.

S: More people having the ability and the capability to modify DNA.

U: I think IT and biological technology are too different, are totally different things. For example, for IT if we spread the technology to more people, then more people can contribute to the technology that we can make the technology better by mass participation. But for biological means, like biological technologies, if someone who is not advanced enough, or do not have enough knowledge to master that technology and the technology gets into their hands, they may not be able to control the thing. It will be quite dangerous if it really happens. And for example we all know that the different countries in the world have been trying really hard to use IT technology either to protect themselves from hackers or to maybe they try to hack somebody else for the sake of themselves. We all know this is happening, but it is still quite safe in our world, because it is still controllable. Because the computer codes, we have really some experts who can read those codes, one-zero-one-zero-one-zero on the computer. And they can do anything they can, or they can just vanish the computer to kill the whole thing. But for {biological technologies} it is totally different. If a country is trying some kind of experiments that they may want to conquer the world or gain more power and then they misuse this technology, it's not easy to solve at all. It is above the level that human beings can manage. It is not like IT things where we can shut down the whole thing. It will be quite inconvenient, but we can still live without computers, without the Internet, but it is not quite manageable for biological things.

S: So I would just like to bring out two things that you said. Correct me if I got them wrong. The first is that you think biological items are so integrated into our world that anything that goes wrong with them will spread too fast for us to control.

U: Yes.

S: Okay thanks. The second thing is that, am I right to say you believe individual users of this technology have too little control for them to use it safely. Or...

U: Yeah, that's true.

S: Alright.

U: And we cannot ensure that they are using it morally, like in an ethical way. Because we can never tell how the people are going to use this technology.

S: Okay thanks for that. We're coming near to the end of my set of questions here. I want to just briefly explain our project, our iGEM HKUST 2012 team's project. We are trying to engineer bacteria to target colorectal cancer carcinomas, and then kill them. Basically we're turning the bacteria into a soldier, the soldier has a gun and bullets, and method to shoot and kill cancer. That gun also has a gunsight so it only shoots, or it tends to shoot more cancerous cells than healthy cells. Also it has training, the training necessary that it will stop shooting when it has shot a certain number of bullets. It will not just keep going, it will shut down. And we can also tell it when to shoot, and when to stop. That is a kind of analogy for our project. This is a form of cancer treatment. The treatment will be administered by... our prediction is that if our project goes through, the treatment will be by the patient taking the bacteria orally and that it will operate in the digestive tract of the patient. So, cancer treatment. Cancer treatment is a very difficult thing primarily because it is difficult to differentiate between a cancerous cell and a healthy cell. So treatment to cure cancers usually result in heavy damage of healthy cells, which is the main reason why cancer patients do not survive treatment. A lot of them do not survive treatment. Treatment includes chemotherapy using drug cocktails, radiotherapy using targeted radiation, both of these methods have the ability to cause cells to die, to kill cells. But they kill cells a bit indiscriminately. So what makes cancer therapy a multi-million dollar industry, what makes it so difficult, is finding ways to kill more cancer cells than healthy cells. If you find a method to target it well enough that the method only destroy cancer cells and no healthy cells, then you have a winner. Technologists believe, and so do we, that synthetic biology methods can help them. Because you're using a biological tool to perform a biological task, instead of using a chemical tool or a form of radiation. So we believe that the biological method can be best. Because it operates under the biological rules. I won't go into details what those rules are but it operates under certain biological rules that might make it superior. Cancer treatments - and this is the same with a lot of kinds of treatments - must undergo a lot of testing. Makes sense?

U: Yep.

S: And in order to do this testing to the best of our ability, we test them on animals. We still do a lot of animal testing. We try and test them on something as close to humans as possible. So we start with mice and rats, because their DNA is similar to ours, and then we sometimes continue to rhesus monkeys, because they are even more similar to us. What is your general view on animal testing?

U: Actually I have answered this question before, when I was having my medical interview. I'm still against it, but it's quite a dilemma actually. I understand that without animal testing it will be even more risky to put into practice with humans, but I still think it is morally incorrect to test on animals because they are innocent.

S: You mean they did not agree, and they don't really know what's happening.

U: Yeah because you can't get their consent. Personally I'm against that, but somehow I understand that it has to be there. Anyhow we need experiments before we really take it into practice with humans so yeah that's my point-of-view.

S: Now let's say in the future, your loved one contracts colorectal cancer, now the doctor tells you the risks and benefits associated with each kind of cancer treatment including chemotherapy and radiotherapy. You also have the option of something that is similar to ours. A synthetic biology method in which engineered living organisms are the agents to cure this patient, your loved one, of cancer. Now you know all the risks associated with the traditional methods, and also you understand our project, you understand the principles behind it. What kind of further information will influence your decision on which treatment to choose?

U: Of choosing a method?

S: Right of choosing a method.

U: I think the most important should be the risk behind that kind of treatment.

S: Alright, so you understand that with a treatment method that is older, that has been put into practice more often, medical practitioners and doctors should be able to give you better predictions on what will happen. And with the newer method, there is just less experience.

U: I think, I will go with the new method. Because, basically for the traditional methods the success rate is not high, and it does not really cure the whole disease, it just lengthens your life before you die.

S: In most cases there's usually a relapse, yes.

U: I do believe that if the method is put into practice, and it should be reliable to try, at least to try. So I think I will go with the new method, in order to have a higher chance of getting cured.

S: And what about information beyond risks, is there anything beyond knowledge of the risks that would influence your decision on which method to choose for treatment?

U: I think another consideration is how painful the treatment would be. Yeah, how would the treatment affect the patients. And also, the cost, maybe, but it's less of a concern, because we try every we can to cure a patient. But the cost is still a concern. Yeah I think it's mainly the riskiness, how painstaking the process.

S: I understand. Well thank you so much for your time. A lot of the things you have said have helped us understand more.

#### **IV. The Secondary School Student.**

*Key*

CS --> Christopher Yu and Sean Carim (HKUST iGEMers)

H --> Mr. Siu (High School Student)

CS: Is it important for society to keep up with the latest technology?

H: Of course. Society in a sense is being driven to a more civilized society. So the latest technology is needed in the society, whether regarding manufacturing, or involving interaction between human beings. The latest technology can stabilize the society.

CS: Do you welcome the onset of new technology? Are there any concerns that you may have regarding new technologies?

H: I welcome it. But I think everything has pros and cons. I will definitely be considering the possible bad sides of new technologies, like is it unfriendly to the environment, or are the prices of high-tech products too high, if the product is a waste of money.

CS: Take for example the situation in HK. You know that HK does not focus much on science and technology industries. People in Hong Kong do not discuss science and technology regularly. What is your personal view for this situation?

H: My view is, I suppose, that what you have said is true, because my age group won't be concerned with such issues. It's not something we know about. We only know what we have studied, or what we'll be tested on. For example, artificial insemination, test-tube babies, we learn about that. But we don't talk about it.

CS: Now we want to ask you about genetic engineering. What comes up in your mind when you hear that term?

H: Idea of coping. Nothing much else, I guess.

CS: Have you heard about “genetically modified foods”?

H: No. I have about the sheep though. I think we were taught something like this in junior school integrated science.

CS: You mean Dolly, the cloned organism?

H: Yes, that.

CS: And what do you think about Dolly’s story?

H: I guess, technology is moving very fast. And I feel the cloning of human beings will come soon.

CS: Technologists are of the opinion that our future will see us manipulating genes far more often to generate living organisms with desirable functions.

- What do you think about the validity of this prediction?

H: If technologists are going to solve the problem of exhausting {NB, we believe he is referring to waste}, or produce a huge amount of resources that are good for us, I think this is no problem.

CS: Technologists further believe that organisms will become very easy to manipulate by human beings. An organism may one day be classified as a tool. We can turn them into tools by transferring DNA to them and provide them with new functions.

H: Um, well this is a bad thing right? Something like this is going to have a lot of risk attached to it.

CS: Well considering the pros and cons, do you think genetic engineering should go on? Or should it be stopped.

H: I think it can go on. I think we can control it, by perhaps not allowing the technology to spread quickly. Actually it will be the government that will consider the feasibility of it and control it. This is not to be decided by me right? I won’t be thinking about this, the government will. There will always be a good and bad side to everything. But I think this will be good.

CS: Many people think there will be ethical issues associated with this, particularly about the concept of changing nature. What is your opinion?

H: Nature. I don't think nature can be changed by us. I think, we cannot make a tree into a building. I don't know for sure, but I don't think we can.

CS: I now want to start talking about synthetic biology. Synthetic by itself means to be man-made. It means to design living organisms, and then engineer them. We do this by designing – you could say writing – DNA segments. After we've written it out, we can get a machine to produce the DNA for us. And since an organism is shown to function depending on its DNA, we can thus effectively design living organisms to perform desirable functions in a predictable way.

Do you have any comments on what I have said so far?

H: Will we make any weird things out of this? (Laughs.)

CS: Maybe in 20 to 50 years we can design organisms.

H: Designing animals is too... strange. Very strange.

CS: Do you have confidence that scientists can do it?

H: I think change and synthesis of something is already strange.

CS: Living systems are powerful, because they can perform a variety of tasks. Take for example the leaves of a plant. The sun passes across the sky from east to west, and the leaves of a plant can turn to face it to receive as much sunlight as possible. This is a function that is coded in DNA. 10 years ago, scientists went looking to link function to DNA sequence. These capabilities can be captured and controlled to revolutionize certain fields, including but not limited to: energy, medicine and environmental management.

But there are vast potential technical risks too. Such as imbalancing ecology, and generating new disease-causing agents. We might create new diseases. Because no one can be perfectly sure about any of this. So there is a likelihood that bad things could arise from normal research. In 15 years, you will be a consumer in society. In that future there may be genetically engineered products. Weighing the advantages and disadvantages, how do you rate the attractiveness of the technology?

H: We would wait first, and see if the product is good enough or not. We will see if it causes harm or side effects to users after they use this new product. From what you have said, it seems that these technologies change easily, so I would watch and wait first, and then decide. I wouldn't just go and buy it straight away.

CS: I want to make some comparisons between genetic engineering and the information revolution. Around the year 2000, we had the internet revolution. Computer

science advancements were very fast. The field of computer science grew very fast. People doing genetic engineering now believe that 50 years later, genetic engineering will rise just like computer technology has risen in our present. But here's a thing: because computer technology rose so fast, problems we could not expect emerged, like computer viruses and hacking. And now many people have computers, and the skill to use computers. Everyone can interact with this technology, and a lot of risks have emerged. Genetic engineers expect the same thing to happen. A lot of risks they cannot predict will come out. That's why we want to ask you whether you think this technology will become more of a problem or more of a success.

H: This is more risky. You said that DNA is complicated and it cannot be predicted. So it is harder than promoting computer technology.

CS: So if risks emerge, would you consider them to be more severe?

H: Yes. Because with a computer it won't affect my life. Genetically engineering maybe. With computer technology we can only do so much modification. But with genetic engineering we can change too many things. It might be changing too much! And that may be a problem.

CS: Now with regard to computer software, everyone can turn their ideas into something helpful, a real piece of software, then promote it and sell it. But then everyone could technically make a computer virus and cause a lot of problems for people. That would be the bad side of everyone having the technology. Now if genetic engineering was exactly the same. Everyone knows how to interact with it.

H: It's still good.

CS: When it's comes to our project, this one by iGEM HKUST 2012, we're also using bacteria. We're doing DNA modification to give the bacteria some functions. The function we are providing it is to produce a medicine, and humans can ingest this bacteria producing medicine. Should a patient have colorectal cancer then the bacteria can find the cancer and suppress it. This is what we want to do. There are plenty of risks, because it will be ingested, and there are other things we cannot predict. What advantages does this have? Well with chemical treatments both healthy and unhealthy cells will be destroyed. Our solution aims to target the unhealthy cells better.

In the research process for such a task we often test on animals. Usually we start on mice, and afterwards progress to monkeys. What is your personal view on animal testing.

H: Definitely that it's not good. It is not good if animals are killed for this reason.

CS: As a case study, one of your loved ones contracts colorectal cancer. You know the risks associated with the existing cancer treatment methods, but doctors have been using them for years. But you have a choice of what method to choose to treat your loved one,

either the existing methods or a method like our project. A genetic engineering solution. Using a living organism to treat the issue.

H: I will stick the old method.

CS: What other factors would you consider in your choice?

H: I will consider whether it is safe or not. My main priority is safety.

CS: What about if someone has tried it before and came out okay, became healthier?

H: Then I might try it.

CS: Overall what are your feelings toward this technology?

H: It is a good thing, and I am looking forward to when the technology comes out.