CONFERENCE ABSTRACT BOOK OPEN ACCESS

SciNapse 2023-2024 Undergraduate Science Case Competition: The Mysterious World of Fungi

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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 study delved into the fascinating and often overlooked field of mycology, exploring the diverse and significant implications of fungi in various global contexts. In teams of 1-4, undergraduate students tackled the case and provided novel research ideas that may hold the potential to drive major breakthroughs and significantly enhance our understanding in the multifaceted field of mycology. In total, the 2023-2024 USCC attracted 489 undergraduate students from 18 universities across North America. The top 15% of written submissions in each division are highlighted in this abstract booklet. You may find more information on the annual SciNapse USCC on our website at https://scinapsescience.com.

Keywords: SciNapse USCC; undergraduate research; science case competition; mycology; fungi

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Lower Division

An Alternative to Conventional Antibiotics: The Antimicrobial Properties of Deacetylated Chitin Extracted from *Gongronella butleri*

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Antimicrobial resistance (AMR) is a growing concern and a threat to global public health and development. It is estimated that AMR was directly responsible for 1.27 million deaths worldwide in 2019, and contributed to many more. Due to the superfluous use of antibiotics, AMR is increasingly widespread, and bacterial infections are becoming more difficult to treat. Chitin is a potential alternative that has demonstrated antimicrobial properties. Most commonly extracted from insects and crustaceans, chitin can also be found in the cell walls of fungi. In previously performed experiments, the results supported the hypothesis that chitin derived from crustaceans and insects displayed antimicrobial properties. Due to the different chemical composition and attributes of fungal chitin, this study will explore whether chitin from fungi displays antimicrobial properties. In this experiment, chitin will be extracted from *Gongronella butleri* fungus and will be deacetylated to form chitosan in liquid form. Chitosan easily interacts with the bacterial cell wall and inhibits the formation of the cell wall. The chitosan will then be added to two bacterial cultures, *Staphylococcus aureus* (Gram-positive) and *Escherichia coli* (Gram-negative), and the diameter of inhibition around the chitosan will be measured. The results will indicate whether fungal chitin has antimicrobial properties and can be used as an alternative to antibiotics. This experiment can be expanded, to test how metal salts, temperature, pH, and varying degrees of deacetylation can influence the antimicrobial properties of chitin. Lastly, the real-world applications of chitin and chitosan will be explored in further research.

Bacterial Filtration Abilities of Mycelium: A New Gauze Substitute

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Climate change is escalating the demand for wound dressings which are produced from non-sustainable materials such as cotton and synthetic fibres. Mycelium has the potential to act as a biodegradable and renewable substitute for gauze material, which could help reduce the negative impact of the medical textile industry on the environment. Mycelium extracted from *Ganoderma tsugae* exhibits healing properties for the skin, making it an appropriate gauze, but its ability to prevent bacterial infections is not well-understood. This study seeks to experimentally investigate the ability of mycelium to filter bacteria from infecting third-degree burn wounds in comparison to a woven cotton gauze and a non-woven Acticoat gauze. No gauze will be used as a control. It is hypothesized that a mycelium dressing would significantly affect the bacterial colony count because previous studies have shown mycelia to be effective at filtration. The mycelium gauze will be made from residues of the fruiting body of *Ganoderma Tsugae*. Third-degree burns will be introduced on mice followed by an assessment of the bacterial filtration efficiency of each dressing type. During a 28-day period, bacterial samples from the wound will be

obtained and plated for cell counting analysis, allowing for a comparative assessment of bacterial colony counts among the different gauze types using Anova. It is anticipated that the mycelium gauze will result in the lowest bacterial colony counts due to the material's filtration ability and tissue repair mechanisms. The findings from this research could serve as the foundation for potential mycelium gauzes with enhanced functionality in hopes of contributing to the advancement of environmentally conscious medical textiles.

CRISPR-Mediated Transcriptional Activation of Squalene Synthase to Increase the Production of Inotodiol in *Inonotus obliquus*

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Chaga (*Inonotus obliquus*) is a parasitic fungus of birch trees used in the traditional medicine of Russia, China, and other Eurasian countries. The secondary metabolites (SMs) produced by *I. obliquus* are known to possess anticancer, anti-inflammatory, antiviral, antioxidant, and hypoglycemic activity, while posing no known adverse effects. The therapeutic properties of *I. obliquus* are thus of particular medical interest. Several studies have demonstrated that the triterpenoids produced by *I. obliquus* provide the anticancer effects. Specifically, the triterpenoid inotodiol has demonstrated promising antitumor effects in human cervical cancer HeLa cells. Unfortunately, the limited natural abundance *I. obliquus* impedes use of this fungus as a source of inotodiol for clinical applications. Furthermore, attempts to culture *I. obliquus* in a laboratory setting are limited by the low expression of biosynthetic gene clusters (BGCs). To address these challenges, we propose using CRISPR-mediated transcriptional activation (CRISPRa) to boost the expression of the enzyme (squalene synthase (SQS)) that mediates the biosynthesis of inotodiol in *I. obliquus*, thereby increasing production of the therapeutic metabolite. The levels of inotodiol production achieved by endonuclease-deficient Cas9s fused to transcriptional activator domains (dCas9-VPR) will be compared using three different single guide RNA (sgRNA) sequences. To evaluate the proposed CRISPRa system, transcriptomic, proteomic, and metabolomic analyses will be implemented. To our knowledge, CRISPRa methodology has not yet been used to improve the yield of *I. obliquus* metabolites.

Hybrid *P. ostreatus* Mycelium Extract and Collagen-Alginate Composite Hydrogel Scaffold for Microbial Infection Prevention and Accelerated Wound Healing in Early Stage Chronic Diabetic Foot Ulcers: A Research Protocol

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Diabetic foot ulcers (DFUs) are a prevalent and often chronic complication in patients with diabetes, characterized by open sores or lesions on the feet. DFUs can progress from early stage non-infected lesions to late-stage full-foot gangrene. Often, DFUs recur and result in severe complications, accounting for more than 80% of amputations amongst diabetic patients. DFUs are highly susceptible to microbial infections, with *P. aeruginosa*, *E. coli*, *S. aureus* and *C. albicans* being some of the most common bacterial and fungal pathogens identified. Additional factors contributing to the prolonged healing period and high recurrence rate include dry skin and necrosis. Current preventative measures and medical solutions are lacking, causing the average healing period of DFUs to range from 12 to 13 months. Thus, the proposed approach incorporates the mycelium strain *P. ostreatus* with collagen-alginate composite hydrogel to synthesize a novel mycelium-hydrogel scaffold for accelerated DFU healing. Sufficient evidence indicates that *P. ostreatus* exhibits significant antimicrobial properties against common pathogenic species in diabetic foot infections, including *P. aeruginosa*, *E. coli*, *S. aureus* and *C. albicans*. Hydrogel in the scaffold promotes autolytic debridement and maintains a moist environment for cell migration. Integrating collagen and alginate with the mycelium-hydrogel scaffold provides biocompatibility for tissue regeneration and scaffold biodegradation, respectively. In vivo experimentation will take place in murine models to test the efficacy of the hybrid hydrogel-mycelium gelation scaffold in the prevention of microbial infections and acceleration of DFU healing. Efficacy will then be evaluated using mathematical models and statistical analyses.

Proposal for In-Vivo Testing of Rubrolide S in Rodents as an α-Glucosidase Inhibitor

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This proposal addresses the potential use of Rubrolide S, a secondary metabolite of the *Aspergillus terreus* species, to treat diabetes mellitus. Type 2 diabetes mellitus results from lower insulin production or non-responsive insulin receptors; in both cases, there is no regulation for glucose uptake into the blood, which causes abnormally high blood sugar levels that the body cannot naturally reduce. Previous treatments for diabetic patients work by competitively inhibiting glycosidases–a family of enzymes that catalyze the breakdown of larger sugars into monomers, effectively increasing postprandial blood sugar levels. Recent studies have indicated that Rubrolide S functions as an uncompetitive glucosidase inhibitor. While the effectiveness of competitive inhibition relies on carbohydrate concentration, Rubrolide S could produce inhibitory effects regardless of carbohydrate concentration, making it a much more effective treatment. Proposed testing for Rubrolide S involves treating diabetic rats with Acarbose (a commonly prescribed competitive glucosidase inhibitor), and Rubrolide S. Non-diabetic and diabetic rats treated with distilled water are used as control groups for comparison. Baseline blood sugar levels will be measured for all groups and re-measured after sucrose administration at selected intervals. The experiment is repeated with increased doses of sucrose. The anticipated result is that the Acarbose-treated rats will exhibit rising glycemic levels as the sucrose dosage increases. Contrarily, Rubrolide S-treated rats should exhibit minimal rises in glycemic levels even as sucrose levels increase. Rubrolide S could prove to be a much better treatment for DM than the pre-existing Acarbose drug.

Psilocybin and its Effectiveness in Increasing Oxytocin Levels to Treat Postpartum Depression: Using a Rodent Model

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Psilocybin is a chemical obtained from psilocybin mushrooms, within the class of serotonergic psychedelics, which is known for its psychedelic effects and antidepressant properties. Past studies have depicted strong correlations between increased oxytocin levels in the brain from Lysergic acid diethylamide (LSD) dosing. However, due to a lack of research on medical applications of psychedelics, there are fewer studies on the effects of Psilocybin on oxytocin levels. Postpartum Depression (PPD) is a widespread medical condition characterized by depressive symptoms experienced by some after childbirth. Despite its significant impact, recent studies indicate that "maternal depression in low- and middle-income countries often goes unrecognized and untreated". Psilocybin mushrooms, easily cultivated in damp environments like Kodaikanal, India, could offer a more accessible treatment option for individuals experiencing PPD in such countries. This study aims to assess the effectiveness of naturally occurring psilocybin in treating PPD when intraperitoneally administered to a mouse model, specifically the species Mus Musculus, and monitoring an increase in oxytocin levels, which alludes to an improvement in PPD symptoms. Using an Enzyme-Linked Immunosorbent Assay (ELISA) test, this research measures oxytocin concentrations before and after psilocybin administration in two groups: non-pregnant and post-pregnant mice. Currently, studies regarding the effects of psilocybin on increasing oxytocin levels are limited, thus this study is a novel approach and can potentially provide a deeper understanding of the relationship between psilocybin and oxytocin to alleviate PPD.

Reducing *Aspergillus flavus*-Produced Aflatoxins Through Enzymatic Malonyl-CoA Pathway Inhibition

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A family of mycotoxins produced by A. flavus, aflatoxins are a major source of economic loss in agriculture. If ingested by humans or animals, mycotoxins can cause DNA damage. This article theorizes that, a reduction method will inhibit the toxin at the production stage, preventing its synthesis altogether; through the disruption of aflatoxin production pathways by inhibiting malonyl-CoA synthesis, the levels of aflatoxins are hypothesized to decrease significantly. This can be done by inhibiting acetyl-CoA carboxylase activity via phosphorylation by upregulating protein kinase C via a non-toxic diacylglycerol analogue: 1-oleoyl-2-acetyl glycerol (OAG). An increased presence of OAG is hypothesized to render acetyl-CoA carboxylase (catalyst of malonyl-CoA) inactive due to phosphorylation. Differing concentrations of OAG will be applied to isolated samples of *A. flavus*, then preserved through incubation for 24 hours. Both qualitative (liquid ammonia vapour test) and quantitative (ELISA) tests will then be administered to determine the presence and magnitude of aflatoxin levels present in the *A. flavus* samples. The resulting aflatoxin concentrations will be compared to the concentrations of OAG

treatment. Results will be analyzed for accuracy through spectrometric and statistical analysis, for the qualitative and quantitative tests, respectively. Theoretically, this can be extrapolated to large-scale farm studies using OAG as the basis of a fungicide, greatly reducing toxic contamination within agriculture.

Space Agriculture: Melanin-Enhanced Plants

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Recent studies have introduced the idea that space colonization efforts could be facilitated with mycology, beginning with NASA's initiative to construct mycotecture buildings on Mars using mycelium bricks. Still, there exist many challenges in sustaining life on Mars including its 98% carbon dioxide atmospheric gas concentration, as well as the thin atmosphere, which provides very limited protection from cosmic radiation. It was discovered previously that melanin in fungi had strong protective properties against radiation, such that hundreds of species were able to grow in spite of, and even exploit, the radioactive environment in Chernobyl. The question arises of whether plants can be genetically modified to synthesize melanin as well, to enhance their survival/viability in similar high-radiation environments including Mars. Many of these fungal species contain similar gene clusters coding for their melanin synthesis pathways (MSP). By transforming these genes of interest (GOI) into *Zea mays* (corn) plants by agroinoculation, we expect to see the plants express these melanin-coding genes and develop an enhanced tolerance to gamma radiation.

Usage of Psilocybin's Neuroplastic Function to Treat Huntington's Disease: A Research Protocol

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Psilocybin is a psychotropic alkaloid that is derived from fungi of the Psilocybe genus which displays a neuroplasticity-inducing and neural atrophy-inhibiting effect. Such effects, whether derived from psychedelic sources or otherwise, have been shown to improve the outcomes and slow the progression of various neurodegenerative diseases, such as Alzheimer's and Dementia. This study aims to apply these findings to Huntington's Disease in hopes of exploring potential treatments. When treated with psilocybin, Huntington's Disease patients will exhibit therapeutic effects from an increase in neuroplasticity of the hippocampus region. Psilocybin's neuroplasticity-inducing effects in mice may also have a neurodegenerative effect in human patients with HD, creating a potential treatment that can slow the progression of the disease. A zQ175 knock-in model mouse was used to mimic the symptoms of Huntington's Disease, including neuronal death. Psilocybin is administered to the experimental mice on a regular schedule. Brain tissue samples are then collected every 5 days and analyzed to determine the potential effects of Psilocybin on neurodegeneration in the hippocampus. It is expected that an increased neuroplasticity in the hippocampus will be observed as a result of psilocybin administration. Applying the findings of this preclinical trial may provide new insights into the development and structure of treatment plans for Huntington's Disease.

Upper Division

A Novel Approach to Modelling Wildfires Using the Optimization Behaviour of *Physarum polycephalum*

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As average global temperatures increase, wildfires are becoming more common and intense. Over 8000 wildfires burn annually in Canada, causing damage to communities, infrastructure, and natural resources. Wildfire simulations are useful tools that can forecast fire direction and intensity, and help with evacuation and suppression. Accurate simulations can effectively reduce casualties and property loss. We propose a novel method of modelling wildfires using the slime mold known as *Physarum polycephalum*. An unassuming single-celled amoeba-like organism, *P. polycephalum* is able to determine the shortest path through mazes and solve optimization problems. In 2010, Japanese researchers demonstrated *P. polycephalum* could recreate the Tokyo railway system with remarkable accuracy. *P. polycephalum* extends plasmodia outwards in search of food in the most optimal path, creating efficient networks. It exhibits chemotaxis and phototaxis so its

growth can be influenced with food and light. Both fires and *P. polycephalum* propagate along the most optimal paths, so we believe *P. polycephalum* growth will resemble fire spread. Our proposed methodology involves translating variables affecting fire spread (tree density, elevation, wind) into light gradient filters with darker regions representing faster fire spread and overlapping these filters to recreate the overall environment. *P. polycephalum* and food will be placed onto an agar plate representing fire and a forest-dependent community respectively. The resultant *P. polycephalum* growth will model the real-life wildfire spread throughout the area. Our approach could provide advantages over current simulations in terms of accessibility, modulability, and portability, and ultimately improve our understanding to combat this growing issue.

Enhancing Fluconazole Efficacy: Investigating the combined effects of AgNPs, α-mannosidase and zymolyase in the treatment of *C.auris* infections

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The emerging pathogenic fungal species *Candida auris* poses a significant concern due to its elevated mortality rates and widespread resistance to antifungal drugs. Predominantly found in ICU settings, *C. auris* manifests through surfaces and skin colonization and displays a rapid infection rate. Its resistance is attributed to biofilm formation, making it resistant to conventional antifungal treatments. This study investigates the efficacy of biosynthesized silver nanoparticles (AgNPs) alongside the enzymes α-mannosidase and zymolyase in hydrolyzing the *C. auris* biofilm for better susceptibility against previously resistant antifungals, notably fluconazole, a very common antifungal to which 90% of *C. auris* strains have shown resistance. Previous studies on *Candida* species have demonstrated that AgNPs' antimicrobial activities have a destructive interaction with the biofilm. The enzymes α-mannosidase and zymolyase target the mannan-glucan matrix of the *C. auris* biofilm. Our research aims to prove that a pre-treatment with AgNPs, α-mannosidase and/or zymolyase will increase the effectiveness of fluconazole treatment against *C. auris*. The experimental protocol involves the inoculation of *C. auris* in 96-well plates, followed by an incubation period for biofilm growth. Subsequently, a checkerboard assay will be performed to assess the combined disruptive effect of fluconazole and solutions containing different concentrations of AgNPs, α-mannosidase and/or zymolyase on the biofilm. A crystal violet assay will be used to assess biofilm degradation. We expect that the treatment with only AgNPs and α-mannosidase or the treatment with all three antifungals present will be the most effective one for breaking down the biofilm thus enhancing fluconazole efficacy in *C. auris* treatment.

Exploring the Potential of Antisense Technologies to Enhance Traditional Antifungal Treatments for *Candida albicans* Biofilms

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Biofilm-related infections present critical challenges in the context of medical implantable devices, often necessitating the removal of these life-saving devices. Among these infections, *Candida albicans* biofilms are particularly prevalent and are often addressed with caspofungin, a fungicidal echinocandin. However, prevailing antifungal treatments exhibit limited efficacy against biofilms due to their intricate structure and the emergence of antifungal resistance. The recent advancement of antisense therapy offers a promising avenue to augment the effectiveness of anti-biofilm treatments. Targeting EFG1, a key transcription regulator in *C. albicans*, anti-EFG1 2′-OMethylRNA can increase membrane permeability while reducing antifungal properties. Consequently, we propose a novel therapeutic approach leveraging anti-EFG1 2′-OMethylRNA to amplify the fungicidal properties of echinocandins. Our study aims to assess the viability of cells subjected to individual and combined treatment modalities. Employing an *in vivo* benchtop biofilm model, we will investigate the efficacy of caspofungin and anti-EFG1 2′-OMethylRNA, both independently and in combination. By evaluating their impact on biofilm growth, cellular viability, and gene and protein expressions, we seek to ascertain the potential synergistic effects of this combinatorial therapeutic approach. Investigating the combination of antisense and caspofungin therapy presents a promising direction toward the more effective treatment of biofilm-related infections on medical implantables. Furthermore, the results of this study may present promising opportunities for the future use of antisense technology in more efficacious treatment of other illnesses.

Fungal Proteases in the Preventative Treatment of Peanut Allergies

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Peanut allergies are a common autoimmune disorder that impacts millions of people worldwide. Currently, there are no known treatments to cure or prevent allergic reactions to peanuts besides avoiding the allergen. To combat this, previous studies have found that fungal proteases can prevent an allergic response; the fungal proteases bind an peanut-specific IgE immunoglobulin, blocking the allergic response. We propose to orally administer these previously identified fungal proteases isolated from the fungus *Aspergillus Niger* prior to exposure to peanut antigens. If the fungal proteases successfully bind the peanut-specific IgE prior to exposure, then peanut allergenicity will be reduced. To test our experimental drug, we will utilize peanut-sensitized mice strains, with one control group receiving a placebo and two groups receiving different dosages of the drug. All three groups will then be exposed to the peanut allergen, and allergy responses will be monitored through body temperature measurements, blood histamine tests and ELISA assays testing the presence of peanut-specific IgE. We anticipate that the fungal proteases will prevent all allergic reaction responses from occurring such that body temperature will remain stable, blood histamine levels will not increase, and the presence of peanut-specific IgE will be lessened. This novel oral drug will be used as a pre-exposure preventative treatment, unlike the current post-exposure treatments on the market, such as an Epi-pen, filling a key gap in knowledge of preventative treatment for peanut allergies.

Harnessing RNA Interference to Constrain *Ustilago hordei* Growth and Barley Infection

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Ustilago hordei, a facultative biotrophic fungal pathogen, poses a significant threat to barley (*Hordeum vulgare*) crops, causing barley smut and leading to substantial economic losses. This research project aims to explore the application of RNA interference (RNAi) to silence genes implicated in barley colonization, aiming to understand its impact on *U. hordei* growth. Three pivotal genes (*UhAvr1, Fly1, GUS*) linked to barley infection will be amplified and transformed into dsRNA that contains small interfering RNA (siRNA) regions through in vitro expression in *E. coli*. The impact of the dsRNA will be assessed on *U. hordei* growth at varying concentrations. The application of target gene dsRNA is expected to limit fungal growth and barley colonization. A positive relationship between translational inhibition and dsRNA concentration is hypothesized. Ultimately, this study provides insights into RNAi as a potential replacement for chemical fungicides with wide agricultural applications.

***Rhizopus arrhizus*-Derived Fumaric Acid Treatment for Prevention of Hemolytic Anemia in Patients with Glucose-6-Phosphate Dehydrogenase Deficiency**

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Glucose-6-phosphate dehydrogenase (G6PD) deficiency is a genetic disorder caused by point mutations in X-linked genes encoding G6PD. Studies demonstrate a correlation between G6PD deficiency and oxidative damage, causing premature destruction of red blood cells, manifesting as the blood disorder hemolytic anemia. However, apart from supportive and therapeutic strategies to manage G6PD deficiency symptoms, a treatment method does not exist. G6PD deficiencies have a high prevalence of 400 million people worldwide, with global immigration increasing incidences in North America. Primary pathogenic explanations for G6PD deficiency-induced oxidative damage results from decreased nicotinamide adenine dinucleotide phosphate (NADPH)-mediated reduced glutathione (GSH) recycling—imperative for ROS detoxification. Previous research has identified nuclear factor erythroid 2-related factor 2's (NRF2) critical role in cellular antioxidant defense, via regulation of genes associated with ROS elimination, highlighting a key potential mechanism to combat hemolytic anemia. We use data from established dimethyl fumarate (DMF) research to support its potential repurposing for hemolytic anemia exacerbated by G6PD through targeting the NRF2 pathway. We founded our rationale on evidence showing (a) the efficacy of NRF2 in enhancing antioxidant enzyme expression, and (b) the activation of NRF2 with DMF. Our findings indicate that low doses of DMF, extracted from *Rhizopus arrhizus* fungi, could prevent hemolytic anemia in patients with G6PD deficiency. The proposed experiment would be the first to test the efficacy of DMF in preventing G6PD deficiency-induced hemolytic anemia *in vivo*, a promising step towards establishing a treatment method for hemolytic anemia and decreasing the burden and mortality of the disorder worldwide.

SC3 Hydrophobins from Schizophyllum Commune as a Novel Lubricant for Urinary Catheters

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Fungi have often been called "nature's chemists" due to their remarkable ability to synthesize a wide range of compounds. Hydrophobins are a class of small, surface-active proteins produced by filamentous fungi which self-assemble into amphipathic films. Hydrophobins have previously been tied to strong antifungal and water-repellent properties. Their biologically-derived origin has been of interest by potentially presenting a more biocompatible alternative to materials from other sources. Catheter-associated urinary tract infections are the most commonly acquired hospital infection, representing a significant strain on the medical system. Current urinary catheter coatings suffer from issues like low biocompatibility and poor antimicrobial properties. Using a hydrophobin-based coating may increase biocompatibility, prevent dangerous biofilm formation, and act as a natural lubricant on the surface of urinary catheters. In this proposal, shizophyllum fungi are cultivated in a laboratory setting. Antimicrobial activity is measured with a disk diffusion method. Fungal species *Candida albicans*, *Cryptococcus neoformans*, *Staphylococcus aureus*, and mold *Aspergillus niger* are grown on media with 6 mm disks containing SC3 hydrophobin, Teflon, or polyethylene glycol to determine the diameters of inhibition. The minimal inhibitor concentration is determined using the broth twofold microdilution method. Frictional forces are separately assayed using lateral force microscopy to compare the ability of an SC3 hydrophobin coating to act as a lubricant against commonly used catheter coatings such as hydrogels, Teflon, and polyethylene glycol. Leveraging SC3 hydrophobin's unique properties, this research suggests a promising, eco-friendly solution for urinary catheters, potentially revolutionizing their antimicrobial efficacy and reducing healthcare-associated infection rates.

The Cognitive-Enhancing Effects of Lion's Mane in A Rodent Model of Attention-Deficit Hyperactivity Disorder (ADHD): A Research Protocol

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The intersection between mycology and modern medicine has captivated the scientific community, with a growing focus on fungi's potential to address symptoms of mental health disorders. Lion's Mane mushroom, renowned for cognitive enhancement attributed to hericenones and erinacines stimulating nerve growth factor (NGF), has emerged as a subject of significant interest. Recent studies suggest its potential antidepressant and anxiolytic properties, broadening its relevance to various mental health challenges. Attention-deficit/hyperactivity disorder (ADHD), characterized by executive functioning difficulties, notably in attention and memory, is often linked to working memory deficits. Numerous investigations indicate that a substantial proportion of individuals with ADHD exhibit impaired working memory. Working memory, responsible for temporarily holding and processing information, plays a pivotal role in encoding memories for long-term storage or extinction. This paper suggests that Lion's Mane may offer therapeutic benefits by enhancing working memory, thereby positively influencing the day-to-day executive functioning of individuals grappling with ADHD. It explores the potential benefits of Lion's Mane with a specific focus on working memory, using a spontaneously hypertensive rat (SHR) model, which presents ADHD-like symptoms. The potential implications of such findings underscore the promising role of Lion's Mane in addressing cognitive challenges associated with ADHD.

The Development of An Optimal Fungi to Degrade Plastic Waste Emitted by Hospitals using Genomic Analysis & CRISPR-Cas9 Models

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Over the past decade, hospitals have experienced a significant increase in plastic waste. In 2019, a study identified that Canadian hospitals generated 87,000 tons of waste, with over 30% of that being single-use plastics. The environmental impact of this waste is a growing concern that has promoted research into new innovative waste management strategies, such as the use of fungi to degrade plastics. However, the use of fungi has challenges such as their speed of action and their ability to degrade only specific types of plastic. Our study aims to enhance the plastic-degrading capabilities of *Aspergillus Fumigatus* through CRISPR-Cas9 by integrating the genes responsible for polyethylene digestion from *Aspergillus glaucus.*

Our study will aim to identify the genes associated with plastic-degradation in the fungi, use CRISPR-Cas9 to transform *A. fumigatus*, and compare the modified and unmodified strain in terms of mRNA levels, enzyme activity, and speed of polyethylene digestion. We anticipate that the modified *A. fumigatus* will be more effective at degrading polyethylene than the unmodified strain. The results of our study would help determine if the modified *A. fumigatus* is an effective agent that can be utilized for plastic waste management at hospitals. Our study would help address the urgent need for sustainable waste management in hospitals and highlight the potential of CRISPR-Cas9 to unlock new capabilities in fungi for plastic degradation. Our results could pave the way for scalable and efficient solutions, contributing to a shift in plastic waste management practices especially in healthcare settings.

Waterproofing Nature's Blanket: Laccase-mediated Dodecyl Gallate Grafting to Increase the Hydrophobicity of Mycelium Composite Insulation

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Global industrialization has resulted in an increased production of insulation materials, causing excess waste and harm to the environment. Mycelium composites (MCs) are novel, sustainable materials that have shown great potential as insulating products due to their biodegradable and thermal insulating properties. However, one key limitation of MC insulation is its high water absorption due to the hydrophilicity of the substrate on which mycelium grows. Moisture retention reduces its insulating properties, compromises its structural integrity, and risks mold growth. We propose a novel methodology to decrease water absorption of MC insulation by grafting a hydrophobic compound, dodecyl gallate (DG), onto the MC substrate using laccase. Laccase, a biocatalyst produced from *Trametes veriscolor* fungi, has been implicated as an environmentally benign method to covalently modify lignocellulosic materials and its use to graft DG has been shown to increase hydrophobicity in corn pith and bamboo. In this study, *Pleurotus ostreatus* fungi will be grown on various agricultural waste substrates, including rice straw, bagasse, coir-pith, sawdust, and corn straw, to generate MC insulation. Following treatment via laccase-mediated DG grafting, we will then test samples of MC grown on different substrates with & without grafting of DG for their water-absorbing properties and thermal conductivity in comparison to industry-standard insulation materials.

Conflicts of Interest

The authors declare that they have no conflict of interests.

Authors' Contributions

RK: Co-President of SciNapse and Co-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.
JGK: Co-President of SciNapse and Co-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.
AM: 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.

Acknowledgements

We want to acknowledge the entire SciNapse Executive Committee for playing an integral role in making this year's USCC a success. The team that helped make this competition possible includes: Rebecca Krnel and Jade Gamelin Kao as Co-Presidents of SciNapse and Co-Chairs of the planning committee; Andréanne Ménard as President of URI; Jebreel Alayche as Vice-President of Finances of URI; Aysha Aftab as Vice-President of Outreach; Marisa Levy as Vice-President of Operations; Will Meisner as Communications Representative; Émilie Marion as Social Media and Website Coordinator; Sarah Heffernan, Michaela Dworsky-Fried, and Mae Padie as USCC Mentors; Chris Kachi and Joseph Ghossein as uOttawa Campus Leaders; Rita Murali and Moumita Dutta as Graphic Designers; Abha Ranjitkar and Jainee Patel as Events Coordinators; Eleni Dubé-Zinatelli as External Campus Coordinator; and Jin-Young Bang, Agnes Chan, and Benjamin Mugisha as Logistics and Statistics Coordinators. The USCC would not have been successful without the contribution and work of the multiple chapters of the SciNapse USCC situated across other universities in Ontario. Finally, we want to acknowledge all the professors, researchers, and graduate students that participated as judges for the competition. Your valuable time and feedback to the participants has had a positive impact on their future success.

Funding
The SciNapse USCC is funded by the Undergraduate Research Initiative.

Article Information
Managing Editor: Jeremy Y. Ng
Article Dates: Received Feb 22 24; Published Mar 04 24

Citation
Please cite this article as follows:
Krnel R, Kao JG, Ménard A. SciNapse 2023-2024 Undergraduate Science Case Competition: The Mysterious World of Fungi. URNCST Journal. 2024 Mar 04: 8(3). https://urncst.com/index.php/urncst/article/view/584
DOI Link: https://doi.org/10.26685/urncst.584