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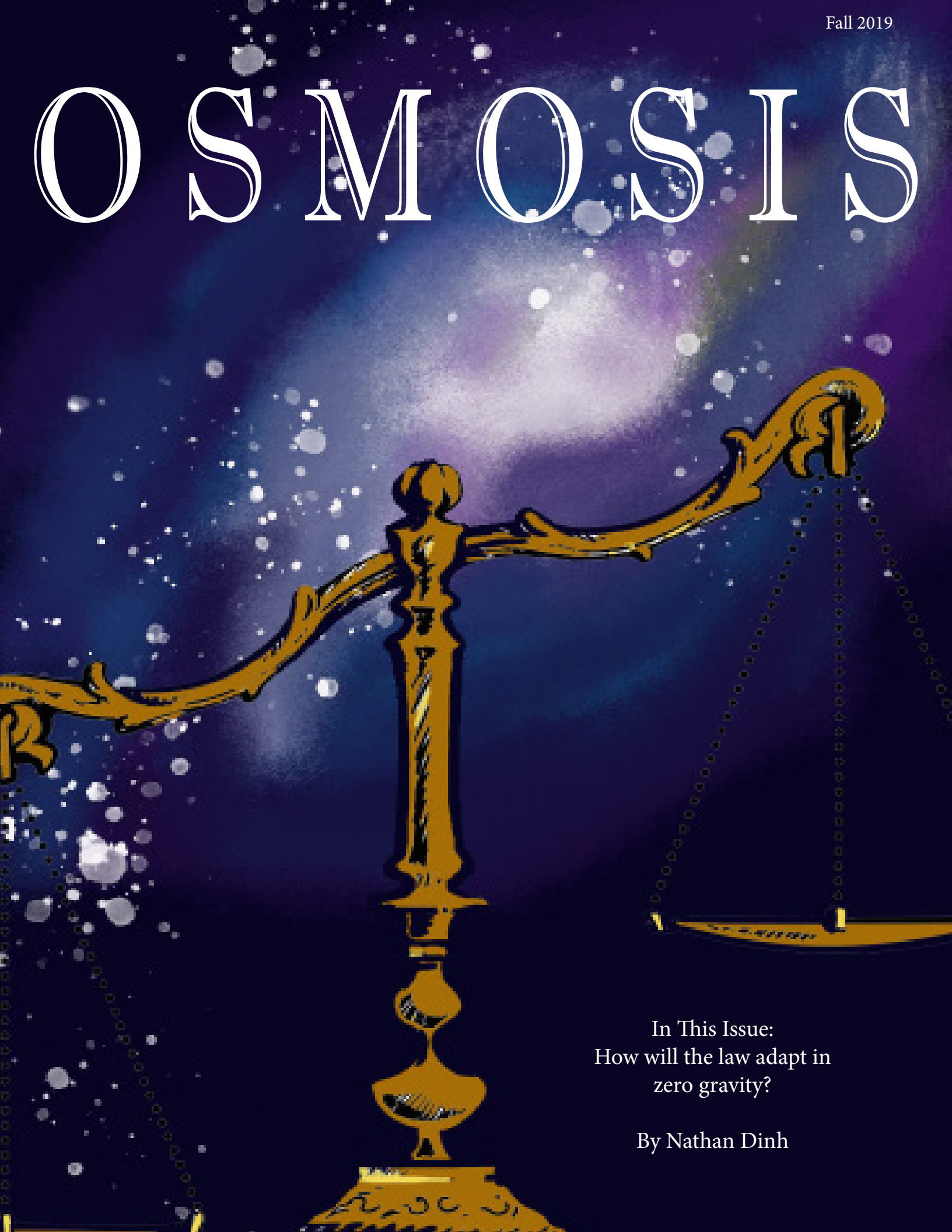

In This Issue:
How will the law adapt in zero gravity?

By Nathan Dinh

Letter from the Editor

Dear Reader,

I welcome you to enjoy our lucky number issue 7 of Osmosis! As a Biology and English double major I have come to deeply appreciate the ways in which science is interesting and should be written in interesting ways that everyone (even those Business majors) will enjoy. This issue has been an interesting one to make and taking on the role of Editor-in-Chief has been a learning experience for me. As a reader, what I hope you take away from this issue is not only some cool new info about some science-y stuff, but also some questions and desire to learn more about the world around you. In a world full of confusing and sometimes contradictory information, remember the wise words of Ms. Frizzle, "Take chances, make mistakes, get messy!"

Science on,
Anthony Isenhour, Editor-in-Chief

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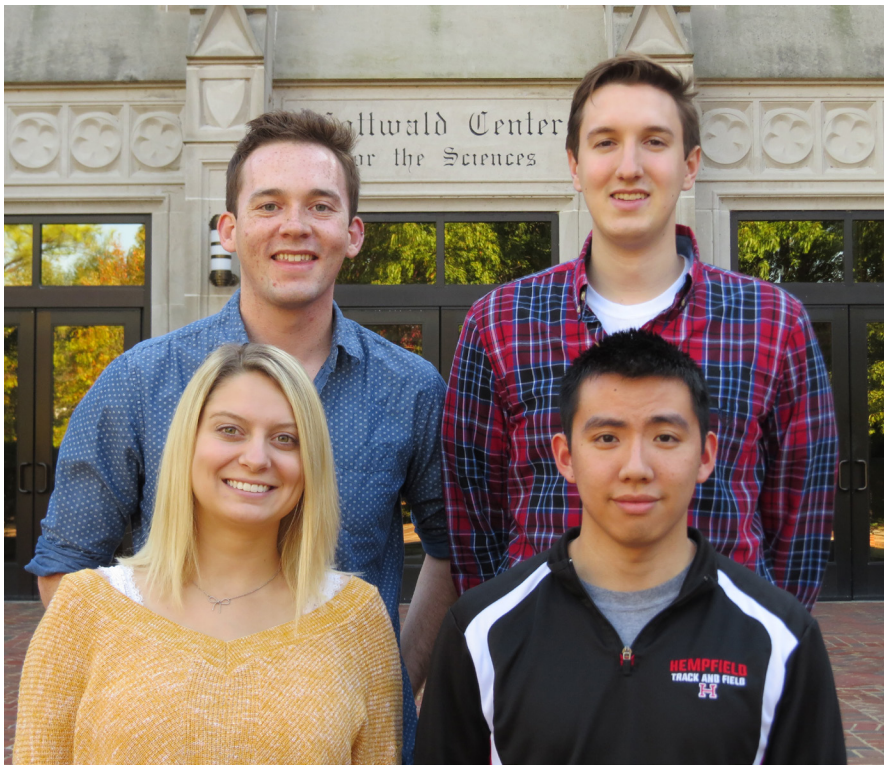

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Mysterious X Lymphocyte Cure to Type One Diabetes?

By George Qiao

Diabetes, the seventh leading cause of death in the United States, is caused by excessive blood glucose.1 Type 1 diabetes is a variation of the disease characterized by a deficiency in insulin, a hormone produced in the pancreas that allows cells to take up glucose from the blood and receive energy. Lack of insulin results in accumulation of sugar in the bloodstream, and subsequently dehydration, excessive urination, and tissue damage.2 The need to prevent the disease is urgent, as over a million children or young adults in the world have type 1 diabetes, and over 100,000 cases of type 1 diabetes are diagnosed every year.3 Type 1 diabetes is known as an autoimmune disease because the immune system destroys insulin-producing beta cells in the pancreas.2 What is not certain is the mechanism by which this occurs. However, recent research has linked the disease to a newly found cell called the X lymphocyte.4

We are familiar with the B and T lymphocytes, which are involved in the acquired immune response in our bodies for fighting against extracellular pathogens. B cells function to secrete antibodies that recognize antigens and are involved in humoral immunity. During maturation in the bone marrow, B cells that react with self-antigens are negatively selected; that is, they undergo apoptosis or receptor modification so that they are not a threat to the body. The surviving B cells then travel to the spleen to complete maturation and become naive B cells, which are mature cells that are not yet activated.5 T cells arrive in different classes and fight against intracellular pathogens through cell-mediated immunity. During maturation in the thymus, , T cells also undergo negative selection, and once matured, are known as naive T cells.6

Antigen-presenting cells (APCs) recognize protein antigens and display them to T cells. A B cell can act as an APC and recognize protein antigens using its B-cell receptor (BCR) to internalize the antigen and process and display the antigen on an MHC II molecule. A helper T cell can recognize the presented antigen through its T-cell receptor (TCR), and the interaction between the MHC II on the B cell and CD4 molecule on the T cell results in T cell activation. The T cell secretes cytokines that activate the B cell, which differentiates into plasma cells that secrete antibodies and memory cells that remain for future invaders.5 Cytotoxic T cells, unlike helper T cells, directly target pathogen-infected cells and destroy the cells along with the pathogen inside.6

Normally, the only two types of lymphocytes that the body produces are B and T lymphocytes. What is previously known regarding the mechanism of insulin destruction is that insulin can bind to a molecule on APCs known as HLA-DQ8. However, the binding is not strong enough to trigger a reaction that leads to type 1 diabetes. Researchers at Johns Hopkins Medicine recently utilized computer simulations that revealed dual-expressor (DE) cells which express both the BCR and TCR. A protein coded by the BCR of DE cells, named the x-Id peptide, can bind to HLA-DQ8 very tightly compared to insulin, and the binding is strong enough to bring out a T cell response that can result in type 1 diabetes.4

To test the strength of the T cell response by DE cells, the researchers produced a genetically-

engineered insulin mimic called the "superagonist," which has a higher affinity for HLA-DQ8 than normal insulin and is 1,000 times more immune-stimulating. The team ran computer simulations which illustrated that the x-Id protein resulted in a T cell response with tenfold increased strength over that of the superagonist; hence, the x-Id protein displayed a trigger in T cell activity that is 10,000 times stronger than that produced by normal insulin. These results suggest that the x-Id protein found in DE cells can elicit strong T cell responses that can then attack insulin-producing cells.4, 7

To confirm the existence of the DE cell, which can be referred to as the "X" lymphocyte, the researchers used a virus to produce genetically-identical duplicates of the cell, and found that the clone cells all expressed both BCRs and TCRs, illustrating that the cell is a hybrid of the B cell and the T cell. Furthermore, the researchers obtained blood samples from donors with type 1 diabetes and healthy donors and found that the DE lymphocytes appeared more frequently in patients with type 1 diabetes than nondiabetic subjects.4, 7

The discovery of the X lymphocyte helps deepen our understanding of type 1 diabetes and can be insightful for those searching for a cure for the condition. While the results of the X lymphocyte study at Johns Hopkins yields valuable information, more studies should be done to further confirm and analyze the new type of cell. In the future, more information regarding the X lymphocyte and its behavior can bring us closer to finding a cure for type 1 diabetes.

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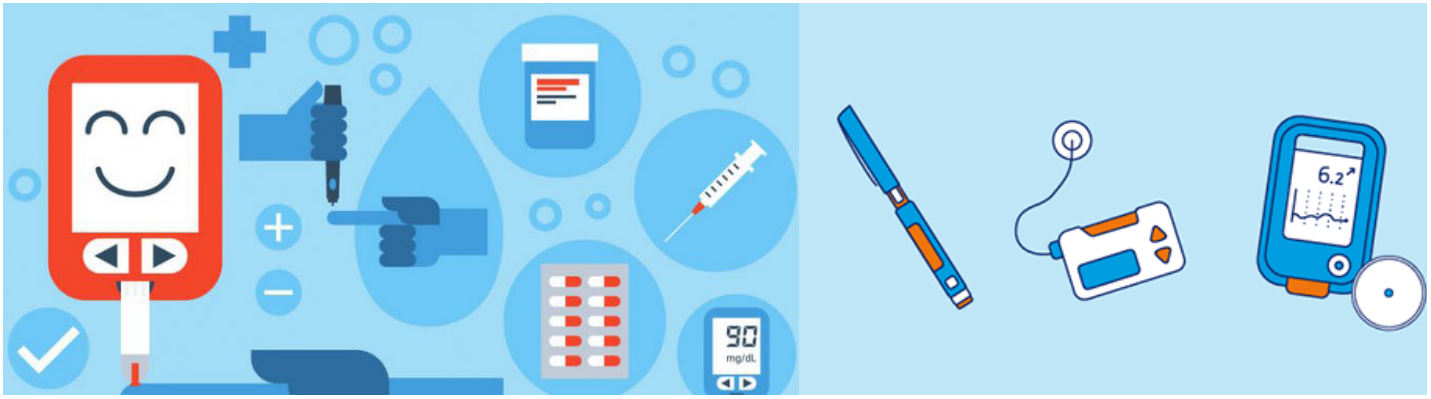

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The Gut Microbiome

Lucy Patterson

The gut microbiome is characterized as living microorganisms, including bacteria and viruses, and genetic material found within the gastrointestinal (GI) tract. These microorganisms aid in the digestion and absorption of nutrients in food, and play an active role in the digestive process. However, recent evidence suggests that the gut microbiome is not only helpful in the digestion of food, but also could be linked to mental health and personality.

The gut-brain relationship begins in early development with factors including birthing and infant feeding method, exposure to stress, environment, diet, medications, stage of lifecycle, andcomorbid diseases.[1] During this time period, the gut microbiome is developing and forming. Significant evidence suggesting that the relationship between these factors and conditions during development can have an impact on inflammatory bowel disease and colitis diagnoses later in life have been evident for many years.

In recent years, the gut microbiome has become a point of interest for many scientists and physicians alike, but for a new reason. Research is no longer solely based on conditions within the gut, but on the person as a whole. With modern technology, the gut has been able to be studied in new ways and the complex organization of microorganisms seen for the first time. Through new research, it is becoming more evident that the gut microbiome does more than process nutrients and waste from food. Now, there is significant evidence and research suggesting that bacteria, including commensal, probiotic, and pathogenic bacteria in the gastrointestinal (GI) tract can activate neural pathwaysand central nervous system (CNS) signaling systems.[2] Therefore, the gut is no longer solely responsible for the digestive process, and instead has the ability to affect the human brain —and personality.

Early studies have shown that the development of the gut microbiome with in the GI systemafter birth can alter brain function and regulate complex behaviors. Disruptions of this development can also lead to problems within the central nervous system later.[3] In addition to innate personality and cognitive function, studies on mice also suggest that dieting, or changesin diet, affect the make-up of the gut microbiome in less than a single day and can also affectgene expression within the microbiome.[4]

Now, evidence suggesting a further relationship between the gut and the brain have risen, andrecent interest in the body's microbiome has renewed scrutiny of gut bacteria; it's possible thatbacterial imbalance alters the body's metabolism of dopamine and other molecules that maycontribute to depression.[5]

While significant studies on humans have yet to be released, the relationship between the gut and the brain is evident, and growing in popularity among the scientific field. However, this provides evidence behind the growing notion of the mind-body connection, and new evidence isconsistently being released about this once-unknown connection.

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Law and Order: Zero Gravity

Nathan Dinh

In August 2019, a woman named Anne McClain logged into her ex-wife's private bank account, violating privacy laws.[1] Whilein any other case this would be just another issue of identity theft, this was no ordinary crime. Rather, McClain was 254 miles above the Earth, travelling 17,150 miles per hour aboard the International Space Station when she allegedly used a NASA-registered computer to log onto her estranged wife's account. Hers was the first crime committed off planet Earth, and it raises the question: how do countries decide who investigates and prosecutes crimes committed in space? As space tourism, interplanetary travel, and international involvement in space grow, the legal questions of space exploration and research have become increasingly complicated and technical.

Given its all-encompassing nature, space law, defined as "the body of law concerning space-related activity,"[2] is the result of international relations and cooperation. The process of establishing cosmic legalese began in 1958 when the United Nations established the ad hoc Committee on the Peaceful Uses of Outer Space, just one year after the Soviet Union's launch of Sputnik, the first satellite in Earth's orbit, and Laika, the first animal in space.[3] The Committee was made permanent in 1959, and in 1961 they passed Resolution 1721, which formally established the body of space law for the first time. So far, the Committee has passed five international treaties and five resolutions dealing with issues such as rights to exploration, exclusion of claims by any country, nuclear weapons in space, and treatment of astronauts.[3] In one treaty, the Agreement Governing the Activities of States on the Moon and Other Celestial bodies, the UN established that "the Moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means."[4] In other words, countries cannot claim any property or region on the Moon. It should be noted, however, that only 18 countries have ratified it and that India is the only signatory that actually has space capabilities.[4] Regardless, this has not stopped companies like LunarLand or Moon Estates from trying to sell "Lunar Land" or "moon acres" for as low as $29.95 to $52.60 per acre.[5,6] Through these treaties, the UN has attempted to coordinateinternational cooperation in all things space, with restricted success.

Apart from UN treaties, the International Space Station specifically is governed by three different agreements. These rules were made by the five space programs involved with the ISS –the United States, Russia, Canada, Japan, and the European Union.[7] The first agreement is the International Space Station Intergovernmental Agreement, or IGA, which was signed in 1998, establishing the basic framework of operation on the ISS. The second includes the four memoranda of understanding between the United States and the otherfour organizations, since NASA is understood to be manager of the ISS. These specify the exact terms for managementand logistics aboard ISS between each country. The third is the various other agreements, including those establishing codes of conduct, criminal jurisdiction, and other behavioral expectations of the astronauts. The most relevant section to astronaut Anne McClain is the clause that establishes that the astronaut's native country will have jurisdiction over any crimes committed by the astronaut in space.[8] So when McClain returned to Earth later in the year, she was investigated by the U.S. inspector general. There are no current updates available on the outcome of her case. Despite the seemingly complicated nature of her crime, previously established international agreements allowed for a peaceful investigation into astronomical activity.

Universities across the country have started programs specifically for space law. In 2013, for example, the University of Mississippi began offering a Masters in space law.[9] The curriculum includes courses in international space law, space security law, and U.S. Space Law. The University of Nebraska-Lincoln began offering a Doctorate of the Science of Law for people with JDs or PhDs who want to author a bookon space law-related topic.[10]Although an intergalactic senate may not be in making for the next millennium or two, space law is a growing field that combines the sciences with the legal field. For those interested in international law, diplomacy, and science, space law is a rapidly expanding field that may be the fit for you.

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What Does Science Say About Sexuality?

Anthony Isenhour

While sexuality is full of cultural variations and subjective definitions used for self-identification, scientists have attempted to investigate the complexity of this topic. There may be benefits and risks involved for many if science rules out specific characteristics that determine one's sexuality, but there is no simple determining factor for sexuality because of its fluidity.

To start, how do scientists study sexuality? One of the most common methods for determining sexual orientation was developed by Drs. Alfred Kinsey, Wardell Pomeroy, and Clyde Martin in the late 1940s. This method is known as the Kinsey Scale and determines a range of sexualities from purely heterosexual to completely homosexual.[1] While this model incorporates sexualities ranging from heterosexual to homosexual, it does not address all possible sexualities. However, the reports that developed this method did lead to a change in the public's view of sexuality.

Additionally, researchers have used methods such as self-reporting, pupil dilation, genital and neural response, and association activities to study sexual orientation.[2] While these all have a variety of benefits and drawbacks, self-reporting has become a more useful method for determining sexual orientation with rises in the public's tolerance of diverse orientations and lessened reluctance of participants to report less accepted orientations.

Now that we know methods scientists employ to comprehend sexual identity and orientation, we can take a look at the studies scientists have conducted regarding sexuality. While many deterministic studies cannot be conducted because they would create many an ethical dilemma, there have been some significant studies that correlate certain environmental factors with an individual's sexual orientation.

A review done by an array of scientists found that childhood gender nonconformity (behaving in a manner inconsistent socially with your presented gender) has a strong correlation with adult sexual orientation.[2] Scientists have found through studies that follow children to adulthood, as well as studies where adults reflect on their childhood, that for men and women in Western and non-Western cultures, that "nonheterosexual adults partook in more repetitive behaviors surrounding gender nonconformity" typically beginning around preschool age (3-4).[3] This correlation potentially presents dangers to children being raised in conservative environments where their behavior may be more strictly regulated and expected to conform to their presented gender. However, this correlation varies and is not a consistent indicator of adult sexual orientation as childhood behavior does not always indicate adult sexuality. However, there is a significant correlation between childhood nonconformity and potential adult sexuality.

In contrast to behavior, some other scientists have found a potential environmental/genetic factor that indicates an increased likelihood for a male to be-homosexual: fraternal birth order. Specifically, these studies have found that an increase in the number of older birth-related brothers increases the likelihood that a male will be homosexual. This study found that it only correlates with birth-related brothers,

regardless if they are raised in the same home.[4] The lack of correlation for other types of siblings, younger siblings, and non-birth siblings such as stepsiblings indicates that this propensity for homosexuality is somehow correlated to the developmental environment in the womb and the potential genetic alterations that occur as a mother has more children. This is an interesting correlation because it combines the concept of nature and nurture as the bases for sexuality (nature as inthe genetic factors, nurture as in the environmental factors) which demonstrates how science is not always reducible to one theory or another.

Scientists have also been able to disprove a lot of conceptions regarding indicators of sexuality. For instance, there was a superstition that one could tell a man's sexuality by the difference in length of the 2nd and 4th fingers. This was supposedly correlated to the increased difference in length commonly found in women and levels of prenatal hormones. However, while men and women do exhibit trends of differences in finger lengths, there is no relationship between this factor, the hormonal cause, and sexual orientation.[2]

One interesting type of study for investigating developmental relationships between sexuality and one's environment is through the use of twins. Identical twins share the same genetics and are raised in the same overall environment, even if there are some small environmental and epigenetic differences between the two, they function as constants in the lab that can be tested against a series of variables that could lead to the identification of factors leading to certain sexualities. However, the ability to perform these studies without self-selecting for certain groupings of twins, as well as appropriately investigating the differences has been too inconclusive and many scientists believe that twin studies need to be supplemented with further environmental studies.[2]

While scientists have not been able to appropriately study twins to investigate genetic and environmental factors, they have been able to study the effects of nonheterosexual parents on the sexuality of their children. Unfortunately large-scale studies of parenting have not been able to be achieved. However, some small-scale studies seem to suggest that children raised by nonheterosexual parents have similar outcomes in sexual orientation and quality of life as children raised by heterosexual parents.[5, 6] These studies however could use additional research because nonheterosexual couples who wish to raise children still experience discrimination under some adoption laws.[2] Studies like this could have a positive effect in eliminating the ways in which laws discriminate against lgbtq people.

In conclusion, scientists have been developing methods for studying sexuality and are still working to improve their techniques. However, these studies raise the question of the ethics of being able to determine sexuality consistently and accurately. If scientists are able to determine explicit factors that lead to one's sexuality, doesn't that raise the risk of discrimination? On the short hand, yes, if there is some simplistic factor that determines sexuality that is a danger, but in looking at the studies done so far and the questions being asked, I do not believe that is the case. Sexuality seems to be driven by a complex number of factors that are both innate and environmental, and these complexities are what contribute to the difficulty of the question being addressed and humanity's diversity. Science has a long way to go before it can tell us about the ways in which sexuality influences us and vice versa, and I look forward to the prospect of science in further comprehending the diversity of life.

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COW CONUNDRUM

the science behind lactose intolerance

BY Dana Morcillo

We've all heard those words before - lactose intolerant. You, a close friend, or even a random stranger at dhall mutters those words and with it comes the inability to eat milk, cheese, and ice cream. But what does being lactose intolerant actually mean? Besides special access to that one refrigerator in dhall you've always wondered about, lactose intolerance means that you lack a special enzyme needed to digest lactose - a sugar present in many of your favorite foods.

What is lactose and its purpose in the body?

Lactose is a disaccharide, or sugar, made up of glucose and galactose. In order to be broken down into its monosaccharides, it requires a specific enzyme called lactase. Everyone is born with an abundance of lactase in order to break down the lactose present in your mother's milk into needed energy. This lactase resides in the inner lining of your small intestine. It can then break down lactose before it passes into your large intestine. Through this process, glucose and galactose - the resulting sugars - can then enter the small intestine and be absorbed into the bloodstream to be converted or used for energy.

If the body contains little or no lactase, it loses the ability to digest lactose in the small intestine. This results in lactose being passed through the large intestine and into the colon where it's broken down by bacterial fermentation. This process of digestion is called lactose malabsorption. However, lactose malabsorption doesn't always lead to lactose intolerance. That transition can depend on different factors such as how much lactose was consumed, and an individual's colonic flora and sensitivity to lactose fermentation products.

What is lactose intolerance?

Lactose intolerance is a condition in which an individual experiences irregular digestives symptoms such as diarrhea, abdominal pain, or bloating after consuming any food or drink that contains lactose.[1] These painful symptoms are the result of lactose malabsorption and can manifest at three different levels. The most common type is primary lactose intolerance. Primary lactose intolerance is caused by a dropoff in the production of lactase seen in adulthood. This type of intolerance is genetically determined and seen most frequently in individuals of African, Asian or Hispanic ancestry.[2] Secondary lactose intolerance is a decrease in lactase production caused by damage to the small intestine whether it's through illness, injury or surgery. The last is developmental lactose intolerance. Those with this heritable condition are born without any lactase or lactase activity.

How does one become lactose intolerance?

The majority of us are born with a working lactase gene that produces all of the lactase present in our intestine. Yet, 75% of the world's population suffers from some type of lactose intolerance.[3] Why is that? The answer lies in both genetics and epigenetics. The expression of the LCT gene is responsible for the production of lactase. However, as we grow and become older, our diet expands beyond milk to other foods. This transition means that the lactase gene is read and expressed less often. Over time, this leads to a decreased expression of that gene and thus, of lactase in a process called lactose nonpersistance that can lead to lactose intolerance. However, a small portion of the population experiences lactose persistence where they are able to continue producing lactase well into adulthood. This population contains mutations within their LCT gene that is believed to allow for the high lactase activity. However, genetically lactose nonpersistent individuals aren't always lactose intolerant nor are genetically lactose persistent always lactose tolerant.

In a study published in 2016 by Labrie and co-authors, researchers attempted to understand the role epigenetics may play in answering why genetics doesn't lead to the expected expressed phenotypes seen in lactose intolerance. Through profiling and sequencing techniques, the authors looked at and compared the lactase genes in the small intestine of a mouse (which does not experience lactase nonpersistence) and a human. In comparing genes, lactase expression was seen to differ through a hindrance of transcription factors or other components responsible for regulating the gene.[4] These regulatory sites are epigenetically-controlled suggesting that epigenetic changes that can accompany age contribute to the lack of connection seen between genetics and phenotypic outcome.

How does one treat lactose intolerance?

The first and possibly most difficult solution is to avoid lactose. Despite lactose being present in milk and cheese, new alternatives are available that can allow you to avoid lactose but still enjoy your favorite foods. These alternatives include soy, almond or oat milk, vegan cheese, and even cashew cream cheese. Another popular treatment is through lactase supplements such as Lactaid. Lactaid contains the lactase enzyme and helps break down the lactose present in these lactose-filled foods. The effectiveness of these supplements can be dependent on the person as each individual is different in their sensitivity to lactose and thus, might need a different amount of Lactaid in order for it to be effective. Overall, it's important to remember that every person is unique in their biology so finding a solution that works can be trial-and-error.

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have an allergy or interested in eating a dairy free diet?
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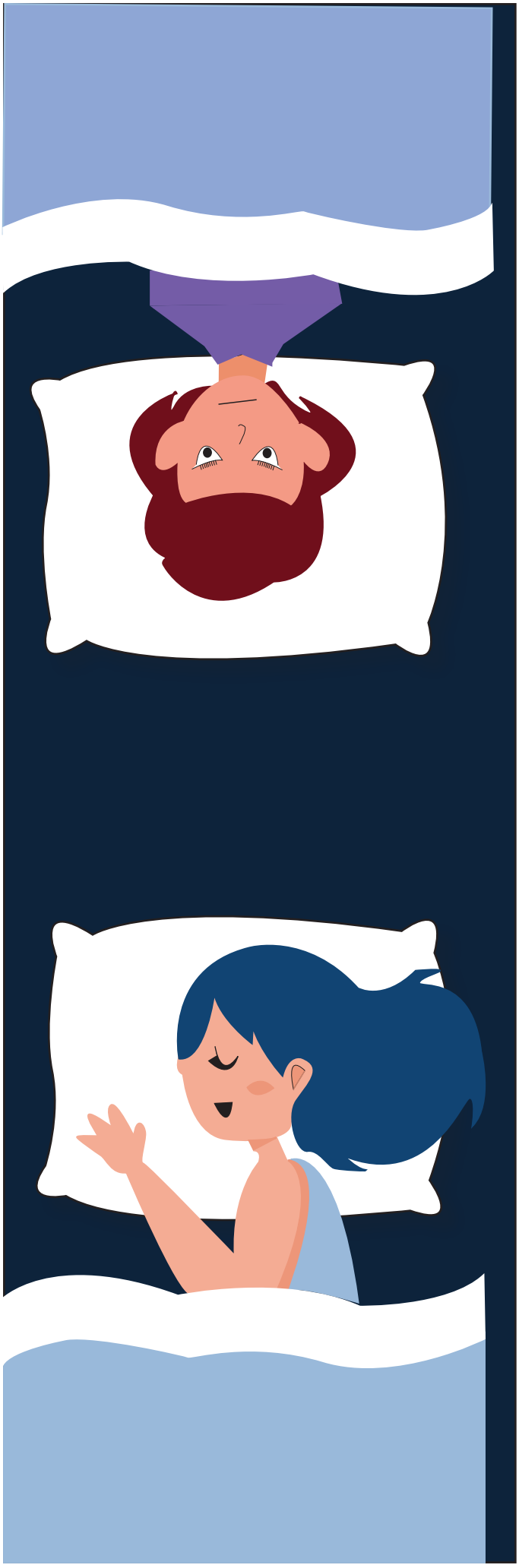


PILLOW TALK:

the science behind the all-nighter

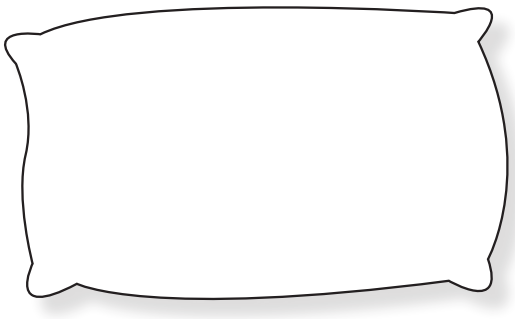
BY Rilyn McKallip

It's that crazy part of the semester. Finals are coming up, and you find yourself staying awake later and later trying to cram for important tests. The night before your toughest final, you decide to pull an all nighter. It's the only way you'll be able to learn all those facts. The day of the test, you feel awful, but you make it through, and have a feeling you probably passed. As you go back to your dorm to crash, all seems well. You think to yourself, "that one night of lost sleep probably won't hurt me at all."

How much does a sleepless night really affect you? As it turns out, sleep is crucial for many bodily functions, and even one night without sleep can have harmful physiological effects.[1] Longer periods of sleep deprivation (generally defined as less than 7 hours of sleep a night) are associated with many health risks, including an increased chance of obesity, diabetes, and cardiovascular disease.[2] Why is sleep so important, and how do these sleep related problems occur?

When you wake up after a good night's sleep, you probably feel refreshed and have a general sense of well being. This is because your body repairs itself in your sleep. Hormones are released, organs are repaired, proteins and lipids are produced, and waste is removed from the brain. Some of the hormones released are related to growth and development, so getting enough sleep helps an individual grow and develop properly.[3] The brain is full of activity during sleep, as it uses this time to clear out waste products that accumulate in the brain. This function of clearing out toxins and wastes in the brain is almost exclusive to sleep, as the brain cannot expel these products and process sensory information at the same time. Therefore, a lack of sleep causes these toxins to build up in the brain and impede memory and brain function.[4] Additionally, while you are asleep, the brain repairs neurons and myelin sheaths, the protein and lipid combination that encloses the axons of neurons and allows them to fire faster. When you don't get enough sleep, or get no sleep at all, the myelin may not be repaired or produced in the proper amounts.

A study examining sleep deprivation on myelin production showed that even a single night without sleep can have detrimental effects. In this study, the researcher showed that myelin is produced and maintained during sleep, a sleepless night can lead to myelin damage, and that sleepless participants had a reduction in white matter (neurons with myelin sheaths) in their brains.[1] Another study looked at both cognitive and physiological effects of an all-nighter in college aged students. After one night, the researchers gave the participants a series of tests to measure cognitive abilities, including a game similar to SIMON© involving repeating a series of colors and sounds and a test consisting of reading words mismatched with their color (for example, "red" printed in blue ink). Reaction time and cardiovascular health were also measured, using a ruler drop test and exercise test, respectively. The sleepless participants exhibited a significantly slowed reaction, with a reaction time of about .01 seconds longer than the control group. While this may not seem like a large increase, even that small of a delay can have disastrous consequences in high risk situations, like driving. According to the study, a night of no sleep affects judgement while driving to the same degree as a 0.1% Blood Alcohol Content (BAC), which is greater than the legal BAC level for driving.[5]



Maybe you're thinking-- "well, I never pull all nighters, per se, so I'm all good, right?" Not necessarily. Sustained poor sleeping habits can have even more disastrous health effects in the long run. On average, adults need 7-8 hours of sleep per night. When that minimum is not met, the body cannot perform its restorative functions as well, and there can be adverse health effects.

A leading journal on sleep showed a relationship between sleep loss and obesity: adults who consistently got less than 6 hours of sleep were 7.5 times more likely to have a higher Body Mass Index than those who got the recommended amount of sleep. The authors suggest that this difference may be because sleep deprivation is associated with increased appetite, as seen by a decreasing amount of leptin, a hormone that suppresses appetite, and increasing levels of ghrelin, a hormone that signals hunger. Consistent sleep loss can lead to weight gain because it may cause an individual to feel hungrier on a daily basis. According to the journal, long term sleep loss is also associated with diabetes, as sleep loss leads to a decrease in glucose tolerance. Those who receive less than 6 hours of sleep are 1.7 times more likely to get diabetes than the adults receiving the recommended amount of sleep. Additionally, not getting enough sleep is associated with cardiovascular disease, with people who sleep less than 5 hours a night experiencing a 45% increase in risk of nonfatal heart attack as compared to adults getting 7-8 hours a night.[2]

While students tend to sacrifice sleep in favor of schoolwork and other activities, getting enough rest is a crucial part of a healthy life. Try to set aside time to get your seven to eight hours. Your body will thank you for it!

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The Future of Healthcare Delivery

Ryan Cvelbar

The advancement of modern technology is a perpetual cycle that enhances the current ways in which we live and our quality of life, while also improving upon older technological conceptions. Just recently, virtual reality (VR), has risen to the top as a result of the media's fascination with the profound level of sophistication with which the product operates. The first concept of virtual reality was developed in 1968 by Ivan Sutherland.[1] Since then, Sutherland's rudimentary invention has blossomed, as have its potential applications in life irrespective of the entertainment industry with which it is most commonly associated. Specifically, virtual reality's applications in the healthcare industry are unprecedented and endless. As a matter of fact, the virtual reality market in medicine is "projected to grow to $3.8 billion by 2020, according to a report by Global Industry Analysts," and "Grand View Research predicts this market to grow to a whopping $5.1 billion by 2025".[2] These projections make it apparent that in just a few years, significant and valuable progress will be made in medical VR technology.

In his article "Virtual Reality Breakthroughs in Medicine," Jack Carfagno covers areas where the VR technology is currently making an impact on the healthcare industry. He states that the technology is being used to create virtual models of a patient's anatomy and explains that, "360 degree-models are generated using CT and MRI images".[2] The ability to create such models has not only allowed surgeons to better understand a patient's condition and identify a treatment, but to also plan how to most efficiently operate in the OR. Moreover, Carfagno argues that, VR has the potential to detect early Alzheimer's disease as "mental satnav that aids in navigation,". This can facilitate in the identification of signs or behaviors associated with the onset of Alzheimer's based on the individual's performance in the virtual reality program. Similarly, Carfagno states that "[r]ecent work has foundVR to be effective in building balance skills in patients with Parkinson's disease" and maintains that "[t]his system successfully improved patient's obstacle negotiation and balance, as well as their confidence in moving around in their environment".[2]

Likewise, Claudia Wallis informs her audience of other avenues virtual reality has taken and by which the technology has benefited patients. One remarkable application she describes is a game called Snow World, which "immerses burn patients in a cool, frozen landscape...temporarily blocking out the real world where nurses were scrubbing wounds, stretching scar tissue and gingerly changing dressings".[3] Similarly, she writes about a burn surgeon, Abraham Difede, who "aims to quantify the pain-distraction effects of...a charming VR game in which patients toss balls at giggly cartoon bears...measuring whether burn patients need lower doses of intravenous painkillers while playing".[3]

The applications in which VR is relevant extend even further than treatment of the patient in the hospital. Wallis continues her exploration of the benefits of VR as she turns her attention to, 'exposure therapy.' Precisely, she describes exposure therapy as, "[t]he approach in which patients mentally revisitthe source of their trauma guided by a therapist... In VR, patients do not merely reimagine the scene, they are immersed in it".[3] The implementation of VR in psychology has enhanced the client's ability to identify the source of their negative emotions and to confront them. As Difede explains, "[w]e're teaching the brain to process and organize the memory so that it can be filed away and no longer intrudes constantly in the patient's life;" and provides evidence of the program's effectiveness stating "[o]ne2010 studywith 20 patients found that 16 no longer met the criteria for PTSD after VR treatment"(Wallis).Wallis states that "[t]herapists can even customize scenes in the program to match a patient's experience. A keystroke can change the weather,add the sound of gunfire or the call to prayers. To think that the program can be customized to such a great extent is incredible.

As you can see, the applications of virtual reality in medicine are countless and even more so with respect to the patient. Often times, people jump to the conclusion that the doctor is the one benefiting from the inclusion of groundbreaking technologies in medicine, but virtual reality is an exception that manages to benefit everyone.

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Paula Ferrada, M.D. FACS Trauma and Acute Care Surgery

Interview by Joseph McEachon

Titles at VCU:

Professor of Surgery at VCU.
Program Director for the Surgical Critical Care Fellowship.
Medical Director of the Surgial and Trauma Intensive Care Unit.

Q: When did you first learn of your interest in medicine?

A: My interest in medicine first beganin Colombia. My dad is a trauma surgeon, and my mom is an OB/GYN nurse in Colombia. When they did not have childcare, they would bring me to the hospital. In Latin American countries, the rules are enforced a bit more loosely regarding children in hospitals. As a result, I scrubbed in for the first time on a ruptured abdominal aortic aneurysm when I was 12 years old. After seeing the surgery, I couldn't shake it. It was the most amazing thing that I had ever seen!

Q: How did you know it was right for you? Did you know?

A: I knew it was right for me because it was like love at first sightwith a partner, but in this case, a profession.

Q: What was your pathway in medicine?

A: In Latin America we start medical school immediately following high school. I went to Universidad del Valle Medical School, a public university in Cali, Colombia. I started medical school in 1994. After graduating, I came to Jackson Memorial Hospital in Miami and spent a few years doing research, then subsequently completed my internship. Following my internship, I moved to Boston and completed my residency at Beth-Israel Deaconess Medical Center, one of the Harvard training hospitals. Next, I did my fellowship in Pittsburgh at UPMC, followed by another fellowship in Shock Trauma at the University of Maryland. Afterwards, I came to VCU and have been working here for the past 9 years.

Q: What is your specialty?

A: Acute Care Surgical Services, Trauma, and General Surgery.

Q: What was the path to your specialty? (medicine-residency-fellowship?)

A: General Surgery is a 5-7-year residency. Many programs require you to do a year or two of research. In my case, I had already done a lot of research at Jackson Memorial Hospital, so I completed my residency in 5 years and then completed two fellowships.

Q: What does your specialty entail?

A: Saving people's lives. Literally, when people are dying, that is where my specialty comes into play.

Q: How many years in have you been in practice?

A: If you start counting after residency, I have been in practice 11 years.

Q: What is your typical practice setting for your field?

A: It depends on where you work. Since I am a professor of surgery, I do a lot of teaching, writing, and research. By far, most of the work is clinical, meaning it is directly involved in taking care of patients. I handle trauma cases: anyone who comes in bleeding to death from a car accident, gunshot wound, or a fall. I also do emergency general surgery, meaning anyone who needs their appendix or gallbladder removed and are at risk for dying. Additionally, I take care of critically ill patients in the ICU. Typically, these are patients who are in organ failure.

Q: What does a regularday look like for you?

A: I get to the hospital at 6:30 AM and go to something called "morning report", which is generally a sign-out from the night shift. We then split the case load for the day amongst the surgeons. Next, we triage which cases

are emergent, namely who will go to the operating room and who will cover the emergency department. Depending on the service that I am covering, I will teach in a classroom, operating room, or during rounds. If it is an administrative week, I spend time writing guidelines, clinical papers, etc.

Q: What brought you to America?

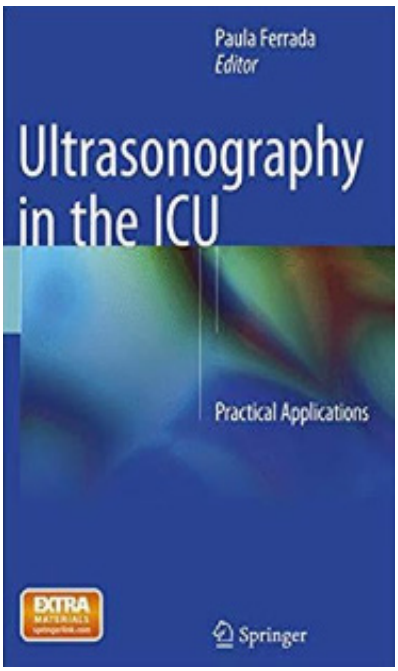
A: For this question, we have to go way back. In 1994, I started medical school at a state hospital in Cali, Colombia. During that time, everybody was suffering and dying as a result of the cartels. There was a lot of trauma and it was a great place to train, but there were sparse resources. It was a government hospitaland many of the things that we take for granted in the United States, we did not have in Colombia. For example, there was no CT scanner. This made it a really good place to train because you had to learn to be a great doctor. You couldn't always rely on technology to make a diagnosis, instead you had to rely on your brain. My school went on a strike and I had the opportunity to go to Grady Memorial Hospital in Atlanta, Georgia. Despite this hospital being considered small in America, it was a huge step up from what I had in Colombia. They had a helicopter and the patients went right from the Emergency Department to the CT scanner. To say the least, my jaw was on the floor. I knew that I needed to come to the United States to learn what the "Gold Standard of Care" was for patients. I thought that if I was a surgeon in the US, then I could get a job anywhere in the world. Equally as influential was the cutting-edge technology. Other countries may be better in terms of how their healthcare system is organized, but if you area dying patient, there is no better place to be than the United States of America. We have so many resources, it is almost impossible to die. That is why I came to the US. The reason I came to Richmond was to follow the most amazing mentor that I had worked with. He has since retired, but I stayed because I like the area. I think Richmond is a great place, particularly VCU. It is a place that fosters diversity and gender equality. Those are both things that are very dear to my heart as a female Latin American surgeon. America has provided a plethora of opportunities for me. I was the youngest person to make full professor at VCU and the first acute care surgery fellow from Shock Trauma. I also was the first Colombian woman to graduate from a Harvard program in General Surgery.

Q: What specialty(s) did you originally think you were going to end up in when you entered medical school? What changed?

A: I always knew I wanted to do surgery. I tried to change my mind, but with everything I did, I found myself drawn to the trauma aspect of it, and that is one of the reasons that I knew trauma was for me.

Q: What passions do you have in medicine?

A: Research. I have over 87 publications and a few teaching trauma and ultrasound textbooks, some of which are printed in two languages. I am passionate about developing ultrasound curricula. It is something that chased me, rather than me chasing it. I care about it so much and it is almost impossible for me to escape. In general, for any scientist to make a difference, it will require passion behind the project. No one else will have the passion for it; you have to be the one. It also makes the time spent on it less of a commitment and more of an investment.



Q: What other passions do you have that are either in or outside of medicine?

A: It was after I became an associate professor, that I started dedicating time to something that wasn't solely my career. I have a 10-year-old son who is my passion, my most important project, and

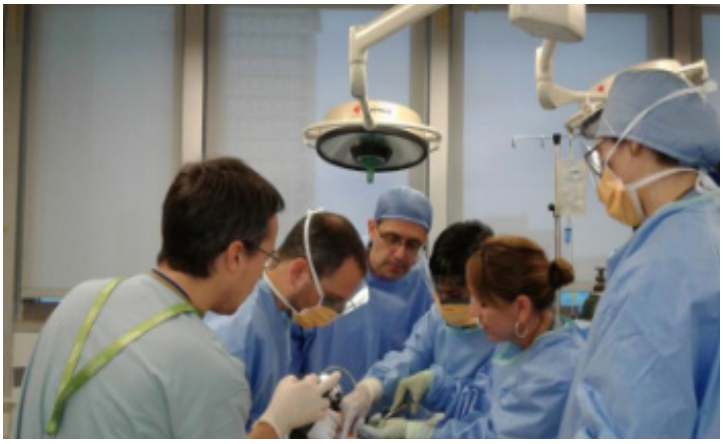
whose life I cannot afford to screw up. I want him to be happy and well adjusted. I also have hobbies like dancing. Specifically, I like to salsa and I even participated in Richmond Dancing with the Stars. I also like nature, in particular the James River. I feel that a connection with nature is important, especially when you feel like your life is changing direction. For me, sitting down in front of the river and feeling that connection can help me reconnect me to my purpose and determine my next goal.

Q: How has medicine affected your home life? Do you feel that you have missed out on any aspect of life because of medicine—is it possible to have a full life in your field?

A: Yes, it is very possible to have a full life. I think my life is full; I have a son, two cats, a dog, and I was married. However, I do not think that our happiness is always linked to how full a life we have. I think everyone's happiness is their own thing.

Q: What is your favorite part about trauma surgery or about medicine in general?

A: My favorite part about trauma surgery is knowing that something I do can change someone's life. Sometimes, it is the difference between living and dying. My favorite thing is when I am operating in the OR and someone is alive because of something that I did. I think that is awesome! For me, there is nothing that can compare.



Q: What is your least favorite part about your job?

A: I think ungratefulness is my least favorite part. I am not only referring to patients. For the most part, patients are usually grateful. Sometimes, it is the people around you and even one's own ungratefulness because, in the end, we are healthy and are the one's taking care of the sick. I think personal ungratefulness is the source of all discontent and burnout. We can all learn to be more grateful for the opportunities that we have in life, even what seems like small things such as breathing and having drinkable water.

Q: What was your most challenging or difficult case and why?

A: The hardest thing that I have to deal with in medicine is when I see children getting injured because of neglect. It emotionally breaks me down to pieces. I am generally a very emotionally stable person. I can operate moving from one critically ill patient to the next and be fine. But if it is a child who gets injured, I lose sleep and get sad.

Q: Do you have a time that you experienced failure or struggle in med school or residency, and how did you overcome it?

A: There is a picture on social media of an iceberg that I feel best encapsulates this. The top is what people see and the bottom is what is underneath. All of the failure and hardship is what is underneathand what is not seen. Everybody has failed at least as many times as they have succeeded. Successful people are the people who have recovered from failure and learned from it. If you have not learned it, life will give you the opportunity to learn again, both professionally and personally. Trying to see the silver lining in situationsand learning from them is key. Those who never fail will also never succeed because they will stay in the status quo. You have to embrace failure. If there was no heartache, there would never be amazing love songs or poems.

Q: What was your favorite part about medical school/residency?

A: Graduated responsibility. When you are in training and you feel that you are just a picture on the wall, then you don't feel like you have a purpose. My

favorite part about residency was feeling that what I was doing actually mattered.

Q: What is one skill that you have that you feel has helped you achieve all that you have?

A: Resilience. Think of any movie or book with a hero in it. In the beginning, there is no hero, it is just a normal person. Someone calls them for adventure, they get advice, struggle, and then they succeed. In life, it is the same situation. As you pursue your dreams, you run into challenges, fail, and pick yourself back up, but in the end, you are the hero of your own story. Resilience is key in failure and making a success out of the many failures in life. It is what determines whether you become great or not.

Q: What personality do you think is required or necessary in traumasurgery or surgery in general?

A: I don't think that there is one personality that applies to surgeons. I don't think that people should do something because they fit a personality. I think you should do what you are passionate about and let others deal with your personality. For me, that was trauma surgery. Where some run away from mass casualties, I run towards it.

Q: What are the fields/aspects in medicine you feel are on rise and what fields or aspects are on the decline?

A: I think in general, anything that is minimally invasive is on the rise and anything maximally invasive is on the decline. With that being said, I also think that nothing in life is predictable. The best predictor of success is not going into a field that is on the rise, rather going into something that you love; that is where you will find success.

Q: What is one piece of advice you would give to those pursuing medicine today?

A: Do what you love and don't do it because of the money. Find and do what gives you pleasure. In your heart, you will have a true North, and that is your purpose. If you never lose purpose, then no one can defeat you. Even when you fail, you will be grounded in your purpose and use that as fuel to recover.

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