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List of CSI CRSP students and their abstracts presented at the 2019 CRSP Symposium

Role of Taurine in Testicular Function in the Fragile X Mouse

Nana Samaké
Mentor: Professor Abdeslem El Idrissi

Fragile X syndrome is an X-linked dominant disorder and the most common cause of inherited mental retardation. It is caused by trinucleotide repeat expansion in the fragile X mental retardation 1 gene (FMR1) at the Xq27.3. The expansion blocks expression of the gene product, Fragile X Mental Retardation Protein (FMRP). The syndrome includes mild to moderate mental retardation and behavioral manifestations such as tactile defensiveness, gaze avoidance, repetitive motor mannerisms, perseverative (repetitive) speech, hyperarousal and it frequently includes seizures. This behavioral phenotype overlaps significantly with autism spectrum disorder. The knockout mice lack normal Fmr1 protein and show macro-orchidism, learning deficits, and hyperactivity. Consequently, this knockout mouse may serve as a valuable tool in the elucidation of the physiological role of FMR1 and the mechanisms involved in macroorchidism, abnormal behavior, abnormalities comparable to those of human fragile X patients. In this study we evaluated the effects of taurine on the testicular physiology to better understand the cellular mechanisms underlying macro-orchidism. We found that there was a significant decrease in the number of Leydig cells in the testis of fragile X mouse. Furthermore, the expression of somatostatin was drastically decreased and differential expression pattern of CDK5 in fragile X mouse testis. In the control testis, CDK is expressed in primary and secondary spermatids whereas in the Fmr1 ko mice CDK 5 is expressed mainly in spermatogonia. Taurine supplementation led to an increase in CDK5 expression in both controls and Ko mice. CDKs (Cyclin-dependent kinases) are a group of serine/threonine protein kinases activated by binding to a regulatory subunit cyclin. Over 20 functionally diverse proteins involved in cytoskeleton dynamics, cell adhesion, transport, and membrane trafficking act as CDK5 substrates elucidating the molecular mechanisms of CDK5 function. CDK5 phosphorylates a diverse list of substrates, implicating it in the regulation of a range of cellular processes. CDK5 is expressed in Leydig cells, Sertoli cells, spermatogonia and peritubular cells indicating a role in spermatogenesis. In this study we examined the expression levels of CDK5 and how it is affected by taurine supplementation in the testes and found that taurine plays an important role in testicular physiology and corrected some of the pathophysiology observed in the fragile x mouse testis.

Alzheimer's and Diabetes: is abnormal tau the link?

Izabella Beniaminova
Mentor: Professor Alejandra Alonso

Alzheimer's disease (AD) is dementia characterized by the presence of hyperphosphorylated tau. Tau is a microtubule-associated protein, which interacts with tubulin and promotes stabilization of microtubules consequently enabling successful neuronal transmission. In the case of AD hyperphosphorylated tau, pathological tau disrupts microtubule assembly and prevents neuronal synapsis. To better understand the mechanisms of pathological tau acting as a culprit of AD, our lab has generated a new inducible mouse model of neurodegeneration that expresses pathological human tau (PH-tau) with pseudophosphorylation at Ser199, Ser262, Thr212, and Thr231. The unique model allows us to derive to groups of mice expressing 4% of the endogenous tau (PH-tau Low) and 14% (PH-tau High) respectively.
Over the years of studying AD, scientist started noticing similar pathologies being present in patients with neurodegenerative disease and diabetes. The idea that both diseases can be interlinked sparked our interest and inspired us to observe changes in the density of insulin receptors and glucose transporter (GLUT4) in the presence of hyperphosphorylated tau protein. Consequently, performing immunohistochemistry and electron microscopy should help us see any changes taking place in the pathological brain. We found that the expression of PH-tau changes the levels of insulin receptor and glucose transporter in the hippocampus neurons of our mouse model.

Neurobehavioral Effects in Mice Exposed To Dibutyl Phthalate

Ommiya Butt and Begzodjon Musaev
Mentor: Professor Abdeslem El Idrissi

Dibutyl Phthalate (DBP) is a developmental and reproductive toxin that causes a broad range of birth defects resulting in neurological impairments. Humans are directly exposed to DBP through a variety of manufactured consumer products. In a preliminary study we evaluated the effects of DBP during early embryonic and postnatal development in mice. In the initial experiments, we tested the effect of DBP injection (1ug/kg s.c) into 2 months old male mice. We found that 15 min post injection of DBP, mice showed a significant alteration in the open field and elevated maze that measure locomotor activity and anxiety respectively. We found that mice were less ambulatory in the open field and their level of anxiety was elevated. In subsequent experiments pregnant mice were injected with DBP (1ug/kg s.c.) seven days after the copulatory plug appeared. After birth and when mice were one month old, they were subjected to three different behavior tests to characterize locomotor activity, anxiety profiles and fear conditioning: 10 minutes in an open field, 10 minutes in an elevated plus maze, and a 2 day fear conditioning freeze monitor test. We found that, similar to the adult mice injected with DBP, offspring of pregnant mice injected with DBP showed similar behavioral profiles that appeared to be male-specific. These observations suggest that long-term exposure to DBP in pregnant mice causes gender-specific neurobehavioral abnormalities in their offspring which may be mediated by alterations in the neuronal circuits associated with these behavioral characteristics

Exploring TGF-β Signaling in Glioblastoma Multiforme (GBM)

Deneisha Campbell and Sathis Niranchchan
Mentor: Professor Nancy Liu-Sullivan

Glioblastoma multiforme (GBM) is the most aggressive grade of glioma in the brain and the spinal cord. In normal cells their cell signaling guide cells in proliferation, differentiation, migration, and apoptosis. In cancer cells, by contrast, signaling governing cellular processes becomes impaired,

resulting in uncontrolled cell growth, cell motility, and resistance to apoptosis. GBM is characterized by aggressive proliferation, metastasis, drug resistance, and currently with no known cure. To develop effective treatment methods, we need to understand cancer gene signaling network and how essential gene associated with GBM function and how these genes are related to the context of GBM. For our research project, we focus primarily on the transforming growth factor beta (TGF-β) pathway. TGF-β is a cytokine that controls cellular differentiation and proliferation in most cells. Our research aims at studying patterns of the genes involved in the pathway, specifically, mRNA expression and DNA copy number. By examining the trends, we hope to see which genes are highly expressed in GBM and which genes are under-expressed. This is important for future research because drug targets can be identified with the goal of developing gene-specific drugs. Here we show gene expression patterns of different isoforms of TGF-β. Ongoing effort will expand to additional components of the TGF-β signaling pathway.

Does Staten Island Have a Problem with Microplastics? A Pilot Study of Microplastics on Lemon Creek

Ting Ting Chen
Mentor: Professor Jane Alexander

Microplastics are small fragments of larger plastic products and are typically classified as being smaller than 5 mm. Staten Island, NY, is located in the five boroughs of New York City, and is an ideal location to look for these particulates due it being located near the mouth of the Hudson River. Lemon Creek is a tidal creek that was sampled in two locations – one with sand sized sediments and another with clay sized sediments – to better understand if microplastics concentrations were different based upon sediment types. Five sand samples and seven clay samples were collected from different locations on the shoreline dried in a low-heat oven, and underwent a sieve analysis to understand how the concentration of microplastics changed with distance from the high tide line and variations in sediment grain size. The microplastic particles were visually identified using a binocular microscope and compared to the total weight percent of the collected samples by size and qualitative observations on shape and color were made.

Using Machine Learning and Brain EEG Signals to control Robots

Miguel Hurtado and Marjan Perbibaj
Mentor: Professor Aleksandar Haber

This interdisciplinary project aims at developing a low-cost non-invasive Brain-Computer Interface (BCI) and Machine Learning (ML) algorithms for controlling complex mechatronics systems such as robotic arms, drones, 2D plotters, etc. One of the main motivations for performing this research originates from the fact that BCI systems can help persons with spinal cord injuries or other mobility-limiting neurological disorders, to use mental commands to operate wheelchairs, prosthetic limbs or other mechanical devices. The BCI system is composed of a low-cost ElectroEncephaloGraphy (EEG) data acquisition card, Arduino microcontroller and a stepper motor. The system detects EEG signals induced by blinking and translates them into the desired mechanical motion of the stepper motor. We use ML and signal processing techniques to interpret the measurements and to compute the control actions for the stepper motor. Our experimental results show that the stepper motor can be reliably controlled by blinking commands. In our future research we will use the developed system to control more complex mechatronics devices, such as drones and robotic arms.

Does Staten Island have a problem with a Microplastic? An environmental survey of South Beach

Alex Fiero
Mentor: Professor Jane Alexander

Microplastic comes from the breaking down of plastic objects and collection of micro fibers that come from clothes, the debris is dumped and can be found on beaches which can potentially affect the marine life. Our research is an environmental survey of micro plastic on the beaches of Staten Island, and the purpose is to collect information and record how much microplastic can be found in the sand. We had also collected an additional sample to measure sediment grain size distribution of the beach. After collecting our samples we dried them and separate them by grain size (greater than 5mm, between 5-1mm, less than, 1mm). The sample used to measure the overall grain size distribution of the deposited sediment will be separated from greater than 4mm, 4-2mm, 2-1mm, 1mm-500um, 500-250um, 250-125um, 125-63um, and less than 63um.
7 samples were collected from south beach the first one being use as a reference of the different grain sizes of the beach. Sample 1) than 4mm; 0g, 4-2mm; 0.5g, 2-1mm; 3.41g, 1mm-500um;26.52g , 500-250um; 53g, 250-125um; 29.55g, 125-63um;1.01g, and less than 63um;0g. Sample 2) greater than 5mm; 0g, between 5-1mm; 3.83g, less than 1mm; 103.39g. Sample 3) greater than 5mm; 0g, between 5-1mm 0g, less than, 1mm; 133.67g. Sample 4) greater than 5mm; 0g, between 5-1mm; 0g, less than 1mm; 98.4g. Sample 5) greater than 5mm; 0.18g, between 5-1mm; 11.97g, less than 1mm; 81.46g. Sample 6) greater than 5mm; 0.38g, between 5-1mm25.31g, less than 1mm; 81.46g. Sample 7) greater than 5mm; 0g, between 5-1mm; .24g, less than 1mm; 128.86. After separating the samples, we observed them under a microscope and discovered suspected microplastic particles. We next perform a density separation of the microplastic from the natural beach sediments using a NaCl solution and mixing with the sand, the micro plastic will separate from the sand and be collected then measured. Once we finish the density separation we can measure the amount of microplastic, if any, from each sample based on the different sizes used to separate the sediment.

Estimation of Temperature Dynamics using Machine Learning Methods

Francesco Pecora
Mentor: Professor Aleksandar Haber

Dynamical systems are everywhere around us. Typical examples are swinging pendulums, autonomous driving vehicles, rockets, the human heart, flow of water through a pipe, etc. In order to develop control algorithms for such systems, it is crucial that we know their mathematical models. However, we usually do not know accurately all the physical constants describing such models, or we are not able to directly estimate them. Due to this lack of knowledge, the design of control algorithms can often be a challenging problem. In order to overcome this difficulty, in this research project, we investigate the possibility of using machine learning and subspace techniques to learn the models of physical systems. We focus on the problem of estimating the temperature dynamics of a long aluminum bar whose temperature is influenced by 4 band heaters. The spatial temperature response is measured using thermocouples. We use a multilayer perceptron and recurrent neural network architectures to learn the model. We address the overfitting and model order selection problems. Our numerical results show that the model can be estimated with the accuracy lower than 2%. In our future work, we will use the estimated models to develop efficient model-based control algorithms. Our results will also be presented at the ASME 2019 Dynamic Systems and Control Conference.

Hydrophobic-Hydrophilic Surfaces for Anti-Soiling Applications

Edmond George
Mentor: Professors Alan Lyons, Illya Nayshevsky, QianFeng Xu

Soiling of solar cover glass by dust is a serious challenge that causes the reduction of electricity generation from solar PV panels. Dew is known to condense on the surface of the glass, causing the dust to adhere, further lowering the solar panel performance and increasing the cost of operation due to cleaning. The aim is to use the dew to clean the panel rather than allowing the dew to reduce the solar panel performance. Even though inert hydrophobic coatings can reduce the cost of cleaning by preventing the dust from adhering to the surface of the glass, an external source of water is still needed for cleaning. In order to use the process of condensation to create a self-cleaning glass surface, we fabricated a hydrophobic coating with an array of isolated hydrophilic rectangular channels. Various test dusts will be used to measure the effectiveness of anti-soiling properties and self-cleaning properties of this hybrid hydrophobic-hydrophilic glass.

Mouse Model of Tau Induced Neurodegeneration

Abdonnie Holder
Mentor: Professor Alejandra Alonso

Alzheimer's is the most common form of dementia that causes a rapid decline in memory and functional processes in a person's everyday activities. This cognitive decline is due to the aggregation of an abnormal phosphorylated form of tau which has been shown to increase the neurotoxicity in the cell. It is still unclear as to how abnormal tau is triggered, yet it is used as a diagnostic marker and a target for therapy in preventing Alzheimer's disease. Thus, we hypothesized that the system for synthesizing tau and controlling its normal activities is not functioning correctly. As a result, a mouse model was generated to determine as to why the abnormal tau protein is not degraded and as to why and how this causes synaptic, autophagic and neurological disorders. We proposed to study expression of the proteins involved in the autophagy system. We found that the expression of abnormal tau induces a reduction of Beclin 1 and LC3A/B proteins.

Modeling Collaboration between Autistic Players using a Kinect Game

Konstantin Novichenko
Mentor: Professor Deborah Sturm

Our goal is to determine if American eel (Anguilla We extended a two-player research game that is designed to study the collaborative and emotion recognition abilities of players on the autism spectrum. Players view animations before each scene and assemble a puzzle by using gestures to select the appropriate emotion of the protagonist. We expected that when an expert player models behavior, a novice player will learn game mechanics and will communicate more as the game progresses. Preliminary tests with typically developing players showed that people understand gameplay better and communicate more with peer modeling than without it. We conducted a series of tests with players on the autism spectrum who demonstrated that expert peer modeling improved their understanding of gameplay and helped them to communicate and collaborate more. We learned from our pilot tests that providing a script for the modelers would help them model the behavior in the most effective way.

Modulation of Handedness in CD-1 Mice by Transcranial Direct Current Stimulation

Adnan Elcharfa
Mentor: Professor Ahmed Zaghloul

Handedness is a strong preference to use either the right or the left hand when performing skilled manual actions. In recent studies, MRI-based methodology has linked this ability to underlying functional and structural motor control. TDCS is a well-known clinical neuromodulation technique which has proved to be of growing interest for applications in neurorehabilitation. The aim of the current study is to examine the effect of applying subthreshold transcranial direct current (TDCS) on one hemisphere on handedness in mice. In the experiment, animal placed in a pyrex cylinder and filmed when rearing to explore the environment. The instances in which the mouse uses each paw to touch the cylinder will be assessed to determine handedness. Following this analysis, the mouse will then be administered a transcranial direct current stimulation (TDCS) of either anodal or cathodal current. The results will show whether the use of TDCS can elicit changes in neural connectivity that will change handedness.

PI3K Pathway Gene Expression Patterns in Glioblastoma Multiforme (GBM)

Arouje Shaikh and Briana Soto
Mentor: Professor Nancy Liu-Sullivan

Glioblastoma Multiforme (GBM) is the most aggressive type of glioma of the central nervous system (CNS) that can be found in the brain or the spinal cord. GBM represents 14.9% of all primary brain tumors, and 55.4% of all gliomas. GBM has the highest number of cases of all malignant tumors, this tumor represents about 15.4% of all primary brain tumors and about 60-75% of all astrocytomas. These tumors increase in frequency with age and affect more men than women. Adults with more aggressive glioblastoma have a median survival of about 14.6 months and two-year survival of 30%. My project shall focus on a key cancer signaling pathway called PI3K. Specifically, I will select important gene components of PI3K signaling, collect gene expression data for each gene from the cancer data base called Oncomine. Gene expression patterns shall also be compared to DNA copy number data. By analyzing the data available on the Human Protein Alas database, it has been determined that there are 25 key proteins expressed within the involvement of the PI3k pathway activation in a distinct group of 20 cancer types. The proteins that we will be concentrating on are PI3k, Akt, TP53, PTEN, CDKN1A, Casp9, and Fas. The findings shall help shed additional light on how PI3K signaling contributes to GBM with the potential of identifying effective therapeutic strategies.

Up-cycling Ibuprofen

Clayton Shaw
Mentor: Professor Leonard Ciaccio

By method of fractionation to separate contents of the bacteria responsible for gingivitis (Porphyromonas gingivalis) and expose them to tissue samples of mice brain cells in order to see if it can provoke a change in the cells. The tissue samples of the mice brain cells will vary in age, one from mice in their youth and one from elderly mice will be used in each trial. The purpose of this experiment is to see if a protein created from a bacteria found in the mouth (which in some cases infects the brain) can somehow result in the brain cells production of an irregular Tau protein.