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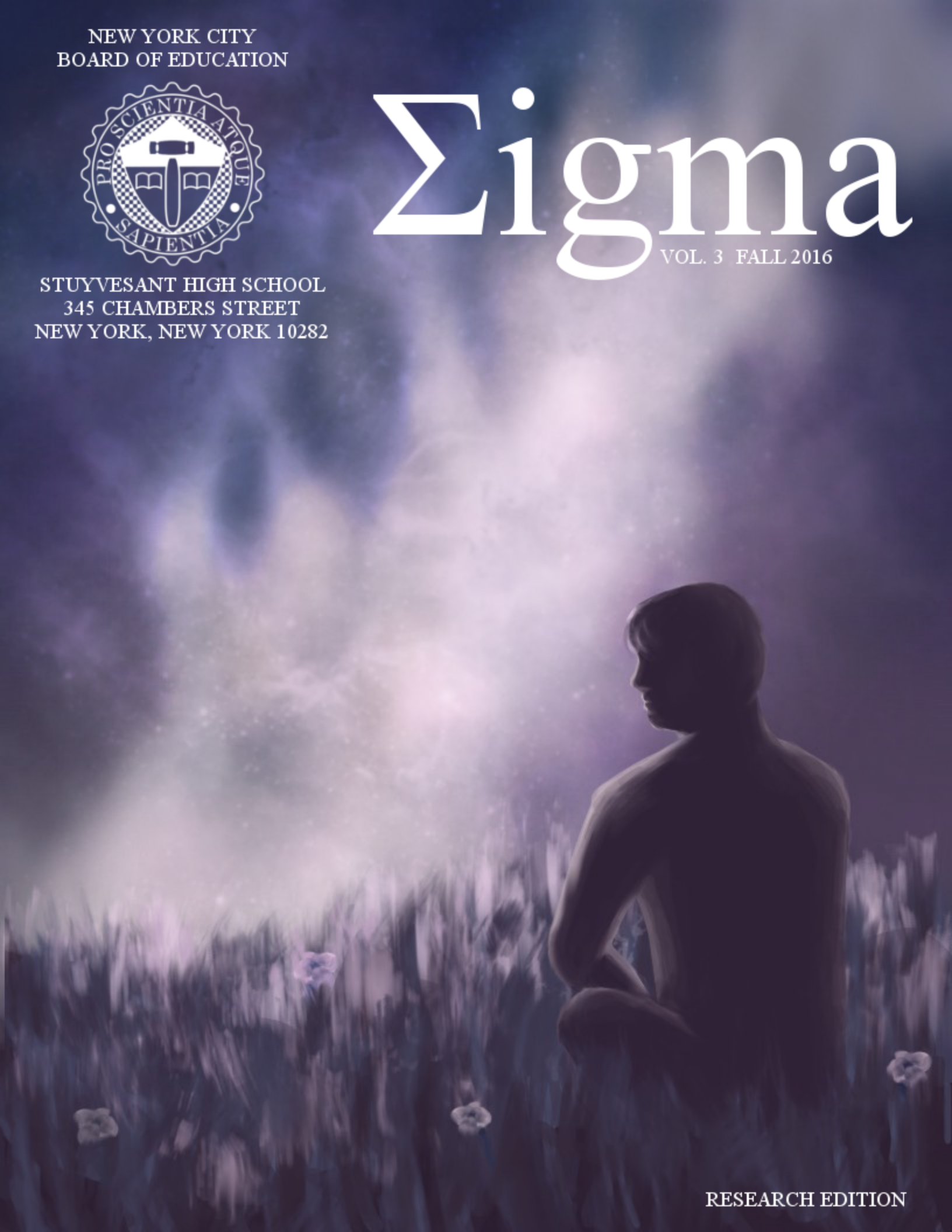

RESEARCH EDITION

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The Research Club

The Research Club was created to facilitate student research in a myriad of topics. One of its main goals is to revive Sigma, its magazine, in order for more members of the Stuyvesant community to have access to scientific material written by their peers. By encouraging its members to write articles, the club aims to hone the writing skills of future scientists.

Additionally, the club will expand and strive to compete in science competitions by forming members into teams based on their interests and levels of experience. The club hopes to motivate its members to actively engage in scientific discussions and earn valuable experience by receiving feedback to improve their scientific writing and teamwork.

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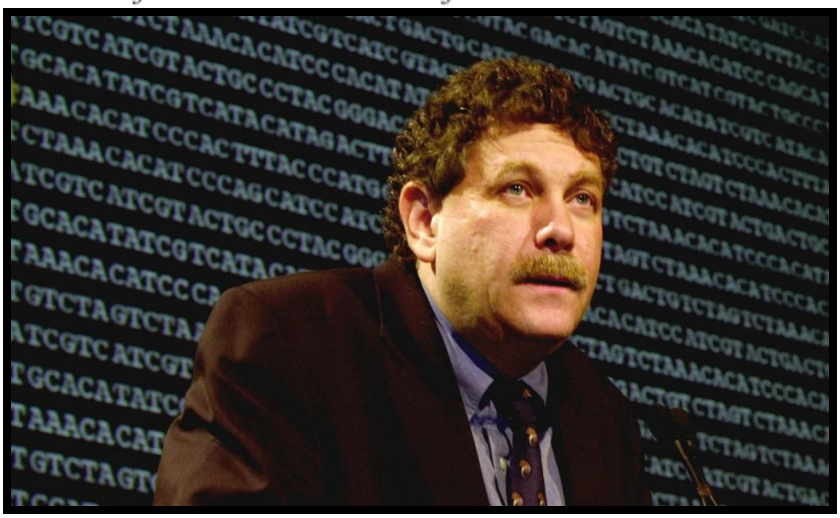
THE BRIEF:

Broad Institute, Teaming Up with Intel, Will Use Big Data to Analyze Genomes

On November 17th, the Broad Institute of Harvard and MIT—led by Stuyvesant alumnus and Founding Director Eric Lander—announced a $25 million partnership with Intel Corporation to scale up researchers' abilities to analyze tremendously large and diverse sets of human genomes. "The size of genomic datasets doubles about every eight months and, as it does, the challenge of acquiring, processing, storing, and analyzing this information increases as well," said Eric Banks, director of the Data Sciences and Data Engineering group at the Broad Institute. The Broad and Intel will develop faster, more efficient tools for scientists to bring their genomics research to a new depth.

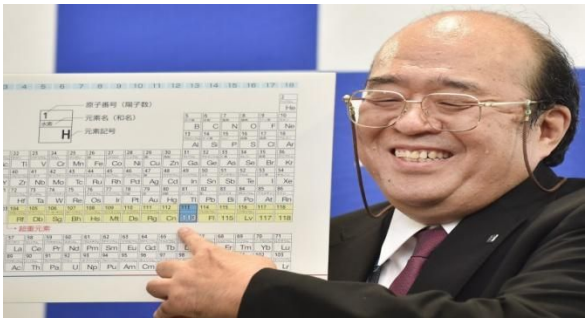
Eric Lander, Stuyvesant alumnus and Founding Director of the Broad Institute of Harvard and MIT



IUPAC Recognizes New Names for Elements 113, 115, 117, and 118

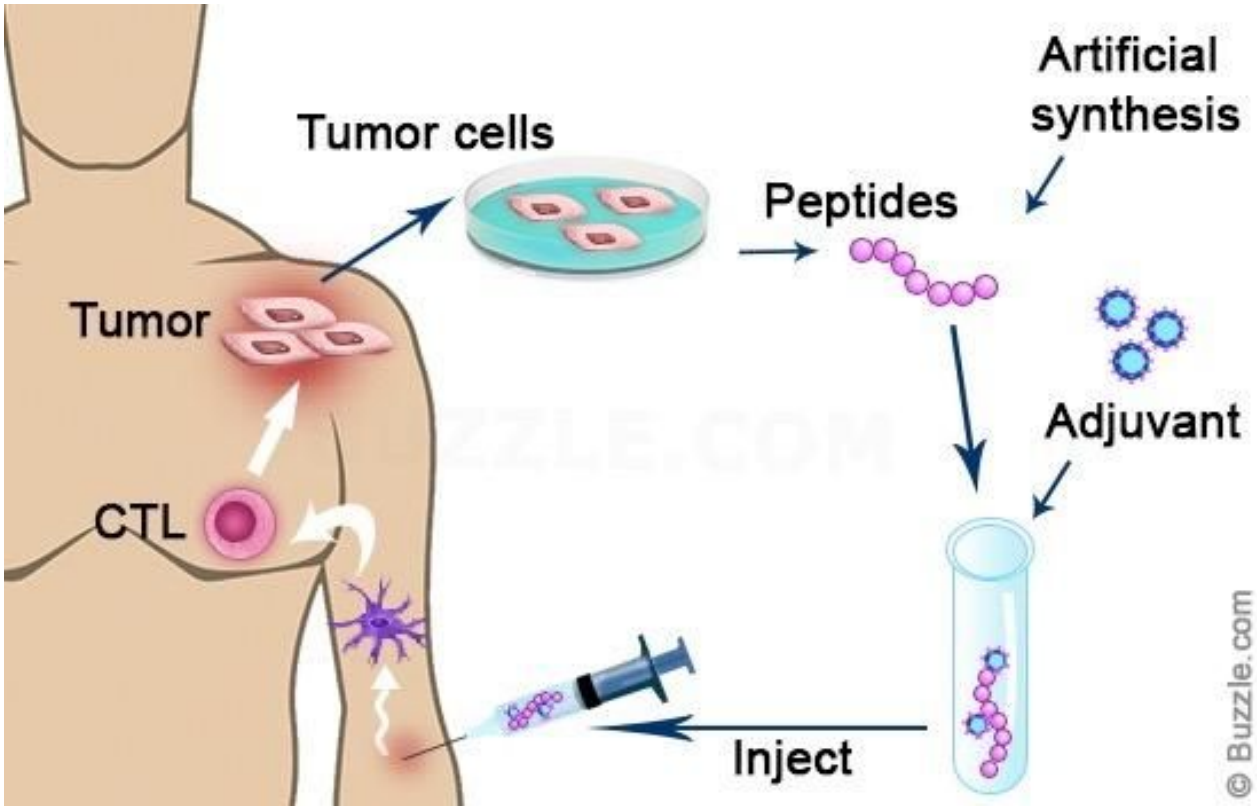
On Wednesday, November 30th, the International Union of Pure and Applied Chemistry announced that the official names of elements 113, 115, 117, and 118 are now Nihonium, Moscovium, Tennessine, and Oganesson. Since the elements were discovered between 2002 and 2010, they were given placeholder names: ununtrium, ununpentium, ununseptium, and ununoctium. The new names were suggested earlier this year by the scientists who discovered the respective elements. Japanese scientists proposed Nihonium, after Nihon (the Japanese

Kosuke Morita, leader of the Japanese team at RIKEN that discovered Nihonium



word for Japan); Moscovium and Tennessine are, of course, named after Moscow and Tennessee, respectively; and Oganesson was named by a team of Russian scientists after Yuri Oganessian, an eminent 83 year-old element hunter.

Parker Institute for Cancer Immunotherapy Partners With Over 30 Institutions to Create New Cancer Vaccines

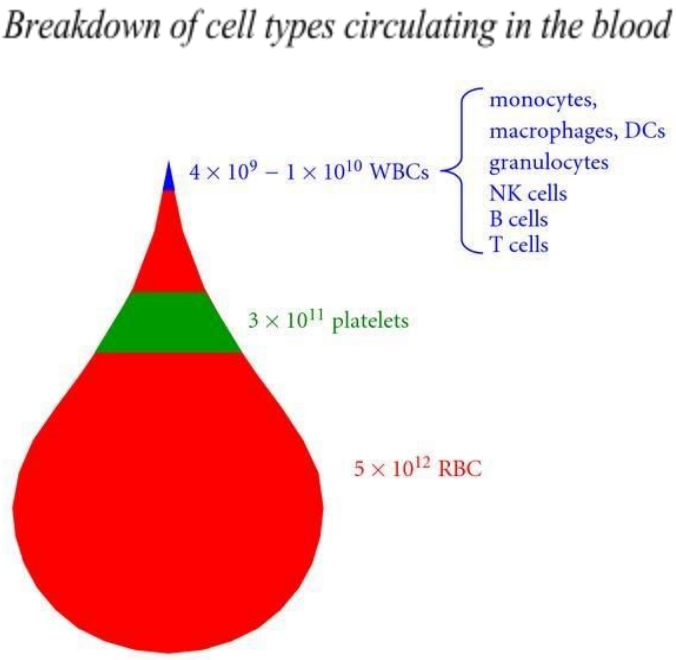


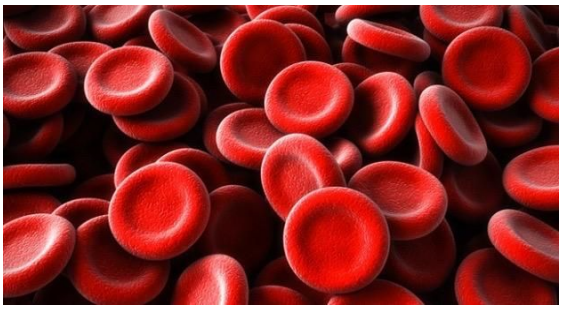
The Parker Institute for Cancer Immunotherapy, created in 2015 by billionaire entrepreneur Sean Parker, will team up with over 30 public, private, and nonprofit institutions to create new algorithms in the search for more effective cancer immunotherapy treatments. The algorithms will comb through sets of genomic data from cancer patients in an attempt to find relevant cancer neoantigens, fragments of mutated DNA in cancer cells that the immune system can be educated to track and eliminate, effectively killing the cancer. The group of institutions involved in the new initiative is comprised of universities such as Harvard and MIT, as well as research institutions and hospitals including the Memorial Sloan Kettering Cancer Center and the Dana-Farber Cancer Institute.

Little Change With Young Blood

by Lauren Mei

In the article "Old Blood Carries Risks for Brain" by Laura Sanders, the effects of old blood on the functions of the body was studied through the use of a new transfusion process in mice. Researchers in the University of California devised a method in which the blood of mice of different ages can be transferred. Then, the effects of the newly introduced blood on the performance of the brain could be studied. While old mice did benefit from the infusions of young blood in other regions of the body, they still had fewer newborn nerve cells in the hippocampus, implying that the new blood didn't really help in terms of cell genesis. However, old blood or the components that it contained seemed to have a detrimental effect on the brains of young mice. The old blood quickly reduced the number of newborn nerve cells in young mice, thus leading the researchers to conclude that a correlation can be drawn between the blood and the mental decline that comes with age.

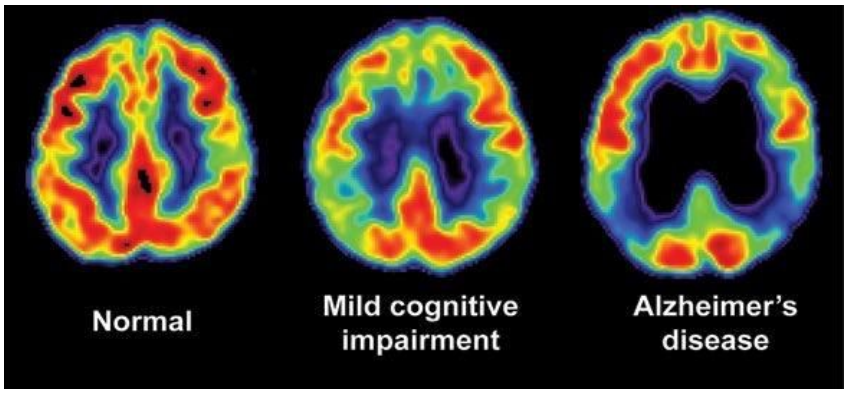




Fun fact: About 45% of human blood by volume is composed of red blood cells (RBCs). RBCs, unlike every other type of cell, don't actually have nuclei, which means that RBCs don't have any DNA. This means one could even argue that, despite being fully functional cells, RBCs aren't actually alive!

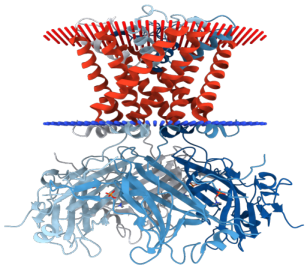
Alzheimer's & the Kir6.2 Channel

by Deena Haque



**Brain scan of an Alzheimer's patient compared to a patient with normal brain function and one with mild cognitive impairment*

There may be more to Alzheimer's disease than we think. According to an article on *ScienceDaily*, Alzheimer's is like diabetes, only in the brain and not your pancreas. Tohoku University researchers, led by Dr. Moriguchi and Professor Kohji Fukunaga of the Graduate School of Pharmaceutical Sciences, have found a new way to treat Alzheimer's disease. They observed similarities between the way insulin signaling occurs in the brain of Alzheimer's patients and in the pancreas of diabetics. In the pancreas, insulin signaling increases due to the blocking of Kir6.2 (a critical subunit of a ubiquitous ion channel), which directly causes a drop in blood glucose levels. In the brain, the Kir6.2 channel blockade first activates a highly energetic signaling molecule (CaM kinase II), eventually causing insulin signaling to increase. Increased insulin signaling in the brain has been shown to lead to memory development. Memantine is a drug that is often used to treat Alzheimer's by inhibiting receptors (N-methyl-D-aspartate receptors) that stops excessive glutamate transmission in the brain. However, new research has also shown that memantine inhibits the Kir6.2 channel. This helps prevent insulin signals from having functional issues in the brain. The researchers performed an experiment with mice and discovered that the use of memantine improved behaviors related to memory in the mice by inhibiting the KATP channel Kir6.2. The two KATP channels Kir6.1 and Kir6.2 are important parts of these receptors. Because memantine inhibits the KATP channel, it moderates the effect of the anti-diabetic drug in peripheral tissues. According to Dr. Moriguchi, this helps improve cognitive functions and how well Alzheimer's patients retain their memory. Now, the goal is to find new treatments for Alzheimer's disease using the inhibition of the Kir6.2 channel.



High Intensity, High Efficiency

Annie Li

It is already known that high-intensity interval training consists of repeatedly alternating between intense activities and lighter activities. The durations of intense activities in high-intensity interval training are short (some as short as 10 to 20 seconds), yet they are as effective as an hour of moderate aerobic exercise. High-intensity interval training is quick and efficient, fitting into many people's busy schedules. However, studies have shown that many people don't like hard exercises, and the intense intervals often discourage people from doing it regularly.

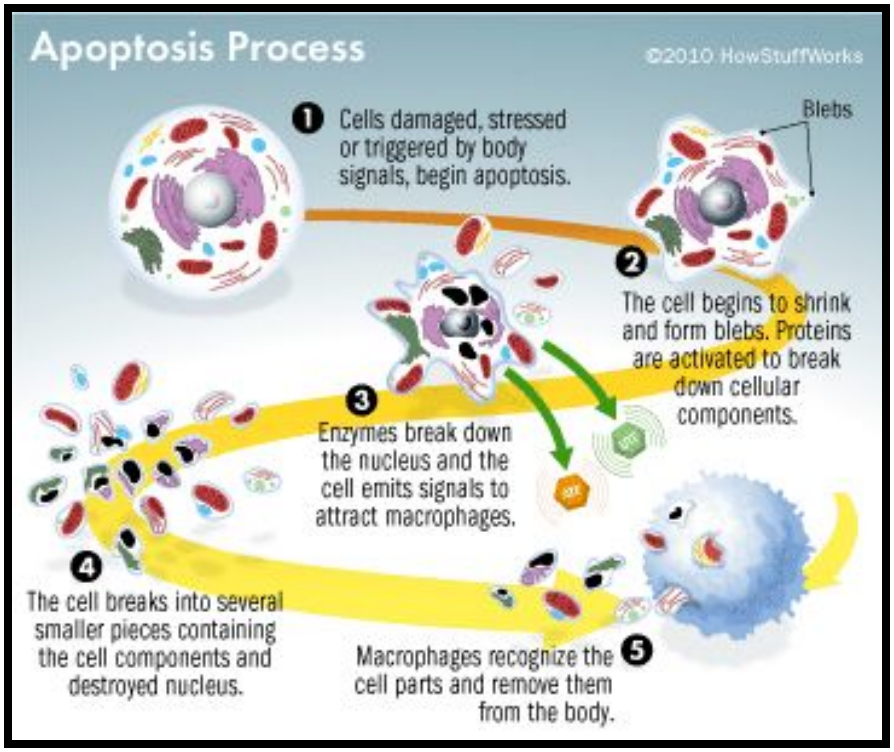
Because of these studies, scientists have tried to find ways to lessen people's discomfort during high-intensity interval training. In a new study, researchers from McMaster University in Hamilton, Ontario tested whether listening to music makes the workout feel better. They brought 20 healthy, young, and physically active males and females who had never tried high-intensity interval training before. They completed questionnaires about what type of songs they liked, how they felt towards high-intensity interval training, and how they think they would like the exercise in the long term.

After the questionnaires, they started with a two-minute warm-up on a stationary bicycle and then completed four 30-second intense intervals with four minutes of rest sandwiched between the intervals. The participants completed this workout two times, one without music and one with music. After each workout, they rested for an hour and completed some questionnaires on how they liked both workouts.

Surprisingly, researchers found out that the participants enjoyed the workout, with ratings of five on a scale of one to seven. They liked the workout with music even more, with ratings close to six. Furthermore, more participants stated they would continue this type of workout with music. These results indicated that intervals can be enjoyable with or without music. However, the study included only young and healthy participants; they were all open to trying the workout and had similar tastes in music. The study didn't show anything on how those who are older, sicker, or less willing to participate in intense exercise would feel. Furthermore, the study allowed the participants to perform the workout only twice; it would be better if they completed it regularly more frequently to see if it really would be a pleasant workout in the long term. As of now, we should try high-intensity interval training if we haven't, and maybe add some jams in because it might not be that bad!

Potential of HIPK2

Heyu Li



In a normal cell, severe DNA damage causes the cellular signaling network to release a cell death signal by activating a signaling molecule—p53. However, a protein named deacetylase Sirtuin I (SIRTI) suppresses the cell death signal conferred by p53 so that the cell death doesn't occur. Researchers in Heidelberg, Germany found that when there is an upregulation of HIPK2, an important signaling molecule, HIPk2, binds to SIRTI and thus prevents SIRT1 from interfering with the cell death signal conferred by p53. This is the opposite of normal relations between HIPK2 and SIRTI. SIRTI usually has numerous effects related to health, tumour suppression, and general longevity while HIPK2 is a Knase that activates certain substrates so that they can carry out their effects. If there is an upregulation of HIPK2, there will be adverse effects like Alzheimer's disease, but if there is a downregulation of HIPK2 then the cell death won't occur. The future goal, like most drug developing goals, is to develop a drug that acts on HIPK2 so that the good parts remain (cell death) and the bad parts are removed (adverse effects as a result of excess amounts).

Parkinson’s in the Guts?

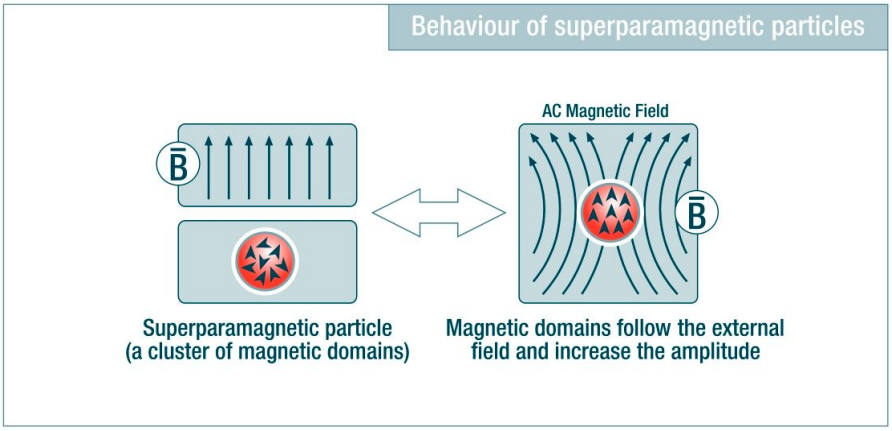
Vanessa Lam

A study has found that alpha-synuclein, a protein linked with Parkinson's disease, can travel from the gut to the brain (at least in mice). Twenty-one days after the injection of synthetic alpha-synuclein clumps into the stomachs and intestines of mice, it was found that new clumps of naturally occurring alpha-synuclein had formed, possibly persuaded by the synthetic versions nearby and that the alpha-synuclein clumps had spread to the vagus nerve. It had then spread to and accumulated in the midbrain. The midbrain is the location of nerve cells that produce dopamine, and those cells die in humans who have Parkinson's. It can then spread through astrocytes (cells in the brain and the spinal cord). The buildup and spread of alpha-synuclein appear to cause abdomen and mobility issues in the mice, similar to the effects experienced by humans with Parkinson's. This research has caused some scientists to start looking for the beginning of Parkinson's disease in the gut.

Potential of Superparamagnetic Magnets

Michael Robertson

A recent study conducted by Ke Zheng Chen and Ji Ma from the Qingdao University of Science and Technology may revolutionize how we deliver medicine to patients. So far, we have simply allowed medicine to drift around our bodies until it diffuses into the desired cells, and nanotechnology has shown great potential for targeted drug delivery. However, we may now use miniature magnets, instead of intricate little machines, to do the same thing. This new study focused on what are called superparamagnetic magnets. These are special nanoscopic magnets that can switch polarity in response to changes in temperature because of their molecular structure. Scientists have been aware of these magnets for some time now and can successfully make them, so why has this study only revealed this possibility now? The answer is that although scientists can make them, it has been difficult to make the paramagnetic magnets larger. A larger size would be ideal because smaller magnets clump together too easily and do not respond to extemal magnetic fields well. With larger superparamagnetic magnets, they will not clump together and will respond to gradients better. In the future, doctors may be able to use external magnetic fields to guide the magnets carrying the medicine directly to the intended cells. With this new accuracy, treatments for diseases such as cancer, where current treatments damage surrounding tissue, could be made harmless for the rest of the body.



Problems With Heartburn Solutions

Zihao Liu

Contrary to popular belief, some of the most frequently used heartburn drugs can actually cause heart problems. An analysis of almost 250,000 medical records in Denmark showed an association of these drugs with stroke. Moreover, the drugs may also be linked to dementia and kidney problems.

The drug, a proton pump inhibitor which is supposed to relieve heartburn, was shown to raise the chance of having strokes by 21 percent in patients who take the drug. Researchers reported that although these patients tended to be older and sicker, the level of risk was associated with dose. The researchers explained that the patients who took minimal doses of this drug did not appear to have a higher risk.

Proton pump inhibitors are available all over the nation; while they are valuable, they are also dangerous. The researchers emphasized that some people often take them for too long or without a clear reason. People need to have a conversation with their doctor to see if they really need these drugs.

Examples of commonly used heartburn drugs.

Student: Patel, Dhiraj

Research Summary: Antimicrobial resistance has become a major global concern during the last half-century. This resistance can render a large and increasing range of treatments of infections caused by a variety of factors including bacteria, parasites, viruses, and fungi, ineffective. These microorganisms can successfully resist a general group of antibiotics usually used in clinical settings, including fluoroquinolones and macrolides. In order to produce effective treatment options for individuals who have developed resistance to antibiotics due to these microbes, they need to be monitored. Many common microorganisms can cause serious ocular infections, making the evaluation of microbial resistance to antibiotics a necessity in order to improve the quality of care that can be provided to patients. This retrospective study is designed to monitor and track the resistance of the Staphylococcus aureus bacteria against a group of antimicrobial agents by analyzing the ocular culture reports collected by the Microbiology Department at the Icahn School of Medicine over the last five years. Furthermore, this study was also designed to test for statistical significance between the age of the patients with a Staphylococcus aureus infection and the resistance values they displayed towards the antibiotics. Resistance and susceptibility were determined by analyzing minimum inhibitory concentrations (MIC) and sensitivity and resistance classifications were determined by utilizing established by CLSI guidelines.

Student: Constantine Athanitis

Research Summary: Many mechanisms are activated during skeletal bone repair, including angiogenesis, osteogenesis, and the inflammatory response. While the individual events are known, the interplay of the inflammatory response and angiogenesis is not completely understood. We hypothesize that the early inflammatory response facilitates angiogenesis through the upregulation of cytokines. Due to the inherent flaws of purely in-vivo and in-vitro studies, we have developed a combination of the two, creating a 3D biomimetic model to study the interactions of the cytokines and vascular cells within the engineered microenvironment. We tested different concentrations and times of various types, which include TNF-alpha, IL-1beta, and IL-6. The angiogenic sprouting length and frequency increased in the presence of cytokine conditioned media. These data suggest that certain in-vitro cytokines can be supplied into the bone injury site to enhance the angiogenesis needed in bone repair.

Student: Lee, Jongyoul

Research Summary: Given a finite nonempty subset V of R^k, where $k \geq 2$, we call V a balanced set if the centroid of V is the origin. Equivalently, if the elements of V are regarded as point particles with equal mass, the set V is balanced if and only if the center of gravity of V is the origin. It's obvious that for $n \geq 2$, a set of n points equally spaced around the standard unit circle in R^2 is a balanced set. Which subsets of that set are still balanced? This is the question we investigate in this project. There are some easy partial answers, but the general answer appears elusive. We consider the question from various related points of view: geometric, vectors, and complex numbers. We first considered a conjecture which we call the Cycle Union Conjecture. While intuitively plausible, it was eventually defeated by a counterexample obtained from a test program we wrote in Maple. The results of further testing led us to a revised conjecture, which we call the Subset Subtraction Conjecture. So far, it has survived all our attempts to disprove it. Along the way, we considered a number of side questions. Some we were able to resolve; some were left open.

Student: Nyarko, Stephen

Research Summary: The ability to increase growth rates in the presence of increased nutrients is crucial to the environmental interactions of all cells, yet the mechanisms behind many of these actions are not well understood. Using Saccharomyces cerevisiae as a model organism, further insights into the actions of other eukaryotic cells, including those of humans can be gleaned. For all increases in growth rate, it has been established that there is a decrease in resilience to stress. As such, shock resistance, and specifically heat shock resistance, can be used as an associated phenotype to examine which cells do not respond to a nitrogen upshift, where glutamine is added to a nitrogen limiting proline media; those cells that survive the heatshock are less likely to have responded to the nitrogen upshift. Using a barcoded knockout library of all non-essential genes in the Saccharomyces cerevisiae species, a heat shock screen can be used to identify which gene knockouts are present in increased frequency after the heatshock. Those gene knockouts are thus most likely to be involved in the nitrogen metabolism pathway. Results have not yet been obtained.

Student: Elbanna, Yassmin

Research Summary: An emerging body of data indicates that cancer cells have more Reactive Oxygen Species (ROS), which would theoretically aid in the imaging of tumors to see which parts are more active and understand how quickly the tumor is growing. In this context, ROS are a key focus of the research into the chemical mechanisms underlying the progression of the disease. The goal to detect ROS has motivated the construction of a primary detection. This project utilized Xanthine Oxidase, an enzyme that

generates reactive oxygen species, to see how quickly the rate at which the Xanthine is picked up by the cell and converts in the Uric Acid and other ROS. To summarize, we believe that xanthine oxidase is the best method for measuring the rate at which xanthine is picked up by a cell and converted into xanthine oxidase. Using UV-Vis and Western Blot technique, we determined that Xanthine was the most efficient metabolite and that cells do in fact pick up the xanthine and change in their absorbency. We then believe that this would be a useful indication of the metabolic qualities of prostate cancer. This importance of this project is that it would develop a more efficient and detailed measurement of cancer imaging.

Student: Yong Gonzalez, Gianluca

Research Summary: Prostate cancer is the most frequently diagnosed cancer in American men, as over 10% of men over the age of 65 are affected by it. Though most prognoses for prostate cancer are positive, many cases can progress into metastatic and eventually fatal disease.There are many genes which are associated with the prostate carcinogenesis and among these MYC plays an important role. Due to the difficulties of studying Myc's role in human prostate cancers, the alternative of using animal models provides an opportunity for further analysis. Various GEM models have been generated to analyze MYC within the context of prostate cancer. The HI-MYC model, which has been extensively investigated, is characterized by the development of adenocarcinoma and a low frequency of metastasis. In this work, I analyzed the MYCT58A model, for the first time, and found that these mice developed adenocarcinoma and can potentially be a superior metastatic model of prostate cancer. This model, can be an important tool for the further advancement of field of prostate cancer.

Student: Park, John

Research Summary: Estrogen receptor-α (ERα), -β (ERβ) and progestin receptor (PR) immunoreactivities are localized in the paraventricular nucleus of the hypothalamus of rats and human. The present study examined the distribution of these receptors in the premenopausal stage of saline induced mice. Antibodies to ERα and PR were localized separately by light and electron immunomicroscopy to premenopausal mice. ERβ was added to both in order to distinguish its activities during the premenopausal phase. Ultrastructural analysis revealed that ERβ was localized exclusively to extranuclear sites in the striatum morer within the ERα induced mice compared to the PR induced, with 40% of the dendrites and axon terminals labeled for these receptors. The labelling patterns in the mice for the two antibodies is similar to the ultrastructural labeling found in rats which can lead us to the suggestion that the regulation of these receptors is conserved across the two animals.

Student: Ho, Kimberly

Research: Stroke is the fifth leading cause of death in the United States. Post-stroke patients suffer mobile, cognitive, and speech disabilities. Many post-stroke patients will find improvement within a range of a month to a year, but the exact amount of recovery is difficult to predict. There are various methods of rehabilitation that will generate different outcomes and rates of improvement. In this work, we propose using Neural Networks to predict recovery based on baseline imaging biomarkers of the anatomical and functional connections in the brain.

Neural Network is a computer system designed to simulate a biological neural system. The goal of the Artificial Neural Network (ANN) is to predict output variables based on input data. ANNs do this by determining system weights to minimize the total sum of squared errors. Applications of the ANN include handwritten characters recognition, image compression, stock predictions, and health and medicine related matters. Neural Networks are efficient because they can train and fit datasets of various sizes, including very large datasets. In the application of ANNs here, we are able to predict how a patient is expected to recover based on measures extracted from their imaging. This tool could help aid physicians in making more accurate prognoses in patients with strokes.

Student: Alice Shao

Research Summary: For my project, I am going to explore the cardiovascular disease and coronary heart disease deaths among males due to air pollution. I will analyze PM2.5 levels, which is harmful particulate matter found in air pollution. I will also include box plots, histograms, and data tables that show median, mean and other summary statistics. I will conduct statistical tests on the data, such as t-tests on a statistical programming language called R. The main objective of this project is to compare the the group of people who died from cardiovascular disease (CVD) and coronary heart disease (CHD) with the group of survivors.

Student: Kirou, Raphael

Research Summary: Tuberculosis is a fatal infectious disease that is responsible for the deaths of approximately 1.5 million people each year. Although several drugs have been found to kill Mycobacterium tuberculosis (Mtb), mutants resistant to the drugs have evolved and constitute a global health problem. New drugs are being sought to target bacteria whose mutated genes cause resistance. One method of identifying potential targets for new drugs is to screen compound libraries, expose bacteria to compounds that kill the cells, and analyze survivors for resistance mutations. Two similar anti-tuberculosis compounds, Compound A and Compound B, were tested with a bacterium genetically

similar to Mycobacterium tuberculosis, Mycobacterium smegmatis. Cells that grew after exposure to the compounds had mutations that caused resistance. After several mutants were isolated, they were tested to identify the genes that mutated to cause resistance. One gene, Gene X (homologous to Gene A in Mtb), had previously been found to be mutated in previous experiments after exposure to Compound A in both M. smegmatis and M. tuberculosis. Another gene, Gene Y, was suspected as a possible mutation in M. smegmatis because its homologous Gene B was confirmed to be mutated in M. tuberculosis. In this study, Gene Y was found to be mutated and cause resistance in one of the M. smegmatis mutants. The gene had a single nucleotide substitution that resulted in a proline amino acid changing to a leucine amino acid. This information helped to confirm the target of Compound A and gave insight into future research for alternate, less harmful drugs to inhibit Mtb.

Student: Jin, Claire

Research Summary: The phenomenon of foveal crowding reduces the ability to recognize objects in clutter and limits visual perception and object recognition. Foveal crowding can impact daily activities that involve identifying small objects in a cluttered background, one example of which is reading rate. I used a custom-designed acuity test called "Critical Spacing" on the program Matlab with 9 custom designed letters, "Sloan" and "Pelli". The 9 letters are used in conjunction with flankers on both sides and presented to the observer 3 at a time. The observer must remain a distance of 90 centimeters from the computer screen. The observer's objective is to fixate at the cross hairs present on the edge of the screen while the 3 letters flash in a horizontal row to the right of them. It is the goal that the observer is able to identify the center letter and enter it into the keyboard. The letters only flash for a fraction of a second before they disappear. Thus, the acuity test measures the level of peripheral vision the observer has, since he or she only has a given amount of time and must have a certain degree of peripheral vision to properly identify the letters in the test.

Student: Yueyang (Sam), Xu

Research Summary: It may seem that the purpose of the visual system is to perceive the natural world; however, it has evolved to perform an additional purpose—to make decisions. The visual system must make an inference about its source in order to make a decision—for example, edges vs shadows. One approach to understanding both the complexity of natural images and the properties of visual neurons is considering the statistical structures of natural images. It is known that the structures of natural images are predictable and distinguishable, which allow the sensory periphery to utilize principles of efficient coding to compress transmission signals and conserve resources for more informative features. The common

statistical properties of natural images are fundamental to the study of cognitive science and computer vision. Not only are the principles of optimal coding used by the visual system to distinguish non-random structures, they are also fundamental in various computer imaging applications: image restoration, super-resolution, image compression, and texture synthesis. Understanding image statistics of different image categories is fundamental in better understanding image statistics and how to better create applications around them. In this research, we seek to study the local image statistics of magnetic resonance imaging (MRI) images. We hope to determine the statistical structures of non-natural images and discover how they vary with natural images and whether different visual salience is necessary for different image categories.

Student: Nina Uzoigwe

Research Summary: Throughout history, fat has been deemed detrimental towards health and lifespan, especially in cardiovascular diseases and diabetes. However, through recent quantification of lipid molecules in C. elegans with prolonged lifespans, studies are revealing a correlation between fat metabolism and longevity. Thus, in this study, I sought to further characterization of the role of genes associated with longevity, called cep-1(gk138), in the light of lipid droplet quantification. Results indicate that cep-1 is not only a critical modulator of the lifespan of C. elegans, but the knockout also significantly increases the lipid droplet concentrations from the norm found in the wild types. Cep-1 was also found to play a role in regulating metabolic stress in mutants with a knockdown in both cep-1 and atg-7, a gene that encodes an E1 enzyme that regulates mitochondrial fatty acid oxidation. These insights as well as further experiments in this area will provide a greater understanding in the complexity found in the relationship between the presence of lipids and longevity.

Student: Habib, Khandker (Shadman)

Research Summary: The evolutions of Othello game playing has transcended from the human mind to the computer mind. Recent efforts to replicate game playing heuristics and mechanisms provide evidence of important aspects of efficient game play. This study was designed to evaluate the positional features, heuristics, search mechanisms and other performance aspects of Othello machine programming in order to gain a stronger understanding of how to improve for the future. The first key theme between many Othello programs is the concept of corners. Corners drive the stability of the game and add coins to the total and thus must be prioritized in machine game play. The next key aspect is search mechanisms with less depth and less time. Genetic programming (GA) offers a great alternative to conventional deep tree searches which often take much longer than GA, which is based off of rotational symmetry. The third key

aspect is the hierarchy of positional features examined in Othello, from most weight to least weight: corners, stability, mobility, coin parity. It is important to recognize these differences and apply them with heuristics to allow consistently strong moves, both offensively and defensively. The final key element is the machine's ability to find heuristics that are associated with winning game states and exploit them before other less important heuristics. For this reason, the machine must learn by playing a copy of itself and keeping large databases of stored information for easy access. When these key aspects are combined, as in some research reviewed by this study, a stronger and more efficient Othello game-playing machine can be developed.

Name: Phillip Kucher

Research Summary: Bacteriophages (viruses that infect bacteria) are the most abundant biological entities on Earth. Deciphering their inner workings and processes is therefore essential to acquiring a working knowledge of the predominant acting selective force acting on the biogeochemical cycles of our planet. One outstanding area in which research of bacteriophages is lacking is the quasispecies phenomenon observed in double stranded DNA (dsDNA) viruses. More specifically, Pseudomonas phage phiNFS exhibits a quasispecies phenomenon in the form of alternating cycles of pseudolysogeny and lysis. The objective of this study was to uncover the underlying genetic reason behind phiNFS's curious growth patterns. Analysis of the genome of phiNFS samples with 6000X coverage of every base revealed 15 sites in the ~40 kb genome at which the base would undergo spontaneous single nucleotide polymorphism more than 1% of the time. The working theory for why this mutation effect occurs is that mutations in the host bacteria, P.aeruginosa, lead to errors in replication of the virus. This circumstance is incredible because it means that phiNFS and similar phages can be used as accurate indicators of mutagenic compounds, as these mutagenic compounds will affect the host bacteria and consequently the phages.

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