

Survey Report on Public Awareness of Synthetic Biology and Preference at Use of Natural products in Pharmaceutical Drugs

Introduction

Despite recent developments in medical science, our society is still facing global health challenges, including emerging infectious diseases and debilitating diseases such as cancer. Hence, there is an unmet clinical need for new and effective drugs. However, a long-existing problem in drug discovery is the cost-effectiveness issue in finding effective drugs for clinical use. To address this, our CityU iGEM Team 2021: 'VarieCure' aims to address a solution toward the problem of emerging infectious diseases by developing a simple and cost-effective fungal synthetic biology platform using a fungus *Aspergillus oryzae* to produce various novel derivatives of variegol, a fungal natural product with potent therapeutic and antimicrobial properties.

In view of that, we aimed to gather data on the public awareness of synthetic biology, natural products and their use as a source of pharmaceutical drugs. We also would like to investigate public opinions on our project: VarieCure and methods to tackle worldwide health problems. Consequently, we designed a public survey, and the results will be analyzed in this paper.

Objectives

- 1) To investigate the public awareness of Synthetic Biology.
- 2) To research public awareness on Natural Products and the use of natural products as a source of pharmaceutical drugs.
- 3) To gather data on public opinions on our project and methods to tackle the above-mentioned problems.

Methodology

The data was collected anonymously from 142 respondents by using Google Forms.

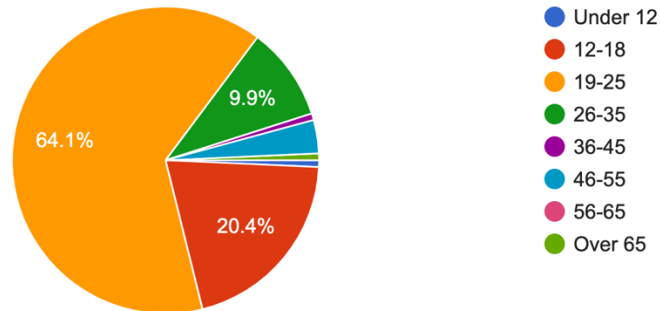
Results

1) General Questions: Background

a) Age and gender

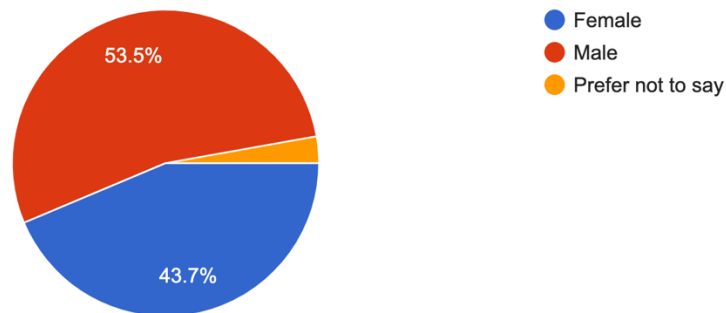
What is your age?

142 responses



What is your gender?

142 responses

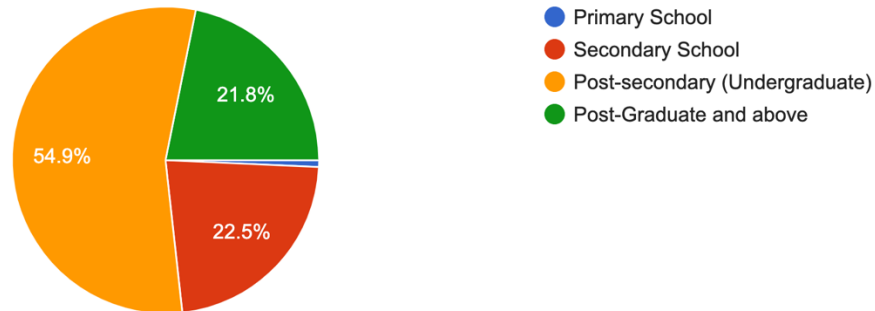


- i) Among the 142 responses, 19-25 years old accounts for the majority of 64.1%, which implies that this public survey was mainly responded by university undergraduates or working people. Secondary school students aged between 12-18 are the second highest group.
- ii) The respondents are equally distributed with gender as 43.7% is female and 53.5% is male, with 2.8% of them prefer not to say.

b) Level of Education

What is your Highest Level of Education?

142 responses

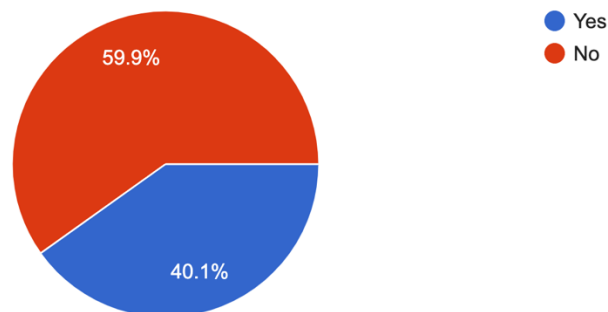


- i) In the survey, respondents are mainly composed of post-secondary educated people, at 54.9%. 22.5% of respondents are secondary educated, and 21.8% are post-graduate or above. This shows the survey results are based on the opinion of young and highly-educated respondents.

c) Affiliation with the City University of Hong Kong (CityU)

Are you affiliated with the City University of Hong Kong?

142 responses

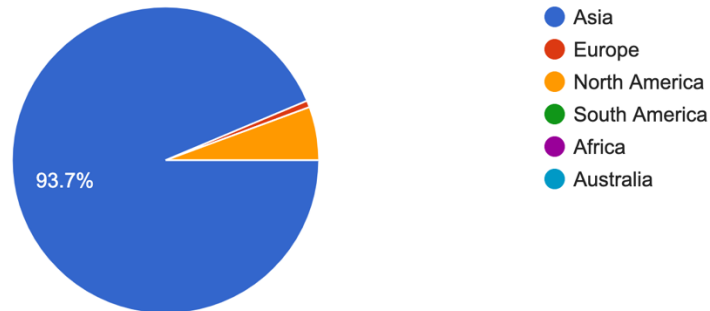


- i) A majority of participants, around 60%, are not affiliated with the City University of Hong Kong, so the reliability of this public survey is proved.

d) Regional distribution

Where are you from?

142 responses

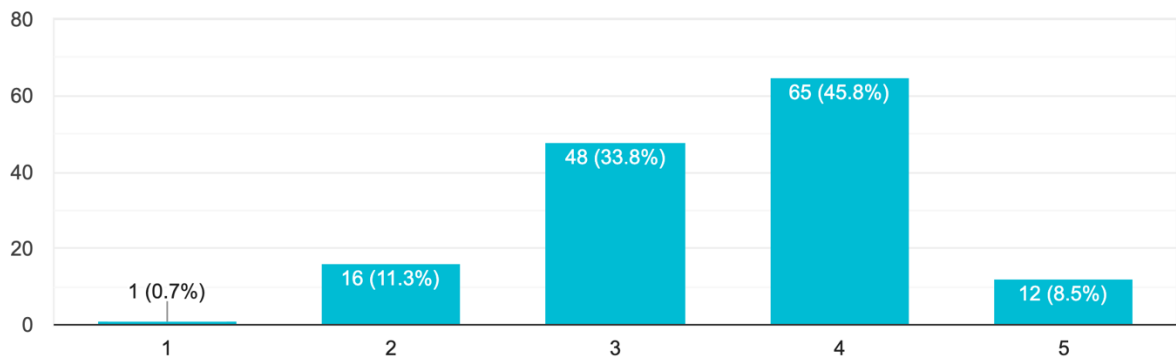


- i) 93.7% of respondents are from Asia as this survey data is collected in Hong Kong. The rest of the interviewees are from North America (5.6%) and Europe (0.7%).

2) General Questions: Health

On a scale of 1 to 5, how physically healthy would you consider yourself to be?

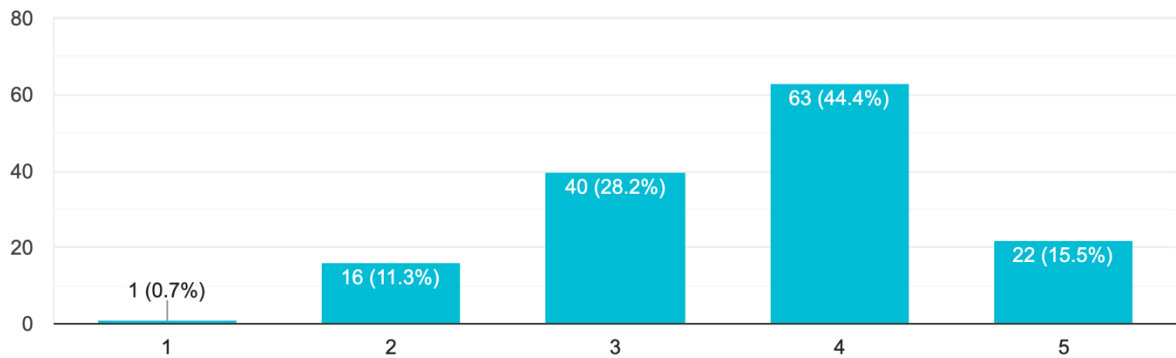
142 responses



- i) A majority of respondents consider themselves to be physically healthy enough as 45.8% of them choose 'very good' and 33.8% answer 'good'. In addition, 8.5% of respondents consider they are 'excellently' healthy, and only one participant considers himself 'unhealthy'.

On a scale of 1 to 5, to what extent do you take care of your health?

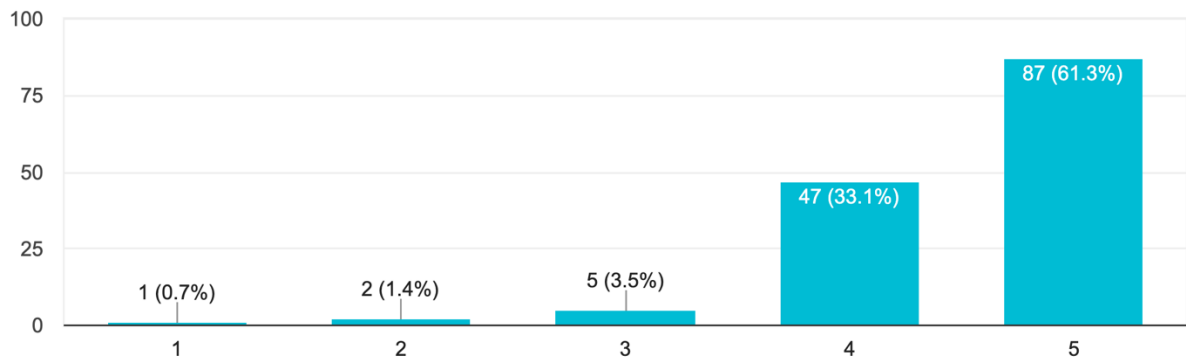
142 responses



- ii) About the healthcare level, most of the respondents take care of their health well. 15.5% choose 'level 5' which means they take care of their health very well. 44.4% and 28.2% of them consider their healthcare level as 4 and 3 respectively. And only a minority of 12% say they take care of their health 1-2 on a scale of 5.

On a scale of 1 to 5, to what extent do you think being free from illness or injury directly affects our capacity to enjoy life or have a good quality of life?

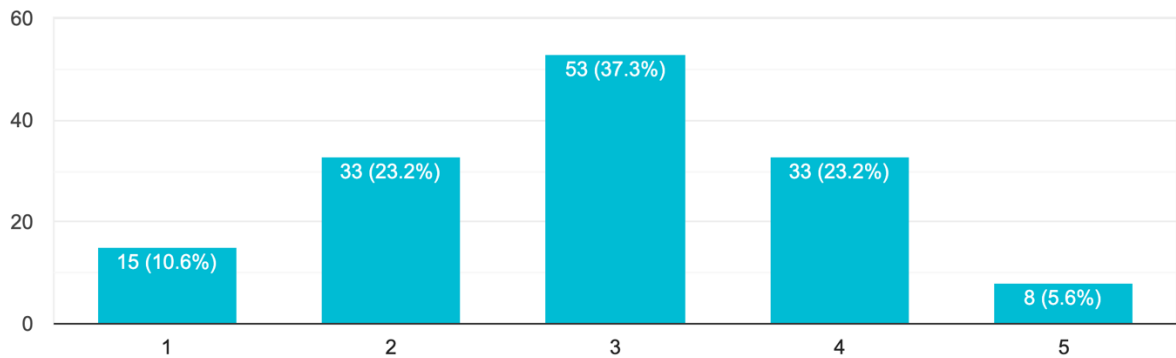
142 responses



- iii) Most interviewees think being free from illness or injury directly affects our capacity to enjoy life or have a good quality of life as 61.3% choose '5' and 33.1% answer as '4' on a scale of 5.

On a scale of 1 to 5, how much do you spend on healthcare products or services?

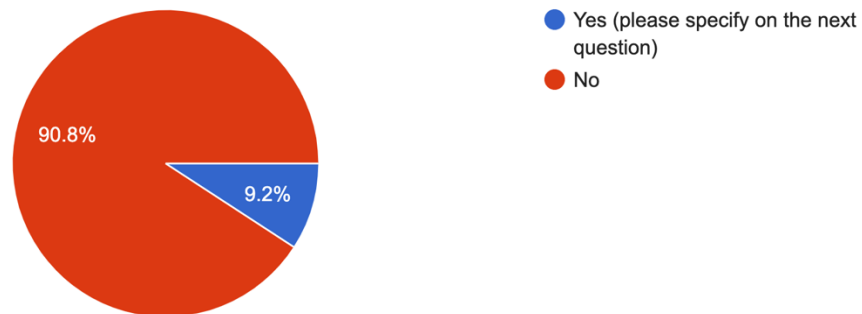
142 responses



- iv) For the question related to healthcare spending, interviewees usually spend at an average level as there are 37.3% responses for '3' out of '5'. 23.2% of them response for both level '2' and '4'.

Do you currently suffer from any chronic disease (e.g. Cancer, Viral disease, Alzheimer's, diabetes, lung or kidney disease)?

142 responses



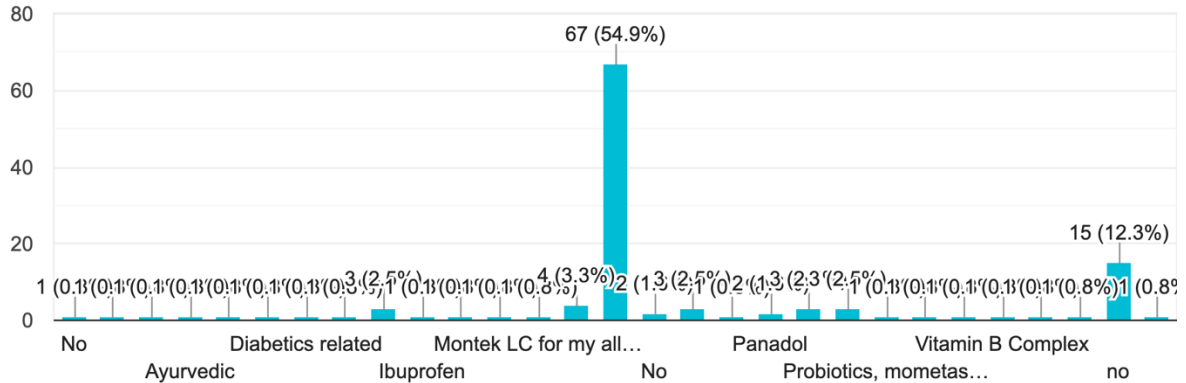
If you chose "Yes" for the previous question, please specify what kind(s) of chronic diseases you are suffering from.

12 responses

- v) 90.8% of interviewees are not currently suffering from chronic diseases while 9.2% of them are suffering from chronic diseases. Those chronic diseases are suggested as follows: diabetes, hypothyroidism, gastritis, mononucleosis, HPV, liver disease, asthma and allergies.

In the past 48 hours, what type of medications have you taken? If you have not take any, please just write down 'No'.

122 responses



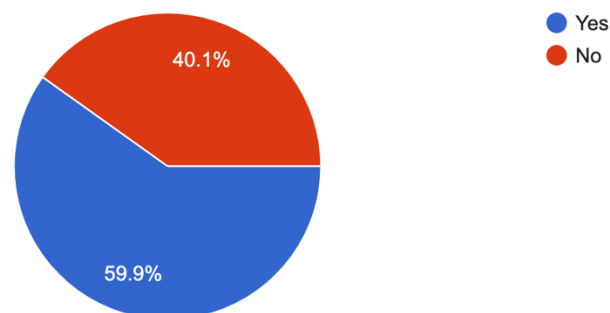
- vi) Out of 122 responses, 93 respondents answer they have not taken any type of medication for 48 hours, but there are some various types of medications provided by the rest of 29 respondents as follow: anti-virus drug, antidepressant, supplements (vitamin complex, calcium, omega 3), metformin, viagra, paracetamol, Livin tablet, synthetic T4, ayurvedic, Panadol, fungal nail related drugs, alterin tablets and ibuprofen.

3) Specific Questions: Our project

- a) General awareness and preference on Synthetic Biology

Do you know or have you ever heard of 'Synthetic Biology'?

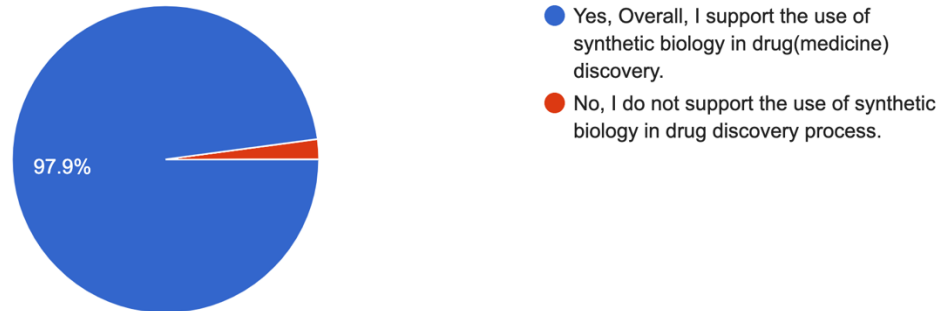
142 responses



- i) Nearly 6 out of 10 interviewees answer that they know or have ever heard of what 'Synthetic Biology' is while 4 out of 10 interviewees say they do not know or have not heard about synthetic biology.

Do you think Synthetic Biology is an important and innovative approach to facilitate the discovery of new and effective medicine?

142 responses



Why do you support/not support the use of Synthetic Biology in Drug Discovery?

72 responses

Expand new ways to find new drugs

COVID 19

On one hand, modeling biological systems and bypassing faulty pathways can in theory help discover effective drugs. However, care is needed to ensure there are no long term side effects

Can help to heal more people especially for those whose illness can't be fully healed

I am be benefited from it one day

Maybe lower the cost of manufacturing.

If it could approach a new cure or medication I don't see why not

that is a great improvement of science in humna history

any advanced tech should be supported

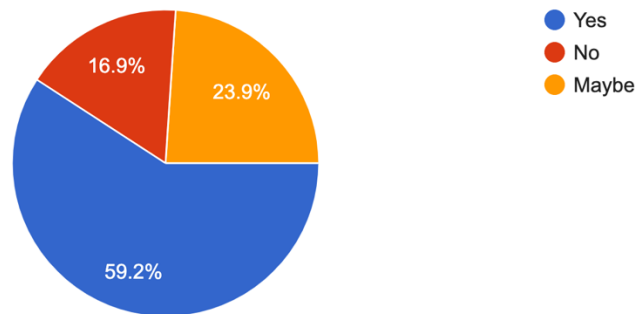
- ii) An overwhelming majority of respondents around 98% support the use of synthetic biology in drug discovery by saying, "It is a novel approach and could be the breakthrough we need in the healthcare field. There seems to be a myriad of possibilities with synthetic biology", "By the research of the biological aspect it can make the drug more accurate to treat the disease", and "I support the use of synthetic biology for new breakthroughs in the field of life sciences".

- iii) Some of them also mention ethical issues or possible side effects even though they support the use of synthetic biology: “It is a different discovery method that shows us a new approach to health problems. So I am not against its usage, until it is not ethically allowed” and “On one hand, modelling biological systems and bypassing faulty pathways can in theory help discover effective drugs. However, care is needed to ensure there are no long term side effects”

b) General awareness and preference on Natural Product

Do you know what is meant by the term “Natural Product”?

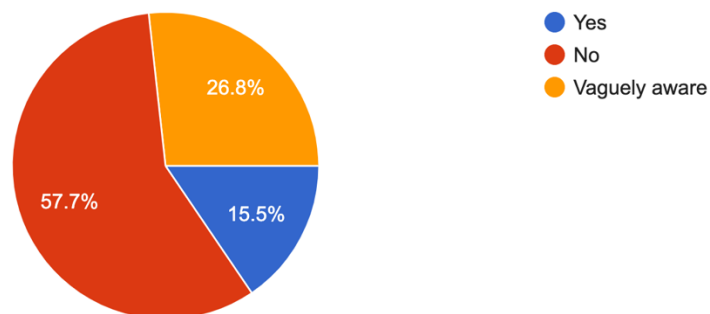
142 responses



- i) Nearly 6 out of 10 people know what the term “Natural Product” is, around one-fourth says they are vaguely aware of the term natural product, and only a minority of 17% says they do not know.

Did you know that in the last 4 decades, about 5% of new medications were derived from natural products, and that 31% were synthetic derivatives ...e to 40% of our arsenal against various diseases?

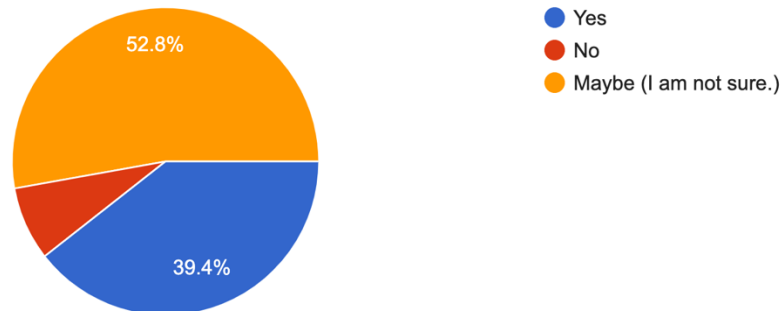
142 responses



- ii) The majority do not know that about 40% of medications were derived from natural products, accounting for 50%. Around one-sixth of the respondents are vaguely aware of this fact, and only a minority of 15% of them say they know.

Do you trust the safety of natural products used in commercial foods, cosmetics and pharmaceutical drugs ?

142 responses



Why do you trust/not trust the use of Natural Products in the food, cosmetic or pharmaceutical industries?

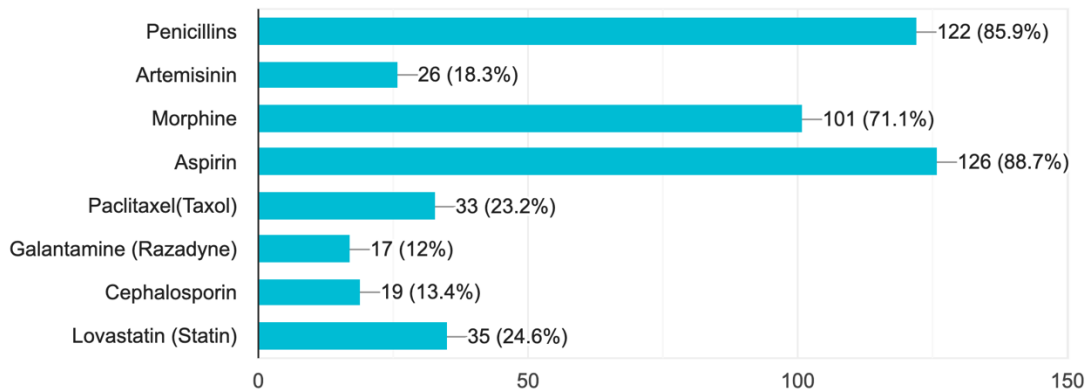
53 responses

- iii) The majority of respondents, around 53% of them, are not sure about the safety of natural products used in commercial foods, cosmetics and pharmaceutical drugs. About 40% of them trust the safety of using natural products and say, "Natural products are natural, they should be safe to consume", "Natural products commonly don't have side-effects" and "They are strictly regulated by government or related associations, so they should be trustable".
- iv) The minority of 7.7% of them do not trust because of the reasons as follow: "derived from natural products does not mean it is safe, eg. natural poisons", "Because natural products may be toxic".

c) Opinions on our project: VarieCure

Have you heard of any of the following pharmaceutical drugs? Please choose all that are true for you.

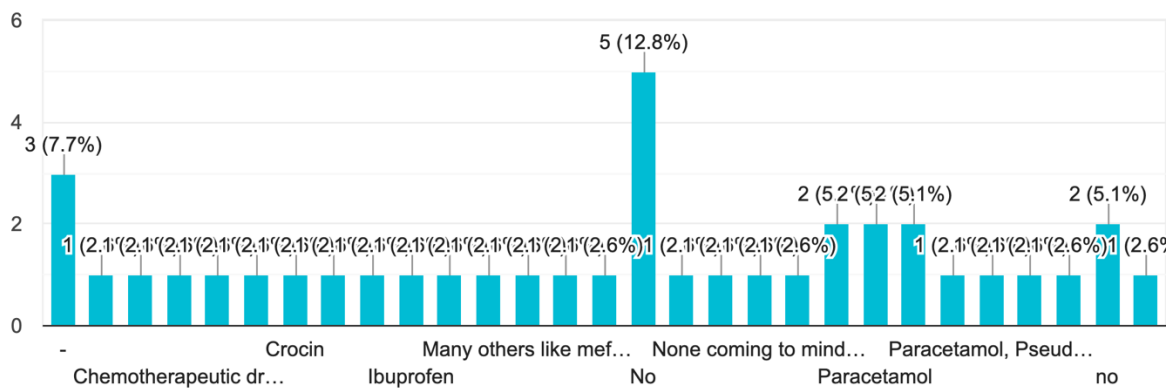
142 responses



- i) The most known pharmaceutical drugs are aspirin, penicillin, morphine, lovastatin (statin) and paclitaxel (Taxol).

What other pharmaceutical drugs do you know of?

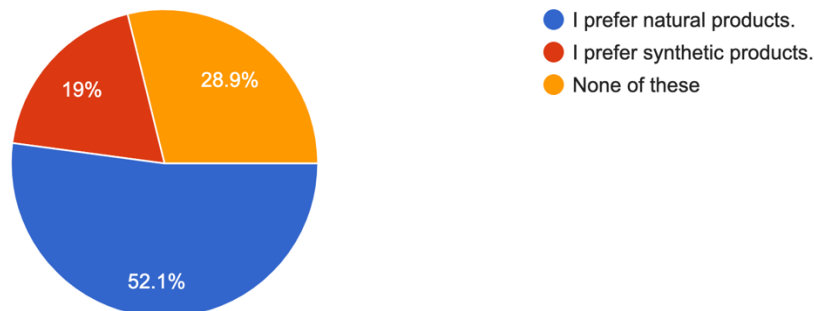
39 responses



- ii) The other pharmaceutical drugs that participants also know include chloroquine, paracetamol, amoxicillin, stugeron, merislon, crocin, melatonin, ibuprofen, albuterol, Panadol and Xanax.

What is your preference in terms of choice of source materials for discovery and production of new drugs?

142 responses



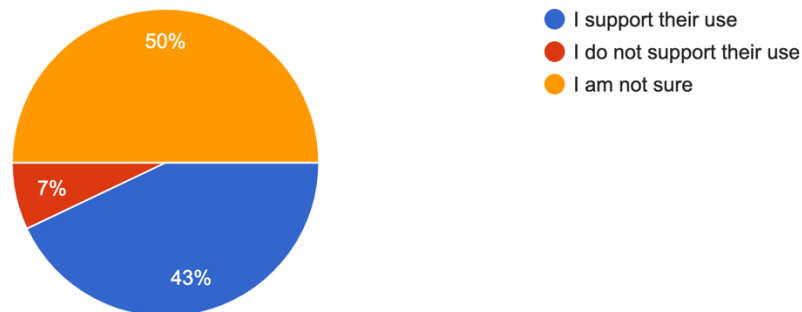
Can you please briefly elaborate on your answer choice for the previous question?

64 responses

- iii) More than 5 out of 10 respondents prefer natural products in terms of choice of source materials for discovery and production of new drugs while 2 out of 10 respondents prefer synthetic products.
- iv) 20% of respondents who prefer synthetic products say "I believe synthetic products would be able to incorporate chemical compounds that can better treat a certain illness than natural products", "Synthetic products may have stronger effects/less contamination than natural products" and "Natural products would be limited in number".
- v) More than 50% of respondents prefer natural products and say "Natural products seem to bear fewer risks on health".
- vi) 30% of them answer they are unsure because "If the new drugs can be developed to save more lives, the source material is actually not a major concern". Some of them also mention "I do not have a strong preference for drug source and discovery. I am primarily interested in ways we can accelerate the drug discovery process and how we can continually produce effective drugs for treatment"

What is your opinion on Genetically Modified Organisms (GMOs) and GM products?

142 responses



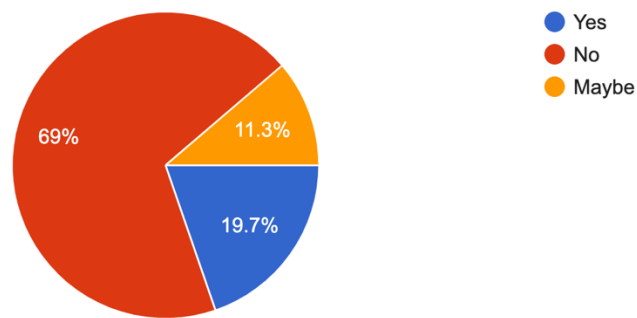
Please briefly elaborate on your answer choice for the previous question.

49 responses

- vii) 43% of interviewees support the use of GMOs and GM products, and half of the survey population are unsure.
- viii) They elaborate their answer by leaving comments as follow: "If it speeds up the discovery process, why not?", "Make our yield more sustainable", "This technology can help us to avoid worldwide famine and pandemics", "GMOs can effectively boost crop yield/nutrient content/climate they can withstand, which would be useful in the changing global climate".
- ix) Only a minority of 7% does not support the use of GMOs and GM products and mentions, "They might produce better yield and size but the negative effects might remain largely undiscovered until it's too late", "It brings various negative impacts on both environment and human health".

Do you know of the fungus *Aspergillus oryzae*?

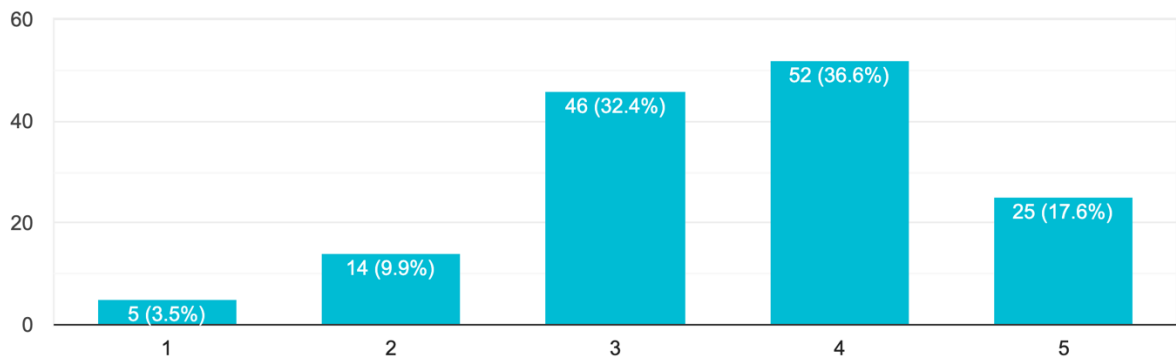
142 responses



- x) Most people of 70% do not know of the fungus *Aspergillus oryzae*. Only 20% knows what it is, and 10% of them are vaguely aware of it.

On a scale of 1 to 5, how interested are you in these novel medicines?

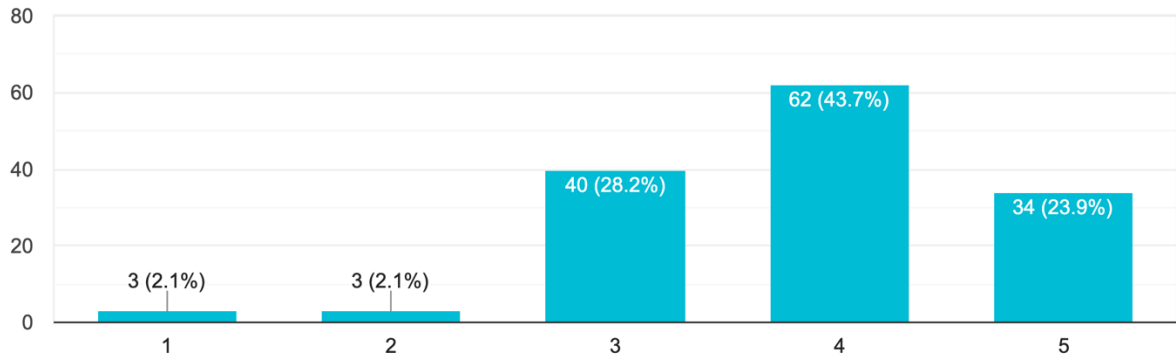
142 responses



- xi) Interviewees are mostly interested in our project, taking up more than 50% of the population. While another 30% are neutral and 15% are not interested.

On a scale of 1 to 5, how effective do you think our project would be in the fight against Emerging Infectious Diseases and Cancer by providing a new platform for the discovery of new medicines?

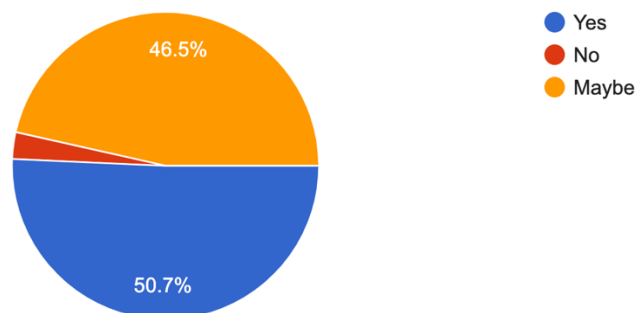
142 responses



xii) The majority, around 70% of respondents, think our project would be effective in the fight against emerging infectious diseases and cancer by providing a new platform for the discovery of new medicines. While 30% of people think that the effectiveness is 3 on a scale of 5. And a minority of 2.1% thinks our project is not effective.

If our iGEM team successfully identifies a new drug produced by a genetically-modified fungus, which is very effective for cancer treatment or ver...f infectious diseases, would you consider using it?

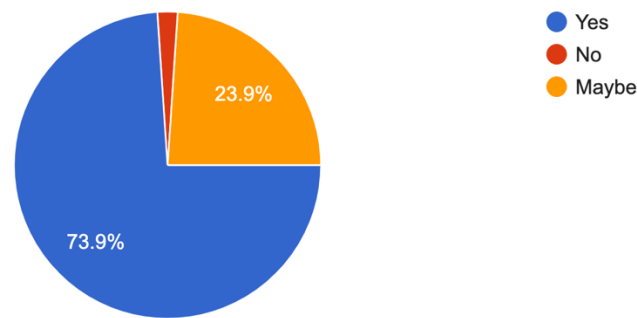
142 responses



xiii) Interviewees are mostly divided into two groups, which are “maybe” and “yes”, 46% and 51% respectively. So, an overwhelming majority of respondents answer that they would consider using the final product of our project if there is a successfully identified new drug by genetically modified fungus, which is very effective for cancer treatment, or for infectious diseases. And only 3 people out of 142 say “no”.

Do you feel that you learnt something new while answering this survey?

142 responses



xiv) 74% of participants say they have learnt something new after completing our public survey questions, and 24% of people are natural.

Discussion

More than half of respondents care about health well in their life as they choose 4-5 on a scale of 5, and over 94% of them are aware that being free from illness or injury directly affects our capacity to enjoy life. This indicates that interviewees mostly consider being healthy as essential in their life, usually spend their income for healthcare products or services at an average level, and have a general understanding of the impact of health on the good quality of life.

Only 13 people out of 142 respondents are currently suffering from chronic diseases such as diabetes, HPV, liver diseases, hypothyroidism, mononucleosis, asthma and allergies. However, 29 respondents say they have taken various types of medications in the past 48 hours. This implies that some of the interviewees take different types of medications in a day even if they are not suffering from chronic disease to enhance their daily health condition or mental health. Furthermore, as one-tenth of interviewees are suffering from chronic diseases, there is still a high chance of getting infectious or debilitating diseases and a high demand for new effective drugs in spite of the advanced medical science.

Surprisingly, more than half of the participants have ever heard of synthetic biology. 98% of interviewees support the use of synthetic biology in drug discovery after providing them with an introduction of what synthetic biology is. Most of the respondents have a positive impression of synthetic biology and its use in the drug discovery industry. Yet, some of them mention ethical issues and possible side effects even though they support synthetic biology.

While there is quite high awareness and support for synthetic biology, the awareness and preference related to the term 'natural products' are very low: nearly 4 out of 10 people are vaguely aware or do not know what the term natural product is. The majority of respondents do not have knowledge of the fact that 40% of medications were derived from natural products, except the minority of 15%. Additionally, 60% of respondents are not sure or do not trust the

safety of natural products used in current industries because of possible toxicity from natural poisons. Throughout these responses, we checked that there is a need to increase the awareness of the application of natural products in drug discovery to the public. Also, we realised the possible toxicity of nature, where resources for our VarieCure project comes from, should be considered.

When we introduce interviewees about our project: VarieCure, the interviewees mostly show their interest in our project. More than half of the respondents prefer natural products rather than synthetic products in terms of choice of source materials for discovery and production of new drugs because they think natural products have fewer risks on health, even though 60% of respondents do not strongly support the safety of natural products. 70% of respondents think our project would be effective in the fight against emerging infectious diseases and cancer by providing a new platform for the discovery of new medicines. Moreover, an overwhelming majority of respondents is willing to use the final product of our project if there is a successfully identified new drug by genetically modifying fungus for cancer or infectious diseases treatments. Hopefully, this proves that the public opinion toward our project 'VarieCure' is very optimistic and open-minded, which encourages our project.

Conclusion

During the whole investigation, we have gathered opinions regarding the public awareness of synthetic biology, natural products and their use in pharmaceutical drugs, as well as the feedback from our project 'VarieCure'. Among 142 respondents, the majority of them are aware of what synthetic biology is, yet they do not know what the term natural product is. Fortunately, we found that respondents are interested in our project 'VarieCure'. They are willing to use our final product as a new treatment for cancer and infectious diseases if we successfully identify new derivatives of variecolin by using biosynthetic progress with the fungus *Aspergillus oryzae* at the end of our project.

Overall, the respondents think the source of material in pharmaceutical drug discovery is not a major concern, whether the source is prepared from laboratory or came from nature. They support a more efficient and sustainable process of drug discovery for treatment because of its benefits, which provide no negative impacts on both environment and human health. Ethical issues, expensive costs, and unreliable credibilities or regulations are the major reasons why people hesitate when they choose between synthetic products and natural products as source material for new drugs.

Therefore, we, the CityU iGEM 2021 team, VarieCure, aim to promote the general population to live a healthier life by discovering novel derivatives of variecolin in an ethical, cost-effective, efficient manner with reliable credibility. And we also promote synthetic biology to address concerns related to global health challenges, including infectious diseases and debilitating diseases such as cancer. Multiple approaches have been progressed in an attempt to educate international high school students in different countries, spread synthetic biology keynote through symposiums, draw public attention by creating a YouTube channel, making educational comics and establishing social media pages.

Appendix

*Extract of the online survey

CityU iGEM 2021 Public Survey

The iGEM (International Genetically Engineered Machine) Competition is an annual, world wide synthetic biology event that gives students the opportunity to push the boundaries of synthetic biology by tackling everyday issues facing the world. And constructing solutions using synthetic biology and biotechnology.

The CityU iGEM Team 2021 - VarieCure - has decided to tackle the problem of Emerging Infectious Diseases. Our goal is focused on the development of a Biosynthetic platform using a fungus *Aspergillus oryzae* to discover novel derivatives of Variecolin - a Natural Product with strong Anti-Bacterial and Anti-Cancer Properties.

This Public Opinion Survey is aimed at gathering data on:

1. The public awareness on Synthetic Biology.
2. The public awareness on Natural Products and use of natural products as a source of pharmaceutical drugs.
3. Public opinions on our project and methods to tackle the above mentioned problems.

Disclaimer: The data collected is completely anonymous.

* Required

[General Questions: Background]

1. What is your age? *

- ☐ Under 12
- ☐ 12-18
- ☐ 19-25
- ☐ 26-35
- ☐ 36-45
- ☐ 46-55
- ☐ 56-65
- ☐ Over 65

2. What is your gender? *

- ☐ Female
- ☐ Male
- ☐ Prefer not to say

3. What is your Highest Level of Education? *

- ☐ Primary School
- ☐ Secondary School
- ☐ Post-secondary (Undergraduate)
- ☐ Post-Graduate and above

4. Are you affiliated with the City University of Hong Kong? *

- ☐ Yes
- ☐ No

5. Where are you from? *

- ☐ Asia
- ☐ Europe
- ☐ North America
- ☐ South America
- ☐ Africa
- ☐ Australia

[General Questions: Health]

6. On a scale of 1 to 5, how physically healthy would you consider yourself to be? *

	1	2	3	4	5	
Not healthy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Really healthy

7. On a scale of 1 to 5, to what extent do you take care of your health? *

	1	2	3	4	5	
Not Interested	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Really Important

8. On a scale of 1 to 5, to what extent do you think being free from illness or injury directly affects our capacity to enjoy life or have a good quality of life? *

	1	2	3	4	5	
Unrelated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very related

9. On a scale of 1 to 5, how much do you spend on healthcare products or services? *

	1	2	3	4	5	
Do not spend	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Spend alot

10. Do you currently suffer from any chronic disease (e.g. Cancer, Viral disease, Alzheimer's, diabetes, lung or kidney disease)?

- ☐ Yes (please specify on the next question)
- ☐ No

11. If you choose “Yes” for the previous question, please specify what kind(s) of chronic diseases you are suffering from.

12. In the past 48 hours, what type of medications have you taken? If you have not take any, please just write down ‘No’.

[Specific Questions: Our Project]

13. Do you know or have you ever heard of ‘Synthetic Biology’? *

- ☐ Yes
☐ No

Synthetic biology is a field of science that includes the design and construction of new biological parts, devices, biological systems, or the re-design of existing natural biological systems for useful purposes using bioengineering approaches.

14. Do you think Synthetic Biology is an important and innovative approach to facilitate the discovery of new and effective medicine? *

- ☐ Yes, Overall, I support the use of synthetic biology in drug(medicine) discovery.
☐ No, I do not support the use of synthetic biology in drug discovery process.

15. Why do you support/not support the use of Synthetic Biology in Drug Discovery?

16. Do you know what is meant by the term “Natural Product”? *

- ☐ Yes
- ☐ No
- ☐ Maybe

Natural products are substances or chemical compounds produced by living organisms and include biotic materials (e.g., wood, silk, fungi), bio-based materials (e.g. bioplastics, cornstarch), bodily fluids (e.g. milk, plant exudates), and other natural organic materials (e.g. soil, coal). Natural products have also been extended to include commercial products such as cosmetics, dietary supplements, pharmaceutical drugs and synthetic foods produced from natural sources without added artificial ingredients.

17. Did you know that in the last 4 decades, about 5% of new medications were derived from natural products, and that 31% were synthetic derivatives of natural products, forming close to 40% of our arsenal against various diseases? *

- ☐ Yes
- ☐ No
- ☐ Vaguely aware

18. Do you trust the safety of natural products used in commercial foods, cosmetics and pharmaceutical drugs ? *

- ☐ Yes
- ☐ No
- ☐ Maybe (I am not sure.)

19. Why do you trust/not trust the use of Natural Products in the food, cosmetic or pharmaceutical industries?

20. Have you heard of any of the following pharmaceutical drugs? Please choose all that are true for you. *

- ☐ Penicillins
- ☐ Artemisinin
- ☐ Morphine
- ☐ Aspirin
- ☐ Paclitaxel(Taxol)
- ☐ Galantamine (Razadyne)
- ☐ Cephalosporin
- ☐ Lovastatin (Statin)

21. What other pharmaceutical drugs do you know of?

Synthetic medicinal products are usually created in pharmaceutical laboratories by mixing different chemicals or intermediate compounds and substances prepared in the laboratory.

22. What is your preference in terms of choice of source materials for discovery and production of new drugs? *

- ☐ I prefer natural products.
- ☐ I prefer synthetic products.
- ☐ None of these.

23. Can you please briefly elaborate on your answer choice for the previous question?

24. What is your opinion on Genetically Modified Organisms (GMOs) and GM products? *

- ☐ I support their use
- ☐ I do not support their use
- ☐ I am not sure

25. Please briefly elaborate on your answer choice for the previous question.

26. Do you know of the fungus *Aspergillus oryzae*? *

- ☐ Yes
- ☐ No
- ☐ Maybe

Aspergillus oryzae, also known as 'kōji mold' is a fungus that is quite popular in the food industry, especially in East Asia. It is used to make alcoholic beverages such as saké and shōchū, and also for making soy sauce and miso. It is referred to as "national fungus" in one of the journals by the Brewing Society of Japan.

Saké



Our iGEM Team has recently discovered that *Aspergillus oryzae* can be genetically engineered to produce various derivatives of the natural product - Variecolin - which has been found to possess potent antimicrobial and anticancer properties.

27. On a scale of 1 to 5, how interested are you in these novel medicines? *

1 2 3 4 5

No Interested ☐ ☐ ☐ ☐ ☐ Very Interested

28. On a scale of 1 to 5, how effective do you think our project would be in the fight against Emerging Infectious Diseases and Cancer by providing a new platform for the discovery of new medicines? *

1 2 3 4 5

Not effective ☐ ☐ ☐ ☐ ☐ Very effective

29. If our iGEM team successfully identifies a new drug produced by a genetically-modified fungus, which is very effective for cancer treatment or very effective for treatment of infectious diseases, would you consider using it? *

☐ Yes

☐ No

☐ Maybe

30. Do you feel that you learnt something new while answering this survey? *

- ☐ Yes
- ☐ No
- ☐ Maybe

31. Any other opinions on our Project or on Synthetic Biology?
