

MARIAN UNIVERSITY
— Indianapolis —



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SENIOR DIVISION

PROJECT LISTING

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Animal Sciences (AS)

GRADE 9

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GRADE 10

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GRADE 11

Alhaffar, Omar (AS)

Behavioral Effects of Ethanol and Folic Acid on Epilepsy and Fetal Alcohol Syndrome Model Zebrafish

"Fetal alcohol spectrum disorder (FASD) is a range of conditions resulting from the consumption of alcohol by mothers during their pregnancy. These conditions are typically lifelong physical, mental, behavioral, and learning issues. Epilepsy is a disorder in which nerves within the brain are disturbed causing seizures. Some FASD patients display epilepsy. These conditions are not curable. Retinoic acid and folic acid have been found to rescue a variety of ethanol-induced defects, like retinal photoreceptor and ganglion cell differentiation defects. The present study uses zebrafish as a model and employs folic acid as a treatment for motor movement irregularities. Embryos were treated at 2 hours post-fertilization (hpf) until 24 hpf with one of four solutions: 50 mM ethanol, 75 μ M folic acid, both 50 mM ethanol and 75 μ M folic acid, and control (embryo medium without additions). Each of the four groups were equal in numbers of embryos. Behavior assays were used to measure larval movement at 7 days post-fertilization. One assay used pentylentetrazole (PTZ), a circulatory and respiratory stimulant, to examine convulsive behavior, which models epilepsy seen in some FASD patients. Our results indicate that folic acid partially rescued the effect of embryonic ethanol treatment."

Raje, Kalika (AS)

Sheep-Eating Blowflies: What makes them different? (Part 2)

"Parasites are a common and consistent threat to a variety of agricultural industries, despite the development of new control techniques. This trend is extremely apparent in countries such as Australia and

South Africa - e.g., one such threat costs the sheep-related industries in Australia approximately \$280 million annually (JURD 2015). This specific threat is caused by the prevalence of parasitic sheep blowflies, and the associated flystrike risk in Australia. Flystrike is the infestation of an animal with blowfly maggots. Sheep blowflies, in within the US, normally consume and colonize only dead sheep matter. However, it has been recently observed is that while the domestic (e.g., in US) flies only harvest and lay eggs on dead carcasses, the international variety (e.g., in Australia) is acting as parasites on living sheep. As indicated by the aforementioned statistic, this issue has significant economic repercussions internationally. This behavior leads to two underlying scientific questions: a) what is the cause behind the behavioral difference between the domestic and international flies? and b) how could that understanding be used reduce the economic devastation caused by these flystrikes? To answer these questions, I wanted to investigate the cellular mechanism associated with the odor reception and identify if there are any fundamental differences between these two fly species. I also wanted to quantify these differences, if present. My research hypothesis is that there would be statistically significant genetic differentiation between the different fly-groups with respect to the odor receptor genes and associated protein sequences that contributes to the behavioral (parasitic vs. non-parasitic) difference. By analyzing the genetic differences between the odor receptor genes of these two fly groups, it could provide information about whether odor reception plays a role in this behavioral difference and if so, to what extent. Furthermore, this information could be applicable to assisting the search for better treatment methods, as well as establishing whether research needs to be done to evaluate the genetic difference between these two groups in different areas (e.g., vision).

To test my hypothesis, beyond my past research, the following methodology was used. A new odor receptor gene was identified. For this new odor receptor gene, the predicted protein sequences were computed using a tool called Augustus. After saving these sequences, two forms of analyses were completed. First, a visual alignment was created using the Clustal Omega tool between all the new

sequences (like last year). Then two different types of quantitative analyses were performed both on the new group of sequences (for one specific odor gene - group 2) as well as last year's group of sequences (for a different odor gene - group 1). Sequences within the same groups were compared against each other, first with local alignment scoring, and then with global alignment scoring. These scores and their similarity percentages were saved to analyze the extent of the similarities and differences between these groups. Preliminary analysis of the data affirm the conclusions made from last year's visual alignments for group 1 - considering the large similarity between nearly all the sequences, there does not appear to be a significant genetic difference between the parasitic and nonparasitic groups. The preliminary analysis of group 2 indicated that while there were considerable differences between parasitic and nonparasitic sequences, these results are not considered to be statistically significant. The reason for this inference is that even inside a group (e.g., parasitic) there are significant variations between protein sequences. Additional analysis are needed for confirming these results. "

GRADE 12

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Behavioral and Social Sciences (BE)

GRADE 9

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GRADE 10

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GRADE 11

Gao, Nicholas (BE)

Developing innovative MCB factor to diagnose financial market sentiments under Fama-French Asset Pricing Models

"Since the introduction of VIX to measure the spot volatility in the stock market, VIX and its futures have been widely considered to the standard of underlying financial market sentiment. This study examines how

the magnitude of contango or backwardation (MCB volatility risk factor) derived from VIX and VIX3M may proxy the financial market sentiments and affect the pricing of assets. The research focuses on the statistical inference of three defined MCB risk factors cross examined with Fama-French's five factors, i.e., the market factor $R_m - R_f$, the size factor SMB, the value factor HML, the profitability factor RMW, and the investing factor CMA. Robustness checks are performed with the revised HML-Dev factor, as well as with daily datasets. The inclusions of the MCB sentimental risk factor, either defined as a spread of monthly VIX3M/VIX and its monthly MA(20), or as a monthly net return of VIX3M/VIX, generally enhance the explanatory power of all factors in the Fama and French's model, in particular the market factor $R_m - R_f$ and value factor HML, and the investing factor CMA also displays a significant and positive correlation with the MCB risk factor. When the more in-time adjusted HML-Dev factor, suggested by Asness (2014), replaces the original HML factor, results are generally better and more intuitive, e.g., higher R2 with the market factor, and more explanatory power with HML-Dev. This research introduces the term structure of VIX to Fama-French's Asset Pricing Model. The MCB sentimental risk factor identifies underlying configurations of investor sentiment. The sensitivities to this timing indicator will significantly relate to returns across individual stocks or portfolios."

GRADE 12

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Biochemistry (BI)

GRADE 9

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GRADE 10

Won, Jinhee (BI)

Investigating Neurofibromin - Fbxo3 interactions in live cells using NanoBIT Technology

"Neurofibromatosis type 1 (NF1) is one of the most prevalent dominantly inherited diseases. It occurs in approximately 1 in 3000 people. NF1 encodes a tumor

suppressor whose functional loss results in the development of neurofibromas, or benign tumors that may progress to malignancy. NF1 is characterized by a haploin sufficiency of neurofibromin. However, little is known about the degradation pathways of neurofibromin. A previous experiment identified Fbxo3 as a possible candidate to mediate the ubiquitin-proteasome pathway (UPP) for neurofibromin. Fbxo3 is the recognizing subunit of the SCF-E3 complex. Thus, we investigate the interaction between Fbxo3 and neurofibromin. In neurofibromin, there are splicing isoforms with two suspected different binding sites of Fbxo3, Gap Related Domain 1 (GRD1) and Gap Related Domain 2 (GRD2). We demonstrate that Fbxo3 directly interacts with both gap domains of neurofibromin in live cells. This project implicates that Fbxo3 in SCF-type E3 ligase mediates the recognition of neurofibromin to cause polyubiquitination and degradation of neurofibromin."

Berger Romeu, Pol (BI)

Powering the Rotation of the F₀ motor in F₁F₀ ATP Synthase with UV Light

"F₁F₀ ATP Synthase is the main source of ATP in all living organisms. ATP Synthase is made up of the F₁ motor and the F₀ motor. Although it is known that the rotation of the F₀ motor is responsible for the rotation of the F₁ motor, it is not known for certain what powers the rotation of the F₀ motor. After reading papers about the structure and function of F₁F₀ ATP Synthase, I found a paper on how temperature impacts ATP Synthase and how light impacts ATP Synthase. This led me to believe that I could produce the same effect with UV light leading to my research question: Can I use UV light to power the rotation of the F₀ motor in F₁F₀ ATP Synthase? In order to answer this question, I will build a chamber out of plexiglass that has a small hole in the center which allows me to create an artificial membrane in the chamber. I then will isolate mitochondria from spinach leaves and isolate the inner mitochondrial membrane. Then I will use detergents to get the F₁F₀ ATP Synthase out of the membrane. I then I will place the ATP Synthase into liposomes made of the same phospholipids as the inner mitochondrial membrane. These liposomes will then be placed into the artificial membrane which will make the proteins all go in the same uniform direction. In order to make the ATP

Synthase work, I will perfuse solutions into both sides of the membrane using syringe pumps, one solution with a high pH, and one with a lower pH. This will create a proton gradient across the membrane. I will then use the electrodes in the chamber to put a voltage across the membrane and balance out the chemical potential. This should make the ATP Synthase stop moving as there will no longer be a current across the membrane. Then, I will hit the side of the artificial membrane with the F₀ motors with UV light (266nm) from a UV light source. I will measure the current across the membrane after the light is shined on the membrane. This will allow me to determine if UV light can power the rotation of the F₀ motor of the F₁F₀ ATP Synthase. This will also allow me to try and find a way to see the rotation of the F₁F₀ ATP Synthase optically. With this research, I hope to prove that I can power the rotation of the F₀ motor in F₁F₀ ATP Synthase using UV light. This research is important as it allows us to understand the mechanism that moves one of the most important proteins in our body better. My research has several future applications. If I find that UV light can power the rotation of F₁F₀ ATP Synthase, further research can be done to see what the light is doing to the F₀ motor, causing it to rotate. If we understand the reason that the F₀ motor rotates, we can better help people struggling with ATP deficiency and other diseases related to F₁F₀ ATP Synthase."

GRADE 11

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GRADE 12

Lao, James (BI)

ASE Sensory Neuron cGAL Driver in Caenorhabditis Elegans

"cGAL, a bipartite GAL4-UAS system for *Caenorhabditis elegans*, was recently developed for cell- or tissue-specific gene expression. The cGAL system consists of a "driver" construct and an "effector" construct. The driver construct uses a cell- or tissue-specific promoter to express the GAL4 protein in designated cells or tissues, and in the effector construct, upstream activating sequence (UAS) sites are placed upstream of the gene of interest. If two separate transgenic lines containing a

driver and an effector individually are crossed, the expressed GAL4 protein will bind to the UAS sites and drive expression in genes encoded downstream of the UAS. The bipartite cGAL system allows for the efficient generation of large numbers of strains by crossing driver and effector lines. The verified driver and effector strains can be used by the broader community as reagents to ensure consistency and reproducibility. In this study, we constructed a novel cGAL driver using part of the promoter region of *gcy-5* due to its specific expression in the ASE neuron. The driver plasmid was constructed through two rounds of polymerase chain reactions and mixed with co-injection marker prior to injection into the 15xUAS::GFP (green fluorescent protein) effector strain. The *gcy-5* promoter sequence was confirmed using Sanger sequencing. The imaging confirmed specific GFP marker expression in the ASE neurons. Our results demonstrate that the driver construct can specifically express the GAL4 protein in ASE neurons, driving selective GFP expression in ASE neurons."

Biomedical and Health Sciences (BM)

GRADE 9

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GRADE 10

Chundi, Sowmya (BM)

Designing a Tumor-Specific Oncolytic Virus Treatment to Induce Suicide Gene Expression in Glioblastoma Cancer

"To what degree do promoters HMGB2 and VEGF drive the expression of suicide gene HSVtk to inhibit cell growth in glioblastoma cancer stem cells? The objective of this research is to identify a novel cancer gene therapy that takes into account cancer's rapid growth and evolution. With tumor specific promoters, we can target a cytotoxic gene to kill cancerous cells exclusively, and preserve healthy cells, ultimately mitigating side effects when it comes to treatment. By utilizing two promoters, we can target two different pathways in cancer at the same time when cancer evolves. This research is novel because it takes into account a cancerous cells unique micro-environmental conditions (hypoxia) and

internal conditions (HMGB2 protein production). In my research, I will be designing two glioblastoma-specific promoters: HMGB2 and VEGF. HMGB2 is a protein that is highly expressed in cancerous cells, but not in healthy cells. VEGF is a hypoxia-responsive element, meaning that only cells that emit hypoxia (namely cancerous cells), will be targeted by this promoter. I will be taking the sequences of both of these promoters and inserting them into a pLOX-GFP-HSVtk backbone to drive the expression of HSVtk. HSVtk is a cytotoxic gene that disrupts a cell's metabolic activity in the presence of the chemical Ganciclovir, and is often used in cancer gene therapies. Plasmids containing promoters HMGB2 and HRE, as well as a plasmid containing both (HMGB2-VEGF), will drive the expression of HSVtk. These plasmids, along with a control plasmid, will be transfected into T98G glioblastoma stem cells and 3T3 healthy stem cells to observe how effective the promoters are in being tumor-specific."

Nazarloo, Shawn (BM)

Modulation of Oxytocin, Arginine Vasopressin and Corticosterone Secretion in Socially Monogamous Prairie Voles (Year 1)

"The goal of our study was to explore the effect of acute restraint and social isolation stress on the plasma oxytocin (OT), Arginine Vasopressin (AVP) and Corticosterone (Cort) in socially monogamous female and male prairie voles (*Microtus ochrogaster*). The plasma was obtained from the animals that were euthanized for a purpose other than the current study. One hour isolation increased plasma OT level in females, but not in male animals. Acute restraint stress test significantly increased the plasma OT level in both female and male animals. In both male and female animals, after isolation and acute restraint stress the plasma AVP level was increased, which could be permissive for mobilization and thus adaptive in response to a stressor. We found that plasma Cort was elevated after isolation and acute restraint stress in both female and male animals. The differential effects of isolation on OT and AVP systems may help in understanding mechanisms through which social interactions can be protective against emotional disorders. Previous studies have revealed a female-biased increase in oxytocin in response to chronic isolation; however, we did not find a gender difference in AVP or corticosterone following

isolation and restraint stress, suggesting that sexually dimorphic processes beyond the oxytocin system, possibly involving vasopressin, might explain this difference. The differential effects of isolation on OT and AVP systems may help in understanding mechanisms through which social interactions can be protective against emotional disorders."

GRADE 11

Mahoui, Ilhaam (BM)

Quantifying Myelin Maturation in Healthy Babies

"In the first years of life, a baby's brain undergoes rapid growth. A major component of this growth is myelin maturation. Myelination is the process by which Schwann cells form a non-conductive fatty sheath around axons, which accelerates the electrical impulses from cell to cell. This sheath in the pediatric brain increases the degree of myelination with age. To assess the degree of myelination, a unique MRI scan is required to measure the changes in tissue proton relaxivity (T1). The goal of this project is to assess the T1 relaxation rate in the white and grey matter of the brain where the density of axons are highest. The T1 relaxation rates correlate with the degree of myelination at a given age, and as the brain matures the T1 decrease. A cross-sectional study measuring T1 relaxation rates in 146 brain regions (white and grey matter) were conducted for 122 MRI patient ranging from birth to 19 years old, and were grouped into the following: 0-6, 7-12, 13-24, and 25 months to adults. Summary statistics were generated for all age ranges and regions, and estimates of population variances were computed to describe the effective myelination rate as a function of age. In addition, test-retest analysis was performed to assess the degree of reproducibility. The degree of correlation for white ($r = 0.88$) and grey ($r = 0.95$) matter was very high showing high reproducibility across 25 randomly selected subjects. Analysis of average T1 relaxation rates for 56 and 90 regions of white and grey matter, respectively, show an age dependent decrease in T1 values of 0.19 and 0.27ms per month. These data will serve as a normal pediatric atlas to permit comparisons of the expected myelination levels with age and regions, thus improving the diagnosis for abnormalities during brain growth and development."

Nazarloo, Parmida (BM)

The possible stress-coping function of the love and trust hormone "oxytocin" in females during psychological stress

"The scope of this study was to evaluate the effect of exogenous oxytocin (OXT) injection on the plasma Arginine Vasopressin (AVP) and Corticosterone (Cort) following wet cage stressor (WCS), in socially monogamous female and male prairie voles (*Microtus ochrogaster*). The plasma were obtained from the animals that were euthanized for a purpose other than the current study. One hour WCS increased plasma oxytocin level in female, but not in male animals. OXT pretreatment significantly increased the plasma oxytocin level in both female and male animals. In both male and female animals, after WCS, the plasma AVP level was increased, but no effect of WCS on plasma AVP was seen in OXT pretreatment group, which could indicate an adaptive role of oxytocin in response to a stressor. We found that plasma Cort was elevated after WCS, but OXT pretreatment inhibited the stimulatory effect of WCS on plasma corticosterone level compared to saline injected group. The differential effects of WCS on plasma oxytocin and AVP systems may help in understanding mechanisms through social interactions can be protective against psychological disorders. Previous studies have revealed a female-biased increase in oxytocin in response to isolation or separation stress; however, we did not find a gender difference in AVP or corticosterone following WCS, suggesting that sexually dimorphic processes beyond the oxytocin system, possibly involving vasopressin, might explain this difference. The differential effects of WCS on oxytocin and AVP systems may help in understanding mechanisms through social interactions can be protective against psychological disorders. Further, female prairie voles exposed to WCS showed an increase in plasma corticosterone level, although no effect of WCS was found in male prairie voles suggesting that females are more sensitive than males to the effects of psychological stress, possibly using oxytocin as component of adaptive and stress coping systems. Alternatively, perhaps males are insensitive to a mild psychological stress, or may rely less on oxytocin, and more on other endocrine systems including urocortin family peptides to adapt to psychological stress."

GRADE 12

Mertami, Mozen (BM)

Mechanistic investigation of tumor-selective activation of a novel cross-linking agent for targeted cancer therapy

"Cancer is one of the leading causes of dreadful demises in the world, which is primarily characterized by uncontrolled cell division. However, tumor-selective therapies to terminate the survival of recalcitrant cancers are mostly nonexistent and palliative therapies have both short- and long-term toxicities especially when used at high concentrations due to drug resistance. There is an urgent need to develop innovative treatment strategies to selectively target the cancer cells while sparing the normal tissues through the use of reliable biomarkers for personalized cancer therapy. Taking these into account, we developed a novel DNA-damaging agent (RLinker) that require specific conditions for selective activation in cancer cells. Relative cell survival was determined using a long term cellular DNA assay in isogenic cancer cell lines with alterations to the expression of a specific biomarker. DNA cross-linking assay, Western blot, and immunofluorescent experiments were performed to determine the mechanism of action. Mechanistically, we confirmed that our novel DNA crosslinking agent (RLinker) is specifically activated by hydrogen peroxide (H₂O₂) in vitro. The combination of sub-lethal doses of RLinker and β-lapachone induced synergistic lethality compared to individual treatments due to increased formation of clustered DNA damage and toxic double-stranded DNA breaks (DSBs) selectively in NQO1-proficient cancer cells. Overall, our new treatment strategy holds great potential to enhance tumor-selectivity, reduce dose-limiting toxicities and significantly improve the overall quality of life."

Newman, Elijah (BM)

Palpable Ingurgitating Pharmaceuticals

"The purpose of this project is to create an advanced pharmaceutical that can ease the tension of multiple medication intake in a safe, timely, and easily tangible matter. I hypothesized that the hard capsule would take longer to dissolve, while the organic vegetable capsule would be the best fit for the outer layer of the pill with the hard capsule being the best match for the inner layer of the pill. I came to this inference because

I assumed a harder capsule would take longer to dissolve and an organic vegetable capsule would dissolve in an instant. To test this hypothesis, I tested 3 types of capsules in 2 sizes to test which capsule would work best in the inner and outer layer of a future super pill in the works in an artificial stomach. The results of the experiment showed that the hard capsule dissolves the quickest while the vegetable capsule held up longer in the stomach in all cases in both sizes of the capsules. In conclusion, my hypothesis was incorrect, for a super pill that delivers an antacid or a separate medication at a quick rate, it would be essential for the hard capsule to be the outer layer and the organic vegetable capsule to be the inner layer because it would take longer for it to dissolve, allowing the pills to activate at separate times, thus avoiding health issues and discomfort."

Chemistry (CH)

GRADE 9

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GRADE 10

Duncan, Jahmai (CH)

Janvier, Francesca (CH)

Neutral or Not?

"I chose this project because I wanted to know if the water we drink on a daily bases are actually healthy and beneficial. I want to know if the better tasting or looking waters, are actually the most acidic. I hope to find out that majority are neutral and do not change colors on the pH scale. In the future, using more well-known brands or brands that seem expensive should be tested to see if they are actually worth drinking."

GRADE 11

Wei, Yanni (CH)

Thermal Properties of Fabric VS Garment

"Chemical protective clothing can restrict heat dissipation mechanisms, causing heat stress that can pose physiological burdens on the wearer. My study investigates how the thermal properties of the fabric differ from those of the garment when worn. The two key parameters of clothing comfort are thermal insulation (RCT) and evaporative resistance (RET),

which are altered in the translation from fabric to garment due to the fit, size of the garment, and degree of motion of the wearer. I conducted my tests with 4 chemical fabrics on a sweating guarded hotplate and a 35-segment newton manikin. For the hotplate test, I conducted both dry tests and wet tests on each of the 4 fabrics without a spacer, with a 3mm spacer, and 6mm spacer. For the manikin test, I conducted dry tests and wet tests with static and dynamic tests. I measured 6 air gap sizes in each the chest and stomach areas using a 0.40mm x 42mm needle. I produced 2 equations correlating the RET or RCT of the garment with the RET or RCT of the fabric and air gap size. There is a direct correlation between air gap size and RCT, and a mostly direct correlation between air gap size and RET. These findings will improve the structural design of chemical protective clothing to reduce heat stress, given that the fabrics producing the least heat stress can be identified or produced."

Ge, Robbie (CH)

An Efficient and Environmentally Friendly Synthetic Method for Aromatic Amino Acids

"Aromatic α -amino acids are important structural units in natural products, pharmaceuticals, agrochemicals, materials, and dyes. Over the course of the past century, considerable efforts have been made to develop methods to synthesize these molecules. Unfortunately, current approaches suffer from the need to use expensive metal species, toxic reagents, surplus and expensive starting materials, or a multi-step synthesis, and, consequently, are not practical to use in industrial production. My research goal was to develop an efficient, economically and ecologically beneficial process to access aromatic α -amino acids. In this study, the α -arylation of an inexpensive, commercially available glycine ester was achieved with aryl iodides under transition metal-free conditions in the presence of potassium tert-butoxide. This reaction features a broad substrate scope and good functional group compatibility, and thus provides a straightforward synthesis for a wide range of aromatic amino acids. Based on the experimental results, it can be surmised that this process begins with the formation of an aryl radical, generated from the treatment of an aryl iodide with potassium tert-butoxide, and yields an aromatic amino acid product, formed from the addition of the

aryl radical to a glycine derivative. Because of the importance of aromatic α -amino acids in natural products, medicine, and materials, this newly developed process has broad applications in organic, pharmaceutical, and material chemistry research."

GRADE 12

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Consumer Science (CS)

GRADE 9

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GRADE 10

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GRADE 11

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GRADE 12

Wang, Jerry (CS)

Automatic Landmark Placement for Large 3D Facial Image Dataset

"Facial landmark placement is a key step in many biomedical and biometrics applications. This paper presents a computational method that efficiently performs automatic 3D facial landmark placement based on training images containing manually placed anthropological facial landmarks. After 3D face registration by an iterative closest point (ICP) technique, a visual analytics approach is taken to generate local geometric patterns for individual landmark points. These individualized local geometric patterns are used to guide the refinement process for landmark points projected from a template face to achieve accurate landmark placement. Compared to traditional methods, this technique is simple, robust, and does not require a large number of training samples (e.g. in machine learning based methods) or complex 3D image analysis procedures. This technique and the associated software tool are being used in a 3D biometrics project that aims to identify links between human facial topographies and their genetic association."

Earth and Environmental Science (EA)

GRADE 9

Makanjuola, Oluwanifemi (EA)

Testing different anthocyanin sources and analyzing the adsorptions on TiO₂ (Titanium oxide) nanoparticles with electron microscope in DSSC.

"DSSC is based on a semiconductor designed such that the nanoparticles of TiO₂ are coated in a light-sensitive dye and surrounded by the electrolyte which is sandwiched between another electrolyte and a cathode anode is a transparent material for the light to pass through. Solar Cells are made of silicon semiconductor that absorbs sunlight and converts it into electrical energy. The use of solar cells in a DSSC is increasing slowly, but cheaper and it's reported to be 12% more efficient than a silicon solar cell. Solar energy means a lot to the earth's survival, it is eco-friendly, it has a very low level of pollution. Most of all, solar energy is the best form of energy to use if we want the earth to be evergreen, solar energy is also more reliable because it is a renewable form of energy. In the nearest future, when some very important non-renewable energy like chemical energy (petroleum) expires, solar energy would save the day. Initially, solar cells were made from silicon, but it was very expensive to get. Later on, scientists created dye-sensitized solar cells using ruthenium dye which was a pollutant and dangerous to nature, but now the best alternative to it is the introduction of fruit dyes and photocatalysts instead of ruthenium dyes. That's why I decide to work on fruit-based Dye-Sensitized Solar Cells (DSSC). The purpose of this project is to produce DSSC using different sizes of FTO glass, different fruits as the source of light-sensitive pigments while comparing the results with three different light sources. I created these solar panels by using three different pairs of FTO glasses of different sizes, fruits extracts, titanium dioxide as a photocatalyst and triiodide solutions as an electrolyte. After creating the solar panels in a sandwiched structure, I tested them under three different source of light source and came up with the conclusion that the best fruit to create a DSSC with is

the blackberries because of its darker color, the best FTO glass is medium-sized, and the best light source to experiment with is sunlight."

Linga, Lainkho (EA)

Analyzing the efficiency of different materials to separate oil and water.

"When oil spills into the ocean, it becomes difficult to remove it. If you can't get the oil out of the ocean, it could have an unhealthy effect on the environment. Finding the best material that can separate oil from water is important because it can prevent environmental damage. The purpose of this project is to see which material works best when it comes to separating oil from water. I hypothesized that sponge would absorb more oil than polyester and cotton. To test my hypothesis, I weighed the mass of the liquid of oil and water from each material. Then, squished each material into the measuring cylinder to see the volume of oil and water. Finally, I used the scanning electron microscope to see and have an understanding of the surface composition and topography. It helped me reach my conclusion. The results were, polyester absorbed more oil. Polyester only absorbed oil. It was difficult to remove the oil from polyester because it kept the oil in, and not the water. Polyester is oleophilic, so this explains why it was able to absorb more oil than sponge and cotton. While sponge and cotton are extremely hydrophilic, this explains why sponge and cotton can't hold a lot of oil like polyester. The scanning electron microscope showed that polyester has a stronger surface area than cotton and sponge. Polyester stays together, while sponge and cotton are very loose. Polyester becomes a type of filter when it comes to separating oil from water. I can conclude that polyester is the best material when it comes to separating oil from water."

GRADE 10

Sankari, Safiya (EA)

Using Novel Soil Microbes as a Neonicotinoid Alternative on Popillia japonica Newman Infestations as a Method of Pollinator Protection

"Neonicotinoids are a family of insecticides that have gained worldwide popularity. By 2009, the global Neonicotinoid market was worth \$2.63 billion.

Recently, their usage has come under question as studies have shown a correlation between Neonicotinoids and a degradation of behaviors necessary for honeybee survival. This is alarming as one third of total crop production is dependent upon insect pollination. This research is focused on determining if novel soil microbes could be a viable alternative to Neonicotinoids. The effectiveness of Imidacloprid (a type of Neonicotinoid), GrubGone G (commercial microbe) and 2 experimental microbes were tested using the model organism *Popillia japonica*. 40 beetles were sectioned off for each trial and caged in cylinders, where they then either remained untreated or underwent treatment from the respective product tested. 4 trials were replicated for each product. The number of larvae present in each plot was recorded in September. The Imidacloprid was the most effective of the products, with a mean of .3 larvae. The first Experimental Microbe was more effective than the second Experimental Microbe in the July 18th trials, but less effective in the August 15th. Overall, the two microbes appear to supply similar levels of control. While not as effective as the Imidacloprid, the experimental microbes did prove to be effective in reducing the number of larvae present in comparison to the control. In the future, different ratios of the microbes could be tested for effectiveness."

GRADE 11

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GRADE 12

Owolabi, Clara (EA)

Light sensitive molecules for DSSC under electron microscope

"Last year I did this project and had lots of questions such as - Have you ever wondered how solar panels work and why we use them? Do you know what solar cells are? - My project will show you what solar cells are and how solar panels work. It will also tell you which light and fruit will conduct more electricity. The purpose of my project is to figure out which fruit will conduct the most electricity. My hypothesis is that if I use blackberries for my fruit cell then, it will have the best results out of all my other fruits. To test this hypothesis I will place some of the blackberry juice on

the FTO (Fluorine-doped Tin Oxide, the solar cell glass) and then see how much energy it will receive outside, inside, and with a heat light. I will also add electrolytes to fabricate the best results. The results of the experiment showed that FTO glass changes color depending on the fruit I used. In conclusion, all my fruits had good results."

Microbiology (MI)

GRADE 9

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GRADE 10

Iyer, Vishnu (MI)

Identification of Escherichia coli O157:H7 outer membrane proteins which mediate adherence to bovine endothelial cells

"Escherichia coli (E. coli) O157:H7 is a human pathogenic bacterium known to cause foodborne outbreaks of bloody diarrhea and hemolytic uremic syndrome. Cattle are the primary reservoirs of E. coli, which are shed in the feces and transmitted to humans through contaminated milk products and uncooked meat. The purpose of the study was to identify bacterial outer membrane proteins (OMPs) involved in the colonization of bovine endothelial cells. It was hypothesized that similar set of E. coli O157:H7 OMPs would be involved in adhesion to both human and bovine endothelial cells. I developed a "pull-down" technique to selectively anchor biotin-labeled bovine endothelial cell surface proteins (CSP) onto a streptavidin bead matrix followed by incubation with E. coli OMPs. After washing the beads, bound OMPs were eluted and subsequently analyzed by peptide sequencing. A total of 90 proteins were identified including significant hits of OmpA, OmpX, Omp slp and flagellin, in addition to several chaperone proteins, which represented a group of previously well characterized mediators of adhesion of E. coli to human cells. This is the first study in the literature to demonstrate the role of these OMPs for attachment of E. coli to bovine endothelial cells."

GRADE 11

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GRADE 12

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