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NU SCI

health

Staff

Letter From the Editor

Wellness means different things to different people – some immediately think of physical health, others think of mental health, and some may think of a holistic combination of the two. Last issue, NUSCI examined the health of our planet so it only made sense that for this issue, we take an introspective look at our own wellness.

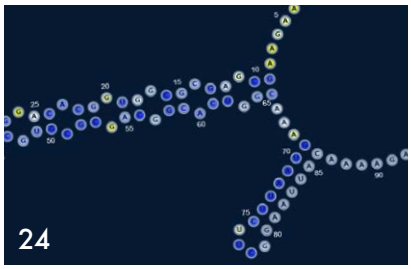
In this, our second issue of the semester, we take this holistic view of wellness. Our writers look at diseases like cystic fibrosis, paralytic shellfish poisoning, and zika virus and the research being done on these diseases. Just in time for finals, we also look at how stress effects our wellbeing; we take a look at mental health, addictions, and discuss the importance of self-care to round out our examination of wellness. We also take a look at things that impact our wellness like vaccines, cognitive supplements, exercise, and even being in outer space for nearly a year. And, of course, in this magazine and on our website, we cover a myriad of other topics such as bugs, bats, and marijuana farms powered by the sun.

I always like to take the latter half of my letter to thank our writers and e-board for their hard work on this issue. This letter is no different – I am always in awe at what our writers, editors, and designers produce and words cannot describe how thankful I am for all of their hard work. However, this time is different since it is the second issue of the spring semester and that means graduation is right around the corner. Five past and current members of the NUSCI e-board will walk at the TD Garden this May: editors Andrew Bloy, Shannon Jones, and Kristen Drummey; Head of Design Naomi Stapleton; and former president Josh Timmons. It has been an absolute pleasure to work with them on this magazine for my past four years with the magazine as a writer, editor, and now as Editor-in-Chief. I know that the magazine is where it is today because of their hard work and dedication over the years and for that I, and the rest of the NUSCI team, are eternally grateful. I hope you all continue to write like you're running out of time.

Be well, enjoy the issue, and I hope to see you next semester.

Sincerely,

Katie Hudson
Editor-in-Chief



Northeastern University's Student Science Magazine

Trending this month:

Catching up with the latest news in science.

BY NAOMI STAPLETON, PSYCHOLOGY, 2016

PHOTOS BY SEAN MCMAHON OF YALE UNIVERSITY, MICROSOFT, SMOOTHGROOVER22, AND U.S. FISH AND WILDLIFE SERVICE

driverless cars

Self-driving cars are quickly becoming a reality. We already have some autonomous features, like blind spot monitoring systems and lane-departure warnings. Government officials recently announced that AEB (automatic emergency braking) will be standard on nearly all cars by 2022. Google is currently piloting its completely self-driving car, but they have run into some roadblocks: a Google Lexus-model hit a bus in February. While there are still some software learning issues to work through, Google argues that eventually the self-driving car will be a much safer alternative. For one, these cars will never get tired or distracted. The Google cars have driven more than one million miles so far, but it is unclear when the technology will be ready for the public.

tully monster

Illinois's state fossil, the Tully monster, has been identified as a vertebrate more than 60 years after its discovery. The soft-bodied creature lived in rivers 300 million years ago, which makes it one of the earliest members of the group that branched in today's vertebrates, including humans. Before Victoria McCoy's analysis identified a primitive spinal cord, many assumed the Tully monster was a spineless invertebrate related to worms or mollusks.

pavlof

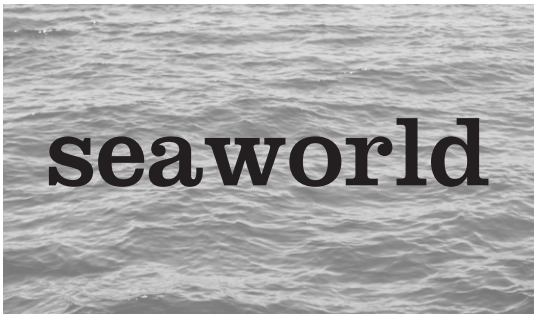
Alaska's most active volcano erupted on March 27, spewing ash 20,000 feet in the air and causing small tremors on the ground. By the next day, the ash cloud had already travelled 400 miles and forced airlines to cancel at least 50 flights. The volcano last erupted in 2013. Because of its relatively unique "open system," Pavlof gave almost no seismic warning of an eruption to come.

chat bot

Microsoft's artificially intelligent chat bot went live for less than 24 hours. In an effort to research AI conversational understanding, the Twitter account, named Tay was designed to become "smarter" as more users interacted with it. Within a few hours, an aggressive onslaught of troll messages from websites like 4Chan led Tay to begin tweeting genocidal and racist messages. Microsoft has since halted the experiment and apologized for the incident, saying they face both social and technical challenges as they approach a redesign.

mobile health care

Hospitals are eager to keep up as mobile health-tracking technology like Fitbit and Apple Health become more prevalent. However, doing so requires big data management and technology many hospitals still lack. More and more health care providers, like Stanford University, and electronic health record providers, like Epic, are beginning to incorporate iPhone data into official records. Beth Israel Deaconess Medical Center has started a pilot program to collect daily data on weight and blood pressure in order to initiate a quicker response to the warning signs of congestive heart failure.



seaworld

Seaworld, a U.S. chain of marine animal theme parks, made a historic announcement in March: they will no longer breed orcas, and will begin to phase out the killer whale shows. Some scientists worry that this will make studying killer whales in the future more difficult, but many animal rights activists, like PETA, praise the decision. Seaworld and its practices came under fire after the release of the documentary Blackfish in 2013. Since then, the organization plagued by controversy hired a new CEO, Joel Manby, and began to promote a new focus on marine-life conservation, but these efforts were evidently not successful in revitalizing the company's image.

The BabySeq Project

How exome sequencing can help newborns

BY TYLER GUITROZ, PSYCHOLOGY, 2017

DESIGN BY ANNIE LEE, GRAPHIC DESIGN, 2019

PHOTO BY PIXABAY

Infants are screened immediately after birth for approximately 30 treatable childhood onset diseases. If detected early, metabolic diseases can be safely managed and monitored throughout one's life. However, there is a vast spectrum of childhood onset disorders and diseases unaccounted for even with today's state mandated newborn screening (NBS). While there is genetic testing available, these options are typically expensive and generally only look at genes specific to certain diseases. Today, there are research studies looking at how to offer parents a more robust insight into the future health of their newborns.

> "Our bodies contain approximately 20 to 25,000 protein-coding genes with millions of possible variants.

BabySeq is one such research study. Headed by Dr. Alan Beggs, Ph.D. and Dr. Robert C. Green, MD, MPH, at Boston Children's Hospital and Brigham and Women's Hospital, BabySeq is one of four studies funded by the National Institutes of Health (NIH) that conducts whole exome sequencing to measure the effects of genomic sequencing on neonatal and pediatric care. The BabySeq team recruits healthy infants and sick infants born in the neonatal intensive care unit. Half of the participants are given standard NBS as control subjects, and the other half receive whole exome sequencing along with guidance from genetic counselors in addition to NBS.

Our bodies contain approximately 20 to 25,000 protein-coding genes with millions of possible variants. Thus, whole exome sequencing of infants provides huge amounts of information. The BabySeq project is working to assess the scientific and societal implications of having access to all of this data. Beggs identified three main points that he hopes to better understand in the course of the project.

The first point revolves around genes and their role in protein function. Scientists have already identified the genetic mutations associated with some diseases, like Nemaline Myopathy, a muscle disorder that affects muscle tone and the contraction of skeletal muscles. Catching these mutations early can help parents understand more about their child's condition as soon as possible, and help medical professionals plan for the necessary interventions. Given the abundance of genetic information encoding proteins in our bodies, BabySeq will only report the findings that are "childhood onset or childhood actionable," as in they will likely occur in childhood or are associated with an intervention that can combat a later onset of disease.

Second, BabySeq questions how particular variants of a genes cause disease. Not all mutations are pathogenic. Therefore, it is important to identify which genes may account for specific illnesses in order to understand its effect on the infant's future health. Having a specific mutation may not always negatively affect the health of the individual carrying it. The genetic counselors also integrate carrier status into the information returned to the family.

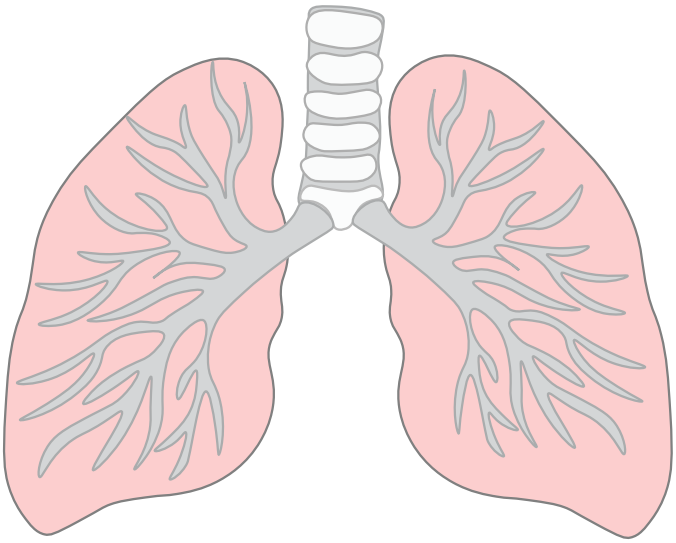
Third, the BabySeq researchers are also assessing the impact of whole exome sequencing of infants on parents and healthcare providers. While knowing as much as possible could certainly help parents and health care providers understand more about childhood onset diseases, it is also possible that too much information could be detrimental in some aspects of care. BabySeq uses a series of questionnaires to study the impact infantile genomic sequencing will potentially have. Acquiring exome sequencing information could impact medical costs, healthcare options, patient-doctor relationships, and even patient-parent relationships. Understanding the ethical, legal and social implications of genomic sequencing will allow researchers, healthcare providers, and patients to more fully appreciate the implications of increasingly prevalent genomic diagnostics.

With genomic sequencing technology becoming more affordable, it is important that we understand its impact. We can assume genomic sequencing will probably never completely replace medical interventions used now in the same way that BabySeq is most likely not "going to replace NBS the way we use it presently," according to Beggs. What we can assume is that given the success of genetic intervention, like the ones used in BabySeq, we can look to genomic sequencing not so much as a solution, but "as a useful adjunct to expand information we have for families."

Searching for a Cure for Cystic Fibrosis

BY GWEN SCHANKER, JOURNALISM AND BIOLOGY, 2018 DESIGN BY ANNIE LEE, GRAPHIC DESIGN, 2019

Kate Marshall, a 16-year-old soccer player and student with an undoubtedly bright future, was diagnosed with cystic fibrosis (CF), a genetic disease that causes buildup of mucus in the lungs, when she was seven months old. She's spent her life undergoing numerous treatments to combat her disease. Like other people with CF, Marshall hasn't let her condition affect her ability to live her best life – she was named the Sports Illustrated High School Athlete of the Month in December of 2014. Last October, Marshall spoke at an event benefiting the Cystic Fibrosis Foundation, stating that, "My hope is that I can be part of a community where everyone can one day soon say 'my cystic fibrosis is under control,' or better yet, 'I used to have CF!'"



For Marshall and approximately 70,000 other CF patients worldwide, that day is certainly getting closer. Research on CF has developed significantly in recent years as knowledge of the disease has increased. CF is caused by a defective or missing protein resulting from a mutation in the CFTR, or cystic fibrosis transmembrane conductance regulator, gene. Mutation of the CFTR gene either prevents its function or causes a reduction in the amount of protein available to transport chloride. Both result in poor ion flow into and out of the cell in a number of organs, including the lungs and pancreas. This leads to the buildup of abnormally thick, sticky mucus that can cause a variety of unfavorable symptoms, including progressive lung damage, gastrointestinal issues, and difficulty gaining weight. People with CF can also experience pulmonary exacerbations, which result in progressive lung decline. There are many different genotypes that result in different CF mutations, each of which causes a different level of severity of the disease.

By far the most prevalent mutation is delta-F508, which affects 8,500 individuals in the U.S. alone. However, scientists have discovered more than 1,900 additional CFTR mutations, over 100 of which have been shown to cause disease. This makes CF a particularly difficult disease to treat. Nevertheless, strides have been made in multiple areas and are on their way to helping people with CF live happier, healthier and longer lives. The current life expectancy is 37 years old, up from less than 20 years in the 1980s.

The most widespread treatments for CF are the physical ones. Many people with the disease use an airway clearance vest, a vibrating piece of clothing that they wear for about 20 minutes approximately twice a day. Use of the vest, along with occasional use of a respirator and regularly taking enzymes to help digestion, helps keep those with CF comfortable throughout the day. People with CF also eat a lot throughout the day and get plenty of exercise, which, even without additional treatment, helps contribute to a healthy lifestyle.

While physical treatments are helpful for improving day-to-day life, newer, more advanced treatments are able to treat the disease at the source. Two oral medicines from Vertex Pharmaceuticals, KALYDECO and ORKAMBI, were approved by the FDA in 2012 and 2015, respectively. These bind to the CFTR channel directly in order to improve chloride transport. ORKAMBI works in combination with KALYDECO to target patients with the delta-F508 mutation, while KALYDECO alone works on a semi-common mutation, G551D. Though the monetary cost of the treatment is high – Vertex is selling ORKAMBI for approximately $259,000 per year – the company is working with payers who will allow the drug to be accessible to as many people as possible.

As Vertex and other pharmaceutical companies move forward with next-generation medicines to treat additional mutations, scientists in other industries are also working to develop possible out-of-the-box treatments. One example is Tracy Mincer's research at the Woods Hole Oceanographic Institution (WHOI). Mincer examines ocean microbes in the hopes of finding chemical compounds that may have relevance in CF treatment. He has developed a chemical library of compounds from algae that colonize phytoplankton, which may be able to target the CFTR protein.

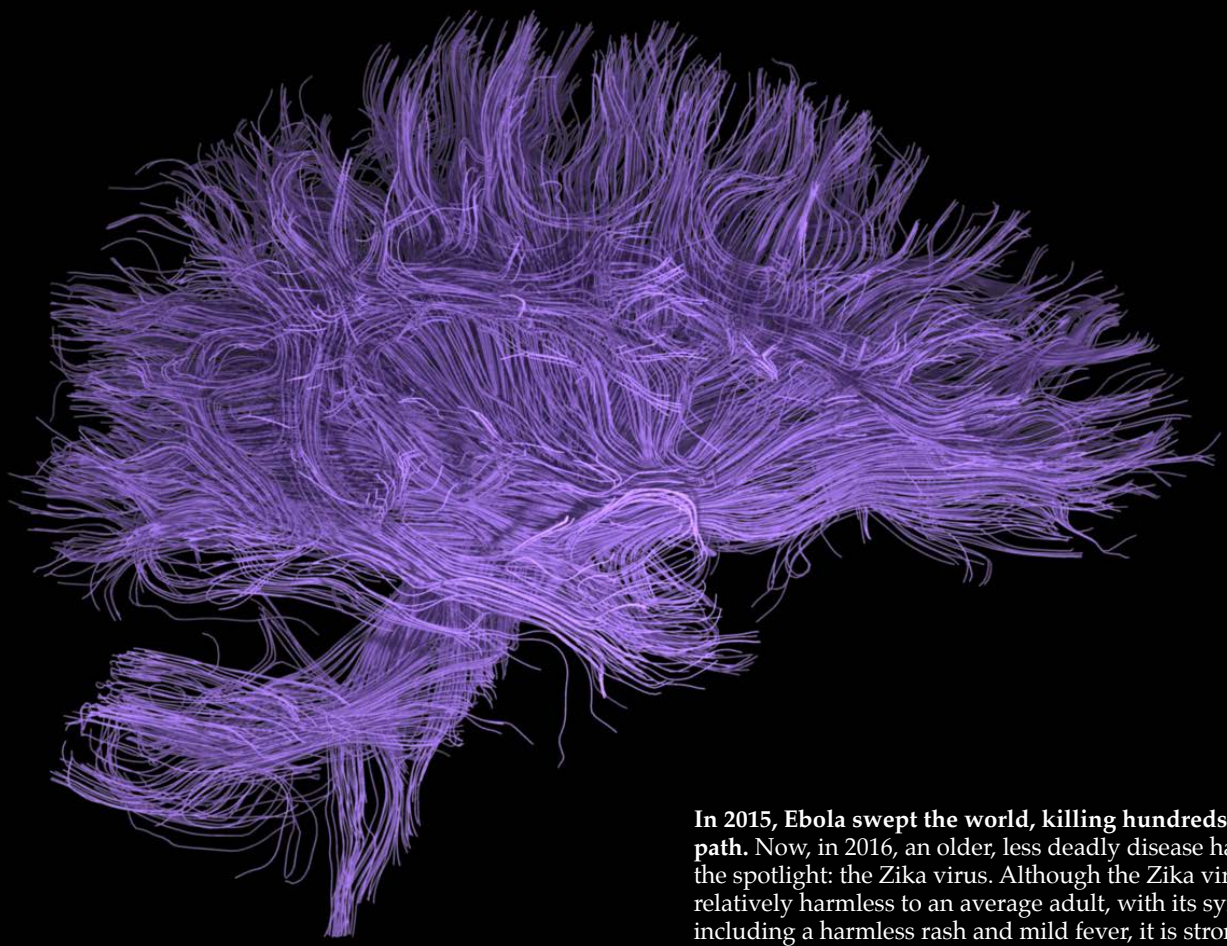
The progress is helped along by the vocal community of people affected by the disease, who are active on social media and at public events like the CF Foundation's "Great Strides" walk, which is hosted in hundreds of cities each spring. Advocacy and awareness are important parts of moving forward in curing any disease, but they are particularly key to rare genetic diseases like CF. With a combination of dedicated researchers and developers at Vertex, microbial ecologists like Mincer, a developing frontier in personalized medicine, and an amazing community of people eager to share their stories, the future for people with CF has never looked brighter.

Microcephaly Modeled in Cerebral Organoids

Lab-Grown Brain Tissue Allows Researchers to Study Genetic Diseases in the Brain

BY WHITNEY KUWAMOTO, BEHAVIORAL NEUROSCIENCE, 2019

DESIGN BY JULIETTE PAIGE, MECHANICAL ENGINEERING, 2020



In 2015, Ebola swept the world, killing hundreds in its path. Now, in 2016, an older, less deadly disease has stolen the spotlight: the Zika virus. Although the Zika virus is relatively harmless to an average adult, with its symptoms including a harmless rash and mild fever, it is strongly theorized to cause microcephaly, a congenital condition resulting in an abnormally small head size in infected, or previously infected, women's offspring.

> “Though it is still impossible to grow a complete human brain in vitro, recent research has found that it is possible to grow discrete regions of the human brain…

Because microcephaly affects fetal brains, studying congenital microcephaly effectively has been difficult. The complexity of the human brain and its functions are not easily reproducible in a laboratory; furthermore, in-utero development of human fetal brains differs greatly from those of rats'.

The inability to study brain diseases under lab conditions and in lab rats emphasized the need for an in vitro, taking place outside a living organism, method of growing brain tissue. Though it is still impossible to grow a complete human brain in vitro, recent research has found that it is possible to grow discrete regions of the human brain, termed cerebral organoids, in vitro. Consequently, these cerebral organoids allowed for close examination of how the human brain develops during embryonic development.

Researchers Madeline A. Lancaster and Juergen A. Knoblich from the Austrian Academy of Sciences and their team

worked with affiliates from the University of Edinburgh, the Wellcome Trust Sanger Institute in Cambridge, and St. George's University in London to model and study microcephaly by culturing cerebral organoids in vitro.

To generate these cerebral organoids, researchers began with neuroectodermal tissue, a developing embryo's outermost layer of tissue that is destined to become part of the peripheral and central nervous systems. Researchers derive this tissue from embryoid bodies, three-dimensional pluripotent stem cell aggregates, grown in vitro. Once cultured, the three-dimensional cultures were then embedded into Matrigel, a gelatinous protein mixture that stimulates complex cell behavior. Lastly, droplets of Matrigel containing neuroectodermal tissues were transferred into a spinning bioreactor (a rotary cell culture system) to boost nutrient absorption.

The spinning bioreactor facilitates rapid growth of the neuroectodermal tissues and maintenance of their three-dimensional shape. After 15-20 days of growing in the spinning bioreactor, cerebral organoids began to form, exhibiting large, continuous growth of neuroepithelial tissue and a region strongly resembling a ventricle. After two months of growth, cerebral organoids reached their maximum size: four millimeters in diameter. Even so, the morphology of the organoids revealed regions resembling the cerebral cortex of a human brain. Further testing and staining showed similarities between the behavior and organization of the cerebral organoids and structures in the actual human brain.

To begin their study of microcephaly in cerebral organoids, researchers identified a patient with severe microcephaly exhibiting the typical manifestations of the condition: reduced head size, reduced stature, and mutations in the CDK5RAP2 gene, a gene heavily involved in cell mitotic processes. Researchers worked to create induced pluripotent stem cells (iPS), pluripotent stem cells directly created from adult cells, from the patient. From these iPS, embryoid bodies were formed, and researchers began the process of culturing patient-derived, microcephaly-infected cerebral organoids.

Researchers immediately noticed that the embryoid bodies were smaller than normal ones cultured from healthy iPS, indicating less neural outgrowth. As a result, the neuroectodermal tissues grown from the embryoid bodies were also smaller than normal, therefore causing the cerebral organoid cultures to be smaller, demonstrating the hypoplasia, the underdevelopment of a tissue, that is typically associated with microcephaly patients.

When studying the differences between the normal control group and patient-derived group cerebral organoids, researchers noticed that the control group had abundant amounts of progenitor cells, which are cells destined to differentiate into neurons, whereas the patient-derived ones had an increased amount of neurons. This data suggests the premature differentiation of neurons in the patient-derived cerebral organoids.

During typical human fetal brain development, the brain undergoes a period of rapid growth through an "inside-out" method, where progenitor cells travel from the inside of the brain out to the cortical regions to form progenitor zones, where they then differentiate into mature neurons. However, during fetal brain development of a fetus infected with microcephaly, the mutation of the CDK2RAP5 gene programs for apoptosis, cell death, of the progenitor cells, rather than programming them to undergo mitosis. Therefore, the usual "inside-out" method of brain growth does not occur as rapidly as it does during normal fetal development, ultimately causing a decreased brain size following the period of rapid development.

Previously, researchers have found methods of studying the growth of other human organs in vitro, but growing the human brain to study in vitro has long been a challenge. From studying microcephaly by using cerebral organoids cultured in vitro, researchers found that the mutation in the CDK2RAP5 gene leads to premature neural differentiation and the loss of progenitor cells during in-utero development. This yields the reduced brain size and other brain-related disabilities in microcephaly patients.

Although the relation between the Zika virus and microcephaly has not yet been proven, determining one of the underlying reasons for why patients develop microcephaly, through the use of cerebral organoids, can aid future researchers in resolving the possible reasons of why Zika seemingly causes microcephaly. As science moves forward in researching the diseases known to affect mankind, the use of cerebral organoids grown in vitro will inevitably add to scientists' understanding of diseases as they relate to the human brain.

PHOTO BY FLICKR DESIGNS BY DAY DONALDSON

State without Stigma:
Redefining the Opiate Crisis in Massachusetts

BY KRISTEN DRUMMEY, BEHAVIORAL NEUROSCIENCE, 2016 DESIGN BY JENNIFER SHUM, MECHANICAL ENGINEERING, 2018

Recently, it seems impossible to turn on the news or scroll through Twitter without seeing someone discussing the rising rate of opiate abuse. It seems that every state is experiencing an increase in overdose deaths related to prescription opiates and heroin, an alarming trend that has been labeled an epidemic. The increase in opiate use has shaken the country, and forced us to reconsider how we view and treat addiction. Historically, addiction has been treated as a criminal problem, with addicts often being arrested, prosecuted, and sent to jail. However, recent trends in legislation and policies have shown that people are starting to realize that addiction is a mental illness, and is a problem that can only be solved through acceptance and treatment.

Opiates have been used in medicine to treat pain for centuries. Opiates work in the body because they are structurally very similar to endorphins, which are naturally occurring ligands that bind to opioid receptors. Administered opiates, like morphine and heroin, act as agonists that can bind to these receptors and produce effects that are similar to those produced by endorphins. Opioid receptors are present at many different junctures in the brain's signaling pathways, which means that opiates have large and varying effects on the body. In addition to alleviating pain, opiates can cause a large amount of dopamine to be released into areas of the brain that process pleasure and reward, creating a high that keeps people wanting more of the drug.

Even though opiates can create addictive highs, they are routinely prescribed by medical professionals to treat pain. Although this is necessary to properly treat patients, it has likely contributed to an increase in opiate addiction across the United States. In the past decade, addiction to opiate painkillers has become much more widespread, and also seems to be correlated with an increase in heroin use. This could be because people who have become addicted to prescription opiates turn to heroin when they are no longer able to access or afford prescription drugs. Nearly 80 percent of recent heroin users took prescription opiates before beginning to use heroin, a disturbing trend that has been seen around the country.

Massachusetts has seen a steep increase in opiate-related fatalities, with overdose deaths nearly tripling between 2000 and 2013. Charlie Baker, who was elected governor of Massachusetts in 2014, has vowed to make battling opiate addiction one of the top priorities of his term. This March, he signed a bill into law that is taking steps to address this growing epidemic. The bill limits initial opiate prescriptions to seven days, requires a follow-up evaluation for overdose patients that have been admitted to emergency rooms, and mandates schools to screen their students for substance abuse. Additionally, the Baker administration has launched a public health campaign called State without StigMA, which aims to increase public awareness that addiction is an illness, not a choice.

Elsewhere in the state, police departments have been making efforts to treat addiction as a mental health problem instead of a criminal one. Gloucester, a seaside town in northern Massachusetts, has been particularly proactive on this front. They encourage police to offer aid instead of arrest to people nearing an overdose, and have even offered to provide overdose blockers free of charge to those who cannot afford them. The policy changes created by Governor Baker and the shift in policing made by towns like Gloucester are recent, and their effectiveness remains to be seen, but the shift in attitude is a positive one that could substantially impact how addiction is perceived in the state.

Addiction is an illness, one that changes the chemistry of the brain and hijacks normal brain functioning. Knowing this, and facing a growing epidemic of opiate abuse, we can better prepare to fight it. Recent trends in legislation and policies in Massachusetts have set a promising precedent, one that will hopefully encourage all of us to treat people suffering from addiction not as criminals, but as people who are in need of our help.

PHOTO BY CHARLES WILLIAMS

New England Journal of Medicine (2016). DOI: 10.1056/NEJMra1508490

Let's Talk about Stress, Baby

How your response to stress affects you more than the stress itself

BY NATASHA MATHUR, BEHAVIORAL NEUROSCIENCE, 2017

I mutter the words "I am so stressed right now" about ten times a day, and that is just while on co-op. As college students, we deal with constant stressors from sources as varied as our exams to our social lives- and unfortunately this stress doesn't go away, with studies showing that stress is constantly present throughout the rest of our lives.

There are two types of stress - chronic and acute. Acute stress is short-term, and can actually be beneficial to us. Studies have shown that acute stress can improve mental performance, such as memory, and can also be beneficial to our immune systems as well. Chronic stress differs from acute stress because it is a constant form of stress (or multiple stressors), that can take a heavy toll on the body. One of the most common ways that chronic stress affect the body is by causing sickness. After going through an extremely stressful time, such as a week of midterms, the body's immune system is weakened and is more susceptible to sickness. Most of us have heard a story about a work-a-holic who refused to take a step back and ended up having major heart issues. But how true is this? Very true, actually- one example being that chronic stress can cause the inflammation in the cardiovascular system, especially in the arteries.

However, a recent study done by researchers at Pennsylvania State University has found that the type of stress, or even the amount, might not be the full story.

Results from this study showed a correlation between how likely one is to have cardiovascular disease and one's response to stress. The study was performed on around 900 middle-aged people who reported undergoing several forms of stress on consecutive days, using phone interviews and electrocardiographs (ECGs) taken at a later time.

In the past, there have been no studies done in which there is a discrimination between perceived stress and the amount of stress presented to a subject. In this experiment, subjects had daily diary entries in which they recorded the number of times during which they felt stress, as well as their perceived reaction to the stress. This information was gathered via telephone interviews for eight consecutive days.

Participants were asked about the types of daily stressors that occurred (e.g. argument, stressful event at work or school, discrimination). This allowed researchers to understand four predictor variables, which were: stressor frequency, stressor severity, affective reactivity (which was defined as the "within-person change in negative affect on days when stressors occurred, compared with one's typical negative affect on non-stressor days"), and daily negative affect. The negative affect was calculated by asking participants to report the frequency of their negative emotions on a scale from 0 to 5. Later on, each participant had an ECG recording done in order to monitor their HRV (Heart Rate Variability) levels.

Data from this study showed that participants who had a lower HRV seemed to have an increase in perceived stress, negative affect, and affective reactivity. This means that those who felt more stressed, or had more subjective stress, were more affected by stress. Individuals who were not as inwardly bothered by the stress showed that during their ECG. This study is unique because researchers attempted to find a relationship between stress and HRV. HRV is the variation in intervals of heart beats, which is a good reflection of the response to any challenge, in this case a stressor. Low HRV has been shown to be linked to mortality, and interestingly enough has an inverse relationship with depression.

> "In the past, there have been no studies done in which there is a discrimination between perceived stress and the amount of stress presented to a subject.

Just because the ECG might show a lower HRV, however, does not mean that individuals who feel the pressure of stress more will be destined to congestive heart failure. This study is actually good for those individuals, because it shows the damage stress does and it reminds us to keep our perceived stress in check.

There are some caveats to this study, one being that participants were only asked about their daily stress for eight days, which was enough to analyze the negative affect and stress response of the participant, but a bit too short to determine which stressors each participant was more exposed to. Another issue is that it is unclear what the participants with lowered affective reactivity and negative affect to stressors were doing differently.

However, this study did show that having a lower affective reactivity to stressors made a difference, as did lowered negative affect. Although it is difficult to stop the daily stresses that we all encounter, there are definite ways to improve how we cope with stress, which can lower our affective reactivity and negative affect. One of the most important things is to actually have a coping mechanism, and utilize it. It is important to remember that the stressors around you do not have to take over your life. Often, our reaction to stress results in even more stress, which is the opposite of what we want to do. It can be difficult to find time to relax, but taking just a few minutes out of the day to de-stress can be a big help.

Psychosomatic Medicine (2016) DOI: 10.1097/PSY.0000000000000306

And the Waves Turned Red with Algae

How what your shellfish eats can impact your health

BY KATIE HUDSON, MARINE BIOLOGY, 2017

DESIGN BY ANNIE LEE, GRAPHIC DESIGN, 2019

In the summer of 2005, coastal waters from Maine to Martha's Vineyard turned red. The cause was not a massive whale stranding event or a large fish die-off - it was a microscopic marine alga known as *Alexandrium fundyense*. This algae bloom, one of the largest since the 1970s, resulted from intense summer storms bringing nutrient-rich waters from the Bay of Fundy down the New England coast. In the weeks that followed, shellfisheries along the coast shut down, resulting in the loss of millions of dollars in the local industry.

These events may seem random to some, but are actually directly correlated. *A. fundyense* is a species of dinoflagellate that produces a toxin known as saxitoxin, which, when ingested in high enough concentrations, can pose serious health risks for humans. Humans do not consume the toxic diatoms directly; however, shellfish, such as mussels, clams, and oysters, do. Shellfish are filter-feeders, meaning that they consume everything in the water column around them – including toxic algae species such as *A. fundyense*. The shellfish are not affected by the toxins (or at least, there is no current research to suggest that they are), but the toxins still bioaccumulate in their tissues. For example, if a person consumes a mussel with a high concentration of toxin in its tissues, the consumer can then be at risk for serious health concerns, depending on the type and amount of toxin consumed. As a result, shellfisheries are shut down by shellfishers or governmental organizations when toxin levels reach a certain level in sampled shellfish to avoid poisoning any consumers.

> “ Harmful Algae Blooms (HABs), have become increasingly more common as water temperatures rise in Massachusetts Bay and around the globe.

These blooms of toxic algae, known as Harmful Algae Blooms (HABs), have become increasingly more common as water temperatures rise in Massachusetts Bay and around the globe. The number of HABs is also strongly correlated with coastal development – research has shown that nutrient runoff is one of the major causes of HABs and other eutrophication events.

There are multiple species of algae that have been identified as causing HABs and, as a result, multiple toxins have been identified and are associated with these different species. These toxins result in what is known as shellfish poisoning when consumed. Currently, several different types of shellfish poisoning have been identified, each with their own toxin, geographic region, and causal species. Four types of shellfish poisoning and one type of fish poisoning dominate in North America: paralytic, amnesic, neurotoxic, diarrhetic, and Ciguatera.

Paralytic Shellfish Poisoning (PSP)
PSP is the type of shellfish poisoning caused by the consumption of saxitoxin, which is produced by several members of the *Alexandrium* genus. On the east coast, *A. fundyense* dominates, especially in the Gulf of Maine, while *A. tamarense* dominates in the Pacific Northwest.

These blooms occur annually, although the 2005 bloom remains the most extreme event in nearly 30 years. As a result, there have been many research projects in the past eleven years that aim to understand the dynamics of this event. At Woods Hole Oceanographic Institute, the Anderson Lab is one of the world's leaders in HAB research. Working closely with NOAA, the lab monitors these annual blooms and is currently working towards creating a model to accurately predict the intensity of the blooms.

PSP is often diagnosed by nausea and a tingling in the lips or tongue. In severe cases, paralysis occurs within 24 hours of consumption. This is because saxitoxin is a neurotoxin that interrupts the function of the sodium/potassium pump located in neurons. Fatalities, while rare, have occurred as a result of PSP since there is currently no cure or antidote.

Amnesic Shellfish Poisoning (ASP)
ASP is caused by the consumption of domoic acid – a toxic produced by the pennate diatom genus *Pseudo-nitzchia.* Not all members of these genus produce domoic acid and the individual species are difficult to identify without molecular methods. As a result, identifying the exact species causing a bloom can be difficult.

Pseudo-nitzchia is prevalent on both coasts. Blooms of this genus are common in the late summer months on the east coast, following the *A. fundyense* blooms. On the west coast, blooms occur throughout the summer. In 2015, a massive *Pseudo-nitzchia* bloom occurred along the entire west coast of North America and continued for a majority of the summer, shutting down king crab fisheries as far north as Alaska.

ASP, as the name suggests, is commonly associated with short-term memory loss. In extreme cases, seizures, respiratory difficulty, and coma have occurred. Like PSP, there is currently no antidote for domoic acid.

Neurotoxic Shellfish Poisoning (NSP)
NSP is a type of shellfish poisoning caused by the recently-renamed dinoflagellate *Karenia brevis*. This dinoflagellate produces a plethora of toxins known as brevetoxins which can bioaccumlate in shellfish and their predators, but can also become airborne due to wave action at the air-sea

interface. Occurring primarily in the Gulf of Mexico, NSP is associated with asthma-like symptoms when airborne and, when consumed, both paralytic and gastrointestinal symptoms. Like PSP, brevetoxins affect the sodium/potassium channels and the depolarization of nerve cells. Luckily, no fatalities have been reported.

Diarrhetic Shellfish Poisoning (DSP)
DSP is caused by a variety of dinophysistoxins and okadaic acid produced by the *Dinophysis* genus, a genus of dinoflagellate found worldwide. Like *Pseudo-nitzchia*, only some members of this genus produce toxins. DSP is usually diagnosed by gastrointestinal upset, one of the primary symptoms being diarrhea. Luckily, symptoms are usually gone in three days in extreme situations. Other than this, not much is known about DSP because *Dinophysis* has proven difficult to culture in lab settings.

Ciguatera Fish Poisoning (CFP)
CFP is the only syndrome of those discussed here that is not found in shellfish. Instead of bioaccumulating in shellfish, the toxins associated with CFP bioaccumulate in a variety of tropical fish species. CFP is caused by a group of toxins known as ciguatoxins, produced by the dinoflagellate genus *Gambierdiscus*. This genus grows with tropical macroalgae and is thus consumed by the reef fish when they consume the macroalgae. CFP has a wide variety of cardiovascular, neurological, and gastrointestinal symptoms and, therefore, can be very difficult to treat. While symptoms can last for weeks or even months, fatalities are rare.

Marine Drugs (2008) DOI: 10.3390/md20080022

Can Movement Become Your Medicine?

BY MEGAN PINAIRE, PSYCHOLOGY, 2018

DESIGN BY SOFIA KIRKMAN, UNDECLARED, 2020

As summer gets tantalizing closer, many of us are hitting the gym in hopes of getting that beach body back. A new study from the UC Davis Health System suggests that not only can exercise improve your physical fitness, but it also has positive effects on mental fitness.

Most gym-goers know that muscles require carbohydrates to keep going while exercising. However, the brain actually needs carbohydrate fuel during exercise as well. The use of carbohydrate consumption in relation to the brain during exercise has previously been overlooked.

Researchers now know that the energy gained from carbohydrates is used to make neurotransmitters, specifically glutamate and gamma-aminobutyric acid (GABA). An increase in these two common neurotransmitters might help prevent or even treat depression.

> “Findings in this study point to a possibly safer, healthier, and more natural intervention for depressed young adults.

To determine exactly how cardio can impact glutamate and GABA levels, the researchers had 38 healthy volunteers ride a stationary bike until they were at about 85 percent of their maximum heart rate. Using a 3-tesla MRI, which can sense the magnetic behavior of the hydrogen atoms in glutamate and GABA, the researchers measured levels of these neurotransmitters before and after the exercise. They compared these levels to a control group who did not participate in exercise.

Researchers discovered two interesting outcomes. First, as predicted, the levels of glutamate and GABA increased in the participants who exercised and did not increase in those that did not exercise. Further, baseline levels of the neurotransmitters correlated with the amount of exercise the person did the previous week. These finding show that regular exercise can have both short and long term positive impacts on the brain.

While this is a preliminary study, it indicates good news for patients suffering from depression and those at risk. It is possible that regular exercise might be able to supplement or even replace therapy for depression.

Therapy for depression can involve both biological interventions (drugs) and meetings with a therapist or counselor. Common anti-depressants are selective serotonin reuptake inhibitors (SSRIs), which can have more severe negative side effects for young adults under 25 as they synthetically alter the amounts of neurotransmitters in the brain. Thus, the findings in this study point to a possibly safer, healthier, and more natural intervention for depressed young adults.

This study also indicates that an inactive lifestyle is not conducive to good mental health. Even if someone is not depressed, keeping up an exercise regime can prevent falling into a depression. This is especially important for those in college, as this is the time when people are the most vulnerable to mental health conditions such as depression and anxiety. Post-exercise studying is also one of the most efficient kinds, as the brain is significantly more focused and able to mentally work out after a good physical work out.

So while you are debating whether to eat that donut or go to the gym, eat the donut. And then go to the gym! It might help keep you in good mental health for finals.

Journal of Neuroscience (2016) doi: 10.1523/JNEUROSCI.3455-15.2016

PHOTO BY TABLEATNY

The Impact of Running: Which Shoes Can Help or Hurt

BY KAYLA GOMES, PHYSICAL THERAPY, 2017

Walking into a running shoe store, buyers notice the common theme of very thick soles. "Maximalist" shoes have become very popular due to claims that they are superior to minimalist, pseudo-barefoot running shoes in preventing injuries. With 50 percent of runners becoming injured each year during training, such promises can mean big money for major brands but is there science to back it up?

The theory behind highly cushioned shoes is that the foam, gel, or air supports will disperse and decrease the shock the foot experiences when hitting the ground. The added height is supposed to decrease the loading rate, or how quickly that shock is transferred to the runner's foot. These peak forces and loading rates are arguably what cause repetitive, overuse injuries such as patellar tendonitis, patellar femoral pain, and stress fractures.

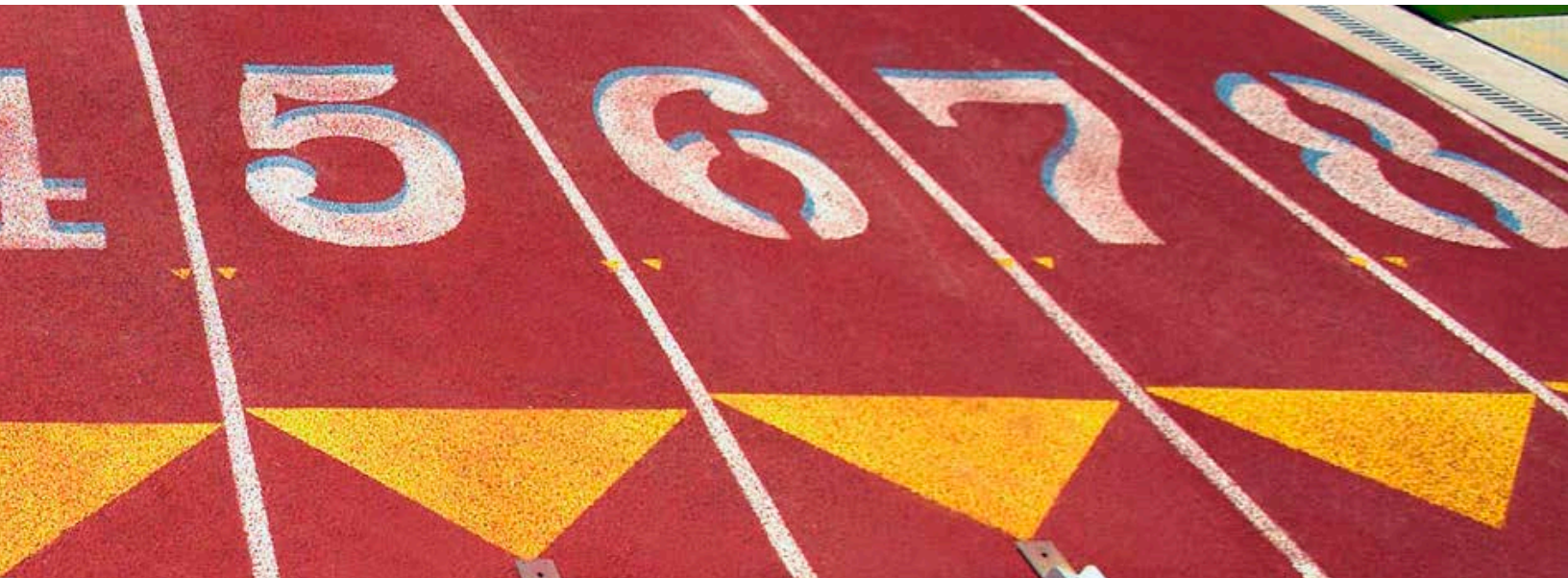
Cushioned shoes do demonstrate a similar loading rate to minimalist shoes during foot strike by dispersing shock. However, though counterintuitive, thick soles actually allow increased vertical forces during foot strike. It all comes down to how the foot strikes the ground when we run. Habitually unshod runners and those who convert to wearing minimalist shoes typically develop a forefoot striking (FFS) pattern; meaning the ball of their foot is the first thing that touches the ground as they land. The muscles in the calf and arch as well as the Achilles tendon stretch and slow down descent of the heel while the ankle moves, leading to a lighter landing and lower forces sent up through the foot. Shoes with a very thick sole allow runners to rear foot strike (RFS) on their heel without pain. The peak vertical force of impact cannot be converted to rotational energy from a flexed ankle during RFS, and thus creates an impact peak that is still up to 7 times higher than a FFS pattern. This increased impact peak is what thought to cause increased rates of pain and overuse injuries.

The promise of lower impacts on joints leads runners to try minimalist shoes and a FFS pattern only to be unpleasantly surprised by problems like shin splints, calf and arch soreness, and stress fractures of the metatarsals in the feet. Proponents of minimal shoes argue that people who have worn cushioned shoes their whole lives cannot simply lace up and run immediately in minimal shoes. Protocols that include a calf and arch strengthening program as well as graduated loading programs are considered the ideal way to begin running in a minimalist sneaker. Either way, while the premise that "less impact means less injuries" makes sense, research is still needed to confirm if this is actually true.

Those who want the best of both worlds with "partial minimal" shoes, traditional running shoes with less cushioning, are out of luck. Studies have shown that these shoes do not facilitate a FFS pattern, but rather a RFS with the same impact forces seen in traditional running sneakers. In fact, one prospective study found runners wearing partial minimal shoes sustained more injuries than those who wore traditional sneakers or minimalist sneakers.

There is not one type of shoe that is the holy grail to preventing injuries. In a world of confusing information on shoe stability, cushioning, and cost, the research says none of it really works that well at preventing injuries. One study found that, if anything, a subjectively comfortable shoe gave the most promise to fewer injuries after a year of running. Whatever happens, research does not affect what the big shoe companies make, trends do. The pendulum between maximalist and minimalist shoe will continue to swing back and forth.

So next time you're in the shoe store: buy the comfiest sneaker in the color you want, because as shoe research stands now, nothing else really matters with rates of injury.



Tampons: Luxury or Necessity?

BY DIANA MOREL, MATHEMATICS AND FINANCE, 2017

The categorization of feminine hygiene products as either non-essential luxury items or necessity items varies by location but is a highly debated topic. Some claim that a tax on tampons is unjust because the population purchasing these products are paid less than their male counterparts. Others argue that taxation of feminine hygiene products is fair because only half of the general population purchases these products. They would also agree that as long as there is a tax on "similar" items, such as toilet paper, there should also be a tax on feminine hygiene products.

The average woman experiences 456 periods throughout her lifetime. The average menstrual cycle length varies by person but generally lasts three to seven days. If the average woman menstruates for five days for 456 cycles, she menstruated for 2,280 days or 6.25 years of her life. The average woman loses 40 milliliters (ml) of blood per cycle or 18,240 ml per lifetime. At this rate of loss, it is estimated that sanitation products are replaced about every 6 hours, which would lead to a lifetime consumption of about 9,120 individual tampons--costing $1,778. Menstruation is unavoidable for nearly all women and therefore feminine hygiene products are necessary for healthy and productive lives.

Menstrual Cycle Over a Lifetime

18,240
mL of blood lost

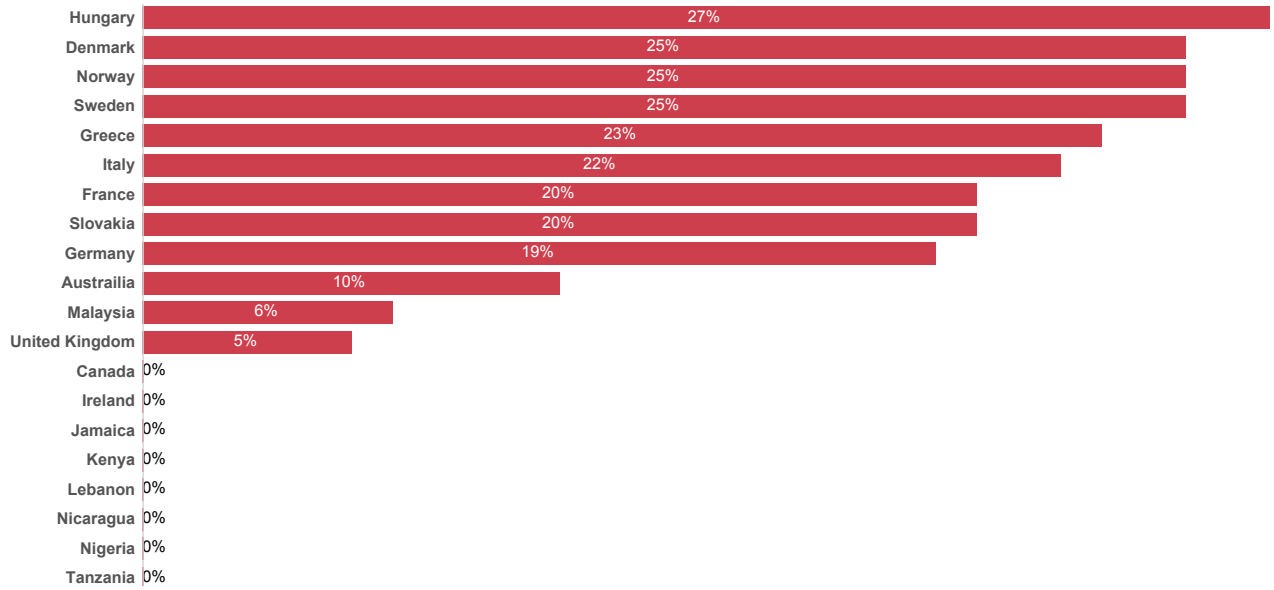
9,120
tampons used

456
menstrual cycles

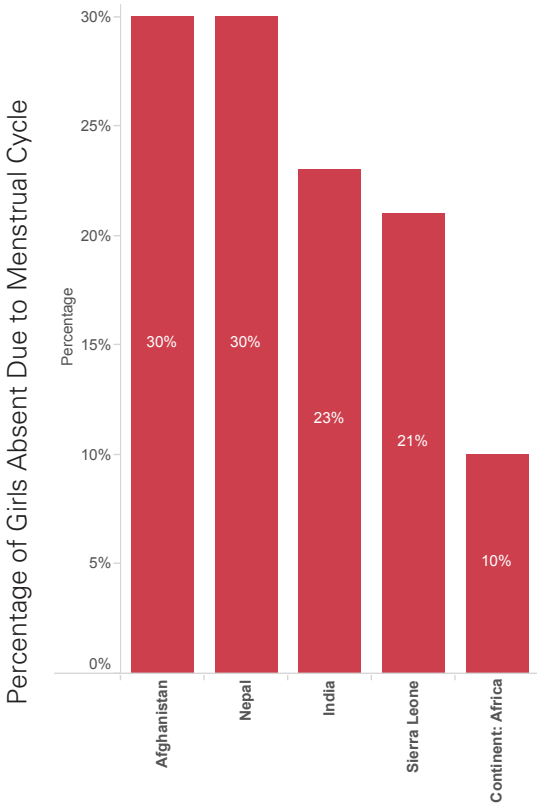
$1,778
cost of tampons

Sales Tax Around the World

Just last year, Canada got rid of the "Tampon Tax". Though some countries have lowered the tax imposed on feminine hygiene products, it is evident that some countries, such as Hungary, have room for improvement. The United Kingdom has recently lowered the Tampon Tax implemented in 1973 from 17.5% to 5%. However, tensions are still high in the UK due to the lack of a tax on edible cake decorations, herbal tea, and exotic meats, such as crocodile, horse, ostrich and kangaroo. Some countries have completely eliminated sanitary product taxes. but girls experiencing high poverty are still unable to access sanitation products.



Access in Developing Countries



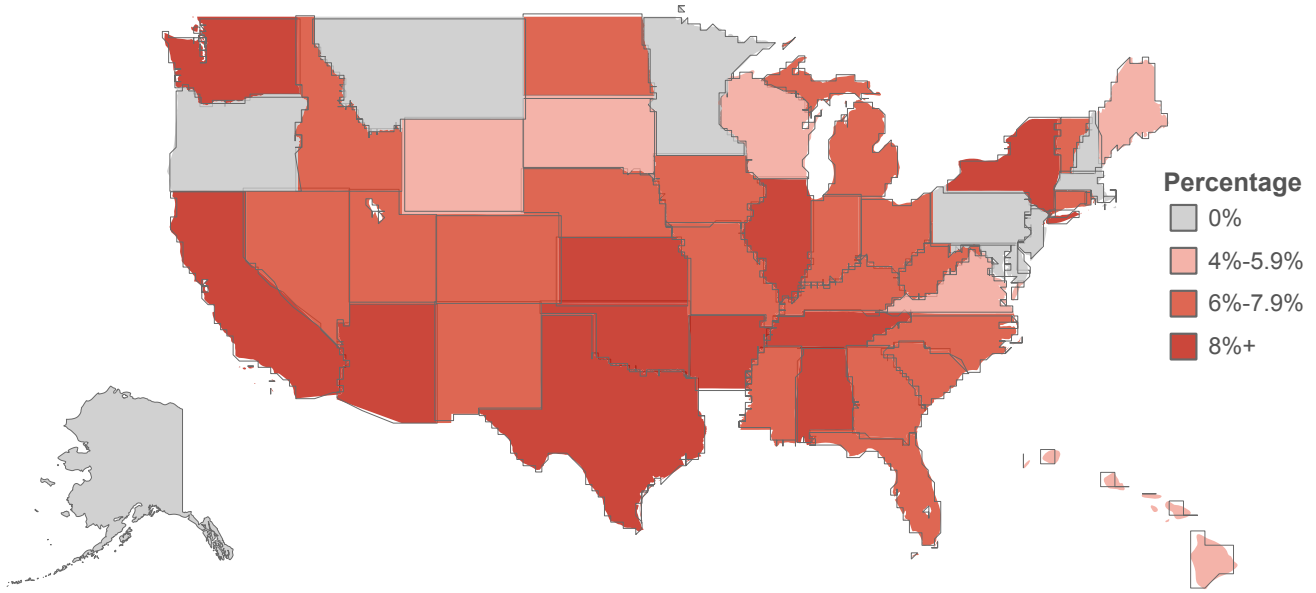
Costs of sanitation products are especially critical to the health of women and girls in developing countries. The lack of access to proper feminine hygiene products leads to a pattern of absenteeism for a few days every month, leading to higher dropout rates and lower overall quality of education. Alternatives used for proper feminine hygiene products are wool cotton, leaves and rags, which exposes the body to reproductive tract infections and disease. Even when attending school during the menstrual cycle, girls are reported to sit in the back of the class due to shame of bleeding through clothing. Some schools do not have proper toilets or facilities for these girls to change and dispose their sanitation products and they must walk home to use a proper toilet. This encourages girls to stay home during their entire menstrual cycle, especially in rural areas where school is a far commute.

A study in rural Uganda reported that girls missed 11% of school, due to their menstrual cycles. Factors that attribute to their absenteeism are lack of proper bathrooms, the presence of male bullies, and lack of sanitation pads. Physical access to sanitation pads are also a constraint, in addition to the cost, because feminine hygiene products are usually sold in urban areas.

Access to feminine hygiene products affect the education, health, and productivity of women and girls everywhere. The need for hygiene products is inevitable and so these products should be recognized by politicians as necessary items.

Tampon Tax in America

Sales tax varies from state to state. However, states make exemptions for certain items categorized as necessities. Unfortunately, state governments rarely consider feminine hygiene products. Pressures to end the sales tax imposed on tampons, sanitary napkins, and other feminine hygiene products are especially high in states who exempt sales tax on candy or soda but do tax feminine hygiene products. Such states include: Arizona, Georgia, Louisiana, Michigan, Nebraska, Nevada, New Mexico, South Carolina, Vermont, and Wyoming.



Bats' super-immunity has potential to help protect humans against fatal diseases.

BY SAGE WESENBERG, BIOCHEMISTRY AND JOURNALISM, 2019

The Australian Black Flying Fox (*Pteropus alecto*) is a black fruit bat with a wingspan larger than 1 meter, making it one of the largest bats in the world. These bats are extremely unique because they are carriers for over 100 diseases, but never get sick from any of them. Many of these diseases like MERS and Ebola are very dangerous, even fatal to humans. Somehow, bats seem to be immune to all of them.

The Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia has been studying these Australian bats and their unique genes, which allow their immune system to be active 24/7. They recently completed sequencing the first gene map of the Type 1 interferon region in *P. alecto*, which is key to understanding how bats can coexist with viruses in their body. Sequencing this region has shown that the bats' immune system is very different than the human immune system, which is only activated after a foreign organism, like a bacteria or virus, enters our body and creates physical symptoms of the disease. Because of this, sometimes it can become very difficult for humans to fight off serious diseases like Ebola.

> "By manipulating human immune response to deadly diseases, we might be able to respond better to infection in the way bats already do.

In *P. alecto*, however, the immune system works to constantly prevent infection from bacteria, viruses, or parasites. An important part of all mammalian immune systems are interferons. Type 1 interferons are especially important for the initial entry of a pathogen to the body. These signaling proteins are then activated and released by host cells to help fight the pathogen and prevent damage to the body. Type 1 alpha interferons are produced by white blood cells, and their purpose is to inhibit viral duplications and regulate immune response. Humans and other mammals have about seven to eighteen alpha interferons whereas bats only have three. Even with only about a quarter the amount of interferons as humans, bats are able to control viruses that often kill people. The bat alpha type 1 interferons are constantly heightened, acting constantly even when the bats are free of infection, which helps control infection and prevent DNA damage. In humans, while type 1 interferons are also present, they are unstimulated and seen at low levels until infection enters the body. This acts as a downstream response system instead of immediately providing immunity.

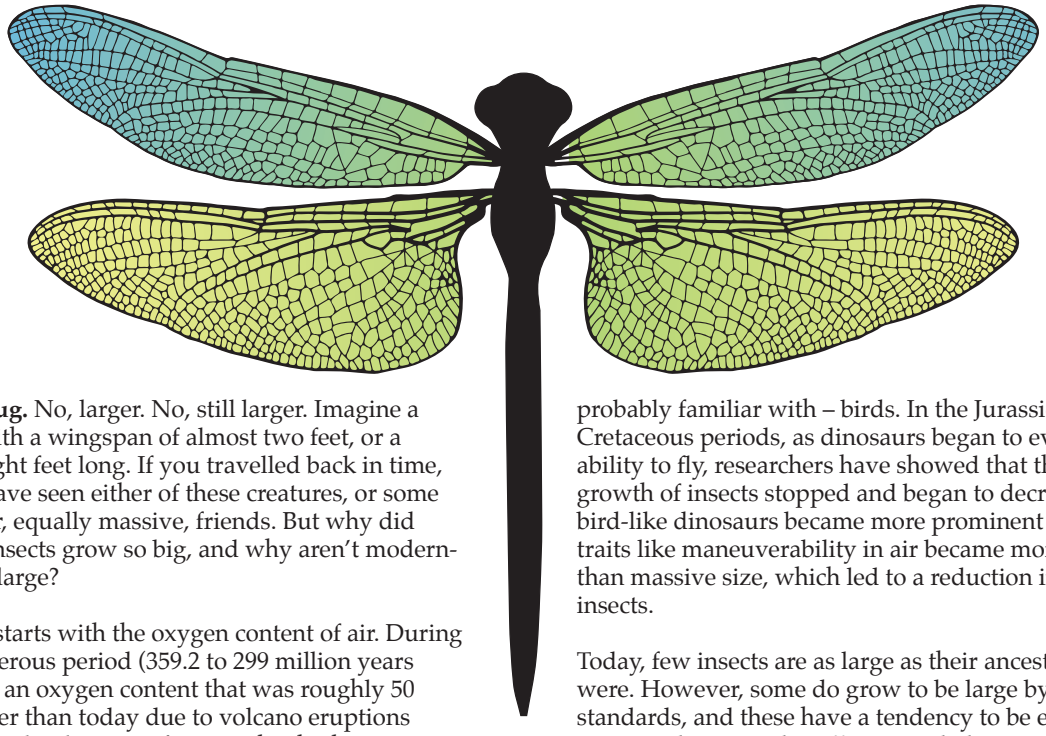
Many scientists are working on developing a better understanding of bat immunity, which may allow for better treatment of human diseases. By manipulating human immune response to deadly diseases, we might be able to respond better to infection in the way bats already do. While human applications would be far in the future, it is clear that the super-immune system of *P. alecto* holds plenty of promise for future scientific study.

I Like Big Bugs and I Cannot Lie

Gigantism in Insects, Prehistoric and Present

BY SHANNON JONES, MARINE BIOLOGY, 2016

DESIGN BY JULIETTE PAIGE, MECHANICAL ENGINEERING, 2020



Imagine a bug. No, larger. No, still larger. Imagine a dragonfly with a wingspan of almost two feet, or a centipede eight feet long. If you travelled back in time, you might have seen either of these creatures, or some of their other, equally massive, friends. But why did prehistoric insects grow so big, and why aren't modern-day bugs as large?

The answer starts with the oxygen content of air. During the Carboniferous period (359.2 to 299 million years ago), air had an oxygen content that was roughly 50 percent higher than today due to volcano eruptions and massive inland swamp forests. That higher oxygen content has been attributed to larger land animals overall – it's much easier to breathe when oxygen is so plentiful, and some dinosaurs had adaptations that took advantage of the air's unusually high oxygen content (For more on gigantism in dinosaurs, see *Titanosaurs, Gigantism, and the Reason for Bigness* in Issue 21.). However, scientists think that this may not be the entire reason for gigantic insects.

Insects reproduce externally, usually incubating larvae in water. This leaves the larvae vulnerable to their environmental conditions. Larvae often cannot regulate what their body takes in, as they have no defined exoskeletons. For example, when oxygen content rises too high, adult damselflies can close their spiracles (openings in the exoskeleton) in order to help regulate the oxygen they take in. Larvae aren't able to do the same, and are left taking in toxic amounts of oxygen. This would be problematic in a hyper-oxygenated world, especially as water acts as an oxygen sink and would contain even higher levels than the surrounding air. In order to defend against this, larvae may have been selected for size – larger larvae would have a larger body, and therefore a smaller oxygen to volume ratio. Progressively larger larvae led to larger adults, until insects were gigantic.

Though oxygen content in air dramatically decreased with the Cretaceous-Tertiary extinction event (the meteor strike that killed the dinosaurs), the end of the supermassive insects came much earlier. Their decline appears to be directly linked with the evolution of another group you're probably familiar with – birds. In the Jurassic and Cretaceous periods, as dinosaurs began to evolve the ability to fly, researchers have showed that the runaway growth of insects stopped and began to decrease. As bird-like dinosaurs became more prominent as predators, traits like maneuverability in air became more necessary than massive size, which led to a reduction in the sizes of insects.

Today, few insects are as large as their ancestors once were. However, some do grow to be large by today's standards, and these have a tendency to be endangered. Dryococelus australis, affectionately known as the "tree lobster," is a kind of nocturnal stick insect that grows to be about six inches long. Tree lobsters once lived on Lord Howe Island in the Pacific, and are one of the few insects still living that exhibit extreme growth as part of their larval process. As the heaviest flightless insect in the modern world, they were slow enough that islanders used to catch them as fishing bait. When a shipping boat crashed on Lord Howe Island in 1918, the rats on board found the slow, heavy, flightless insects to be easy prey. By 1920, no tree lobsters remained on Lord Howe Island, and they were thought to be extinct. However, a small group of the insects was found in 2001 on Ball's Pyramid, a nearby uninhabited island that consists almost entirely of sheer cliffs. After deliberation, the Australian government allowed four of the insects to be removed an entered into breeding programs. Today, there are roughly 13,000 tree lobsters in Australian breeding programs alone, and eggs are being shipped to zoos around the world in order to forestall the species once again becoming near-extinct. Scientists hope that the tree lobsters can soon be reintroduced to their natural habitat, but are apprehensive about islander's reaction.

Today, bugs are commonly thought of as small pests that are easily squashed. Many readers will be relieved to know they will never come into contact with a prehistoric-sized insect. However, if you're interested in getting a taste of the Carboniferous period, Lorde Howe Island or your local zoo might soon be a destination to see the largest insects left on the planet.

PNAS (2012). doi: 10.1073/pnas.1215989109

PHOTOS BY NASA

The Twin Study

One year of space leads to a birth of new knowledge

BY SAMANTHA GLASSNER, MECHANICAL ENGINEERING, 2020

DESIGN BY JENNIFER SHUM, MECHANICAL ENGINEERING, 2018

Astronaut Scott Kelly and Russian Cosmonaut Mikhail Kornienko successfully returned home to Earth on 11:26 p.m. EST on March 2nd. This marked the end of the One-Year Mission, a collaboration between NASA and Roscosmos State Corporation in which one man from each country lived out an entire year of his life in outer space, on the International Space Station (ISS). The end of their one-year mission marks the beginning of even more research to come, studying the changes that have occurred from their long-duration mission as well as how their recovery process goes. The standard duration of a mission to the ISS is six months, so this mission gave researchers an unprecedented opportunity to analyzes long term effects of space habitation on the human body. This mission was differentiated even further by Scott Kelly's twin brother, Mark, who created the opportunity for additional studies, tailored to the brother astronauts in a project called the Twins Study.

Human Research Program – Space Race 2.0, Countries Collaborate
The teamwork of these space faring countries extended into the Human Research Program, a project dedicated to uncovering superior methods and technologies to improve spaceflight to be safer and more productive. The program focuses on facets of spaceflight such as: physiology, psychological and mental health, environmental and human factors, medical capabilities, habitability, exercise psychology, and space radiation. By leveraging assets from national and international collaborators, teaching, and exciting the general public about human space flight, the program tries to anticipate, evaluate, and solve problems humans face in space. Above all, the Human Research Program is striven to improve astronauts' ability to remain healthy, both before and after spaceflight, in order to more effectively gather data and solve problems or emergencies.

Twins Study – What difference can a year and a mustache make?
Einstein once proposed a Twin Paradox, based on his theory of relativity, which stated that if you took a twin and sent them on a rocket at a very high speed while the other twin remained on earth, that when the first twin returned to earth they would be younger. Although inspired by the concept, the Twin Study that NASA chose to undertake concurrently with the One-Year Mission did not aim to prove this. Instead, it strove to take advantage of this unprecedented opportunity to conduct experiments on Scott and his twin, Mark. The twins' identical genetics gave investigators the unique chance to study the subtle effects of spaceflight on the human body. While cataloging the changes Scott experienced on the ISS, they could compare it to his brother Mark, who acted as the experiment's control on Earth. This study is multi-faceted, spanning ten investigations, integrating twelve universities with various corporations and government laboratories, and incorporating four main categories of research: human physiology, behavior health, microbiology/microbiome. The Twin Study allows NASA to further their research in personalized medicines to better identify an individual's reaction to the environment of spaceflight, in addition to conducting a coordinated study involving everything from the molecular level to the entire body function.

To Infinity and Beyond! - #JourneyToMars
An even more exciting result of the One-Year Mission and Twin Study was very succinctly pointed out by NASA Administrator Charles Bolden: "Scott has become the first American astronaut to spend a year in space, and in so, helped us take one giant leap toward putting boots on Mars." Research into the health and wellness of astronauts on long-duration space missions is crucial in preparing for the forecasted long-duration Mars missions. The knowledge gained in these studies will be imperative to advance our understanding of how the weightlessness of space effects the human body and mind so that we can create methods to improve quality of space life and astronaut productivity.

Leaving Orbit leaves behind all pretension

BY ADANYA LUSTIG, LINGUISTICS, 2018

Leaving Orbit: Notes from the Last Days of American Spaceflight, a book by Margaret Lazarus Dean, is as much a chronicle of the end of the shuttle program as a sociological case study of American spaceflight. Dean deftly weaves together her own space obsession, the heartbreak of the end of shuttle, and the history of the so-called heroic period, when we went to the moon.

Dean drives to Cape Canaveral for the last three launches of the shuttle program, and takes her readers along with her. We're there with her—eating junk food on the I-75, listening to Katy Perry's "Firework," and observing the space fanatics. We're there while she's talking to the die-hards, who don't work in the space industry, but collect pins and paraphernalia, citing the number of launches they've witnessed as street cred.

In order to understand the end of the shuttle program, Dean also takes us back to the beginning of NASA. She includes passages from American journalist Norman Mailer watching the launch of Apollo 11, and Italian journalist Oriana Fallaci lounging poolside with the pre-Apollo 11 astronauts. The feverish competitiveness, the idea that Americans must explore, is prevalent. But over the course of the 50 years after the creation of NASA—most Americans feel differently. They watched Challenger and Columbia explode, and without the pressing need to beat the Russians, they're asking "What is the point of space travel?"

Dean answers the question by introducing us to the people who love space travel the most—astronaut Buzz Aldrin, who punched a man for saying that the moon landing was faked, and Omar Izquierdo, a hard-working employee at NASA who was eventually laid-off after the shuttle program ended.

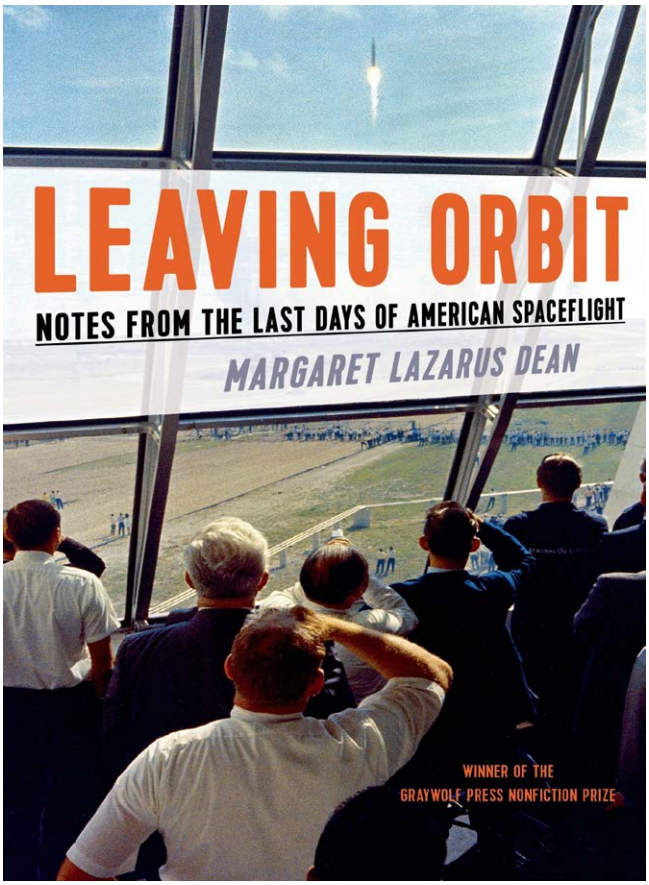
Behind Dean's integral question "What does it mean that we were going to space for 50 years and now we're not?" there is another examination of gender in space and journalism. Mailer was traipsing around the space coast while his five children were cared for by their various mothers. Dean's husband is similarly caring for their child, but she is wracked with guilt. In 2011, Dean is interviewing a female Hispanic astronaut, whereas in July 1962, astronaut John Glenn said, "The fact that women are not in this field is a fact of our social order. It may be undesirable."

Space travel has always felt close to magic to my untrained eyes, but *Leaving Orbit*, manages to demystify the story and pull us down to earth. Dean sets her reverence aside and even describes the bugs of Cape Canaveral.

"Histories of the Kennedy Space Center acknowledge without exaggeration that the obstacle posed by the mosquitoes was so serious that NASA quite literally could not have put a man on the moon by Kennedy's "before the decade is out" deadline without the invention of DDT. In this way, the challenges of spaceflight reveal themselves to be distinctly terrestrial."

She writes not for the fan who has been to 20 launches, but to the fan who, like me, is excited but rather unknowledgable about NASA's politics.

The way that Dean pulls us through this story is engaging, compelling, and kind. She doesn't shame her readers for not knowing the history of the space program, but rather carries us through the history, sociology, and political climate surrounding American space travel.



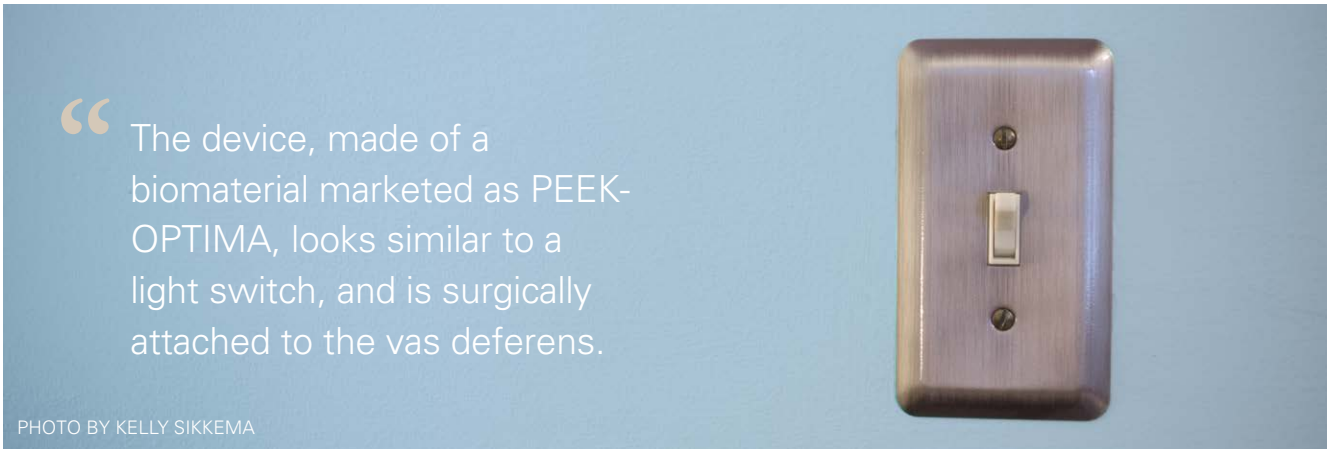
Stopping the Swimmers

The Challenges of Male Contraception

BY LUCAS COHEN, MARINE BIOLOGY, 2019

If you were asked to name a method of male contraception, you would undoubtedly choose the condom – and for good reason. Condoms are cheap, easy to use, portable, and, above all, effective. There are few other contraceptive methods that can compete with condoms in terms of popularity, but is there anything better out there for men?

There are, of course, some notable alternatives. In early January several national and international news outlets reported a surprising story: German carpenter-turned-inventor Clemens Bimek had announced a plan to develop and introduce to the market a device that allows men to quite literally stop the flow of sperm through the vas deferens – a duct that transports sperm from the testicle to the urethra – on demand.



> "The device, made of a biomaterial marketed as PEEK-OPTIMA, looks similar to a light switch, and is surgically attached to the vas deferens.

PHOTO BY KELLY SIKKEMA

What's remarkable about Bimek's device, called the Bimek spermatic duct valve, or Bimek SLV, is that it's a mechanical approach to male contraception that doesn't involve the use of a condom. The device, made of a biomaterial marketed as PEEK-OPTIMA, looks similar to a light switch, and is surgically attached to the vas deferens. Once in place, the patient can theoretically feel for the device through the skin of the scrotum and flip the switch on or off, as desired to release sperm.

Though Bimek claims that this switch will completely eliminate the possibility of pregnancy, the device is still in the early stages of development, and has yet to appear in clinical trials. Some have expressed serious concerns that the implant procedure will produce scarring, or that prolonged closure of the valve will cause clogging. When Bimek himself was subjected to the procedure, he found the device difficult to use, and needed additional surgeries.

Because of various social media and websites like Reddit, the Bimek SLV became a popular topic in early 2016 – but it certainly isn't the only proposed method of male contraception besides condoms. Vasectomy, wherein the vas deferens are made non-functional, is advertised as a permanent option, though pregnancy rates after reversal of this procedure have been reported as high as 50 percent.

Of course, there are many general approaches to male contraception to be considered. We already know that we can construct physical barriers to sperm, as in condoms, or implement surgical procedures to introduce alterations to the male reproductive system in some way, as in vasectomy or the Bimek SLV. Other, less defined non-hormonal approaches to male contraception have been proposed as well, such as the local application of heat to the testes as a way to reduce sperm count and motility, or the use of largely unsuccessful drugs like gossypol, a derivative of cotton, that target sperm viability more directly. Vaccines have even been proposed.

More recently, researchers have made an effort to develop methods of practical hormonal contraception for men, but no single solution has been devised. A notable approach is the inhibition of gonadotropin-releasing hormones (GnRHs), which, as their name suggests, regulate the release of gonadotropin.

In males, gonadotropin is released in regular pulses and, put simply, is important in maintaining reproductive functions like the production of testosterone and sperm. Perhaps the most promising method of gonadotropin secretion involves combinations of testosterone and progesterone, which have shown to surpass treatments of testosterone alone and suppress spermatogenesis. However, even this method has produced some worrying side effects, such as decreases in HDL cholesterol and weight gain.

Male contraception is a complex, largely incomplete field. For now, condoms are the sole practical commercially available male contraceptive – and it looks like they will be continue to be for some time.

Anderson & Baird. *Endocrine Reviews* (2013).

A New Guard(asil) against HPV

BY RACHEL SON, BIOLOGY, 2020

DESIGN BY SARAH BABSKI, COMP SCI & INTERACTIVE MEDIA, 2018

> "The data seems promising, even if vaccination rates are still worryingly low.

PHOTO BY JAN CHRISTIAN

Vaccinations have become a common (and necessary) ordeal for all children in the United States. To the horror of children everywhere, about ten years ago, the United States Food and Drug Administration (FDA) approved yet another vaccination called Gardasil: a three dose human papillomavirus (HPV) vaccine administered over a six-month period.

HPV is a sexually transmitted disease with over 100 strains. According to the World Health Organization, HPV 16 and 18 are responsible for at least 70 percent of cervical cancers and HPV 6 and 11 may cause genital warts. Luckily, Gardasil protects against these four most common and life-altering strains, and since the advent of the HPV vaccination program, the prevalence of these four strains, as well as the frequency of genital warts in young women, have decreased.

A recent study analyzed data collected by the National Center for Health Statistics and Centers for Disease Control and Prevention with the intent to determine how the prevalence of HPV 6, 11, 16, and 18, as well as other HPV strains, have changed since Gardasil was first approved for use by the FDA.

Between 2009-2012, 34.6 percent of females between the ages 14 and 19 received all three doses of the HPV vaccine. The prevalence of HPV 6, 11, 16, and 18 in this cohort decreased by 64 percent. Eighteen percent of females between the ages of 20 and 24 received all three doses of the HPV vaccine. Although the vaccination rate in this cohort is much lower than the vaccination rate in the younger cohort, the prevalence of HPV 6, 11, 16, and 18 in this cohort still decreased by 34 percent. The data seem promising, even if vaccination rates are still worryingly low.

However, unlike HPV 6, 11, 16, and 18, the prevalence of all other strains of HPV in these cohorts did not change significantly. Gardasil does not seem to help prevent the spread of HPV strains that it does not specifically target. Furthermore, the prevalence of HPV 6, 11, 16, and 18 in females between the ages 24 and 34 has not changed significantly. Although the HPV vaccination has incredible potential to address a public health problem, it cannot eradicate all strains of HPV at this point in time.

In 2014, the FDA approved Gardasil 9, an HPV vaccination that targets HPV 6, 11, 16, 18, 31, 33, 45, 52, and 58 – five more strains than that original Gardasil. Hopefully, this trend of medical advancements in the fight against HPV will continue. However, with so many strains of HPV, there is still much work to do.

Pediatrics (2016). doi:10.1542/peds.2015-1968

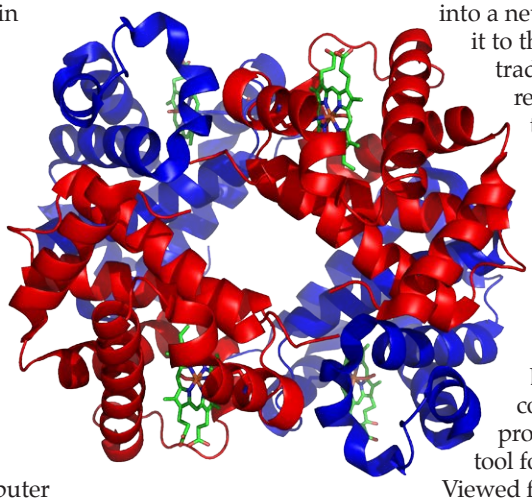
The Game of Life (Science)

BY MATT DEL MASTRO, BIOLOGY, 2017

IMAGES BY ETERNA AND RICHARD WHEELER

Struggling to get published in a scientific journal? Drop the extra hours in the lab and play more computer games.

Players of an online game recently found their usernames appended in a scientific publication as their endeavors facilitated the development of an exciting new biological research tool. RNA can fold and contort itself into a variety of complex shapes, and the specifics of these structures are intimately linked to their biological functions. However, researchers building their own synthetic RNA molecules are often disappointed to find that designs that look perfect on a computer fold in completely different ways in the lab. When the design algorithms fail, scientists often have no choice but to fall back on time-consuming trial-and-error methods in order to generate a feasible RNA structure.



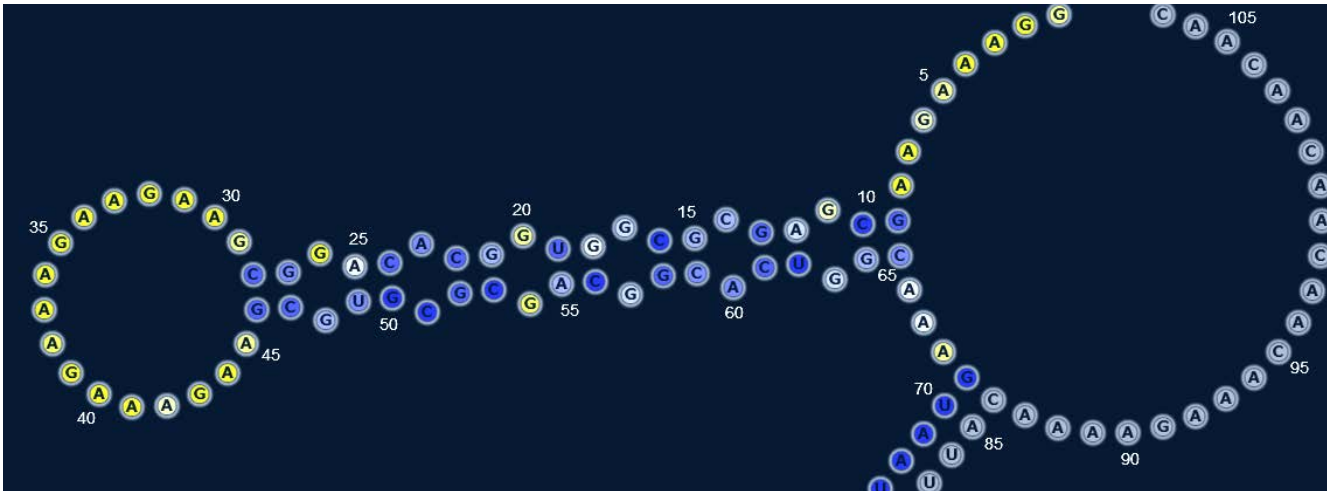
Researchers need algorithms they can rely on to produce RNA designs that work as well on the bench top as on the hard drive. But generating better algorithms from such vast swaths of data requires both a processing power surpassing that of a small research team and a human intuition beyond that of even the most advanced computer programs available. To meet the challenge, the group developed a groundbreaking concept: thousands of members of the public accepted the invitation to become researchers in a "massive open laboratory." In the form of an online game, dubbed EteRNA.

Through the online platform, players were challenged to build RNA molecules according to specific design goals, and the eight designs ranked highest by the community were synthesized in the lab by the research team each week. This interplay between the traditional wet lab and the digital realm of the EteRNA players generated exciting developments. When gamers received the results of the weekly test runs, they could evaluate what worked and what didn't. Many players picked up on patterns previously unnoticed in the RNA design field, and the game encouraged them to submit such hypotheses to a collection.

The scientists speculated that the development of novel design rules was what allowed the players to overtake the performance of computer algorithms as design targets became more and more complex. To test this theory, the team programmed the recently discovered rules into a new RNA synthesis algorithm and put it to the test against both the players and traditional algorithms. The result was a resounding victory for citizen science: the new algorithm emerged victorious over the traditional programs.

While the algorithm still fell short of the scores of the players themselves, the scientists are confident that the performance gap will close as players continue to submit new design rules to the algorithm. By distilling the knowledge of the community in digital form, the EteRNA project could generate an invaluable tool for RNA researchers everywhere. Viewed from a wider perspective, the project is a significant demonstration of the benefits of crowdsourcing science. Many of today's great scientific problems involve overwhelmingly large data sets. While they may be highly trained, professional scientists lack the sheer numbers to efficiently elucidate the patterns within. The connective power of the Internet allows small teams to harness the creativity and analytic potential of the public as a whole, and amateur scientists are given the opportunity to make meaningful advances in what often seems like an exclusive field.

PNAS (2014). DOI: 10.1073/pnas.1313039111



Cognition Enchanting Supplements: Alpha Brain Review

BY VASILEIOS KREOUZIS, BEHAVIORAL NEUROSCIENCE, 2018

DESIGN BY MANNY BARROS, MECHANICAL ENGINEERING, 2020

In the 1900's, a rising medical establishment was under the investigation of therapeutic agents that would allow for disease eradication and societal improvement. One of those agents was cocaine, a very addictive and potentially dangerous drug produced from coca leaves. Two prominent and successful physicians at the time—Sigmund Freud and William Halsted—both experimented with cocaine and eventually became addicted to it. Both characterized cocaine as a miracle drug that would be able to cure life's ills in many areas of abnormal function. Although initially beneficial, the over-prescription of the drug led to unprecedented effects to patients and the doctors using it. These physicians, in peruse of medical and scientific progress, almost lost their careers in their attempt to discover a "magic bullet."

The hope for a "magic bullet" has not ceased to exist, especially in educational settings to boost performance. Over the past few years, cognitive enhancing supplements have increasingly become popular—marketing an ability to increase cognitive performance. Their largest market is students who are willing to risk their health to improve their grades. The drug's compounds are sold under the trademark of supplements, which don't require rigorous testing by the Food and Drug Administration (FDA). Therefore, it is the responsibility of scientists to care about health and wellness and to provide the instructions and warnings associated with the drug.

Alpha Brain, one of the top selling cognitive enhancer companies, is supplied by Onnit, who claims Alpha Brain is a powerful tool that supports cognitive health. Through marketing tricks, the company has sold 34 million capsules. Moreover, there is a great deal of effort to provide the public with ingredients and scientific evidence on the products effectiveness. Onnit provided three clinical trials to establish its effectiveness – all by a team led by Dr. Todd Solomon.

To provide the public with evidence that would promote sales, the company funded Solomon to execute three studies for proof of effectiveness.

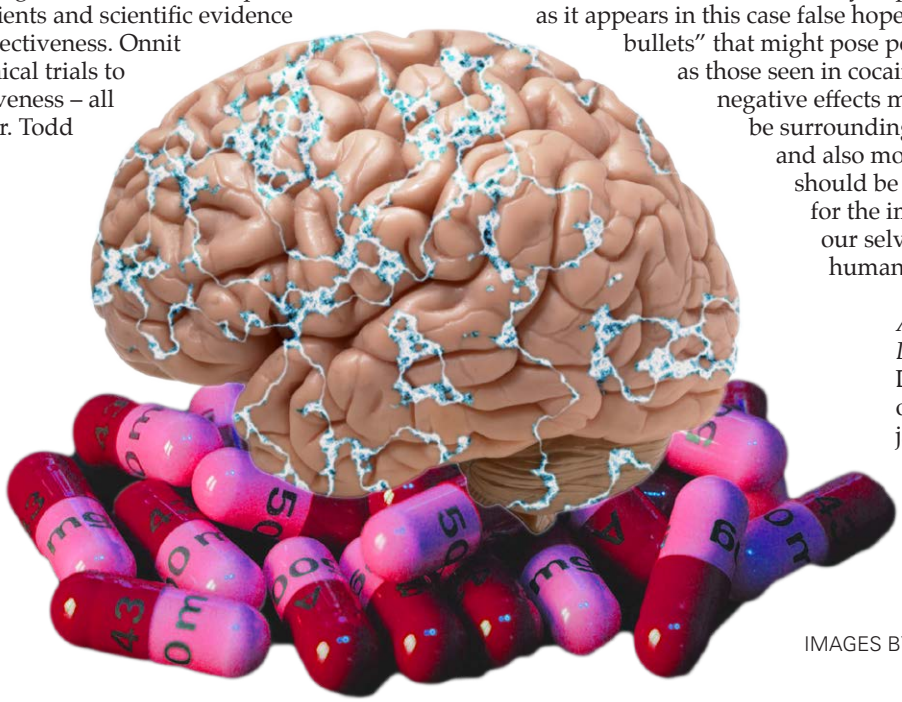
The first two studies focused on measuring a series of psychometric parameters such as word retention and speed of recall. These experiments did not support the claims made by Onnit.

The third study focuses on measuring EEG signals in brain areas that were not outlined in the study's methodology. The certain voltages measured were correlated from past evidence to be markers of attention and task-related energy utilization. The results of the study showed that upon acute administration of Alpha Brain, there was an increase in the small number of participants used. The level of significance established in analyzing potentials was not that effective, since in another study the range of potential latency among young adults appeared to be in the range established as significant due to Alpha Brain usage.

Those studies focused on several measures of brain activity and psychometric cognition to establish that Alpha Brain supports a healthy cognitive function. Even marketed as so, the data were not convincing to establish such a relationship and appear to be very deceiving to the average costumer. As noted earlier, those supplements enter the market without any regulation and appear to make such grandiose claims about their effectiveness. Apart from the fact that side effects such as headaches, stomach aches, and sleep disruption were noted in those studies the apparent long-term effects of this supplement appear to be non-existent.

In the science of medicine, a rigorous process is utilized to protect people from harmful effects. When business is confused with healthcare, a dangerous link is established due to the fact that business will try to provide you with as it appears in this case false hopes about "magic bullets" that might pose potential effects such as those seen in cocaine. To avoid any negative effects more research should be surrounding those formulations and also more awareness should be inside our minds, for the improvement of our selves and our fellow human beings.

Alzheimer's & Dementia (2015). DOI: http://dx.doi.org/10.1016/j.jalz.2015.06.490

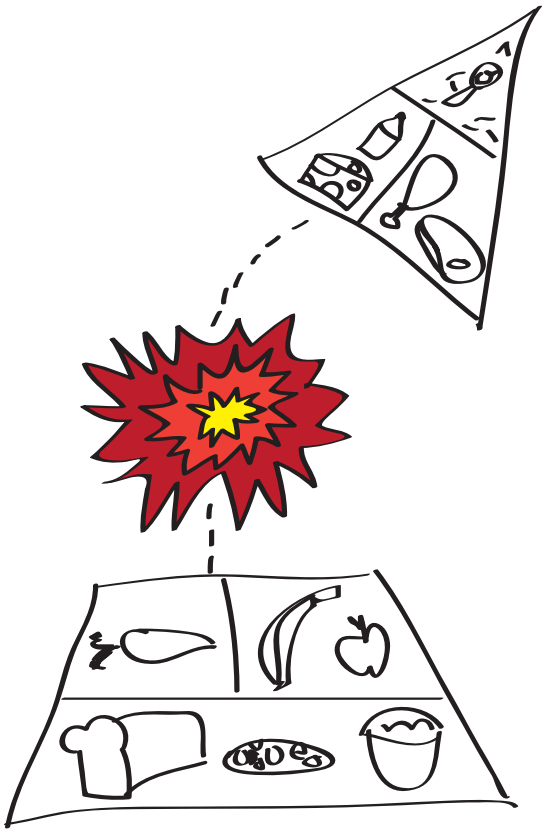


IMAGES BY _DJ AND SAGE ROSS

Some Dirt on Veganism

BY STEPHANIE ZATWARNICKI, BEHAVIORAL NEUROSCIENCE, 2020

DESIGN BY MANNY BARROS, MECHANICAL ENGINEERING, 2020



In the American education system, nutrition is not something discussed in a factual manner. Students are told that drinking milk keeps bones strong and that meat is the only sufficient source of protein for a growing person, but are never told about any alternatives. Government programs and national campaigns drilled the idea of the food pyramid into the heads of students and motivated them to drink milk by placing relevant celebrities into ad campaigns. How are students to believe otherwise? Children believe what they hear based on who is talking - when Britney Spears tells you to drink milk, there are no questions asked.

In reality, these claims are about as credible as saying that "Eating an apple a day will keep the doctor away." The fact of the matter is that milk does not necessarily reduce the risk of bone fractures or an osteoporosis diagnosis, and that most fruits and vegetables (along with nuts, seeds and beans) do actually contain protein. People do not need to consume any form of animal based product to survive, yet those who choose to go against the grain and remove these components from their diet are seen as radical and outlandish. Society has created this negative connotation towards veganism in self defense that they could be wrong about what they are putting into their bodies - that the foundation they were brought up upon is a lie. As a result, the stereotype that vegans are self-righteous preachers has formed. The only problem with this is that critics have never given a thought to what vegans are suggesting. It is time to break down the barrier between the types of people that make the conscious decision to not eat meat or dairy, putting the ethical considerations aside, and examine the health benefits that have been observed by people practicing a plant based diet lifestyle.

An overwhelming amount of scientific research has spoken on the effects of transitioning to a vegan lifestyle, making claims that it can stabilize conditions like obesity, heart disease, diabetes, and hypertension. Dr. Phillip Tuso outlined the gains that could come from suggesting a plant-based, junk food diet-limited as the first line of defense to a newly diagnosed victim of a chronic illness in the paper titled "Nutritional Update for Physicians: Plant-Based Diets." It states that people who graze a wholesome vegan diet have generally lower Body Mass Indexes (BMIs), about half the risk of developing diabetes, and lower blood pressure and cholesterol levels than people eating a 'normal American diet.' It affirms that taking the step towards a lifestyle that focuses more on fruits and vegetables and less (or not at all) on animal products could significantly improve the quality of life of the patient and even reverse damage.

An example of the success of this lifestyle is the story of Marc Ramirez, who was able to get rid of his diabetes, which he originally accredited to his family background and ethnicity, through this style of eating. He reflected on how cutting meat and dairy out of his diet helped him lower his cholesterol levels and his weight. Ramirez highlighted that it was the consumption choices that he made every day and the lifestyle he led that caused him to develop the disease in the first place, not his family background and ethnicity as he previously thought.

> "Researchers are beginning to acknowledge that diet, along with several other factors, correlates to the health of a person in more ways than just taking red meats out of one's diet.

His account is just one of many stories that have had this kind of outcome. Researchers are beginning to acknowledge that diet, along with several other factors, correlates to the health of a person in more ways than just taking red meats out of one's diet. Some people are starting to recognize that consuming animal products is not sustainable and can be done in moderation. It is only with awareness and openness to change that individuals can be their own catalysts and recognize that they should eat to live, not live to eat.

The Permanente Journal (2013). doi: 10.7812/TPP/12-085

Smart Food: Making Sense of Food Data

BY DAVID ROSENBERG, CHEMICAL ENGINEERING, 2020

If you need a reminder that we live in the Information Age, take a look around your local grocery store. The dizzying variety of products displayed on any shelf comes with a barrage of claims and facts to differentiate them. Many people find themselves drawn to the ingredients list printed below the black-and-white Nutrition Facts panel. Both are regulated by the Food and Drug Administration for most packaged foods with multiple ingredients. The familiar labels have been around since 1990 and provide detailed data on common nutrients and standard nutritional requirements, but increasing interest in producer practices and the challenge of government regulation in an increasingly international food system has fueled the rise of certification schemes. Thus a host of labels from both government and third party bodies claiming products are 'organic', 'fair trade', and the like now adorn packaging.

The growing transparency of the food system impacts a number of levels from farm to plate. European vendors have begun requiring Europgap certification, and Subway has some of its produce tested by Primus Labs. The need for certifications often leads suppliers to invest in new equipment, practices, and monitoring. On top of the cost of inspections and certification, this imposes a significant financial burden, especially on smaller operations. Collaboratives are forming to distribute some of the investment costs, while some labels (e.g. organic certification) come at a premium to consumers. Some of these schemes help mitigate the costs by providing training and methods for quality control to producers and can help fight purchaser's attempts to lower prices by claiming poor quality.

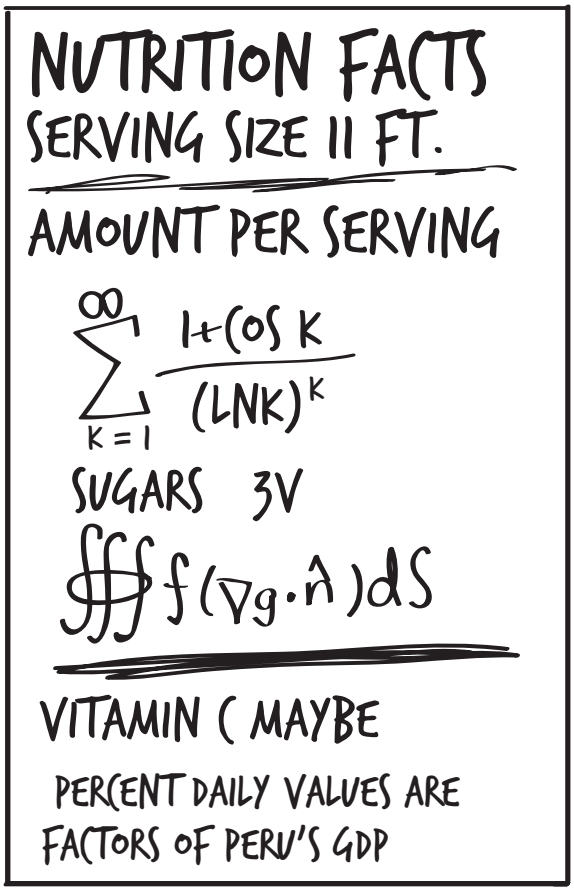
Shoppers are responding to these disclosures at the supermarket. Seventy-three percent of adults in a 2006 USDA survey reported using the Nutrition Facts panel, and a 2013 study in Food Policy found that consumers were willing to pay 25 to 42 percent more for organic apples. Activist groups use information on ethical and ecological practices to put pressure on corporations to improve with 'name and shame' campaigns and by encouraging consumers to recognize their labels.

In terms of college campuses, the Real Food Challenge uses such information to increase the accountability of food provided by dining halls. Students evaluate food based on certifications or verified practices to determine Green Light (high quality), Yellow Light (acceptable quality) or Red Light (unverifiable or poor quality) standards each for community contribution, working conditions, treatment of animals, and ecological impacts. These results go into a total calculator that displays a percentage breakdown of single and multiple category compliance for each university that takes on the challenge. This becomes a tool towards the goal of allocating 20 percent of each university's food budget to 'real' food.

Of course, no amount of data means anything without interpretation. Public policy professor Christopher Bosso points out, "Consumers want information. It isn't always clear what information they're getting. Or what it means." Less than a third of participants in a 2006 study were able to correctly calculate total carbohydrates from the Nutrition Facts panel, and companies can mask the prevalence of added sugars by listing similar components such as sucrose, maltose, and dextrose separately to shift them further down the mass-ordered ingredients list. Certification stamps appear simpler, but the criteria behind them isn't readily apparent. USDA organic foods, for example, can contain natural pesticides.

The food industry demonstrates the power of knowledge from individual purchases to global practices. While consumer information can't be confused with education, data and transparency still make their mark on agriculture and business.

New England Journal of Medicine (2014) DOI: 10.1056/NEJMp1402971



A Booming Industry Against High Energy Costs:

The Costs and Benefits of Medical Marijuana

BY CAYMAN SOMERVILLE, ENVIRONMENTAL SCIENCE, 2016

DESIGN BY MANNY BARROS, MECHANICAL ENGINEERING, 2020

Since 10,000 BC, one of humanity's oldest cultivated crops has had its clutches firmly in society. Thousands of years ago, Asians used cannabis medicinally and it gradually diffused around the world and into the Americas. National Geographic reports that marijuana was popular among some of our nation's leaders, including one of United States' founding fathers, George Washington, who grew it himself. Prior to its criminalization in the early 1900's, extracts and mixtures containing cannabis were legal and were used commonly.

Due to the association of marijuana with the resented and feared Mexican immigrants, anti-drug campaigns and governmental action largely contributed to public concerns over the drug. By the Great Depression, these apprehensions became unavoidable and marijuana was outlawed. National propaganda campaigns labeled it evil. Medical research was halted. Since 1970, marijuana has been classified a Schedule I drug and branded a "dangerous substance with no valid medical purpose and a high potential for abuse." The following War on Drugs led to increased violence and promoted incarnation.

Today, marijuana's image has been reborn: 23 states, including our capital, have legalized medical use and four have legalized recreational use. Despite this, it is difficult to get the required approval from the FDA, Drug Enforcement Agency and National Institute on Drug Abuse to conduct cannabis research. Although the U.S. government largely limits cannabis research, the National Institute of Health spent $297 million on potential medical benefits of the drug and $1.1 billion on abuse and addiction between 2008 and 2014. When the legalization of recreational usage went into motion in Colorado in 2014, the marijuana industry boomed. Unfortunately, cannabis cultivators face enormous restrictions and high-energy costs. These challenges have opened up the door for clean energy solutions.

High Energy Costs and a Cleaner Solution

While outdoor cannabis production has nearly zero energy costs, state laws prevent marijuana from being grown outdoors in Colorado and cultivators must construct perfect indoor climates in enclosed places to grow the plant. According to 36 Solutions, a pro-marijuana lobbying organization, cannabis cultivation in warehouses produces monthly electricity utility bills ranging from $30,000 to $100,000, on top of licensing fees and federal roadblocks. A single pound of cannabis requires 2,000 kWh of electricity. Marijuana growth facilities use about 200 gigawatt hours (gWh) of electricity each month to power fans, heaters, equipment and grow lights. These energy costs largely stem from the artificial lights they require, which must imitate the sun. A greenhouse is a more cost-effective option, and could cut energy usage by nearly two thirds. However, growing in a greenhouse is often not a viable option, due to zoning laws. In addition to the many other challenges facing cannabis cultivators, escalating energy costs (which affect all industries) threatens their ability to make ends meet and survive.

Cannabis growers have turned to innovative technological solutions to lower energy usage, such as renewable energy or LED lights. As marijuana growers seek power-saving measures, the solar industry has recognized their opportune role in Colorado's energy crisis. Colorado's primary energy company, Xcel Energy, offers rebates to businesses that use LED lights or solar power to offset their consumption. According to Xcel, energy usage in the cannabis industry consumes nearly 0.5 percent of Colorado's power—equal to more than 285,000 homes. While there is clear potential for growers to reduce their footprint through solar, they can also purchase renewable energy credits to offset their artificial light costs. Boulder, Colorado actually mandates that cannabis cultivators either purchase these credits or buy carbon offsets.

Despite the solar energy potential in this industry, there are also challenges for growers who want to go solar. First, there is often a high installation cost. While this cost is rapidly trending downward, it is important to compare the initial costs of installing solar panels and the long-term

PHOTOS VARIOUS

savings—cutting your energy bill in half each month will certainly cover the upfront costs in less than a few years. Second, cannabis grow houses have high-energy demands that cannot be entirely covered with solar energy. One 1,000-watt light fixture is estimated to consume about 3 kilowatts (KW) of power. Grow houses could have between 50 and 500 light fixtures depending on their size. To power a large, 500-light grow house, it would require a 1.5 MW solar array. Last, we are currently unable to store solar power, although Tesla Powerwall has revolutionary battery technology that will become more accessible in the future.

> “ Cannabis cultivation in warehouses produce monthly electricity utility bills ranging from $30,000 to $100,000, on top of licensing fees and federal roadblocks.

Health Benefits of Marijuana

While largely a controversial issue, many people advocate for the legalization and taxation of medical marijuana. Recent legislation enables more researchers to study the medicinal properties of the drug. According to Business Insider, only 6 percent of cannabis research analyzes the medicinal applications. These researchers believe two active chemicals in cannabis could provide health benefits: cannabidiol (CBD) and tetrahydrocannabinol (THC). THC is known to have pain-relieving applications and is often distributed as medicine in the form of pills.

In fact, Studies have found many surprising health benefits of THC beyond just pain relief. In addition, cannabis has been seen to help treat and relieve symptoms of a number of diseases, including Glaucoma, Arthritis, Crohn’s Disease, Parkinson’s disease, Lupus, Irritable Bowel Syndrome, Hepatitis C, Multiple Sclerosis, and many others. It has also been seen to slow the progression of brain-related diseases or injuries, such as Alzheimer’s disease and strokes. While a common application of medical marijuana is to reduce side effects of chemotherapy and stimulate appetite, the California Pacific Medical Center reports that CBD may stop the spread of cancer or even potentially kill cancer cells. Furthermore, some studies highlight the mental health benefits, such as treating post-traumatic stress disorder (PTSD), eliminating nightmares, and decreasing anxiety. The American Journal of Health even suggests it could speed up pot smokers’ metabolism and keep them skinnier than an average person.

While problems may arise in recreational usage, many parents advocate for medical marijuana as a treatment for their children’s severe epileptic seizures. CBD has been found to interact with the cannabinoid receptor 1 (CB1), reducing neuronal “excitability” and silencing seizure triggers. Children with Dravet’s syndrome, a rare form of epilepsy, have been found to experience nearly 50 convulsions per day. In one case, the therapeutic treatment was found to reduce seizures to two or three nocturnal seizures per month. Furthermore, 84 percent of parents responded in a questionnaire that their child’s seizures reduced due to cannabis and 11 percent reported their seizures stopped. Clearly, there is a demand for medical marijuana that superposes the high-energy costs and challenges associated with its growth. It is up to the clean energy industry to help cannabis growers work toward a cleaner future.

Epilepsia (2014) doi: 10.1111/epi.12610.

The Science of Self Care

BY MACKENZIE COLEMAN, MECHANICAL ENGINEERING, 2019

Self care is a relevant buzzword in a world where social activism is becoming increasingly mainstream. Many of the actions often associated with self care, however, have existed since the beginning of time. Communities throughout history have employed countless practices and traditions to address the healthcare needs of their members.

The rise of scientific and medical discoveries and the formal development of the healthcare professions in the 19th and 20th centuries created an institution that filled a vital role for humanity. However, the role of medical professionals has changed in recent years. Doctors were once mystical providers of services to passive patients who possessed little information about how to care for themselves. This paternalistic model of medicine is becoming less acceptable in the present day, and it does not account for the individuals who do not have access to established healthcare systems. It is also expensive, as it looks to treat preexisting ailments instead of preventing them from occurring. This model flagrantly seeks to maximize profit from the illnesses of individuals instead of focusing on their autonomy, their right to information, and their unique needs.

Thus, self care was developed to push back against these entrenched institutions and practices as the principal method of addressing individual health. No one can know a person's body and mind better than they do, and no one can address a person's needs as immediately as they can themselves.

So what exactly is self care, anyway? UK Department of Health published a broad and thorough definition in 2005: "Self care is a part of daily living. It is the care taken by individuals towards their own health and well being, and includes the care extended to their children, family, friends and others in neighbourhoods and local communities." By this definition, self-care is a conscious choice to constructively and strategically combat stressors in daily life, not a method to avoid problems with momentary distractions. As a practice, self care has seven pillars outlined by the International Self Care Foundation:

1. Health literacy – It is crucial to know the options available to cater to unique needs as that knowledge can make many services more accessible.

2. Self-awareness – One must acknowledge their physical, emotional, social, spiritual, and professional needs.

3. Physical activity – Exercise is commonly stressed as a crucial activity to boost positive brain chemistry, improve overall physical and emotional health, and reduce the risk of developing diseases.

4. Healthy eating – A deliberate and nutritious diet can truly make a difference when accessible. Chromium and magnesium help boost serotonin levels, which elevates happiness. Calcium, vitamin B6, and iron can regulate mood swings and depression for people who menstruate. Zinc both bolsters the immune system and improves the response of anti-depressants while lowering side effects. As a baseline, it's important to simply eat regularly when possible.

5. Risk mitigation – While certain risks may be inevitable, reducing the negative impact of the risk can result in less harm towards an individual's health, which is care in its own right. For example, sun exposure, which can lead to skin cancer and other diseases, is an unavoidable part of life, but wearing sunscreen can reduce the harmful impact of UV rays.

6. Good hygiene – No one can be perfectly clean all of the time, but washing oneself, cleaning any injuries or infections, and executing regular maintenance in general can increase happiness and self-esteem and ground an individual in their body.

7. Rational use of products and services – It is vital to take the appropriate medication that has been prescribed at the recommended frequency. Other elements of this pillar are understanding how medicine may affect ability and behavior and consuming health products like vitamins and minerals.

A common misconception is that self care is synonymous with selfishness, impulsivity, or laziness. This idea couldn't be any farther from the truth – when practiced in an ideal fashion, self-care is a very deliberate group of actions. Anyone with money can buy food, drinks, substances, or possessions that will satiate a craving and provide an instantaneous, temporary mood boost. Unfortunately, these indulgences often come with consequences that can cause more damage than their original benefit. Truly positive care requires discipline and planning, and each action compounds upon those before it to elevate an individual's health for longer stretches of time.

Ultimately, taking care of oneself is the foundation upon which all other care is built. For humans, continuously checking in with themselves builds self-awareness that positively supplements all areas of life. Self care has an impact that reaches far beyond what is immediately satisfying – when employed correctly, it carefully addresses needs in the present to cultivate a healthier, happier, and more stable future.

NUSCI Loves Our Seniors

As much as we all like to deny it, at some point we all graduate and move on to the adult world. This semester, we say good bye to five past and present members of the NUSCI executive board. Working with these amazing editors throughout my time at NUSCI has been a pleasure and the entire NUSCI team will miss them dearly.

BY KATIE HUDSON, MARINE BIOLOGY, 2017

Josh Timmons, Former President and Editor
Josh wrote his first article for NUSCI in Issue 12 and was President of NUSCI from 2014 to 2016. He told me not to put him in this feature but I didn't listen to him. Also known as MAJOR YEAR, Josh holds the record for number of NUSCI website and logo changes during a presidential term. NUSCI would not be where it is today without his vision and leadership and the entire NUSCI team wishes him well in the future.

Shannon Jones, Editor and Unofficial Archive Master
Shannon has been with NUSCI since Issue 9, making this her 20th issue! Out of all of the articles she has written for NUSCI, her favorite is *Titanosaurs, Gigantism, and the Reason for Bigness* in Issue 21, although her favorite overall issue is Issue 11 (and if you would like a copy of this issue, Shannon wants you to know that there are plenty in the NUSCI Office). She is graduating with a BS in Marine Biology and is planning on working in a research lab for a few years before going to graduate school. Immediately after graduation, she plans on physically and mentally recovering from *Captain America: Civil War.* Her favorite parts of NUSCI were being able to tell people "Yeah, I've got issues" un-ironically, hocking magazines to fellow Huskies, and geeking out with all of her favorite nerds.

Naomi Stapleton, Editor and Head of Design
Naomi's first issue of NUSCI was Issue 16. Her favorite article was *Failure to Replicate: Is Psychology in Crisis?* (published on the NUSCI website) because she enjoyed writing about an ongoing controversy and a hugely important paper in her field. Naomi's favorite overall issue is Issue 21 because of the cover. She is graduating with a degree in Psychology and will be working at Evidera as a market access medical writer after graduation. She loves that this magazine brings together people from so many different majors and interests, and that everyone gets excited about the same thing: sharing science! She's loved seeing the magazine grow so much over the past few years.

Andrew Bloy, Former Editor
Andrew joined NUSCI in Fall 2012 for Issue 12. His favorite issue was The Controversy Issue (Issue 22) and he has two favorite articles: Matt DelMastro's *Discovery & Division: Scientific Controversy Through the Ages* and his own article titled *The Curious Case of Pablo's Hippos,* both from Issue 22. His favorite parts of NUSCI were the people and the editor meetings. Andrew graduated in December with a degree in Biology and is currently working at Jersey Shore University Medical Center. He plans to apply to medical school in Europe.

Kristen Drummey, Former Editor and Webmaster
Kristen first joined NUSCI for Issue 15. Since she is a Behavioral Neuroscience major, it shouldn't come as a surprise that her favorite article was *Deflated Brains* which was published on the NUSCI website and covered concussions in the NFL. Her favorite overall issue was Issue 22, the Controversy Issue. Kristen's favorite part of being in NUSCI was getting to learn and write about fields of science that she otherwise wouldn't know about and getting to know some great people. After graduation in May, Kristen plans to continue to participate in olfaction research at Harvard Med for the summer. She plans to pursue a PhD in neuroscience but if that doesn't work out, alternate plans include starting a rock band or going into seclusion to write the next Great American Novel.

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