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Message from Editors-In-Chief

Dear Student Researchers,

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So, as you embark on your research journey, hold on to your passion, question everything, and never stop exploring. The world awaits your discoveries, and your work has the power to make a difference.

With admiration for your commitment to knowledge and discovery,

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“Featured Article of the Current Volume”

Investigating Uveal Melanoma Using a Seurat scRNA-seq Analysis of SEAM Organoid Gene Clusters

Ethan Chiu
Yale University

ABSTRACT

Uveal Melanoma (UM) is the most common eye cancer with a mortality rate of 80%. However, only 1% of patients have detectable UM at metastasis and UM exhibits punctuated early growth. The origin and proliferation of UM was investigated using single-cell RNA sequencing analysis as it is currently the best method to define cell states and phenotypes. The Seurat R toolkit was used to separate the cells of a self-formed ectodermal autonomous multi-zone (SEAM) organoid and UM cells into gene clusters. These gene clusters were then identified using canonical gene markers and compared in samples with and without UM. In this way, the origin of UM was attributed to certain genetic clusters and targeted for future treatments. Distinct cell clusters with unique gene expression patterns were found in the UM datasets, which provided insight into the mechanisms underlying UM progression and facilitated comparisons between the control SEAM organoid and the experimental UM gene datasets. Moreover, the potential of the SEAM organoid model in modeling UM metastasis was verified. In the future, both in vitro and in vivo experiments will be performed to confirm the results of the scRNA-seq analysis. Additionally, RNA interference with lentivirus therapy will be tested using the SEAM organoid model to determine whether it effectively minimizes the UM phenotype.

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Protecting Unionization Through Labor Law Reform

Alexander Wang

ABSTRACT

This paper will examine the effect of critical moments in the American history of unionization on today's political and economic landscapes pertaining to labor unions; numerous acts, such as the National Labor Relations Act of 1935 have legitimized union activities. Upon examination, this paper will analyze how the modern political and economic landscapes regarding American labor unions impact the effectiveness of organizing; unethical employer tactics decrease the likelihood of success for unions. Lastly, this essay inspects the possible benefits of specific actions that could be taken to strengthen the labor movement. In 1935, the National Labor Relations Act (NLRA) was signed into law marking a significant moment in the history of American unions as workers' right to unionize was legitimized. In 1947, a different shift in the landscape of unions occurred under the Taft-Hartley Act which restricted certain union activities in some states.

In recent times, the economic and political landscapes pertaining to labor unions have been plagued by numerous factors creating an uphill battle for organizing workers. However, in 2021, the US House of Representatives passed the Protecting the Right to Organize (PRO) Act, restricting the egregious methods commonly applied by employers to oppose unions. It was observed that attempts to unionize were generally met with employer retaliation. Varying unethical tactics were employed to dissuade workers from unionizing, such as holding mandatory anti-union meetings and excessive stalling. Such attempts were generally fruitful due to a paucity of sufficient punishment.

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Associating Blood Lead Concentration and Gray Matter Volume in the Brain Across the United States, as a Model for Flint, Michigan

Shira Lichter

ABSTRACT

In 2015, Flint Michigan changed water sources from Lake Huron to the Flint River, which had water lead levels [15], correlated with blood lead levels [17]. Lead is highly neurotoxic [19], lowering grey matter volume [5]. Due to a lack of data from Flint, fMRI scans (after 2015) from Los Angeles, New York City, and Philadelphia were analyzed with voxel-based morphometry in spm12. Grey matter volumes were stratified by gender. Significant differences were found between average grey matter and water lead levels ($p < 0.00001$). Philadelphia, with the highest lead levels (3.0 ppb), had significantly lower grey matter volume than all other cities. All locations had significantly lower volume than the control, demonstrating the impact of water lead. There were significant differences between cities of varied water lead concentrations. Philadelphia and Flint had the highest water lead levels, at 3.0 ppb, allowing Philadelphia to be used as a possible model for Flint.

Keywords: Flint, lead, water lead, blood lead, blood-brain barrier, grey matter volume, fMRI, spm12, voxel-based morphometry, model, toxicity.

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The Effect of Microplastics on the Chlorophyll Content of *Solanum lycopersicum* L

Rosina Wickham

ABSTRACT

Approximately 107,000-730,000 tons of microplastics are dumped into agricultural soil yearly. It has recently been reported that microplastics change the chlorophyll content of pumpkins, decrease root and shoot growth, and decrease the leaf number. There is a great deal of information on microplastics causing harm to the environment, including negatively impacting crops grown in contaminated soil. However, there is very little research on how microplastics in the soil may alter the chlorophyll levels of *Solanum lycopersicum* L., the tomato plant. This is a research study designed to investigate the effect that microplastics have on *Solanum lycopersicum* L.'s chlorophyll content. Upon planting, tomato seeds were exposed to 0.1% microplastics in the soil, 0.2% microplastics in the soil, or no microplastics (control). Day of germination, the height of the plant, and leaf number were recorded daily for 39 days. On day 39, the plants were harvested and the root length and chlorophyll content was measured. The results of the experiment concluded that plants exposed to 0.2% of microplastics had an overall decrease in chlorophyll, leaves, delayed germination, height, and mass. These results agreed with the study that evaluated the chlorophyll contents of pumpkins exposed to microplastics. In conclusion, microplastics are a rising threat to the environment. The higher percentage of microplastics found in the environment, the worse agriculture will become. For future research, increased concentrations of microplastics could be used or the effects of different types of plastic could be assessed.

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Study on Geometry of Pin Fins for Effective Conduction and Convection

JeongWon Moon

ABSTRACT

Pin fins, which typically have a circular cross-section and extend outward from a base plate, enhance heat transfer efficiency through improved turbulence generation, better airflow management, and more effective use of surface area. These are preferred over straight fins in industrial applications because they have lower overall flow resistance to the air passing through them. Also, the circular cross-sectional and multiple rows of pin fins expose more surface area to the surrounding air from all sides, enhancing the convective heat transfer.

The longer the fin, the more surface area is available for heat transfer, but with diminishing returns due to heat conduction limitations. A larger diameter increases the surface area for convection but also affects the conduction through the fin. Thus, the optimization of the length of fins is our concern in this research. For the optimization, this paper considered several factors, including the geometry of the fin, such as diameter(d) and length(l). Material properties such as Thermal conductivity (k), specific heat(c), and density(ρ) are also considered. Each rod has one end attached to the wall at $x = 0$, while the opposite end ($x = L$) is exposed to air, which is maintained at a specific temperature and convection coefficient. We calculated the rate of heat transferred from the system through each fin and the wall, assuming the same convection coefficient for the fin and the unfinned wall surface. A general governing equation for the steady-state temperature distribution in a pin fin in one-dimensional heat conduction was used to find the temperature distribution along the length of the fin and to calculate the rate of heat transfer.



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The Effect of *Apis mellifera* Propolis on the Growth of Tumors on *Solanum lycopersicum*

Dwight Evans Jr.

ABSTRACT

Plants are an integral part of human life. Crops, especially fruits and vegetables, provide humans with energy and nutrients. What would happen if we didn't have these foods at all? The aim for this research study was to determine if the plant ridding disease, Tobacco Mosaic Virus (TMV), could be mitigated if treated with propolis; a substance collected from *Apis mellifera* (honey bees) when they pollinate flowers. The plant selected for this study was *Solanum lycopersicum* (tomato plant) due to its commonality with the virus itself. Due to the hardships of germination, the plants were bought and not grown and only the leaf count was measured. The plants were split into two groups, control and experimental. TMV was applied to both groups, but only the experimental group was treated with *Apis mellifera* propolis. Several days later, the experimental group received the propolis. With the control group, about 6 leaves were destroyed and wrinkle while in the experimental group only 2 leaves were shriveled and destroyed. The control group plant had a tilt as the stem was weakening, while the experimental group was upright. The colors didn't change all too much in either except for the leaf color. In the control group, the leaves looked black and brown, while in the experimental it looked slightly brown-rather than black. According to the data collected, the plant-ridden disease of the Tobacco Mosaic Virus can be rid of with the propolis of *Apis mellifera*.

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Efficacy of Mask Use in Reducing Sars-Cov2 Infection Rates

Sabrina Guo

ABSTRACT

ARS-CoV-2, a novel coronavirus also known as COVID-19, has caused a global pandemic, claiming the lives of over 3 million people, and counting. Governments and local polities have implemented public health mandates to reduce the spread, including mask-wearing, a policy that remains controversial. The aim of this study was to examine how effective strict enforcement of mask-wearing policies is in reducing COVID-19 infection rates. A total of 30 countries and subnational political jurisdictions were selected using Text Finder's random choice generator, then sorted into three categories of mask enforcement: strict, moderate, and lax, characterized by punishments, non-enforcement, or lack of precautions. The percent changes in cases were recorded over a 3-month period prior to and after the declaration of mask mandates for each locality, then analyzed using the Kruskal-Wallis test to rank the three categories. The mean rankings from greatest to least were: lax (24.90), moderate (12.90), and strict (8.70). The Kruskal-Wallis test result was $H(2) = 18.240$, $P = .000$. Locations with stricter mask policies had lower infection rates. Therefore, it was concluded that strictly enforced mask policies were most effective in limiting COVID-19 transmission. Confounding variables include political agendas, the sway of public opinions, and a transient lack of data on COVID. Future research could analyze the effectiveness of mask enforcement in locations with different COVID-19 variants.

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American Blacks: The Power of Representation

Cayla Midy

ABSTRACT

African Americans are often viewed as a monolithic group in the United States because Black people generally have been subjected to the same racism and prejudice throughout American society. While African Americans have had many similar experiences in the United States, their opinions on the current political, social, and economic worldview may differ based on ethnic groups. The author chose to closely examine the extent to which family history and decade of one's arrival (or one's family's arrival) to the United States, and the region from which one (or one's family) originated, might influence the current political, social and economic worldview of adolescent and adult Americans who self-identify as Black. In order to study the effects of these variables, I administered surveys to 146 African American adults in suburban New York City. The online survey consisted of four parts. These parts included views on economic success, law enforcement, current events, specifically the Black Lives Matter Movement, and Black representation in American society. Ultimately the study found statistically significant differences between region/decade of arrival and societal world views. There were also gender gaps.



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Holistic Approach to Healthy Aging Through Intergenerational Activities

Jay Kim

ABSTRACT

Research studies show depression causes brain amyloid plaque buildup which appears before emotional brain areas show cognitive decline. The research shows depression in older adults serves as an indicator for neurodegenerative disease so healthcare professionals need to perform frequent screenings and begin immediate treatment. The main goal of this research is to understand the biological connection between depressive symptoms and fast amyloid disease progression and to assess non-drug treatments that protect against this risk. The combination of culturally adapted psychosocial therapy with social activities and personalized life changes produces better long-term mental health results than medication treatment alone. Our research focuses on care systems which unite psychological health with physical health to develop enduring practices that enhance brain flexibility and minimize swelling. The best approach to support elderly people's physical and emotional and mental health needs exists through intergenerational programs. The activities enable people to establish social connections while acquiring new knowledge and maintaining physical activity which results in enhanced mental health and better depression resistance. The successful models from educational and community and digital platforms show promise for broad implementation which would create equal advantages for all participants. The implementation of intergenerational programs by society will create an active system for dementia prevention and aging health support through the transformation of community infrastructure into a proactive pub-



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Evaluation of Therapeutics to Target Stem Cell Like Prostate Cancer

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ABSTRACT

Prostate cancer relies on androgen receptor (AR) signaling for growth. Hence, androgen deprivation therapy (ADT) is effective against prostate cancer (Tang et al., 2022). However, the disease progresses to a lethal stage termed castration-resistant prostate cancer otherwise known as CRPC. Reactivation of AR signaling is the most common driver of CRPC growth, leading to the development of AR signaling inhibitors (ARSIs) which drive the evolution of CRPC towards AR-independence (Figure 1a). In prostate cancer, there are two well-known subtypes, AR and neuroendocrine (NE), and two newer subtypes, WNT (Wingless-related integration site) and stem-cell like (SCL) (Figure 1b). I focus on SCL as it is the second most common after AR. Patients with CRPC-SCL responded poorly to ARSI than those with AR, hence the need to find better therapeutic options. CRPC-SCL is driven by FOSL1, where genetic perturbation of FOSL1 in SCL models leads to reduced viability (Tang et al., 2022). FOSL1, a component of AP-1, could be playing an oncogenic role (Xiong et al., 2022). Previous studies have also shown that ERK (extracellular-signal-regulated kinase) regulates FOS levels (Figure 1c) (Caunt, 2015). Based on this observation, I hypothesized that FOSL1 is also regulated by ERK in prostate cancer. To test this hypothesis, I decided to evaluate the effects of ERK inhibitors on FOSL1 and the viability of a panel of prostate cancer cell lines and organoid models. Here, I uncovered that ERK inhibition using small molecules leads to suppression of FOSL1 and decreased viability in CRPC-SCL models. These data suggest that targeting the MAPK-ERK signaling pathway serves as a potential therapeutic strategy for stem cell-like prostate cancer.

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Photodynamic Therapy in Alzheimer's Disease: Adjusting the Strength of Radicals Using Nanoparticles

Hanna You

ABSTRACT

Photodynamic therapy (PDT) is a promising technique as a treatment for Alzheimer's disease, focusing on the use of photosensitizers to produce reactive oxygen species (ROS) to break down toxic brain aggregates like amyloid-beta plaques. Effective Alzheimer's photosensitizers must generate ROS efficiently and be biocompatible.

In this paper, functionalization of fullerenes, such as hydroxylation or carboxylation, was performed to reduce the cytotoxicity and improve the biocompatibility of the fullerenes when they enter cells through passive diffusion and endocytosis. Fullerenes, carbon-based molecules, are suitable for PDT due to their ROS production upon light exposure. Modifications like hydroxylation make them more biocompatible and can cross biological barriers into brain tissue. Porphyrins and Phthalocyanines are also ROS generators activated by red and near-infrared light, making them highly photostable and suited for repeat sessions. These photosensitizers show promise in Alzheimer's treatment through PDT, with researchers working to enhance targeting, stability, and biocompatibility for optimized outcomes.

In this paper, these molecules are modeled and investigated their physico-chemical properties using computational simulations. We observed an energy transfer between the fullerene and porphyrin molecules.

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The Effect of Age on Short-Term Memory: In-Person and Online

Grace Kuriakose

ABSTRACT

Memory is in the hippocampus, the center for learning. With increasing age, the hippocampus has fewer neuronal connections leading to weaker memory. 65% of adults 65+ suffer with memory. 1% progress onto serious impairments. Previous studies suggest age hinders memory, however, it's not well understood how short-term memory assessment methods (i.e. in-person vs. online) varies across age. This study investigated whether age affected short-term memory in an in-person versus an online setting. This study gathered 10 individuals across three age groups, ages 12-15 (n=5), 42-52 (n=3), and 72-76 (n=2). To assess short-term memory, an in-person and online exam were conducted. The in-person exam was a matching game where 20 matching pairs were laid in front of participants. Participants had 20 seconds to memorize the card's location, until flipped over. The participants had to find the most pairs in 30 seconds. The online test analyzed working memory through remembering numbers. The 12-15 age group had an average of 3.7 cards remembered on the in-person exam, compared to averages of 2.1 and 2.7 cards from the middle and older groups, respectively. The 42-52 age group had an average of 100.3 on the online exam compared to averages of 94.6 and 66.5 points from the younger and older groups, respectively. These findings suggest younger people have better visual memory, but middle-aged people have better working memory. This data could lead to a better understanding of neurological conditions across all ages such as Dementia.

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