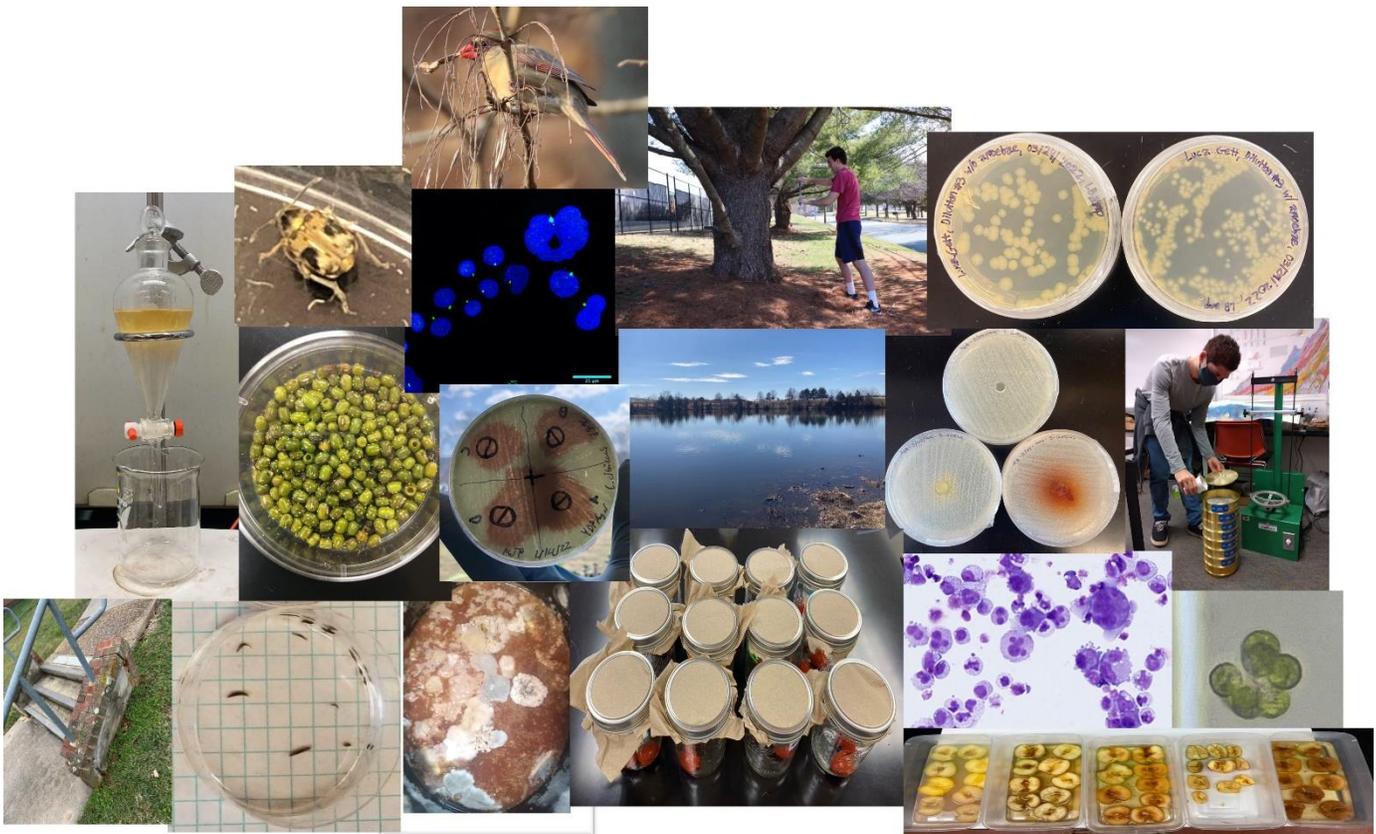


Spring 2022 Science Presentations

 *Science 299 independent research projects are semester-long independent research projects that students pursuing an A.S. in Science are required to complete prior to graduation. Students carry out their research under the guidance of a PVCC science faculty member as mentor. The Abstracts of projects completed in Spring 2022 are included in this booklet.*



Gordon Alexander– Geology 299

Applying lichenometry to the dating of PVCC campus surfaces

Determining the age of rocks is essential in geology as it allows scientists to construct timelines that inform scientific theories and discussions. There are many effective and reliable methods of dating; however, these trustworthy practices are not available in many regions where geologists conduct field work. One of these more field-methods is lichenometry. Lichenometry is the practice of employing lichens on a given surface to determine how long the surface has been exposed. Lichenometry is controversial because of the potentially wide margins of error when conducting lichenometry experiments, including the misidentification of lichen species, the true age of the control surface, as well as the unknown period between a surfaces' exposure and the point when a lichen anchors onto it. Despite this, the intention of this study was to establish a consistent rate of growth for *Flavoparmelia caperata*, or the common greenshield lichen, across different surfaces on Piedmont Virginia Community College (PVCC) campus. If a consistent rate of growth can be identified, then the rate of growth can be established to rock surfaces on campus to date their dates of exposure. Data was collected by measuring the diameter of the six largest lichens at each of the twenty-nine identified lichen-bearing sites between the canvas banners that were hanging in the campus parking lot, the PVCC Main Building and the Dickenson building. Additionally, these groups were delineated into subgroups based upon the cardinal direction in which they face to glean influence that facing, which effects daylight exposure, has on lichen growth. The calculated rates of growth, from largest to smallest were lichens on the banners, lichens from the Dickinson Building, and followed closely behind by those on the Main Building. On average, the lichens on the parking lot banners were much larger than those found elsewhere. With this in mind, as well as knowing that the banners are the youngest of all the included lichen-bearing surfaces, it is apparent that a consistent rate of growth between each of the surfaces would be unobtainable, although, there is vivid correlation between rate of growth from northern and western facing lichens found on the Dickenson (0.165 cm per year) and Main (0.15 cm per year) buildings. Despite this affirming relationship, these similar rates of growth are made null by the lack of correlation between any other surfaces.

Faculty Advisor: Mr. Callan Bentley

Brandon Bickley–Biology 299

The Effect of Antennae Removal on the Frequency of Oviposition on Occupied Seeds by *Callosobruchus maculatus* Females

Callosobruchus maculatus, commonly referred to as the bean beetle, is a pest of stored legumes. The female beetle lays her eggs on the surface of legumes and the hatched larvae burrow inside and use the seed as a food source during development. Bean beetle females have evolved to preferentially lay eggs on unoccupied beans to limit larval competition. With each egg laid, the female places a chemical marker that deters subsequent oviposition. Female bean beetles have been observed passing their antennae over beans prior to oviposition. Because insect antennae have tactile and chemoreceptive functions, it was hypothesized that clipping females' antennae would increase the frequency of

oviposition on occupied seeds by reducing the females' ability to recognize eggs. It was also hypothesized that the increased frequency of second eggs would reduce adult beetle emergence rates due to increased larval competition. Ten petri-dishes were filled with 150 green mung beans and one breeding-pair of beetles was added to each dish. Five of the breeding pairs had unclipped females and five had clipped females. The breeding pairs were kept on the beans for seven days then the number of beans with one and two eggs were counted. All beans were returned to their dishes and left for 28-35 days, after which emerged adults were counted. Of four unclipped females who laid any eggs, only one laid an egg on an occupied bean. All five clipped females laid at least one egg on an occupied bean. A Mann-Whitney U-test showed the difference in the frequency of second eggs for the unclipped and clipped groups to be significant at the 0.05 alpha level. No statistically significant difference was found between unclipped and clipped emergence rates. The results of this experiment support the hypothesis that clipping female bean beetles' antennae will increase the frequency of oviposition on occupied seeds. The results did not support the hypothesis that eggs laid by clipped females would have lower rates of adult emergence. Considering previous findings that second eggs have a lower survival rate it is possible that a decrease in emergence rates from eggs laid by clipped females would have been found with a larger sample size. Better understanding of the functions served by insect antennae in egg laying could reveal information useful for pest control and improving food security.

Faculty Advisor: Dr. Anne Allison

Valentin Burguener– Biology 299

Ascertaining Role of PLK4 in Megakaryocyte Morphogenesis via Centrosomal Inhibition

Megakaryocytes are polyploid cells that form platelets. Polyploid cells have more than one pair of homologous chromosomes. For megakaryocytes, the mechanism of polyploidization involves duplication of the centrosomes by PLK4 (Polo-Like-Kinase 4). Centrinone is an inhibitor of centrosomal amplification that was used in this experiment. The hypothesis is that centrinone will inhibit the megakaryocyte morphogenesis. During this experiment, light, IF and confocal microscopy as well as flow cytometry were used to examine megakaryocytes exposed to centrinone to determine its effects on polyploidization. The results indicated that at day 0 polyploidization was inhibited by centrinone. The cells were larger in size & more granular, but had less centrosomes. However, in the cells that were incubated on day 3, the cultures showed evidence of amplified polyploidization. The cells were not only larger and more granular, but they also had significantly more centrosomes. While the data gathered from day 0 incubations is in support of the hypothesis, the data gathered from day 3 incubations, while seemingly contradictory, suggests that the mechanism responsible for megakaryocyte morphogenesis cannot be explained using a single disrupted enzyme.

Faculty Advisor: Dr. Virginia York

Glenn Coleman– Geology 299

Virginia Pines Record a Dendrochronological Timescale for Albemarle County

As the glaring issue of climate change looms large over our planet, scientists have turned to dendrochronology. Dendrochronology is defined as the analysis of a tree's wood growth rings, to extract a natural record of a region's climatological history. A fuller understanding of the past better positions us to predict future change. At first, dendrochronology was conducted using saws, which are harmful to living trees. However in 1889, the introduction of the increment borer revolutionized the field, allowing dendrochronologists to extract a drinking straw-shaped sample of wood tissue with relative ease. This project's goal was to constrain the climatological history of Albemarle County through a dendrochronological study of tree rings of the Virginia Pine (*Pinus virginiana*). By collecting, preparing, and documenting the pattern of tree rings in multiple samples, I sought to establish a dendrochronological timescale. Using a chainsaw and increment borer, I took twelve samples from Virginia pines in six different locations across the county, and used the cross dating methodology to objectively compare the record of each tree through analysis of individual rings. Samples obtained with a chainsaw were sanded, while samples obtained with an increment borer were coated in white chalk to enhance the definition of the rings. Once the samples were prepared, I used the imaging software ImageJ to count and measure the rings of each sample. Patterns in the widths of wood ring growth changed over time. Prior to 1995, wood growth rings showed a pattern where for two years, the wood growth rings would show growth two standard deviations above average, and then the following year, would show growth around one standard deviation below average. This pattern was broadly reproduced across the sampled trees. For the next fifteen years, wood growth ring widths alternated year to year from being a standard deviation above and below average. The past decade at first showed consistent growth one to two standard deviations above average, and then for the second half of the decade, showed growth two to three standard deviations below average. A correlation test using Pearson's method showed very strong and positive correlation between trees, though there were numerous outliers, attributable to local perturbations in temperature or moisture - for instance, by a neighboring tree falling, exposing the sampled tree to more sunlight. Despite these idiosyncratic deviations from a common "script," the sampled population of trees showed a broad, statistically-validated agreement in recording regional climatic fluctuations over the past century.

Faculty Advisor: Mr. Callan Bentley

Brock Davis– Chemistry 299

Water Quality Analysis of Bodies of Water in Crozet, Virginia

Lakes are some of the most important, fertile, productive, and diverse ecosystems in the world. They provide nearly half of the global renewable freshwater and play a large role in the economic development of human welfare. The surface water of lakes generally contain municipal and industrial waste, agricultural runoffs, and weathering rocks. Lakes and ponds serve as a habitat for many species of fish and other aquatic organisms. The decline of the quality of water in our lakes not only poses major health risks for aquatic life, but also human health. Knowing the quality of water in our lakes

and ponds is important for the health of the environment and the prevention of diseases. In this experiment three bodies of water were tested in Crozet Virginia to evaluate water quality. The properties used to determine water quality were pH, dissolved oxygen, conductivity, turbidity, nitrates, and copper. If four out of the six determinants display good water quality, then the body of water is considered safe. Vernier sensors were used to gather information about the different bodies of water. Samples were collected from each water source. Dillard Pond had an average pH of 6.3, turbidity of 11.6 NTU, dissolved oxygen content of 20.0 mg/L, conductivity of 119.43 mg/L, nitrates of 10.0 ppm, and copper value of 0.83 ppm. The first lake had an average pH of 6.3, turbidity of 3.8 NTU, dissolved oxygen content of 18.7 mg/L, conductivity of 27.23 mg/L, nitrates of 6.67 ppm, and copper value of 0.33 ppm. Finally, the second lake had on average pH of 6.0, turbidity of 25.3 NTU, dissolved oxygen content of 18.8 mg/L, conductivity of 32.53 mg/L, nitrates of 6.67 ppm, and copper value of 0.0 ppm. All results fell within acceptable values. The data support my hypothesis as all three bodies of water are considered healthy.

Faculty Advisor: Dr. Frances Rees

Luca Gett– Biology 299

Amoeba proteus and the Development of Antimicrobial Resistance in *Shigella sonnei*

Shigella sonnei is a Gram-negative bacillus bacterial species and a causative agent of diarrhea. Worldwide, increases in economic development are reflected in a rise in the ratio of *Shigella sonnei* infections to infections caused by other members of the *Shigella* genus. There are many speculations for how *Shigella sonnei* is advantaged when faced with improved methods of water treatment and medical care. Among them is the commensal relationship between this bacterial species and *Acanthamoeba castellanii*, a species of freshwater amoeba. One way in which *Shigella sonnei* is supposedly benefited by this relationship is by the accelerated development of antimicrobial resistance through access to a genetic reservoir inside of the amoeba. This research project sought to explore any similar relationship between *Shigella sonnei* and *Amoeba proteus*, another species of freshwater amoeba. It was hypothesized that *Shigella sonnei* would see increased resistance in the presence of these amoebae. To test this, ampicillin-resistant *Escherichia coli* and non-resistant *Shigella sonnei* broth cultures were grown before being combined in a specialized saline solution. One coculture contained only the mixed bacteria, while live *Amoeba proteus* were added to the other. The cocultures were incubated and plated on ampicillin-infused Luria-Bertani agar. A sample of fifty resulting colonies were taken from each plate and differentiated using catalase testing. This differentiating test determines the presence of the catalase enzyme, an enzyme produced by some bacterial species that degrades superoxidative agents. Plates inoculated with the coculture containing the amoebae presented more colonies overall. It was found that resistant *Shigella sonnei* colonies were present on plates made from both cocultures. However, the coculture containing the amoebae presented more of these colonies, with the difference being statistically significant ($p = 0.03$). There was additional evidence suggesting that the bacteria were phagocytized by the amoebae. The results showed that *Shigella sonnei* was able to develop antimicrobial resistance more readily in the presence of the *Amoeba proteus*. These findings supported a hypothesized relationship between this bacterial and freshwater-dwelling amoebic species. This research project demonstrated the existence of just one of many ways in which *Shigella sonnei* can outcompete other members of the *Shigella* genus when faced with the improved sanitation that comes with economic development.

Faculty Advisor: Dr. Marlana Yost

Emma Glover– Biology 299

Comparison of Sweetgrass oil and Pyrethrin Spray effectiveness upon Wingless Fruit Flies

Chemical pesticides are used all over the world on our plants and produce. However, these chemical pesticides have warning labels on them about the dangers of ingestion, inhalation and skin contact. A new repellent is needed that has the same efficiency as a chemical pesticide but without the harmful effects. Native Americans, such as the Flatheads and Blackfoot, used sweetgrass fumes to repel flying insects. Sweetgrass was also used for medicinal purposes and has no harmful effects. Pyrethrin spray, a widely used pesticide, was used to test the efficiency of sweetgrass oil. If sweetgrass oil was an effective repellent by Native Americans, then it should be an effective and preferred repellent over pyrethrin spray on fruit flies when applied to grape tomatoes. The sweetgrass oil was tested against pyrethrin spray and water, the control, on organic grape tomatoes. The grape tomatoes were sponged with their assigned liquid and placed into jars with 10 fruit flies (*D. melanogaster*) of each sex. The jars were covered, and the number of dead fruit flies was tracked and counted every day. Sweetgrass oil followed the same pattern of death as pyrethrin spray. To ensure that age was not a disrupting factor, old and young fruit flies were tested, and no difference was found. To attain even more precise treatment effects, the interval was changed to every 10 minutes. Sweetgrass oil again followed pyrethrin spray in this third run. It was determined that sweetgrass oil could be a sustainable substitute for pyrethrin spray. With this conclusion, instead of using harmful chemical pesticides on our plants and produce, using natural repellents like sweetgrass oil could be an effective and safe alternative.

Faculty Advisor: Dr. Donna Hoefner

Cory Greene– Geology 299

Changes in the Proportion of Magnetic Sediment Along the Upper Moormans River, Virginia

The Moormans River flows principally across a single bedrock unit, the Neoproterozoic greenstone of the Catocin Formation where magnetic detrital magnetite is a primary accessory mineral. Large quantities of magnetite can be found in the sediments of the Rivanna River of which the Moormans is a tributary. In stream water, magnetic oxides undergo hydrolysis and form goethite (rust), which is not as magnetic, potentially decreasing magnetic river content downstream. Magnetite is the most magnetic of all minerals and denser than most common Virginia minerals. Heavy minerals settle more quickly out of river currents and bars onto placers in river bottoms compared to lighter weight minerals in sand like quartz or feldspar. This study quantifies magnetic fraction of sediment from the Upper Moormans River; explores the relationship between sediment sample position along the length of the stream and the magnetic fraction of sediment collected there; and determines if this relationship varies by sediment size.

It was hypothesized that magnetically susceptible fraction of the sediment would be higher in

upriver samples compared to downriver samples and that there would be more magnetically susceptible pebble fraction of the sediment in upriver samples compared to downriver samples. Ten, one-cup sediment samples were collected from sand pockets of the North Fork Moormans River streambed beginning four miles above Sugar Hollow Trailhead. Samples were air-dried then sieved and separated into eight particle size categories. A neodymium disc magnet was used to extract magnetic sediment. As expected, samples contained significant quantities of magnetic sediment. Contrary to expected results, the proportion of magnetic sediment was greater downstream, specifically in larger to medium-sized sands. Among sands, larger sands have the potential for more magnetic crystals than smaller sands, silt and clay, which may lose more magnetic grains through oxidation caused by the weathering process. While pebbles have even more magnetic potential due to their volumetrically unweathered interior, there were more pebbles overall in the upstream samples than downstream. Pebbles may drop out of currents more quickly due to heavier weight compared to smaller sediments. Size of sediment may be a greater factor than magnetic content in causing sediment to drop out of river currents. Further study is needed.

Faculty Advisor: Mr. Callan Bentley

Samuel Hess– Biology 299

Prompted Formation of Colonies by Unicellular Algae

Understanding the genesis of multicellular life is a key component of gaining insight into how individual cells stick together, collaborate, and specialize which has broad implications in biology. This study was conducted to investigate the link between colony formation in the Volvocine family of spherical green algae and how pressure from a predator may affect their rates of being single cellular or in a colony form. The Volvocine family include two of the species tested, *Chlamydomonas reinhardtii* and *Eudorina elegans* which vary in complexity with *C. reinhardtii* being viewed as mainly remaining in a single celled form while *E. elegans* has been seen to form colonies of up to 64 cells. These species of algae were tested separately using *Daphnia magna* as the predator. These are small planktonic crustaceans which use green algae as a food source. Trials were completed by placing a sample of the species of algae with multiple *D. magna* in a covered beaker under natural sunlight for 24-hour intervals. Data collection was then performed using a light microscope to count the instances of single cells versus colonies of four or more cells in organized groups. The results for the experimental group following the 24-hour interval showed an increase in the colony count for *E. elegans* but little to no colony formation was observed with *C. reinhardtii*. This experiment illustrates a repeatable method for inducing colony formation in *E. elegans* which can be expanded on to investigate the same effect in other species of the plant adjacent protists as well as the long-term effects of colony formation.

Faculty Advisor: Dr. Anne Allison

Sarah Johnson– Biology 299

Kitchen Nightmare: The Efficacy of Cleaning Chemicals on Countertop Samples and *Pseudomonas aeruginosa* Biofilms

Interest in green cleaning products (GPCs) has been growing over the past several years. Consumers are moving away from conventional cleaners, seen as potentially dangerous or bad for the environment. Despite this growing market, these products have not been extensively studied. This two-pronged experiment sought to examine the antimicrobial properties of several common household cleaners: Granite Gold (a conventional store-bought cleaner), Method All-Purpose (a store-bought GPC), and a homemade cleaner. I hypothesized the commercial cleaner (Granite Gold) would demonstrate greater antimicrobial properties. This experiment looked at cleaners both on dry surfaces of countertops and on biofilms. For the countertop portion of the experiment, Dawn and water was also tested. First, a pair of countertop samples—one quartz and one granite—was exposed to kitchen hazards for one week. The countertop samples were swabbed for microbes before and after cleaning and the results compared. The cleaners were sprayed onto the countertop and immediately wiped away according to the instructions of the substances. Only two cleaners, Dawn and Granite Gold, demonstrated a reduction in number of colony forming units (CFUs). All other cleans resulted in an overall increase; however, only Dawn's results were statistically significant when compared to the control alone. For the biofilm portion of the experiment, *Pseudomonas aeruginosa* was grown in a nutrient broth with glass slides inserted to allow the bacteria a surface to cling to. After that, the slides with the biofilm were exposed to their respective test substance and were stained. Using a spectrometer, the absorbance of both the broth and the de-stain were taken and compared. Every substance, including the control, demonstrated a reduction in biofilm. The differences between the results were not statistically significant. Therefore, it was not possible to say one product outperformed another; future research is needed to determine the efficacy of these products. There were many factors which may have contributed to the results, including the low exposure time and the variety of organisms present on the countertop samples. Increasing exposure time and focusing on a specific organism would help clarify the results found in this experiment.

Faculty Advisor: Dr. Marlena Yost

Marcus McCrea– Biology 299

The Effect of L-Ascorbic Acid, Caffeine, and Vitamin A Acetate on Planaria Regeneration Rate

Planaria are flatworms of the Class Turbellaria. They are known for their incredible regenerative capabilities. Even when divided into over 200 tiny pieces, each piece can fully regenerate into a whole organism. This incredible regenerative capability is due to the Planarian stem cell system. Planaria have an abundance of stem cells called neoblasts in their bodies, which allows for rapid cell differentiation. In connection with cell growth, L-Ascorbic Acid and Vitamin A Acetate are two vitamins vital to human cell health and growth. Additionally, Caffeine has been observed to aid in the regeneration rate of planaria. Therefore, it is hypothesized that L-Ascorbic Acid, Caffeine, and

Vitamin A Acetate will aid in the regeneration rate of planaria when compared to a control of Spring Water. To test this, three different solutions were prepared, one for each substance. The planaria were cut just below the head, and the bodies were placed in four different petri dishes of spring water, 15 planaria for each. Small amounts of the solutions were individually added to three out of four of these dishes, leaving the fourth dish with only Spring Water as a control. The planaria were monitored for the next two weeks, with pictures being taken and measurements taken using the ImageJ software. Spring Water had the greatest positive effect on growth rate, followed by Caffeine, then L-Ascorbic Acid, and lastly Vitamin A Acetate. This is contrary to the original hypothesis, as all three substances performed worse than Spring Water. From these results, it is possible to conclude that at a 10 micromolar concentration, L-ascorbic Acid and Vitamin A Acetate are detrimental to the regeneration rate of planaria. It is possible that these concentrations are too high, or that these substances are toxic to planaria. It is also possible that these results are due to measurement errors. While Caffeine has been observed to increase the regeneration rate of planaria, it is possible that L-Ascorbic Acid and Vitamin A Acetate, while vital to humans, may not necessarily benefit planaria in the same way, particularly at these concentrations. More trials testing different concentrations of these substances and minimizing outside interference and errors would be required to make more definitive conclusions.

Faculty Advisor: Dr. Donna Hoefner

Lucas McNamara– Chemistry 299

Extraction and Determination of Caffeine from Tea Varietals of *Camellia sinensis*

The stimulating effects of caffeine, an alkaloid, make it one of the most globally consumed psychoactive drugs, mainly through tea. While it is commonly thought that caffeine content varies depending on the tea varietal's oxidation process, evidence suggests that brewing conditions such as steep time and temperature are the driving factors behind different caffeine concentrations. In this experiment, caffeine from samples of oolong and black tea varietals from *Camellia sinensis* were extracted under the same conditions to determine if a difference in caffeine content was due to the oxidation process or differing brewing conditions. It was hypothesized that if brewed under the same conditions, the caffeine content of the black and oolong samples be statistically similar. The samples first underwent a solid-liquid extraction at 100°C for 10 minutes in 100mL of water and 2 g of sodium carbonate. The extracted samples were then partitioned using dichloromethane. The dichloromethane layer was dried using sodium sulfate and boiled with petroleum ether to form a caffeine precipitate. The extracted caffeine was weighed, and a melting temperature analysis was performed to verify the solid as caffeine. The experiment produced an average extracted caffeine concentration of 0.0072 g per gram of black tea leaf and 0.0067 g per gram of oolong tea leaf. The melting temperature ranges varied from 231.8-238.7°C, characteristic literature values for caffeine. After statistical analysis, no significant differences in caffeine content between the two varietals when extracted under the same conditions were found, supporting the null hypothesis. Further experimentation on other varietals, such as white or green teas, is necessary to determine if conclusions hold for all varietals from *C. sinensis*.

Faculty Advisor: Dr. Frances Rees

McKenzie Moore– Biology 299

The Medicinal Effects of Onion tested on *Klebsiella pneumoniae* & *Staphylococcus aureus*

Antibiotics, also known as chemotherapeutic agents, have not shown to be successful in fighting off all mutated forms of bacteria. While many individuals rely on antibiotics to fight off infections/diseases caused by bacteria, some still rely on more natural remedies (Shaheen, G., et al., 2019). *Allium cepa*, more commonly known as onions, are known to have many active components which aid in the killing or slowing the growth of bacteria. For example, two components found in onions that aid in this impact are quercetin, which is found in the dry skin of onions, and allicin, which is a chemical produced when an onion is cut (Ciardi, et al., 2021). It was hypothesized that the medicinal effects of the onion would have a greater impact on *S. aureus* compared to *K. pneumoniae* because it is smaller in size and its lack of an outer membrane. These effects were tested in both a liquid broth tube as well as on agar plates. The bacteria were exposed to 1 mL and 3 mL of onion extract within a broth tube for 24 hours and growth was then measured using spectrophotometry. For the plate experiment, the bacteria was tested against both the dry skin as well as a piece of raw onion using a modified Kirby Bauer method. Results showed that the onion had a much larger effect on *S. aureus* than on *K. pneumoniae* in both tests. They also showed that a greater concentration of onion extract had a larger effect on *S. aureus*; however, the 1 mL concentration had a larger effect on *K. pneumoniae*. Based on the p-values, there is sufficient evidence to support the claim that onion is effective in killing/slowing the growth of *K. pneumoniae* and *S. aureus*. These findings also support the initial hypothesis that the medicinal effects of the onion would have a greater impact on *S. aureus* than *K. pneumoniae*.

Faculty Advisor: Dr. Melinda Clark

Milo Penzell– Biology 299

Interactions between a pathogenic fungus, *Candida albicans*, and a bacterium, *Pseudomonas aeruginosa*.

Polymicrobial infections cause significant harm to an individual by complicating infections and prolonging therapies. *Candida albicans* is a fungal opportunistic pathogen and *Pseudomonas aeruginosa* is a bacterial opportunistic pathogen; both are part of normal human microflora. In studies, they have been shown to form biofilm together and hyphal *C. albicans* cell death occurs when *P. aeruginosa* is present. This study observes if *P. aeruginosa* will inhibit hyphal *C. albicans* growth in a dual cultural agar medium and if *P. aeruginosa* will limit *C. albicans* biofilm forming ability. This study incorporated the use of a dual-culture agar assay where 4 drops of *P. aeruginosa* culture were placed on *C. albicans*-lawned agar plates and observed for zones of inhibition after incubation. This study also incorporated the use of a coverslip-biofilm formation analysis in which glass coverslips were suspended in a liquid broth inoculated with *P. aeruginosa* and *C. albicans*. After 24h and 69h, samples of both were measured for absorbance at 600nm and the coverslips were stained with crystal

violet and destained with gram destainer which was then measured for absorbance at 580nm. The ratio of these two values was used to determine the biofilm formation of these cultures. There were no fungal zones of inhibition observed in my dual-culture assay yet, larger zones of bacterial growth were observed with full concentration bacterial compared to 1:10 diluted culture. The linear analysis of the biofilm formation showed that the mixed cultures as well as the *P. aeruginosa* showed peak biofilm development at 24h with a decrease at 69h. In contrast, *C. albicans* had zero biofilm development at 24h with only marginally more at 69h. My results did not support my hypothesis as there were no zones of inhibition apparent and it's unclear whether the bacteria reduced fungal cell biofilm formation. The biofilm analysis, although shedding light on the different growth patterns of the mixed cultures compared to the controls, was inconclusive as far as how introducing them together may cause any cell death. Although these experiments did not replicate the inhibition of *C. albicans* observed in other studies, they were insightful in demonstrating that the conditions which may lead to this phenomenon are narrow and have large ties to time and yeast/hyphal cell type.

Faculty Advisor: Dr. Melinda Clark

Najla Rashedi– Chemistry 299

Evaluation of Browning of Apple Slices with Color Analysis Lite App

Fruits and vegetables are the important components of daily diet. Browning of fruits and vegetables is a problem because it can negatively affect the color, taste, and nutrition value of the food. Therefore, it is important to protect fruits and vegetables from turning brown and prevent food waste. Browning can be a challenge in food products during the preparation, processing or storage of foods. Browning in foods can be divided into two types: enzymatic browning and non-enzymatic browning. Enzymatic browning in the chopped fruits is related to polyphenol oxidases enzyme (PPO). When we cut fruits such as bananas and apples, PPO enzyme in the fruit is exposed to oxygen and changes the color of the fruit into brown (commonly called “browning”). There are various chemical methods available for preventing enzymatic browning reactions and evaluating the degree of browning. However, in this research project, some inexpensive materials such as lemon juice (citric acid), baking soda (sodium hydrogen carbonate), and vinegar (acetic acid) were used to evaluate browning activity in freshly cut apple slices stored in the refrigerator at 4°C. Three different types of apples Granny, Opal, and Washington were used. Percent browning was determined every 2 days using the images taken by smartphone and *Color Analysis Lite* app. Commercially available light box was used to maintain the consistency in lighting conditions while taking images. The results showed that lemon juice was the most effective at preventing browning in apple slices. It could be due to the chelating effect of ascorbic acid (commonly known as vitamin C) present in lemon juice. Future studies may include the replacement of oxygen with nitrogen or carbon dioxide gas and analytical detection methods such as spectrophotometry.

Faculty Advisor: Dr. Harish Subedi

Ezra Staengl– Biology 299

Comparison of Northern Cardinal Diet between an Urban and a Rural Park in Central Virginia

Northern cardinals (*Cardinalis cardinalis*) are generally more abundant in cities than surrounding rural areas. The causes of this discrepancy are unknown, but diet may be an important factor. Cardinals are omnivorous but are known to consume mostly plant material during the winter, including the seeds of common native trees and shrubs such as tuliptree (*Liriodendron tulipifera*), wild grape (*Vitis sp.*), dogwood (*Cornus sp.*) and sumac (*Rhus sp.*). I investigated cardinal diet at an urban site (Greenbrier Park, 38.064057, -78.475611) and a rural site (Walnut Creek Park, 37.929144, -78.590378) in Central Virginia during the late winter period between February and March. I expected to see a difference in diet between the two sites in accordance with the hypothesis that differences in diet may be partly responsible for the urban vs. rural abundance disparity. Furthermore, I expected the urban birds to eat more nonnative plant material because cities generally have greater variety and higher densities of nonnative plants. I expected no difference between the diets of male and female cardinals. Diet observations were made in ten-minute intervals, during which I watched a cardinal and recorded everything it ate. Sixteen ten-minute observation sessions were conducted at each site, split evenly between male and female cardinals. Cardinals ate significantly more nonnative plant material at the urban site than at the rural site ($X^2(1, N = 256) = 28.00, p < 0.001$). Additionally, the diets of male and female northern cardinals did not differ ($X^2(4, N = 257) = 4.43, p = 0.35$). Diet consisted almost entirely of plants, most frequently tuliptree (*Liriodendron tulipifera*) at both sites. Other than tuliptree and wild grape, there was very little overlap in diet composition between the sites. The results are consistent with the hypothesis that differences in diet (specifically nonnative plants) may be a factor contributing to cardinals' larger urban populations. However, the data do not indicate a causal link. More broadly, this study corroborates previous findings about the importance of plant material to cardinals' winter diet and provides a list of important local winter food sources, as well as information about urban vs. rural diet differences.

Faculty Advisor: Dr. Joanna Vondrasek

Ryan Thacker– Biology 299

The Effects of Creatine Anhydrous on the Movement of *Callosobruchus maculatus*

Supplemental creatine has become a major supplement for gym enthusiasts and athletes around the world over the past decade. Creatine phosphate is an important molecule in the production of ATP, keeping energy levels high in the muscle temporarily until aerobic respiration can predominate. Although it has been deemed safe for human consumption, does supplemental creatine really enhance athletic performance? To answer this question, I tested the effects of varying levels of creatine on *Callosobruchus maculatus*. *C. maculatus*, better known as the bean beetle, is a common pest in parts of Africa and Asia. Cultured on cowpeas, bean beetles were divided into three groups, exposed to different concentrations of creatine. Groups A and B showed significantly more movement in the first two days of testing compared to the beetles that had no creatine exposure. However, by the last day of testing, my results showed no difference between the groups. This suggests that while creatine phosphate may contribute to increased movement initially, its effects are short-lived.

Faculty Advisor: Dr. Virginia York

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Joshua Sprouse (Biology)

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