



STEM 2 Schools Science Journal

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Note From Founder and President

Dear Readers:

It gives me great pleasure to introduce the third issue of the Stem 2 Schools Science Journal. I founded Stem2Schools.org, a STEM (Science, Technology, Engineering and Math) knowledge-sharing platform with a mission to spread awareness of STEM to high school students. Since the publication of our second edition, we have accomplished great things. We had a very successful STEM Conference on June 16, 2017. We hosted three outstanding speakers at the event: Dr. Jeffrey Morgan, Professor of Medical Science and Engineering at Brown University; Dr. Zorina Pitkin, Senior VP of Quality Systems, Organogenesis, Inc.; and John Shannon, Geologist at AECOM. Our website has more details on the conference including videos of the presentations.

In November 2017, our club chapter in Sharon, MA visited AccuRounds, Inc., a contract manufacturer that machines and assembles precision turned components for the medical, defense, aerospace, semiconductor and emerging technology markets. Stem 2 Schools continues to educate and spread awareness of STEM fields to high school students locally and across the country. We continue to engage with additional companies and academia to help spread our mission. Our hope is to spread the love of science across every school in America. As I think back to how much we have progressed as an organization, I cannot but help feel excited. What started off as an idea has now become a national movement (with one chapter in Canada). I believe in our mission to educate students on STEM research and career paths to be an invaluable service to high school students. This is the last issue that I will oversee as a high school senior. I am indebted to my team, both at Sharon, and across all of our chapters for

turning my vision into reality. I am also optimistic that as new leadership comes in to take this organization forward, our future ahead is even brighter. There are endless opportunities before us and we must never limit our thinking to what we can achieve. I want to thank each and every one of you for this incredible journey and while I plan to continue my mission of engaging in STEM in college, STEM 2 Schools will transition to a new leadership next year and I hope its spirit of educating the next generation of STEM leaders will continue long into the future.

I hope you enjoy and share the joy of what you read in this journal. Thank you for going on this journey with me. I wish future leaders and members of STEM 2 Schools the very best of success.

Best Regards,

Russell Rapaport

President and Founder, STEM 2 Schools

Multifunction Proteins in Mouse Cells Contribute To Blood Cell Development

By Danujan Thirumavalavan

A team of investigators from the Salk Institute for Biological Studies has found a protein called nup98, a special protein that not only controls the diffusion and osmosis processes of molecules in and out of a cell, but also helps direct the development of blood stem cells. Through a multicellular organism's growth and development, these stem cells can differentiate into many other mature cell types.

Martin Hetzer, leader of the study at the Salk Institute, describes how the process of his finding involved multiple fields of biology; these fields included genomics, proteomics, and cell biology. "This model wasn't easy to study, but we developed some very clever techniques in the lab to answer these questions," said Hetzer.

For years, Hetzer's lab has focused on a class of proteins called nucleoporins (nups for short), which are part of the nuclear pore complex. This complex regulates movement between the nucleus of the cell and the cytoplasm containing other cellular structures. There are about 30 proteins in the nucleoporin family, and they carry out a number of different functions in addition to forming the nuclear pore. Several of them are known to act as transcription factors, meaning that these nucleoporin proteins help to regulate when and how genes get translated into proteins.

The finding that nup98 has this additional function was not entirely unexpected. Earlier research from Hetzer's lab had found that it plays a role in gene regulation in other cell types. But the team didn't know about its function in hematopoietic (blood) cells.

In addition, until now the mechanism of how nup98 regulates transcription was not known. The investigators found that it acts through a link with a protein complex called Wdr82-Set1/COMPASS, which is part of the cell's epigenetic machinery. " This epigenetic process helps

to control when genes are transcribed into proteins and when transcription is blocked," says Hetzer, who also holds the Jesse and Caryl Phillips Foundation Chair.

Another thing that was different about this study is that it was done in mouse cells rather than simpler model organisms like yeast and fruit flies. "This is the first mechanistic insight of how one of these nup proteins works in mammals," Hetzer adds. "We have only touched the surface here in uncovering how this evolutionarily conserved mechanism works in mammalian cells." Future work in his lab will extend the study of nup98 to primates and humans.

Progress in Cancer Treatment

By Scott Blatte

Cancer is the second leading cause of death in the United States, taking over 600,000 lives in 2014 alone. Roughly 40% of Americans will be diagnosed with cancer in their lifetime. Yet, many forms have no cure. However, important progress is being made as we speak, giving hope to many that cancer's dominance may be at an end.

One new solution involves our immune system. Our immune system is what fights off foreign intruders, and helps heal cuts and bruises. The immune system is programmed to attack these things at the source, thereby removing them for good. However, cancer is not a foreign invader. Rather, it is the body's own cells that have mutated so that they grow beyond control. As a result, our immune system as is can't take on cancer. An innovative new idea hopes to change that reality. If immune cells could be programmed to carry cancer treatments to the source, it would take cancer treatment to a new level. Some describe this as "hacking the immune system". If this were to become a reality, there would be two critical benefits. First, drugs would be guaranteed to reach the cancer cells at the source, slowing the replication and growth of the tumor. Second, the damage to non-cancerous cells would be limited by hacking. Currently, cancer drugs are injected, causing damage to nearby cells, as the drugs kill cells indiscriminately. By hacking the immune system, this would no longer happen, as the immune cells would carry cancer treatments directly to the tumor, mitigating the damage to nearby organs. Hacking the immune system has shown promise in animals, and soon enough it may show more than promise in humans.

Another innovative solution could potentially stop the cancer before it spreads. Most cancers, if caught earlier, can be treated. However, cancer is hard to detect, leading to tumors

going unnoticed. A simple blood test could make identifying cancer a much easier task. When cancer cells die, they release the virus into the bloodstream. A new test could catch these specimens, which would alert the patient that they have a tumor growing. Two Hong Kong studies have shown real promise, and a commercial product may be coming soon that could become standard in every doctor's office within years of its release.

Drug Reverses Memory Loss in Alzheimer's

By Russell Rapaport

For decades, one of the most pressing diseases to the health of the entire world has been Alzheimer's; however, there have been no new treatments for the disease in nearly 15 years. Alzheimer's disease is the most common cause of dementia; according to the Alzheimer's Society, it is expected that the disease will affect two million people in the United Kingdom alone by 2051. In the UK, researcher Professor Christian Holscher of Lancaster University led research that investigated the use of a drug to treat Alzheimer's. Professor Holscher claims that his novel treatment "holds clear promise of being developed into a new treatment for chronic neurodegenerative disorders such as Alzheimer's disease."

Although it was initially created to treat Type 2 diabetes, this drug has proven to have extreme potential in the fight against Alzheimer's. A triple receptor drug that combines three growth factors, GLP-1, GIP, and Glucagon, the former drug for diabetes can protect the brain from degeneration. In fact, a triple receptor drug has never been used for this purpose before. Problems with growth factor signaling have been shown to be impaired in the brains of Alzheimer's patients. Thus, with the use of three growth factors, this drug type aims to improve the memory of its patients.

In the study, APP/PS1 mice, which are aged transgenic mice in the advanced stages of neurodegeneration that express the mutated genes that cause Alzheimer's, were tested. The genes that are present in these mice are also found in people who have an inherited form of Alzheimer's. The mice underwent a maze test that indicated the improvement of both their learning and memory formation. Specifically, the test revealed enhanced levels of a brain growth factor which protects nerve cell functioning, a reduction in both the amount of amyloid plaques

in the brain linked with Alzheimer's and chronic inflammation and oxidative stress, as well as a decreased rate of nerve cell loss.

Despite the mice tests indicating clear effectiveness in Alzheimer's treatment, it remains unclear whether the same results will be produced in clinical trials. According to Professor Holscher, even though his research shows that a novel triple receptor drug has promise as a treatment for Alzheimer's, "further dose-response tests and direct comparisons with other drugs have to be conducted to evaluate if this new drug is superior to previous ones."

Can We Create Organs?

By Max Brody

As Stem Cell research has developed, scientists have been able to successfully create and implant human body parts into humans. For example, surgeon Paolo Macchiarini was successful in removing a cancer ridden windpipe, and replacing it with a new windpipe that was created in the lab. The questions scientists have now is, can we create solid human organs in the lab such as kidneys and hearts?

Unlike windpipes which just act as a tube for fluid, organs must perform tasks and carry out specific functions on demand, secreting, expanding, or filtering when necessary. As of now, we have been successful in the implantation of bladders in patients that have been living with their new bladders for over a decade. The greatest challenge, however, proves to be creating solid, working organs in the lab such as hearts, kidneys, lungs, and livers. These organs are the hardest to create because they require a multitude of different types of cells, and contain an extensive network of blood vessels that provide them with oxygen and nutrients.

To create an organ, you need a source of the patient's own cells, "persuading" the cells into growing a certain way. To persuade these cells, they need to experience the forces and environments that they would experience in the body. Lungs need to have a constant flow of air going through them. These cells then need to have the correct scaffolding to grow so that they form the correct shapes. However, solid organs have more complex scaffoldings, requiring some teams to use existing organs, stripping down the cells to leave the scaffolding of the heart. Then they replace the old cells with the patient's cells, creating a living solid organ. Scientists have been successful in creating functioning livers and even beating hearts using this method, some are beginning to implant them into living animals as a part of the testing.

Some researchers are very enthusiastic about the possibility of the organ-building capabilities of 3D printers. Rather than using ink, these printers would use living cells, building, layer by layer, functional organs. As of 2011, we were able to print blood vessels, and it is only a matter of time before we develop the technology to print organs.

Thousands of people are on lists for receiving a donor organ, whether it be a heart or a liver. Many of these people will die before they even have the chance to receive the organ necessary to sustain their lives. With organ building capabilities expanding and advancing, many of those who would have died waiting on a list to get an organ will be able to live. Organ building is a stepping stone in the advancement of biotechnology and the understanding of the human body. If we can give someone a new heart, what won't we be able to do in the future?

NASA Telescope Reveals New Exoplanet: Trappist 1

By Danujan Thirumavalavan

In February of 2017, NASA revealed the first-known system of seven Earth-like planets around a single star. This is a huge breakthrough in a continuing search of Earth-like exoplanets around our galaxy which could possibly meet the standard criteria to harbor life, showing that maybe we are aren't the only ones in this vast Milky Way Galaxy 100,000 light years across! Three of these planets are located in the habitable zone. A habitable zone is an area around a star in which a planet can harbor rocky climates and contain liquid water.

This seven-star exoplanet system is known as Trappist-1, named after the star in which these seven exoplanets are orbiting around. In contrast to our sun, the Trappist-1 star – classified as an ultra-cool dwarf – is so cool that liquid water could survive on planets orbiting very close to it, closer than is possible on planets in our solar system. All seven of the Trappist-1 planetary orbits are closer to their host star than Mercury is to our sun. The planets also are very close to each other. If a person was standing on one of the planet's surface, they could gaze up and potentially see geological features or clouds of neighboring worlds, which would sometimes appear larger than the moon in Earth's sky!

Spitzer, an infrared telescope that trails Earth as it orbits the sun, was well-suited for studying Trappist-1 because the star glows brightest in infrared light, whose wavelengths are longer than the eye can see. In the fall of 2016, Spitzer observed Trappist-1 nearly continuously for 500 hours. Spitzer is uniquely positioned in its orbit to observe enough crossing – transits – of the planets in front of the host star to reveal the complex architecture of the system. Engineers optimized Spitzer's ability to observe transiting planets during Spitzer "warm mission," which began after the spacecraft's coolant ran out as planned after the first five years of operations.

In addition to the Spitzer telescopes, other telescopes are currently being developed by NASA to investigate the climate of these seven-star systems. For instance, NASA has announced a new telescope called the James Webb Space Telescope, which is planned to be launched in 2018. This telescope will not only continue to work from the data provided from Spitzer, but it will also be able to look for certain substances that are important for life. With much greater sensitivity than the Spitzer, the Webb telescope contains mechanisms that search for chemical fingerprints of water, methane, oxygen, ozone, and other components necessary for the planet's atmosphere to make sure that the planet is safe enough to harbor life.

Supermassive Black Holes Regulate Star Production

By Zachary Light

As time goes on, galaxies reach a point where they stop forming new stars. This process is known as quenching, and it's been somewhat of a mystery to us. Now, new research has shed some light on the matter. Most large galaxies have a black hole at the center millions of times the mass of our sun. The origin of these supermassive black holes is a mystery in themselves, but they may help to explain quenching.

The study was done by researchers at the University of California at Santa Cruz. Using data from the Hobby-Eberly Telescope Massive Galaxy Survey, they have found a correlation between the size of these black holes and the speed of the transition from active stellar formation to no stellar formation. In other words, between two similar galaxies where one has a much more massive black hole in the center, the period when new stars form is shorter and ends more abruptly in the galaxy with a more massive black hole.

It's not entirely clear how the black holes would cause quenching, but a popular theory has to do with Active Galactic Nuclei. Before large amounts of matter fall into a black hole, its orbit gets smaller and smaller and it moves faster and faster. As it moves faster and collides with other matter, it heats up and forms an accretion disk around the black hole, releasing monumental amounts of energy in the form of radiation. When an accretion disk forms around a supermassive black hole, it's known as an Active Galactic Nuclei (AGN). These AGN sometimes release x-ray bursts, which can eject gas from the galaxy entirely if they're powerful enough. Large clouds of gas are necessary for the formation of new stars, so this could explain how larger black holes lead to faster quenching.

Interstellar Object

By Daniel Lilienfeld

Astronomers have long theorized that objects from outside of our solar system could pass through it, however, until recently, interstellar objects have not been observed in our solar system. On October 19, 2017, astronomers in Hawaii chanced upon an intriguing object using the Pan-STARRS 1 telescope, and quickly determined that it had come from outside of our solar system. This observation was the first interstellar visitor into our solar system ever observed and the object was named 'Oumuamua by its discoverers which is Hawaiian for "messenger from afar arriving first."

Directly after the object's discovery, numerous telescopes from around the world put their sights to it to study this historical finding. 'Oumuamua was determined to be an asteroid rather than a comet since it did not display the cloud of gas that would normally surround and trail a comet. Astronomers initially thought it could have been a comet due to its speed of 85,700 miles per hour relative to the sun, meaning it could travel from Boston to Los Angeles in two minutes. However, since there was not a hint of dust surrounding the object, it was determined to be chemically inert and, therefore, an asteroid. The asteroid's shape is different from those of our solar system as it is about a quarter mile long but only 40 meters wide making its length ten times longer than its width. Karen Meech was able to determine the elongation of the cigarette shaped asteroid by observing its brightness through telescopes. Astronomers observed a massive variation of brightness as the asteroid moved away from earth indicating that it was significantly longer in its length than its width. Moreover, 'Oumuamua has been traveling through space for hundreds of millions of years so it has encountered and been struck by an immeasurable quantity of cosmic rays, therefore, leading to its dark red color. The combination of these properties led

astronomers to believe that 'Oumuamua is an asteroid comprised of dense rock and possibly metals and that it has no water or ice.

Astronomers are excited about 'Oumuamua's discovery since the interstellar asteroid will provide clues as to how other solar systems are formed outside of our own. The asteroid will be studied continually until it completely vanishes from our sight, yet it will greatly enhance the study of other solar systems and how they are formed. The lucky discovery that happened when the Hawaiian astronomers had their telescope in the right place at the right time has led to lots of new research and increased our potential to create protection from stellar threats to our solar system and planet. As of now, however, astronomers are waiting anxiously for the next interstellar object to visit our solar system.

How Meditation Alters Your Brain

By Russell Rapaport

Everyone knows meditating is good for you; it relieves stress, calms you down, and increases your mindfulness. However, a new study has proven that meditation literally changes the human brain. Sara Lazar, a neuroscientist at Harvard Medical School and the Boston's Children's Hospital, became interested in how meditation works after trying yoga and decided to conduct her own research.

The first study Lazar conducted compared those who meditated (the experimental group) with those who did not (the control group). Interestingly, her study found that the experimental group had a significantly increased amount of gray matter located in the sensory regions, insula, and auditory and sensory cortex. Logically, an enhancement of one's senses from meditation makes sense, because it causes people to be more mindful, pay closer attention to their surroundings, and think less. Furthermore, despite the fact that our cortex shrinks as we get older, Lazar's study proved meditation can change that—50-year olds that engaged in long term meditation had the same amount of gray matter as people half their age who didn't meditate.

In addition, Sara Lazar's second study of meditation's effects on the brain indicated even more concrete results. Specifically, Lazar found an increase in thickness in four separate regions of the brain. The most prominent increase in size was in the posterior cingulate, a part of the brain involved in mind wandering. Secondly, those who meditate had a size increase in their left hippocampus, which assists in memory cognition and learning. Also, the temporo parietal junction, or TPJ, saw an increased thickness in the brains of those who meditate, as it is associated with the control of empathy and compassion. Lastly, the amygdala, which is the fight

or flight part of the brain, crucial for anxiety and stress, was smaller in the group that went through the mindfulness-based stress reduction program.

Because Lazar scientifically proved there is a causation between meditation and the size of various regions of the brain, she also was able to conclude that meditation is most effective if it's practiced once a day for eight weeks. After eight weeks, Lazar's data showed changes in the brain. Nonetheless, she cannot indicate from her data exactly how long each day one should engage in meditation in order to get clear results and a decrease in stress.

In the future, Sara Lazar hopes to investigate just how much time a day someone needs to meditate to benefit. Further, Lazar also hopes to combine the efforts of other scientists, who have shown that meditation is able to enhance emotion and attention regulation skills, with her own studies. By combining neuroimaging science with behavioral science, she hopes to determine the functionality of the changes in the brain.

In addition to changes in the brain, several scientific studies have shown definitive changes in the human body from meditation. For instance, a study led by Dr. David Creswell indicated that those who practiced mindfulness had much lower levels in their blood, a marker of unhealthy inflammation. However, even he indicated further studies must be conducted to determine just how precisely meditation leads to a reduction in inflammation. Thus, while it is clear meditating has significant scientific effects on the body beyond spiritual voodoo, it remains unknown just how effective meditation can be.

3D Printing, Digital Communication, and Virtual Reality Enhance Movies

By Max Brody

While movies have been around for an extended period of time, they have not always been as complex and “life-like” as the films seen today in movie theaters and homes across the globe. They used to be silent and in black and white, whereas, now, they are full of color and sound effects that add to the experience of the movie viewer and enable the director to be much more creative and imaginative. As time goes on, technology continues to improve and develop, leading the way for movies to become increasingly advanced, realistic, and efficient.

3D printing has become very helpful in making props for designing the sets of movies. A director can imagine what they want and create it, making it a reality. For example, the canopy of Peter Quill’s spaceship in *Guardians of the Galaxy* was 3D-printed. In creating their reality, the directors are now able to visualize the set that they wish to create before they create it with virtual reality goggles. The set that they wish to create can be created in a program, and the director is able to walk through it and make sure that it is perfect before the set is physically created. Also, with the development of digital communication, creating a film has become much more efficient and much less costly. A production team can work in one place while the film shoot is in another. This enables the movie to acquire the best team regardless of their location, and streamlines the movie-making process. Animation has also developed film-making, as a producer is able to create any scene that they can possibly imagine. Animated movies have no limitations in that they can be created on a computer and don’t have to blend with reality. Animation has created everything from talking animals to people with superpowers, which could never have been done when movies were first being created. Animation has formed its own new genre.

The constant innovation in technology is giving movie-makers an increasingly number of tools to create exactly what they imagine or picture. As technology develops, movies will become increasingly close to what the creator was dreaming up in their imagination. There are no boundaries as to what we can create, as we have already been able to develop virtual reality. In the future, movies will be seen in new formats (Like virtual reality), 4D, and much more. The possibilities for movies are endless, and we have only seen the start.

Robert Bunsen's Contributions to Science

By Jake Ross

Robert Bunsen, a chemist born in Germany, was most famous for his invention of the bunsen burner. Robert was born on March 30th, 1811 and died on August 16th, 1899. His long, spectacular science career started off in 1831 when Dr. Bunsen received his PhD at the University of Gottingen. He went to the University to study mineralogy, physics, and of course chemistry. There he received a good source of education that he later used in future positions. After graduating, Bunsen took his knowledge and spread it to others by acquiring a lecturing position at the University of Gottingen in 1833. That same year, Bunsen discovered that the type II binary compound, Iron Oxide Hydrate when combined with arsenic makes the arsenic nonpoisonous. As he continued to lecture he focused mostly on his discovery and the way he discovered it. In a lab, he decided to try it out of curiosity and then tested the arsenic using chemistry strategies and finally formed the conclusion that when both substances are mixed then arsenic ceases to be poisonous.

About 22 years after he discovered this, he invented the bunsen burner. This scientific tool creates a burning flame that is hollow on the inside and gives the scientist the ability to choose what happens to the flame. This tool is also used to teach people how flames react with different types of compounds. For example, when you burn potassium chloride in a flame it then makes the flame turn violet. When you burn potassium nitrate the flames are again violet. This proves that the color of the flame is only based on the cation that is used. Using Dr. Bunsen's invention helps scientists flourish in the world of chemistry because he gave them a resource to be able to try different experiments involving gas and fire.

Pharmacogenomics: The Future of Medication

By Sam Zlota

Drugs are used to treat, cure, and prevent a wide range of diseases; nonetheless, they have varying levels of effectiveness and many have side effects. It is well known that drugs undergo rigorous testing to determine if they are safe to consume; however, these tests often fall short to testing the efficiency of the drug, simply put, because disease differently affects everyone. As genetic technology develops, scientists hope to study further the connections between the effects of drugs and genetics. Essentially, with this ability, doctors will be able to personalize medications to maximize the effectiveness and ensure safety when treating their patients. With detailed knowledge of the human genome, scientists are now steps closer to prescribing drugs based off unique genetic differences.

One person may respond quickly to a drug, another may respond slowly, and another may have an adverse reaction to the same drug. Also, there is usually more than one drug to treat a single disease. As a result, doctors often use a “trial and error” approach for treatments because of their inability to predict outcomes. Moreover, certain diseases may never be able to be treated through this “one size fits all” approach. Most diseases affect people at an individual level and should be treated likewise; however, doctors are fairly limited now, but someday may be able to achieve complete personalization for their patients.

Scientists have discovered that one’s genetic makeup has a great influence on how they will respond to treatment. Moreover, the same disease is usually caused by varying factors among different people and will affect them likewise. To the same extent that genetics can be used to determine the diseases a person may develop, genetics can be used to discern what the best treatment option for those diseases may be thereafter.

Today, pharmacogenomics is in use with patients suffering from severe diseases. Cancer, for example, is one the most prevalent genetic disorders; there are many methods that are used to treat cancer, but many have debilitating side effects. Doctors hope to use pharmacogenomics to better treat their patients.

Today Doctors can screen patients to pinpoint genetic variations that are known to cause adverse reactions. On the contrary, some drugs can only work for patients with certain genetic variations. For example, the breast cancer drug Herceptin will only work for patients with a certain variation in the HER2 gene.

This promising discipline that combines two major fields sheds light on the future of personalized medicine and eventual cures for devastating diseases that affect many on a daily basis.

Imperial College of London launches New 3-D Printing Techniques

By Kennedy Martin

The researchers of Imperial College of London have refined a new method for constructing 3D structures using cryogenics, which is the branch of physics dealing with the production and effects of very low temperatures, and different 3D printing techniques. This builds from previous research. But it is the first one to come up with structures that are soft and flexible enough to mimic the properties of different organs. Organs such as the brain, heart, and lungs. Their technique that has been brought to life, has now been published in the journal entry “Scientific Reports”.

Being able to create an almost exact replica to match the softness, as well as structure of body tissues means that these replicas could be used in medical procedures to use as a template for the regeneration of tissue, meaning that damaged tissue can be manipulated to regrow. “Regenerating damaged tissue by 'seeding' porous scaffolds with cells and encouraging them to grow allows the body to heal without the issues that normally affect tissue-replacing transplant procedures, such as rejection by the body.” This technique is becoming more common because it creates the replica as if it is just as soft as the tissues in the human body.

Researchers have tested the 3-D printed structures, and they have successfully found that there had been a success in the attachment and survival of the tissues. This study could eventually lead to more opportunities and possibilities, which is “medically exciting due to their ability to change into different types of cells.”

In conclusion, there is so much to gain from the experimentation of this new technique with 3-D printing that can bring so much to our world. It allows so many opportunities, and can

help with the numerous fatalities daily dealing with the lack of certain organs that are necessary for survival. We can use this promising technique for our advantage.

Brain Hacking

By Kelvin Pierre

Today, nobody can take their eyes from their phone. One is either playing a game, keeping up with the news, or following social media. Some think that this is just a natural effect of technology, however these effects may be more intentional than we thought. On CBS's "60 Minutes", we were able to see in-depth what really goes into these apps. Tristan Harris, a former manager at Google, shared that there are specific engineers whose titles are "brain hackers" and their purpose is to keep you glued to your phone. "This phone is a slot machine", said Harris. We have been trained to become so dependent on notifications that every time we turn on our lock screen we are pulling the "lever" hoping to find a new Twitter update or text messages.

Another mechanism used to trick our brains into turning on our phones is a new feature on Snapchat called "snap streaks" where it tracks how many days in a row you have communicated. This gets user into thinking that they cannot lose the streak, so they make sure they contact that person at least once every day. If the streak is close to ending, an hourglass appears next to the person's name incentivizing action.

We are at a point where advertisers are selling our eyes and our attention off to companies, and the more effective the brain hacking is, the more eyes will show on the ads, meaning more money for the various app companies. We need to be wary that there are people who are deliberately attempting to glue us to our phones, making them an addictive drug. When it comes to young children with impressionable minds, this could be a real issue. Parents need to be informed about the implications of brain hacking, and companies need to be more upfront to the public about the algorithms and methods used to increase user interaction.

Human Connectome

By Sam Zlota

Due to an abundance of technological advancements, there have been many biological discoveries in the past century, but there are still many phenomena that have yet to be explained. The genome several decades ago was emerging as a seemingly impossible feat that has since been conquered. Today, the Connectome is the new biological challenge.

What is the Connectome? The Connectome serves to map all neural connections in the brain. The brain is made up of approximately one hundred billion neurons and seven hundred trillion synaptic connections. The patterns of the neural connections, synapses, hold the unique identity of a person, including their memories, fears, likes, dislikes, and so on.

Neural mapping can be recognized by and consequently programmed into computers, which would be a huge advancement and would facilitate the creation of a Connectome. However, this data, in totality, would require an incomprehensibly large amount of storage. For comparison, the data stored in one one thousandth of a mouse brain would require approximately two million gigabytes of storage.

Understanding the meaning of a synapses and neurons is imperative to fully comprehending the significance of the Connectome. A neuron is a brain cell and a synapse is the complex connection between neurons. Although they can be defined simply, synapses and neurons vary greatly within an individual's brain and execute sophisticated functions at a microscopic level.

Human behavior is easily observed; however, it's yet to be fully explained in a neurological sense. Neurons function together to carry out tasks that on a macro level correlate to human behavior. With the ability to compare different individuals' connectomes, scientists will

be able to further their knowledge and abilities of certain neurological diseases. Additionally, synapses are where memories are stored.

Connectomes of much smaller organisms have been constructed manually without the aid of computers. For example, the roundworm *C. elegans* is an organism that is one and a half millimeters with a neural network of three hundred neurons and seven thousand synaptic connections. To complete its Connectome scientists worked for years, studying microscopic pictures of *C. elegans*' brain.

Nevertheless, what these connections mean is still not known in entirety. Although a successful and complete Connectome is far from reality, its creation will lead to many more new discoveries regarding the brain and its effects moreover. With this ability, scientists will be steps further towards unlocking the enigma that is the brain.

Do We Finally Have Evidence of Aliens?

By Scott Blatte

Whether it be about Area 51, a “secret government base where they store aliens and alien artifacts”, unexplained lights in the site, or even those who claim to have been abducted by aliens, conspiracy-theories and rumors about the existence of aliens have been around for years. However, actual evidence of alien life visiting earth has been limited at best. However, a bombshell report by the New York Times showed that alien life may very well be real.

Everyone has their own beliefs about extraterrestrial life. Unlike most other far-fetched theories, many celebrities and intellectuals believe that we are not alone in the universe. One of those people just happened to be the most powerful senator in the United States. Harry Reid, Democratic Senator and ex-Senate majority leader helped guarantee funds for a program run by the Defense Department called the Advanced Aerospace Threat Identification Program. Its budget was about \$22 million; to put it in perspective, the Defense Department received approximately \$600 Billion. This secretive program was effectively hidden from any budget report; however, it received government funding for at least 5 years. In general, the goal of the program was to gather evidence relating to the existence of aliens. While most of the evidence was eyewitness reports or other, sketchier evidence, a few pieces of evidence were shocking, including one eye-opening video. In the video, two Navy fighter jets are doing reconnaissance where there had been reports of strange objects that were descending at rapid speeds and then disappearing in the same general area when they spotted an unknown object. When they examined it closer, they realized that it seemed to lack basic propulsion technology. Amazingly, the object was able to keep up with them as they flew at speeds of well over 700 miles an hour. They reported this information to their superiors and prepared to return to a rendezvous point. As

they began to head towards it, they realized the object had disappeared. Suddenly, a communication from their superiors informed them that the mystery object had already arrived at the rendezvous point. Traveling that distance in such a short amount of time was unheard of for any aircraft in existence, lending credence to the argument that it did not originate from Earth. And better yet, they have the video to prove it.

Does this prove aliens are real? Absolutely not. One strange sighting does not prove anything. Sara Seager, an M.I.T. astrophysicist, cautions that, “When people claim to observe truly unusual phenomena, sometimes it’s worth investigating seriously,” she said. But, she added, “what people sometimes don’t get about science is that we often have phenomena that remain unexplained”. Still, the very existence of this video is enough to warrant more investigation into the existence of aliens. Who knows what they’ll find?

Jumping Genes: Our Genome Is More Dynamic Than We Thought

By Zachary Light

When discussing genetics, we generally imagine that genes stay where they are on chromosomes. Over the past 50 years, however, evidence has mounted that our DNA is more complicated than that. After first being identified in the mid 1940's, transposable elements, or transposons, are now attracting attention for their role in genetic disease.

Transposons were first identified in corn plants. In 1945, when comparing the genomes of each generation of maize plants with those of the parent generation, researchers discovered that certain parts of the chromosome had switched position. In the 1960's a similar phenomenon was documented in bacteria. We now know that almost all living things have at some point had transposons in their DNA.

Transposons are similar to genetic parasites. They spread themselves through the host's genome without necessarily conferring any phenotypical advantage, similar to viruses. Indeed, it's hypothesized that some transposons started out as parts of viral DNA inserted into host cells, and began propagating throughout the genome.

Transposons can be grouped into two types based on how they operate. Type I, or retrotransposons, get naturally transcribed into RNA, and then use a special protein to reverse transcribe themselves back into DNA. The protein, known as reverse transcriptase, is usually encoded for in the jumping genes themselves. After being reverse transcribed, the copies are inserted into various other points in the genome. This type is also colloquially known as copy and paste transposons.

If Retrotransposons are copy-and-paste, Type II transposons can be thought of as cut-and-paste. They use an enzyme that cuts them out of their position and inserts them in another.

Since they don't self-copy, they aren't as common in most genomes, but they still compose roughly 4% of our DNA.

While very few genes in our body still change position from time to time, more than 40% of our genome is made up of transposons. The vast majority of them have accumulated mutations that compromise their effectiveness, one gene, Line-1, still has some functioning copies, and makes up about 17% of our genome.

When transposons insert themselves in or near another gene, it can compromise that gene's ability to do its job. This has been linked to Hemophilia, Alzheimer's, and various kinds of cancer.

The Exploration Ends

By Maytal Cooper

Most people are aware of the wonderful planet of Saturn. The gas giant made of elements such as hydrogen, helium, and methane, and know best by its countless rings, is but a shining light in the night sky for us here on Earth. But, in 1997, NASA's Cassini Spacecraft left Earth and began its journey to this gaseous planet. It began its orbit around Saturn in 2004 after taking a trip of around 7 years just to get there! Once it started to orbit, it would be around 20 years later before its expedition finally ended on September 15th, 2017. The spacecraft had finally entered Saturn's atmosphere which is where the team lost signal with the spacecraft and ended the mission.

During its 20-year expedition, the Cassini Spacecraft picked up stellar footage of Saturn, its rings, and its moons - "particularly Enceladus, with its subsurface ocean and signs of hydrothermal activity – remain pristine for future exploration."

Every week, the spacecraft would take 22 daring dives in between Saturn and its rings, something never attempted by a spacecraft.

Although the signal to the spacecraft was lost, the team analyzes Cassini's final observations over the few weeks after the expedition, such as indications regarding the planet's formation, evolution, and the processes that occur in Saturn's atmosphere that make it the way that it is.

"Things never will be quite the same for those of us on the Cassini team now that the spacecraft is no longer flying," said Linda Spilker, Cassini project scientist at JPL.

The Cassini Spacecraft's historic exploration of the planet Saturn and its moons has helped scientists to learn more about it and for that reason and many more, will not be forgotten by the team of people who contributed to its success!

The Effects of Global Warming on Coral Reefs

By Daniel Lilienfeld

It is estimated that between 700,000 and 1 million different species live in the ocean. Although approximately 71% of the Earth's surface is covered by water, man has intentionally occupied and impacted the 29% of land immensely and disproportionately. Humans have built great structures, invented innovative technologies, and left a significant mark all over the lands. Except for a few outliers such as overfishing or water pollution, people have had far less direct influence on ocean life yet man's effect on marine life, especially on coral reefs, which is home to many species of marine life, is as impactful to the underwater ecosystems as it is to their own. This impact is a result of a heated topic: global warming.

Although reefs only cover about 1% of the ocean floor, many organisms know these small areas as their home. The reef itself is alive as corals are plants; therefore, when the coral is damaged or killed, many fish lose their habitats.

Global warming damages the reefs in many ways including ocean warming which leads to coral bleaching (death of coral polyps by water which is too warm) and disease of the coral, rising sea levels which results in sedimentation which asphyxiates the coral, more frequent and random storm patterns which destroy corals, increased runoff of freshwater, sediment, and land-based pollutants as a result of changes in precipitation which leads to algae blooms and murky water that reduces light, altered currents which leads to lack of food and dispersal of larvae, and finally, ocean acidification. Carbon Dioxide emissions which fuels global warming have dramatically increased, and even though the ocean helps to slow global warming by absorbing some emissions, it has impacts on ocean chemistry. More Carbon Dioxide leads to a reduction in pH levels. This detrimental change in acidity decreases growth rates and structural toughness and

cohesion of corals. Man's ability to impact the planet extends to the biodiverse ocean kingdom and delicate coral reefs that are the backbone of most marine life. Millions of organisms will suffer due to the ever-interfering hands of man. The only way to change the fate of the reefs and oceans, and ultimately our own fate, is for humans to emit significantly less greenhouse gases in the future.

You Snooze, You Win?

By Max Price

Millions of American teenagers begin their day by putting it off. The snooze button is an integral part of each day's routine for many adolescents, who rise feeling exhausted and unfulfilled. Rafael Pelayo, a "sleep doctor" from the Stanford Center for Sleep Science and Medicine, has suggested that teenagers face a unique series of issues, both neurological and societal, that prevent them from getting the right amount (between 9 and 10 hours) of sleep. "Adolescence," says Pelayo, "is sometimes referred to as the 'perfect storm' of problems of sleep."

While people of all ages need regular sleep to properly maintain mental and physical health, it is especially important (and difficult) for teens. When children reach a certain age, their brain's internal clock begins to shift forward; they struggle to fall asleep early and wake up for school. Additionally, teenagers face increasing responsibilities as they enter adulthood, often juggling homework, extracurriculars, and hanging out with friends. Pelayo estimates that as many as 90 percent of teens do not get enough sleep due to this tricky set of obstacles. Research from the National Sleep Foundation indicates that sleeping habits worsen throughout adolescence. Stanford Medical School calls teen sleep deprivation "an epidemic".

Teenagers agree—they are not receiving enough sleep. However, a recent study from Andrew Fuligni of UCLA goes further, suggesting that teenagers who receive too little sleep can face consequences that transcend hitting the snooze button. The report asserts that sleep-deprived teenagers are more prone to "mental and physical illness" (including depression, anxiety, and learning disabilities) and face "a heightened risk of car accidents" due to fatigue at the wheel. Teenagers are plagued by these issues in our society; according to the National Center for Health

Statistics, automotive accidents, and suicide account for over 46% of teenage death in America. These findings indicate the necessity of reforming school times and expectations for teenagers.

Many a teenager has bewailed early school start times, and bemoaned late nights of homework that turn into early mornings. Teens find themselves sleepwalking through school, sports, and extracurriculars, unable to balance increasingly demanding schedules with the physiological necessity of sleep. As they take on greater responsibilities, entering high school, college, or the workforce, it is important for teens (as well as their teachers and parents) to remember that the right amount of sleep is essential for their developing brains.

Works Cited

- ScienceDaily*, ScienceDaily, www.sciencedaily.com/releases/2017/12/171222090310.htm. -- Newly Found Multifunction Proteins in Mouse Cells Contribute To Blood Cell Development
- Northon, Karen. "NASA Telescope Reveals Record-Breaking Exoplanet Discovery." *NASA*, NASA, 22 Feb. 2017, www.nasa.gov/press-release/nasa-telescope-reveals-largest-batch-of-earth-size-habitable-zone-planets-around.--NASA Telescope Reveals New Exoplanet: Trappist 1
- Regalado, Antonio. "Now There's Proof Blood Tests Can Catch Cancer Early." *MIT Technology Review*, MIT Technology Review, 9 Aug. 2017, www.technologyreview.com/s/608601/cancer-blood-tests-score-early-success/.-- Cancer Treatment
- Surveillance, Epidemiology, and End Results Program*, seer.cancer.gov/statfacts/html/all.html.--Cancer Treatment
- "We Can Hack Our Immune Cells to Fight Cancer | Elizabeth Wayne." *HealthStatus*, HealthStatus, 25 Oct. 2017, www.healthstatus.com/health_blog/cancer-2/we-can-hack-our-immune-cells-to-fight-cancer-elizabeth-wayne/.-- Cancer Treatment
- "National Center for Health Statistics." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 5 May 2010, www.cdc.gov/nchs/products/databriefs/db37.htm. -- Cancer Treatment
- Reynolds, Gretchen. "How Meditation Changes the Brain and Body." *The New York Times*, The New York Times, 18 Feb. 2016, well.blogs.nytimes.com/2016/02/18/contemplation-therapy/.-- Contemplation Theory
- Schulte, Brigid. "Harvard Neuroscientist: Meditation Not Only Reduces Stress, Here's How It Changes Your Brain." *The Washington Post*, WP Company, 26 May 2015, www.washingtonpost.com/news/inspired-life/wp/2015/05/26/harvard-neuroscientist-meditation-not-only-reduces-stress-it-literally-changes-your-brain/?utm_term=.3c13743268f0. --Contemplation Theory
- Lancaster University. "Diabetes drug 'significantly reverses memory loss' in mice with Alzheimer's: A drug developed for diabetes could be used to treat Alzheimer's after scientists found it." *ScienceDaily*. ScienceDaily, 1 January 2018. <www.sciencedaily.com/releases/2018/01/180101144803.htm>. --Drug Reverses Memory Loss in Alzheimer's
- Yong, Ed. "Future - Will We Ever... Grow Synthetic Organs in the Lab?" *BBC*, BBC, 24 Feb. 2012, www.bbc.com/future/story/20120223-will-we-ever-create-organs. -- Creating Organs
- Dvorsky, George. "New Evidence That Supermassive Black Holes Eventually Suck the Life out of Big Galaxies." *Gizmodo*, Gizmodo.com, 2 Jan. 2018, gizmodo.com/new-evidence-that-supermassive-black-holes-eventually-s-1821705193. -- Black Holes Regulate Star Production
- Beckmann, R. S., et al. "Cosmic Evolution of Stellar Quenching by AGN Feedback: Clues from the Horizon-AGN Simulation." [1701.07838] *Cosmic Evolution of Stellar Quenching by AGN Feedback: Clues from the Horizon-AGN Simulation*, 6 Nov. 2017, arxiv.org/abs/1701.07838. -- Black Holes Regulate Star Production
- Beckmann, R. S., et al. "Cosmic Evolution of Stellar Quenching by AGN Feedback: Clues from the Horizon-AGN Simulation | Monthly Notices of the Royal Astronomical Society | Oxford Academic." *OUP Academic*, Oxford University Press, 21 July 2017, academic.oup.com/mnras/article-abstract/472/1/949/4002680?redirectedFrom=fulltext. -- Black Holes Regulate Star Production
- cosmology.lbl.gov/talks/Coil_13.pdf. --Black Holes Regulate Star Production
- Sheldon-Hicks, David, and co-founder and creative director of Territory Studio. "Five Ways Film-Making Is Evolving Thanks to New Technology." *The Guardian*, Guardian News and Media, 12 June 2015, www.theguardian.com/culture-professionals-network/2015/jun/12/film-technology-evolution-film-making-3d-printing-vr-motion-capture. --3D Printing, Digital Communication
- "Pharmacogenomics." *YouTube*, 14 July 2016, youtu.be/biQOqLzP4Dc. -- Zlota Pharmacogenomics
- "What Is Pharmacogenomics? - Genetics Home Reference." *U.S. National Library of Medicine*, National Institutes of Health, ghr.nlm.nih.gov/primer/genomicresearch/pharmacogenomics. -- Zlota Pharmacogenomics
- "FAQ About Pharmacogenomics." *National Human Genome Research Institute (NHGRI)*, www.genome.gov/27530645/faq-about-pharmacogenomics/. -- Zlota Pharmacogenomics

“The Brain Preservation Foundation – Connectome.” *The Brain Preservation Foundation*, www.brainpreservation.org/content-2/connectome/. -- Connectome wired. “Neuroscientist Explains One Concept in 5 Levels of Difficulty | WIRED.” *YouTube*, YouTube, 7 Mar. 2017, www.youtube.com/watch?v=opqIa5Jiwuw. -- Connectome

bu. “The Connectome.” *YouTube*, YouTube, 16 Jan. 2015, www.youtube.com/watch?v=zKyO_AB7aMc. -- Connectome

Cooper, Helene, et al. “Glowing Auras and ‘Black Money’: The Pentagon’s Mysterious U.F.O. Program.” *The New York Times*, The New York Times, 16 Dec. 2017, www.nytimes.com/2017/12/16/us/politics/pentagon-program-ufo-harry-reid.html. --Are UFO’s Real?

Roberts, Molly. “Opinion | The Aliens Are Coming, and No One Cares.” *The Washington Post*, WP Company, 19 Dec. 2017, www.washingtonpost.com/blogs/post-partisan/wp/2017/12/19/the-aliens-are-coming-and-no-one-cares/?utm_term=.c5732c0f9a0d. -- Are UFO’s real?

Beck, Christine R., et al. “LINE-1 Retrotransposition Activity in Human Genomes.” *Cell*, U.S. National Library of Medicine, 25 June 2010, www.ncbi.nlm.nih.gov/pmc/articles/PMC3013285/. --Transposons

Saey, Tina Hesman. “Jumping Genes Play a Big Role in What Makes Us Human.” *Science News*, 16 May 2017, www.sciencenews.org/article/jumping-genes-play-big-role-what-makes-us-human. --Transposons

Nature News, Nature Publishing Group, www.nature.com/scitable/topicpage/transposons-or-jumping-genes-not-junk-dna-1211. --Transposons

Nature News, Nature Publishing Group, www.nature.com/scitable/topicpage/transposons-the-jumping-genes-518. --Transposons

“Transposable Element.” *Wikipedia*, Wikimedia Foundation, 11 Jan. 2018, en.wikipedia.org/wiki/Transposable_element. --Transposons

Northon, Karen. “NASA’s Cassini Spacecraft Ends Its Historic Exploration of Saturn.” *NASA*, NASA, 15 Sept. 2017, www.nasa.gov/press-release/nasa-s-cassini-spacecraft-ends-its-historic-exploration-of-saturn. --The Exploration Ends

Talbert, Tricia. “Solar System’s First Interstellar Visitor Dazzles Scientists.” *NASA*, NASA, 20 Nov. 2017, www.nasa.gov/feature/solar-system-s-first-interstellar-visitor-dazzles-scientists. -- Interstellar Object

“First Observed Interstellar Object Is a Speedy, Cigar-Shaped Asteroid.” *Yahoo! Finance*, Yahoo!, 22 Nov. 2017, finance.yahoo.com/news/first-observed-interstellar-object-speedy-000900819.html. --Interstellar Object

US Department of Commerce, National Oceanic and Atmospheric Administration. “How Does Climate Change Affect Coral Reefs?” *NOAA’s National Ocean Service*, 3 Mar. 2015, oceanservice.noaa.gov/facts/coralreef-climate.html. -- Global Warming And the Reefs

Jones, Adrian. “Coral Reefs and Climate Change - How Does Climate Change Affect Coral Reefs - Teach Ocean Science.” *Title Banner*, www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/how_does_climate_change_affect_coral_reefs/. -- -- Global Warming And the Reefs

Prabhune, Meenakshi. "For Teens, a Good Mood Depends on Good Sleep." *Science News for Students*, 30 Nov. 2017, www.sciencenewsforstudents.org/article/teens-good-mood-depends-good-sleep. --Snooze

"National Center for Health Statistics." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 5 May 2010, www.cdc.gov/nchs/products/databriefs/db37.htm. --Snooze