Name(s)

Ruchi Agashe

Project Number

S1201

Project Title

Identification of Treatments for Hemophilic Joint Disease through Evaluation of Vascular Defects

Abstract

Objectives

Hemophilia A, or FVIII deficiency, is characterized by spontaneous bleeding in weight-bearing joints, resulting in a debilitating orthopedic complication called hemophilic arthropathy (HA). Bleeding causes inflammation and hypoxia which induces angiogenesis. Despite advances in treatment, HA still continues to develop. The goal of this project was to identify alternative treatment targets and a treatment for hemophilia that prevents vascular abnormalities.

Methods

The goal was approached by developing insight into the formation of abnormal blood vessels, identifying multiple angiogenic markers expressed in FVIII KO models to serve as treatment targets, and testing the efficacy of the most promising anti-angiogenic treatment candidate targeting Vascular endothelial Growth Factor (VEGF).

Results

It was determined that anti-VEGF significantly reduced aSMA positive vessels at week 2, but increased hypoxia. These results were validated with vascular casting. It was also discovered that abnormal blood vessels is specific to hemophilia as compared to rheumatoid arthritis and osteoarthritis. It was confirmed in mice that the new vessel formation and vascular remodeling was increased in hemophilia (FVIII KO) mice after bleeding, but not to the same extent in wild type mice subjected to joint bleeding. It was determined that lack of hemostasis is driving excessive vascular changes. Finally, multiple angiogenic targets were identified in the mouse hemophilic joints after bleeding.

Conclusions

This project provided insight into the formation of abnormal vasculature in HA. Multiple angiogenic markers were identified, providing potential treatment targets. It was discovered that anti-VEGF treatment significantly reduces aberrent vasculature. It was established that FVIII deficiency drives aberrant vasculature in hemophilic joint disease as compared to bleeding. In addition, various imaging techniques were developed/optimized to analyze blood vessels in the joints.

Summary Statement

Antibody treatments were identified for hemophilic joint disease, the cause of the development of hemophilic arthropathy was discovered, and the changes in vasculature were analyzed via the optimization of imaging techniques.

Help Received

Dr. Tine Wyseure and Dr. Laurent Mosnier mentored me by providing their insight and teaching me. Dr. Robert Sah and Dr. Saeed Jerban did the microCT scans. Dr. Annette von Drygalski and Dr. Martin Lotz provided the clinical samples. Genentech provided the anti-VEGF antibody.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Chinmayi Balusu

Project Number

S1202

Project Title

Can the Longevity Compound Rapamycin Rescue Brain Tissue in Age-Related Diseases in Old Mice?

Abstract

Objectives

Rapamycin is an immunosuppressant that inhibits mTOR (the mammalian target of rapamycin) and extends lifespan in organisms such as worms, flies, and mice. While it is known that rapamycin s effects on cardiac and skeletal muscle contribute to lifespan extension, it is unknown if rapamycin s effects on the brain contribute to lifespan extension. Some of the proteins associated with rapamycin have decreased while other proteins have increased in the brain tissue of old mice. Moreover, several of these proteins have been implicated in various age-related diseases, such as Alzheimer s disease and Huntington s disease. However, these proteins have not been jointly studied with rapamycin treatment in age-related diseases. In this experiment, I utilized wet lab techniques, including but not limited to Western blots, to investigate glial fibrillary acidic protein (GFAP), peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1a), fibroblast growth factor 21 (FGF21), and zinc metallopeptidase STE24 (ZMPSTE24) in the brain tissue of old mice treated with rapamycin to see if rapamycin could rescue the proteins by affecting the protein expression.

Methods

Brain tissue samples from male old mice were obtained; six samples were from vehicle (control, untreated) mice while six samples were from mice that received 8 mg/kg of rapamycin I.P. (high dose) injections every other day. Wet laboratory techniques such as tissue cryohomogenization and Western blots (gel electrophoresis, protein transfer, chemiluminescent detection, and film development) were used to obtain data.

Results

GFAP expression in the brain tissue was not affected by the rapamycin treatment. PGC-1a had greater protein expression in the brain tissue of the mice treated with rapamycin. Rapamycin may have increased the protein expression of FGF21 in the brain tissue.

Conclusions

Rapamycin rescued PGC-1a in the brain tissue of the old mice, which suggests that rapamycin could be used in treatment for Alzheimer s disease, Huntington s disease, or ALS. Rapamycin may rescue FGF21 in the brain tissue, and this suggests that rapamycin could be used in treatment for metabolic disease. Rapamycin did not rescue GFAP in the brain tissue, which suggests that rapamycin may not be able to treat Alexander disease. Rapamycin did not rescue ZMPSTE24 in the brain tissue.

Summary Statement

The longevity compound rapamycin rescues several important proteins in the brain tissue of old mice, which suggests that it could potentially be used in treatment for various age-related diseases, including neurodegenerative diseases.

Help Received

Used lab equipment in Kennedy Lab at the Buck Institute for Research on Aging under the supervision of Dr. Chen-Yu Liao

Name(s)

Adolat Beshimova

Project Number

S1203

Project Title

Calpains 8 and 9 are Expressed in the Murine Intestines and Regulated by wnt3a in Colon Cancer Cells

Abstract

Objectives

Calpains are calcium dependent proteases that are reported to be implicated in processes such as signal transduction, cytoskeleton remodeling and apoptotic cell death. Upregulation of calpains have been seen in tumors and cancers including gastric cancer, breast, and ovarian cancer suggesting its activity in cancer development. However, their activity in colon cancer remain unknown. To investigate a potential role in colon cancer, we have stimulated human colon cancer cell line with WNT3A, Tumor Necrosis Factor alpha (TNF) and both for 24 hours. After WNT stimulation, the relative mRNA expression of calpain-8 and calpain-9 significantly increased, whereas TNF did not affect the expression of calpain-8 and 9. However, when stimulated with both; TNF has suppressed the ability of WNT to upregulate, suggesting an interaction between the two. We also found that calpain-9 to be highly expressed in murine colon through our immunohistochemical analysis. Taken together, our result suggest a possible role for calpains-8 and 9 that warrants further investigation.

Methods

Quantitative real-time PCR was used to analyze our stimulated RKO (colon cancer) cells. Slides of wildtype mouse colon tissue were treated with specific calpain antibodies to analyze calpain expression

Results

Wnt3a increased the expression of calpains 8 and 9 in RKO cells. The expression of calpains 8 and 9 in colon and stomach was made evident through our IHC results.

Conclusions

After wnt3a stimulation, the relative mRNA expression of calpains-8/9 increased by 18-fold. In contrast, stimulation with TNF did not affect calpain 8/9 expression in colon cancer cells. Interestingly, concurrent stimulation of TNF with wnt3a abrogated the ability of wnt3a to upregulate calpains 8/9, suggesting an interaction between the wnt3a and TNF signaling pathways. No significant change in calpains 1/2 were found with any stimulation, consistent with their known ubiquitous expression in most tissues. Furthermore, both calpains 8/9 were found to be expressed in the epithelium of murine colon as well as stomach. Previously reports describe an increase of calpain-2 activity in colorectal adenocarcinomas compared to normal mucosa While the expression of calpain-9 was reported to be decreased in gastric cancer, the expression in colorectal cancer is unknown. Further research is needed to determine the expression and consequence of calpain-8/9 in the normal colon and colon cancer.

Summary Statement

The roles of calpains in colon cancer is unknown, therefore we looked at their genetic expression in RKO cells and their localization in wildtype mouse colon.

Help Received

All the materials were provided by the research facility at University of Southern California. The project was designed by principle investigator, Dr.Shao. I performed the experiments under the supervision of mentor.

Name(s)

Corynn Branche

Project Number

S1204

Project Title

Novel Insights into Human Obesity through Identification of Genetic Polymorphisms in Lean vs. Obese Labrador Retrievers

Abstract

Objectives

Mutations in the proopiomelanocortin (POMC) gene have been associated with obesity in Labrador retrievers while mutations in the related melanocortin-4 receptor (MC4R) gene have been associated with obesity in humans. We hypothesize that polymorphisms exist in the POMC, MC4R and nearby genes between an obese and a lean Labrador retriever and that studying these genetic variants may lend insight into obesity.

Methods

DNA obtained from an obese and a lean Labrador was run on a microarray chip containing over 200,000 genetic markers (Embarkvet). The UCSC browser Canine 3 genome assembly was used to analyze the data.

Results

The dogs have different genotypes at all of the markers within the POMC and MC4R genes. While interrogating the POMC gene we encountered several variants at the adjacent NCOA1 gene. The dogs have different genotypes at five of the 6 markers in NCOA1. Interestingly, the obese dog is homozygous for the wild type alleles in the POMC and NCOA1 genes while the lean dog has the polymorphisms. The lean dog is homozygous for the wild type allele in the MC4R gene while the obese dog has the polymorphism. These genes are implicated in energy intake and expenditure, and the dogs have measurable differences in these indices.

Conclusions

This research provides insights into the genetic basis for and linkages between canine and human obesity, and offers a roadmap for using comparative genomics as a translational tool for studying high impact human diseases, such as obesity.

Summary Statement

Polymorphisms in the POMC, MCR-4, and NCOA1 genes exist in Labrador Retrievers and may lend insight into human obesity.

Help Received

Barbara Natterson-Horowitz MD, Sara Makanani, Karol Watson MD PHD, Jessica Wang MD PHD, University of California Santa Cruz open source genome browser

Name(s)

Ishaan Brar

Project Number

S1205

Project Title

A Novel Multi-Lumen Urinary Catheter with Sustained Unidirectional Biocide Flow

Abstract

Objectives

Urinary catheter is the most common indwelling catheter used worldwide. It is used to drain urine from the urinary bladder into a collection bag to relieve urinary obstruction. It is a tube (catheter) with the diameter less than that of human urethra. It has 2 lumens, larger one is used to drain the urine, while the smaller one is used to inflate a balloon in the bladder which prevents accidental dislodging of catheter. The catheters are a major source of infection, resulting in 13,000 deaths in US and over 250,000 annually worldwide, costing 24 billion a year. Infection starts in the inner lining of catheter and is related to biofilm formation. Biofilms are difficult to eradicate because of bacterial organization and resultant resistance to biocides. The novel catheter was designed and prototyped with the objective to prevent biofilm formation. The hypothesis was that the multi-lumen catheter, one-way valve and pumping mechanism would allow sustained instillation of biocides into the catheter lumen without backflow into the bladder, thus preventing biofilm formation.

Methods

After sketching the catheter design, and then employing auto CAD and 3D printing techniques, a silicon-based catheter prototype was made. This novel catheter design had multiple channels, a mixing chamber at the insertion end, and a one-way valve at the tip. With this design, the biocide could be introduced, or pH could be altered within the urinary lumen of the catheter without effect on the urinary bladder. Essentially, the conditions within the lumen of the catheter could be modified so they were not conducive to bacterial growth, help remove the biofilm in the lumen and prevent the growth of bacteria in the urinary collection bag. Pressure dependent biocide delivery system ensured that there was a sustained or a cyclic introduction of biocide at a controlled rate into the urinary lumen of the catheter. The testing apparatus was also 3D printed to perform in-vitro testing and to demonstrate functioning of the design.

Results

Biocide in the form of alkaline fluid, with pH of 11.5, was instilled into the catheter lumen. Acidic fluid with a pH of 6.5 was instilled into the bladder lumen. The pH of fluid in the collection bag and in bladder lumen was measured every 3 hours for 12 hours. Results showed that the pH maintained at 6-6.5 in bladder and 11.4-11.6 in the collection bag.

Conclusions

It demonstrated multi-lumen catheter and the one-way valve functioned as hypothesized. These modifications in the catheter design could potentially lead to significant reduction of UTIs, sepsis and mortality and help save millions of healthcare dollars. Other catheters like triple-lumen catheters and PICC

Summary Statement

A novel design of a urinary catheter that can prevent biofilm formation and reduce urinary tract infections.

Help Received

Mentor: Harjeet Brar, MD. -supervised project, transcribed sketches into Auto-CAD, uploaded designs to 3D printer. Student sketched diagrams, thermoformed and created non-3D printed mechanism, created testing device and catheter with supervision, performed the tests.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Ashlyn Burrus

Project Number

S1206

Project Title

Acne Treatments: Proactiv vs. Home Remedy

Abstract

Objectives

The objective of this experiment will be testing the effectiveness of two different acne fighting routines: 3 step acne skin care product vs. home remedy for acne.

Methods

Methods:

Subjects Using the Home Remedy used this Routine

1. To make one Apple Cider Vinegar Honey Mask
   a. Mix a tablespoon of honey with a half a tablespoon of apple cider vinegar
   b. Apply an Apple Cider Vinegar Mask to your face 2x throughout the 7 days.
2. To make the Coffee Exfoliator scrub
   a. Mix the four tablespoons of coffee with one tablespoon of coconut oil and two tablespoons of Coconut Palm sugar
   b. When finished mixing, add three drops of lemongrass essential oil and Eucalyptus oil
   c. Use this exfoliator every other day throughout the 7 days
3. Use the Unrefined Cold-pressed Hemp oil as a cleanser in the morning and at night during the 7 days

Subjects Using Proactiv used this Routine

1. The Proactiv should be used daily and nightly throughout the seven days
   a. First, use the Renewing cleanser
   b. Then use the Revitalizing toner
   c. Lastly, use the Repairing Treatment

Results

In my project there were 3 participants. Subject #1 and #2 both used the Home Remedy Routine, and Subject #3 used Proactiv . They used the products for a duration of seven days.

Subject #1 has moderate acne and combination skin. Before testing the Home Remedy, pimples were very inflamed and skin had many dry patches. After the week, Subject #1 s skin was very moist and hydrated.

Summary Statement

I compared two different acne treatments (Proactiv vs. Home Remedy) to determine which one is more effective.

Help Received

My sister, my friend, and my teacher's daughter used the one of the two acne treatments for a duration of a week, which gave me the results I needed for my project. My science teacher gave me the tools I needed to complete my project and purchased proactiv. My parents purchased the other materials needed to make

Name(s)

Iliana Close; Keira Swei

Project Number

S1207

Project Title

Correlating Inflammatory Markers and the Development of Neurodegenerative Lesions Using Machine Learning

Abstract

Objectives

The purpose of this project was to determine if machine learning algorithms could predict the development of neurodegenerative lesions found in a subset of patients diagnosed with Langerhans Cell Histiocytosis (LCH). Neurodegenerative lesions are a devastating late-effect that develops in some patients diagnosed with LCH, yet the overall incidence remains unknown. By using specific data in a patient s medical history, including inflammatory markers and the location of other LCH lesions throughout the body, the overall likelihood of a patient developing neurodegenerative lesions can be determined. These high-risk patients can therefore be more closely monitored, allowing for earlier detection and intervention with life-saving treatments.

Methods

Data were acquired from parents of 213 patients that are members of a closed LCH group on Facebook. The data included age, gender, birth month and location, type and location of LCH lesion, and blood markers such as complete blood count, sedimentation rate (inflammatory marker) and vitamin D levels. Patients also reported whether they had been diagnosed with neurodegenerative disease and a subset provided brain MRIs. Two types of software were used, including OsiriX for MRI analysis, and MATLAB for machine learning and feature identification and extraction.

Results

Approximately 11% of patients reported a diagnosis of neurodegenerative lesions. We were able to independently discover the presence of neurodegenerative lesions in additional patients by using their brain MRIs in our feature detection algorithm, bringing the overall total to 14% of all LCH patients. Neurodegenerative lesions were present in 53% of LCH patients who had previous cranio-facial lesions or pituitary involvement, and in 68% of patients who had these specific lesions in addition to elevated inflammatory markers 1 year after chemotherapy treatment ended. We found no correlation between vitamin D level and presence of neurodegenerative lesions.

Conclusions

Our risk calculator resulted in 0.83 sensitivity and 0.68 specificity; the number of false negatives was 2% and the number of false positives was 11%. Based on these results, we recommend that patients with cranio-facial or pituitary lesions, who also have elevated inflammatory markers 1-year after chemotherapy treatment ends, should be more closely monitored in order to initiate early preventative treatment.

Summary Statement

We determined which patients diagnosed with Langerhans Cell Histiocytosis were most likely to develop neurodegenerative lesions based on the location of prior lesions and developed a machine learning algorithm to predict their 5-year risk.

Help Received

Sigrid Close taught us how to code in MATLAB and helped with the online data gathering. Nicolas Lee advised us about different types of machine learning algorithms.

Name(s)

Jason Hepfer

Project Number

S1208

Project Title

Variations in Behavior Tendencies of House Mice as a Result of Gravitational Manipulation

Abstract

Objectives

The objective of this study is to determine whether there is a correlation between the strength of gravity's pull and the energy that an organism requires to perform a task.

Methods

Mouse habitat, stopwatch, and three house mice. I set up the habitat for my three mice and supplied them with food and water. I then transported them to several locations that varied in distance from the Earth's center of gravity and measured several aspects of their behavior at each of the locations.

Results

As the mice's distance from the planet's center of gravity was increased, I witnessed a noticeable increase in the duration of the mice's physical activity, caloric intake, duration of social interactions, and number of aggressive interactions toward each other. When the mice were reintroduced to higher levels of gravity, their results indicated that they had become relatively lethargic and idle.

Conclusions

That the mice could maneuver and perform tasks with relative ease in habitats with lessened gravity compared to habitats where the strength of gravity was higher indicates that organisms are able to perform tasks more easily and efficiently when the strength of gravity's pull is lessened.

Summary Statement

I brought mice further and closer to the planet's center of gravity in order to test how mice would behave in reaction to varying levels of gravity.

Help Received

My chemistry teacher advised me on how I could eliminate various sources of error and extraneous variables such as temperature, oxygen levels, and exposure to light in order to make my project as controlled as possible.

Name(s)

Allison Jia

Project Number

S1209

Project Title

Modeling Neurodegeneration in vitro: A Dynamic Study of Tau in a Microfluidic Chamber System via Quantum Dot Labeling

Abstract

Objectives

Current research suggests that toxic tau aggregates propagate from neuron to neuron in a prion-like manner. However, no dynamic proof exists to trace tau s transmission and traffic in neurodegeneration. To dynamically image tau s propagation, an in vitro system must be created by 1. constructing biologically functional quantum dot (Qdot) conjugated tau filaments (wild type (WT) and P301L mutation causing tauopathy) and 2. performing the propagation and transport experiments in vitro with a specially designed microfluidic chamber system.

Methods

I developed a protocol to synthesize tau proteins that could be uptaken by neurons and could conjugate to the Qdot tags for visualization.

Results

A staining study was conducted for the biotinylated tau s uptake in neurons with Texas Red-Streptavidin. Not only were WT and P301L tau filaments both uptaken, but P301L tau induced aggregation of native tau inside the neuron, suggesting my system accurately reflected tau s clinical behavior. Finally, a live neuronal transport of tau filaments with Qdot-Streptavidin was conducted in the microfluidic chamber which serves as a unique transport environment by isolating neuron axons from soma. This setup allows for clear imaging of tau proteins propagating retrogradely from axon to soma: the first time tau s transport in primary neuron culture has been virtually observed.

Conclusions

I successfully developed this system to model neurodegeneration and propose that tau filaments (both WT and P301L) were uptaken and traffic from terminal to soma in neurons. My in vitro system may service as a platform for detailed mechanism studies and for drug screening tests to further understand and potentially find cures for tauopathies such as Alzheimer s Disease.

Summary Statement

I successfully developed an in vitro system that can serve as a novel dynamic platform for researchers to understand the detailed biological mechanism behind the neurodegeneration process as well as conduct real time drug screening tests to

Help Received

I conducted all experimental procedures, data collection, data evaluation, conclusions, and written reports/ presentations by myself. Professor Yanmin Yang and Dr. Wei Wang from the Department of Neurology at Stanford University provided me with project feedback.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Hara Jo

Project Number

S1210

Project Title

The Effect of 3T3/NIH Fibroblast Co-Culture on the Growth and Survival of HMEC

Abstract

Objectives

Skin grafts are surgical methods to heal affected areas through the transplantation of skin from one area of the body to another. These grafts are avascular and fail to survive if blood vessels do not grow to supply them with nutrients. This study serves to understand the effect fibroblasts have on the growth of human microvascular endothelial cells in an in vitro co-culture.

Methods

Prior to culturing the cells, the cell lines were first obtained from cryogenic storage. Then the cells were passaged to new tissue culture dishes and were passaged and fed with media until they reached confluency of ~80%.

The interactions were investigated using 3D Cell Culture. The cells were cultured in collagen gels inside polydimethylsiloxane wells. The control of the experiment contained just HMEC and experimental group contained equal numbers of HMEC as the control, but were cultured with additional 3T3 to assess the interactions. The cells were then observed using confocal microscopy and analyzed through the program Fiji Is Just ImageJ.

Results

The 3T3 did indeed serve as a growth factor the the HMEC. The co-culture of HMEC with 3T3 was successful, with an average of 27 HMEC positive cells for the co-culture and 11 HMEC positive cells for HMEC only culture.

Conclusions

Through the co-culture of HMEC with 3T3, the HMEC were able to have better survival and increased growth. The method of 3D cell culture allowed for successful culture of the HMEC, providing data that helps in understanding what effect the fibroblasts have on growth of HMEC. An average of 27 HMEC positive cells were identified in the co-culture condition whereas an average of 11 HMEC positive cells were identified in HMEC only culture.

The hypothesis that the HMEC will increase in growth and survival when co-cultured with NIH/3T3 Fibroblasts was proved to be correct by the quantitative analysis done through the investigation. Previous studies have found that Hepatocyte Growth Factors released by fibroblasts encourages the growth of epithelial cells, but this experiment focused on the growth of endothelial cells considering the fact that epithelial and endothelial cells are similar in some ways. The results of the experiment can be part of a larger study regarding tissue cultures and skin grafting.

Summary Statement

This experiment investigated the role 3T3 Fibroblasts play on the growth and survival of human microvascular endothelial cells in an in vitro co-culture to assess the effect fibroblasts has on the growth of endothelial cells.

Help Received

I would like to thank Dr. Joshua Morgan for allowing me to perform this research at the Morgan Lab at UCR and his supervision throughout the research. I would also like to thank my teacher, Mrs. Hampton for her guidance and mentorship throughout the process of completing the project.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Elisha Johnston

Project Number

S1211

Project Title

Developing a Novel Physiologically Relevant Model to Study Cartilage Regeneration

Abstract

Objectives

Osteoarthritis (OA) plagues a variety of mammalian species, including humans, dogs and horses. Many clinicians inject dextrose to stimulate mammalian immune systems to regenerate cartilage but some physicians raise doubts. Scientists have conducted few in vitro studies and not yet produced results with important translational implications. As a step towards elucidating mechanisms of dextrose-based cartilage regeneration, I aimed to develop an in vitro model more effectively representing cartilage growth in mammalian joint space and determine a dextrose dose that stimulates cartilage cell proliferation.

Methods

To create an in vitro model with higher translational potential, I extensively reviewed standards for culturing cells, selected a line better representing mammalian cartilage cells, formulated and custom-created a media within the normoglycemic range of most mammals (3.9-7.8 mM), and validated with Subject Matter Experts. To investigate proliferation, I empirically developed a dose schedule and physiologically relevant control. I experimentally optimized the colorimetric assay PrestoBlue (provides indirect measure of cell proliferation via metabolic activity). I conducted an experiment with 3 time points, 6 arms, and 4 replicates per arm/time point. To establish a preliminary therapeutic window that allows for a biphasic distribution, I tested a cubic regression model using the statistical significance criterion of $p<0.05$.

Results

Scientists and clinicians with expertise in dextrose injections for OA agreed in principle to a model with mouse cartilage cells in a DMEM/Ham s F12 media mixture and a 4.24 mM glucose concentration. Several weeks of microscopic observation indicated the model s ability to maintain cells. For the optimization experiment, I found incubating cells in the PrestoBlue assay for 20 minutes produced a highly linear correlation between cell number and absorbance. I anchored a dosing schedule at 25 and 400 mM hypertonic dextrose, with log defined intermediate points of 50, 100, and 200. A cubic regression model fit my dose-response experimental results ($p<0.01$) and enabled estimation of a therapeutic window centered around 250 mM.

Conclusions

Establishing a physiologically relevant in vitro model and effective dose for cartilage cell proliferation is a necessary first step towards designing informed molecular mechanisms and animal disease model research projects.

Summary Statement

I establish a physiologically relevant in vitro model and hypertonic dextrose effective dose with the aim of advancing the study of regenerating cartilage in mouse disease models and subsequently a variety of mammalian species.

Help Received

Professor Lin Chen provided lab space for me to conduct cell culture work and approved my research proposal. His lead post doc, Dr. Yi Kou, helped in troubleshooting laboratory challenges.

Name(s)

Zuriel Erikson Joven

Project Number

S1212

Project Title

Development and in Vitro Evaluation of Dextrose Transdermal Patches as a Low-Cost Alternative to Intravenous Delivery

Abstract

Objectives

The purpose of this project was to evaluate the feasibility of transdermal patches as a cost-effective replacement for the intravenous (IV) delivery of dextrose to patients.

Methods

Prototype transdermal patches were fabricated containing dextrose at three different concentration levels. Each was subjected to an in vitro evaluation aligned with United States Pharmacopeia (USP) standards. Patches were applied to the bottom of a dissolution bath of distilled water, at 32 degrees Celsius and stirred by a paddle at 50 RPM, and samples were taken at three times: 0.5, 1.0, and 1.5 hours (N=216). The samples were 10x diluted in distilled water and analyzed for dextrose concentration using a blood glucometer. Correcting for volume changes, the cumulative dextrose present in the water bath at each time point was calculated and analyzed in comparison to IV rates of infusion (~12 g/hr +- 5%).

Results

Regression functions mapping the data (cumulative dextrose released vs. time) using the Higuchi model of diffusion show nonlinear release kinetics of the transdermal patches as opposed to the linear release kinetics of IV. This means transdermal patches are considerably less accurate (<70% accuracy) in matching the typical IV infusion rate than does an IV line (95% accuracy). However, the daily cost of using patches is only ~$10 whereas that of IV is ~$200. Ratios of accuracy to daily cost show that patches are nearly 15 times as cost-efficient than IV for delivery of dextrose.

Conclusions

Because transdermal patches are far more cost-efficient than IV delivery of dextrose, these patches constitute a feasible solution to replace costly IV administration of dextrose. This has revolutionary implications as transdermal patches, unlike IV lines, can be made accessible outside of the hospital, for potential use in malnourished developing countries, by hypoglycemics or diabetics, or even by athletes and the military.

Summary Statement

I developed prototypes of novel transdermal patches and used in vitro evaluation to show they are feasible low-cost alternatives to intravenous (IV) treatment.

Help Received

None. I designed and conducted the development of the prototypes and the experiments by myself.

Name(s)

Maya Khurana

Project Number

S1213

Project Title

Occult Breast Cancer: Does Molecular Profile Matter in Treatment?

Abstract

Objectives

In this study, I aimed to describe the hormonal profile of occult breast cancers and also to evaluate the relationship between progesterone receptor and grade of the occult breast cancer. Additionally, I compared occult breast cancer patients with typical breast cancer patients in order to understand the molecular subtypes of occult breast cancer in relation to breast cancer and to improve treatment options for both groups. To my knowledge, the prevalence of progesterone receptor expression in occult breast cancer has not been investigated. In addition, the relationship of progesterone receptor and the cancer grade has not been studied in occult breast cancer. I hypothesized that patients with lower PR prevalence would have a higher grade, and that occult breast cancer patients, overall, would have adverse prognostic features compared to breast cancer patients.

Methods

I conducted a review of both typical breast cancer and occult breast cancer cases from Kaiser Permanente Los Angeles Medical Center spanning the years 2008-2018. The search was conducted through the use of ICD-9 codes. The obtained data were then delinked from all patient medical identifiers such as medical record numbers, name of the patient and surgical pathology case numbers.

New lists of cases were then created, and each case was assigned a number: BC 1-28 and OBC1 - OBC31. Using the patient data that we had acquired, I compared trends in breast cancer patients to trends in occult breast cancer patients; I then arranged the information into various graphs and tables (see figures below) in order to study the correlation between isolated variables such as the PR percentage and the grade.

This study is IRB approved.

Results

This molecular profile comparison revealed that between breast cancer and occult breast cancer patients, there were 16 Luminal A breast cancer patients compared to 5 Luminal A occult breast cancer patients. Because Luminal A patients tend to have better prognoses, the lower frequency of Luminal A in occult breast cancer patients indicates an adverse prognosis. Additionally, including Luminal B patients, there were 19 HER2 positive occult breast cancer patients compared to the 9 HER2 positive breast cancer patients in the study. There were over two times as many occult breast cancer patients with the more aggressive profile of HER2 than there were breast cancer patients. And, 4 triple negative occult breast cancer patients compared to the 3 triple negative breast cancer patients. Furthermore, of the 31 occult breast cancer patients studied, 8 of them, or 25.8%, died over a 10 year period, from 2008 to present. No breast cancer patients

Summary Statement

This project aimed to determine how the molecular profiles of occult breast cancer affect patients' prognoses and potential treatments.

Help Received

I was mentored by Dr. Victoria O'Connor, a surgical oncologist at Kaiser Permanente in Los Angeles.

Name(s)

Susanna Kim

Project Number

S1214

Project Title

Identification of Novel Biomarkers for the Early Diagnosis of Acute Myocardial Infarction

Abstract

Objectives

Heart disease is one of the leading causes of death worldwide. As the death rates due to heart disease continue to grow throughout the years, it is necessary to find a non-invasive method for early diagnosis because time is crucial in acute myocardial infarctions (AMIs). The purpose of this project is to find certain genes that are differentially expressed in AMI patients relative to the healthy population to be used as potential biomarkers for AMIs.

Methods

Gene expression data from AMI patients relative to the healthy population were obtained through the NCBI Gene Expression Omnibus. The data of the common genes found in the peripheral blood of patients with first-time acute myocardial infarction under two studies were analyzed through two methods. The heat cluster maps gave a visual depiction of the contrast of gene expression among the populations. The statistical analysis was conducted on a spreadsheet software by calculating the ratios and p-values between the gene expression groups. Then, the common genes identified in both studies were further analyzed to find the common biological pathways through the Panther Gene Ontology Consortium.

Results

From the comparison of the two studies, sixty-four commonly expressed genes between AMI patients were discovered. In addition, the classification of the genes into their respective pathway ontologies through Panther indicated that there is the greatest variance among the categories in the molecular function ontology as well as the cellular component with variances between the largest and smallest amount of genes of 13 and 14, respectively. For reassurance, the statistical analysis of the expression rates of the genes of interest resulted in a p-value of less than 0.01, meaning that there is 99.99 percent confidence in the data.

Conclusions

The 99.99 percent statistical confidence is a reassurance that the data came from the same sources. Among the sixty-four genes, one or more may be potential biomarkers for they were expressed by AMI patients in both studies and aren't highly expressed by the healthy population. The pathway analysis suggests that it is likely for the potential biomarker to have binding and catalytic activity and be located on cells due to the great amount of genes in those categories. This experiment served to begin the process of searching for a potential biomarker that will allow the early diagnosis of AMIs. It narrows over fifty-thousand potential expressed genes to sixty-four and gives indications as to where the desired biomarker may be located and what function it plays in the human body.

Summary Statement

A meta-analysis approach was utilized to compare the expression rates of over 50,000 genes in acute myocardial infarction patients relative to the healthy population to be used as potential biomarkers for early diagnosis.

Help Received

My research mentor taught me about the scientific research process and introduced me to the online tools used in this project.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Katie Moon; Kyle Morrissey

Project Number

S1215

Project Title

Measuring Stress on the Patellar Tendon at Various Bend Angles

Abstract

Objectives

Katie and I both being athletes have experienced knee stress or strain at one point in our athletic career, so we wanted to pin point exactly what major angles contribute most to patellar tendon stress and exactly how much strain in pounds force.

Methods

Our first step to reaching our goal was to create a knee model out of wood, plastic, a single spring, and a single fishing line. The model can bend from 180 degrees to 10 degrees which stretches the spring applying increasing stress to the fishing line (Patellar Tendon).

Results

We recorded the stretch of the spring (In inches then converted to meters) from each bend angle going by tens (i.e. 180, 170, etc.) from there we plugged the stretch value, restorative force value, and the 'k' value which we found from multiple tests on the suspended spring with known masses. We took all the values and plugged them into Hooke's Law (F=-kx) from which we concluded the pounds of force on the patellar tendon, which was an arithmetic growth of up to 97 pounds on the tendon at the lowest bend angle.

Conclusions

Tireless nights spent over pages of equations, model failures, and pressure of school and sports were only a few of the challenges we faced and overcame. We experienced many failures yet we persevered and were able to successfully finalize our project. Applying up to 97 pounds of pressure to the knee daily (Add that to your body weight!) is insanely strenuous, and it's important to know just how much damage is being done to one of the most important joints of the body.

Summary Statement

We created a knee model which could simulate significant amounts of stress on the patellar tendon at different bend angles.

Help Received

My partner and I designed and built the model on our, we received help from Mr. Jacquette, the VHS' AP physics teacher when working with Hooke's Law

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Sina Moshfeghi

Project Number

S1216

Project Title

Transdermal Lactate Collection with Agarose Gels for Noninvasive and Painless Monitoring of Patients

Abstract

Objectives

Biomarkers are extremely important in medical diagnostics, as they can help monitor a patient's medical status. Heart disease and sepsis, for example, can be identified by a spike in the concentration of the lactate biomarker. Previous biomarker assimilation has been limited to invasive, painful, or expensive blood and sweat collection methods such as blood tests, iontophoresis, and microneedles. The objectives of this project were to consistently and noninvasively collect transdermal lactate with hydrogels, test transdermal glucose collection, and establish a correlation between transdermal lactate and blood or sweat lactate.

Methods

Agarose gel solutions were created and molded to a single hydrogel in an elliptical orientation with constant major and minor axis measurements. Before testing the method on volunteers, in vitro studies were conducted using lactate and glucose stock solutions, a diffusion cell, porcine skin, and agarose gels. A constant sterilization procedure was established for each volunteer to reduce the possibility of sweat lactate interference. After collection, samples were diluted with a phosphate buffer solution and sonicated. Hydrogels were then removed from the vials and the diluted samples were placed in the YSI machine. Lactate and glucose concentrations were measured, and results were recorded. To evaluate trends in blood lactate as well as transdermal, trials were taken before and after eating and blood samples were also drawn.

Results

The results show that transdermal lactate collection with hydrogels is an excellent alternative to invasive and painful methods. Glucose concentrations were below the limit of detection, therefore transdermal collection of glucose with hydrogels would require a more sensitive glucose sensor. Blood and sweat lactate concentrations increase just after eating, and transdermal samples showed similar trends.

Conclusions

Transdermal biomarker collection with hydrogels is a noninvasive and painless method for monitoring a patient s status. Due to the apparent correlation between blood and transdermal lactate, the lactate collected with hydrogels can be used to diagnose septic shock and heart disease early on after conducting successful clinical studies.

Summary Statement

I sought to turn invasive medical diagnostic procedures into a noninvasive procedure by using agarose gels to transdermally collect biomarkers and diagnose illnesses early on.

Help Received

I conducted research at UCLA's Integrated and Interconnected Bioelectronics Lab with my mentor Shuyu Lin. My mentor discussed ideas with me, collected blood from my volunteers, and allowed me to use lab equipment to conduct my experimentation.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Kenny Nguyen

Project Number

S1217

Project Title

Fractals and the Chaos Theory in Oncology and the Analyzation of Tumors

Abstract

Objectives

Comparison of the fractal dimensions healthy tissue to cancerous tissue to find a trend or pattern and be used for earlier diagnosis or a different method of diagnosis.

Methods

ImageJ, a public domain Java-based program developed my the NIH for Computational Instrumentation and a computer capable of running ImageJ. TCIA (The Cancer Imaging Archive), a public domain with an archive of medical images of cancer available for download. Plugin for ImageJ (FracLac) which is used for fractal analysis. Scanned images from TCIA using ImageJ and FracLac to recieve the fractal dimension of said images for analysis. 3 images of cancerous imagery and 3 images of healthy images for 5 cancers and 8 images of cancerous and healthy images for brain cancer.

Results

ImageJ produced the fractal dimensions of the cancerous images to have a larger deviation and range compared to the healthy images which displayed more consistent and linear dimensions. A pattern of higher values of fractal dimensions and irregular dimensions show a link between fractals and the growth of cancer.

Conclusions

Using the data from the experiment, more testing can be done with different methods of fractal analysis to obtain a clearer differences between fractal dimensions in healthy tissue and cancerous tissue as well as strengthen the correlation between cancer and the concept of fractals. Using machine learning to recognize these patterns inside of tissue can lead to development in cancer diagnosis to even the smallest levels of biology as fractals are infinitely conplex. Difficulties could be that cancer baries from patient to patient and many factors go into diagnosis. Another obstacale may be the difficulty of obtaining the amount images for a machine to learn from.

Summary Statement

Using fractal analysis on cancer scans such as ct and mri and the healthy counterparts, there was a pattern in the cancerous images which was more irregular and on average fractal dimensions within those images.

Help Received

Dr. Rachel Auld, Dr. Kim Lawe

Name(s)

Seeta Patel; Hyunjin Rheem

Project Number

S1218

Project Title

Surface-Modified Loaded Human Red Blood Cells for Targeting and Delivery of Drugs

Abstract

Objectives

The fabrication of nanoparticles derived from red blood cells is accompanied with the expression of an apoptotic marker which creates the problem of ineffective nanoparticles. Thus, the project serves to create the most efficient nanoparticles with the lowest outward expression of the apoptotic marker done by testing different fabrication processes and analyzing the results.

Methods

The methods of this experiment were separated into two distinct procedures: fabricating the four different nanoparticles and setting up the nanoparticles for flow cytometry in order to analyze the data. Human erythrocytes were utilized in order to fabricate erythrocyte ghosts. 1x PBS, 5 mM NaH(2)PO(3)/Na(2)HPO(3) solutions were utilized in order to wash erythrocytes, 0.5X PBS (contains 50 micromolar ICG) also used in order to resuspend particles after each centrifuging session. Hemoglobin depletion forms erythrocyte ghosts, and the addition of different solutions: PIGPA-C (pyruvate, inosine, glucose, phosphate), which serves as a rejuvenating solution, and PIGPA-NaCl solution, which has NaCl as a base. The fabrication process includes using 10 microliter cells (RBCs, EGs, NETs, or P-NaCl NETs) to 100 micro liter Annexin binding buffer (~ 1x106 cells/mL). After 5 microliter Annexin V - AF488 is added, the cells are mixed and incubated, then analyzed using a flow cytometer.

Results

Through flow cytometry, the resulting experimental data indicated very low expression of PS for both RBCs and P-NaCl NETs. Meanwhile the number of PS+ cells were significantly higher for both EGs and NETs. Approximately, 60-65% of EGs and NETs expressed PS on the outer leaflet of the RBC membrane, whereas in RBCs and P-NaCl NETs only 1-2% of the cells were PS+.

Conclusions

Due to the fact that the translocation of PS is an apoptotic marker, exposed PS drastically lowers the circulation time of the RBC-derived drug delivery vehicles. P-NaCl NETs had significantly lower amounts of exposed PS than the EGs and NETs, quantified by the use of an Annexin V Alexa Fluor 488 conjugate that would bind to PS on the outer leaflet of the membrane. They were also the most similar to human RBCs in relation to the amount of translocated PS. These results, caused by PIGPA rejuvenation make the use of P-NaCl NETs most ideal for targeting and delivery of drugs in the human vasculature as these particles have the longest circulation time.

Summary Statement

We have determined that the most efficient loading method for erythrocytes in order to serve as potential drug delivery vehicles is by the utilization of PIGPA-NaCl .

Help Received

We give our gratitude to Dr. Anvari and Mr. Tang for mentoring us with this project and allowing us to use UCR's materials and facilities. Mr. Tang assisted us in the data collection and the interpretation of the data that was collected. However, the analysis and conclusion was reached by ourselves.

Name(s)

Omer Randhawa

Project Number

S1219

Project Title

Impact of APOE Gene on Alzheimer's Gender Discrepancy

Abstract

Objectives

The objective of this project is to find the genetic reason for the higher incidence of Alzheimer's in women using bioinformatics.

Methods

Access to computer and bioinformatics(OMIM) database

Throughout the project, the various SNPs and proteins were found through the use bioinformatics.

Results

Through rigorous research, it was discovered that the A117T SNP had the greatest impact on the SNP gene. Other SNPs such as R50C and P102R have a greater impact on the APOE gene(-3.34 and -2.65) however, they do not cause a missense mutation in the protein. To find the correct SNP, I had to search through over 1,500 SNPs related APOE mutation, 500 of which were missense mutations. In addition to this, the SNP has more effect on the female mitochondria than males. The less mitochondrial activity of the woman causes more senile plaques to accumulate. Senile plaques are the cause of AD.

Conclusions

This project successfully determined the primary SNP which causes a higher incidence of AD in women than men. Despite the useful information discovered in this project, access to a lab would be make the project s conclusion stronger.

Summary Statement

This project aimed to identify the main factors which caused a higher diagnosis rate of AD in women than men.

Help Received

None

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jesus Rivera

Project Number

S1220

Project Title

Formula Milk vs. Mother's Milk

Abstract

Objectives

What helps a baby goat grow better? Formula milk or its own mother's milk.

Methods

Two subject twin goats, Formula milk, feeding bottle nipple, goat's milk from the mother.

Results

The Mothers milk goat beat other goat by ? inches and .3 pounds but still passed it in weight because it did weight less at day three the starting mark as you could see.

Conclusions

From my experimenting and testing i found out how the goat being raised with mothers milk grew heavier and taller. With this result my hypothesis was correct. Correlation in my data could have been that the scale could have been off the feeding was sometimes off schedule but good things were that they had little genetic variation since they were siblings. All of my experiment went well because they never got sick throughout this experiment. Something that was not as good wasa that sometimes i would mess up on the feeding times and that one was a boy and the other was a girl. A follow up study could be the same just using different variables and results such as using cow milk and horse milk and maybe being able to check their vitals.

Summary Statement

What will make a baby goat grow better, formula milk or its own mother's milk?

Help Received

Name(s)

Dalton Robinson

Project Number

S1221

Project Title

Parasite Susceptibility in Icelandic Sheep: A Comparison of Offspring of Iceland-born Rams vs. American-born Rams

Abstract

Objectives

Society's preference for organic, naturally-raised, grass-fed meat, wool and cheese products requires that ruminant animals be humanely raised, which includes continuous access to grazing. This management system results in an increased exposure to parasitic worms present on pasture grasses, the most significant, due to its pathogenicity, is the roundworm, Haemonchus contortus. Haemonchus contortus is a lethal and common internal parasite of sheep that feeds on blood, leads to anemia and if untreated, results in the death of the sheep.

Methods

This project investigates the susceptibility to Haemonchus infection in two genetically distinct groups of lambs on a Mendocino County ranch using a quantitative measure of fecal egg counts. All lambs in this study are purebred Icelandic Sheep, either sired by an American-born ram (lambs conceived by natural mating), or sired by an Iceland-born ram (lambs conceived with the use of frozen imported semen.) It has long been suspected, but remains unknown, that offspring of rams born in Iceland may have a greater susceptibility to Haemonchus infection, because the parasite doesn t occur in Iceland, therefore there has been no selection pressure for Haemonchus parasite resistance. In the United States, Haemonchus is the most significant parasite of sheep and almost all American-born sheep are exposed to this parasite throughout their lives.

Results

Results of this study demonstrate that lambs sired by an Iceland-born ram suffered more ill effects of Haemonchus contortus and required more deworming to prevent illness and death. The FEC (fecal egg counts) of the lambs sired by an Iceland-born ram were lower than the FEC of the lambs with an American-born sire, indicating that the lambs sired by an Iceland-born ram were more susceptible to the ill effects of the parasite, even at a lower parasite loads.

Conclusions

Based on the data from this study, sheep breeders may need to change the way they monitor their sheep for parasites if they introduce direct descendants of Iceland-born rams into their flocks. Early detection and intervention can save the life of a parasitized lamb and help prevent other illnesses such as pneumonia that can occur when lambs are weakened by anemia caused by the Haemonchus parasite.

Summary Statement

Sheep breeders may need to change the way they monitor their flock for parasites if they introduce direct descendents of Iceland-born rams into their flocks.

Help Received

I collected fecal pellet samples and performed all FECs (fecal egg counts) after researching the test procedure on the internet. After recording all FECs, I received deworming records from the veterinarian and I correlated the deworming results with the FECs.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Julia Vargas

Project Number

S1222

Project Title

Superiority In Grip Strength: Athletes or Non-athletes?

Abstract

Objectives

The objective of my project was to clearly see the correlation between the athletes and non-athletes grips strength versus the independent variable, which was the length and hand span in inches. My goal was to see if the their correlations would have a positive, negative, or no linear correlation.

Methods

I used a hand dynamometer to test the grip strength in pounds, I connect to a labquest 2, both products were borrowed from my mentor. I used excel spread sheets to display my data and to help make my graphs.

Results

My results showed that each graph had a positive linear correlation, since I used Pearson's Correlation to see if this would be my outcome. Athletes did have a superior correlation in both categories I was testing, but the difference wasn't as large as I expected it to be.

Conclusions

This project expands in providing athletes or people looking for an improved physical health, the range that their grip strength should be in. This can help people realize that a low grip strength could be potential implications for diseases, such as heart disease.

Summary Statement

I observed the correlations of an athlete's grip strength were higher than those of non-athletes.

Help Received

My mentor provided the hand dynamometer and LabQuest 2, but I decided to use Pearson's Correlation to carry out the data analysis in my experiment.