SILVER HUMAN PRACTICES & GOLD HUMAN PRACTICES
MAKING SCIENCE SERVE THE PEOPLE

ONLINE RESEARCH

Written By Yuchen Tian

Noticing that there is an increasing gap between the supply and demand of blood for transfusion around the globe, our group drafted a project that aims to create hemoglobin based oxygen carriers. Before starting the experiments, we did some research on this topic to gather information. Here are some key information we found.

WE NEED BLOOD

In a car accident, one victim can require as many as 100 pints of blood.

For every 7 people entering a hospital, about 1 of them needs blood.

Patients with severe sickle cell anemia need to receive blood transfusions every month to survive.

Every 2 seconds, someone in the United States needs a blood transfusion to save his life.

WE ARE SHORT OF BLOOD

Among the 500000 women who die each year during pregnancy and childbirth, haemorrhage, a condition that invariably requires blood transfusion, is the most common cause.

Although 38 percent of the United States population is eligible to donate blood, less than 10 per cent of that group actually does.

CURRENT BLOOD DONATION IS UNSAFE

Globally, up to 4 million people have been infected with HIV by the transfusion of unsafe blood.

The prevalence of hepatitis B, hepatitis C and syphilis in donated blood is still extremely high in many developing countries; the prevalence of Chagas disease in donated blood is a major problem in South and Central American countries.

ABOUT ARTIFICIAL BLOOD

Artificial blood is a product made to act as a substitute for red blood cells.

Red blood cells substitutes or synthetic oxygen transporters studied so far are perfluorocarbon, also known as PFC, and Hb based substitutes.

After over 100 years of research, there still have not been any successful artificial red blood cells currently in use.

Short circulation in human body, immune response, and increased probability in stroke are all current problems for artificial red blood cells.

After seeing these statistics, we steeled our resolve to do this project. Our goal was to engineer human cell line to produce exosomes that work as cellular hemoglobin based oxygen carriers, which can be used in blood transfusion and stroke treatment.

CITATION

http://www.who.int/worldblooddonorday/campaignkit/WBDD_GlobalNeed_English.pdf

http://fourhearts.org/facts/

https://www.healthline.com/health-news/blood-donations-at-critically-low-levels#2

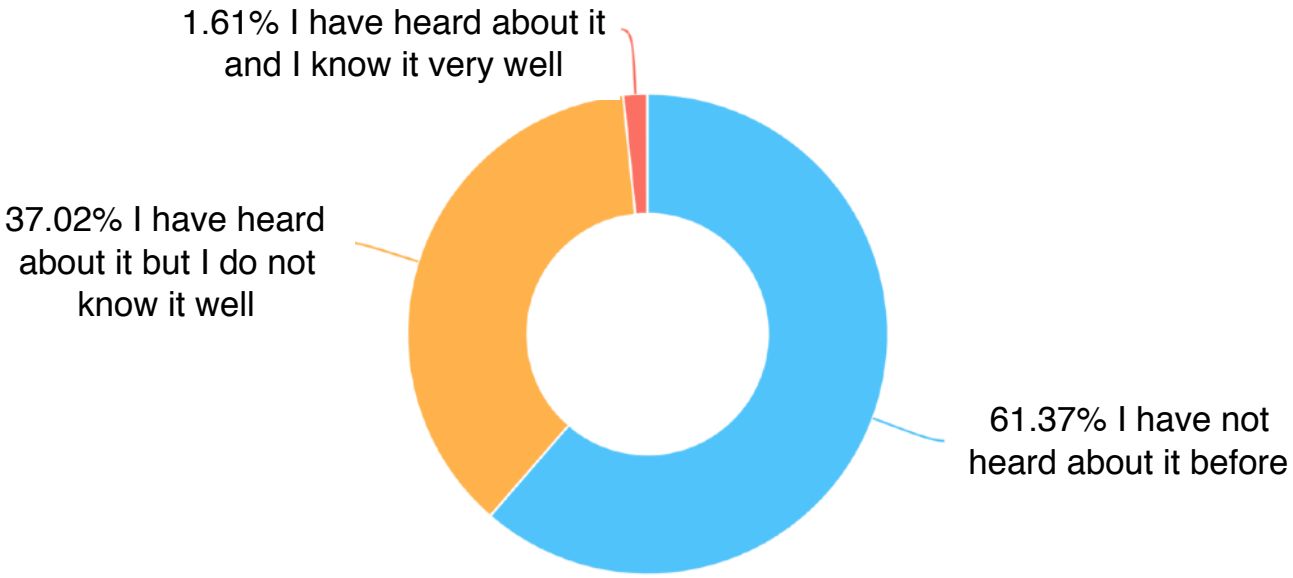
PUBLIC OPINION SURVEY

Written By Yuchen Tian

In order to understand how the general public view artificial blood, we created a survey to gather opinions from different groups of people. Over 500 people filled in our survey; the results are shown below.

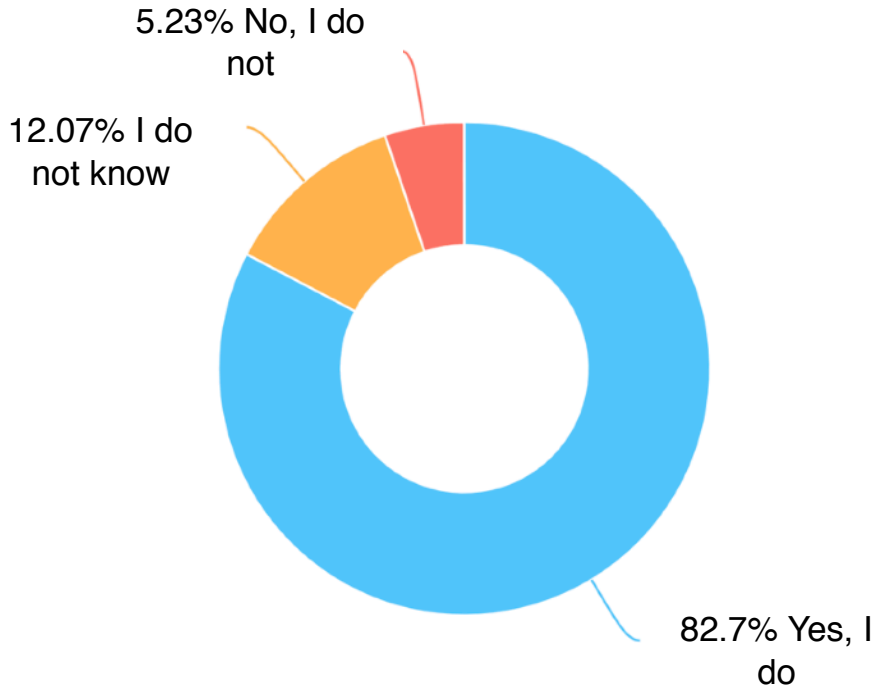
Q1

Have you ever heard about artificial blood before?



Q2

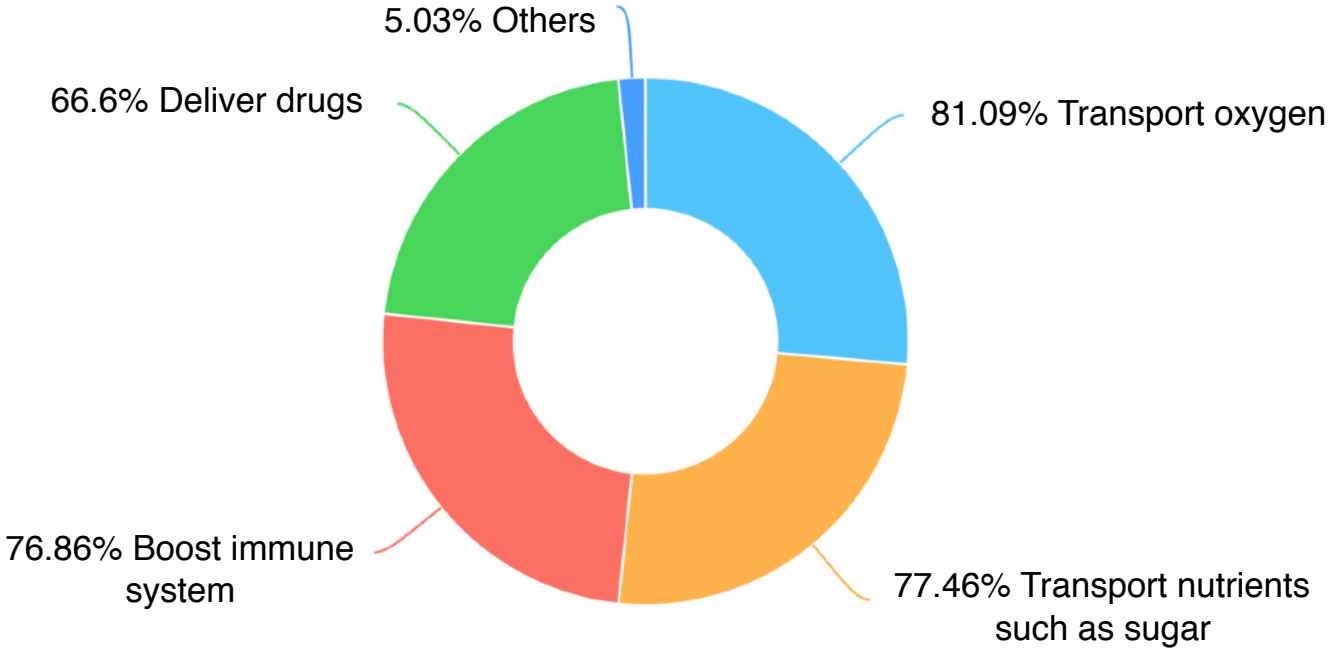
Do you support the development of artificial blood that can replace part of the blood function?



Q3

In your opinion, what functions should artificial blood have?

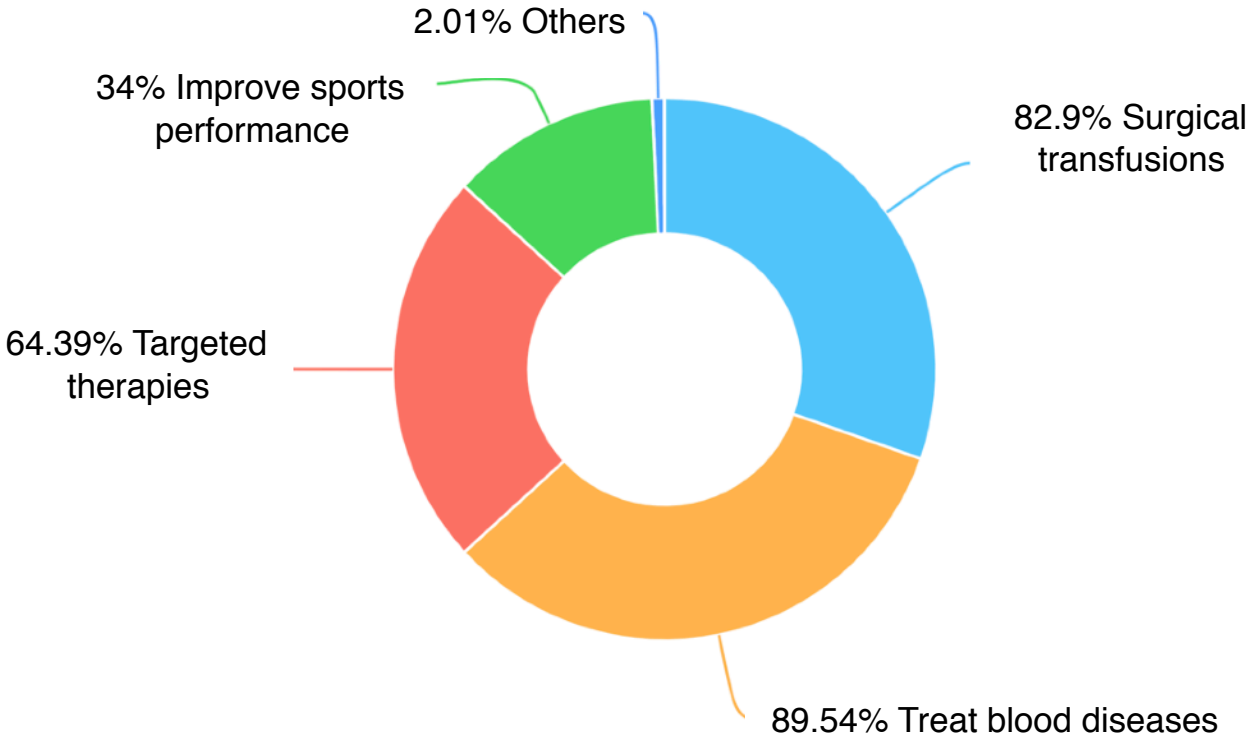
[You can choose more than one answer]



Q4

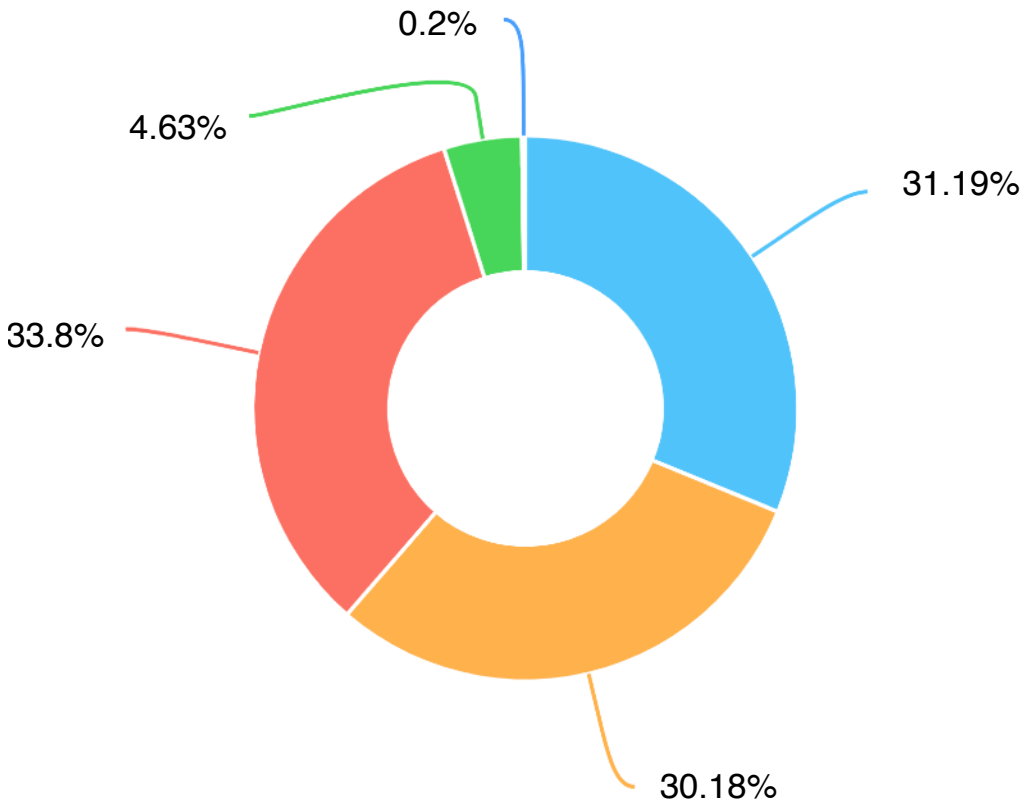
In your opinion, what could artificial blood be used for?

[You can choose more than one answer]



Q5

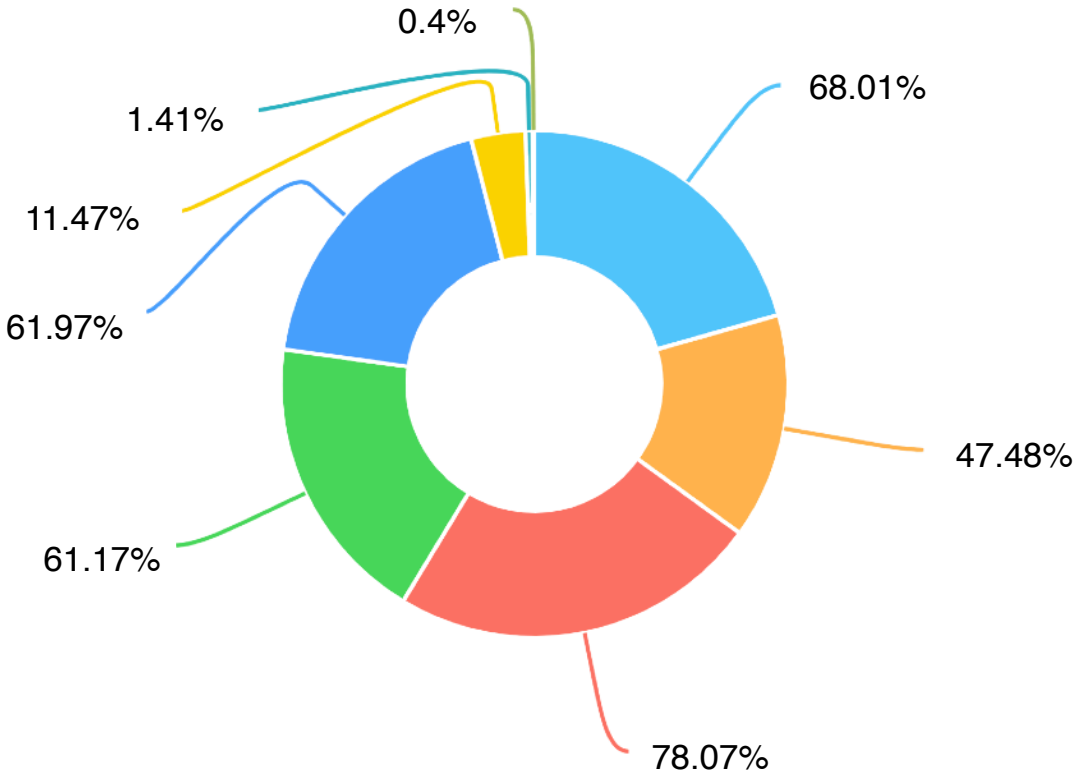
In your opinion, in which areas can we use artificial blood if it is available? [You can choose more than one answer]



Q6

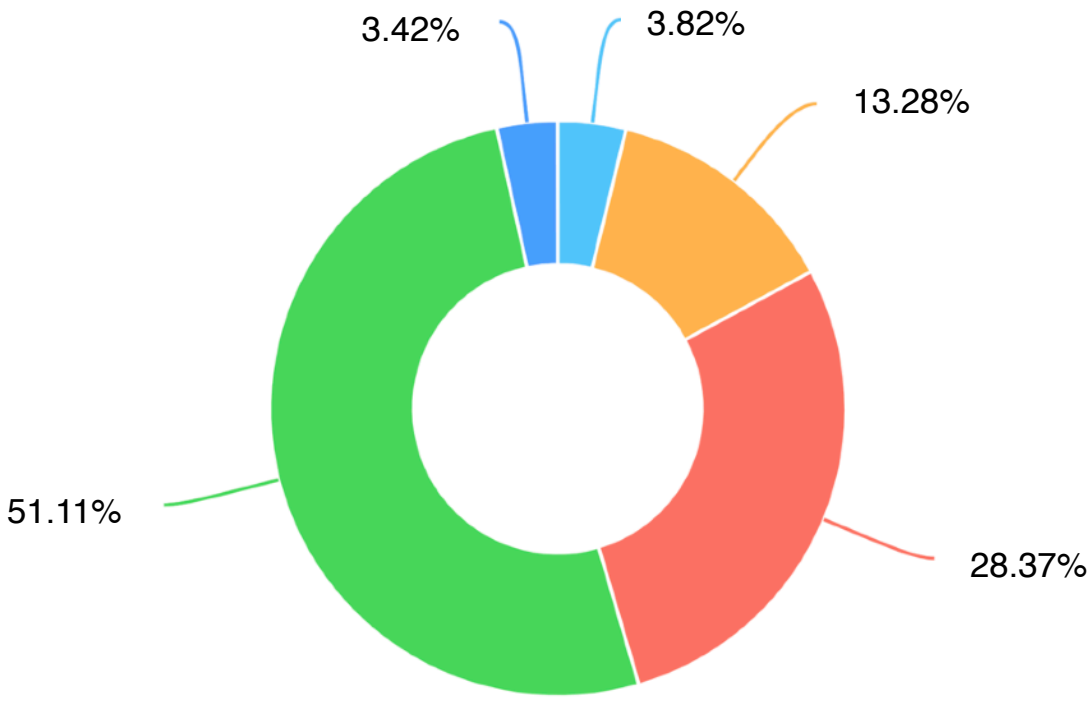
Currently there are some problems in human blood transfusion, which of the following problems do you think are very serious?

[You can choose more than one answer]



Q7

If you are to accept a blood transfusion, would you prefer natural blood or artificial blood?



I can only accept artificial blood

I prefer artificial blood over human blood

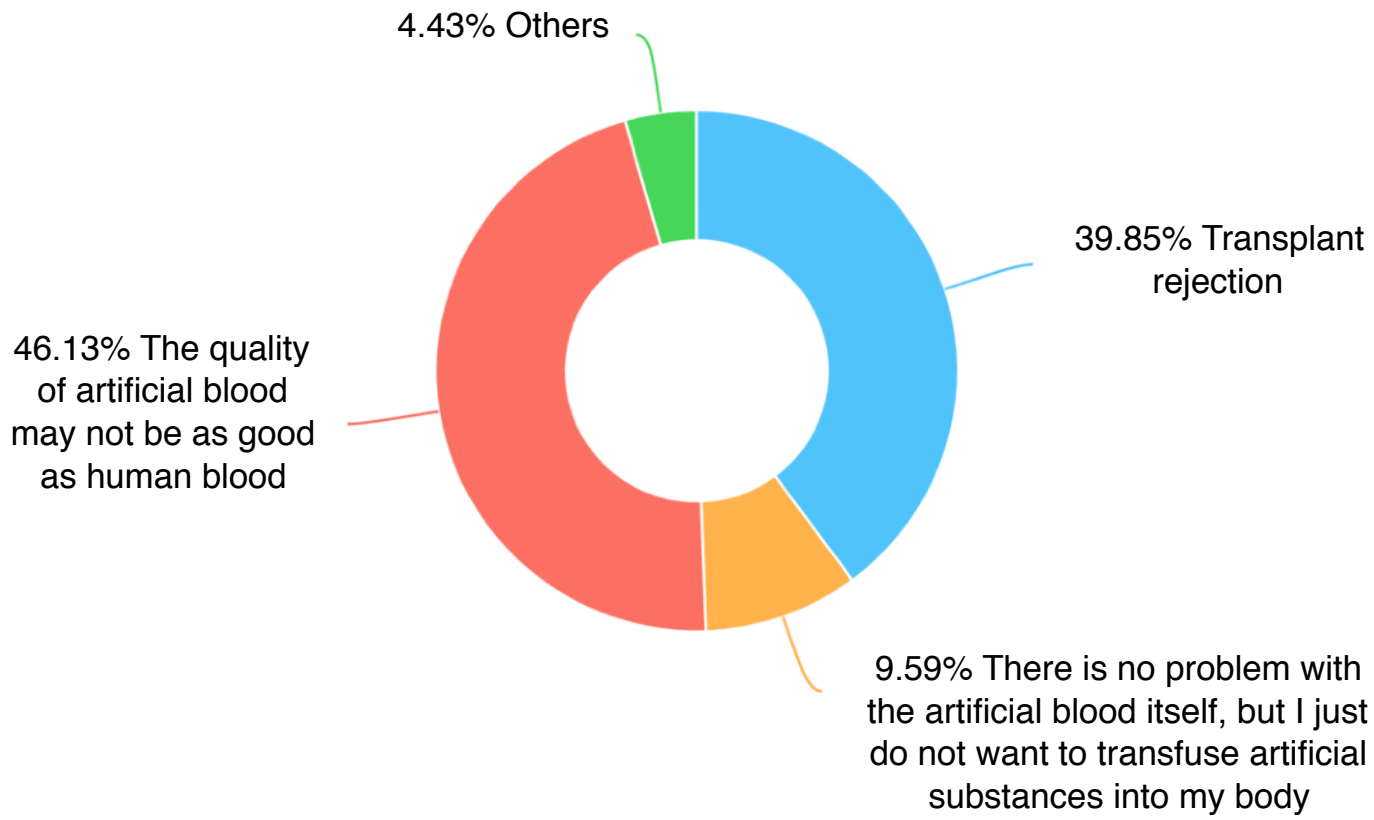
I have no preference

I prefer human blood under normal circumstances

I can only accept artificial blood

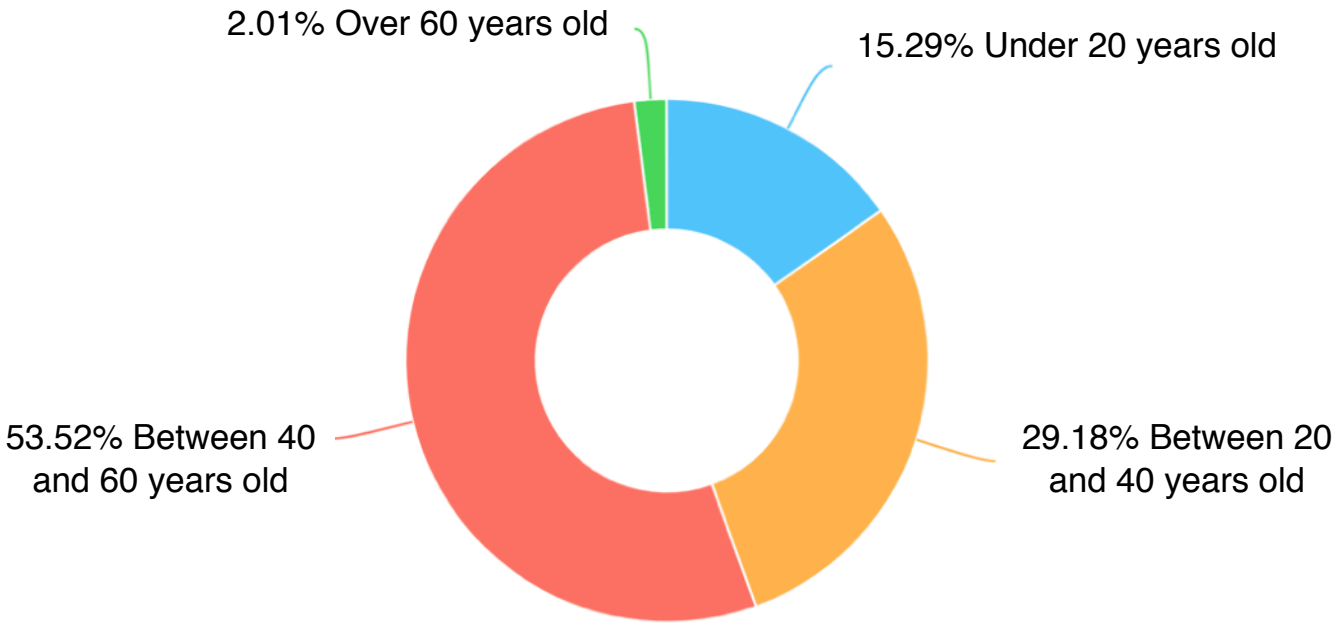
Q8

If you prefer human blood, which of the following problem about artificial blood do you worry the most?



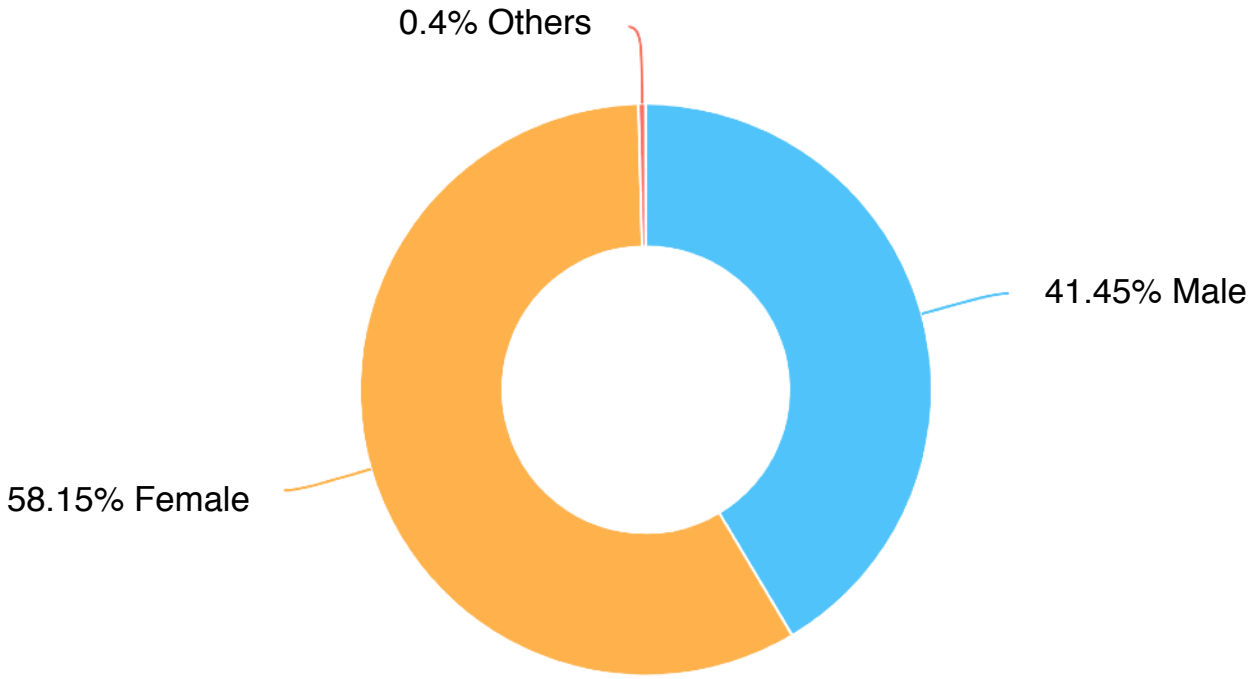
Q9

How old are you?



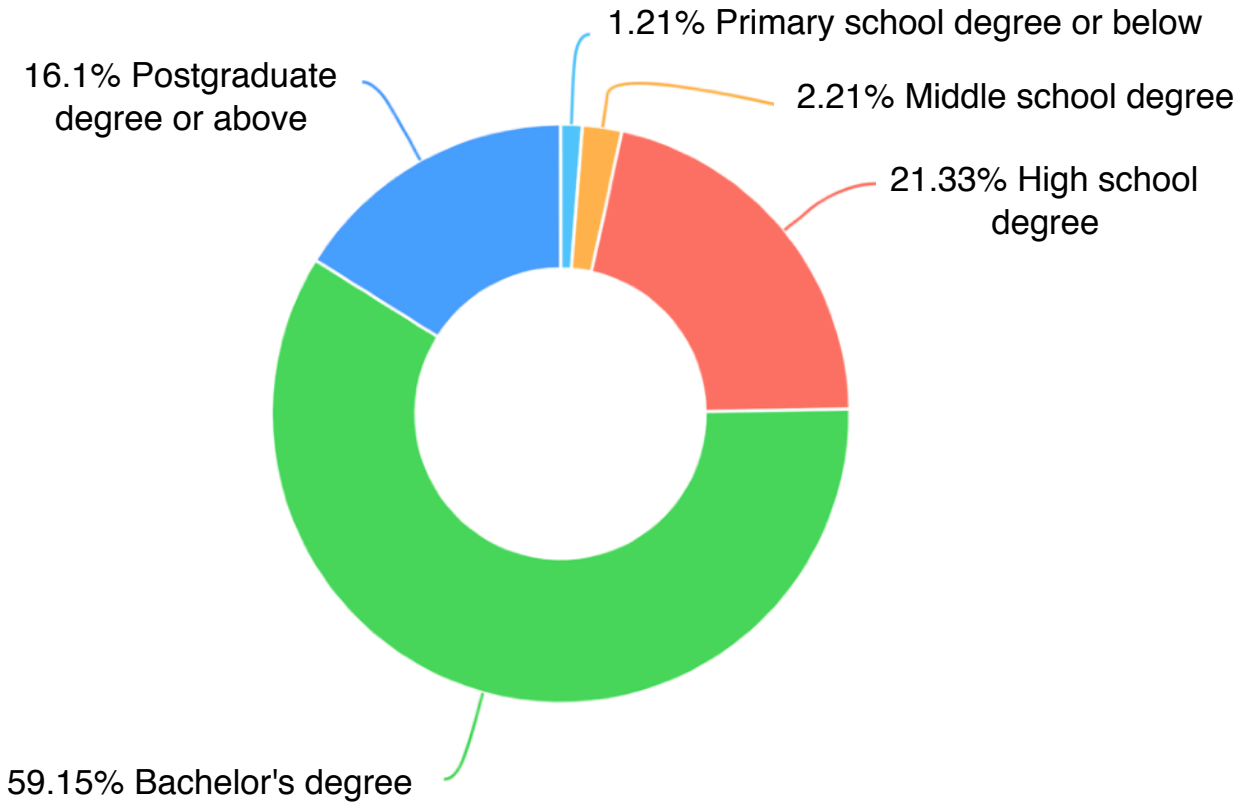
Q10

What is your gender?



Q11

What is your level of education?



RESULT ANALYSIS

Q1

Most people have never heard of artificial blood, so it is our responsibility to introduce it to the general public.

Q2

The majority of people support the development of artificial blood, which means that our project is supported by most people.

Q3

People think artificial blood should not only have the same functions that natural blood has, but also should be able to help people fight diseases.

Q4

Most people believe that artificial blood can be used for medical purposes, and about one third of people believe that it can be used to improve athletic performance.

Q5

Most people believe that artificial blood can be used for medical purposes, and about one third of people believe that it can be used to improve athletic performance.

Q6

People are most concerned about the safety of natural blood; they also think the limited supply of natural blood is a problem. If we develop artificial blood, we would aim to solve these problems.

Q7

Currently, the majority of people more readily accept natural blood than artificial blood, or have no preference between the two. We aim to help people relieve their mental barriers, so that more of them can accept artificial blood.

Q8

People who prefer natural blood are mainly concerned about the quality and safety of artificial blood. We can address these problems in our presentations to tackle their concerns.

Q10 to Q12

We created these three questions to ensure that people who did this survey can represent the general public.

In our opinion, raising public knowledge on blood transfusion is crucial to the development of artificial blood. We believe the power of education and engagement at social and personal levels can help us achieve this goal.

SYNTHETIC BIOLOGY DATABASE

Written By Sihan Yang

“How can we select a meaningful and practical subject for the project” is always a good question to think about in the synthetic biology research. For iGEMers, especially for high school students, we are struggled at first to choose our own projects like many others. There is only one clue, that is, we can refer to the database of previous iGEM teams. However, all those previous iGEM projects are also started by some freshman and they are just some preliminary researches comparing with those successful projects which have already evolved into large synthetic biological startups or even IPO listed companies. Numerous researches failed due to the project design in the initial stage where a large amount of capital could be saved by just reading some more successful projects and careful design. Instead of only reading the previous preliminary iGEM teams’ projects or posters, we want to dive into some more successful projects that are more mature, including those projects that have already changed the world. Unfortunately, there is not such a database that could be understood by the freshmen.

Still, there are nearly nine hundred synthetic biology related companies that have overcome the difficulties and successfully become listed on NASDAQ and some more in other stock markets. There are even more projects that have come out of the lab and got invested by the venture capitals. As to a freshman intruding the biological field to start any research, these projects are the good examples to study. Studying enough successful cases could be helpful to find out how a successful project is started and evolved. Most importantly, it is the one of the best ways to learn how to evaluate the feasibility of a project in the early stages. But where can we find them?

Based on this idea, our team act to formulate a small database of some more successful synthetic biology projects as one of the human practice work so that we could learn some more cases during the preparation and share it with all the coming teams. We hope it could evolve into a wikipedia of synthetic biology and iGEM case study resources. It is basically composed of two types of companies: one type is some famous biological companies that have already become listed in the open stock market. The other type is some emerging startup synthetic biological companies who were already invested by the venture capital investors .

These projects are all outstanding in the relevant specific areas of study and could be the inspiration for newcomers who have just ventured into the biological field. Imaging that you standing at the top of the pyramid, you will definitely get a whole picture of the industry. There are several basic categories of company information included: the companies' history, including the abstract, purpose, development of main products and approaches of the company. The information is highly summarized and arranged in an order which is conveniently accessible for everyone. It is also fantastic pieces of approaches to obtain more knowledge of research and development collaboration between companies. On the other side, by analysis of the emerging companies, everyone will have a quick glimpse of the most popular topics of the current time to foresee industry trends. Take one company for example that was described in our database, Intellia which is a biotechnology company developing biopharmaceuticals using a CRISPR gene editing system. We display the milestone along the history to see if there are some patterns. From the skyrocket growing transfers to the stable stock price which IPO had successfully closed with the full 6.9 million shares sold, Instellia is an indisputably fast booming genetic engineering company .

Due to the limitation of time, we only include a small number of companies on the list. However, it is an initiation project and attempt which has a colossal potential. From this point, we can make more innovations. It can be adapted to a unique platform with vitality. People could keep devoting more information to extend the database which makes the collection of larger diversity. We hoped that it would help more people including ourselves in the future.

For the full version of our database, please visit http://parts.igem.org/wiki/images/a/a0/T--SHSU_China--Companylist.xlsx.

Program Info				
Year	Progress		Partner	Results
	Business	Project		
2014	license gene-editing technology from Caribou and contract with the company for research and development services.		Caribou	
2014	Series A investment round that raised $15 million in cash.		Atlas Venture and Novarti	
2015	Novart and Intellia announced a five-year research and development collaboration focusing on the use of CRISPR-Cas9 in developing chimeric antigen receptor T		Novartis	

	A	B	C	D	E	F
1	Name	Name URL	Type	Descript:	CB Rank	
2	Moderna T	https://v	Organiza	Moderna T	1,862	
3	Caribou I	https://v	Organiza	Caribou I	3,016	
4	Synlogic	https://v	Organiza	Synlogic	6,405	
5	Poseida T	https://v	Organiza	Poseida T	7,090	
6	Vedanta I	https://v	Organiza	Vedanta I	7,917	
7	Cell Des	https://v	Organiza	Cell Des	8,817	

Moderna Therapeutics

Moderna Therapeutics specializes in drug discovery and drug development based on messenger RNA.

Cambridge, Massachusetts, United States

Categories	Biotechnology, Genetics, Health Care, Medical, Pharmaceutical
Headquarters Regions	Greater Boston Area, East Coast, New England
Founded Date	2010
Founders	Noubar Afeyan, Robert Langer, Stephane Bancel
Operating Status	Active
Funding Status	Late Stage Venture
Last Funding Type	Series H
Number of Employees	101-250
Also Known As	Moderna
Hub Tags	Unicorn
IPO Status	Private
Company Type	For Profit
Website	www.modernatx.com
Facebook	View on Facebook
LinkedIn	View on LinkedIn
Twitter	View on Twitter
Contact Email	info@modernatx.com
Phone Number	6175485422


NASDAQ LISTED SECTOR DISTRIBUTION
450
400
350
300
250
200
150
100
50
0
Biotechnology: Biological Products (No Diagnostic...
Biotechnology: Commercial Physical & Biological...
Biotechnology: Electromedical & Electrotherapeutic...
Biotechnology: In Vitro & In Vivo Diagnostic Substances
Hospital/Nursing Management
Industrial Specialties
Major Pharmaceuticals
Medical Electronics
Medical Specialties
Medical/Dental Instruments
Medical/Nursing Services
Ophthalmic Goods
Other Pharmaceuticals
Precision Instruments


NASDAQ LISTED SECTOR DISTRIBUTION
450
400
350
300
250
200
150
100
50
0
Biotechnology: Biological Products (No Diagnostic...
Biotechnology: Commercial Physical & Biological...
Biotechnology: Electromedical & Electrotherapeutic...
Biotechnology: In Vitro & In Vivo Diagnostic Substances
Hospital/Nursing Management
Industrial Specialties
Major Pharmaceuticals
Medical Electronics
Medical Specialties
Medical/Dental Instruments
Medical/Nursing Services
Ophthalmic Goods
Other Pharmaceuticals
Precision Instruments

EXPERT INTERVIEWS

Written By Yuchen Tian

In order to get more insight into the topic of artificial blood, our group member Yuchen Tian interviewed six experts face to face. These professionals are all involved in fields related with artificial blood, from the head of hematology department to the investor of various biomedical companies.

INTERVIEW WITH PROFESSOR ZHAI

Zhai Yonggong
翟永功教授
Professor at the School of Life Sciences at Beijing Normal University
Visiting scholar at the School of Pharmacy at University of Pittsburgh
Expert in the field of molecular and cellular pharmacology

“Blood donation is voluntary in China, so the demand for human blood is far greater than the supply. This is why we need artificial blood, and I am glad to hear that your group is working on it.”

“But you should know that making artificial blood is very difficult. Around a decade ago, some top experts began to work on creating artificial blood cells, and they are still working on it now. In the field of medicine, it is impossible to create something new in a year or two. It can actually take up to a decade or two.”

“It is easier to create a substance that carries oxygen than to create a complete red blood cell, but it can still be hard. Instead of working on increasing its half life, I think you should first focus on minimizing the immunoreaction that your substance can cause. In order to so this, you can choose to use human hemoglobin to create the oxygen carriers. I know this can be a great challenge; but I believe you guys can do it if you have enough time. Good luck on your project.”

INTERVIEW WITH MS. GUO

Guo Jingbo

郭静波女士
Investor of various biomedical companies
Graduate student at the School of Life Sciences at Beijing Normal University

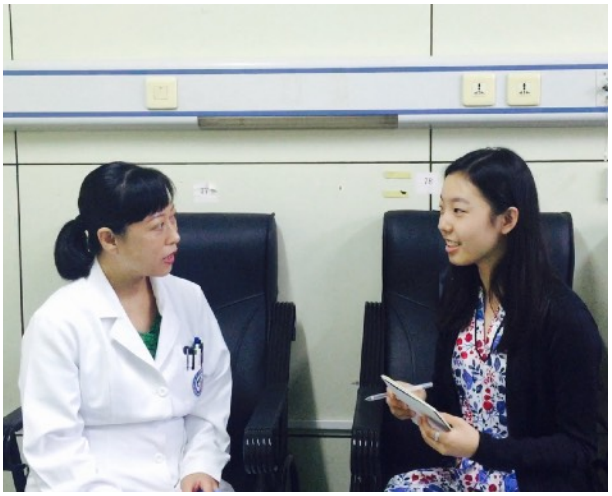
“I know a product called EPO, which promotes the ability to carry oxygen in human bodies. It is somewhat similar to the substance that you are trying to make, and I think the consumers of this kind of products are mainly athletes.”

“Scientists can already produce artificial plasma, which is used in hospitals to maintain the osmotic pressure in blood vessels. In China, scientists make artificial plasma with proteins from bovine bones, but this kind of plasma cannot be used in humans because of the impurities inside. Hence, the artificial plasma we are using comes from the United States.”

“It is true that we have artificial plasma, but we do not have artificial blood cells. Your group is trying to make something that has not been produced by any companies in the world. If you succeeded, I would definitely invest in your project. I am very happy to have young people like you to take this challenge.”

INTERVIEW WITH DOCTOR ZHANG

Zhang Dan
张丹主任
Head of the emergency department at Peking University Shougang Hospital
Graduate student at the Medical School at Peking University

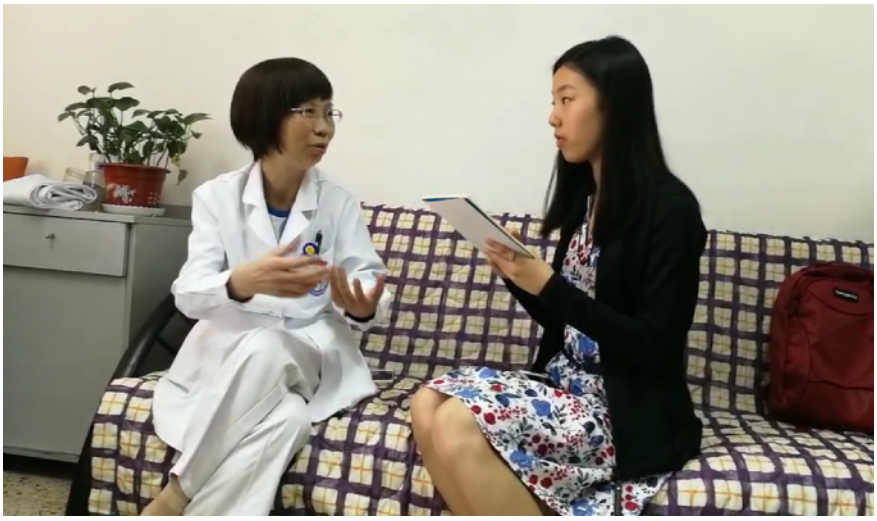


“In my department, patients do not usually need blood transfusion, so if we need blood, we can get it. However, in some other departments, blood is clearly not enough. Sometimes the doctors have to postpone their surgeries simply because they do not have blood for transfusion. Every doctor in our hospital knows that he cannot use blood unless it is absolutely necessary.”

“I think blood transfusion is very safe now, but there is a small possibility that it can cause some problems. If any kind of immunoreaction happens, the patient is in danger. He might get a high fever, a syncope, or even a shock. If artificial blood can 100% prevent these problems, it will be very helpful for us.”

INTERVIEW WITH DOCTOR YU

Yu Yanfang
余延芳主任
Head of the hematology department at Peking University Shougang Hospital



“Hospitals are running out of blood, so we no longer transfuse whole blood into our patients unless he has a serious liver disease. In the blood bank, machines help us separate red blood cells, white blood cells, platelets, and plasma. Doctors then transfuse different parts of blood into different patients according to their needs.”

“Blood transfusion is a lot safer now than that of before, but there are still two problems. First, we may not be able to detect some virus. In China, we check the blood for two times before it is transfused. Practitioners do a quick test before the blood donation, and a more careful inspection before the transfusion. However, some diseases such as Hepatitis B have a long incubation period, so HBV may not be detected during the inspection. HBV can infect the patient if he receives the contaminated blood. Secondly, although we cross match the blood before every blood transfusion, allergic reactions are possible. Patients might get high fevers and chills after the transfusion; they may even die. I do not have any examples for you because I have not encountered any of these situations before.”

“It is very cool that your group is trying to make artificial blood, and our hospital definitely need it. If you want to use it in hospitals, you have to make sure that it does not produce immunoreactions. Remember that immunoreactions can be fatal. Personally, I support your project. I am just a bit worried that some patients may not want to transfuse artificial blood because of ethical problems.”

INTERVIEW WITH DOCTOR QIN

Qin Xiuchuan
覃秀川主任
Head of the emergency department at Beijing Anzhen Hospital, Capital Medical University

Doctor Qin was about to preform a heart surgery when we interviewed her, so her response was brief.

“Chinese hospitals receive less blood every year. I used to have enough blood to use, but then I started to postpone surgeries because of the lack of blood. I think artificial blood can be really helpful in surgeries. It can save lives.”

INTERVIEW WITH DOCTOR SONG

Song Yandong
宋艳东医生
Doctor in the cardiology department of Beijing Anzhen Hospital, Capital Medical University

“I can tell you that hospitals really need artificial blood, but I do not think they need oxygen carriers that much. I do agree that oxygen carriers can be used to treat a small number of blood diseases, but they definitely cannot be used in surgical transfusions. Although we do not transfuse whole blood, we need to transfuse something more than just oxygen carriers. Red blood cells have a lot more functions then carrying oxygen. So if you are

trying to make oxygen carriers, you should narrow your target consumers to people with specific blood diseases and athletes. Keep in mind that this is still a large group of people. If you can manage to add more functions to your oxygen carriers, then it might be useful in surgical transfusions. Good luck on your project!"

INTEGRATED HUMAN PRACTICE IN OUR INTERVIEWS

After interviewing these experts, we created a list to summarize the common ideas expressed by them, as listed below.

I. Hospitals are running out of blood.
II. Hospitals need artificial blood for transfusions in surgeries.
III. It is very difficult to create artificial blood cells.
IV. It is important that the oxygen carriers do not generate immunoreactions.
V. If the only function of artificial red blood cells is to carry oxygen, then the target consumers can only be people with specific blood diseases and athletes.

Interviewing the experts enabled us to see how the professionals view our research and our project about artificial blood.

Since three of the six experts mentioned that it is important to eliminate the possibility of immunoreactions, we focused on this aspect when devising our experiment. After weeks of discussions, we chose to use biogenesis to create oxygen carriers. Biogenesis can help our oxygen carriers to have long circulation time and fast production speed; it is also not as expensive as other methods. Most importantly, it addresses the major concern of the experts. Biogenesis was proven to be more immune friendly than many other methods, so we finally achieved unanimity in the usage of it.

In our experiment, we first tried to use human hemoglobin in ExoBlood because Professor Zhai mentioned this in his interview. However, we failed to get the required parts due to the complexity of this task and the time limits. Hence, we alternatively used Vitreoscilla haemoglobin, a kind of hemoglobin used by multiple

iGEM teams to increase bacterial survival in low oxygen environments. We subcloned Vitreoscilla haemoglobin from BBa_K1321200 in the iGEM distribution kit.

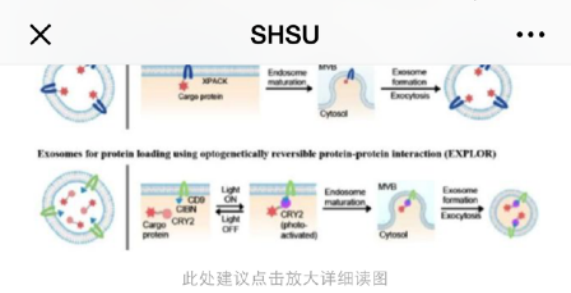
In a nutshell, interviewing these professionals helped us gain a deeper understanding of our project, so that we could better devise our experiments and educate the public.

PUBLIC OUTREACH

Written By Yuchen Tian & Yan Luo

WECHAT

WeChat is a popular social software in China; therefore our team created an official account on WeChat and published multiple articles concerning our research process and the topic itself. With the goal of fascinating the public, instead of boring them with serious scientific essays, we used our daily language, even adding a humorous tone, in discussing our research. From time to time, we referred to trending topics to make our research much easier to be comprehended and a whole lot more interesting to those who aren't involved in the scientific field. For instance, in one of articles, we introduced our research project, referring to the trending anime series Working Cells. In this way, science appears less daunting and connects more to our daily activities.



简单介绍：

其一，离体使用电穿孔等方式直接装载；

其二，在细胞内过表达该蛋白，随后便和外泌体一起分泌；

其三，通过某些膜锚定蛋白(membrane-anchored proteins)，将运输蛋白质直接结合在脂双分子层上，或是通过一个糖分子和脂双分子层连接，最后在外泌体产生时自动包被分泌；

其四，通过某种病毒复制通路进行干预。

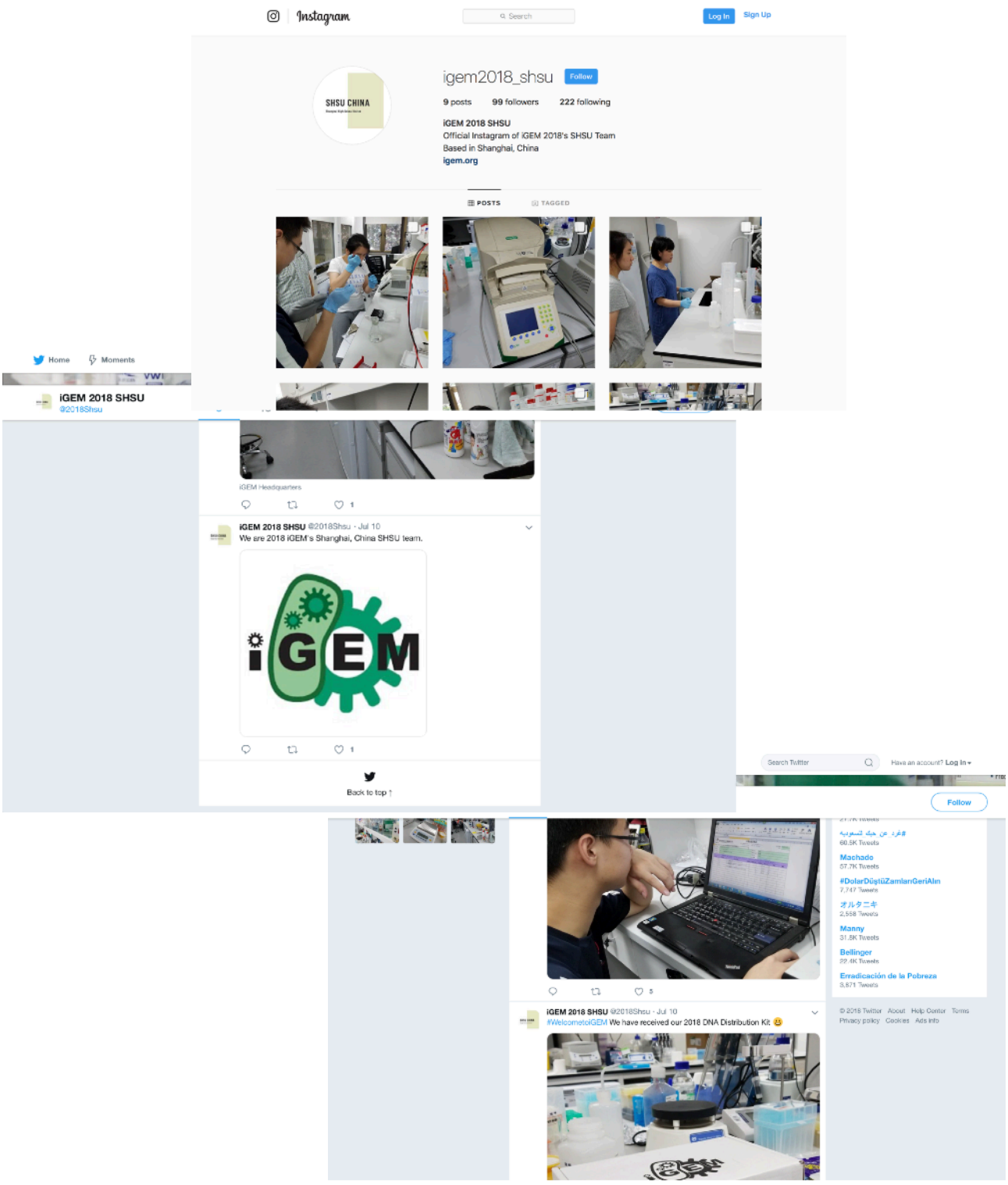
而要做到比较实惠，推荐使用的便是第三或第四种方式，大量制造所需要的血红蛋白载氧体(Cellular Hemoglobin Based Oxygen Carrier, HBOC)。

【01 跑胶】

【02 挑菌+涂板】

TWITTER & INSTAGRAM

Since WeChat is only popular in China, we created a Twitter and Instagram accounts. Similarly, we post fun pictures and updates on a regular basis.



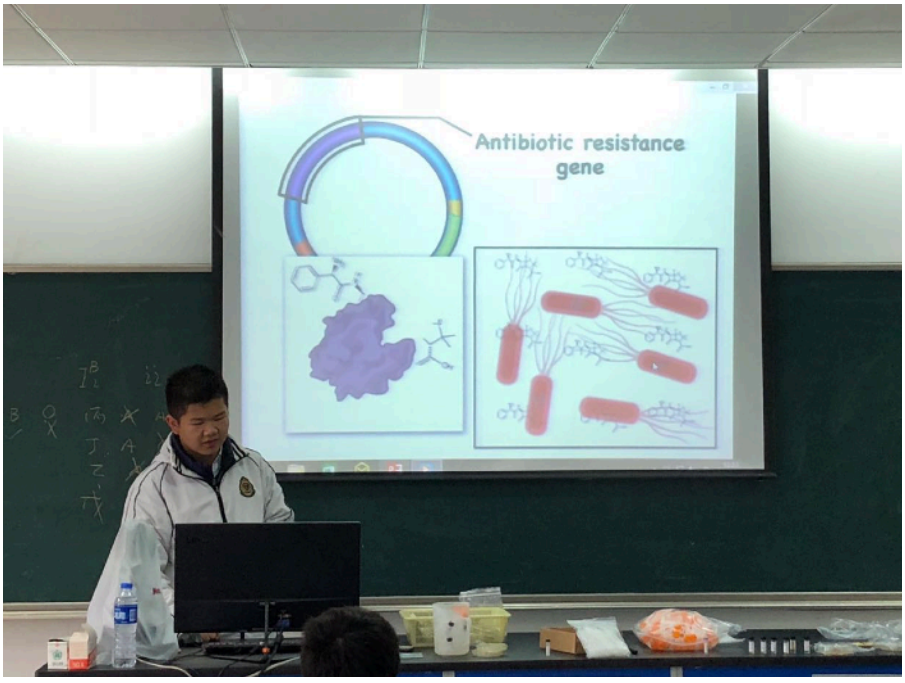
EDUCATION

Last year we started the first Biobuilder synthetic biology course in Chinese mainland to introduce the novel idea of synthetic biology to high school students in SFLS. We translated part of the course materials and posters into mandarin and put them into use in our strawberry DNA extraction and colorful bacteria experiments. This has great effect on the students and on us; our iGEM team is directly formed from the original education group.

推文

Systems Sally
@SystemsSally

So excited to anticipate 2018 with #BioBuilders around the world! Thanks go to YOU @SFLS_BioBuilder for the hard work and to @MITdeptofBE @CarolinaBio + @OReillyMedia for sharing #synbio resources



ONLINE TRANSLATION

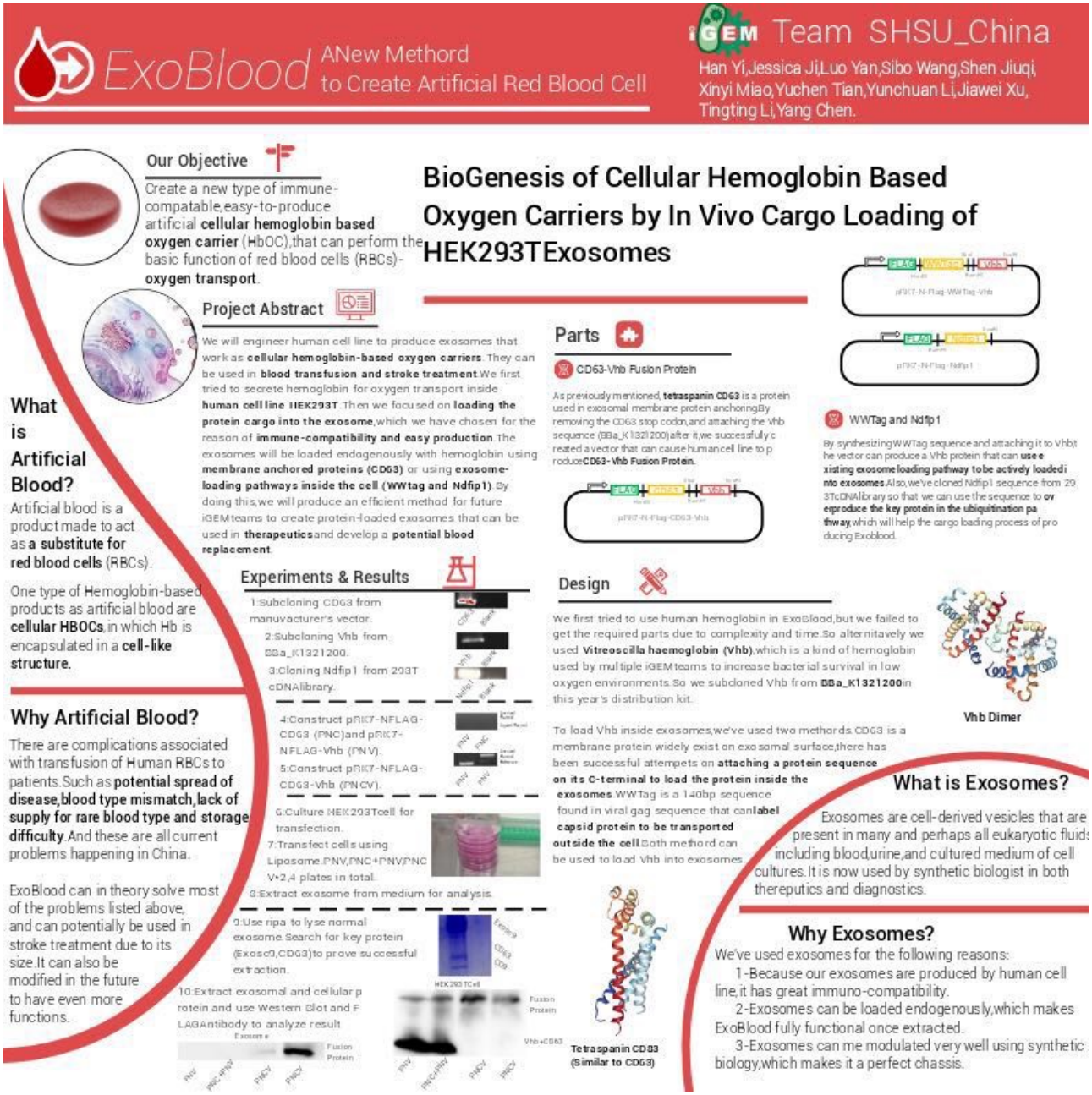
During this summer, we used our language skills to help MITx to translate its molecular biology online courses on Edx. The translation group already had 10 people and was using the transifex platform to translate the videos. We hope that through translating these courses into Chinese, we can increase their popularity, thus raising public knowledge on biology outside our school and on a rather social level.

CCIC MEETUP

Written By Yuchen Tian

During this summer vacation, our group members attended the CCIC meetup in Shanghai. During the meetup, we did a presentation about our project and exchanged our ideas with other iGEM teams. Specifically, we joined the iGEM high school tract discussion group. We not only found learnt a lot from other teams, but also contributed a lot of ideas.

To prepare for this meetup, we also made a poster that introduces our project, as shown below. We got the Best Poster Award for this poster.




Human Practice - Social Study
• People's idea about artificial Bond

IGEM SHANGHAI MEETUP

Written By Yuchen Tian

In order to better prepare for the Giant Jamboree, our team organized a Shanghai iGEM meetup on October 15th. It took place in Fudan University; different teams did their presentations to each other and asked each other questions during the meetup. We also discussed about our projects in detail and gave each other suggestions on how to improve our presentations. We felt more confident about the Giant Jamboree after this meetup.