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SYNTHETIC BIOLOGY REVIEW

A GLOBAL JOURNAL

Multilingual 50 page feature on interdisciplinary questions tackled by young scientists. Features the work of iGEM teams from around the world.

Stony Brook University iGEM 2022

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INTRODUCTION

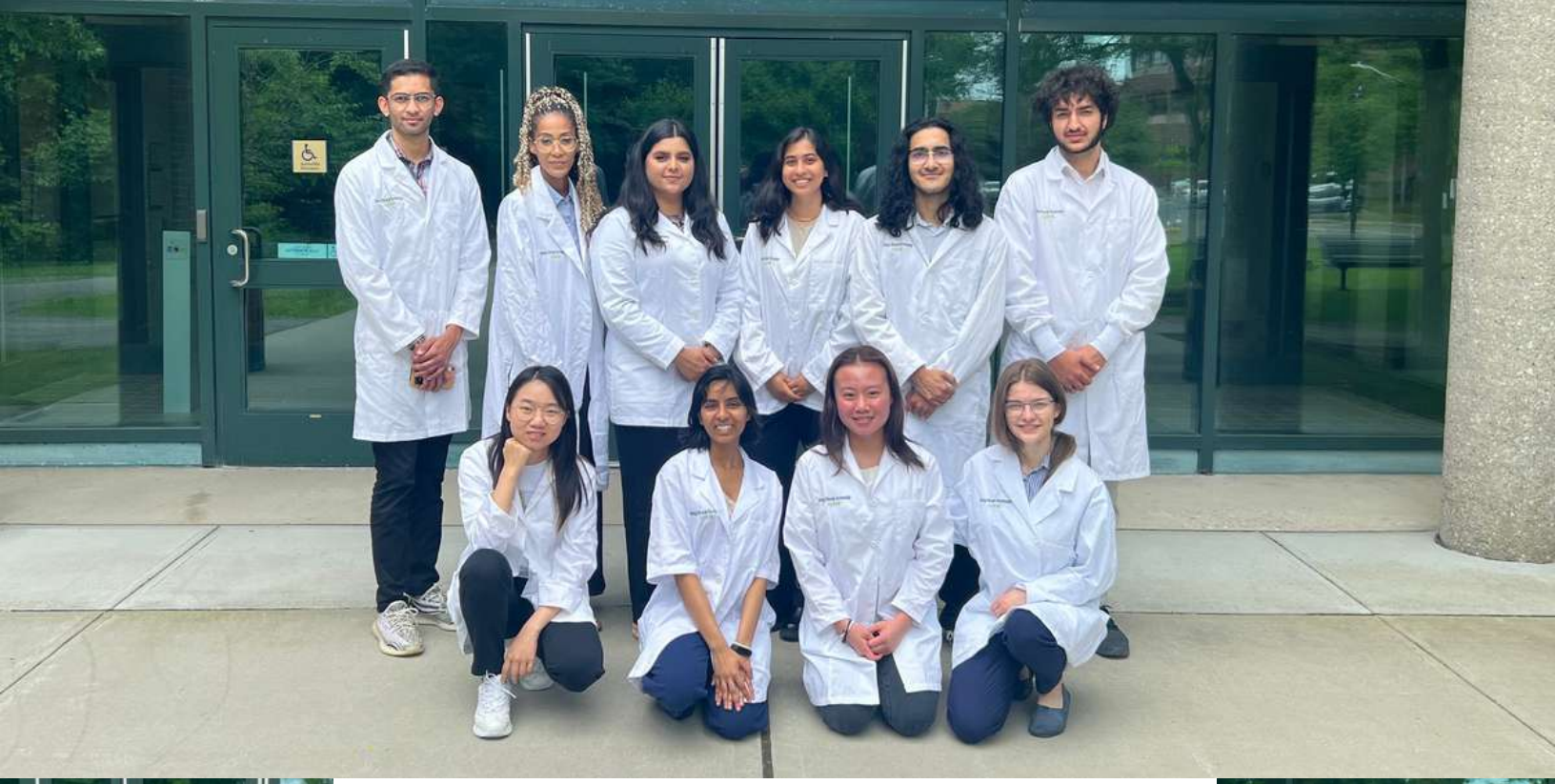
In this scientific magazine, we have the pleasure to present the work of iGEM students around the world. iGEM, which stands for "International Genetically Engineered Machine," is a competition where student teams apply synthetic biology and introduce novel DNA and innovate biological systems, in order to solve issues in the world.

Between hours of surveying their surroundings, designing their projects, searching the literature, working in the laboratory, formulating mathematical equations, and being carefully aware of existing inequities in their fields, these young scientists are taking steps to creating a safer, better, and healthier world.

Join us on this journey and explore the specifics of their projects. We call for the support of young science and synthetic biology, and we hope that you too will feel so compelled after exploring this selection of scientific works.

Eva Paruch and Lori Saxena
2022 Stony Brook University iGEM Team
Stony Brook University
Team Leaders

August, 2022



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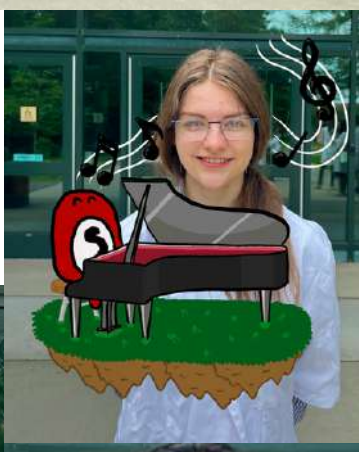
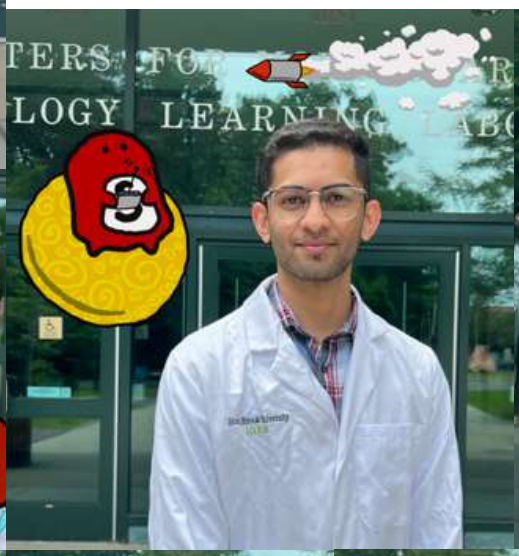

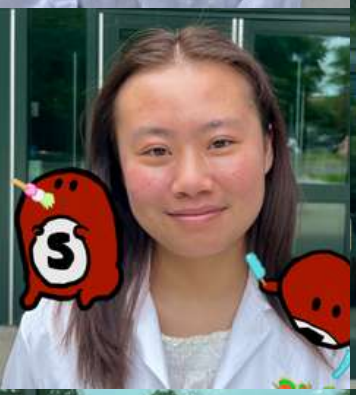
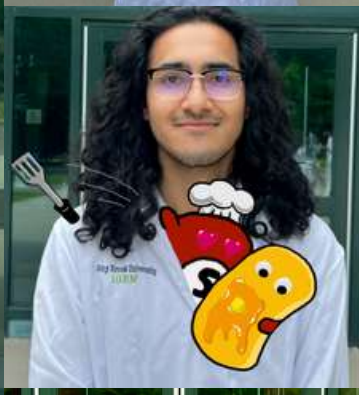


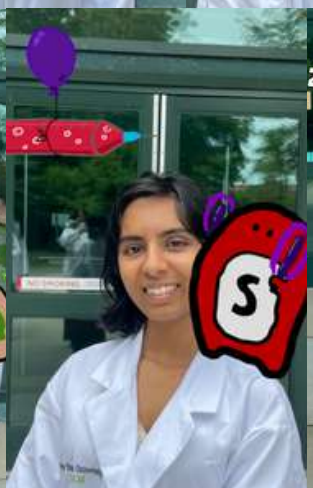

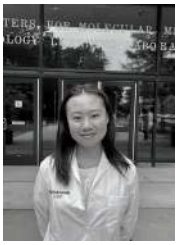

Stony Brook University

2022 iGEM Team

Ya Jing Chen

WHAT IS SYNTHETIC BIOLOGY?

A Brief Overview

The History of Manipulating Genes

DNA is the biological code present in every single cell, and it carries all of the genetic information for every living organism. It determines an organism's species, biological sex, and physical traits and characteristics. For humans, it determines all of our traits, such as the shape of our nose, hair color, eye color, and even whether we can roll our tongue or not.

Synthetic biology is an emerging field of biology in which scientists are studying how to manipulate DNA in order to redesign organisms to have specific abilities and traits. Although synthetic biology is a relatively new field, selecting organisms for certain desired traits is not a new concept.

For years, humans have selected for desired traits using conventional breeding methods. For example, by breeding a fruit plant with small seeds with a fruit plant that produces big fruit, farmers can create a plant with both big fruit and small seeds. However, with the development of synthetic biology, scientists now have the tools to genetically modify a plant that will yield both big fruit and small seeds by directly placing the DNA which causes those two traits, the genes of interest, into the plant's genome. This modern technique is more efficient, and allows for the placement of multiple desirable genes into an organism.

IN THE 1970S, SCIENTISTS FOUND A WAY TO EASILY MASS-PRODUCE HUMAN INSULIN WITH MINIMAL SIDE EFFECTS, BY USING GENETICALLY ALTERED E. COLI BACTERIA. THIS IS STILL THE CURRENT SOURCE OF MANY INSULIN PRODUCTS ON THE MARKET.

1923
Insulin first discovered by **Frederick Banting** and **Charles Best**.

ELI LILLY
One of the developers of mass producetion of insulin.

1978
Insulin produced using E. coli and genetic engineering.

In recent history, there have been several improvements in the field of synthetic biology. For example, Dolly the sheep was a landmark case. Dolly was the first ever cloned mammal. Another example include genetically modified organisms (GMOs), which are currently used in many farming systems to provide a more abundant harvest and more nutrient dense food. For example, golden rice is a type of rice that has been manipulated to produce beta-carotene. Vitamin A deficiency can be combated with beta-carotene, preventing blindness in children and lowering the risk of infectious disease.

Synthetic biology has also been used to create new medical treatments. In the 1920s, diabetics used insulin extracts derived from purifying animal pancreases. However, this had many risks and side-effects. In the 1970s, scientists found a way to easily mass-produce human insulin with minimal side effects, by using genetically altered E. Coli bacteria. This is still the current source of many insulin products on the market. Overall, the development of synthetic biology and synthetic biology techniques has created many products that have significantly benefited society in various ways.

Emerging Techniques of Synthetic Biology

While genetic engineering may seem as limitless as inserting any gene of interest into an organism (host), this can be an oversimplified approach. When inputting a gene of interest, one must consider how the host cell will interact with the gene. Even if the host cell was to accept the DNA, not all cells have evolved the machinery to create proteins and other biological materials in the same procedure as other cells. This can result in a protein product that is different from the one that was desired. Despite these challenges, synthetic biology has come a long way.

When compared to traditional cell cultures, plants are an increasingly attractive option as hosts. Plants allow for the harnessing of photosynthesis to create a desired molecule. Additionally, plants already create bioactive molecules (for example, dhurrin, a natural pesticide), and are a great option for the large-scale manufacturing of biological materials. For example, tobacco plants have grown vaccines that fight malaria, anthrax, hepatitis and influenza. The future of "pharming" seems very bright for commercialization, as plants can produce human therapeutic agents more cheaply when compared to traditional methods.

Plants are not the only frontier that synthetic biology is using to impact medicine. In a process called xenotransplantation, pigs are being genetically altered to help with the shortage of organs in the medical world. In the future, it may be possible that pigs have a genome that is human-like enough to provide organs which can be successfully implanted into patients.

Another example of an application of synthetic biology is chimeric antigen receptor (CAR) technology. CAR T-cells (which are part of the immune system) can be genetically programmed to kill cancer cells. Other applications include viruses which can correct inherited genetic disorders such as Severe Combined Immune Deficiency (SCID) and epidermolysis bullosa. Because these disorders are inherited from parents at birth, and are caused by genetic mutations, traditional medications cannot directly target the root cause. However, synthetic biology techniques can help fix these mutations and cure these disorders. These are just a few examples of the ways in which new approaches using synthetic biology can save lives and alter existing therapies.

There are many cases in which biology and emerging technology can partner together to revolutionize industry. For example, cybernetics, which involves computer control of a gene. When a computer is triggered by a certain signal, it can turn a gene "on" or "off." This technology allows for the selectivity of choosing when a gene is activated and expressed. Furthermore, artificial intelligence is also being used to help predict which combinations of host cells and genes of interest will yield functional results, thereby saving the time and resources that would have gone into creating a defective product.

Overall, synthetic biology is a rapidly developing sector, in which innovative ideas allow for more successful and intricate organisms to be created. In 2016, the Defense Advanced Research Projects Agency (DARPA) challenged MIT-Broad Institute Foundry to create 10 molecules unknown to researchers within 90 days. By using a variety of techniques, both new and old, six molecules were successfully created for use by the US Department of Defense, showing that synthetic biology has the potential to bridge the gap in material shortages in a short amount of time. The increasing development of synthetic biology has drawn interest from people outside of biology, including but not limited to, polymer chemists, physicists, engineers, and politicians.

Illustration by Kimberly Ca

Additionally, scientists also answer to their local authorities for certain projects where there are biosecurity concerns. For example, the Federal Select Agents Program has control over high-risk infectious agents. If researchers want to work with such agents, they are held to strict regulations. Another example is the Dual Use Research of Concern (DURC) policy that all NIH-funded research requires labs to follow if they work with high-risk infectious agents. Furthermore, if all local governments set a precedent of what is acceptable in scientific research, all scientists will know what boundaries must not be crossed.

Another current concern over synthetic biology is the scalability of current research. Researchers are incentivized to publish their findings in scientific journals. Published projects usually contain the procedures used. However, projects that work in the lab may not be scalable or easily mass-produced at an industrial level. For this reason, all major players that are involved in making science available to the public: academia, government, and industry, should work together tangentially on projects. If all parties regularly collaborate as a project progresses, each sector can have input on how to best distribute the science that is being developed.

Current Barriers

There are many ethical concerns associated with synthetic biology. One such concern is that scientists may utilize synthetic biology for a reason that is not agreeable to others within the scientific community. There are also concerns that once developed, new synthetic biology treatments may not be available for everyone due to cost barriers. One way to tackle these problems is to have open communication between scientists and the public about current projects. By allowing the risk and benefits associated with each project to be transparent, people can decide for themselves if a project is ethical. Furthermore, it will eliminate the hesitation of the public regarding synthetic biology.

Scientists should also consider a more collaborative environment. For example, if the scientific community had a standardized method of recording all findings on synthetic biology, it would make it easier for future researchers to understand which parts to choose for the project they are creating. Pooling together such information might also advance the artificial intelligence programs which currently suggest what biological parts are best suited for use together. Artificial intelligence is more likely to produce correct answers when given a large database of information. Having more information will also allow scientists to better develop the code for their programs.

Lastly, scientists from different specializations should consider collaborating on projects more frequently. Because synthetic biology is an emerging field that attracts people of many backgrounds, involving experts from various fields can contribute to creating a project that addresses the needs of many different communities, takes into account various different perspectives, and has an overall wider impact.

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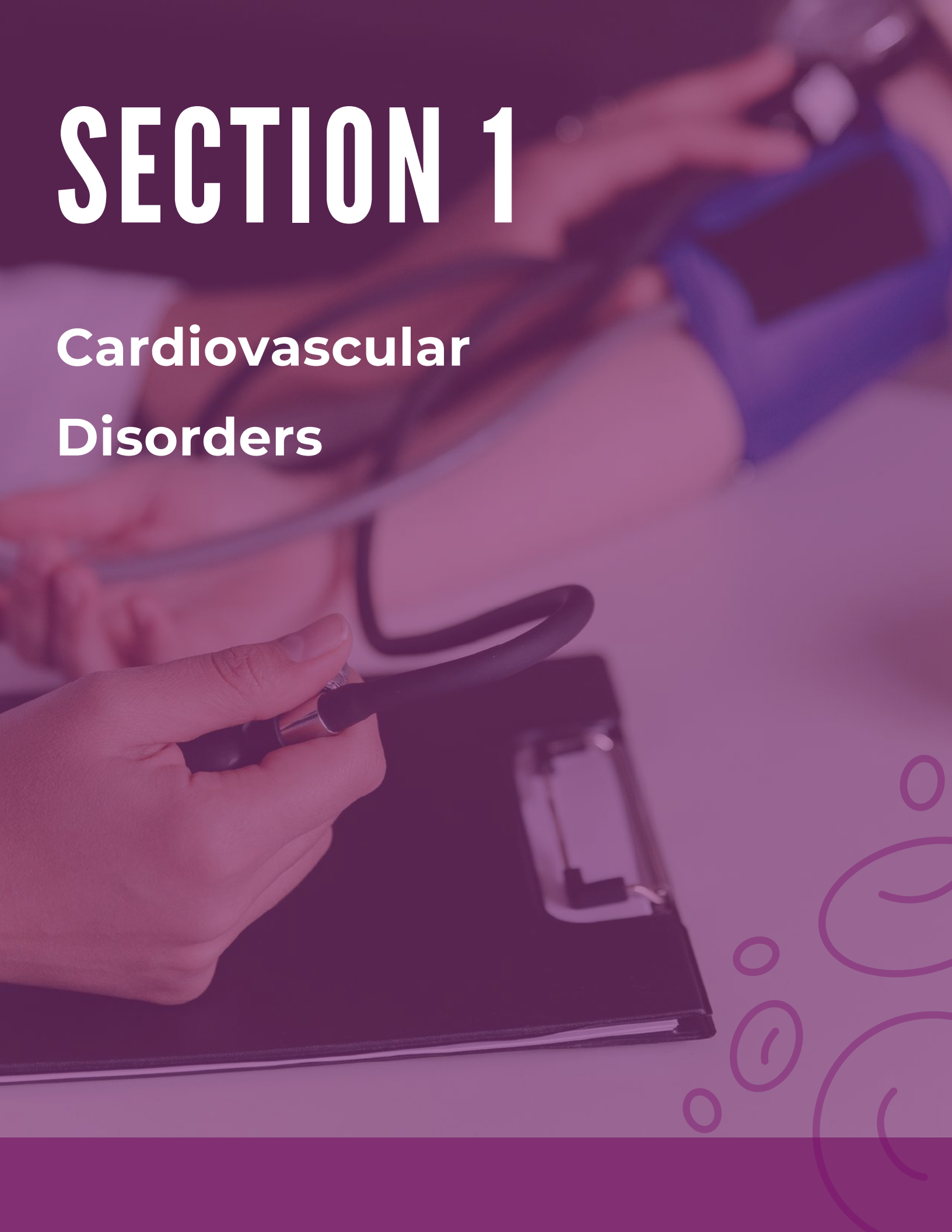

SECTION 1

Cardiovascular Disorders

PROTEIN S

A REVIEW OF PULMONARY EMBOLISM

Isam Adnan and Eva Paruch, iGEM

Stony Brook University

Venous thromboembolism (VTE), also known as abnormal blood clotting, is a disorder that includes deep vein thrombosis (DVT) and pulmonary embolism (PE). A deep vein thrombosis (DVT) occurs when a blood clot forms in a deep vein, usually in the lower leg, thigh, or pelvis. This blood clot then travels through the bloodstream and lodges in the lungs, causing a pulmonary embolism (PE). These clots can quickly result in life-threatening consequences and even death.

Blood thinners (anticoagulants) and clot dissolvers (thrombolytics) are commonly used to treat PE. They are not always expensive, but can have dangerous side-effects, especially when administered life-long, which is usually the case in people with protein S deficiency and other coagulation disorders. Furthermore, blood thinners such as Warfarin cause placental bleeding and may not always be safely administered during pregnancy.

PEs are the third most common cause of cardiovascular death. They are often caused by old age, blunt trauma, fractures, age, blunt trauma, fractures, infectious material, or tumor emboli. A potential PE can be distinguished by a patient's uniquely rapid heartbeat and unexplained shortness of breath. Despite major strides made in the development of diagnostic tools to detect PE, many cases go untreated.

There is a major difference in the mortality rate of untreated PE cases (30%) compared to the mortality rate of diagnosed and treated PE cases (8%). Recent data suggests that almost 33% of hospitalized patients are at risk of VTE, and that approximately 31% of the 38 million US hospital discharges were considered to be at risk of VTE. However, despite these risks, it is reported that many eligible patients either receive no or suboptimal preventative treatment. Increases in treatment rates could increase our ability to prevent PE-related deaths.

There are two different types of treatments currently available for patients with PE: conservative and surgical. Conservative treatment involves the administration of antibiotics, anticoagulation drugs, or analgesics. The most common drugs administered are Heparin and Warfarin. Heparin prevents the growth of existing blood clots, while Warfarin disrupts the blood clotting cycle, resulting in a longer period of time before new clots can develop. Though effective, these drugs can have many unwanted side effects such as bleeding, hemorrhages, abdominal pain, thrombocytopenia, nausea, etc. These risks are further compounded by the fact that patients often need to remain on blood thinner treatments for life.

Major advances have been made in the technology used to detect diseases such as VTE. However, the mortality rates for the disorder are significantly high, and continue to rise. Countless studies support that PE prevention and diagnosis is significantly under-prioritized in the modern American healthcare system. The Stony Brook University iGEM Team of 2022 is focused on creating a novel alternative treatment to the modern drugs currently used in the conservative treatment of PE, as well as improving diagnostic methods for related disorders. This is just one example and one little step towards a greater focus on the treatment of coagulation disorders in the US healthcare system, but also in the general population.

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HEALTHCARE INEQUALITY ON LONG ISLAND: CARDIOVASCULAR DISEASES

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Cardiovascular diseases include heart disease, heart attack, stroke, heart failure, arrhythmia, and heart valve issues. Heart disease is characterized by problems of the heart and blood vessels. Heart attacks and strokes occur when a portion of the heart or brain do not receive adequate blood flow. Heart failure occurs when the heart doesn't pump as effectively as normal. Finally, arrhythmia is characterized by an abnormal heartbeat.

A population's cardiovascular health trends are important to consider when looking at their health at large.

Long Island's Nassau County is a suburb where many residents' incomes are above the American average. One would assume that the healthcare outcomes are equally distributed across the county, but the distribution of different ethnic groups across the county creates different healthcare trends; residents that live in underserved, low-income, or minority communities are disproportionately affected by diseases. The main cause of death for residents in nearby Suffolk County is heart disease. According to the Suffolk County Community Health Needs Assessment, cardiovascular disease can stem from obesity at the

pediatric level. There are many school districts in Suffolk County that cite more than 40% of their students either as overweight or obese. By addressing obesity at the pediatric level, conditions such as cardiovascular disease can be prevented in the future for those individuals.

Healthcare inequality in Long Island shows up in its cardiovascular disease trends. However, by increasing access to healthcare to different minority groups and using inclusive language, it is possible to work towards addressing healthcare inequality in terms of cardiovascular disease in the Long Island region.

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SECTION 2

Protein S and Protein S Deficiency

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2022 iGEM Team

Maira Riaz

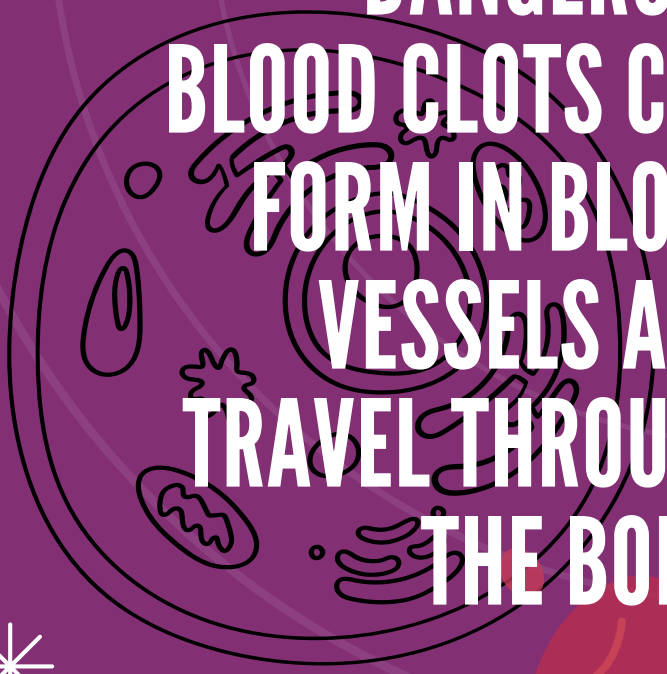
PROTEIN S DEFICIENCY LITERATURE REVIEW

Protein S is a protein found in plasma that is made in the liver, and prevents blood clots from forming. Protein S is dependent on vitamin K to function properly, and typically works to keep blood in a liquid state. It is present in the blood at low concentrations; 40% of protein S is in a free state and 60% of it is bound to another protein called C4b-binding protein (C4BP). When protein S is bound to C4BP, it increases the effects of activated protein C, which works to inhibit factors that contribute to blood clots. Both protein S and protein C work to control excess clotting at various points, and in a person that is protein S deficient, this process goes unchecked which can lead to serious complications.

A person who is protein S deficient is at an increased risk for abnormal clotting and life-threatening conditions such as deep vein thrombosis (DVT) and pulmonary embolism (PE). DVT occurs when there is a blood clot that forms in the deep veins of limbs, typically in the legs. Symptoms of DVT include pain, swelling, and redness in the affected leg. Symptoms of PE include, but are not limited to: sudden shortness of breath, chest pain, feeling anxious, dizziness, fainting, heart palpitations, coughing, excess sweating, and low blood pressure. here are three different types of protein S deficiency. In type I, patients produce an insufficient amount of

PROTEIN S PREVENTS BLOOD CLOTS FROM FORMING. WHEN IT IS LACKING, DANGEROUS BLOOD CLOTS CAN FORM IN BLOOD VESSELS AND TRAVEL THROUGH THE BODY.

Illustration by Kimberly Carrera



DVT
Deep vein thrombosis
More in article on the next page.

PE
Pulmonary embolism
More in section 1, article 1.

PROS1
Gene that encodes human Protein S.

both free and C4BP bound protein S. In type II, patients produce a normal amount of both forms of protein S but there is decreased activity, making protein S nonfunctional. Finally, in type III, patients also produce a normal amount of the bound protein; however, levels of free protein S are low.

Protein S deficiency results from mutations in the PROS1 gene that encodes for protein S. If an individual inherits the defective gene from just one of their parents, then there is a 50% chance that they will develop venous thromboembolism (VTE), which includes DVT and PE. In cases where an individual inherits two copies of the mutated PROS1 gene from each parent, the result is a life-threatening condition called purpura fulminans. This occurs during the neonatal period, and it causes clots in the small blood vessels to develop and lead to necrosis, or death of the affected tissue cells.

In addition to these disorders, protein S deficiency makes it difficult for women to carry children to term, often resulting in fetal loss. Severe protein S deficiency can be difficult to diagnose and often gets overlooked in individuals who present symptoms of VTE. In individuals who do not have a family history of the deficiency, the incidence rate is 0.03-0.13%. However, in patients who have a family history of VTE, this rate increases to 3-5%.

The standard therapy for protein S deficiency is to take blood thinners such as heparin and warfarin. However, these drugs have side effects such as skin necrosis and some individuals depend on these drugs during their entire lifetime. Furthermore, warfarin results in birth defects for pregnant women. Besides low-dose aspirin, low molecular weight heparin may be suitable for pregnant populations; however, the risks associated with this drug are currently unclear.

Protein S deficiency can present a variety of symptoms which can be mistaken for something else. Being aware of the signs and symptoms of VTE can limit the amount of fatalities that occur each year from this disorder. In addition to informing communities about protein S deficiency and its associated symptoms, there is a need for more research on how this disorder affects different populations of people. While blood thinners may be suitable for some populations, there is a need for an alternate therapy in patients who cannot take blood thinners. Reliable therapy has not been established in multiple populations, such as pregnant populations.

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Ahmed Rehman

DEEP VEIN THROMBOSIS RELATION WITH PROTEIN S

Symptoms, causes, and effects

Deep Vein Thrombosis (DVT) is a medical condition in which red blood cells form a blood clot in the deep extremities of the body, such as the lower legs or around the armpits. The noticeability and severity of symptoms like pain or swelling are related to the size and growth of the abnormal blood clot.

DVT is caused by factors such as age, lack of movement of the extremities, pregnancy, and genetics. If not treated properly, the abnormal

Illustration by Kimberly Ca

PROTEIN S

blood clot could be dislodged from the deep vein and travel to the lungs, increasing fatality rates.

Pulmonary Embolism (PE) is the after-effect of a dislodged blood clot from a DVT. PE occurs when the dislodged blood clot from the extremities travels into the lungs and blocks the capillaries' ability to exchange oxygen and carbon dioxide. This critical condition causes a sudden shortness of breath, coughing up blood, discomfort around the chest, wheezing, and even death. To counteract these complications, many physicians attempt to treat the symptoms of PE and DVT with diet, exercise, but most importantly by using blood thinners and other medicines. Long-term antithrombotic therapy with Heparin and Warfarin is the usual treatment for DVT. However, these medications have problematic side effects for vulnerable populations such as pregnant women and infants.

Some of these side effects include hemorrhages, birth defects, severe bleeding, hematuria, hematochezia, dyspepsia, swelling, coughing blood, dizziness, vision change, and increasing vulnerability to concussions and contusions. Many researchers are looking to find alternative ways in treating DVT, specifically in patients with hereditary disorders like protein S deficiency, which leads to increased susceptibility to DVT and PE.

Protein S is a cofactor of another protein called Protein C which when activated, helps in dissolving blood clots by deactivating blood factors V and VIII. Protein S deficiency can be caused by various conditions, but is also an inherited disorder caused by a change in the PROS1 gene.

For individuals with protein S deficiency, the chances of developing a DVT increase by 50% before the age of 45. In severe cases, newborns have a high chance of experiencing purpura fulminans, an often fatal condition characterized by an increase of abnormal blood clots in the infant's blood vessels and necrosis of their tissues.
The prevalence of Protein S deficiency is 1 in 500, while patients with a history of abnormal blood clots have a 5% chance of having this abnormality. The Japanese population has the highest prevalence of Protein S deficiency, with a 10x greater prevalence than in European and American populations. To diagnose this deficiency, clotting analysis and ELISA tests are used to measure the amount of protein S in the bloodstream.

While Protein S deficiency is a rare condition, it is still crucial to understand, because it is a contributing factor to widespread diseases such as DVT and PE.

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Maulik Masaliya

PROTEIN S DEFICIENCY AND ASSOCIATED COMPLICATIONS IN SEVERE COVID-19 INFECTIONS

Illustration by Kimberly Carrera

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. This disorder is widely characterized as a respiratory disease, however this is not necessarily accurate. COVID-19 patients experience a variety of symptoms including pneumonia, inflammation, micro-vasculature dysfunction, hyper-coagulation, nervous system damage and multi-organ failure. Moreover, there are multiple long-term complications, which are still not well-characterized.

Any of these symptoms can be responsible for COVID-19 related mortality. However, thrombosis (abnormal blood-clotting) is the leading cause of death in severe COVID-19 infections. Researchers have linked these abnormal blood-clotting events in COVID-19 with a decline in protein S levels.

Protein S is a multifunctional protein which maintains normal and healthy blood clotting activity, and prevents overcoagulation of the blood. It also inhibits inflammation following cell death and infection, and is used in many cell-signaling pathways. Because protein S has so many different roles, protein S deficiency can have grave consequences.

There are multiple causes for the decline in protein S levels following a COVID-19 infection. In severe COVID-19 infections, there is an extreme immune response, known as thrombo-inflammation, which occurs by overproduction of cytokines, small molecules which regulate the activity of cells.

COVID-19 can cause a “cytokine storm,” which damages cells, and leads to organ failure. It also causes a decline in protein S levels, causing many mini blood clots (microthrombi) throughout the body. Autopsies of patients with severe COVID-19 infections have revealed the presence of these clots in the lungs, causing extensive lung damage, which is a major cause of COVID-19 related deaths.

million US hospital discharges were considered to be at risk of VTE. However, despite these risks, it is reported that many eligible patients either receive no or suboptimal preventative treatment. Increases in treatment rates could increase our ability to prevent PE-related deaths.

There are two different types of treatments currently available for patients with PE: conservative and surgical. Conservative treatment involves the administration of antibiotics, anticoagulation drugs, or analgesics. The most common drugs administered are Heparin and Warfarin. Heparin prevents the growth of existing blood clots, while Warfarin disrupts the blood clotting cycle, resulting in a longer period of time before new clots can develop. Though effective, these drugs can have many unwanted side effects such as bleeding, hemorrhages, abdominal pain, thrombocytopenia, nausea, etc. These risks are further compounded by the fact that patients often need to remain on blood thinner treatments for life.

Major advances have been made in the technology used to detect diseases such as VTE. However, the mortality rates for the disorder are significantly high, and continue to rise. Countless studies support that PE prevention and diagnosis is significantly under-prioritized in the modern American healthcare system. The Stony Brook University iGEM Team of 2022 is focused on creating a novel alternative treatment to the modern drugs currently used in the conservative treatment of PE, as well as improving diagnostic methods for related disorders. This is just one example and one little step towards a greater focus on the treatment of coagulation disorders in the US healthcare system, but also in the general population.

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PROTEIN S DEFICIENCY IN THE AFRICAN AMERICAN POPULATION

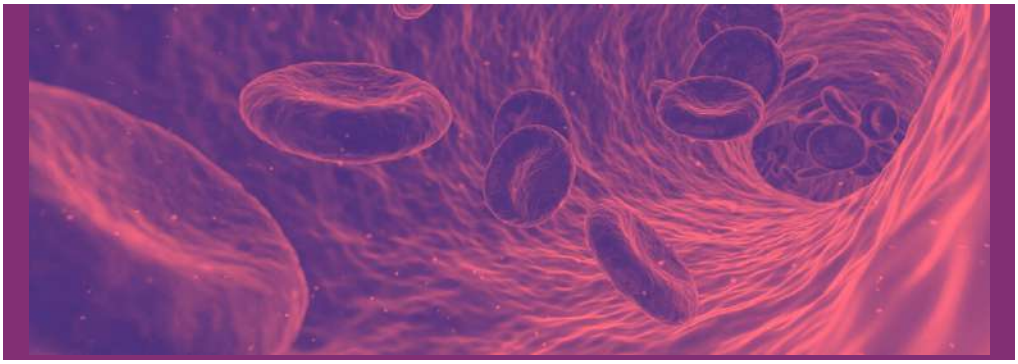
Stony Brook University

2022 iGEM Team

Stephanie Laderwager

Protein S deficiency is a rare condition that can be genetic or acquired, and it can contribute to excessive and abnormal blood clotting. This is referred to as thrombophilia. The clots usually develop in the limbs, and this condition is called deep vein thrombosis (DVT). A DVT may then break off and travel to the lungs, causing a pulmonary embolism (PE), which can be fatal. Protein S deficiency is caused by mutations in the PROS1 gene. which can be fatal. Protein S deficiency is caused by mutations in the PROS1 gene. Studies have shown that African Amercians have a 30-60% higher rate of Venous thromboembolism (VTE), which includes DVT and PE, than those of European descent. The genetic predisposition for thrombophilia has been well documented in the European population, but not in the African American community.

Protein S deficiency in the African American community has complex, intersecting factors that contribute to the inequity that is seen in this disease. Hereditary differences in mutations of the PROS1 gene, lack of African American representation in clinical trials, and general healthcare disparity all contribute to the inadequate knowledge of how this condition affects this population.



One mutation that has been found to increase risk of VTE 3-5 times in European carriers is called Factor V Leiden, but this mutation is not typically seen in the Black population. One study sought to examine genetic factors that contribute to the increased rate of VTE in the African American population only. The PROS1 gene was analyzed in an African American family that had a history of frequent VTE as well as decreased levels of protein S based on prior lab reports.

Researchers found a variant called PROS1 V510M, and found that this mutation changed a valine to a methionine at the 510th position. Then they evaluated the significance of this variant in a larger study. It was found that PROS1 V510M was associated with increased incidence of VTE among African Americans. While this study was successful in identifying a population specific variant in the PROS1 gene in African Americans, it also highlighted a major issue among the limited data that was available due to the lack of Black representation in clinical studies.

Minorities are more likely to be affected by health disparities, yet in the United States, Black patients make up only 5% of clinical trial participants. A 2015 study published by ProPublica and Stat announced that a new cancer drug designed to treat multiple myeloma was now FDA approved. The issue is that out of 722 trial participants, only 13 of those were Black. In the general population, of those diagnosed with multiple myeloma, 20% are black. In this study, less than 2% of the participants identified as Black.

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There are many factors that contribute to the low participation rates of underrepresented communities in clinical trials. One of these factors is the exclusion criteria that is associated with many trials. Oftentimes, clinical trials exclude participants who are obese, above a certain age, have chronic diseases, or individuals who have a severe mental illness. Underrepresented communities who disproportionately experience chronic diseases compared to their white counterparts are being excluded from health studies. By re-evaluating the exclusion criteria, trials can develop a more diverse participation that is representative of the general population.

An important aspect of establishing inclusivity in a trial is to outline what potential barriers may prevent members from underrepresented communities from participating. These barriers can be subdivided into three categories: financial, communicative, and belief systems.

Financial barriers could include inability to miss work to participate in the trial, cost of transportation, and need for childcare during involvement in the study. Language and communication barriers could also prevent participation. Lack of trust in the healthcare industry due to past experiences or moral beliefs need to be considered in underrepresented communities.

After establishing potential barriers that may inhibit participation from underrepresented communities, the trial should be restructured to eliminate those barriers. Some examples of this would be to provide transportation to site, offer compensation for missed work, provide childcare, offer informational materials in multiple languages, and offer support to individuals who may feel hesitant to participate.

When designing a clinical trial, there are a variety of components that must be considered, but not limited to: outlining the research objective, defining the target population, and determining the parameters. To see involvement in a trial from underrepresented communities, it is essential that the inclusivity of participants be considered from the preliminary design stage through the conclusion of the trial.

The lack of inclusion of African-Americans mirrors the health disparity that is seen by this community, through limited access to healthcare, and implicit bias by providers that may affect treatment. By making clinical trials more inclusive to those from underrepresented communities, we have the opportunity to tailor therapeutic interventions and provide better care for all.

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VTE AND PROTEIN S DEFICIENCY IN ASIAN COMMUNITIES

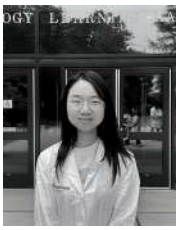

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Illustration by Kimberly Ca

Thrombosis, also known as a blood clot, acts like a plug blocking the passage of blood through vessels, depriving the organs of blood supply and causing sudden death. Once the vessels are blocked, they paralyze the blood transport system, which can be fatal. Thrombosis can occur at any age, at any time, and is a serious threat to life and health. Venous thromboembolism (VTE) includes deep vein thrombosis (DVT) and pulmonary thromboembolism (PTE), both of which are manifestations of the same disease in different stages and different tissues and organs.

Venous thromboembolism (VTE) is caused by a combination of genetic, environmental, and behavioral factors. 50%-60% of the occurrence of VTE can be attributed to genetic factors. Known genetic factors are quite different between eastern and western populations, and protein S deficiency counts for the majority of genetic defects in Asian populations.

The incidence of VTE in the Asian population is about 29 per 100,000, and it has been increasing in recent years. Based on data from 90 hospitals in China from 2007 to 2016, the hospitalization rate of VTE in China increased from 3.2 per 100,000 people to 17.5 per 100,000 people in the past decade. The hospitalization rate for DVT increased from 2.0/100,000 to 10.5/100,000, and that of PTE increased from 1.2/100,000 to 7.1/100,000. Overall, the incidence of VTE in China is increasing year by year. Although mortality rates from DVT and PTE are decreasing, VTE remains the third leading vascular disease worldwide.

Genetic risk of VTE mainly comes from the loss of function of anticoagulant factors, including antithrombin, protein C (PC), and protein S (PS), or the acquisition of function of procoagulant factors, such as factor V Leiden and prothrombin G20210A, which are prevalent in Caucasian populations but are rare in non-Caucasian populations. In contrast, genetic defects in PS and PC are common in VTE patients in Japan and China, but rare in Caucasian patients.

Protein S deficiency (PSD) is an autosomal dominant genetic disorder, which can increase the risk of thrombosis by 2.5-11.0 times. More than 300 mutations have been reported, most of which are point mutations with high heterogeneity. For example, it was reported in Japan that the Tokushima mutation of protein S carried significantly higher rates in patients with thromboembolism than in healthy people, which were 6%-9% and 2% respectively, which may be the dominant mutation of protein S in Japanese people, which can increase the risk of thromboembolism.

Studies have shown that the incidence of protein S deficiency in the Japanese population is 5-10 times that of the white population. PS gene (PROS1) variant PS Tokushima is a genetic risk factor for plasma phenotypic type II PS defects. The median allele frequency in the Japanese population is 0.6%-0.9%, and the risk of DVT is 3.7-8.6- fold higher in heterozygous.

It has also been reported that the A139V mutation in the Japanese population can lead to the decreased binding ability of protein S, while other mutations can increase the instability of protein S and decrease its number. Further mutations were also associated with decreased protein S activity in Thai children. Finally, there are multiple mutations correlated with PSD in the Chinese population. Another study in northeast China showed that plasma protein S activity in VTE patients in northeast China was significantly lower than that in healthy people, and the detection rate of decreased plasma protein S activity in VTE patients was also significantly higher than in healthy people. Thus, we can see that hereditary protein S deficiency increases the risk of VTE in Asian populations.

Therefore, understanding the genetic protein S deficiency is of great clinical value and significance in the treatment of thrombosis in the Asian population. At the same time, the inclusion of PS variants in routine testing for thromboembolism may also improve diagnostic and prevention strategies to help us identify patients at high risk of developing VTE and develop reasonable and targeted treatment plans.

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SECTION 3

Water Contamination

WATER CONTAMINATION

A COMPLICATED HISTORY OF HEAVY METAL CONTAMINATIO N IN ARIZONA GROUNDWATER

Priyati Sharma and Gabriella Cerna,
iGEM Arizona State University

As a natural desert, Arizona's arid dry climate is nothing new for its residents. Historically, the state was sought out for its abundance of valuable minerals like silver, gold, lead, zinc, and copper. Though explorers and indigenous groups had used the area's natural resources for centuries, 1854 marked the first time mining efforts were officially pursued in the state by the Arizona Mining and Trading Company. Many other mining operations soon followed, and historical records show that by 1864, just 10 years later, a quarter of the male settler population were prospectors themselves. By the time the Arizona territory achieved statehood in 1912, the mining industry was worth 67 million dollars.

Despite being a great source of economic growth for the state, mining took an immense toll on the environmental landscape of Arizona. Not only did it deplete the region of its natural resources, it also left behind major pollutants like uranium, manganese, and arsenic as a result. The nature of mining operations is such that rocks beneath the surface,

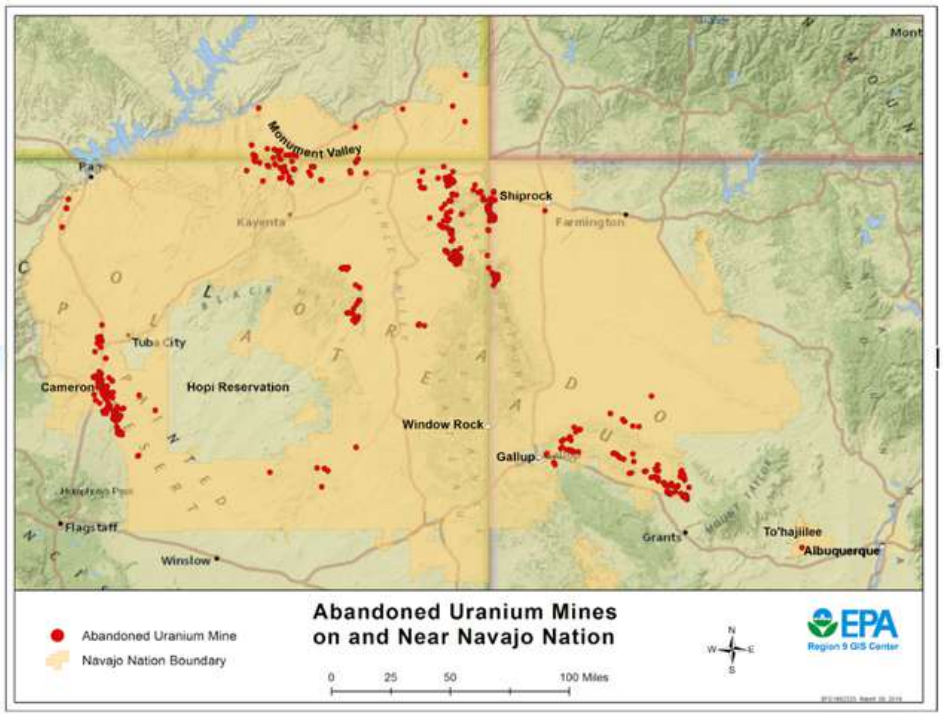

Figure 1: A map depicting the locations of abandoned uranium mines in relation to the Navajo Nation's reservation in the southwestern United States.

which often contain high concentrations of heavy metals, are unnaturally moved and disturbed, thereby releasing those heavy metals into the environment. If water sources are nearby, this makes it especially easy for "invisible" contamination to occur.

Upon closer inspection, it's clear that a vast majority of these mines exist in rural parts of the state, and especially overlap with regions associated with the "Four Corners" region of the United States, also home to the Navajo Nation.

The reservation, which houses over a quarter of a million members of the Navajo community, lies on an abundance of uranium mines, a resource that was heavily exploited beginning in the 1940s. The year 1948 marked the inception of uranium production in the Navajo Nation. Though the "uranium boom" on Navajo lands only lasted about 20 years, the health consequences of such concentrated mining efforts are still felt in the region today.

The first immediate health consequences of heavy metal contamination affected the Navajo men that worked in the mines. At the time, little was known about the relationship between heavy metal mining and lung cancer. Research conducted by John Harley and William Bale in the early 1950s eventually pinpointed that radioactive isotopes of radon, paired with the poor ventilation systems present in the mines, were the main culprit in lung cancer cases. By then, however, it was too late – Navajo men who had worked in these uranium mines were already suffering higher rates of lung cancer as compared to those who hadn't worked in the mines.

Unfortunately, data shows that the prevalence of health issues linked to uranium mines in the

WATER CONTAMINATION

Navajo Nation is not an isolated incident that was resolved once the mining operations became less popular. In the two decades following the 1970s, cancer rates in the Navajo Nation had increased two-fold. Even as of 2016, Navajo children were reported to have been born with abnormal concentrations of uranium in their bloodstream.

Despite the clear scientific links between heavy metal exposure and irreversible health risks, uranium mines are still being opened today and are actively threatening the safety of nearby water sources. In April 2022, Arizona's Department of Environmental Quality reportedly approved a new mining permit that would establish a uranium mine near the Grand Canyon National Park. Not only do decisions like these threaten the health and safety of people visiting high-traffic areas like the Grand Canyon, but they also pose a significant health risk to Indigenous communities that rely on these groundwater sources.

Faced with the continued legacy of mining on the reservation and lack of response by the federal government, indigenous leaders and community members are advocating for Congress to acknowledge and take action on this issue. They aim to do exactly this by demanding the cleanup of abandoned uranium mines and receiving further recognition for this contamination through the expansion of the Radiation Exposure Compensation Act (RECA).

Despite recent action, Indigenous communities are still grappling with the lasting effects of uranium mining, all while current and future mining projects threaten further damage to the environment and community health. The fight to receive due compensation and recognition by the federal government for uranium exposure has yet to be resolved, but incremental progress on this important issue is made possible by Indigenous community members who continue to advocate for their wellbeing and land.

Figure 2: Warning outside abandoned uranium mine on reservation

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iGEM Team

University of Queens, Canada

THE CONNECTION BETWEEN FRESHWATER INEQUITIES AND HEALTHCARE DISPARITIES FOR CANADIAN INDIGENOUS PEOPLES

Illustration by Kimberly Carrera

73% of First Nations' water systems are at high or medium risk of contamination in Canada. These contaminants include heavy metals, such as iron, manganese, or lead, and organic material, such as bacteria and viruses. In 2021, the Government of Canada agreed to an $8 billion dollar settlement with the Indigenous communities in the country. However, 34 long-term drinking water advisories still remain in these communities across the country, some of which originated in 1995. Thus, the Neskantaga First Nation peoples have not had access to safe drinking water in over 27 years. Each drinking water advisory can represent up to 5,000 people who lack access to clean, safe water.

Many people do not know how their water became harmful, why their water is unsafe, or what they can do to fix the problem. One thing the communities know for sure is that their water makes them sick. Whether it is because of acute gastrointestinal diseases from ingesting the water, or skin irritations from hygienic practices, it is very clear that the water these people are receiving is not safe for human use.

The fear of getting sick and the lack of government communication has led to the spread of many misconceptions. Rightfully so, many affected people do not trust the water coming from their taps, so unfortunately, they turn to consuming untreated natural water from lakes, rivers, brooks, etc. Untreated natural water may still contain pathogenic microbes that lead to acute gastrointestinal symptoms such as abdominal pain, diarrhea, and vomiting, but may also result in more serious illnesses such as gastric ulcers and gastric cancers. Accordingly, the Indigenous Drinking Water Crisis has resulted in a statistically significant increase of waterborne illnesses in Canadian Indigenous communities compared to non-Indigenous people. Therefore, this crisis leads to a befitting demand in healthcare services for the affected communities.

Sadly, Indigenous peoples in Canada face many barriers on their way to seeking medical assistance. Some of the major barriers include geography, health education, and negative bias among healthcare professionals.

Health centers in remote or isolated Indigenous communities are often mostly run by nurses and associated health workers. Though there is no debate that these professionals provide the highest standard of care they can, these health centers have limitations regarding equipment, training, and scope of practice. Thus, people with serious illnesses must travel to more urban health centers that have access to medical specialists and more advanced technologies. As shown in Figure 2, this results in a geographical barrier to healthcare.

A deficiency in health education encapsulates a few topics that create barriers for Indigenous peoples. Unfortunately, a large proportion of Indigenous people do not

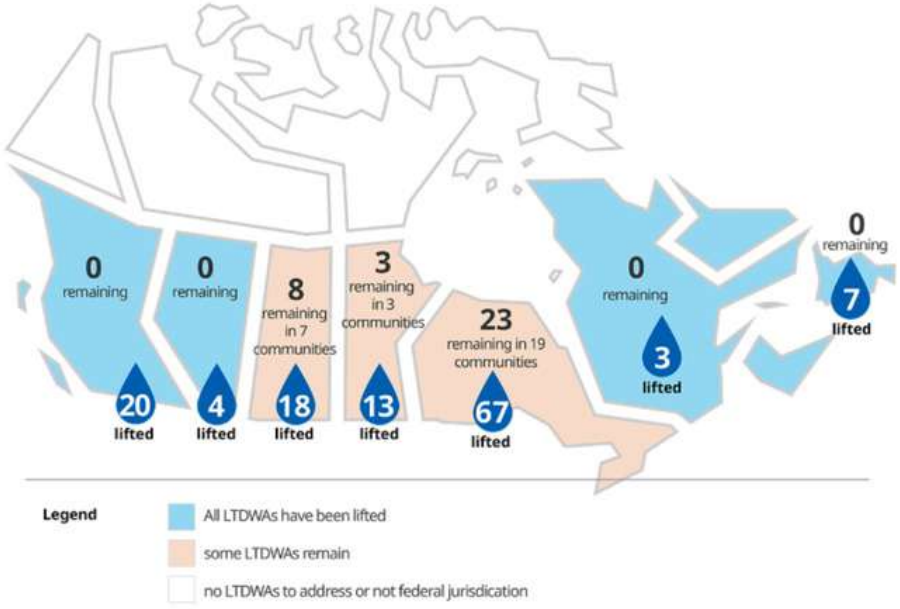

Figure 1. Stylized map of Canada displaying the number of remaining long-term drinking water advisories (LTDWAs) and lifted LTDWAs.

attend or complete educational studies, most likely due to the lack of cultural awareness in Canadian curricula. Incomplete education is directly correlated with poor literacy, and thus, makes it harder for someone to navigate the healthcare system. On a similar note, professional healthcare education often favors western medicine over traditional medicine. This inadequacy in healthcare curricula can both deter Indigenous students from seeking healthcare careers, and discourage Indigenous peoples from seeking help at urban health centers.

Intergenerational trauma, colonization, and physical trauma have haunted the Canadian Indigenous peoples for many years, which can lead to alcoholism, violence, and other self-destructive behaviors. Sadly, negative stereotypes have formed around Indigenous peoples due to inaccurate representation of these behaviors in the media. These media-perpetuated stereotypes have led some physicians to assume most Indigenous people are alcoholics, and that Indigenous people are pretending to be sick to abuse medicine, and other horrible accusations. Views such as these are very harmful to the Indigenous peoples as it may lead healthcare providers to limit their interactions with Indigenous patients, deny them essential medicine or specialists, and other harmful actions. Unfortunately, but understandingly, the negative bias of healthcare professionals can deter Indigenous patients from seeking proper care.

Overall, there are a plethora of barriers that Canadian Indigenous people face when they need to access healthcare. Sadly, due to other infrastructure inadequacies, like the Indigenous Drinking Water Crisis, the Indigenous peoples of Canada need healthcare assistance. Beginning to solve issues such as supplying clean drinking water to communities, increasing geographical access to care, improving educational attainment, and decreasing negative bias, is a step towards lowering the barriers for these communities. Only with the help of all Canadians can these barriers be demolished for those whose land we live upon.

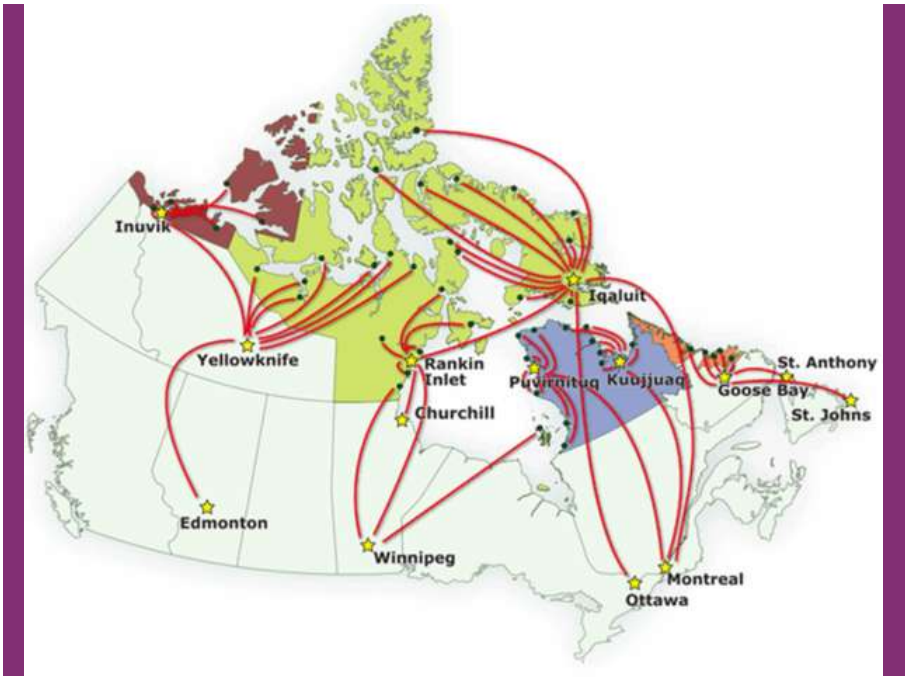

Figure 2. Stylized map of Canada displaying the common medical travel routes of Inuit people seeking medical assistance. Black dots represent communities and yellow stars represent health centers.

Illustration by Kimberly Ca

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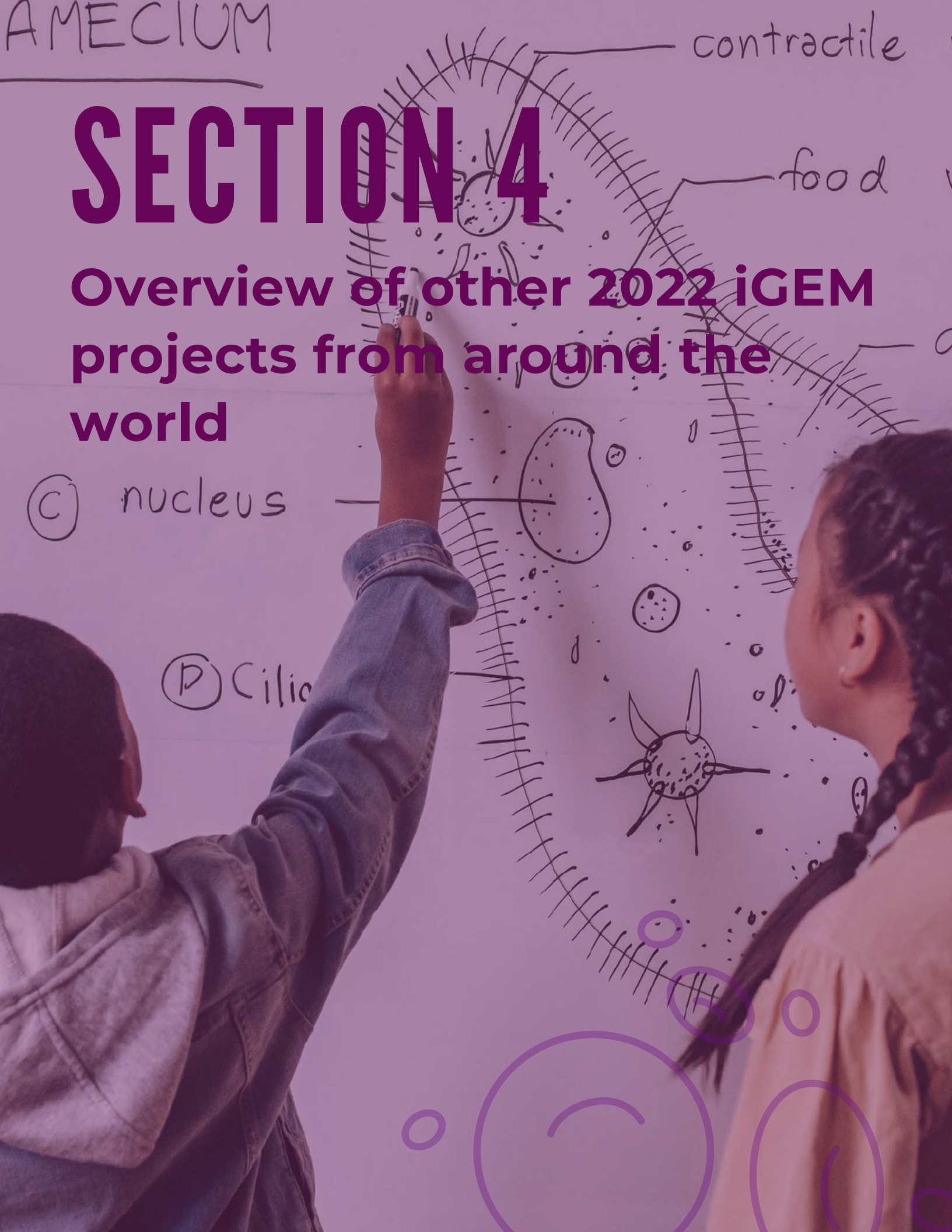
SECTION 4

Overview of other 2022 iGEM projects from around the world



iGEM EmpireGene

Epiphany Manhattan Academy, New York, USA

DISPROPORTIONATE PREVALENCE OF STROKE IN THE UNITED STATES

Strokes are the fifth leading cause of death in America-—every 40 seconds, a person in the United States dies from a stroke. Strokes occur when blood stops flowing to the brain, causing brain cells to die from lack of oxygen. According to the American Stroke Association, Black Americans have a higher prevalence and the highest death rate from stroke than any other racial group. In addition, Black stroke survivors are more likely to become permanently disabled and have difficulties doing daily activities than stroke survivors from other racial groups.

Stroke disproportionately affects African Americans for many reasons. The type of healthcare an individual receives, their neighborhood, and affordable treatment options affect their likelihood of having a stroke. According to a study done in 2018, 9.7% of Black Americans were uninsured, compared to 5.4% of white Americans.

African-American households throughout the USA spend an unsustainably high average of near 20% of their annual household income on healthcare. The Affordable Care Act (ACA) ensured health care coverage for millions of Americans, but only 14% were African American. The southern United States, which has a comparatively higher African-American population, has an underdeveloped healthcare system with low insurance coverage, high costs, and lower access to quality care.

This type of systemic socio-economic and healthcare inequality, exacerbated by factors like gentrification, implicit and explicit racism, can contribute to increased stress for Black Americans, and there is a proven link between

AFRICAN-AMERICAN HOUSEHOLDS THROUGHOUT THE USA SPEND AN UNSUSTAINABLY HIGH AVERAGE OF NEAR 20% OF THEIR ANNUAL HOUSEHOLD INCOME ON HEALTHCARE.

Illustration by Kimberly Carrera

stress levels and heart attack or stroke. According to the CDC, Black Americans are more likely to have high blood pressure than any other ethnic group, over half affected (54%). As stress accumulates, Black Americans become more prone to spontaneous health risks, including strokes. A lack of well-entrenched support systems can make it more difficult to adjust to healthy life or enter lifelong care once they get sick.

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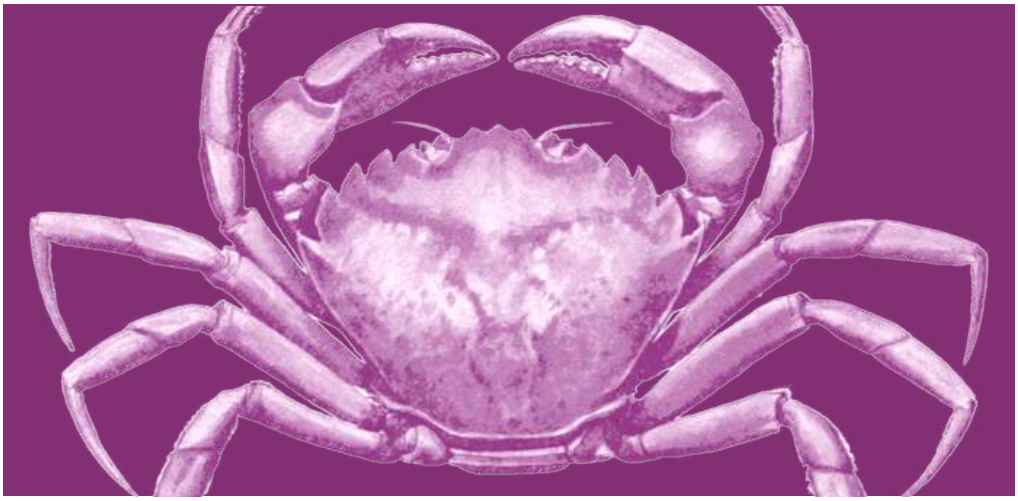
ACCESSIBLE HPV DETECTION - GAME CHANGER IN THE PREVENTION OF CERVICAL CANCER

iGEM IIT Roorkee, India

Cervical Cancer is the fourth-most common type of cancer and the fourth most common cause of death from cancer in women. Despite it being one of the most preventable and treatable cancers, it records an alarmingly high mortality rate (out of the 570,000 cases in 2018, 311,000 patients died). If detected at an early stage, precancerous cellular changes due to HPV infection and mild lesions can be treated before it becomes an invasive cancer. It's imperative to understand where our healthcare infrastructure fails, and continually misses the mark when it comes to keeping the rampant statistics of cervical cancer in check. Multiple studies have revealed that effective prevention of cervical cancer right now is lacking in the secondary stage of prevention, i.e., an accessible and effective screening and testing programme facilitating early detection and treatment.

About 70% of cervical cancers and 90% of deaths occur in developing countries, with one third of the world's cases being from India. According to a report published by the HPV Information Center, 483.5 million women in India are at risk for cervical cancer. To understand the disproportionate impacts of cervical cancer on low and middle-income countries, we need to consider geography, traditional practices and beliefs, screening levels, socioeconomic status, healthcare access, and public awareness. Sexual health and education continue to be taboo in mainstream discourse, especially among women in rural parts of India, which significantly impacts the odds of them actively seeking out tests and treatment, despite its prevalence. This is coupled with psychological factors like the fear of a painful and invasive test, anxiety about the results, and embarrassment. Currently, deaths due to cervical cancer have been steadily declining in urban areas while the rural statistics remain the same.



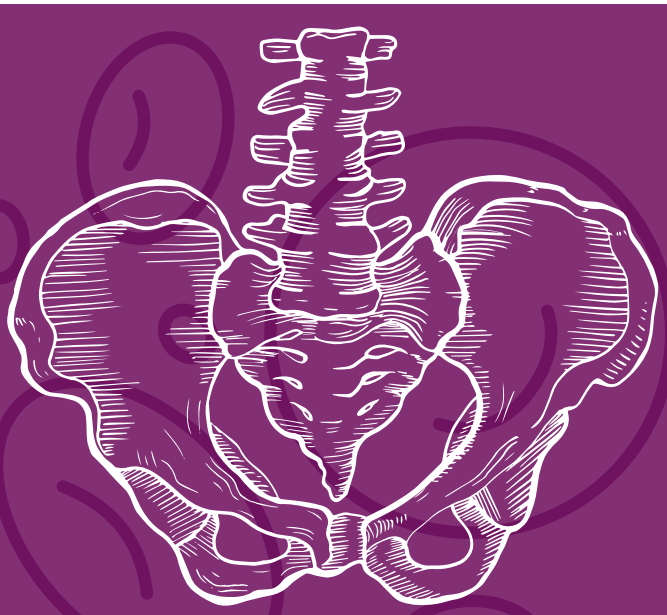
It's extremely concerning that no national HPV screening programme exists in India. Despite national guidelines, the rates of screening remain very low. At the very least, much needs to be done to ensure that existing screening is targeted to subsets of the population most vulnerable to HPV. For screening to be effective, developing countries also require major improvement in testing methodology that are more suited to low-resource settings.

Currently, prevalent methods of screening and detection have multiple issues. Beginning right at the point of sample collection, invasive methods are utilized like the PAP Test, which can cause pain and aggravate already existing abnormal cells in the birth canal. It's also important to note lack of compliance of patients and increasing inhibitions when it comes to getting tested, because of these methods. Testing also relies on sophisticated equipment that would require trained personnel to operate which will significantly affect accessibility and cost. Most HPV screening involves time-taking methods, for example, PAP

test results come in 1-3 weeks. These methods have evident portability issues and are also expensive compared to testing with home-based sample collection kits that tend to be much more cost effective.

We aim to design a fast and sensitive point of care diagnostic kit to detect the most oncogenic strain of HPV i.e., HPV16. Our kit would be cost-effective and easy to use. It is designed for use in low-resource settings without the need of special equipment or a trained professional. Unlike existing diagnostic methods that use the L1 protein in the viral capsid, our method is based on the highly conserved E7 oncogenic gene found in hpv16 making the kit very sensitive, effective, and specific to HPV that could become cancerous. The patient would only be required to take a vaginal swab.

Our project's spawn point was an earnest belief in the urgency and relevance of the issue of the disparate and disproportionate effects of cervical cancer. Our proposed solution is a direct result of our commitment to the cause. The need of the hour in India, and other low and middle-income countries, is national HPV screening with as immediate an effect as possible. Along with screening camps, educated professionals must interact directly with the masses and make high-risk populations aware of the prevalence and curability of HPV, if detected early. People need to be educated about the importance of sexual health and encouraged to regularly test for HPV. The latter is only fruitful if we have an easily accessible testing solution to back it up with. We hope to see sustainable designs supporting a very real, urgent and so far, unacknowledged need in our healthcare systems.



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FUSARIUM WON'T: A SOLUTION TO THE BANANA CRISIS

iGEM GEMS Taiwan, Taiwan

Illustration by Kimberly Ca

According to the Guinness World Records, the banana is the most widely eaten fruit in the world, the fourth most important staple food, and the fifth most important agricultural commodity. However, bananas weren't always the sweet, seedless, peelable domesticated banana we know and love today.

Wild bananas are full of seeds and are about half the size of modern bananas. To improve marketability, farmers cultivated banana plants themselves, selecting for taste, less seeds, and more flesh. Through years of cultivation and trade, the Cavendish banana was ultimately created and is now the most common strain of banana in the world. As a result, most commercially available bananas are genetically identical. Although there are more than a thousand different types of bananas in the world, more than half of them are inedible. Out of all the edible bananas, most planted bananas are of the same several strains; the most common of them being the Cavendish, which represents 47% of all planted banana trees.

Due to artificial selection (aka cultivation), commercially available bananas lack the ability to create seeds—a side effect is that it is impossible for bananas to reproduce sexually. Bananas are monoculture; cultivated bananas are grown from root clumps called rhizomes which contain the same genetic material as the parent. There is no sexual reproduction, so genentic diversity is extremely low.

While asexual reproduction is great for making sure bananas taste consistent, it also leads to some pretty glaring issues, one of them being increased vulnerability to disease. We learn in evolution and ecology that a species protects itself against disease and predators by maintaining a variety of traits. When predators or environmental factors

strike, those in the population with advantageous traits survive and pass on their genes, while those that don't are removed from the gene pool. However, when 99% of all exported bananas have identical DNA, if a banana plant is vulnerable to a disease, this means that all banana plants are vulnerable.

Fusarium Wilt (aka Panama Disease), a wilting disease caused by the fungus Fusarium oxysporum f. sp. cubense (foc) has evolved to prey on Cavendish bananas. The disease is believed to have originated in Southeast Asia, where it quickly spread to countries through global trade and led to the near-extinction of Gros Michel bananas, the most popular commercial banana during the 20th century. Fusarium Wilt infests plants through their roots. The fungus takes up residence in the trunk and spreads upwards through the xylem, eventually killing the plant by clogging up the xylem and stopping any water from reaching the leaves. Fusarium Wilt Race 1 (TR1) was originally targeted at Gros Michel bananas, however, the disease has since affected a wider range of bananas including the Cavendish banana.

Before the 1950s, Gros Michel was one of the most important fruits in the global market. Gros Michel was very important in America, and was even considered the "poor man's fruit" because of its affordability, and high starch and sugar content. In a New York Times article about a banana tax, the author said: "...the wonderful extension of the banana trade that has marked recent years has been nothing less than a national blessing." However, when Fusarium Wilt devastated Gros Michel banana plants, farmers all over the world had to switch from Gros Michel to the less popular, but more disease-resistant, Cavendish.

There's more at stake than our enjoyment. About 400 million people depend on bananas for food security, and in some rural areas, a quarter of the total calorie intake every day comes from bananas. The banana industry also supports over two million jobs in Ecuador, where bananas account for 10% of Ecuador's exports in terms of value—about 2.8 billion USD in 2018. With banana exports reaching 22.7 million tonnes in 2017 and a total market value of 20-25 billion USD, replacing Cavendish is going to be a painful and difficult process. The half billion people whose meals and livelihoods depend on Cavendish bananas, would face starvation and poverty.

Even though there are many methods to temporarily stall Fusarium Wilt, none of the methods can indefinitely prevent its spread. For example, quarantining farms is a known method for containing the disease. However, foc can survive for up to 40 years in soil, and can leave the quarantine zone when carried by animals or water.

In order to find a cheap, effective method to save Cavendish bananas everywhere, our team decided to look for ideas in an unlikely product: gut probiotics. Gut probiotics have been known to use a variety of methods such as niche competition to prevent opportunistic infections, and its primary characteristics are that it forms a mutualistic relationship with its host and that it persists around said host. Taking that as inspiration, we aim to engineer a Bacillus subtilis (B. subtilis) based bacterial biofungicide that colonizes the banana roots to deter foc infestation.

To secrete the antifungal protein, our team chose to use the SEC secretion system. In essence, it is a pathway used by most bacteria to export proteins with special tags across its cell wall. This system is particularly convenient in that it is used by most bacteria including E. coli and B. subtilis, so we can experiment using the more common E. coli, then transfer our engineered systems to B. subtilis, our chassis of choice.

Our team is focusing our efforts on the protein, chitinase. Chitinase is the enzyme that breaks down chitin. Because the cell wall of foc's vulnerable hyphae are made of chitin, making our bacteria secrete chitinase will also give it the ability to attack foc and destroy its hyphae before they are able to break into banana roots.

To further allow our engineered bacteria to combat foc, we've exploited the fact that foc is attracted to the banana plant's root. Inspired by the work of the 2018 Pasteur Paris Team, we designed a similar toxin-antitoxin killswitch that makes our bacteria dependent on malate to produce the antitoxin to sustain itself. This enables us to let the bacteria grow wherever foc is stimulated to invade, and to ensure that our bacteria does not escape beyond its intended use so that it does not cause unintended ecological harm.

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INEQUALITY IN THE MEXICAN HEALTH SYSTEM AND ITS REPERCUSSIONS IN ANTIBIOTIC RESISTANCE

iGEM Tec-Monterrey, Mexico

Abstract

The Public Health System in Latin American countries like Mexico, undergoes several historical, political and economical changes that aim to have an impact in the quality of this public service. However, due to social dilemmas and inequalities, the Mexican population continues to lack access and remain exceptic towards good quality health public attention. This, combined with poor health education, contributes to the proliferation of dangerous practices and behaviors regarding the self-prescription of drugs such as antibiotics, leading to the appearance of multidrug resistant bacteria which are expected to cause millions of deaths in the near future. Our work aims to explore the different social determinants of health (socioeconomic status, education, physical environment, employment, and social support networks), that constitute the core of the Mexican healthcare problem and shine a light on the repercussions this might generate in the long term.

Introduction

Latin America has been, for many years, one of the most affected parts of the Americas regarding the quality and availability of healthcare. This is mostly because of social factors such as: corrupted politics, racism, pro-rich inequality and generalized violence. In this sense, the minorities that constitute Latin America's diversity such as: indigenous people, the LGBTQ+ community, ethnic groups, migrants, refugees, women, and girls are the most vulnerable to the inefficiencies and deficiencies of the healthcare system

Mexico is considered one of the countries with the highest inequality population in the world. In Mexico, there is a very important public health problem called health inequality, that is due to economic and political causes. These social inequalities in health refer to those unfair and inevitable differences that appear in groups, defined socially, demographically, or geographically.

Hence, it's important to understand and address how health can be limited by social factors. As stated by Artiga Hinton, "social determinants of health include factors like socioeconomic status, education, neighborhood and physical environment, employment, and social support networks, as well as access to health care, and addressing these determinants is important for improving health and reducing long standing disparities in health and health care."

A social system can be described as the connection between people, groups and organizations, that by interacting with one another, make up a whole.This concept is linked to privilege and oppression because in social systems there will always be a power dynamic that indirectly dictates who has more privileges depending on their social identity.

In Mexico's healthcare system, a social system of privilege and oppression can be noticed, and income inequality and poverty are persistent health challenges. For instance, of the 38 countries making up the Organization for Economic Co-operation and Development (OECD), Mexico has the highest level of income inequality, which is then reflected in the quality of the health system.

The mexican healthcare system is divided into public health systems and private initiatives, the former becoming affected by the low capital invested from governments in public health and the inefficient evaluations of the educational system for becoming a health professional, and the latter promoting pro-rich inequality that is dependent on the socioeconomic status of the patient to afford the attention needed. This leaves millions of patients who cannot afford health care. Furthermore, if we add the generalized violence experienced everyday, causing the destabilization of the country, and the corruption inside the government, it devalues the healthcare system even more. At the same time, these inequalities in the health system also contribute to the proliferation of certain diseases, including exacerbating the sensibility of pathogens against certain treatments, leading to antimicrobial resistance.

Knowing that most of the health care problems come from social aspects, our work will focus on Mexico's health care situation and its relationship with the social development factors that are considered to affect the inequality in the Mexican healthcare system, and how this impacts antibiotic resistance.

Historical Context of the Social Inequalities in the Mexican Healthcare System and Their Repercussions in Antibiotic Resistance

The historical context behind the development of Mexico's healthcare system and other Latin American countries is as follows: first to transit different phases that promoted and laid the groundwork for the current state of this service, passing through 4 development stages. Historically, the first two phases of the healthcare system took place between 1810 to 1946. These phases were characterized by a very inequitable socioeconomic context and institutional segregation. These phases were fueled by political independence, and therefore the creation of the first Ministry of Health, the system was built upon institutional segmentation which delivered health-care services across different population groups based on the people's social class and their employment status.

The turning point that characterized the third phase in each Latin American country was the implementation of segmentation of the health system through changes in the social security legislation between 1946 and 1980. This legislation caused the division of society into two main groups, the first half of the population was included under the welfare legislation and the other segment was excluded from these benefits. Alternatively, this phase was also characterized by the expansion of primary health care towards people with low income. Nonetheless, the social segmentation of healthcare services and the segregation of population groups was not removed, and in many cases, deepened into the system itself. During this phase, the healthcare system reached an inflection point, causing society to look towards a more equitable distribution of the service.

In response to this, the fourth phase began years later in 1952 in Chile, in 1960 in Cuba, in 1984 in Costa Rica, in 1989 in Brazil, in 1993 in Colombia, and in 2004 in Mexico, and it is characterized by the implementation of reforms that were designed to equalize the healthcare benefits received by the segregated population groups. The lag between the beginning of this phase in different Latin American countries was more significant
than in the previous stages, and although it has not begun yet in some Latin American countries, the effects of this type of legislation will probably lead to more countries heading in this direction.

Social Determinants in the Mexican Healthcare System and Their Repercussions in Antibiotic Resistance

The antibiotic resistance pandemic is projected to cause almost four times the amount of deaths per year than the lives COVID-19 took during 2020.

Although the proliferation of this antibiotic resistance pandemic can be attributed to the multiple inequalities between countries and society, social classes stand as the major factor. The lack of access to antibiotics in some developing countries as well as the interruption of antibiotic treatment is a main cause of mortality in children under 5 years of age. Alternatively, the inability to access more modern and expensive antibiotics that are needed to treat the increasing toll of multidrug-resistant bacteria

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(MDR) and extensively drug resistant (XDR) bacterial infections caused by these practices generates increasing concern; alongside the inequity in the provision of basic public health services as discussed in previous sections of this work, this creates a vicious cycle in which millions of people are being affected every year.

Relationship Between the Education of the General Population in Antibiotic Resistance

According to UNICEF, Mexico has a higher completion rate for primary education in both females and males compared to the world average (96 and 97% respectively compared to 83 % for both females and males).

In terms of lower secondary education ,Mexico also has a higher completion rate compared to the world average in both females and males (87 and 88% compared to 69 and 71% respectively). Higher secondary education is where Mexico has a lower completion rate compared to the world average, with a 22 % completion rate for females compared to 43 % and a 25 % completion rate for males compared to 47%.

However, although Mexico does not appear to have a poor performance regarding basic educational rates, there is poor performance regarding the content and distribution of subject matter and content. This is true for both the humanities and public health ethics, where these subjects have a tenuous presence, or even total absence in Mexican

Education programs. Additionally, there are very few Mexican public health thinkers or scholars that are currently addressing this topic with the necessary rigor.

This lack of public health education causes the Mexican population to react towards medical procedures in various inappropriate ways, significantly affecting their quality of care. For example Mexicans often visit physicians only once when they are undergoing an illness, and later when they identify similar symptoms, they continue using the same drugs to treat what they perceive as the same illness. However, this is not always the case and the administration of medication like antibiotics when they are not needed or the interruption of the treatment when the symptoms cease, contributes to public health problems like antibiotic resistance, which is is a severe and concerning issue that is already affecting the worldwide population.

In developing countries, the threat is often bigger and it increases at an alarming rate. According to the World Health Organization (WHO), infections like pneumonia, gonorrhea, blood poisoning or foodborne diseases have become harder to treat.

Antibiotic resistance in bacterial pathogens and multidrug resistant bacteria have caused problematic or even impossible treatment for infections with conventional antimicrobials, thus associating the problem with high morbidity and mortality due to diseases that used to be treatable.

Since most healthcare systems are not able to recognize the specific microorganisms responsible for infections, broad spectrum antibiotics are frequently unnecessarily used. It has been discovered that the spread of diseases caused by microorganisms which already have the resistance, along with poor infection control practices, are the main cause of its increase in the population.

Bacteria that are resistant to antibiotics represent enormous risks to the healthcare system because of the possibility of contagion to other patients and hospital personnel, increased expenses, and the consequences of a prolonged infection to the health of patients.

The problem of antibiotic resistance in Mexico and Latin America is not that different from developed countries on the molecular basis; nonetheless, the different conditions in life and healthcare conditions mainly enhance the contrast of its consequences and its proliferation among the population.

It has been presumed that some drugs promote resistance genes such as quinolones or tetracycline, and that these are more frequently used in Latin America. However, their impact is unlikely to be significant. An article published in 2022 asserts that antibiotic use and resistance is associated with socioeconomic and cultural factors, not only microbiologic ones.

Educational Impact on Health Professionals

In Latin America, it is common to access medication through pharmacies because of their accessibility, low price and quick service, especially in the low-income sector. Prescription-only medicines are often available without the corresponding protocols, which means that a doctor-approved prescription and medical advice is not needed to access such medicines in most Latin American countries.

Patients tend to rely on pharmacists' advice than doctors' because without insurance, a brief interaction with a pharmacist is easier and cheaper than making an appointment with a doctor that may dismiss their pain, take longer waiting hours at the consultory, and have higher appointment costs. Unfortunately, there are conflicts of interest that may be involved as pharmacies often offer discounts, extra drugs, and their employees lack education in the medical sector. Therefore, their opinion may not be accurate and can put the patient's life at risk.

Besides, there are also problems within the medical education system. Residency programmes have important weaknesses since many of the examinations are not being performed with adequate rigor. In this sense, the Secretariat of Health is planning to stop hospital rotations for students from schools that have not been certified, causing several medical schools that do not fulfill the requirements to cease their services.

THE SPREAD OF DISEASES CAUSED BY MICROORGANISMS WHICH ALREADY HAVE THE RESISTANCE, ALONG WITH POOR INFECTION CONTROL PRACTICES, ARE THE MAIN CAUSE OF ITS INCREASE IN THE POPULATION.

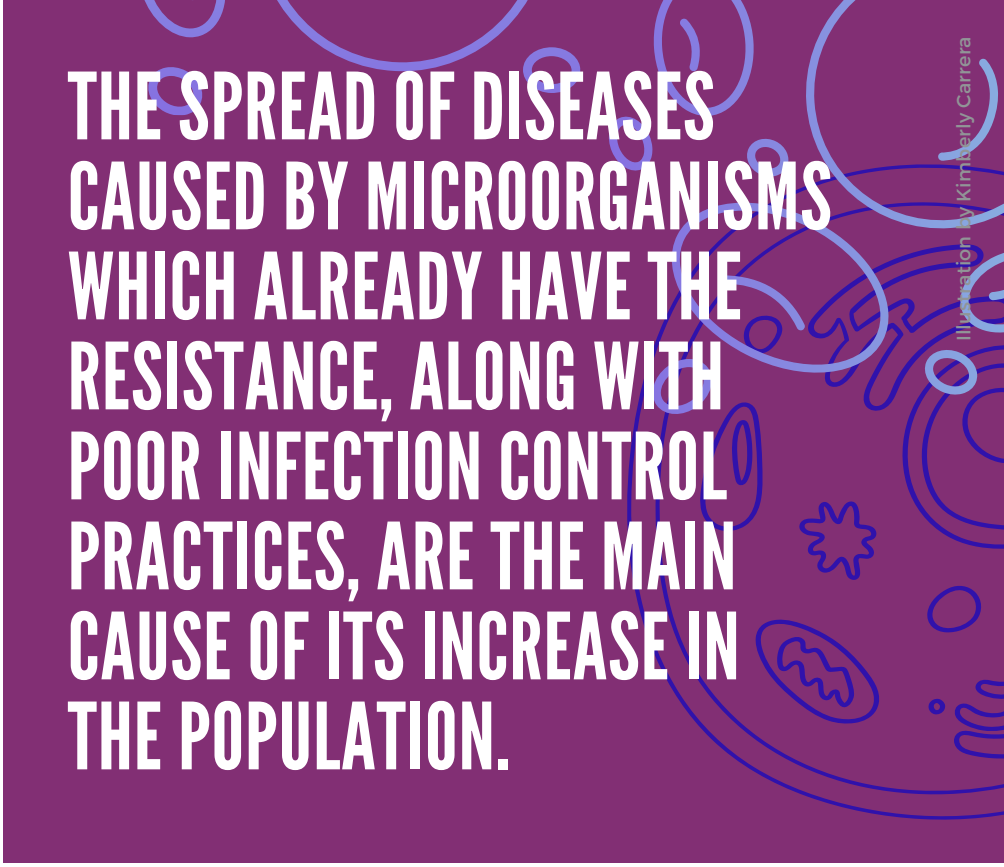

Illustration by Kimberly Carrera

Alternatively, some universities are trying to establish presence in rural areas, where their graduates are doing their social-service year, providing diagnosis and treatment advice with specialist visits and telemedicine programmes, continuing medical education to their graduates and local physicians.
Even though antibiotics have faced difficulties with resistance, they are still considered powerful and effective tools to treat diseases. This is a reason why practitioners are struggling to change inappropriate antibiotic prescriptions.

There are many reasons why physicians choose to prescribe antibiotics, sometimes excessively, and a major factor is their lack of knowledge on infectious diseases, the microorganisms that possibly cause them and how susceptible they tend to be to. Sometimes, there is even simply a lack of knowledge about the differences between a bacterial or viral infection.

Additionally, health providers often also face pressure from their colleagues and patient expectations can also have an impact on the prescription. In particular, there is evidence showing that if a patient expects an antibiotic, they will be 3 times more likely to be prescribed one than a patient who does not expect it. Additionally, if the physician
thinks the patient wants an antibiotic, they will be 7 to 10 times more inclined to prescribe it.

Physical Environment

With 364 living languages, Mexico is the world's fifth most linguistically diverse country, however 60% of these languages are at risk of extinction.

In Mexico, Indigenous people who speak native languages are often discriminated against. Nonetheless, the Mexican population is composed of the following ethnicities: Mestizo (Amerindian-Spanish) 62%, predominantly Amerindian 21%, Amerindian 7%, other 10 % (mostly European).

In Latin America, the health indicators of Indigenous populations (IPs) show the persistence of gaps and lags in the healthcare system. In Mexico, 50% of IPs live in rural localities and, of this percentage, 79% are poor and 39 % are extremely poor.

It has been suggested that these lags have to do with cultural factors such as worldviews, languages, and traditions. Nonetheless, these do not explain the inequalities in health. These inequalities are a product of social systems and the dynamics of power in society, in which minority groups are othered and oppressed by the social system.

According to Ceron et al., the stratified social structure is based on racist belief systems and ideas, and is manifested in discriminatory practices that are reproduced in all areas of life, including the health system.

An important part of the physical environment is the distribution of medical service and education throughout the country. Mexico has 78 medical schools with an average of 2-4 per state. Mexico's physician to population ratio is about 1:600, and is similar to that of Great Britain or Germany. However the physicians are distributed unequally in the country, and most specialists live in the most populated urban areas rather than the rural zones, which are left unattended.
In developing countries such as in Latin America, hospitals face difficulties with overcrowding, poor equipment, and a lack of staff. These problems enhance the dissemination of multi-resistant infections and their slow detection at a higher rate than countries with a more developed and equitable healthcare system.

Cities in these countries lack urban infrastructure and management of garbage and wastewater, hence increasing levels of pollution and creating a proper environment for the propagation of bacteria and horizontal transfer of resistance.

The contagious spread of resistant bacteria drives the high presence of it in the population; even when it can happen through mutations, contagion is the main cause of acquisition of resistance. Many developing countries like Mexico struggle with poor infrastructure, inadequate management of sanitation and community hygiene, and this leads to human-to-human contagions or spread via vectors such as air or water.

Corruption and lack of proper government administration also play a big part in the creation and allowance of the latter conditions. Even if a community has a lower percent of antibiotics usage, if it faces a strong contagion, most likely due to poor sanitation and contaminated drinking water, the prevalence of resistance will be high.

Employment

The INSABI (National Institute of Health for the Wellbeing) is a program from the Mexican federal government which aims to provide free health services to populations that have no access to any other social security programs. This institute also has the authority to promote the integration of local organisms of the SNS (National Health System).

The population sector to which this institute aims to aid is the informally employed population, which amounts to about 31.3 million in Mexico who don't receive employment benefits, including social security.

Although the health services are supposed to be provided by the local governments, this is an effort from the federal government to decrease the social gap between the formal and informally employed populations.

There is also an important sector of 16 million people that are self-employed workers, farmers and non-remunerated workers that lack social security, and thus are subject to high out-of-pocket expenses that, together with low wages, contribute to increasing healthcare inequality.

Social Support Networks

As it was previously mentioned, in Mexico the healthcare system is divided into subsystems belonging to the private and public initiatives. Most medical services are provided by Popular Insurance, which provides healthcare to the population that does not have permanent jobs. The second most important provider is the Mexican Institute of Social Security (IMSS) , which provides service to 36.4% of the population. The requirements to have this service involve working for the private initiative, and cover the premiums of the service.

The third provider is the Social Security and Services for State Workers (ISSSTE), which covers 5.5% of the population, and who acquire this service for their labor in governmental instances.

Finally the remaining population gets medical attention only through private healthcare insurance.

Despite the creation of these subsystems, according to the 2020 report from the National Institute of Statistics and Geography (INEGI), in 2020, 33 million Mexican citizens did not have access to any form of healthcare.

Different initiatives have been created to decrease the inequity and improve access to health for the poor population, like Seguro Popular and Programa de Desarrollo Humano Oportunidades, but still new strategies are necessary to provide health services to specific vulnerable zones.

The head of INSABI defends the program by affirming that the flaws and uncertainty are the products of the resistance faced by the ambitious project since it affects economic interests. He also

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mentions that the budget allocated to INSABI is much higher than the one allocated to Seguro Popular. The former Health Minister in charge of creating the now-extinct Seguro Popular, warned that the INSABI puts the federal government in charge of medical attention, which was previously in the hands of local governments, resulting in its failure to properly address the needs of the population.

INSABI currently has 32.8 million people enrolled in the program. The economical implications for the federal government of providing health services to this many people are dangerous, since the money needed for its operation often comes from redu- cing the budget of other SNS organisms like IMSS, which endangers the services available to the 47.2 million people affiliated to this program. The private health services are not affected by this budget reorganization, and thus are able to continue providing the same quantity and quality of services.

On the other hand, the budget reduction of the IMSS affects both quantity and quality of the services provided, further increasing the gap between private and public health services.

In 2021, the OMS issued a recommendation for public health services budgeting, with a 1% GDP increase for this sector. In 2022, the budget for nationwide social security and public health services was increased by only 0.37 %. This includes the INSABI, IMMS and other organisms from the SNS.

This lack of funding for the public health sector further increases the gap with the private health sector.

Political and Legislation Impact on the Mexican Healthcare System

Mexico is currently undergoing an epidemiological transition by the amount of diseases that Mexicans are suffering. These range from infectious diseases (diarrhea, infections, tuberculosis) to chronic degenerative diseases (types of cancer, diabetes, renal insufficiencies, heart diseases, maternal mortality, etc.). Currently, Mexico ranks 90th globally in terms of life expectancy, meaning that the average Mexican citizen is expected to live 75 years.

The administration of E. Peña Nieto proposed a health reform in Article 4 of the Mexican Constitution to reduce the medical care and State's responsibility to provide the population minimum health packages. This involved reducing health interventions to less than 400 in public health institutions (IMSS, ISSTE), leaving people no other choice than to search for treatment in the private sector. Essentially, through this, the government created a "minimum health basic package" to standardize treatment protocols, reduce the types of operations public health services are allowed to perform, implement an office that is in charge of checking these procedures, and relocate patients to private institutions.

Nonetheless, Mexico hasn't always had a deficient health system, especially in terms of vaccination. In 1905, Mexico's president Porfirio Diaz created the National Bacteriological Institute, which was devoted to vaccine production. During the Mexican Revolution and World War I, the institute's budget was canceled. Later, the government upgraded the institute to the Institute of Hygiene and began the production of local vaccines. In 1960, the National Institute of Virology was created and it was recognized as the Center Reference of Vaccines supporting the World Health Organization (WHO) for its technical capacity and high quality of vaccines, by which it produced the polio vaccine of particular importance for babies and toddlers. During the 1980's and 1990's, vaccination production increased not only for polio, but for different diseases such as: malaria, smallpox, measles, dengue, cholera, polio, ORT and tuberculosis. Mexico was one of the seven countries with sufficient manufacturing of vaccines for its residents.

But at the same time, instead of increasing its production for the rest of the world, Mexico's vaccine production started to decrease by the dis- mantling of the fabrics and the reduction of

the budget allocated to the public healthcare system by recommendations made by the World Trade Organization and by the North American Free Trade Agreement. These agreements increased the restriction of the budget even more. By 1998, Mexico was no longer sufficient in vaccine production with great consequences in the Influenza H1N1 epidemic and evidently seen in the COVID-19 pandemic. With this in mind, it is clear that the Mexican government is not able to sufficiently produce and provide vaccines for the people; even though Mexico has bottled up 30.8 million doses of the AstraZeneca vaccine and 11.9 million of the Cansino vaccine, most of them were sent abroad.

To combat this, the administration bought 244 million doses of different types of vaccines: COVAX, AstraZeneca, Pfizer/BioNTech, CanSinoBIO, Sinopharma and Sputnik V to satisfy the demand, but because of the economic crisis at the time, vaccination was limited to the states that provided a greater economic input for the country: particularly in areas that included Nuevo Leon and Mexico City. These are where most of the industry and economic powerhouses are located in the country. States like California and Yucatán were also favored because they help further tourism, which was important in redeeming the economy. These practices mark great inequality; states that were not considered economically valuable were not considered in the vaccination plan.

Furthermore, the great wave of migrants coming into the country became a problem, especially with the USA, as this country donated 11 million vaccine doses of AstraZeneca, Johnson and Johnson, and Moderna vaccines, but with the condition that the Mexican Government restricted the migrant flow into the USA and supported them with social programs like the reactivation of Migrant Protection Protocols (which aims to keep migrants in Mexico). This shows great disparity not only between the most and least economically developed Mexican states, but also the power of greater countries with more economic power.

Conclusion

The stratification in the healthcare system in Mexico roots itself in multiple factors, most of them stemming from the socioeconomic inequalities and hence the complex structures of power in the social system. Factors including economics, educational level, physical environment, social support networks, and political legislation, play a key role in health.

These factors often lead to an increase in dangerous practices and behaviors regarding the self-prescription of drugs such as antibiotics, contributing to the appearance of multidrug resistant bacteria, which is a serious threat for world public health.

In order to make a change in this matter, governmental institutions must aim for the wellbeing of the population and not just the political status given by inefficient and deficient social programs. They must invest more in efficient health programs that decrease inequalities. There should also be experts in the public health field that are qualified to control existing and future epidemics and pandemics, such as the forewarned antibiotic pandemic.

In conclusion, there are multiple stakeholders playing a role such as the Mexican government, pharmaceutical companies, the private initiative, health professionals, and minority groups, and in the end, it all comes to the power dynamics of a complex system that favors those on the top.

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iGEM IISER Tirupati

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THE DIAGNOSIS AND DETECTION OF PCOS

Introduction

This year, Team IISER Tirupati's project is called "AptaSteles." Our project involves developing a novel detection kit for Polycystic Ovarian Syndrome (PCOS).

About PCOS

PCOS, also called Stein Leventhal syndrome, is a syndrome that is expressed in the form of metabolic and hormonal fluctuations. The disease has symptoms which include acne and hirsutism, irregular menstrual cycles, insulin resistance, heart diseases, and certain cancers. The etiology is still unclear but studies show that the causes could be a combination of genetic factors and lifestyle issues. Other factors like geographic differences, age, diet, and even economic position contribute to the development of symptoms in PCOS. Due to the lack of knowledge about the exact causes of PCOS, effective diagnosis and treatment methods are lacking.

The prevalence of PCOS in India ranges from 3.7 to 22.5%, depending on the population studied and the criteria used for diagnosis. Globally, women of reproductive age accounted for 1.55 million incident cases of PCOS. A study done in urban and rural parts of South India show that the prevalence rate of PCOS are 8.9% and 1%, respectively.

There is a distinction in the number of cases in urban and rural areas partly due to differences in lifestyle. In studies done in Northern parts of India and Maharashtra, the prevalence of PCOS (by Rotterdam's criteria)

GLOBALLY, WOMEN OF REPRODUCTIVE AGE ACCOUNTED FOR 1.55 MILLION INCIDENT CASES OF PCOS (POLYCYSTIC OVARIAN SYNDROME).

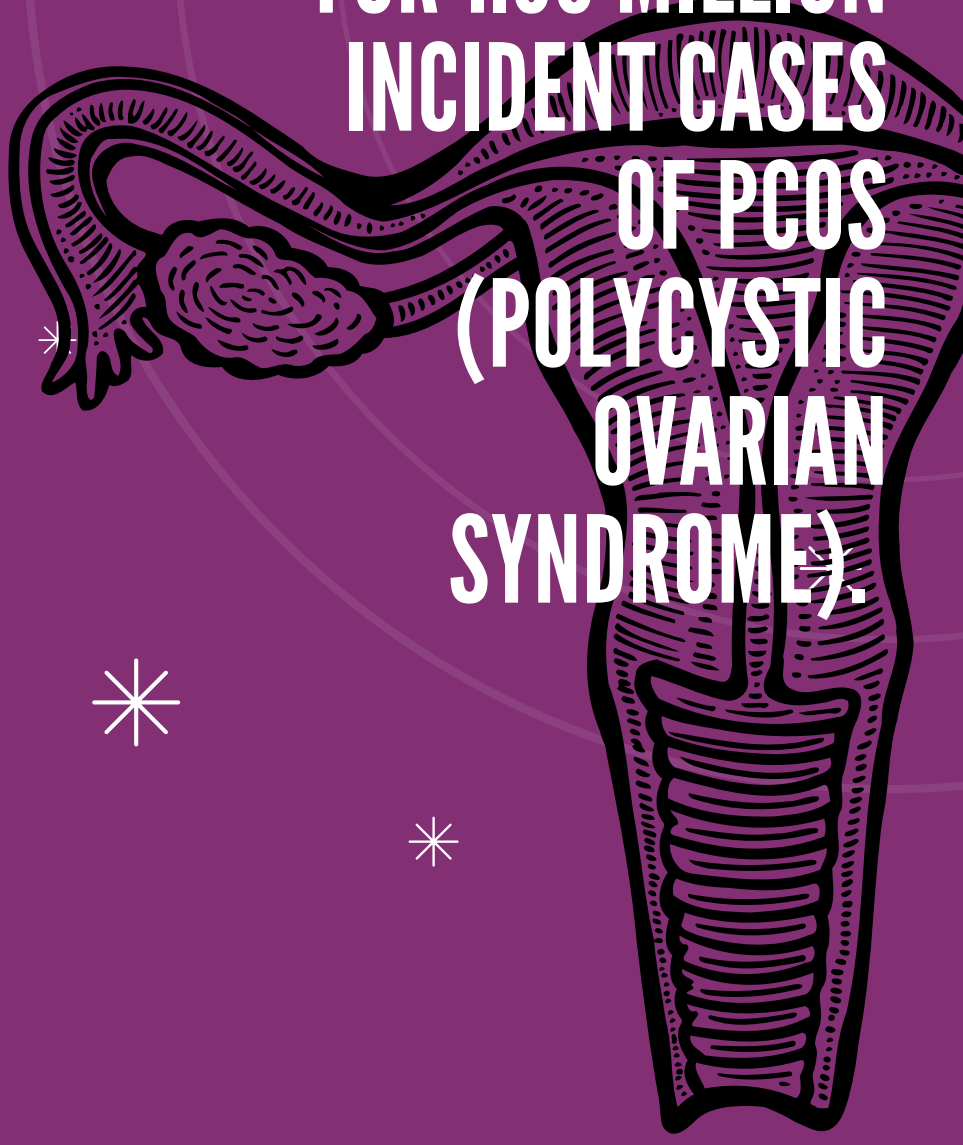

Illustration by Kimberly Carrera

was reported as 6.8% and 22.5%, respectively, and a study estimated a prevalence of 8.2% of PCOS in Central India. This data indicates the prevalence of PCOS in India while justifying the inconsistencies in the diagnosis of this disorder. These numbers can be indiscriminate because half of the cases go undiagnosed due to a lack of awareness.

Current Diagnostic Methods and Shortcomings

Generally for PCOS diagnosis, a blood test, an ultrasound scan and a pelvic examination are advised. There are many sets of criteria built by different medical boards and committees around the globe for the diagnosis of PCOS. However, doctors prevalently use the Rotterdam criteria, made by an expert panel in 2003. The criteria has three sub-criteria, of which at least two must be fulfilled to be classified as PCOS: i) Polycystic ovaries (multiple cysts in ovaries), ii) Hyperandrogenemia (excess of male hormones), iii) Oligo anovulation (irregular menstrual cycle).

Though the use of the Rotterdam criteria is customary, it is prone to deviations due to the patient's specific age, ethnicity, and geographical region. Thus, it is challenging to standardize the symptoms and diagnosis. Since PCOS diagnosis does not have a precise detection method, this leads to misdiagnosis of the disease. It is also observed that nearly 50-70% of PCOS cases go undiagnosed.

Misconceptions About PCOS

There are several severe misconceptions about PCOS. It is rigidly believed that PCOS is just a lifestyle disease, though it is shown that many other factors like those mentioned above contribute to the development of symptoms. It is also perceived only as a 'period' problem, making it an entire reproductive health issue and ignoring the diaspora of physical and mental health effects. Further, issues like obesity, anovulation, and irregular menstrual cycles are instantaneously coupled to PCOS, which may not be true for all people with PCOS. In a few cases, PCOS is thought to cause infertility.

Our Solution

To bring about a revolution in the diagnosis of PCOS, we are detecting PCOS through biomarkers instead of symptoms. Biomarkers are certain molecules whose quantity changes indicating the presence of a disease or disorder. Since PCOS is a syndrome, not a disease, it does not have one particular biomarker. Therefore we propose to detect an array of biomarkers. By examining the literature, we have identified potential biomarkers for PCOS. These biomarkers are miRNAs, proteins, and hormones. A combination of these biomarkers is necessary as symptoms and underlying causes of PCOS are varied.

How Will We Accomplish This?

We are building genetic designs using aptamers that make the detection and quantification of this array of biomarkers specific and sensitive. Aptamers are oligonucleotide or oligopeptide sequences that have a particular secondary structure. They are called "chemical antibodies" because of their ability to mimic antibodies in function, and bind to ligands. Light-up aptamers are a type of oligonucleotide that produce a fluorescence output.

Since we are taking into consideration a wide range of biomarkers including proteins, miRNAs and hormones, the aptamers for each of these are in different stages of progress. For some, there are already known aptamers. However, for those which do not have classified aptamers, our team aims to identify novel DNA/RNA aptamers for a few biomarkers using SELEX parallelly assisted by computational tools. For miRNAs, due to their comparatively lesser concentration, we plan to incorporate an isothermal nucleotide amplification technique, Recombinase Polymerase Amplification (RPA), to increase the accessibility and sensitivity of our kit.

With the vision of implementing the kit, the team is driven to integrate and actualise our kit's components in a hardware-based prototype using microfluidic channels, and develop it into a POC (point of care) device.

Conclusion

Ultimately our goal is to make a user-minded kit that detects PCOS with the help of biomarkers. This enables a precise and accurate detection method focused on different aspects of the syndrome. By standardizing our methodologies, we envision a kit that can cater to a broader range of people. Our kit, assembled to be used as a preliminary test, would allow a person to check and assess their results, helping them to move towards further prognosis. In addition, it would also fulfill our goal to combat misnomers associated with PCOS. The kit was designed mainly to achieve two goals: first, to make the diagnosis of PCOS more accessible so that it would bring down the number of undiagnosed cases, and second, to eradicate the misconceptions regarding PCOS.

SHRIMP FARMING CALLS FOR URGENT HELP

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Illustration by Kimberly Carrera

Shrimp, a delicious seafood high in protein, currently plays a leading role in crustacean aquaculture production with a fast-growing market and farming size. Penaeus vannamei, Macrobrachium rosenbergii, and Penaeus monodon are known as the three best-quality shrimps with the highest production rates in the world. Penaeus vannamei in particular, is especially rich in proteins, minerals, unsaturated fatty acids, and contains functional biological components that have various beneficial effects for the human body. Overally, it is a high-quality and balanced source of nutrition. Therefore, this kind of shrimp has broad applications in health products, medicine, cosmetics, food additives, and aquaculture, and has a high economic and medicinal value.

Penaeus vannamei has the advantages of fast growth, strong disease resistance, easy rough culture and transportation, and high meat yield. With the development of China's economy and the improvement of people's living standards, the current yield of shrimp is unable to satisfy the fast-growing market demand. Among the artificially cultured shrimp and crabs in China, the yield and culture of Penaeus vannamei rank first. According to the data from China Fishery Statistical Yearbook, Chinese shrimp production showed an overall upward trend from 2013 to 2020, reaching 6.3073 million tons (MT) by 2020, while the whole world currently exceeds 8 MT of high value. This proves that shrimp has emerged as a highly traded seafood product in China and around the world.

Aquaculture dominates aquatic food production both in Asia and globally, and is now facing a significant challenge. In this industry, economic losses due to disease outbreaks have been estimated by the Food and Agriculture Organization (FAO) to be over $9 billion per year, which is approximately 15% of the world's farmed fish and shellfish production value. The threat of disease has become a barrier that prevents numerous aquaculture industries from developing, and has even led to the collapse of some. Because of this, shrimp production has been seriously damaged in several countries.

Acute hepatopancreatic necrosis disease (AHPND), originally known as early mortality syndrome (EMS), has a devastating impact on the shrimp aquaculture industry.

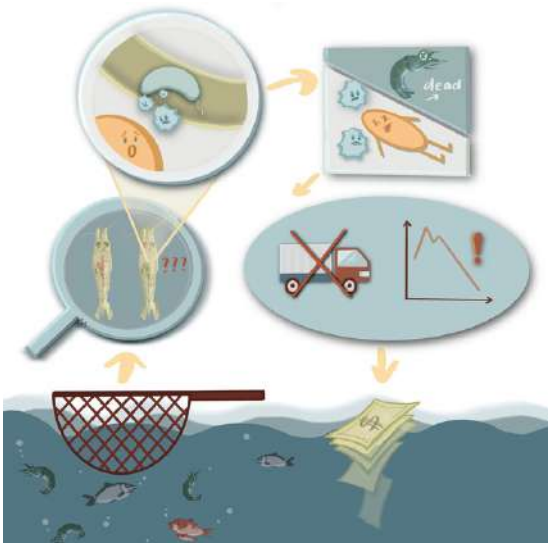
This disease develops quickly, starting about 8 days post-stocking, with severe mortalities (up to 100%), occurring within 20-30 days. It is estimated that these losses raised prices by $25.5 per hectare, and loss probability raised 1.4% for every 1% increase in disease mortality.

Since the outbreak in 2009, AHPND has spread rapidly around the world, causing massive shrimp mortality and severe economic losses to the shrimp farming industry, as well as posing a threat to food safety. Moreover, it escalated in late 2013, when the industry collapsed in South Asian countries. In 2017, the World Organization for Animal Health (OIE) adopted amendments to create a specific chapter in both the Aquatic Code and Manual for AHPND, which demonstrates that the authorities have acknowledged its seriousness.

The major pathogen of AHPND is Vibrio parahaemolyticus which carries a unique plasmid, pVA1. The plasmid encodes the binary PirA and PirB toxins which target the digestive gland of shrimp. These toxins bind with hepatopancreatic epithelial tissue, forming pores and leading to subsequent cell death.

The pVA1-type plasmid can also be transferred from V. parahaemolyticus to another species, such as V. punensis, V. harveyi, V. owensii, V. campbelli , and Shewanella sp., giving the host bacteria a stronger pathogenic ability. The bacteria then spread and colonize the shrimp's digestive tract, causing severe damage to tissues. Moreover, the primary clinical AHPND symptoms in infected shrimps are anorexia, lethargy, slow growth, soft shelling, and empty digestive tract. Due to the rapid development of AHPND, once the disease occurs, it will cause an irreparable large-scale acute shrimp death.

The conventional approaches for preventing and curing AHPND either have limited success, or are unsustainable in the long-term. Mixed in the shrimp diet or added to rearing water, antibiotics are used as powerful medicines to fight bacterial infections in shrimp production. However, their use presents a serious threat to public health and the environment.



Additionally, there is growing antibiotic resistance which is curbing the effectiveness of these drugs. Continuous application of antibiotics by shrimp farms facilitates the development of antibiotic-resistant bacterial (ARB) strains. Antibiotic-resistant strains can be more tolerant to mild heat treatments, such as pasteurization in shrimp processing, which will threaten food safety. Further, it has been proved that microbiome diversity significantly impacts host health. The competitive exclusion principle, which is also known as Gause's law of competitive exclusion, states that the higher gut microbial diversity, the lower the possibility for pathogenic colonization. The application of antibiotics at hatcheries and shrimp farms would disrupt the microbiota homeostasis. An alternative strategy to mitigate the effects associated with Vibrio infections in shrimp farms, is to improve water quality. As Vibrio species are opportunistic, the susceptibility of Vibrio infection to shrimp is often affected by water conditions that favor a disease outbreak, which raises the urgency to manage the water quality of shrimp farming to prevent mass infection. Besides, maintaining the biological balance among algae and bacteria in ponds and the gastrointestinal tract of shrimps is also one of the ways to reduce the effects of AHPND infection.

The use of probiotics to inhibit certain bacterial infections in shrimps and enhance water quality has proved to be valid for aquaculture purposes. However, it is unclear whether the actual probiotics or their natural products actually inhibit certain pathogenic bacteria like Vibrio in aquaculture ponds. There is limited knowledge on the synergistic protective effects of different probiotics on shrimp in aquaculture.

Recent research has found that, in response to AHPND, the shrimp immune system expresses antimicrobial peptides (AMPs) such as penaeidins and crustins, which provide some protection against AHPND-causing V. parahaemolyticus. Several immune-related factors have been discovered to be antibacterial in shrimp, and the injection of recombinant proteins of these factors can be an effective treatment to prevent AHPND. While some plant extracts and phages (bacterial virus) can serve as a potential antimicrobial agent to inhibit the growth of V. parahaemolyticus, they have also been successfully utilized as feed supplements in the shrimp diet to minimize the effect of pathogen and improves the survival of shrimp species.

Despite the progress in AHPND-related research, the potential mechanisms of PirA/B that cause AHPND in shrimp remain unknown. Although many reports related to the pVA1 virulent plasmid, the critical information remains a mystery, including variability of the plasmid copy number per bacterial cell and how this influences the pathogenesis of AHPND, indicating further investigatory for the pathogenesis of AHPND is also needed.

The current diagnosis of AHPND includes the examination of the affected shrimps through the clinical symptoms of AHPND, PCR amplification detection, molecular diagnostic tools, etc. However, effective methods, used on-site and in-time, have not been established to help diagnose AHPND. In summary, effective prevention, treatment, diagnosis, and management of this disease are still in urgent need to take precautions and deal with further outbreaks.

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AN AFFORDABLE & FAST APPROACH TO GOLD PROSPECTING IN GHANA

Illustration by Kimberly Ca

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Abstract

Ghana is rich in gold, but gold prospecting is expensive. Surface and subterranean exploration procedures are typically costly and time-consuming. Only large-scale mining corporations have the resources to explore effectively. Due to the resource-intensive nature of gold prospecting, small-scale miners who possess ancestral land rights do not reap the full benefits. By offering a biosensor as a gold exploration tool, we hope to help the community, and large-scale and small-scale miners in this industry to minimize the cost of gold prospecting as much as possible. We plan to reduce the wastage of time and money, raise the revenue of individual miners, lessen the negative impact on the environment, and increase community service programs in mining towns.

Introduction

Today, Ghana is the leading producer of gold in Africa and the seventh leading producer globally. Gold abounds in Ghana but prospecting is not so easy. Surface and underground exploratory processes are usually expensive and time-consuming. Only large-scale mining companies have the resources to explore efficiently. Although small-scale miners have ancestral rights to lands, they do not benefit fully because of the resource-intensive nature of gold prospecting. They resort to cheaper methods which are not exactly accurate, so they leave a vast number of open pits after failed

explorations. These open pits and other environmental hazards created during exploration lead to several unintended implications for the locals. Considering this, the Ashesi-IGEM team is leveraging synthetic biology to provide a fast and affordable approach to gold prospecting.

Impact

Gold prospecting is mostly done in rural and remote communities. For the people living in these communities, digging and probing for gold threatens their health. For example, the open trenches which are dug in the process, collect water during the rainy season and expose residents to malaria and water-borne diseases such as cholera and diarrhea. On the other hand, farmlands and the general aesthetic value of lands are destroyed. Our approach will conserve land and eliminate the threats posed by open exploration pits strewn across gold-prone areas.

Interviews with mine workers reveal that mining companies compensate for the costly exploration methods by cutting down on workers' remuneration. Large-scale mining companies also compensate by reducing their effort toward Corporate Social Responsibilities (CSR). CSR is another term for the give-back projects they do in the host communities. Instead of maintaining roads damaged by their heavy trucks, they do less expensive projects like painting buildings to compensate for the environmental cost incurred in exploration. Hence, communities suffer from the mining companies' activities but do not get befitting returns.

As mentioned earlier, expensive and unreliable exploration techniques drastically reduce small-scale miners' productivity. Their mining activities disrupt agriculture, making it an unfruitful and unattractive economic venture. Hence most people turn to gold mining as a means of livelihood. The more they mine inefficiently, the more they destroy their agricultural farmlands; the poorer they become and delve more into mining. Because they are stuck in this vicious cycle, they earn meager incomes, leading to prevailing poverty rates in these communities.

Our Approach

We are developing a biosensor that can indicate the presence of gold by detecting pathfinder elements. According to research, pyrite and inorganic arsenic come together to form a spongy structure that accumulates gold; ergo, iron and arsenic are the pathfinders we seek. For our biosensor, we are engineering strains of E-coli bacteria that will emit distinct light colors for the different pathfinder elements detected in the soil. The light displayed after a soil sample is tested with our biosensor, will tell us whether there is gold or not. If our biosensors are adopted, it will decrease the costs of exploration, which will lead to increased remuneration for mine workers and better community projects.

Figure 1: The Environmental Impact of Pre-exploratory Mining

Conclusion

In short, by introducing the biosensor as a gold exploration tool, we are benefitting three stakeholders in this space: the community, large-scale miners, and small-scale miners. We project to cut resource wastage: time and capital, boost the individual income of miners, reduce unfruitful damage to the environment and increase community giveback projects in mining communities

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SECTION 5

Chinese Translation of Selected Articles

CHINESE TRANSLATION

严重的COVID-19感染中的S蛋白缺乏及相关并发症

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冠状病毒病（COVID-19）是一种由SARS-CoV-2病毒引起的传染性疾病。这种疾病被广泛定性为呼吸系统疾病，然而这并不一定准确。COVID-19患者会出现各种症状，包括肺炎、炎症、微血管功能紊乱、高凝状态、神经系统损伤和多器官衰竭。此外，还有多种长期并发症，这些并发症仍未得到很好的描述。

这些症状中的任何一个都可能是与COVID-19有关的死亡原因。然而，血栓形成（血液凝固异常）是严重COVID-19感染的主要死因。研究人员已将COVID-19的这些异常凝血事件与蛋白质S水平的下降联系起来。

蛋白S是一种多功能的蛋白质，它维持正常和健康的凝血活动，并防止血液过度凝固。它还能抑制细胞死亡和感染后的炎症，并被用于许多细胞信号传导途径。由于蛋白S有这么多不同的作用，蛋白S的缺乏会产生严重的后果。

COVID-19感染后，蛋白质S水平下降有多种原因。在严重的COVID-19感染中，有一种极端的免疫反应，即所谓的血栓性炎症，它是通过过度生产细胞因子（调节细胞活动的小分子）而产生的。

COVID-19可引起 "细胞因子风暴"，损害细胞，并导致器官衰竭。它还会导致蛋白S水平下降，在整个身体内造成许多微型血凝块（微血栓）。严重的COVID-19感染患者的尸体解剖显示，这些血块存在于肺部，造成广泛的肺部损伤，这是COVID-19相关死亡的一个主要原因。

在COVID-19期间，蛋白质S水平的下降也可以用蛋白质S和在病毒表面发现的尖峰蛋白之间的结构相似性来解释。这种尖峰蛋白是由免疫系统识别的。感染后，免疫系统产生针对尖峰蛋白的抗体来中和病毒，但这些抗体可以攻击蛋白S的结构相似部分，导致其水平下降。

总体而言，严重的COVID-19感染已被证明会导致蛋白S水平的下降。然而，研究还表明，对于在任何感染之前已经有遗传性蛋白S缺乏的患者，其影响要严重得多。在一份COVID-19病例报告中，初步的蛋白S缺乏已被证明会导致缺血性中风。

基本上可以得出结论，严重的COVID-19感染导致蛋白S水平明显下降，并增加异常或致命的血液凝结和炎症的发生率。研究蛋白S缺乏和COVID-19之间的直接关系的研究人员建议，在严重的COVID-19患者中给予蛋白S可以是一种有效的治疗，并可作为传统治疗的替代。给予蛋白S也可以作为蛋白S缺乏症患者的预防性治疗，以防止中风的发生。

总的来说，正确施用蛋白S或许能够成为严重的COVID-19的有效治疗方法。并且蛋白S和病毒性疾病之间有许多的联系。我们应该做更多的研究来了解这种联系，并探索蛋白质S作为严重COVID-19感染的治疗方法。

非洲裔美国人中的蛋白质S缺乏症

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Stephanie Laderwager

蛋白S缺乏症是一种罕见的疾病，可以是遗传性的，也可以是后天获得性的，它可以导致过度和不正常的血液凝结。这被称为血栓性疾病。血块通常发生在四肢，这种情况被称为深静脉血栓（DVT）。深静脉血栓可能会破裂并进入肺部，导致肺栓塞（PE），这很可能导致生命危险。蛋白S缺乏症是由PROS1基因的突变引起的。

研究表明，非洲裔美国人的静脉血栓栓塞症（VTE），包括深静脉血栓和静脉血栓，比欧洲裔美国人高30-60%的比率。血栓性疾病的遗传倾向在欧洲人群中已被充分记录，但在非洲裔美国人社区中却没有。

非洲裔美国人社区的S蛋白缺乏症有复杂的、相互交织的因素，造成了这种疾病的不公平。PROS1基因突变的遗传性差异，临床试验中缺乏非裔美国人的代表，以及普遍的医疗保健差异，都导致了对这种疾病如何影响这一人群的认识不足。

已发现有一种突变可使欧洲携带者的VTE风险增加3-5倍，这种突变被称为因子V Leiden，但这种突变通常不在黑人群体中出现。一项研究试图研究仅在非洲裔美国人中导致VTE发病率增加的遗传因素。在一个非裔美国人家庭中分析了PROS1基因，该家庭有频繁的VTE历史，并且根据以前的实验室报告，蛋白质S的水平下降。

研究人员发现了一个名为PROS1 V510M的变体，并发现这一突变在第510位将缬氨酸改为蛋氨酸。然后他们在一个更大的研究中评估了这个变体的意义。结果发现，PROS1 V510M与非裔美国人中VTE的发生率增加有关。虽然这项研究成功地确定了非裔美国人中PROS1基因的一个特定人群变异，但它也强调了由于黑人在临床研究中缺乏代表性而导致的有限数据中的一个主要问题。

少数民族更有可能受到健康差异的影响，然而在美国，黑人患者只占临床试验参与者的5%。ProPublica和Stat发表的2015年研究报告宣布，一种旨在治疗多发性骨髓瘤的新的癌症药物现已被FDA批准。问题是，在722名试验参与者中，只有13人是黑人。在普通人群中，被诊断为多发性骨髓瘤的人中，20%是黑人。在这项研究中，只有不到2%的参与者被认定为黑人。

有许多因素导致代表性不足的社区在临床试验中的低参与率。其中一个因素是与许多试验有关的排除标准。通常情况下，临床试验排除了肥胖、超过一定年龄、患有慢性疾病或患有严重精神疾病的参与者。与白人同行相比，代表人数不足的社区过多地经历了慢性疾病，他们被排除在健康研究之外。通过重新评估排除标准，试验可以发展出更多样化的参与，以代表一般人群。

在试验中建立包容性的一个重要方面是概述哪些潜在的障碍可能会阻止代表性不足的社区成员参与。这些障碍可以细分为三类：财务、沟通和信仰系统。

经济上的障碍可能包括不能耽误工作来参与试验，交通费用，以及在参与研究期间需要照顾孩子。语言和沟通障碍也可能妨碍参与。由于过去的经历或道德信仰而对医疗行业缺乏信任，这一点需要在代表性不足的社区加以考虑。

在确定了可能抑制代表性不足的社区参与的潜在障碍后，应该对试验进行重组以消除这些障碍。这方面的一些例子包括：提供前往现场的交通，提供误工补偿，提供儿童保育，提供多种语言的信息材料，以及为那些可能对参与感到犹豫的人提供支持。

在设计一项临床试验时，必须考虑各种因素，但不限于：概述研究目标，确定目标人群，以及确定参数。要看到代表性不足的社区参与试验，从初步设计阶段到试验结束，都必须考虑参与者的包容性。

缺乏对非裔美国人的包容，反映了这个社区在健康方面的不平等，因为他们获得医疗服务的机会有限，而且服务提供者的隐性偏见可能会影响治疗。通过使临床试验对那些来自代表性不足的社区的人更具包容性，我们有机会定制治疗干预措施，为所有人提供更好的护理。

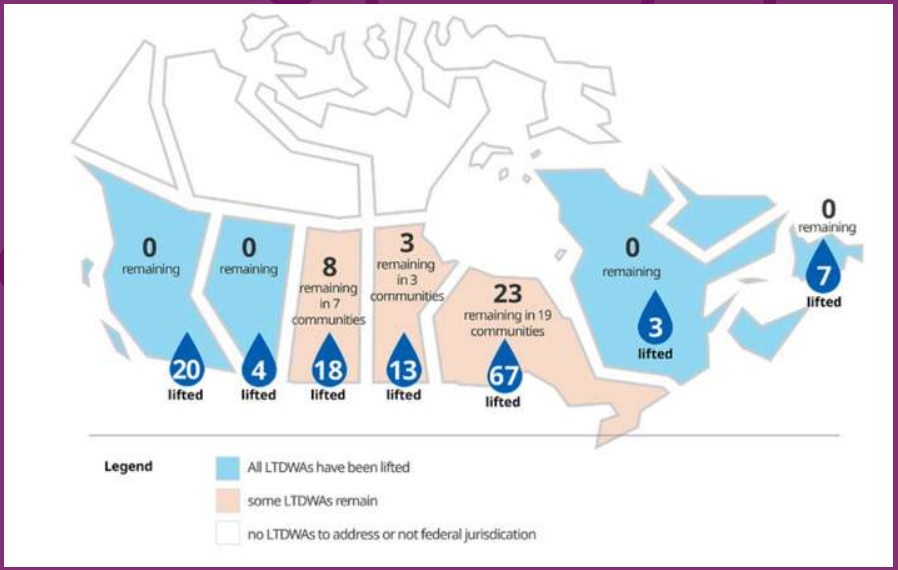

图1. 显示剩余建议长期饮用水（LTDWAs）和被取消资格的LTDWAs数量的加拿大地图。

加拿大原住民的淡水不平等与医疗保健差异之间的联系

加拿大皇后大学iGEM

在加拿大，73%的原住民水系统处于高度或中度污染的风险之中。这些污染物包括重金属，如铁、锰或铅，以及有机物质，如细菌和病毒。2021年，加拿大政府同意与该国的土著社区达成80亿美元的和解。然而，全国各地的这些社区仍有34个长期饮用水建议，其中一些建议源于1995年。因此，Neskantaga第一民族的人民已经超过27年没有获得安全的饮用水。每个饮水警告可能代表多达5000人无法获得清洁、安全的水。

许多人不知道他们的水是如何变得有害的，为什么他们的水不安全，或者他们可以做什么来解决这个问题。社区知道的一件事是，他们的水使他们生病。无论是因为摄入水而导致的急性胃肠道疾病，还是因为卫生习惯而导致的皮肤过敏，非常清楚的是，这些人所接受的水对人类来说是不安全的。

对生病的恐惧和政府沟通的缺失，导致了许多误解的传播。理所当然，许多受影响的人不相信从他们的水龙头流出的水，所以不幸的是，他们转而饮用来自湖泊、河流、小溪等未经处理的天然水。未经处理的天然水仍可能含有致病微生物，导致急性胃肠道症状，如腹痛、腹泻和呕吐，但也可能导致更严重的疾病，如胃溃疡和胃癌。因此，与非原住民相比，原住民饮用水危机导致加拿大原住民社区的水传播疾病在统计学意义上明显增加。因此我们可以说，这场危机导致了受影响社区对医疗保健服务的适当需求。

但可悲的是，加拿大的原住民在寻求医疗援助的道路上面临许多障碍。一些主要的障碍包括地理环境、健康教育和医护人员的消极偏见。

偏远或孤立的土著社区的医疗中心通常主要由护士和相关卫生工作者管理。尽管这些专业人员提供了他们所能提供的最高标准的护理，但这些健康中心在设备、培训和业务范围方面都有限制。因此，患有严重疾病的人必须前往更多的城市卫生中心，那里有医疗专家和更先进的技术。如图2所示，这就造成了医疗保健的地理障碍。

健康教育的不足囊括了对土著人造成障碍的几个主题。不幸的是，很大一部分土著人没有参加或完成教育学习，很可能是由于加拿大课程中缺乏文化意识。不完整的教育与识字率低直接相关，因此，使某人更难驾驭医疗保健系统。同样，专业的医疗保健教育往往偏向于西医而不是传统医学。医疗保健课程的这种不足既会阻止土著学生寻求医疗保健职业，也会使土著人不愿意到城市保健中心寻求帮助。

代际创伤、殖民化和身体创伤多年来一直困扰着加拿大原住民，这可能导致酗酒、暴力和其他自我毁灭的行为。可悲的是，由于媒体对这些行为的不准确描述，围绕土著人民形成了负面的陈规定型观念。这些媒体传播的刻板印象导致一些医生认为大多数土著人是酗酒者，土著人装病滥用药物，以及其他可怕的指责。诸如此类的观点对原住民非常有害，因为它可能导致医疗服务提供者限制与原住民病人的互动，拒绝给他们提供基本药物或专家，以及其他有害行为。不幸但又客观存在的是，医护人员的负面偏见会使土著病人不敢寻求适当的治疗。

总的来说，加拿大土著人在需要获得医疗服务时面临着大量的障碍。可悲的是，由于其他基础设施的不足，如土著居民饮用水危机，加拿大的土著人民需要医疗援助。开始解决诸如向社区供应清洁饮用水、增加获得医疗服务的地理机会、提高教育程度和减少负面偏见等问题，是降低这些社区障碍的一个步骤。只有在所有加拿大人的共同努力下，才能为那些与我们一起生活的人破除这些障碍。

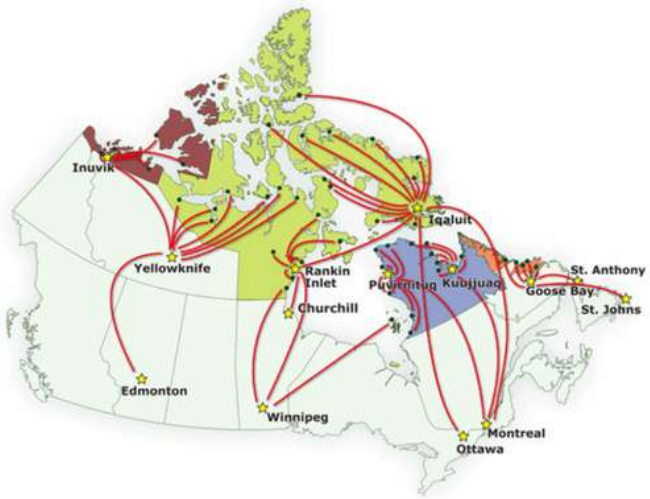

图2. 显示因纽特人寻求医疗援助的常见医疗旅行路线的加拿大风格化地图，其中黑点代表社区，黄星代表医疗中心。

可获得的HPV检测--预防宫颈癌的游戏改变者

印度罗尔基工业大学iGEM项目

宫颈癌是第四大最常见的癌症类型，也是妇女因癌症死亡的第四大原因。尽管它是最可预防和治疗的癌症之一，但它记录的死亡率却高得惊人（在2018年的57万个病例中，有31.1万名患者死亡）。如果在早期阶段发现，由于HPV感染和轻度病变导致的癌前细胞变化可以在它变成侵袭性癌症之前得到治疗。当务之急是了解我们的医疗保健基础设施在哪些方面出现了问题，在控制宫颈癌的猖獗统计数据方面不断失误。多项研究表明，目前对宫颈癌的有效预防缺乏二级预防阶段，即方便有效的筛查和检测计划，有利于早期发现和治疗。

大约70%的宫颈癌和90%的死亡发生在发展中国家，世界上三分之一的病例来自印度。根据HPV信息中心发布的一份报告，印度有4.835亿妇女面临宫颈癌的风险。为了了解宫颈癌对中低收入国家的不成比例的影响，我们需要考虑地理环境、传统习俗和信仰、筛查水平、社会经济地位、医疗保健机会和公众意识。在主流话语中，性健康和教育仍然是禁忌，特别是在印度农村地区的妇女中，这大大影响了她们积极寻求检查和治疗的几率，尽管它很普遍。再加上心理因素，如对痛苦的侵入性检查的恐惧、对检查结果的焦虑和尴尬。目前，城市地区因宫颈癌而死亡的人数一直在稳步下降，而农村的统计数字却没有变化。

印度没有全国性的人乳头瘤病毒筛查计划，这一点令人极为担忧。尽管有国家指导方针，但筛查率仍然很低。至少，需要做很多工作来确保现有的筛查是针对最容易受到HPV影响的人群的子集。为了使筛查有效，发展中国家还需要对检测方法进行重大改进，使之更适合于低资源环境。

目前，盛行的筛查和检测方法存在多种问题。从收集样本开始，就采用了有创的方法，如PAP测试，这可能会导致疼痛，并加重产道中已经存在的异常细胞。同样重要的是要注意到，由于这些方法，病人缺乏依从性，而且在接受测试时越来越拘谨。测试还依赖于复杂的设备，需要经过培训的人员来操作，这将大大影响到可及性和成本。大多数HPV筛查涉及到耗时的方法，例如，PAP测试结果在1-3周内出来。这些方法有明显的便携性问题，而且与使用基于家庭的样本采集工具的测试相比，价格昂贵，而后者往往更具成本效益。

我们的目标是设计一种快速而敏感的护理点诊断试剂盒，以检测致癌性最强的HPV病毒株，即HPV16。我们的试剂盒将具有成本效益且易于使用。它是为在低资源环境中使用而设计的，不需要特殊设备或受过培训的专业人员。与现有的使用病毒外壳中的L1蛋白的诊断方法不同，我们的方法是基于hpv16中发现的高度保守的E7致癌基因，使该试剂盒对可能变成癌症的HPV非常敏感、有效和特异。病人只需要取一个阴道拭子。

我们项目的催生点是对宫颈癌不同程度和不相称的影响这一问题的紧迫性和相关性的诚挚信念。我们提出的解决方案是我们对该事业承诺的直接结果。在印度和其他中低收入国家，当务之急是进行全国性的人乳头瘤病毒筛查，并尽可能立即见效。除了筛查营，受过教育的专业人员必须与群众直接互动，让高危人群意识到HPV的流行性和可治愈性，如果早期发现的话。人们需要接受关于性健康重要性的教育，并鼓励他们定期检测HPV。后者只有在我们有一个容易获得的测试解决方案来支持的情况下才会有成果。我们希望看到可持续的设计能够支持我们的医疗系统中一个非常真实、紧迫和迄今未被承认的需求。

对虾养殖的棘手难题

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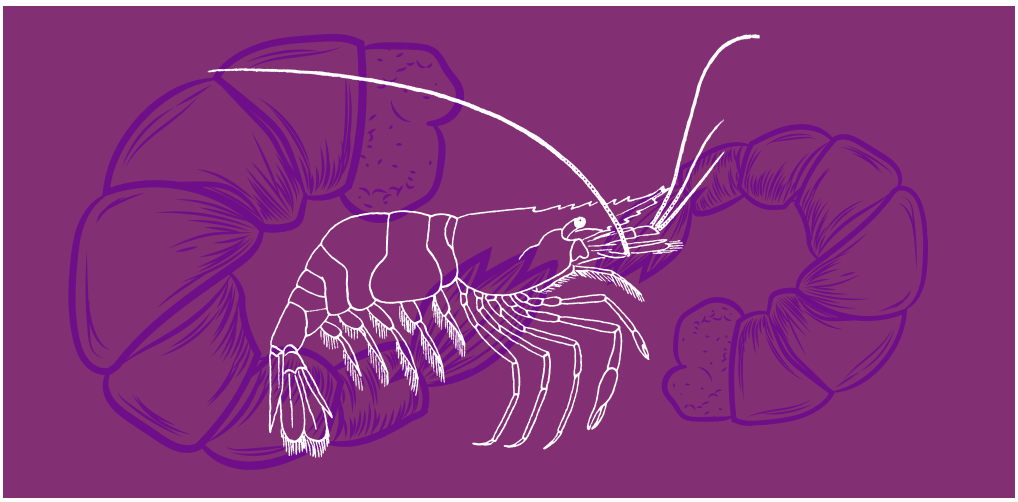
对虾是一种美味的高蛋白海鲜，养殖规模大，在甲壳类水产养殖中占据首要地位，也备受消费者的喜爱。凡纳滨对虾（Penaeus vannamei）、罗氏沼虾（Macrobrachium rosenbergii）和斑节对虾（Penaeus monodon）是世界范围内产量最高的三种优质对虾。其中，凡纳滨对虾富含蛋白质、矿物质和不饱和脂肪酸，并且含有多种对人体有益的生物活性成分，是一种质量优良、营养均衡的食源性营养源。因此，凡纳滨对虾在保健品、医药、化妆品、食品添加剂以及水产养殖等方面都具有广阔的应用前景，有较高的经济价值和医用价值。

凡纳滨对虾还具有生长速度快，抗病能力强，易粗养易运输以及产肉量高等优点。 随着中国经济的发展和人民生活水平的提高，目前的对虾产量已不能满足快速增长的市场需求。凡纳滨对虾的产量和养殖规模在中国虾蟹类人工养殖业中均居首位。根据《中国渔业统计年鉴》的数据，在2013年至2020年间，中国对虾产量总体呈上升趋势，到2020年达到630.73万吨。目前全球对虾产量超过800万吨，由此可见，在中国乃至全世界，对虾已经成为一种交易量很大的海鲜。

水产养殖业在亚洲甚至是全球水产行业中占据主导地位，但目前正面临着严峻的考验。据世界粮农组织估计，由疾病造成的经济损失每年超过90亿美元，约达世界鱼类和贝类养殖行业产值的15%。疾病的威胁不仅阻碍许多水产养殖业的发展，甚至导致一些养殖企业倒闭。一些国家的对虾产业也因病害而遭受重创。

例如对虾急性肝胰腺坏死病（AHPND），最初被称为早期死亡综合征（EMS），对对虾养殖业就造成了毁灭性的打击。这种疾病发病快，从放养后约8天开始传染，在20-30天内对虾出现大量死亡（死亡率高达100%）。据估计，疾病死亡率每增加1%，经济损失每公顷增加25.5美元，损失概率增加1.4%。



对虾急性肝胰腺坏死病自2009年首次暴发以来，迅速在世界各地蔓延，不仅导致对虾大量死亡，给对虾养殖业造成严重经济损失，也对食品安全构成了威胁。自2013年底南亚国家的养殖行业崩溃以来，该疾病危险性不断升级。在2017年，世界动物卫生组织（OIE）通过了修正提案，在《水产守则》和《养殖指南》中为该疾病设立了专门的章节，进一步强调了该疾病的严重性。

对虾急性肝胰腺坏死病的主要病原是一种携带pVA1质粒的副溶血性弧菌（Vibrio parahaemolyticus），该质粒编码靶向虾的肝胰腺细胞的PirA和PirB二元毒素。这些毒素会结合对虾的肝胰腺上皮组织并造成穿孔，最终导致细胞的死亡。

pVA1质粒可从副溶血性弧菌转移到其他菌种，如朋氏弧菌（V. punensis）、哈维氏弧菌（V. harveyi）、欧氏弧菌（V. owensii）、坎贝氏弧菌（V. campbelli）、希瓦氏杆菌（Shewanella sp.）等，这使宿主病菌具有更强的致病能力。致病菌传播后会定居在对虾的消化道内，对组织造成严重破坏。感染AHPND的对虾的主要临床症状是食欲减退、嗜睡、生长缓慢、外壳软化和空肠。由于AHPND的发展迅速，一旦发病，就将导致无法挽回的大规模对虾急性死亡。

传统AHPND的防治方法存在收效甚微或者治疗效果不可持续的缺点。例如，将抗生素添加进对虾饲料或养殖水体中是对抗对虾细菌感染的有效方法之一，但使用抗生素会对公众健康和环境构成严重威胁。在对虾养殖场中，抗生素的持续使用将促进抗生素耐药细菌（ARB）菌株的发展，从而使这些药物渐渐不再有效。ARB菌株更加耐受温和的热处理方法，如食品加工中的巴氏杀菌法，这将严重威胁到食品安全。此外，由于微生物组多样性对宿主健康有显著影响，而竞争排斥原理认为肠道微生物多样性越高，病原菌定植的可能性就越低。 在孵化场和养虾场使用抗生素会破坏肠道微生物的动态平衡，因此这也可能导致情况恶化。

减轻养虾场弧菌感染的另一种方法是改善水质。由于弧菌感染是概率性事件，而对虾对致病菌的敏感性往往受到有利于疾病爆发的水质条件的影响，因此对对虾养殖场的水质进行监管以防止大规模感染是很重要的。

此外，维持池塘和对虾胃肠道中藻类和细菌之间的生物平衡也是减少AHPND感染影响的有效途径之一，使用益生菌可以抑制对虾的某些细菌感染。然而，实际上益生菌或其天然产物是否真的抑制了水产养殖池塘中的某些诸如弧菌的病原菌目前尚不清楚，具体的抑制途径与机理也有待进一步探究。而关于不同益生菌在水产养殖中对对虾的协同保护作用也尚不清楚。

最近的研究发现，对虾免疫系统会对AHPND作出响应，分泌抗菌肽（AMP）（如penaeidin和crustin）。此外还发现多种免疫相关因子在对虾体内具有抗菌作用，注射这些因子的重组蛋白可以有效预防AHPND。同时，一些植物提取物以及噬菌体也可作为潜在的抗菌剂来抑制副溶血性弧菌的生长。它们已经被应用到对虾饲料中，以最大程度地减少病原体的影响，提高对虾的存活率。

尽管与AHPND相关的研究取得了许多进展，但PirA/B引起AHPND的潜在机制仍不清楚。pVA1毒力质粒的关键信息，包括每个细菌细胞内的质粒拷贝数的变化及其对AHPND发病机制的影响仍是未解之谜。因此，AHPND的发病机制还需要进一步的研究。

目前AHPND的诊断主要通过观察患病对虾的临床症状，此外也有对病原菌利用包括PCR扩增检测、分子诊断工具等方法进行检测。但目前尚无可用于现场检测且有效快速的检测方法。综上所述，我们仍然迫切需要针对该病的有效的诊断、治疗、预防和管理手段，以应对未来可能出现的大规模疾病暴发。

在加纳进行金矿勘探的一种经济而快速的方法

在加纳进行金矿勘探的一种经济而快速的方法

iGEM AshesiGhana, 加纳

Illustration by Kimberly Carrera

图1：勘探前采矿的环境影响

摘要

加纳拥有丰富的黄金资源，但黄金勘探的成本很高。地面和地下勘探程序通常是昂贵和费时的。只有大规模的矿业公司才有资源进行有效勘探。由于黄金勘探的资源密集型性质，拥有祖传土地权的小规模矿工并没有获得全部收益。通过提供生物传感器作为黄金勘探工具，我们希望能够帮助社区，以及这个行业的大规模和小规模的矿工尽可能地减少黄金勘探的成本。我们计划减少时间和金钱的浪费，提高个体矿工的收入，减少对环境的负面影响，并增加采矿镇的社区服务项目。

简介

今天，加纳是非洲的主要黄金生产国，也是全球第七大黄金生产国。全球第七大黄金生产国。加纳的黄金很多，但探矿却不那么容易。地面和地下勘探过程通常是昂贵和耗时的。只有大型矿业公司才有资源进行有效勘探。虽然小规模的矿工拥有祖传的土地权，但由于黄金勘探的资源密集型性质，他们并没有充分受益。他们求助于便宜的方法，但这些方法并不完全准确，所以他们在勘探失败后留下了大量的露天矿坑。这些露天矿坑和勘探过程中产生的其他环境危害，给当地人带来了一些意想不到的影响。考虑到这一点，Ashesi-IGEM团队正在利用合成生物学来提供一种快速和负担得起的黄金勘探方法。

影响

淘金活动大多在农村和偏远社区进行。对于生活在这些社区的人来说，挖掘和探测黄金威胁着他们的健康。例如，在这个过程中挖掘的露天沟渠，在雨季会积水，使居民面临疟疾和水传播疾病，如霍乱和腹泻。另一方面，农田和土地的一般美学价值也被破坏。我们的方法将保护土地，并消除散落在黄金易发区的露天勘探坑所带来的威胁。

对矿山工人的访谈显示，矿业公司通过削减工人的报酬来补偿昂贵的勘探方法。大型矿业公司还通过减少对企业社会责任（CSR）的努力来进行补偿。企业社会责任是他们在所在社区开展的回馈项目的另一个术语。他们不维护被重型卡车破坏的道路，而是做一些成本较低的项目，如粉刷建筑物，以补偿勘探过程中产生的环境成本。因此，社区受到采矿公司活动的影响，但却没有得到相应的回报。

如前所述，昂贵而不可靠的勘探技术极大地降低了小规模矿工的生产力。他们的采矿活动扰乱了农业，使其成为一个没有成果的、没有吸引力的经济冒险。因此，大多数人转向金矿开采作为一种谋生手段。他们的开采效率越低，对农业耕地的破坏就越大；他们变得越穷，越是钻研采矿。由于他们陷入了这种恶性循环，他们的收入微薄，导致这些社区的贫困率居高不下。

我们的方法

我们正在开发一种生物传感器，可以通过检测探路者元素来显示黄金的存在。根据研究，黄铁矿和无机砷聚集在一起，形成一个海绵状的结构，可以积聚黄金；因此，铁和砷是我们寻找的探路者。对于我们的生物传感器，我们正在设计大肠杆菌的菌株，这些菌株将为土壤中检测到的不同探路者元素发出不同的光色。用我们的生物传感器检测土壤样本后，所显示的光将告诉我们是否有黄金。如果我们的生物传感器被采用，它将减少勘探成本，这将导致采矿工人的报酬增加和更好的社区项目。

结论

简而言之，通过引入生物传感器作为黄金勘探工具，我们正在使这个领域的三个利益相关者受益：社区、大型矿工和小型矿工。我们计划减少资源浪费，比如时间和资本；提高矿工的个人收入；减少对环境的无益破坏；增加采矿社区的社区福利项目。

Gold AU Alliance
iGEM Ashesi GH

亚洲社区的VTE和蛋白S缺乏症

张子吟 石溪大学iGEM

Ziyin Zhang

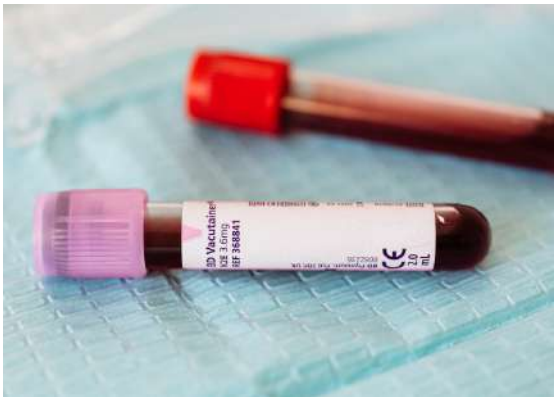
血栓通俗地说就是“血块”，它像塞子一样堵塞了身体各部位血管的通道，导致相关脏器没有血液供应，造成突然死亡。血栓就像是游走于血管内的幽灵，一旦堵塞血管，会使血液的运输系统瘫痪，其结果是致命的。而且，血栓可发生在任何年龄、任何时间，严重威胁生命健康。静脉血栓栓塞症（VTE）包括深静脉血栓形成（deep vein thrombosis，DVT）和肺血栓栓塞症（PTE），两者是同一疾病在不同发病阶段和不同组织器官的表现方式。

静脉血栓栓塞症（VTE）是由遗传、环境、行为等多种因素共同作用的疾病，VTE的发生50%~60%可归因于遗传因素。现已知的遗传因素在东西方人群中存在较大差异，其中蛋白S缺陷是亚洲人群主要的遗传缺陷类型。

亚洲人群的VTE发病率约为29/10万人年，且近年来呈现不断增加的趋势。例如，中国的VTE发病率逐年上升。对2007至2016年中国90家医院的数据进行分析发现，十年来中国国VTE的住院率从3.2/10万人上升到17.5/10万人；其中DVT住院率从2.0/10万人增加到10.5/10万人，PTE的住院率从1.2/10万人增加到7.1/10万人。虽然DVT和PTE的死亡率在下降，但在世界范围内，VTE仍然是导致死亡的第三位血管疾病。

VTE 的遗传性患病风险主要来自于抗凝血因子的功能丧失，包括抗凝血酶、蛋白 C (PC) 和蛋白 S (PS)，或促凝血因子功能获得，例如因子 V Leiden 和凝血酶原 G20210A后两种基因变异在高加索人群中普遍存在，但在非高加索人群中很少见。相比之下，PS 和 PC 的遗传缺陷在日本和中国的 VTE 患者中普遍存在，但在白种人患者中很少见。

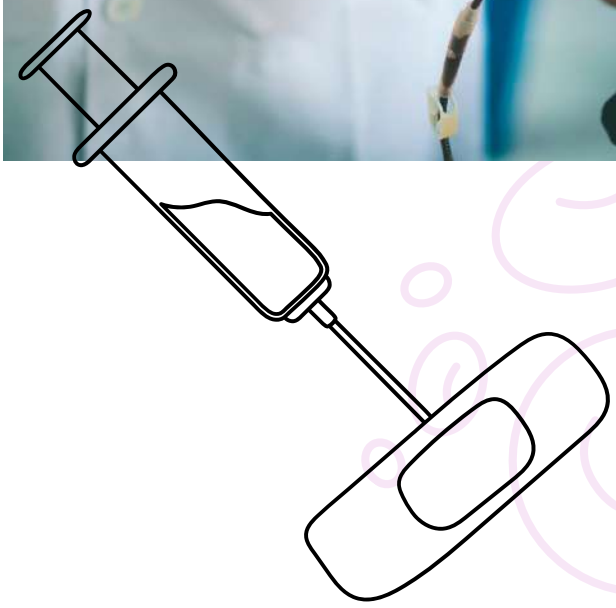
蛋白S缺陷（PSD）是一种常染色体显性遗传病，可使血栓发生风险增加2.5~11.0倍。突变主要位于蛋白S编码基因（PROS1）上，已报道的突变超过300种，其中大多为点突变，突变具有高度异质性。如日本报道蛋白S的Tokushima突变（p.Lys196Glu）在血栓栓塞患者中的携带率较健康人群显著升高，分别为6%~9%和2%，可能是日本人群的蛋白S优势突变，可增加血栓栓塞发生风险。研究表明，日本人群中蛋白质 S 缺乏症的发生率是白人的 5-10 倍。PS基因(PROS1)变体PS Tokushima (p.Lys196Glu, K155E在成熟蛋白编号; rs121918474)是一个血浆表型II型PS缺陷的遗传危险因素，在日本人群中等位基因频率为0.6%-0.9%，杂合子中DVT的风险高3.7-8.6-倍。



另有报道在日本人群中A139V突变可导致蛋白S结合能力下降，C449F、R451Q、C475F、A525V和D599TfsTer13突变可增加蛋白S不稳定性而使其数量下降；p. R355C、p. G336D、p. E67A、p. N188KfsX9和p.N188KfsX9突变与泰国儿童人群的蛋白S活性下降有关；p. Asn365Lys和p. Pro410His、c.74dupA与中国人群的PSD相关。

另一项在中国东北地区的研究则显示，中国东北地区VTE患者血浆蛋白S活性明显低于健康人群体，且VTE患者血浆蛋白S活性下降检出率也明显高于健康人群体。由此我们可以看出遗传性的蛋白S缺乏增加了亚洲人群VTE患病的风险。

因此，了解遗传性的蛋白质S缺乏能够更加完善的处理亚洲人群中的血栓治疗，具有巨大的临床价值和意义。同时在常规易栓症检测中包含PS的变体也可能会改善诊断和预防策略，以帮助我们识别可能发生VTE的高危患者，制定合理的具有针对性的治疗方案。



SECTION 6

Japanese Translations of Selected Articles

JAPANESE TRANSLATIONS

アクセス可能なHPV検査-子宮頸がん予防のゲームチェンジャーとして

iGEM IIT Roorkee, India

子宮頸がんは、がんの中で4番目に多く、女性のがん関連死亡原因の第4位を占めています。 最も予防と治療が可能ながんの一つであるにもかかわらず、驚くほど高い死亡率（2018年は57万件のうち31万1千人が死亡）を記録しています。 HPV感染による前がん細胞の変化や軽度の病変は、早期に発見すれば、進行性のがんになる前に治療することが可能です。 子宮頸がんの蔓延を抑制するためには、医療インフラのどこに問題があり、失敗し続けているのかを理解することが不可欠です。 いくつかの研究により、子宮頸がんの効果的な予防には現在、二次予防の段階、つまり早期発見と治療を容易にする便利で効果的な検診・発見プログラムが欠けていることが明らかにされています。

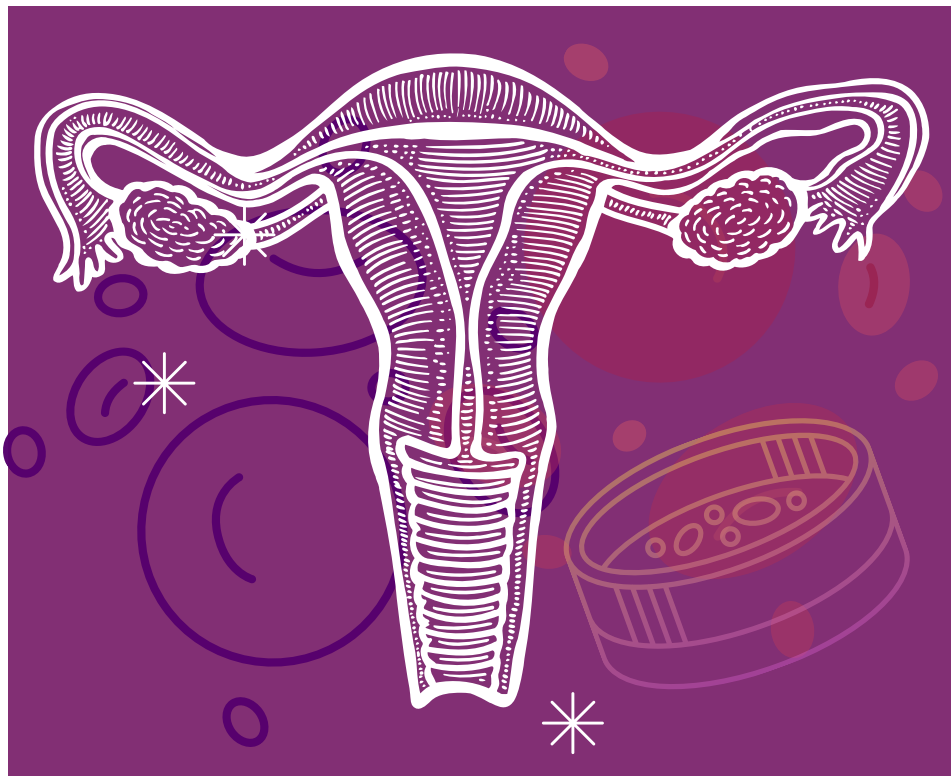
子宮頸がんの約70%、死亡の90%は発展途上国で発生しており、世界の症例の3分の1はインドで発生しています。 HPV情報センターが発表した報告書によると、インドでは4億8350万人の女性が子宮頸がんの危険にさらされているという。 中低所得国における子宮頸がんの不釣り合いな影響を理解するためには、地理的条件、伝統的な慣習や信念、検診レベル、社会経済的状況、医療へのアクセス、国民の意識などを考慮する必要があります。 性の健康と教育は、特にインドの農村部の女性の間では支配的な言説の中でタブー視され続けており、それが、その普及にもかかわらず、彼らが積極的に検診や治療を受ける可能性に大きな影響を与えています。 これには、苦痛を伴う侵襲的な検査への恐怖、結果に対する不安や恥ずかしさなどの心理的要因が加味されています。 現在、子宮頸がんによる死亡者数は、都市部では着実に減少していますが、農村部では横ばいの統計となっています。

インドには全国的なHPVスクリーニングプログラムが存在しないことが大きな懸念材料となっています。 国のガイドラインにもかかわらず、検診率は非常に低いままです。 少なくとも、既存の検診がHPVに対して最も脆弱な集団の一部を対象としていることを確認するために、多くの作業を行う必要があります。 スクリーニングが効果的であるためには、発展途上国において、低資源環境に適した検査方法の大幅な改善も必要である。

現在、一般的に行われているスクリーニングや検査方法には、複数の問題があります。

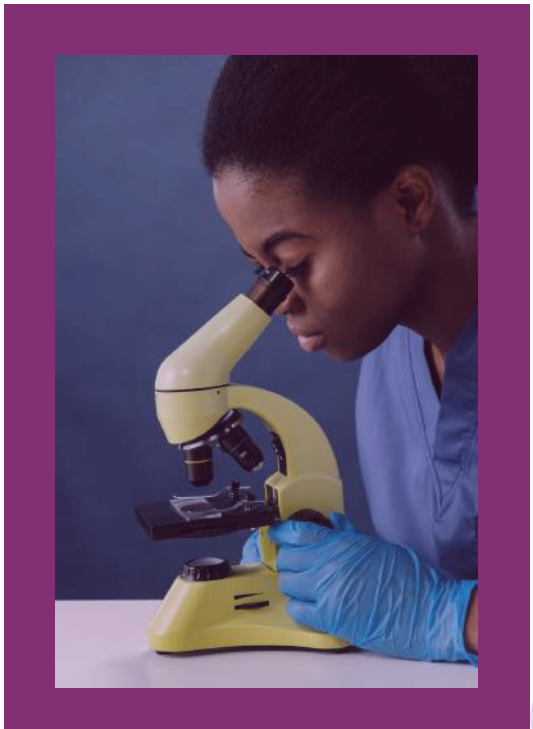
PAP検査などの侵襲的な方法は、検体を採取するときから痛みを伴ったり、産道ですでに存在する異常細胞を悪化させたりする可能性があります。 また、これらの方法による患者のコンプライアンス不足と検査を受けることへの拘束が強まっていることも重要である。 また、テストは訓練を受けた担当者を必要とする複雑な機器に依存するため、アクセス性とコストに大きな影響を与える可能性があります。 HPV検診の多くは時間のかかる方法を採用しており、例えばPAP検査の結果は1〜3週間以内に出ます。

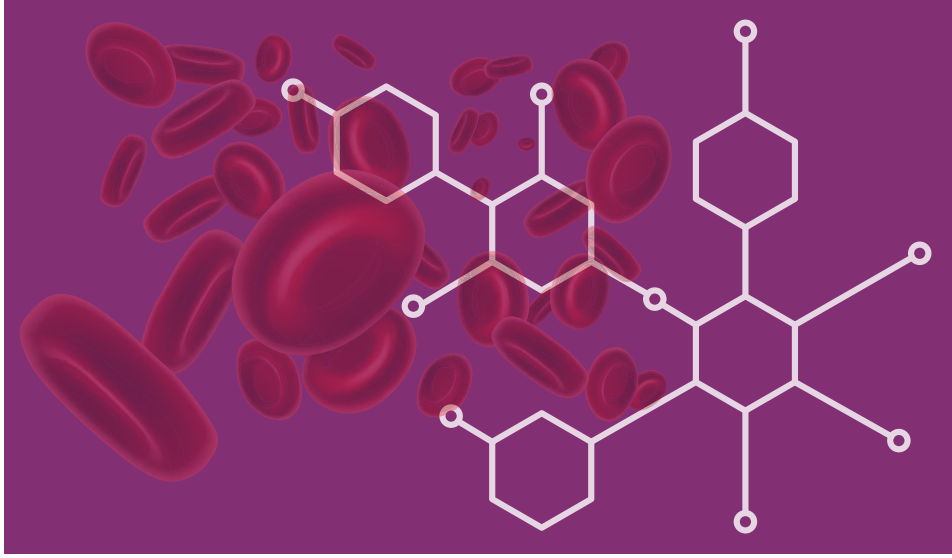
これらの方法は、携帯性に問題があることは明らかで、費用対効果が高い傾向にある家庭用サンプル採取キットを用いた検査と比較すると高価である。



私たちの目標は、HPVの最も発癌性の高い株であるHPV16を検出するための迅速かつ高感度のポイントオブケア診断キットを設計することです。 このキットは、費用対効果が高く、簡単に使用できます。 低資源環境での使用を前提に設計されており、特別な機器や訓練を受けた専門家を必要としない。 ウイルスカプシドに含まれるL1タンパク質を用いる既存の診断方法とは異なり、当社の方法はhpv16に見られる保存性の高いE7癌遺伝子に基づいているため、癌化する可能性のあるHPVに対して非常に高感度で有効かつ特異的に診断できるキットとなっているのです。 患者さんは膣内のスワブを採取するだけです。

私たちのプロジェクトのきっかけは、子宮頸がんがもたらす差益と不均衡な影響という問題の緊急性と関連性を心から信じることです。 私たちが提案するソリューションは、私たちのこだわりをそのまま形にしたものです。インドをはじめとする低・中所得国では、HPVの国民検診を実施し、その結果をできるだけ早く受診できるようにすることが必須となります。 検診キャンプに加えて、教育を受けた専門家が大衆と直接交流し、リスクの高いグループにHPVの流行と早期発見すれば治癒可能であることを認識させる必要があります。 人々は、性の健康の重要性について教育され、HPVの定期的な検査を奨励される必要があります。後者は、それをサポートする簡単にアクセスできる検査ソリューションがあって初めて実を結びます。 私たちは、医療システムにおける現実的かつ緊急で、これまで認識されていなかったニーズをサポートするサステナブルなデザインを見たいと考えています。





アジア人社会におけるVTEとプロテインS欠乏症

Ziyin Zhang SBU iGEM

血栓は一般に「血の塊」と呼ばれ、栓のような働きをして体の様々な部分の血管の通り道を塞ぎ、当該臓器に血液が供給されずに突然死を引き起こす。 血栓は血管の中をさまよう幽霊のようなもので、一度ふさがると血液輸送系を麻痺させ、致命的な結果を招きます。 さらに、血栓は年齢や時間帯を問わず発生する可能性があり、生命や健康を脅かす重大な問題です。 静脈血栓塞栓症（VTE）には、深部静脈血栓症（DVT）と肺血栓塞栓症（PTE）があり、いずれも同じ疾患が異なる発症段階、異なる組織や臓器で発現するものです。

静脈血栓塞栓症（VTE）は、遺伝的要因、環境要因、行動的要因の組み合わせで発生し、VTEの50-60%は遺伝的要因で発生すると言われています。 既知の遺伝的要因は東洋と西洋の集団でかなり異なり、アジア集団ではプロテインS欠陥が主な遺伝的欠陥のタイプであることが知られている。
アジア人集団におけるVTE発症率は10万人年あたり約29人であり、近年増加傾向にある。 例えば、中国におけるVTEの発症率は年々増加しています。 2007年から2016年までの中国の90病院のデータを分析したところ、同国におけるVTEの入院率は10年間で3.2/10万人から17.5/10万人に増加し、DVTの入院率は2.0/10万人から10.5/10万人に、PTEは1.2/10万人から7.1/10万人に増加したことが判明しました。

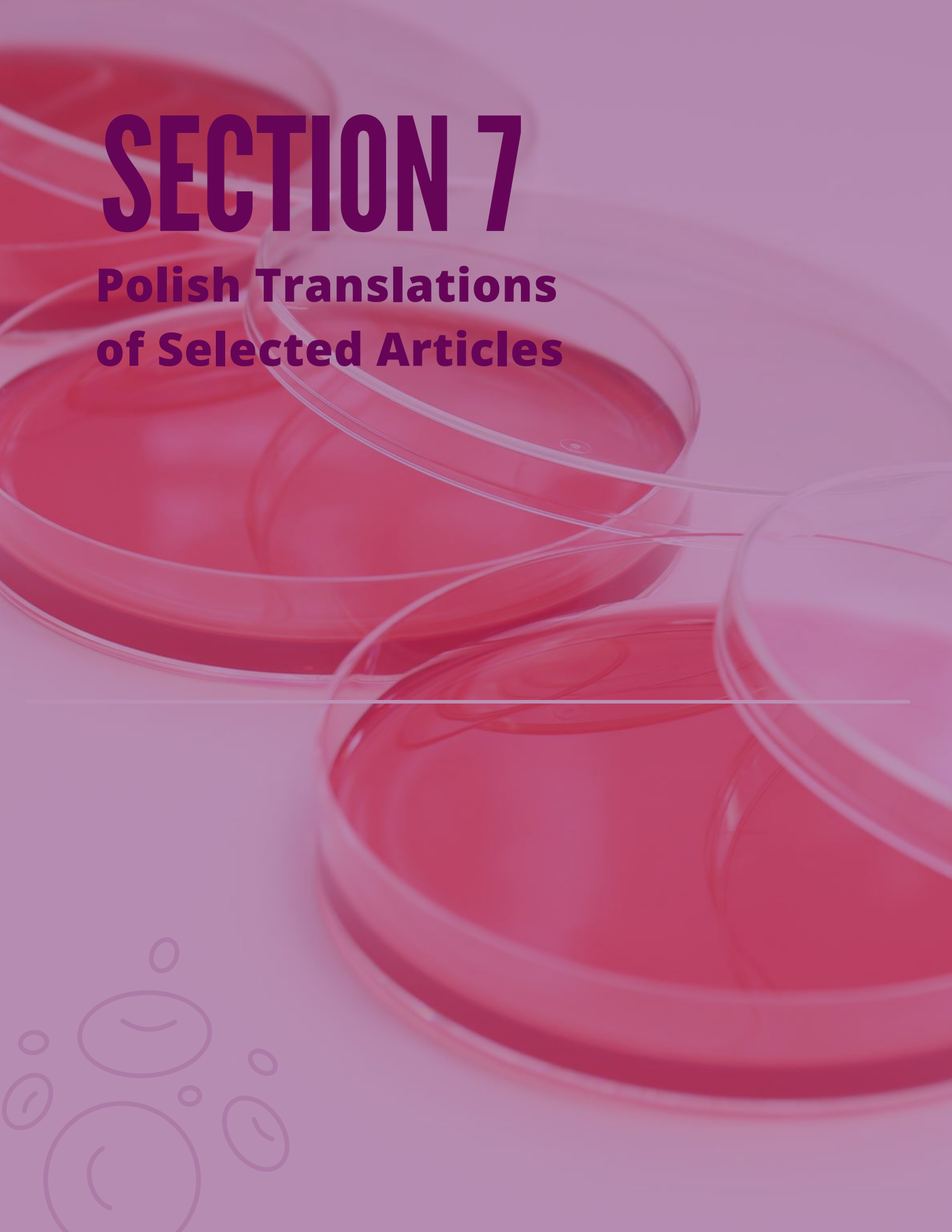
DVTとPTEの死亡率は低下していますが、VTEは依然として世界第3位の血管疾患として死亡の原因となっています。

VTE発症の遺伝的リスクは、主にアンチトロンビン、プロテインC（PC）、プロテインS（PS）などの抗凝固因子の機能低下、あるいはV型ライデン因子やプロトロンビン遺伝子G20210Aなどの凝固促進因子の機能獲得によってもたらされる。 一方、PSとPCの遺伝子異常は、日本人や中国人のVTE患者に多く見られるが、白人ではまれであることがわかった。

また、日本人ではA139V変異がプロテインS結合能の低下を、C449F、R451Q、C475F、A525V、D599TfsTer13変異がプロテインSの不安定性を高めその数を減少させると報告されており、p. R355C, p. G336D, p. E67A, p. N188KfsX9 およびp. N188KfsX9変異はタイの小児集団におけるプロテインS活性の低下と関連していた。p. Asn365Lysとp. Pro410His, c.74dupAは中国の集団におけるPSDと関連していた。
中国東北部における別の研究では、中国東北部の健康な集団に比べ、VTE患者では血漿中プロテインS活性が有意に低く、血漿中プロテインS活性低下の検出率も健康な集団に比べVTE患者で有意に高いことが示された。 このことは、遺伝性のプロテインS欠乏症がアジア人集団におけるVTEリスクを高めることを示唆している。
したがって、遺伝性プロテインS欠乏症の理解は、アジア人集団における血栓症のより良い管理にとって、大きな臨床的価値と意味を持つ。 PSの変異体をルーチンの血友病検査に含めることは、VTE発症のリスクが高い患者を特定し、合理的で的を射た治療計画を立てるための診断および予防戦略を改善する可能性もあります。

SECTION 7

Polish Translations of Selected Articles



POLISH TRANSLATION

Niedrogi i Szybki Sposób Na Pozyskiwanie Złota w Ghanie
iGEM Ashesi-Ghana, Ghana

"Mimo, że małoskalowi górnicy mają dziedziczne prawa do ziemi, nie są oni wstanie zdobyć pełnię korzyści płynących z ich ziemi, z powodu zasobochłonności poszukiwań."

Streszczenie

Ghana jest bogata w złoto, ale poszukiwanie złota jest kosztowne. Eksploracja powierzchniowa i podziemna are zazwyczaj najbardziej drogie i zajmują najwięcej czasu. Tylko korporacje kopalnicze o dużej skali są wstanie prowadzić wydobycie złota efektywnie. Z powodu zasobochłonnej natury poszukiwań złota, górnicy pracujący na małą skalę, którzy posiadają prawa do ziemi z dziada pradziada nie są wstanie zebrać wszystkich płynących korzyści. Poprzez złożenie propozycji użycia biosensora jako narzędzia w poszukiwaniu złota, mamy nadzieję wesprzeć społeczność a także mało i wielkoskalowych górników aby zminimalizować koszty poszukiwania złota. Planujemy zmniejszyć ilość marnowanego czasu i pieniędzy, podnieść przychody górników, zmniejszyć negatywny wpływ poszukiwań na środowisko, a także zwiększyć ilość programów społecznościowych w miastach górniczych.

Wstęp

Dzisiaj Ghana jest wiodącym producentem złota w Afryce i siódmym na świecie. Złoto obfituje w Ghanie, ale jego wydobycie jest niełatwe. Powierzchniowa i podziemna eksploracja jest zazwyczaj kosztowna i czasochłonna. Tylko wielkoskalowe firmy górnicze mają zasoby potrzebne do efektywnych poszukiwań. Mimo, że małoskalowi górnicy mają dziedziczne prawa do ziemi, nie są oni wstanie zdobyć pełnię korzyści płynących z ich ziemi, z powodu zasobochłonności poszukiwań. Uciekają się do tanich metod, które nie są dokładne, co sprawia, że tacy górnicy często pozostawiają po swoich poszukiwaniach wiele porzuconych wykopalisk. Te otwarte rowy wraz z innymi niebezpieczeństwami dla środowiska powodują wiele niechcianych implikacji dla lokalnej ludności. Zespół Ashesi-iGEM wziął to pod uwagę i użyje biologii syntetycznej aby dostarczyć szybki sposób na poszukiwania złota, na który niskoskalowych górników Ghany będzie stać.

Wpływ

Złoto jest najczęściej poszukiwane w okolicach rolnych. Dla ludzi tam zamieszkujących, tworzenie kopalni i rowów w poszukiwaniu złota zagraża zdrowiu. Na przykład, otwarte rowy zbierają wodę podczas sezonu deszczowego, co zwiększa ryzyko malarii i innych chorób wspieranych przez pobliże zbiorników wodnych takich jak cholera czy rozwolnienie. Jednocześnie, ziemie rolne a także ogólna estetyka okolic są kompletnie zniszczone przez takie kopalnie odkrywkowe. Rozwiązanie naszego zespołu iGEM AshesiGhana pomoże chronić ziemię i wyeliminować niebezpieczeństwa kopalni odkrywkowych w okolicach bogatych w złoto.

Wywiady z górnikami pokazują, że firmy górnicze kompensują wysokie koszty eksploracji poprzez obniżanie wynagrodzenia górników dlań pracujących. Wielkoskalowe firmy górnicze także kompensują poprzez zmniejszanie wsparcia dla tak zwanych Zbiorowych Socjalnych Odpowiedzial-ności - ZSO (Corporate Social Responsibilities - CSR). ZSO to inaczej projekty, które wspierają lokalną ludność, na której ziemiach złoto jest poszukiwane. Zamiast naprawy dróg zniszczonych przez ciężkie ciężarówki górnicze, firmy górnicze fundują dużo tańsze projekty takie jak malowanie budynków. Lokalna ludność nie dostaje stosownego wynagrodzenia ani wsparcia.

Jak wspomniane powyżej, drogie i niedokładne techniki poszukiwawcze zmniejszają produktywność niskoskalowych górników. Ich działalność górnicza zakłóca rolnictwo, sprawiając, że rolnictwo staje się bezowocnym i nieatrakcyjnym finansowo przedsięwzięciem. Z tego powodu, większość ludności lokalnej wybierają wydobycie złota jako sposób na życie. Jako niskoskalowi górnicy, wydobywają wtedy nieefektywnie, niszczą ziemie i pola uprawne, co powoduje, że coraz więcej ludzi decyduje się na wydobycie złota. Ten okrutny cykl sprawia, że coraz więcej ludzi biednieje w społecznościach rolnych i górniczych Ghany.

Załącznik 1: Środowiskowy Impakt Przed-Eksploracyjnego Górnictwa

Nasze Podejście

Planujemy rozwinąć biosensor, który będzie mógł wskazać czy złoto jest obecne poprzez detekcję substancji tropiących złoto. Z badań wynika, że pyrid i nieorganiczny arszenik tworzą gąbczasty związek, który akumuluje złoto, ergo, żelazo i arszenik są substancjami tropiącymi złoto, które są nam potrzebne. Aby stworzyć nasz biosensor, poddajemy bakterie E. coli inżynierii biologicznej aby te bakterie emitowały różnokolorowe światło zależnie od danej substancji tropiącej znajdującej się w ziemi. Światło wykryte w testach na danej próbce ziemi może powiedzieć czy w danym miejscu można znaleźć złoto. Jeśli nasze biosensory zostaną przyjęte, zmniejszą koszta eksploracji, co zwiększy wynagrodzenie górników i polepszy projekty Zbiorowych Socjalnych Odpowiedzialności.

Wnioski

W skrócie, poprzez wprowadzenie biosensora jako narzędzie do poszukiwania złota, wspomagamy trzech interesariuszy ziemi: społeczności, wielkoskalowych górników, a także małoskalowych górników. Zamierzamy zmniejszyć marnotrawstwo zasobów takich jak czas czy pieniądze. Zamierzamy też zwiększyć wynagrodzenie górników, zmniejszyć bezowocne niszczenie środowiska i zwiększyć wsparcie społeczności w projektach dla górniczych społeczności.

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Gold AU Alliance

iGEM Ashesi GH

Związek Między Słodkowodną Niesprawiedliwością a Niewspółmiernością w Opiece Zdrowotnej Kanadyjskiej Ludności Rdzennej

iGEM Uniwersytet Queens, Kanada

W Kanadzie, 73% systemów wodnych Pierwszej Nacji są pod dużym lub średnim ryzykiem zanieczyszczenia przez substancje zanieczyszczające takie jak metale ciężkie (żelazo, mangan, ołów) czy materiały organiczne takie jak bakterie i wirusy. W 2021 roku, Rząd Kanadyjski zgodził się na stworzenie w kraju osady ludności rdzennej o wartości $8 miliardów dolarów. Jednakże, 34 długoterminowych oficjalnie zgłoszonych problemów z wodą pitną nie zostało rozwiązanych w tychże wspólnotach w całej Kanadzie. Niektóre z tych problemów trwają od 1995 roku. Z tego powodu, ludzie Pierwszej Nacji Neskantaga nie mają dostępu do bezpiecznej wody pitnej od przeszło 27 lat. Każdy z 34 problemów wody pitnej można reprezentować nawet 5 tysięcy ludzi bez dostępu do czystej, bezpiecznej wody.

Wielu ludzi nie wie jak bardzo szkodliwa może być ich woda pitna, dlaczego jest szkodliwa i co mogą zrobić aby się z tym uporać. Jedyną rzeczą, z której rdzenne społeczności zdają sobie sprawę jest to, że woda powoduje u nich choroby. Ostre żołądkowo-jelitowe choroby spowodowane przez picie wody, podrażnienie skóry przez higienę z użyciem zanieczyszczonej wody pokazują, że woda, do której mają dostęp nie jest bezpieczna do użycia.

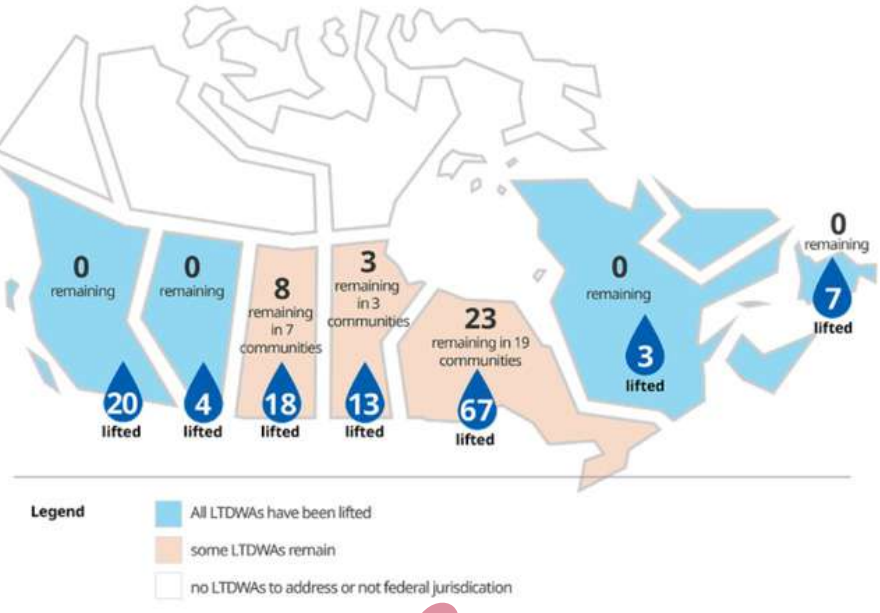

Figura 1. Stylizowana mapa of Kanady obrazująca liczbę długoterminowych oficjalnie zgłoszonych problemów z wodą pitną a także liczbę takowych rozwiązanych problemów.

Strach przed chorobą i brak komunikacji z rządem spowodowały rozpowszechnienie wielu nieporozumień. Słusznie, wielu ludzi dotkniętych problemami z wodą pitną nie ufa wodzie z kranu, więc zwracają się do picia nieoczyszczonej wody z jezior, rzek, strumieni, itd. Nieoczyszczona woda może nadal zawierać szkodliwe mikroby, które powodują symptomy takie jak ostre żołądkowo-jelitowe bóle, rozwolnienie czy wymioty, ale także poważne choroby takie jak wrzody czy rak żołądka. Z tego powodu z Kryzysu Wodnego Ludności Rdzennej wynikło statystycznie znaczące zwiększenie liczby chorób związanych z wodą wśród Kanadyjskiej Ludności Rdzennej w porównanie do ludności nie należącej do tej społeczności. Z tego wynika, że ten kryzys wymaga stosownej opieki zdrowotnej dla dotkniętej społeczności.

Niestety, Kanadyjska Ludność Rdzenna boryka się z wieloma barierami na jej drodze do medycznego wsparcia, takimi jak odległość, edukacja zdrowotna czy negatywna stronniczość u lekarzy.

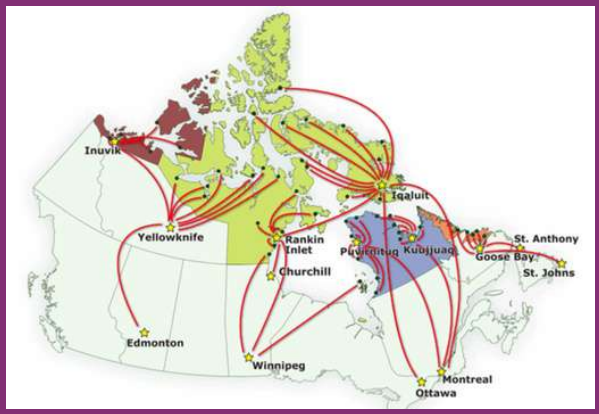

Figura 2. Stylizowana mapa Kanady pokazująca przeciętne trasy pokonywane gdy Inuici potrzebują opieki medycznej. Czarne kropki reprezentują społeczności, żółte gwiazdy reprezentują centra medyczne.

Centra medyczne w oddalonych lub wyizolowanych społecznościach rdzennych są często prowadzone przez pielęgniarki lub innych pracowników medycznych, którzy nie

są lekarzami. Bezsprzecznie, ci ludzie dają potrzebującym najlepszą opiekę w ich mocy. Jednakowoż, takie centra mają ograniczenia w wyposażeniu, treningu czy zakresu praktyk. Ludzie z poważnymi chorobami muszą podróżować do centrów medycznych w miastach, gdzie mogą znaleźć specjalistów i bardziej zaawansowane technologie. Figura 2 pokazuje barierę geograficzną między ludnością rdzenną a opieką medyczną.

Niewystarczająca edukacja zdrowotna to szkopuł problemów, które powodują bariery dla rdzennej populacji. Niestety większa część tej populacji nie uczęszcza lub nie ukańcza edukacji, zazwyczaj z powodu braku kulturalnej świadomości w kanadyjskich programach nauczania. Niekompletna edukacja jest bezpośrednio skorelowana z niską piśmiennością, co utrudnia takim osobom nawigować system opieki zdrowotnej. Szkoła medyczna często popiera wschodnią medycynę a nie medycynę tradycyjną. To może hamować studentów o rdzennym pochodzeniu od prób ukończenia medycznej edukacji lub szukania pomocy w centrach medycznych w miastach.

Międzypokoleniowa trauma, kolonizacja i fizyczna trauma, która prześladuje Kanadyjską Ludność Rdzenną przez przeszło wiele lat prowadzi do alkoholizmu, przemocy i innych autodestrukcyjnych zachowań. Niestety, negatywne stereotypy powstały w związku z ludnością rdzenną z powodu niecelnej reprezentacji tych zachowań w mediach. Te stereotypy uwieczniane w mediach sprawiły, że niektórzy lekarze zakładają, że większość obywateli ludności rdzennej są alkoholikami, udają chorobę lub mają inne okropne założenia. Takie poglądy są bardzo krzywdzące dla ludności rdzennej i mogą sprawiać, że lekarze próbują zmniejszać liczbę interakcji jakie mają z takimi ludźmi, odmawiać im leczenia lub podejmują się innych krzywdzących działań. Niestety, co jest zrozumiałe, negatywne podejście lekarzy może odstręczać ludność rdzenną od szukania się właściwej opieki medycznej.

Ogólnie, jest wiele barier, które Kanadyjska Ludność Rdzenna musi pokonać aby mieć dostęp do opieki zdrowotnej. Niestety, z powodu nieadekwatnej infrastruktury czy Kryzysu Wody Pitnej i Ludności Rdzennej, Kanadyjska Ludność Rdzenna potrzebuje wsparcia w kwestii opieki zdrowotnej. Dostarczanie wody pitnej do tych społeczności, zwiększenie dostępu do opieki zdrowotnej w sensie geograficznym, zwiększenie edukacyjnych osiągnięć, a także zmniejszenie negatywnej stronniczość to niektóre z możliwych rozwiązań. Tylko z pomocą wszystkich Kanadyjczyków te bariery mogą zostać zburzone dla ludzi, na których ziemi żyjemy.

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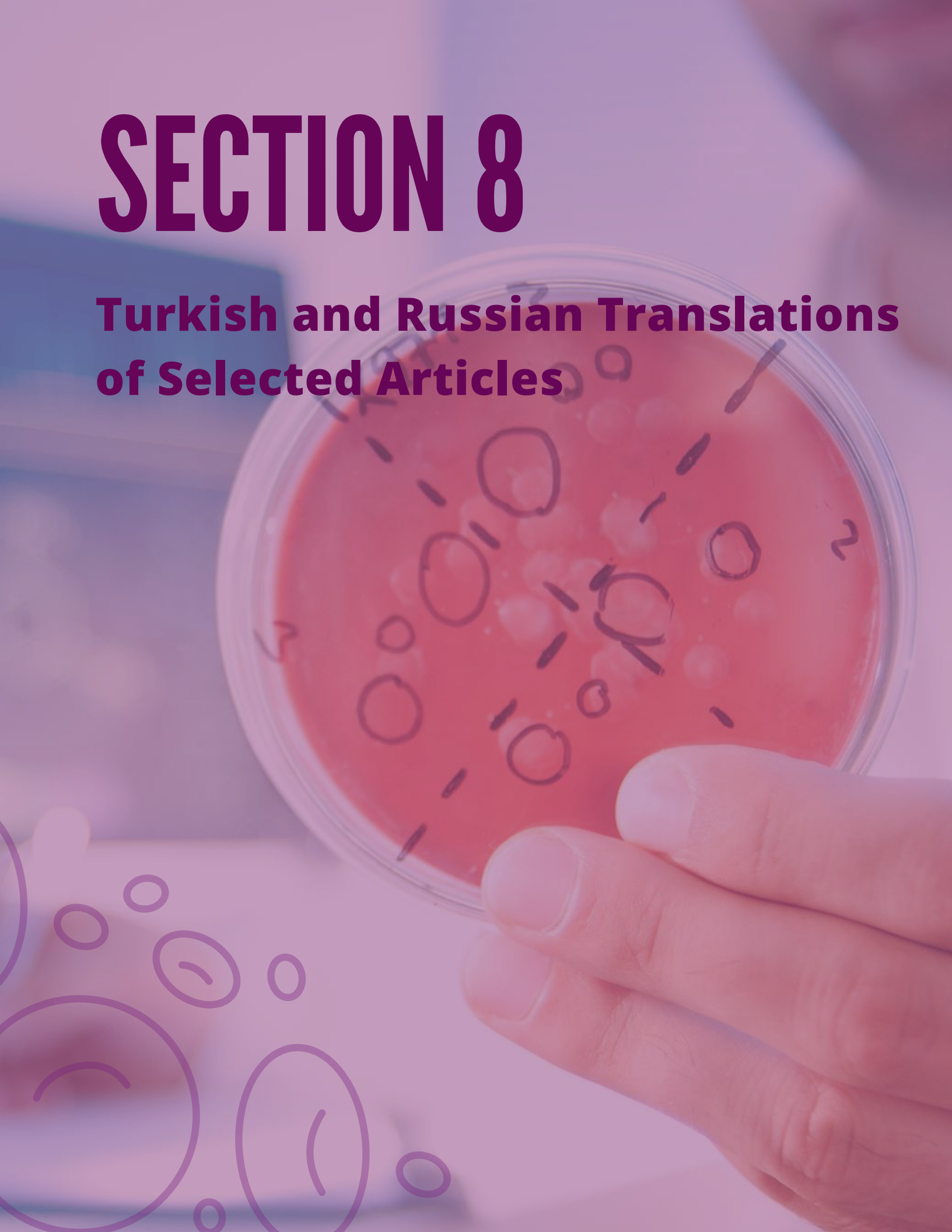
SECTION 8

Turkish and Russian Translations of Selected Articles



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Stony Brook University
Перевод выполнила команда iGEM
Bilkent UNAM

ВЗАИМОСВЯЗЬ МЕЖДУ ДЕФИЦИТОМ ПРОТЕИНА S И ТЯЖЕЛОЙ ФОРМОЙ ЗАБОЛЕВАНИЯ COVID-19

Illustration by Kimberly Carrera

Коронавирусная болезнь (COVID-19) — это инфекционное заболевание, вызываемое вирусом SARS-CoV-2. Это расстройство широко характеризуется как респираторное заболевание, однако это не всегда аккуратно. Пациенты с COVID-19 испытывают различные симптомы, включая пневмонию, воспаление, дисфункцию микроциркуляторного русла, гиперкоагуляцию, поражение нервной системы и полиорганную недостаточность. Однако, существуют множество долгосрочных осложнений, которые пока что недостаточно хорошо охарактеризованы.

Любой из этих симптомов может быть причиной смертности, связанный с COVID-19. Однако тромбоз (аномальное свертывание крови) является основной причиной смерти при тяжелых инфекциях COVID-19. Исследователи связали эти аномальные явления свертывания крови при COVID-19 со снижением уровня белка S.

Белок S является многофункциональным белком, который поддерживает нормальную и здоровую активность свертывания крови и предотвращает гиперкоагуляцию крови. Он также предотвращает воспаление и инфицирования после гибели клеток, а так же используется во многих сигнальных путях клетки. Поскольку протеин S имеет очень много разных ролей, дефицит протеина S может иметь серьезные последствия.

Существует несколько причин снижения уровня белка S после заражения с COVID-19. При тяжелом инфекцировании COVID-19 наблюдается экстремальный иммунный ответ, известный как тромбовоспаление, которое возникает в результате перепроизводства цитокинов, небольших молекул, регулирующих активность клеток.

COVID-19 может вызвать «цитокиновую бурю», которая повреждает клетки и приводит к отказу органов. Он также вызывает снижение уровня протеина S, что приводит к образованию множества мини-сгустков крови (микротромбов) по всему телу. Вскрытие пациентов с тяжелыми инфекциями COVID-19 выявило наличие этих сгустков в легких, вызывающих их обширное повреждение, что является основной причиной смерти, связанный с COVID-19.

Снижение уровня белка S во время COVID-19 также можно объяснить структурным сходством между белком S и шиповидным белком, обнаруженным на поверхности вируса. Этот спайковый белок распознается иммунной системой. После инфекции иммунная система вырабатывает антитела против шиповидного белка, чтобы нейтрализовать вирус, но эти антитела могут атаковать структурно сходные части белка S, что приводит к снижению его уровня.

В целом было показано, что тяжелые инфекции COVID-19 вызывают снижение уровня белка S. Однако исследования также показали, что у пациентов, у которых уже есть генетический дефицит белка S до поражения любой инфекцией, последствия намного хуже. В отчете о случаях COVID-19 было показано, что предварительный дефицит белка S вызывает ишемический инсульт.

По сути, можно сделать вывод, что тяжелые инфекции COVID-19 вызывают значительное снижение уровня белка S и увеличивают частоту аномального или фатального свертывания крови и воспаления. Ученые, изучающие прямую корреляцию между дефицитом протеина S и COVID-19, предполагают, что введение протеина S пациентам с тяжелой формой COVID-19 может быть эффективной терапией и может использоваться в качестве альтернативы традиционному лечению. Введение протеина S также можно использовать в качестве профилактического средства для пациентов с дефицитом протеина S, чтобы предотвратить возникновение инсульта.

В целом, введение протеина S потенциально может быть эффективным средством лечения тяжелой формы COVID-19, и существуют много взаимосвязей между протеином S и вирусным заболеванием. Необходимо провести дополнительные исследования, чтобы узнать об этой связи и изучить протеин S в качестве терапевтического средства для лечения тяжелых инфекций COVID-19.

ДОСТУПНОЕ ВЫЯВЛЕНИЕ ВПЧ - МЕНЯЕТ ПРАВИЛА ИГРЫ В ПРЕДОТВРАЩЕНИИ РАКА ШЕЙКИ МАТКИ, IGEM IIT ROORKEE, ИНДИЯ

ПЕРЕВОД ВЫПОЛНИЛА КОМАНДА IGEM BILKENT UNAM

Illustration by Kimberly Carrera

Рак шейки матки является четвертым по распространенности самым часто встречаемым видом рака и четвертым по смертности среди женщин. Несмотря на то, что это один из наиболее излечимых и в то же время предотвратимых видов рака, уровень смертности от этой болезни тревожно высокий (из 570 000 случаев в 2018 году 311 000 пациентов умерли). При обнаружении на ранней стадии предраковых клеточных изменений из-за инфекцией ВПЧ, а так же легких поражений, их можно лечить до того, как они перерастут в инвазивный рак. Крайне важно понимать, где именно наша инфраструктура здравоохранения терпит неудачу и часто ошибается, когда дело доходит до регулирования безудержной статистики рака шейки матки. Многочисленные исследования показали, что эффективной профилактики рака шейки матки в настоящее время не хватает на вторичном этапе предотвращения, то есть доступной и эффективной программы скрининга и тестирования, способствующей раннему выявлению и лечению.

Около 70% случаев рака шейки матки и 90% смертей приходится на развивающиеся страны, при этом одна треть случаев в мире приходится на Индию. Согласно отчету, опубликованному Информационным Центром ВПЧ, 483,5 миллиона женщин в Индии подвержены риску рака шейки матки. Для понимания диспропорции воздействие рака шейки матки на страны с низким и средним уровнем дохода, нам необходимо учитывать географическое положение, традиционные обычаи и верования, уровни скрининга, социально-экономический статус, доступ к здравоохранению и осведомленность населения. Сексуальное здоровье и образование по-прежнему остаются табу в мейнстримном дискурсе, особенно среди женщин в сельских районах Индии, что значительно снижает вероятность того, что несмотря на его распространенность они будут активно искать анализы и лечение. Это сочетается с психологическими факторами, такими как страх перед болезненным и инвазивным тестом, беспокойство по поводу результатов и смущение. В настоящее время смертность от рака шейки матки неуклонно снижается в городах, в то время как статистика в сельской местности остается неизменной.

Крайне тревожно, что в Индии не существует ни одной национальной программы скрининга на ВПЧ. Несмотря на государственные рекомендации, показатели скрининга остаются очень низкими. В конце концов, очень многое необходимо сделать для того, чтобы убедиться, что существующий скрининг нацелен на подгруппы населения, наиболее уязвимые к ВПЧ. . Для эффективного скрининга, развивающимся странам также стоит серьезно усовершенствовать методологию тестирования, которая больше подходит для условий с ограниченными ресурсами.

В настоящее время доступные методы скрининга и обнаружения вируса имеют множество проблем. Начиная с момента взятия образца, используются инвазивные методы, такие как тест Папаниколау, который может вызвать боль и усугубить уже существующие аномальные клетки в родовых путях.

Также важно отметить нежелание пациентов и увеличение отказов, когда дело доходит до прохождения тестирования, из-за этих методов. Тестирование также зависит от сложного оборудования, для работы с которым потребуется обученный персонал, что значительно влияет на доступность и стоимость. В большинстве случаев скрининг на ВПЧ занимает время, например, результаты ПАП-теста приходят через 1-3 недели. Эти методы имеют очевидные проблемы с портативностью, а также являются дорогостоящими по сравнению с тестированием который включает сбор образцов в домашних условиях, и как правило, намного более рентабельны.

Мы стремимся разработать быстрый и чувствительный диагностический набор для выявления наиболее онкогенного штамма ВПЧ, т. е. ВПЧ16. Наш комплект будет экономичным и простым в использовании. Он предназначен для использования в условиях ограниченных ресурсов без необходимости использования специального оборудования или квалифицированного специалиста. В отличие от существующих диагностических методов, в которых используется белок L1 в вирусном капсиде, наш метод основан на высококонсервативном онкогенном гене E7, обнаруженном в hpv16, что делает набор очень чувствительным, эффективным и специфичным к ВПЧ, который может стать раковым. От пациентки требуется только взять мазок из влагалища.

Отправной точкой нашего проекта стала искренняя вера в безотлагательность и актуальность проблемы несоизмеримых и непропорциональных последствий рака шейки матки. Предлагаемое нами решение является прямым результатом нашей приверженности делу. Насущной необходимостью в Индии и других странах с низким и средним уровнем дохода является общенациональный скрининг на ВПЧ с как можно более быстрым эффектом. Наряду с лагерями скрининга, образованные специалисты должны взаимодействовать непосредственно с населением и информировать группы высокого риска о распространенности и излечимости ВПЧ в случае раннего обнаружения. Людей необходимо информировать о важности сексуального здоровья и поощрять регулярное тестирование на ВПЧ. Последнее полезно только в том случае, если у нас есть легкодоступное тестирование для его поддержки. Мы надеемся увидеть устойчивые проекты, поддерживающие очень реальную, неотложную и до сих пор непризнанную потребность в наших системах здравоохранения.

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ŞIDDETLI COVID-19 ENFEKSIYONLARINDA S PROTEINI EKSIKLIĞI VE İLIŞKILI KOMPLIKASYONLAR

Koronavirüs hastalığı (COVID-19), SARS-CoV-2 virüsünün neden olduğu bulaşıcı bir hastalıktır. Bu hastalık yaygın olarak bir solunum yolu hastalığı olarak tanımlanır ancak bu tam olarak doğru değildir. COVID-19 hastaları; zatürre, iltihaplanma, mikro damar sistemi disfonksiyonu, hiper pıhtılaşma, sinir sistemi hasarı ve çoklu organ yetmezliği gibi çeşitli semptomlar yaşar. Ayrıca hâlâ iyi karakterize edilmemiş çok sayıda uzun vadeli komplikasyon vardır.

Bu semptomlardan herhangi biri COVID-19 ile ilişkili ölümlerden sorumlu olabilir. Bununla birlikte, tromboz (anormal kan pıhtılaşması), şiddetli COVID-19 enfeksiyonlarında önde gelen ölüm nedenidir. Araştırmacılar COVID-19'daki bu anormal kan pıhtılaşma olaylarını S proteini seviyelerindeki düşüşle ilişkilendirdi.

S proteini, normal ve sağlıklı kan pıhtılaşma aktivitesini koruyan ve kanın aşırı pıhtılaşmasını önleyen çok işlevli bir proteindir. Ayrıca hücre ölümü ve enfeksiyon sonrası iltihabı da engeller ve birçok hücre sinyal iletiminde görev alır. S proteininin pek çok farklı rolü olduğundan S proteini eksikliğinin ciddi sonuçları olabilir.

COVID-19 enfeksiyonunu takiben S proteini seviyelerindeki düşüşün birden fazla nedeni vardır. Şiddetli COVID-19 enfeksiyonlarında hücrelerin aktivitesini düzenleyen küçük moleküller olan sitokinlerin aşırı üretimi ile ortaya çıkan ve tromboenflamasyon olarak bilinen bir aşırı bağışıklık tepkisi vardır.

COVID-19, hücrelere zarar veren ve organ yetmezliğine yol açan bir "sitokin fırtınası"na neden olabilir. Aynı zamanda S proteini seviyelerinde bir düşüşe neden olarak vücutta birçok mini kan pıhtısına (mikrotrombi) neden olur. Şiddetli COVID-19 enfeksiyonu olan hastaların otopsileri, geniş çaplı akciğer hasarına neden olan ve COVID-19 ile ilişkili ölümlerin önemli bir nedeni olan bu pıhtıların varlığını ortaya çıkarmıştır.

COVID-19 enfeksiyonu sırasında S proteini seviyelerindeki düşüş, S proteini ile virüsün yüzeyinde bulunan spike proteini arasındaki yapısal benzerlik ile de açıklanabilir. Bu spike proteini bağışıklık sistemi tarafından tanınır. Bir enfeksiyonun ardından bağışıklık sistemi virüsü nötralize etmek için spike proteinine karşı antikorlar üretir ancak bu antikorlar S proteininin yapısal olarak benzer kısımlarına saldırabilir ve seviyelerinde bir düşüşe neden olabilir.

Genel olarak, şiddetli COVID-19 enfeksiyonlarının S proteini seviyelerinde bir düşüşe neden olduğu gösterilmiştir. Bununla birlikte araştırmalar, herhangi bir enfeksiyondan önce zaten genetik olarak S proteini eksikliği olan hastalarda etkilerin çok daha ağır olduğunu da göstermiştir. Bir COVID-19 vakası raporunda preliminer S proteini eksikliğinin iskemik inmeye neden olduğu gösterilmiştir.

Esasen, şiddetli COVID-19 enfeksiyonlarının S proteini seviyelerinde önemli bir düşüşe neden olduğu ve anormal veya ölümcül kan pıhtılaşması ve iltihaplanma insidansını artırdığı sonucuna varılabilir. S proteini eksikliği ile COVID-19 arasındaki doğrudan ilişkiyi inceleyen araştırmacılar, şiddetli COVID-19 hastalarında S proteini verilmesinin etkili bir tedavi olabileceğini ve geleneksel tedaviye alternatif olarak kullanılabileceğini öne sürüyorlar. S proteini verilmesi, S proteini eksikliği olan hastalarda inme oluşumunu önleyici bir terapi olarak da kullanılabilir.

Sonuç olarak S proteininin verilmesi şiddetli COVID-19 enfeksiyonları için potansiyel olarak etkili bir tedavi olabilir ve S proteini ile viral hastalık arasında birçok bağlantı vardır. Bu bağlantı hakkında bilgi edinmek ve S proteinini şiddetli COVID-19 enfeksiyonları için terapötik bir tedavi olarak incelemek adına daha fazla araştırma yapılmalıdır.

ERIŞILEBILIR HPV TESTLERI - RAHIM AĞZI (SERVIKS) KANSERINDE ÇIĞIR AÇAN ÖNLEM

IGEM IIT ROORKEE, HINDISTAN ÇEV. BILKENT UNAM IGEM TAKIMI

Rahim ağzı (serviks) kanseri, kanser türleri içerisinde en yaygın dördüncü tür ve kadınlarda kanserden ölümün en yaygın dördüncü nedenidir. En önlenebilir ve tedavi edilebilir kanser türlerinden biri olmasına rağmen endişe verici derecede yüksek bir ölüm oranı vardır (2018 yılında 570,000 vaka içerisinden 311,000 tanesi hayatını kaybetti). Erken teşhis edilirse HPV enfeksiyonuna bağlı kanser öncesi hücresel değişiklikler ve hafif lezyonlar, hastalık invaziv kansere dönüşmeden tedavi edilebilir. Sağlık hizmetleri altyapımızın nerede başarısız olduğunu ve rahim ağzı kanserinin hızlı ve kontrolsüz artışının istatistiğini tutmayı gerçekleştiremediğini anlamak bir zorunluluktur. Çeşitli çalışmalar şu anda rahim ağzı kanserinin etkili bir şekilde önlenmesinin, önlemenin ikincil aşamasında yetersiz olduğunu (yani erken teşhis ve tedaviyi sağlayan erişilebilir ve etkili bir tarama ve test programının eksikliğini) ortaya koymuştur.

Rahim ağzı kanseri vakalarının yaklaşık %70'i ve buna bağlı ölümlerin %90'ı gelişmekte olan ülkelerde meydana gelip dünyada vakaların üçte biri Hindistan'da görülmektedir. HPV Information Center tarafından yayımlanan bir rapora göre Hindistan'da 483.5 milyon kadın rahim ağzı kanseri riski altındadır. Rahim ağzı kanserinin düşük ve orta gelirli ülkeler üzerindeki aşırı etkilerini anlamak için coğrafyayı, geleneksel uygulamaları ve inançları, sağlık taraması düzeylerini, sosyo ekonomik statüyü, sağlık hizmetlerine erişimi ve kamu bilincini dikkate almalıyız. Cinsel sağlık ve eğitim, özellikle Hindistan'ın kırsal kesimlerindeki kadınlar arasında, kamusal söylemde tabu olmaya devam etmektedir. Bu durum, hastalığın yaygınlığına rağmen kadınların aktif olarak test ve tedavi arama ihtimallerini önemli ölçüde etkilemektedir. Buna acı verici ve girişimsel (invaziv) testlerin yarattığı korku, test sonuçları hakkında duyulan endişe ve utanç gibi psikolojik faktörler de eklenmektedir. Mevcut durumda rahim ağzı kanserine bağlı ölümler kentsel alanlarda istikrarlı bir şekilde azalırken kırsal alanlardaki istatistikler aynı kalmaktadır.

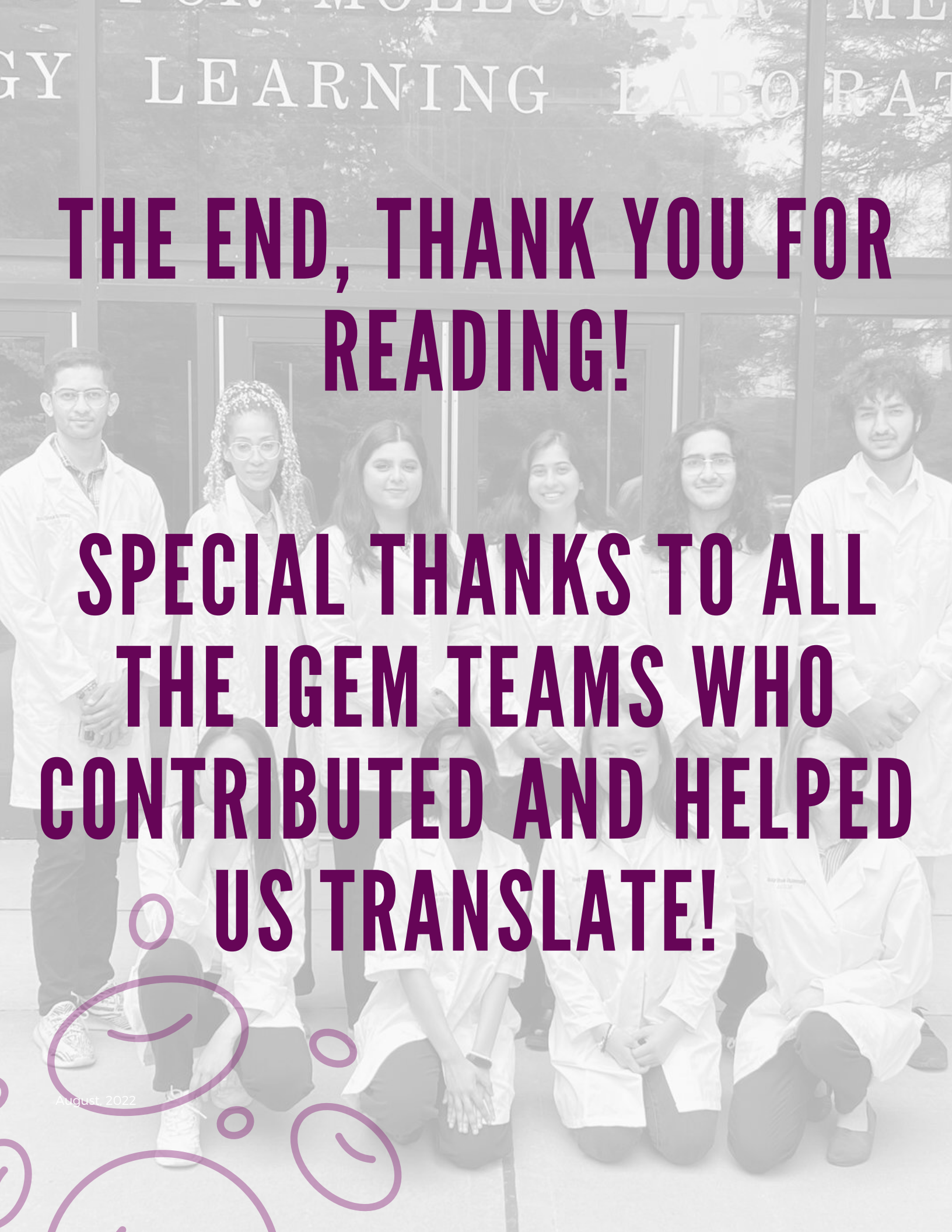
Hindistan'da hiçbir ulusal HPV tarama programının bulunmaması son derece endişe vericidir. Tarama oranları, ulusal yönergelere rağmen çok düşük kalmaktadır. En azından mevcut taramanın nüfusun HPV'ye karşı en savunmasız alt kümelerini hedef almasını sağlamak için yapılması gereken çok şey var. Taramanın etkili olması için gelişmekte olan ülkelerin tarama metodolojilerinde düşük bütçeye daha uygun geliştirmelere de gitmesi gerekmektedir.

Şu anda yaygın tarama ve tespit yöntemlerinin birden fazla sorunu vardır. Acıya neden olabilecek ve doğum kanalında halihazırda var olan anormal hücreleri kötüleştirebilecek PAP testi gibi girişimsel (invaziv) yöntemler numune alma aşamasından başlayarak kullanılmaktadır. Bu yöntemler nedeniyle test yaptırma konusunda hastaların rızasının eksikliği ve artan engeller göz önünde bulundurulmalıdır. Test aynı zamanda komplike ekipmanların eğitimli personel tarafından kullanımına dayanır ve bu durum erişilebilirliği ve maliyeti önemli boyutta etkilemektedir. Çoğu HPV taraması zaman alan yöntemleri içerir. Örneğin, PAP testi sonuçları 1-3 hafta içerisinde gelmektedir. Bu yöntemlerin belirgin taşınabilirlik sorunları vardır ve çok daha uygun maliyetli olmaya eğilimli ev yapımı numune toplama kitleriyle yapılan testlerle karşılaştırıldığında daha pahalı yöntemlerdir.

HPV'nin en onkojenik suşu olan HPV16'yı tespit etmek için hızlı ve hassas bir teşhis kiti geliştirmeyi amaçlıyoruz. Kitimiz uygun maliyetli ve kullanımı kolay olacaktır. Özel ekipmana ya da eğitimli uzmanlara ihtiyaç duyulmadan düşük bütçede kullanıma uygun olacak şekilde geliştirilecektir. Viral kapsit içerisinde L1 proteini kullanan mevcut teşhis yöntemlerinin aksine bizim yöntemimiz hpv16'da bulunan oldukça yüksek oranda korunmuş E7 onkojenik genine dayanmaktadır. Bu durum, kiti çok hassas, etkili ve kansere dönüşebilecek olan HPV'ye özel hale getirmektedir. Hastaya sadece vajinal sürüntü alınırken ihtiyaç duyulacaktır.

Projemizin çıkış noktası, rahim ağzı kanserinin tamamen farklı ve aşırı etkileri sorunun aciliyeti ve önemine olan ciddi inancımızdı. Önerdiğimiz çözüm, davamıza olan bağlılığımızın doğrudan bir sonucudur. Hindistan'da ve öbür düşük ve orta gelirli ülkelerde şu an ihtiyaç olan şey, mümkün olduğunca hızlı bir etkiye sahip ulusal HPV taramasıdır. Tarama kamplarının yanı sıra eğitimli uzmanlar, kitlelerle doğrudan iletişim kurmalı ve yüksek riskli popülasyonları HPV'nin yaygınlığı ve erken teşhis durumunda tedavi edilebilirliği konusunda bilinçlendirmelidir. İnsanlar, cinsel sağlığın önemi konusunda eğitilmeli ve HPV testlerine düzenli olarak girmeye teşvik edilmelidir. İkinci durum ancak kolayca erişilebilir bir testimiz olursa verimli olacaktır. Sağlık sistemlerimizde çok acil ve şimdiye kadar resmen tanınmamış bir ihtiyacı destekleyen sürdürülebilir tasarımlar görmeyi umuyoruz.

Illustration by Kimberly Carrera



THE END, THANK YOU FOR READING!

SPECIAL THANKS TO ALL THE IGEM TEAMS WHO CONTRIBUTED AND HELPED US TRANSLATE!

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