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With admiration for your commitment to knowledge and discovery,

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"Featured Article of the Current Volume"

18-Year Trends in Phytoplankton Blooms and Associated Physical Variables in New York and San Francisco Estuaries

[1]Sonia Hasko, [2]Alisha Ansari,
[1]Princeton University, [2]Columbia University

ABSTRACT

Phytoplankton is a critical producer in, but copious blooms can harm ecosystems through eutrophication. In northern urban estuaries, seasonal fluctuations in water properties encourage phytoplankton growth, leading to seasonal blooms. The current experiment analyzed phytoplankton growth in the urban estuaries bordering the NY-NJ coasts and the San Francisco region. Remotely-sensed [Chl-a], FLH, and SST data was gathered, spanning the years 2002 to 2020, whereas remotely-sensed salinity data was available from 2015 to 2020. Data composite medians were the primary form of data analysis. Spring blooms, autumn blooms, and seasonal SST and salinity trends were expected. The study found that median [Chl-a] confirmed known blooms and confirmed hurricanes' impacts on blooms, while FLH data raised questions regarding low measurements during months of known peak phytoplankton activity. Remote sensing limitations may have impacted data. The data indicated an overall decline in phytoplankton, but the relationships between FLH and [Chl-a] were weaker than expected ($r^2 = .184$ for NY; $r^2 = .254$ for SF). The greatest significant changes ($p<.05$) in Chl-a, FLH, and SST were only found in NY. Monthly SST values increased across the seasons in NY (0.04-2% per year) and SF (0.08-0.6% per year). High phytoplankton biomass was consistently found near coasts, highlighting the need for continued monitoring of NY bays and rivers and the SF Bay area.

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Managing Sleep and Recurring Dreams for Optimal Health: Neurobiology and Therapeutic Interventions

Dayeon Lee

ABSTRACT

The biological process of sleep exists as a complex system which alternates between Non-Rapid Eye Movement (NREM) and Rapid Eye Movement (REM) stages to achieve physical restoration and cognitive function and emotional control. The exact structure of sleep stages maintains health but remains highly susceptible to disruption from stress and medical conditions and lifestyle factors which produce substantial negative effects on well-being. It is interesting to study how disrupted sleep patterns create recurring dreams which appear as distinct oneiric experiences that contain symbolic content and link to psychological conflicts and anxiety and Post-Traumatic Stress Disorder (PTSD). The brain creates recurring dreams because it fails to process emotional memories correctly during REM sleep so it keeps showing distressing content. The author reviewed articles on neuroimaging and sleep science research to figure out the brain mechanisms which create sleep stages and dreams. Thereby, this paper tried to examine recurring dream themes through psychodynamic and cognitive-neuroscientific models to understand their psychological meaning. Finally, this paper assesses treatment methods with special emphasis on lucid dreaming as an effective method to treat nightmares. Also we discussed on findings from neuroscience and psychology and clinical practice to demonstrate that studying sleep and dreams requires multiple disciplines for developing effective treatments that boost emotional strength and mental wellness.

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Human Hepatic Liver Stellate Cells And Hepatocytes

Kate Bondarenko and Marta Melis

ABSTRACT

Vitamin A, not naturally produced by the body, undergoes a series of metabolic steps to become retinyl esters, which are then stored and activated in the liver. Before being stored as retinyl ester in HSCs (hepatic stellate cells), though, the liver receives retinol bound to chylomicrons from the intestine and transported through the blood.

It is known that retinol is first released in hepatocytes, but there is not a consensus on what reactions occur in hepatocytes and in HSCs. Mechanistically, the final product of retinol is retinoic acid (RA), the natural ligand for the retinoic acid receptors (RARα, β, and γ) that drive the transcription of target genes. In order to test what processes happen in HSCs and hepatocytes, gene expression of the RARs was tested in response to RA, and AC261066 (AC), a RARb2 agonist, using gel electrophoresis. It was reported that RARβ is essential to maintain lipid homeostasis, so this was tested in both stellate cells and hepatocytes using oleic and palmitic acids with dye-fold change, then quantified.

In addition, fibrosis-related genes were tested in stellate cells, because it is known that they produce scar tissue in the liver. Overall, RA did not affect the expression of the RARs in the HSCs and hepatocytes. For the lipid accumulation experiments, RA and AC were both extremely effective in reducing fat levels, especially in the hepatocytes. In conclusion, hepatocytes are more affected by RA and AC, especially

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Improving the Effectiveness of Neosporin on Escherichia coli by Supplementation with Resveratrol

Carissa Spencer

ABSTRACT

Approximately 95,000 cases of E. coli related food poisoning are reported in the U.S. each year. The purpose of this study is to improve the effectiveness of the antibiotic Neosporin against bacteria by supplementing it with the polyphenol resveratrol. There is a great deal of information about the impact of polyphenols on the function of topoisomerase and the development of resistance to standard antibiotics. However, there is very little research on the impact of the polyphenol resveratrol combined with the standard antibiotic, neosporin, on the growth of Escherichia coli. This study was designed to investigate the effect of the common antibiotic neosporin enhanced with the polyphenol resveratrol on Escherichia coli. This study was completed by combining the neosporin with resveratrol and examining the zones of inhibition versus the control (water) using a Kirby-Bauer assay. Two different trials were conducted over the course of 4 days. The results of the Kirby-Bauer assay showed that, as hypothesized, the neosporin and resveratrol combined had the largest zones of inhibition. Thus, this novel combination could be a promising new method to address antibiotic resistance.

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A Comparison Between Eugenia caryophyllata Extracted From Syzygium aromaticum Buds and Prepared Syzygium aromaticum Essential Oil on the Antimicrobial Resistance of Escherichia coli

Ronan Higgins

ABSTRACT

Pathogens that can develop resistance to antimicrobial treatments has become a phenomenon extensively recorded over the last few years. Pathogens including Escherichia coli are dangerous to humans and are capable of resisting a variety of treatments. Treatments using clove (Syzygium aromaticum) essential oil and eugenol extracted from clove buds have been shown to deactivate Escherichia coli strains and to prevent the development of antimicrobial resistance. As pathogens such as Escherichia coli have concerned the medical world, it is crucial to attempt to find the most effective treatment, a comparison on the performance of these two treatments would be beneficial in finding this. Samples of clove oil and eugenol were applied to antibiotic disks and placed in agar plates inoculated with Escherichia coli. Plates with ampicillin and no treatment were prepared as well. These plates were stored in an incubator and taken out once three days each, the areas of the zones of inhibition were recorded and their averages were calculated, visual observations were written down as well. The eugenol plate demonstrated dense Escherichia coli growth and small zones of inhibition while the essential oil plate featured sparse growth, this could suggest that clove essential oil is more capable of inhibiting Escherichia coli growth, though it was theorized that the oil may have been thin enough to diffuse across its plate.

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The Effect of Wood Ash on the Developmental Rate of Artemia salina

Katelyn Agtuca

ABSTRACT

Approximately 17 million animals die each year because of wildfires and those that survive are heavily affected by them. These fires release very fine ash particles into the air which are the most impactful on an animalâ€™s health, such as breathing. The effect of ash on freshwater plants was recently studied and showed the ash negatively impacted their development . There is a great deal of information on the negative impacts wildfires can directly have on terrestrial organisms. However, there is very minimal research on the effect ash has on the development of aquatic species such as Artemia salina, commonly known as brine shrimp. This study was designed to investigate the effect of frequent exposure to wildfire ash had on the developmental rate of Artemia salina. The brine shrimp were divided into four groups, control, and three experimental groups with ash concentrations of 25%, 50%, and 75%. All groups were evaluated for their development and survival and four pictures were taken of each separate group evaluation for 10 days over a 12 day period. The results concluded that exposure to ash had a negative impact on the development of the brine shrimp. These results support previous research performed using aquatic plants. Thus, this study shows it is important to consider the impact of wildfires on the aquatic ecosystem as well.

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The Effect of Allura red AC on the Motility and Regeneration Rate of Dugesia tigrina

Christie Lauren Arce

ABSTRACT

Red 40 dye has been banned in European countries due to rising health concerns. There is evidence that Red 40, also called Allura red AC, can cause hyperactivity in humans along with negatively affecting the colon and causing Early Onset Colorectal cancer in mice. This study aimed to investigate if doses of 0, 15, 30, and 60 microliters of Allura red AC can contribute to negative effects on the phototaxis rate and the rate of regeneration of Dugesia tigrina. It is hypothesized that if Allura red AC is fed to Dugesia tigrina then, it will increase motility, and slow the rate of regeneration. This study was performed using four groups of Dugesia tigrina with 0 µM, 0.125µM, 0.25µM, and 0.5µM of red 40 and measuring the length of the planaria, and the rate of movement of planaria over the course of 31 days. The results of this study show that an increase in Allura red AC exposure causes a decrease in the regeneration rate, an increase in phototaxis, and an increase in mortality. Future research suggests a conversion in dosage and/or form of dye (powder version). Also, recommendations for future research include using a different type of organism such as Drosophila melanogaster.

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Alleviating Mitochondrial Depolarization With Inhibition of mPTP in Catecholamine-Stimulated White Adipocytes

Serena Chen

ABSTRACT

Obesity, defined with a BMI ≥ 30.0 kg/m2, affects over 40% of U.S. adults. Although dieting or surgery are possible, majority of treatments have consequential side effects. Recent studies have found increased energy expenditure in white adipocytes via lipolysis of fat droplets that may lead to weight loss induced by catecholamines, which are neurotransmitters. However, it is associated with mitochondrial depolarization that is linked to apoptosis, causing lipotoxicity and further complications. Studies have found that curcumin, an antioxidant, can alleviate mitochondrial depolarization through the mitochondrial membrane permeability transition pore (mPTP), a transmembrane protein, but has not been studied in adipocytes. Therefore, this study investigated the role of mPTP opening in membrane depolarization and antioxidant properties of curcumin in catecholamine-stimulated white adipocytes. Preadipocytes isolated from C57Bl/6 wild type male mice were differentiated. Oxygen consumption rate (OCR) and normalized intensity measuring membrane potential were measured using seahorse assays and tetramethylrhodamine methyl ester (TMRM) dye imaging, respectively. Results revealed normalized intensity with addition of mPTP inhibitor cyclosporine A (CSA) was significantly higher than CL-316,243 Control ($p<0.05$), suggesting that inhibition of mPTP can alleviate membrane potential loss. However, addition of CSA still decreased mitochondrial membrane intensity, suggesting mPTP opening only plays a partial role in membrane depolarization. Results also found 24-hour curcumin pretreatment had significantly increased OCR at its peak compared to V Curcumin ($p<0.0001$), suggesting curcumin may increase energy expenditure. However, curcumin did not prevent mitochondrial dysfunction as observed with steady OCR decline.

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The Effect of Copper Sulfate on the Development and Mortality Rate of Artemia salina During and After Remediation

Alyson Vargas and Stephanie Rekas

ABSTRACT

As the world pushes towards net zero emissions, demand for metals and minerals has increased, prompting discussions regarding deep-sea mining to meet this need. Although there is a good understanding of the effect of copper and other metals found in sediment plumes produced by deep-sea mining on aquatic organisms, there is little research on the effect of sulfate copper exposure specifically on Artemia salina, once remediated from contaminated water. The problem being investigated is, to what extent is the development and mortality rate of Artemia salina affected by acute exposure to copper sulfate during and after remediation? This study hypothesized that if Artemia salina is exposed to copper sulfate, it would inhibit development and increase the mortality rate, even after remediation. This study was performed using three cultures of Artemia salina labeled “Control”, “Short Exposure”, and “Long Exposure”. The long-exposure group was exposed to 12.5 μM copper sulfate throughout the study, whereas the short-exposure group was remediated halfway through the study using a specialized net. Data was collected by recording the Artemia salina development stage and mortality rate every day for one week. In summary, the hypothesis was supported. Artemia salina exposed to copper sulfate displayed conspicuous retardation in the development and a notable escalation in mortality rates during and after remediation compared to the control group.

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Bridging the Gap for Alice: Charitable Organizations Acting Amid Rising Inflation and Further Solutions Using Artificial Intelligence

Nikhil Chepuri and Rishika Porandla

ABSTRACT

Nationwide, nearly 37.9 million U.S. households fall into the Asset Limited, Income Constrained, Employed (ALICE) population which consists of households making incomes above the Federal Poverty Line (FPL) but below the financially-secure ALICE Household Survival Budget, rendering them ineligible for numerous public assistance programs due to income thresholds. To bridge this gap, nonprofit organizations such as United Way and Feeding America are providing ALICE-tailored assistance programs. Through data collected from ALICE reports and U.S. Census data, comprehensive analysis has been conducted using the U.S. Bureau of Labor Statistics Data Retrieval Tools and the Federal Reserve Bank of Atlanta's Policy Rules Database to provide insight into the complications associated with the ALICE population. Further, this study conducts extensive analysis on data extracted from the "Integrated Public Use Microdata Series - Current Population Survey (IPUMS CPS) data repository using Microsoft Excel's "Pivottable" to quantify the impact of nonprofit organizations through the Household rasch food security score (FSRASCH) metric. As a result of these methods, a large gap – in terms of ALICE households benefitted – is evident, leading to aconclusion: inadequate access to information regarding assistance programs. Further, a working prototype was built using Yellow.ai's Orchestrator LLM to serve as a proof-of-concept.This study sheds light to the millions of ALICE households nationwide left without assistance from public programs and offers practical solutions with significant possible implications to enhance economic stability.

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The Effect of Thiolated GMO consumption on the Fecundity and Longevity of Drosophila melanogaster

Kenzie Albano and Saswati Bhattacharya

ABSTRACT

Genetically modified organisms (GMOs) have made a significant impact on our lives today. Most food products we consume have been genetically modified to enhance certain characteristics. This may include genes inserted to produce proteins that repel insects or enhance nutrient production in the food. Recently, yeast has become the newest organism to be genetically modified. This genetically modified yeast produces thiols, compounds that replace oxygen with sulfur. Thiols are present in industrial brewing and are highly aroma active. They are highly reactive even in low concentrations, making them extremely difficult to analyze thoroughly. However, GMOs, a recently developed technique, lack sufficient long-term research on potential human impacts due to the extended human lifespan. The EU has stringent guidelines on GMOs due to insufficient knowledge about their impact on human health. It is imperative to investigate potential effects of GM foods over generations. The purpose of this research was to determine whether consuming GM yeast would have any effect on fruit flies over several generations. Fruit flies are a model organism, sharing over 60% genetic similarity to humans. They were fed different concentrations of genetically modified yeast, and their reproduction rate and longevity were observed over three generations and compared to control groups. Eggs were counted and survival rates were calculated. The Cosmic Punch yeast (100% GMO) had the highest fecundity rate overall while the British Ale Yeast (Positive Control) had a higher rate of longevity. It was concluded that while the Cosmic Punch yeast enhances reproductive rates, the British Ale Yeast promotes greater survival in fruit flies.

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Impact of Fluctuations Between Mglur5 and Melatonin in Major Depressive Disorder (MDD)

Afnan Ali

ABSTRACT

Major Depressive Disorder (MDD) is a debilitative illness that severely impacts quality and duration of life, with neurologists and psychologists seeking remedies to this disease. Currently, past studies have found that metabotropic glutamate receptor subtype 5 (mGluR5) and melatonin have been implicated in depressive pathways; however, there is a lack of studies investigating the relationship between mGluR5 and melatonin in MDD pathogenesis. Thus, the objective of this study was to observe fluctuations in mGluR5 and melatonin levels in MDD pathogenesis. 67 patients were recruited for this study, after being screened to identify whether they meet the inclusion/exclusion criteria. Actigraphy monitors were used to identify the baseline circadian rhythms of the patients, with the patients entering the lab for a three night stay. During these three nights, PET scans, and melatonin extractions were performed. Melatonin levels exhibited fluctuations throughout the the three nights, with the levels primarily decreasing during the sleep deprivation period. However, the majority of participants did not exhibit significant differences between one another in melatonin level phase shifts. Additionally, mGluR5 levels were not significantly different among MDD participants, when compared to their control counterparts. Due to the non-significant differences between MDD and control groups for both factors, there was no significant liink observed between mGluR5 and melatonin levels in MDD vs control participants. Thus, results suggest that there is another underlying factor impacting MDD. Future applications include studying alternative pathways of MDD pathogenesis.

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Bistable Structures: The design and fabrication of a large-scale hygroscopic bistable sinusoidal arch structure with applications with autonomous environmental actuation

Chris Zhang

ABSTRACT

Bistable structures, structures with two distinct equilibrium states achieved via buckling-like deformations, are seen throughout engineering applications in shape-morphing and energy-harvesting systems. Typically actuated by mechanically induced snap-through buckling, sinusoidal arches, a unique geometry, can induce bistability when fixed or pinned. However, environmental actuation via heat and humidity has yet to be explored in the literature. While existing studies focus on designing and evaluating mechanically actuated small-scale bistable arch structures, this study focuses on designing and fabricating a large-scale bistable sinusoidal arch with structural programmability through a curling property in the compliant base, that possesses applications of environmental actuation through an effective fabrication method for structural uniformity and zero initial structural frustration. Two hygroscopic materials: balsa wood and white ash wood were explored for bending. Though only mechanical actuation was tested, the material selection suggests potential for environmental actuation, paving the way for environmentally triggered autonomous actuation. The fabrication procedure required a steaming vessel and sinusoidal mold to form the arch-like component. After testing, white ash wood proved superior due to its resistance to flexural failure. The structure was tested twice, with design adjustments made and tested via numerical and experimental simulations after the first trial revealed excessive stress concentrations in the base. A final design was proposed and demonstrated bistability, though the curling action in the base was minimal.

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