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Scinapse 2021-2022 Undergraduate Science Case Competition: Surviving the Climate Crisis

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We regret any inconvenience caused.

Abstract
The Scinapse Undergraduate Science Case Competition (USCC) provides an opportunity for undergraduate students to experience the development of a novel research proposal. A case is presented to all participants and, using in-depth literature search (publications, reports, studies and published writings), students connect and pinpoint key elements allowing them to develop a hypothesis in support of the case in question. Participants also develop a methodology which will test the validity of their hypothesis. This year's case topic focused on climate change as a global crisis that threatens many of the fundamental determinants of a healthy planet. Innovation and science play a crucial role in enabling a global, multifaceted response to this crisis – from reducing greenhouse gas emissions, to building resilience to the harmful effects of climate change. In teams of 2-4, undergraduate students tackled the case and provided novel research ideas that may hold the key to combating the global climate crisis. The top 10% of written submissions are highlighted in this abstract booklet.

Keywords: undergraduate research; science case competition; climate change

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Conference Abstracts
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Lower Division

A novel cellulose-based N95 respirator via the repurposing of paper mill sludge

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Pollution and waste from the healthcare sector is a major cause behind greenhouse gas emissions, primarily through the regular disposal of face masks and N95 respirators, which accelerates the impact of climate change globally. In fact, due to the ongoing COVID-19 pandemic, it is estimated that around 3.4 billion single-use face-masks and face shields are discarded daily. Additionally, an important contributor to the ongoing pollution crisis is paper mill sludge, with regular incineration leading to rapid rises in CO_2 and N_2O levels atmospherically and aquatically. Approximately 26% of solid municipal waste is composed of discarded paper, typically converted into the aforementioned sludge. A recent alternative discovery was the incorporation of cellulose into mask filtration systems. However, many of these masks lack the required antiviral and antimicrobial activity. We propose the development of a novel, biodegradable, cellulose-based N95 respirator through the repurposing of paper mill sludge into cellulose nanofibers and the addition of a unique coating to improve antimicrobial and antiviral activity with hydrophobic properties. The transition towards such novel biodegradable alternatives for face masks

would substantially decrease greenhouse gas emissions from both pollution sources, reducing the quantity of paper mill sludge disposed of, leading to a net improvement in environmental health.

Application of cover crops in weed biomass suppression as an alternative to glyphosate-based herbicides to mitigate climate change: A research protocol

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Cover crops are plants that are used to reduce nutrient loss in soil by slowing erosion and runoff while improving soil health. Another major benefit of these crops is their ability to suppress weed biomasses in farming. Due to rising global temperatures and high CO_2 emissions, existing methods of herbicide treatment, such as the chemical additive glyphosate, are no longer as effective or practical as they once were. Thus, this proposal intends to evaluate the effectiveness of cover crops as a glyphosate-based herbicide alternative in projected climate conditions in 2100. Carbon chambers will be used to alter CO_2 levels (ppm) and temperature (°C) to simulate Intergovernmental Panel of Climate Change (IPCC) projections. Using the outlined experimental procedures and controls, predicted results showing correlations between the variables may invite a possible alternative to herbicides that are more climate-conscious.

Combating the parasite propaganda

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Approximately 40% of known species are parasitic, yet they are the least protected in conservation attempts. Although some parasitic species are a threat to human health and wildlife preservation, the majority are nonzoonotic. In fact, many play vital roles in ecosystems through their contributions to biomass flow, food web connectivity, population control, and more. However, due to climate change, parasites face an immense threat to extinction, both directly due to habitat loss and indirectly due to the extinction of their host species. We predict that the loss of parasites will have an enormous impact on ecosystems, which we aim to establish in our experiment. To do this, we will vary parasite abundance in identical forest plots and trees grown in glasshouses. We will collect data pertaining to plant health given that plants are integral to an ecosystem's function. Specifically, we will measure plant biomass, growth rate, photosynthetic rates, and fecundity. Data will be collected via random quadrat sampling along belt transects and will be measured on a monthly basis. We hypothesize that areas with decreased parasite abundance will lead to reduced plant health and consequently ecosystem health. We hope that our study is able to stress the importance of parasite conservation in a warming world.

Efficacy of extreme temperature treatments for DNA damage repair via heat shock proteins

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Climate change presents itself as a global crisis with a wide variety on all aspects of life. Climate change threatens to increase cancer rates and death from air pollutants by 20%. To investigate processes in which we can reduce the risk of cancer, the proposed experiment will expose *Eschrichia coli* (E. coli) to extreme temperature ranges in order to facilitate the synthesis of heat shock proteins (HSP). After scheduled exposure to extreme temperatures over a period of six days, comet assays and single cell electrophoresis will be used to analyze and measure the amount of DNA damage within the bacteria. The magnitude of damage sustained in bacteria that did not receive any extreme temperature exposure, will then be compared with those that did, to conclude whether or not HSP's reduce DNA damage. HSP's are integral in maintaining cell and DNA structure. It is expected that the bacteria introduced to extreme temperatures will have less DNA damage, due to the larger amount of HSP's produced, and the protective/restorative function that they serve. If the expected results occurred, one could conclude that short, regular exposure to stressful environmental conditions can lead to production of more HSP's, which decreases the amount of DNA damage within cells, essentially lowering cancer risk.

Efficacy of *Pleurotus eryngii* mycelium containers as an alternative to current single-use plastic based methods

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The COVID-19 pandemic has led to an increase in takeout orders due to the mandated loss of dine-in options at restaurants. The significant rise in takeout has led to the use of single-use plastic containers, currently made out of materials such as polyethylene and polystyrene. Single-use plastic containers can remain in the environment for centuries without decomposing, contributing to plastic pollution, endangering both human health and the health of global wildlife and ecosystems. The slow degradation of such plastics releases greenhouse gases, such as methane and carbon dioxide (CO_2), which accumulate in Earth's atmosphere and exponentially warms the planet. This study aims to determine the effectiveness of *Pleurotus eryngii* (king oyster mushroom) based mycelium food containers in replacing current hazardous plastic containers, as well as its ability to safely store a variety of food. This study hypothesizes that the hydrophobic, fire-retardant, biodegradable, and durable properties of *Pleurotus eryngii* based mycelium will provide a viable environmentally-friendly alternative to plastic-based containers.

Genetically modifying *Bacillus subtilis* to express PET & PE degrading enzymes to eliminate microplastics from the food chain

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The manufacturing of plastic shows no signs of slowing, which calls for an effective and economically friendly method to degrade said plastic. An approach targeting the microplastics in the oceans, reducing the toxicity climbing up the food chain and disruptions of ecosystems is our goal. High percentages of plastics found in oceans consist of polyethylene terephthalate (PET) and polyethylene (PE), so the recent discovery of the *Ideonella sakaiensis* bacteria capable of enzymatically degrading PET could lead to great advancements in the elimination of microplastics. Studies on this bacteria highlight needing a method to apply the organism in pelagic environments. Our objective is to use *Bacillus subtilis* to create a modified species with pelagic water survivability while maintaining the plastic degrading enzymes. The Bacillus subtilis grown and cultivated in lab controlled optimal conditions undergoes treatment to become electrocompetent in order to integrate PET hydrolase enzyme and MHETase. This plasmid was constructed using gene therapy technology CRISPR / Cas 9, where the genetic information of *Ideonella sakaiensis* was extracted and inserted into the chromosome of the now modified *B. subtilis*. Both PETase and MHETase were tagged with their own fluorophore-conjugated antibodies to serve as indicators, confirming that the new components were integrated. By manufacturing this hybrid, *B. subtilis*' ability to degrade plastic was bolstered by the PETase and MHETase genes. Coupled with the pretreatment of the plastics from the Sun's UV radiation and other environmental factors, it results in a promising and economically friendly approach to degrade plastic in oceans.

Inhibition of *Borrelia burgdorferi* by 3,3-diindolylmethane (DIM)

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The spread of *Borrelia burgdorferi* is greatly exacerbated by the climate crisis, as rising global temperatures have increased the geographic range of *B. burgdorferi*-carrying ticks. The chemical compound 3,3-diindolylmethane (DIM) is a molecule with a highly concentrated positive charge, which could potentially inhibit bacterial growth by attracting the negatively charged bacterial membranes and tearing the membranes as a result. To determine whether DIM displays antimicrobial properties, its effect on membrane-enclosed vesicles will be compared with polymyxin B, which is known to inhibit membrane structural integrity. This comparison will be analyzed by filling the vesicles with red aniline dye, mixing the vesicles with polymyxin B and DIM respectively, and comparing the resulting absorbances caused by the release of dye from vesicles with torn membranes.

Investigating the efficacy of nitazoxanide in preventing prenatal ZIKV transmission during different stages of gestation using mouse models

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The climate crisis has generated concern regarding the potential increase in the spread of vector-borne diseases. Zika Virus (ZIKV) in particular, is a topic of concern due to its association with congenital anomalies in infants like microcephaly, Guillain-Barré syndrome, and other neurodevelopmental abnormalities. Studies exploring the effectiveness of certain therapeutic approaches in treating and preventing ZIKV transmission have been performed. One such treatment is Nitazoxanide, an FDA approved drug, safe for pregnancy, demonstrating the potential to inhibit the viral post-attachment step for prenatal ZIKV transmission. Evidence shows that the gestation period at which an individual is infected with ZIKV affects the severity of Congenital Zika Syndrome (CZS) in offspring, however, it is unknown if the stage of gestation at which treatment is administered affects the presence or severity of CZS symptoms. We propose a study investigating the effectiveness of Nitazoxanide treatment at three different stages of gestation. This study will administer treatment via intrauterine injection to ZIKV infected C57BL/6J mice to determine if the time of administration affects the presence of ZIKV and the severity of CZS symptoms. The presence of ZIKV in offspring will be evaluated using RT-PCR and gel electrophoresis analysis. The presence or severity of CZS symptoms will be assessed 21 days after birth by harvesting, and measuring the weight and size of the offsprings' brains. If Nitazoxanide treatment for prenatal ZIKV infection is more effective in earlier stages of gestation, it would provide a significant contribution to our knowledge regarding treatment and prevention of CZS.

Proposing nitrogen-doped quantum dots as nanoprobes for nonenzymatic photoluminescence detection of hydroquinone

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Hydroquinone is a prevalent phenolic compound that poses a threat to the aquatic environment and human health. Cost-effective methods for rapid and sensitive determination of hydroquinone concentrations are needed to effectively prioritize the cleaning of heavily polluted water sources based on hydroquinone concentration; biosensors can be used to continuously monitor hydroquinone. A common method of detecting hydroquinone is the use of the photoluminescence properties of quantum dots (QDs) due to their simplicity and high sensitivity. In practice, when hydroquinone is oxidized by an enzyme or the QD itself to become p-benzoquinone (BQ), BQ proceeds to quench QDs' photoluminescence. The amount of the observed "quenching effect" can predict the concentration of hydroquinone. Similarly, graphene QDs (GQDs) have been used as biosensors for hydroquinone because of its intrinsic peroxidase-mimicking catalytic activity. They catalyze the oxidation of hydroquinone to p-benzoquinone, which then quenches GQD photoluminescence. However, due to low quantum yield, GQDs must be replaced with QDs that have higher quantum yield. As N-doped GQDs have much higher quantum yield, along with stronger electron-withdrawing ability, and excellent photoluminescence properties and catalytic activity, we propose the novel use of N-doped GQDs (N-GQDs) as a fluorescent sensing platform via nonenzymatic photoluminescence detection of hydroquinone. N-GQDs would be synthesized by hydrothermal treatment of citric acid and dicyandiamide. Fluorescence experiments for N-GQDs would be performed for p-benzoquinone and hydroquinone. Therefore, we hypothesize that a quenching effect should be observed when N-GQDs are mixed in both hydroquinone and p-benzoquinone because of its potent catalytic activity.

Rhizospheric inoculation of *Calamagrostis stricta* with *Ideonella sakaiensis* to reduce PET concentrations in great lakes coastal ecosystems

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In recent years, increased plastic pollution has led to the rapid accumulation of microplastics within and around the Great Lakes, quickly and severely impacting native flora, fauna, and the millions of people dependent on the lakes for food and water supply. The proposed research study aims to reduce microplastic concentrations in the Great Lakes coastal ecosystems by examining the viability of rhizospheric inoculation of *Calamagrostis stricta*, a coastal grass native to three of the Great

Lakes, with the PET-digesting bacterium *Ideonella sakaiensis*. The experiment will be conducted on juvenile *Calamagrostis stricta* raised in a greenhouse setting over the course of 14 weeks. Germination will take place in the first week, the seeds will be planted in the second week, and at the beginning of the third week, seedlings in the Experimental group will undergo inoculation of *Ideonella sakaiensis* into their root system to a concentration of 106 CFU/mL. The Control group will receive no inoculation. Seedlings in the Experimental and Control groups will then be artificially polluted with powdered PET, and visNIR spectroscopy will be used to measure Baseline PET soil concentrations. The seedlings will continue to grow until the end of the fourteenth week, during which PET soil concentrations will again be measured using visNIR spectroscopy. We anticipate a significantly lower concentration of PET in the Experimental group compared to Baseline levels and the final concentration of the Control group.

The degradation of polyethylene terephthalate using the two-enzyme system in *Ideonella sakaiensis*
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Polyethylene terephthalate (PET) is the most abundant plastic due to its high durability and low cost. However, its imperishability has made it difficult to degrade. In the past decade, research has found that the bacteria, *Ideonella sakaiensis*, creates a two-enzyme system containing PETase and MHETase, which is capable of completely degrading PET. The gene pET-21b(+) was isolated to be responsible for the production of these enzymes. The goal of this experiment is to identify whether micro green algae inserted with pET-21b(+), can express similar catalytic activity of PETase and MHETase. It is hypothesized that the transgenic algae will be able to express the two-enzyme system and depolymerize PET to a similar degree as *I. sakaiensis*. In conclusion, using genetically modified microalgae could provide a cost-effective and convenient method to recycle plastics. However, the feasibility of this method depends on future improvements to the speed of degradation and the ability to degrade crystalline PET.

The DipStrip: Using monoclonal antibodies as a means of detecting *Salmonella typhimurium* in water samples
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Water is the primary medium that we experience the ramifications of climate change through. Water availability is becoming less predictable, while surges in flooding incidents threaten to destroy sanitation facilities and contaminate water sources. Ensuring access to sustainable water is a critical step to mitigate consequences of climate change. Rather than contributing to the well-established field of water sanitation, we propose a method of testing for pathogenic presence in water samples to discern drinkability. Current tests for *Salmonella typhimurium* (*S. typhimurium*) are done on affected patients. We propose a design for a low-cost device capable of detecting *S. typhimurium* in water samples through porous paper substrates. The bottom edge of this paper will be coated in a mixture of: chemoattractant, bacteria protein extraction reagent (B-PER), and monoclonal antibodies (mAbs) conjugated to dye enzymes. The paper will also contain a hydrophobic barrier at the top and a custom formulated test zone directly below. When the paper is dipped in water, it will induce chemotactic migration of *S. typhimurium*. Capillary action will allow ascension to the test zone. Movement will be arrested at the hydrophobic barrier. Bacteria at the test zone will interact with a second set of monoclonal antibodies conjugated with a dye substrate. Interaction of both sets of monoclonal antibodies will bring the dye enzyme and substrate in close proximity and induce a colour change. This colour change will indicate presence of *S. typhimurium*, and can become a potential solution for screening water samples for *S. typhimurium*.

Upper Division

Bioremediation of polluted air in Delhi using engineered *Methylobacterium populi*
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'Slash and burn' practices in the northern grain farming regions of India, produce a thick smog that coats the city of Delhi. Polluted air in Delhi is composed of NO_2, SO_2, and polycyclic aromatic hydrocarbons (PAHs), which are hazardous to human and environmental health. The Indian government has legislation to ban 'slash and burn' and has invested in the installation of large filtration units throughout Delhi. Unfortunately, farmers still continue 'slash and burn' practices, so a feasible air

filtration alternative is required. We propose a novel method, relying on the surface plant biomass and engineered bacterial endophytes to remediate air pollution. Bioremediation using engineered endophytic gram-negative bacteria *Methylobacterium populi* with genes to detoxify SO_2, NO_2, and PAHs will permit the conversion of toxic molecules into non-toxic compounds. The research objective is to engineer *M. populi* and colonize *Acacia auriculiformis*, with the end goal of creating a biofertilizer that's compatible with most plants. It is hypothesized that the *A. auriculiformis* colonized by *M. populi* will change pollutant levels in the air. DNA extraction and next generation sequencing can assess *M. populi* engineering validity, in addition to using concentration assays to assess the detoxification capacity of the microbe. This technology can be applied across the city of Delhi, and eventually scaled up to other global cities to deal with severe smog levels, in addition to being adapted to handle additional air pollutants.

CRISPR-Cpfb1-mediated manipulation of EPFL9 in *Oryza sativa* for increased drought tolerance as a climate change adaptation strategy

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As a result of climate change, increased drought incidence significantly affects the crop yield of rice, *Oryza sativa*. Given that rice serves as a staple food, adaptation strategies to combat climate change-induced drought are critical. Water retention is regulated by stomata size, stomata density, and the opening and closing of the stomata central pore. Previous studies have identified relevant developmental genes in the *Arabidopsis thaliana* model system, encoding for epidermal patterning factor (EPFs) and EPF-like (EPFL) signaling peptides, and their orthologs across various plant species. In barley (*Hordeum vulgare*), genetic manipulation of *EPF1* has been shown to reduce stomatal density, resulting in improved drought tolerance. In rice, overexpression of *OsEPF1* yields a similar phenotype. Moreover, it has been shown that CRISPR-mediated editing successfully generated knockouts (KO) of *EPFL9*—a positive regulator of stomatal development—in *Oryza sativa*. Taken together, we propose to downregulate *EPFL9* via CRISPR-Cpfb1 gene editing in *Oryza sativa*: we expect to observe reduced stomatal densities and better drought tolerance in the mutant *Oryza sativa* samples. Our proposal uniquely addresses the impact of climate change on rice by potentially providing an opportunity to scale-up, generating a drought-tolerant rice plant for comparison with previous prototypes, and secondarily, the elucidation of stomatal development.

Exploring the antiviral mechanisms of cyclophilin inhibitors against dengue virus

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Dengue virus (DENV) is a mosquito-borne Flavivirus that is one of the most frequently transmitted diseases and poses a huge burden on public health institutions. It is estimated that more than 390 million people are infected with DENV each year. The increase in temperature and rainfall alongside urbanization impacts the climate and is regarded as one of the major factors enhancing the transmission intensity of dengue fever. Currently, there are no approved antivirals available to treat dengue and the only approved vaccine used in some countries is limited to seropositive patients. Therefore, it is essential to develop an effective antiviral therapy that is effective against all DENV serotypes in inhibiting viral replication and engaging immune responses. The potential targets for antiviral development are host factors that are essential for viral replication such as cyclophilins (Cyps), a family of cellular peptidyl-propyl isomerases (PPIases). These proteins play a regulatory role in protein folding and have successfully been manipulated with the use of cyclophilin inhibitors (CypI) to activate antiviral immunity to protect cells against the Hepatitis C virus (HCV) and Human immunodeficiency virus (HIV). Interestingly, a study discovered that Cyps is also required for flavivirus replication and can be a potential target for antiviral treatment for DENV. This proposal seeks to determine if antiviral immunity can be activated in DENV-infected cells through the utilisation of CypI.

Genetically engineering *Synechocystis sp PCC 6803* to degrade microplastics and produce isobutanol for biofuel production

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As we continue to rely on non-renewable materials and sources, the fate of our environment lies precariously within our hands. The ongoing climate crisis has wreaked havoc to levels from which we may be unable to recover fully -, but it is not too late. Our current reliance on climate-damaging microplastics and fossil fuels can be changed, and the answer may lie in the growing field of synthetic biology. Both microplastics and fossil fuels are significant drivers of the ongoing climate crises, mainly through water pollution and carbon emissions, respectively. To address these issues, we propose a two-pronged approach. Using the cyanobacteria strain *Synechocystis* sp PCC6803, we will engineer a bacteria with enzymes that can degrade microplastics such as polyethylene terephthalate (PET) to produce a harvestable biofuel such as isobutanol. To ensure our organism is viable, we will screen for critical enzymes, test for PET degradation and identify significant byproducts such as isobutanol using ultraviolet-visible spectroscopy and gas chromatography-mass spectrometry. While bioremediation innovations have been slowly implemented into everyday practice, a bifunctional organism may be vital to tackle the worrisome climate crisis. With further work, this project may be implemented in local wastewater treatment plants. Overall we aim to develop a robust engineered tool for the bioremediation of water and collection of biofuels to be used in place of our detrimental reliance on plastics and fossil fuels.

The use of phage therapy to promote ferroptosis in *Candida auris* to limit infection in immunocompromised individuals

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The rise in average global temperature has propagated the spread of infectious diseases through viral, bacterial, and fungal pathogens. Lethal fungal infections are rare primarily due to differences in environmental temperatures and high basal temperatures; however, as environmental temperatures elevate, adaptations in fungi allow for infection and propagation in humans. This places immunocompromised individuals at great risk. The displacement of natural disaster-associated fungi like *Candida auris* further leads to the spread of infection in non-native environments. Antifungals can be used to treat *C. auris* infection; however, the fungus presents great resistance towards azoles, polyenes, as well as flucytosine and some resistance to echinocandins. The use of antifungals alone is not recommended for immunocompromised patients as high doses are required to eliminate the infection and this poses a threat of organ toxicity. Alternatively, we propose the use of phage therapy using bacteriophages produced by *Pseudomonas aeruginosa* to target and inhibit the biofilm of *C. auris*. Upon inhibition the bacteriophage will sequester iron from the fungi and restrict growth of the pathogen. Once the spread of infection is inhibited through ferroptosis, treatment with lower doses of echinocandin antifungals can be used in immunocompromised patients as the inhibition of the biofilm further decreases the antifungal drug resistance of the pathogen.

TROPSA and TRE31 gene knockouts prevents the transmission of lyme disease from tick to host

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Ixodes scapularis, the blacklegged tick, is responsible for the transmission of Lyme disease. Rising temperatures and shorter winter seasons, due to climate change, is resulting in the Northward expansion of tick range. This is correlated with the increasing prevalence of Lyme disease. To address this issue, we will mutate the blacklegged tick which is primarily responsible for the transmission of *Borrelia burgdorferi*, the bacterium that causes Lyme disease, in North America. This mutation involves two gene knockouts: TROSPA and TRE31. TROSPA is a tick midgut receptor that binds to OspA, a bacterial outer-surface protein. This interaction facilitates the colonization of *B. burgdorferi* in the midgut. TRE31 is another *I. scapularis* gut protein that interacts with BBE31, an outer surface bacterial lipoprotein. TRE31-BBE31 binding facilitates the dissemination of *B. burgdorferi* from the tick gut, into the haemolymph, then salivary glands, enabling Lyme disease transmission to the host. We predict our *I. scapularis* mutant, with both TROSPA and TRE31 gene knockouts, will be unable

to transmit Lyme disease in the white-footed mouse, *Peromyscus leucopus* because without TROSPA binding, *B. burgdorferi* will be unable to colonize the tick midgut and the small proportion of *B. burgdorferi* that does manage midgut colonization will still fail to transmit Lyme disease due to a lack of BBE31-TRE31 binding. This study aims to decrease the rate of Lyme disease amongst ticks, and thus humans, in the face of the climate crisis.

Utilization of CRISPR/dCas9 as a potential novel treatment and prevention measure against hypermethylation and the development of lung cancer

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Climate change is a significant concern in today's world that has threatened both the environment and human health. Particulate matter (PM) released through the burning of fossil fuels has contributed to an increased risk for lung cancer development. PM alters the DNA methylation patterns of critical genes that prevent cancer development (*CDH13, RASSF1A, APC*) and tumour suppression (*P16*). Through the development of CRISPR and the utilization of both in vitro and in vivo models, this proposal intends to provide a method of treating lung cancer resulting from the effects of climate change. This technology will combine dCas9 and single-guide RNAs in order to treat non-small cell lung cancer (NSCLC) cells exposed to PM by activating genes that have been silenced through hypermethylation. This technique also has the potential to be used as a prevention method where DNA methyltransferases (DNMT) can be repressed/silenced in order to prevent future development of cancer cells, especially as concentrations of PM begin to increase. To test the effectiveness of these treatment and prevention experiments, selective organ targeting (SORT) technology on mice will be done. Successful elimination and prevention of cancer development using CRISPR/dCas9 will pose as an alternative to current treatments such as chemotherapy and as a preventative measure against the effects of climate change.

Conflicts of Interest
The authors declare that they have no conflict of interests.

Authors' Contributions
CN: President of the Undergraduate Research Initiative, served on the planning committee for the USCC, drafted the conference abstract booklet, and gave final approval of the version to be published.
RK: President of Scinapse and Chair of the USCC planning committee, assisted authors with their abstract submissions, drafted the conference abstract booklet, and gave final approval of the version to be published.

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