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Welcome to the 37th issue of The Synapse Intercollegiate Magazine! My name is Emma Rekate (OC ’24) and I am one of the Editors in Chief, alongside Susan. We hope that this magazine brings as much joy and pride to others as it does to us. My favorite thing about The Synapse is the culmination of Art and Science and how it works together to make both disciplines more accessible for our readers. Prior to becoming Editor in Chief I worked for two years as The Synapse’s Outreach Coordinator and wrote a couple of articles for various issues. In my role, I get to work directly with the writers, content editors, copy editors, layout editors, artists, and board members to create each and every issue. I hope you all enjoy Issue 37 and I am thankful for all of the people who worked extremely hard on this magazine.

Welcome to Issue 36 of The Synapse; we are excited to present this to you! My name is Susan Robinson-Cloete (OC’24), and I am one of the Editors in Chief alongside Emma. We look forward to you seeing these fantastic articles, art, and featured contributors. This issue has many interesting topics, from the future of jackfruit in our diet to unpacking the effects of developmental dyslexia. As Editor-in-Chief, we are pleased to work with writers, editors, artists, and layout to create this magazine. Issue 37 is the product of many people's hard work; thank you! I hope you enjoy this issue, and we thank everyone for their contributions and readership to The Synapse.
Without a doubt, the pharmaceutical industry is one of the most controversial and mistrusted across the world. With anti-vaccine sentiment at an all-time high and many people claiming wild stories about companies hiding cures for diseases like cancer, it can be easy to dismiss this mistrust as a ridiculous conspiracy. However, pharmaceutical fraud has been unfortunately commonplace, and it is essential to examine these cases to remember how many have been affected by these companies and understand how the public could mistrust this industry.

One of the most shocking cases of pharmaceutical malpractice causing large amounts of harm to people focuses on the drug Thalidomide. In 1956, Thalidomide was approved for over-the-counter sale in Germany following animal testing with no significant side effects. The drug was recommended for sickness symptoms, such as nausea and vomiting. Crucially, it was explicitly marketed for morning sickness in pregnant women despite no prior testing on pregnant women. Despite the drug being used across Europe, it was rejected in the United States as Dr. Frances Kelsey expressed serious concern about the lack of evidence showing it was safe in pregnancy and caused no peripheral nerve damage. Despite the lack of safety testing that led to this decision, German pharmaceutical company Grünenthal insisted on its approval. Six times, they repeatedly requested approval from the U.S. Food and Drug Administration (FDA), which was rejected every time.

In 1961, evidence began to surface about Thalidomide. Horrifying congenital disabilities. The babies’ limbs were severely deformed, and many growing fetuses had malformed organs, causing them to be stillborn or die shortly after birth. As many as 100,000 pregnancies were said to be affected by Thalidomide. Despite this, formal warnings about the medication were not heavily publicized, so many who purchased it a while ago would still use it after it was recalled from shelves, further prolonging the crisis. Throughout the story of this scandal, Grünenthal never took clear steps to rectify their mistakes, such as taking action to warn the public about the dangers of the drug as the stories of horrible pregnancy side effects began to emerge. A formal apology from the company was not published until 2012, long after most victims had passed away.

As many as 100,000 pregnancies were said to be affected by Thalidomide.

Despite the public and FDA learning a great deal from this disaster, incorrect approval of drugs continues to be a problem, often spearheaded by companies looking out for their bottom line rather than the safety of their customers. In May 1999, the FDA approved a new nonsteroidal anti-inflammatory drug. Advertised as a new treatment for chronic pain, arthritis, and migraines by Merck, one of the largest pharmaceutical companies, Vioxx was an instant commercial success as millions of people were prescribed this drug for a wide variety of conditions. However, the cracks almost immediately began to form around this drug. By 2002, studies warned about Vioxx putting people at risk for severe heart problems. In 2006, the drug was voluntarily taken off the market by Merck. Later research published by Lancet, a peer-reviewed medical journal, proposed that almost 88,000 Americans had heart attacks directly due to taking Vioxx. In less than a decade, Vioxx had been approved, contributed to tens of thousands of deaths, and then subsequently taken off the market.

People immediately began to question how this was possible due to the typically rigorous standards medication studies are held to. It turned out that the answer to this question was Merck’s negligence and alleged purposeful exploitation of the approval process. Merck, when seeking approval, was halted after a study showed a doubled increase in the risk of heart attacks on this medication. Wanting to get the drug out quickly, Merck approached the head of the Data and Safety Monitoring Board (DSMB), an independent board tasked with reviewing drug trials. Within a month of this meeting, the chairman was given a consulting role at $5,000 daily and disclosed he owned $70,000 in Merck stock simultaneously. While there is no direct proof of this, including the eventual approval of the drug or his opinion on the trial, suspicious conflicts of interest can significantly impact the eventual approval of a harmful drug. Additionally, Merck published additional studies done by employees and consultants that even other Merck employees were skeptical, with one executive scientist claiming that, “The data appears to have been interpreted to support a preconceived hypothesis rather than critically reviewing the data to generate hypotheses.” Merck implanted itself into all aspects of the regulatory mechanisms meant to prevent crises like these, motivated by a desire to push out a profitable medication.

The ripple effects of pharmaceutical companies’ negligence are unquestionably still present today. From the harmful effects of improperly testing medications to the considerable distrust many people have in medications and the medical field, it is challenging to quantify the large influence that unethical and fraudulent behaviors have had on the health and safety of the public. Not only are the people who took these medications harmed, but also people who mistrust medicine due to these incidents. When companies push medications that have not been properly tested, it becomes more difficult for doctors and other medical professionals to justify safe and effective treatments. As medicine continues to advance, there must be a continued emphasis on preventing the profit incentive of companies from affecting the health and safety of patients and their trust in medicine.
A Prescription for Deceit
Pharmaceutical Frauds’ Dangerous Side Effects
Written by Calvin McMurtrey
Illustrated by Patrick Estell
Is Fair Triage Possible?
Navigating the Complexities of Triage in Healthcare Crises

Written by Caleb Rader
Illustrated by Ophelia Jackson

At the height of the COVID-19 pandemic in 2020, triage practices were no longer a theoretical exercise but a daily reality under a deluge of patients. State health authorities issued flow charts including conditions such as heart disease, cognitive disabilities, and – in one iteration of Alabama’s guidance – AIDS. Problematically, many conditions used as deciding factors may serve as proxy indicators for other protected classes. For example, almost all Alzheimer’s patients are elderly, and age is a protected class and a strong predictor of COVID-19 outcomes. Disability and civil rights groups sued several health agencies, leading the Health Department’s civil rights office to issue a bulletin affirming the rights of protected groups in triage cases. “Our civil rights laws protect the equal dignity of every human life from ruthless utilitarianism,” said the office’s director, Roger Severino.

While this is a noble goal, there is little dignity in dying from a viral infection in a crowded hospital. Fundamentally, triage decisions are an unpleasant trolley problem, offending our moral and ethical sensibilities no matter how we delineate between those who receive care and those who do not. Responding with indignation and criticizing such decisions as “ruthless” is easy. Proposing better alternatives is hard. No healthcare workers are responsible for a shortage of resources, but instead, they are responsible for administering certain ones in the first place. Some advocate lottery-based or first-come-first-serve approaches, but inaction is a choice – that may result in more overall deaths and fewer added years of life. Where we draw red lines regarding triage

Fundamentally, triage decisions are an unpleasant trolley problem, offending our moral and ethical sensibilities no matter how we delineate between those who receive care and those who do not.

In a society where no one is immune from suffering, the idea of prioritizing any group’s access to healthcare is ethically problematic. Groups with higher access to resources and medical care are often those who are more likely to receive care during a crisis, perpetuating existing inequalities. This is particularly concerning in the context of COVID-19, where the disease has disproportionately affected marginalized communities.

There is a pressing need for ethical frameworks that prioritize the equitable distribution of healthcare resources. Utilitarian principles, which advocate for the greatest good for the greatest number, can be applied to triage decisions, ensuring that the most critical cases receive care first. However, egalitarian principles, which prioritize fairness and equal access, also play a crucial role in ensuring that everyone has a fair chance to receive care.

As healthcare crises become more frequent, it is essential to develop ethical guidelines that balance both utilitarian and egalitarian principles. This requires a deep understanding of the ethical dilemmas faced by healthcare providers during triage decisions and the development of frameworks that can guide ethical decision-making in these situations. By doing so, we can work towards a healthcare system that is fair, just, and responsive to the needs of all its members, regardless of their background or circumstances.
professionals as acts of deprivation. Humans are loss-averse, meaning we avoid making decisions framed in terms of potential negatives. Health agencies should rewrite guidelines to attenuate the psychological biases of those enacting them, reframing triage processes as targeted assistance to those in need. Additionally, healthcare providers use computerized systems to score patient viability based on a number of metrics. Suppose this process is further automated based on biometrics, which no individual clinician is responsible for recording or inputting. In that case, the difficult task of evaluating a patient’s eligibility for care can be distributed across multiple individuals and obfuscated in the process. These changes will lift a portion of the ethical burden of triage. Providers will adhere more closely to guidelines, make difficult, time-sensitive decisions faster, and suffer from reduced emotional trauma. While this change may also mitigate some public backlash, triage decisions will always challenge our social norms – particularly in America and other wealthy countries, where acclimation to abundance has left us incapable of grappling with zero-sum problems. Even during the invasion of Iraq, thanks to an unprecedented airlift and field hospital program, death rates among American troops were far lower than in most modern conflicts but inspired proportionally greater backlash. When we face the next natural disaster, terrorist attack, or epidemic, we will again be challenged with these difficult decisions. Still, we should not misdirect our anger at the healthcare providers making them. We must understand that our discomfort with triage as a concept does not necessarily indicate its unethical nature but reveals our alienation from loss. • • •
ow do humans feed the world? How do we ensure all 7.8 billion people get fed? Mass production of crops. As humans are required to provide for an increasing global population, agricultural technology has to improve. However, with this production of crops comes pests. Locusts, japanese beetles, harlequin beetles, corn rootworms, and stink bugs are some of the most common insects that are destructive in agriculture. The way we control them is through pesticides. Chemical pesticides are the most common source of treating pests and are not without their benefits. The major one is that they can recover 30 to 40 percent of total crop losses worldwide. However, they have their drawbacks. According to the National Institute of Health, applying these chemical pesticides causes much environmental harm. Contamination of soil, turf, and other vegetation and eutrophication of waterways are just some downsides of chemical pesticides.

Another negative side effect is that these pesticides can harm other organisms like birds, fish, beneficial insects, and non-target plants. The way these pesticides can spread to them is by the food chain. Pesticides’ main effect is that they reduce the fertility of the target species. The goal is not to kill a species but to reduce its population. So, examining how their populations are declining is crucial when looking at the non-target species. A study examining the effects of neonicotinoid insecticides found they spread through the soil food chain, affecting the predator beetles and impairing/killing them at rates greater than 60 percent. Furthermore, these pesticides remain in our ecological systems for decades after application. When conditions in soil are such that there is not much sun, water, or microbes, the pesticides that reside take longer to break down. They can persist in the soil for years after they are applied.

With this production of crops comes pests. Locusts, japanese beetles, harlequin beetles, corn rootworms, and stink bugs are some of the most common insects that are destructive in agriculture. The way we control them is through pesticides.

These pesticides are less effective than they used to be. This is due to the resistance that pests are gaining to our most common pesticides. According to the USDA, genetics and intensive application of insecticides are responsible for the rapid development of resistance in insects and mites. The species resistant to these pesticides live on and pass their resistance trait to their offspring. So, with the environmental risks of pesticides growing and the pest’s resistance to them rising, we need a new way to control pests while maintaining our high crop demands. This need is being met in the form of biopesticides.

While there is no formal definition for biopesticides, they are generally considered pesticides that use non-toxicological mechanisms, limiting their ecological impact. These pesticides include biochemical pesticides, microbial pesticides, and genetically modified protectants.

Multiple benefits result from using these biopesticides. One of the main ones is that they are decomposable. This is the main benefit of biochemical pesticides. Their formation is usually made from living organisms and the structure of their metabolism. They also are not known to damage the ecological systems they apply to, meaning they do not linger in the ecosystem. This is because of the microorganisms within the pesticides. They become nutrients in the soil and decompose into small molecules.

Another benefit is these biopesticides make it difficult for pests to produce resistance. This is because of the mechanisms these biopesticides target. Generally, when a pesticide targets a pest, it has five different areas it can target: the nervous system, the production of energy, the output of cuticles, the endocrine system, and the water balance. Most chemical pesticides are narrow-specific, targeting one of these five areas. With biopesticides, their targets are non-specific, so they target a broad spectrum of areas within the pest. Specifically, microbial pesticides have this effect. For example, fungi in crops, which kill certain weeds and other fungi, which kill other insects. This makes it more difficult for the pest to develop resistance from generation to generation.

So if biopesticides excel in the areas where chemical pesticides fail, why have they not been used yet? Why are they just now appearing in the agriculture industry? One main reason is safety. With new products, especially ones that change how a product has been done for a long time, significant testing must be done to ensure the product's safety. The Environmental Protection Agency (EPA) does not have a formal definition of biopesticides, and the typical approval process for a pesticide is about six years. Furthermore, these biopesticides are much more labor-intensive than their chemical counterparts. Previously restricted resources, supplies, and long production processes bottlenecked the rollout of biopesticides. Finally, the emergence of the field of biosynthesis (the generation of natural products through enzymatic reactions, e.g., cellular metabolism). New tools and ways of constructing biological models are coming out daily, and the agricultural industry is racing behind.

Despite this slow rollout of biopesticides, progress is being made. According to the National Library of Medicine, by 2025, the global market for biopesticides is expected to grow from five percent to more than 20 percent, with an anticipated growth rate of 16 percent per year. This means the growth of biopesticides could skyrocket in the next few years.

Overall, the future for biopesticides looks bright. With the products slowly coming out of their bottleneck and overwhelming benefits, they will soon be seen in farms worldwide. This will eventually lead to a more sustainable and profitable agriculture market, which benefits the earth.
A New Key to Sustainable Farming

A New Wave of Pesticides has the Potential to Change Farming

Written by Michael Eddy Harvey
Illustrated by Natalia Covin
As the global food crisis advances, seeking alternative food is an alarming concern for many countries. Nutritionists aim to find promising food innovations that provide people with adequate carbohydrates, vitamins, and minerals to rescue the future of diminishing animal meat and plant sources.

Luckily, they found one: young jackfruits.

Let us meet jackfruit to explore its contributions to the future food industry. Jackfruit grows in tropical regions such as Asia, Africa, and South America. However, it is said to have originated in Southwestern India. Jackfruit, known to be the largest edible fruit in the world, reaches maturity about three to seven months from pollination time, differing from country to country, and contains rich macro and micronutrients.

In 2019, scientists from Sri Lanka at the University of Sri Jayewardenepura found that 37.4 percent to 42.5 percent of jackfruit seeds and flakes consist of carbohydrates. This presence of starch in jackfruit increases when they begin to ripen. These researchers also emphasized that the number of minerals in jackfruits dominates over bananas, mangos, and avocados, the most flavorful fruits in the United States. Jackfruit flakes and seeds provide an average of 90 mg of magnesium and 50 mg of calcium per 100 g of edible fruit. In contrast, avocado, banana, and mango only supply a quarter of that amount.

Regarding vitamins A and C, jackfruit nutritional supplements are equivalent to avocado, mango, and banana. In summary, jackfruits’ strength lies in their nutritional value: while consuming healthy carbohydrates, consumers also benefit from essential vitamins and minerals.

Having been introduced to jackfruit, let us discuss its developmental stages and why young jackfruits are ideal for the future food industry. There is no difference in nutritional content between young or ripe jackfruit. However, the texture and smell of young and mature jackfruit flesh are quite different, with many finding the latter less appealing. Ripe jackfruit does not have as strong an odor as durian, known for its overpowering smell and is banned on many public transportation systems. Still, it may smell unpleasant to people who notice a hint of onion-like odor. When ripe, Jackfruit flakes also turn yellow and sugar-sweet and

Written by Minh Tran Ha
Illustrated by Maya Akazawa
can be mushy and amorphous when cooking. The ripe jackfruit sweetness challenges chefs to adjust their dishes to incorporate it in a palatable manner, which minimizes jackfruit's potency as raw cooking material. Young jackfruit does not possess odor, texture, or flavor concerns, making it a potential candidate as a cooking ingredient instead of the ripened version.

Recently, young jackfruits have been included in dishes to serve vegan consumers. Chefs take advantage of jackfruits' fibrous layers, which allows it to act as a meat substitute. With their firm and stringy texture, young jackfruits can be sliced into wedges and fried with added spices to make vegan sausages or nuggets. Also, pulled jack-pork, shredded jack-chicken, or jack-beef are delicious and popular young jackfruit applications. For example, the company Jack & Annie’s has successfully introduced jackfruit recipes for familiar meat dishes: jack meatballs, jack sausage, jack nuggets, jack patties, or jack wings. In the future, we hope not only vegans or vegetarians prefer young jackfruit products but meat-eaters, as well.

Having established the culinary quintessence of young jackfruit in many recipes, we are heading down a path to see the widespread availability of jackfruits in the present and future. Jackfruits must be grown and provided efficiently manufacturers to compete as alternative plant-based food. Jackfruits now are underutilized food in Africa and India, although worldwide producers harvest tons annually. According to the latest WorldAtlas 2019, India could provide 1.4 million tons of jackfruits per year, followed by Bangladesh with 926 tons and Thailand with 392 tons per year. Data suggests the harvest of jackfruits is effective. However, the utilization rates are still low. These enormous yields of jackfruits have been wasted 75 percent in India, according to data from the United Nations Food and Agriculture Organization, because of difficulty in preservation. Jackfruits can quickly go bad if not consumed promptly or preserved within a few days. Preservation technique becomes the only challenge at the moment to jackfruit food production. If companies and governments could together diminish the wasted jackfruits via pioneering jack food production, our world would lighten the burden of food insecurity.

In summary, the young jackfruit mission might be bigger than we thought but still feasible. Jackfruit meals could significantly reduce that statistic because jackfruits are primarily grown in Africa and India, which simultaneously possess a high hunger rate. Moreover, as worldwide malnutrition rises each year and while the world seeks food innovations, the question arises: why do we not utilize the demonstrated resource of young jackfruits?
Corn Ethanol’s Positive and Negative Effects

Our world is scrambling to find clean energy sources. One explored solution is turning biomass into fuel, specifically corn. Corn ethanol has been an established source of biofuel for decades, with the United States leading the world in biofuel production by producing 47 percent of global output in the last ten years. Initially, this alternative fuel was promoted because it was believed to be more environmentally friendly than fossil fuel choices, producing overall less emissions. The U.S. government passed the Renewable Fuel Standard in 2005, spurring the production and adoption of biofuel. In 2021, the U.S. consumed nearly 14 billion gallons of corn ethanol. However, recent re-evaluations of corn ethanol’s life cycle impact show that it is not better than gasoline as a fuel source — and likely much worse.

Ethanol is an alcohol produced from sugars through fermentation processes carried out by yeast. Fuel ethanol is highly concentrated, with water removed and compounds added, rendering the alcohol undrinkable. Fuel ethanol can be used alone or blended with gasoline. Most ethanol in the U.S. is produced from starch-based crops by dry or wet mill processing. Dry-milling grinds corn into flour and ferments it into ethanol using the co-products of distillers’ grains and carbon dioxide. Wet-milling first separates the corn’s starch, protein, and fiber before processing these components into products such as ethanol. Ethanol production technology can now produce about 2.7 gallons of fuel ethanol per bushel of corn. The processing of corn into ethanol produces co-products that can substitute corn grain and soybean meal in livestock feed, doubling the products of this process.

At first glance, corn ethanol is a clean fuel — better for the environment than traditional gasoline. Corn is biomass and derives its initial energy from the sun, while it can also be regrown relatively quickly (unlike fossil fuels). A study examined how technological advancements will affect the land required to produce corn ethanol. In 2011, 25 percent of acres in the U.S. were used to grow corn for ethanol fuel production. In 15 years, as technology develops, the study predicted that just 13-19 percent of acres will be used. One way this might happen is a fermentation technology that converts both starch and other sugar components, like fibers, into ethanol. This technology increases yield by 2.759-3.078 gallons of ethanol per bushel of processed corn. With such technological advancements, the land needed to produce corn ethanol decreases. Overall, the argument for expanding corn ethanol is that it is clean, corn can be easily regrown, and technological developments will reduce the land required.

The U.S. government was tuned in to the innovative, agriculturally-produced, and renewable fuel sources as their popularity grew and technology developed. In 2005, the government enacted the Renewable Fuel Standard program, which requires a minimum volume of renewable fuels to replace petroleum-based transportation, heating, or jet fuel. The program aimed to replace fuels that emit greenhouse gasses with clean energy sources, promote rural economic development and reduce U.S. dependence on foreign energy sources by encouraging domestic fuel production. At the time, the U.S. was a net energy importer and relied on other countries for fuel. Part of the Renewable Fuel Standard requirements included the expansion of the use of corn ethanol by up to 15 billion gallons annually. This policy motivated farmers to plant corn for corn ethanol processing. Major agencies in the U.S. — including the U.S. Department of Agriculture, the U.S. Environmental Protection Agency, and the U.S. Geological Survey — all reported rapid cropland expansion. Since 2000, corn ethanol production in the U.S. has increased significantly, from 1.6 to 15 billion gallons. Throughout the last decade, ethanol production has kept corn in high demand, making it the most planted U.S. crop and bringing record profits to leading companies that buy and sell corn.

Unfortunately, using land for this purpose has a cost vastly underestimated by those who encourage corn ethanol production. The extent of domestic land use change is at least equivalent to the change caused by gasoline use — and likely to be up to 24 percent higher. Modern farming releases carbon stored in the soil, especially as farmers scramble to develop their previously untilled areas to boost corn production. One big concern is that farmers have been plowing land previously used for conservation purposes. The Conservation Reserve Program is a federal program that pays farmers to keep some of their land uncultivated. After the Renewable Fuel Standard was updated in 2007, however, farmer enrollment in this program decreased substantially as farmers chose to capitalize on high corn prices. The CRP is now at its lowest enrollment in 30 years, which means a lot of carbon previously stored in uncultivated soils has been emitted into the atmosphere.

Farmers also rely on fertilizers to grow corn, introducing pollutants to the land and runoff waters. Since the Renewable Fuel Standard was passed, a study found that nationwide annual fertilizer use surged by three to eight percent, and water pollutants rose by three to five percent — likely due to increased fertilizer use. Downstream of many U.S. farms, in the Gulf of Mexico, an annual dead zone appears because of the increasingly toxic water. In 2021, more than 6,300 square miles of Gulf Coast waters were starved of oxygen, leaving four million acres of fish habitat uninhabitable. This oxygen depletion disrupted fisheries and damaged marine habitats, costing about $2.4 billion.

With an incentive to grow more corn, farmers have been neglecting other crops like soybeans and wheat. Normally, the rotation of crops is important for the soil to maintain a healthy nutrient balance. However, farmers are skipping rotations and farming corn as a monoculture, where only one crop is planted in an area. Monocultures decrease biodiversity in an area, which can...
harm the land long-term and make it unhealthy and unsuitable for agriculture. The lack of soybeans and other crops has also caused their prices to spike by 20 percent, making food more expensive and exacerbating food justice issues. Additionally, the race in the U.S. to produce corn ethanol is in danger of triggering the fuel market rebound effect: when a greater fuel supply is available, an overall rise in fuel consumption occurs. This situation risks Americans becoming dependent on and demanding more of this land-intensive fuel. These factors highlight gaps in previous studies and underscore how the effects of land use changes were underestimated. Instead of feeding growing populations or conserving land, the U.S. uses productive farmland for fuel production.

While studies initially treated increased land use for corn farming as a minor problem, expanding these agricultural practices will deplete farmable land and pollute waters. These factors question the effectiveness of climate change mitigation policies that promote corn ethanol and other biofuels. Although these policies guarantee a market for farmers and ethanol producers, corn ethanol production, as encouraged by the U.S. government, is costing the American public. We pay more for gas, certain crops have become more expensive, and our taxes are subsidizing crop insurance programs. Iowa farmers receive the most federal subsidies in the country, meaning we are paying farmers to continue expanding harmful corn-growing practices. America is also facing reduced water and air quality, degraded soil, and habitat loss because of corn ethanol expansion. This makes the Renewable Fuel Standard counterproductive.

When the Renewable Fuel Standard became law, the U.S. was a net oil importer, relying on foreign sources for fuel. The U.S. is now a net oil exporter and has less reason to be concerned with energy independence, as it produces most of its own energy domestically. The policy needs to be updated and re-evaluated, as it encourages a fuel that is no better than gasoline. As a climate solution, the Renewable Fuel Standard’s encouragement of corn ethanol production has proved counterproductive, especially in the face of more efficient and worthwhile innovative energy technologies. • • •
Sara Fields

I am a 4th-year double major in psychology and studio art and a dual sport athlete in lacrosse and field hockey. I intend to pursue a career in art therapy and get a Ph.D. after college. Besides classes, I do many things around campus for the photo lab, athletic department, research on cognitive psych, and trying my hardest to attend most events! I love staying busy and creating—those are my passions as a student at Oberlin! Don’t hesitate to reach out to your Chief Layout Editor!
Calling all students of Oberlin College, Denison University, Case Western Reserve University, and The College of Wooster!

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Primates and Pregnancy
Lessons in Childbirth from Human Evolution
Written by Amelia Merithew
Illustrated by Ophelia Jackson
Anthropologists are fond of stating that “There are no human universals.” What they mean by this is that even behaviors that exist universally—for example, eating—are not performed or viewed in the same way across all cultures. Of course, absolutely all categorical rules ever have exceptions. One suggested exception to this rule of human universals is birth. Not only do all human cultures give birth, but according to one study, 296 out of 320 human cultural groups always give birth in group settings and with assistance (the other 24 sometimes, but not always, give birth alone). Research suggests that not only is this the case in the modern day, but it has been for longer than anyone would guess. Why? And what can this tell us about ourselves?

As humans, we are the only living primate to spend most of our time on two legs instead of four. As a result, our pelvises are slimmer and more bowl-shaped than our relatives. Our birth canals must accommodate this shape, twisting and changing diameters in ways other primates do not. On top of that, our skulls are disproportionately large. Human babies are born underdeveloped because allowing them to gestate any longer would mean that their heads would not fit through the birth canal. Some bioanthropologists call this “the obstetric dilemma,” meaning we must walk the line between babies dying. They are not developed enough when born, and birthing people pass because they cannot deliver their babies. Interestingly, this issue is not unique to humans but is shared by monkeys and gibbons rather than our closest relatives (the great apes).

Bioanthropologists guess that midwives have been a part of human birth since the beginning of the human species—and possibly even before then.

However, one unique issue to humans is the previously mentioned twisting of our birth canal. In other primates, babies are born with their faces upward, allowing the mother to grasp the baby behind the neck and back and pull them up towards their chest. Humans’ birth canals force the baby to rotate as it is born, resulting in the baby facing downward as it emerges from the canal. In this position, in attempting to pull the baby towards themselves, the birthing person risks breaking the baby’s spine. For this reason, bioanthropologists guess midwives have been a part of human birth since the beginning of the human species—and possibly even before. If another person is present to pull the baby from the birth canal, the risk of spine snapping can be eliminated. Furthermore, the fear and anxiety accompanying our particularly painful and risky births may be alleviated by a companion’s presence.

Many mammals prefer to be alone when in labor and giving birth. They find a dark, warm, secluded place to bring their offspring into the world, and there is a good reason. Having other organisms present during birth means having other germs present. Newborns have fresh and underdeveloped immune systems, so germs that might not affect their parents can be deadly for them. In some species, males tend to look unkindly upon offspring that aren’t theirs—best to keep the babies away, just in case. These risks only increased by having other humans present during birth. Therefore, there must be some advantages to having others present, which outweigh the significant risks.

Researchers have long believed that most primates preferred to give birth in solitude, like other mammals. Evidence for this is that nocturnal primates give birth during the day, while diurnal primates give birth at night. However, recent research has shown that many primates prefer giving birth in a group setting, watched by other members of their species from a distance. Unlike humans, primates rarely assist in each others’ births, but there have been a few documented cases of other females pulling babies from the birth canals. Some experts believe this behavior, combined with pelvic remains from non-human ancestors such as Neanderthals, indicates that other primates once gave birth with assistance. This means that midwifery may go back even further than the beginning of our species to the progenitors of homo sapiens.
Over the past few centuries, the scientific world has taken great strides toward curing disease. Doctor Edward Jenner’s use of cowpox to prevent the progression of smallpox has led to the creation of vaccines. The development of the germ theory of disease by French chemist Louis Pasteur has helped us discover the origins of infectious diseases, revolutionizing many fields of medicine and vastly improving public health and sanitation. Alexander Fleming’s observation of molds that make bacteria-killing substances led to the development of antibiotics, specifically penicillin, used widely to treat soldiers during World War II by curing battle wound infections and pneumonia. As our knowledge of the natural world and the human body constantly increases, so does our potential to cure disease. Nevertheless, one curse remains as the bane of medicine that we have yet to discover an adequate treatment for – genetic diseases.

Genetic disorders are often particularly challenging to treat compared to other diseases. This is because these conditions result from changes in a gene present in essentially every single cell within the body. These disorders affect several body systems and are often difficult or impossible to cure as they can only be alleviated or prolonged. One such disease is Duchenne’s Muscular Dystrophy (DMD), an X-linked recessive genetic disorder characterized by significant muscle weakness and muscle atrophy.
DMD is caused by the alteration of the gene coding for dystrophin, a vital part of a protein complex that connects the cytoskeleton of muscle fibers to the extracellular matrix. The dystrophin gene is the largest gene within the entire human genome, spanning 2.6 million DNA base pairs with 79 exons. As opposed to the normal dystrophin gene, 40 percent of DMD patients have frameshift or point mutations, and 60 percent have large insertions or deletions. These cause premature truncation in translation, making the dystrophin protein unstable and non-functional. DMD patients exhibit their earliest symptoms at two to three years of age, some of which may include difficulty climbing stairs and fumbling. The progression of DMD causes patients to be wheelchair-bound as early as 12 years old and require assisted ventilation by 20. Even with optimal medical treatment, patients only survive until 20 or 40 years old, with the primary causes of death being respiratory or heart failure. The severity of DMD and patients' low quality of life demand treatment to alleviate these symptoms.

Currently, there are a few known methods used to treat DMD. Glucocorticoids have been used to slow the progression of DMD and increase muscle strength. Gene replacement therapy introduces the correct form of a gene through a viral vector, which inserts a gene inside a cell to override the faulty gene. The effectiveness depends on whether there is long-term delivery of the correct gene and persistent gene correction in most muscle fibers in DMD patients. Intramuscular injections only transduce cells a few centimeters from the injection site, which means that most injections will have to be done throughout the body, including the heart muscle, making the treatment difficult and improbable in certain areas. Another therapy comes from the observation that at the early stages of DMD, the existing myoblasts in our body can fuse together to form new muscle fibers. However, that proliferative potential is eventually exhausted. Myoblast transplantation, the delivery of myogenic cells, is therefore used to combat muscle atrophy in DMD patients. Mutation-specific therapies have also been used to treat DMD since DMD mutations can be nonsense, missense, deletion, or duplication. Around five to 15 percent of mutations are caused by nonsense mutations, which result in an early stop codon. These are usually more detrimental to patients because they generate an incomplete protein that is often non-functional, especially if the stop codon occurs early in the dystrophin gene. Thus, drugs that promote translational readthrough of stop codons, such as aminoglycoside antibiotics, have been suggested. They produced hopeful results in mouse models of DMD but did not perform in human trials. These are among the many therapies currently being investigated or used to treat DMD, and many have shown promise. However, there is currently no permanent, sufficiently effective, and inexpensive treatment to combat muscle wasting in DMD.

A novel treatment being discussed to combat DMD is patient-derived induced pluripotent stem cells (iPSCs). The therapy involves several steps. By forcing the expression of four embryonic transcription factors, OCT4, SOX2, KLF4/MYC, and NANOG/LIN28, iPSCs can first be generated from adult somatic cells of the patient, like fibroblasts. Following the induction of pluripotency, genome editing technologies such as TALEN or CRISPR-Cas9 are used to correct the dystrophin gene. The iPSCs are then cultured in large quantities, induced to differentiate into myogenic progenitors and precursor cells, and subsequently transplanted back into the patient. Patient-derived iPSC therapy combines several past ideas, such as the usage of cells with regenerative capabilities, genome editing to introduce functional copies of dystrophin, and transplantation of stem cells into the patient. Currently, patient-derived iPSC therapy is limited to mouse models of X chromosome-linked muscular dystrophy (mdx) but shows promise in increasing muscle regeneration and functional recovery.

Patient-derived iPSC therapy provides several potential benefits and solves certain problems that other therapies may have. This therapy removes the ethical issues involved in using embryonic stem cells for stem cell therapy and exceeds the regenerative potential of adult stem cells or constant myoblast transplantation. Due to the aforementioned increased regenerative capabilities, it concurrently removes some of the need to supply new myoblasts from donors consistently. Patient-derived iPSC therapy also addresses an important issue with using donor iPSCs. When donor iPSCs are transplanted into the patient, it may cause immune reaction due to a mismatch in Human Leukocyte Antigen proteins, the human version of Major Histocompatibility Complex (MHC) at the cell membrane. Using patient-derived genome-edited iPSCs removes this issue for obvious reasons.

However, there are certain downsides that patient iPSC therapy presents. Although iPSC cells have commonly been generated using fibroblasts, some studies have reported that iPSCs retain some epigenetic memory from the somatic cells that may result in limited differentiation potential for certain cell types, including muscle progenitors. It is also noted that some residual epigenetic memory diminishes after some time in cell culture. Another challenge is finding the optimal method of delivery of the embryonic transcription factors to derive iPSCs. There have been concerns about the fact that certain delivery methods integrate these transcription factors into the genome, which would inactivate the tumor suppressor genes that are significant in the development of cancer. Approaches that use transient and integration-free methods are preferred for deriving clinically safe iPSCs. Another concern comes from the fact that iPSCs can accumulate chromosomal abnormalities, genetic instability, and loss of heterozygosity among other genetic alterations. There is still a need to study and refine our methods to develop a safer and more effective therapy.

The discovery of generating iPSCs has been revolutionary in the field of regenerative medicine. It has opened the doors to possible treatments for many previously incurable and debilitating diseases and disorders. Although iPSC therapy requires a lot more experimentation, discovery, and refinement, it is an intriguing as well as promising approach to treating disease.
An Urgent Need for Classroom Support

Uncovering Developmental Dyslexia’s Effect on Classroom Anxiety

Written by Susan Robinson-Cloete
Illustrated by Leah Potoff

Dyslexia is a learning disorder characterized by learning difficulties, including accurate word recognition, poor spelling, and poor decoding. It is one of the more common neurodevelopmental disorders. There are currently five theories that attempt to explain the etiology of dyslexia; their explanations range from an auditory to a visual processing deficit. While there are no definitive answers as to why dyslexia happens, it is clear that there is a genetic component. More specifically, there is a 52 percent heritability rate. In the same vein, developmental dyslexia is the unexpected difficulty in reading, specifically in children who are otherwise intelligent, motivated students. Students with developmental dyslexia undergo fluctuations throughout their early education; regardless of their diagnosis, the children may experience a gradient of developmental problems. Adolescents with developmental dyslexia are not any less intelligent or capable of success. They require a system that expands its breadth of techniques. In recent cognitive neuroscience studies, researchers have been investigating the question: How does developmental dyslexia affect students’ ability and confidence in the classroom?

Classroom anxiety can manifest in various ways, from disrupting class, abstaining, and reluctance to share. Unfortunately, the individualized nature of reading can isolate students from their peers. Students’ isolation and internalized self-doubt can
manifest into anxiety disorders. One theory for the prevalence of these comorbidities is the Nelson Demoralization Hypothesis. The Nelson Demoralization Hypothesis states that higher rates of demoralization – i.e., falling behind on reading markers without a diagnosis – lead to the development of anxiety. Down the line, these anxiety levels profoundly impact the quality of life for people with developmental dyslexia. On average, they will drop out of school at higher rates than their peers without reading problems and may be less inclined to continue postsecondary school education or advanced training.

Researchers have established the lifelong impact of the comorbidity, but just how many people with developmental dyslexia will have anxiety as well? Piechurska et al. hypothesized that people with dyslexia suffer from significantly higher levels of reading and writing anxiety than their asymptomatic peers because of their experience in the classroom. In 2009, Whitehouse et al. supported their claim by stating that individuals with dyslexia are at an increased risk for anxiety disorders. A UK epidemiological study found that 9.9 percent of children with specific reading and spelling disabilities had a co-morbid anxiety disorder, a significantly greater prevalence than those without literacy difficulties: 3.9 percent. The constant expectation of failure in reading by children with dyslexia is assumed to be associated with severe emotional consequences since reading is so profoundly central to the modern educational system. One of the most convincing results of this hypothesis is derived from a 2019 meta-analysis of 58 studies performed by Nelson et al. They found that school-aged children with learning difficulties, including dyslexia, have higher anxiety than non-LD children (d = .61). A study by researcher Dr. Mai Eissa revealed that dyslexia had negatively influenced adolescents’ self-esteem and caused them to feel different from others. Furthermore, dyslexic adolescents in this study suffered from anxiety, externalizing, and internalizing symptoms of withdrawal, somatic complaints, depression, social problems, thought problems, aggression, and delinquent behavior.

The reality is that most resources for students with learning differences are challenging to acquire as they are typically connected to private education.

Interestingly, research has found gender differences in the prevalence of developmental dyslexia and anxiety comorbidities. Studies concerning gender and anxiety among students in a school setting also confirmed that females reported higher anxiety on all anxiety subscales than males. This is explained through the notion that female students with reading disabilities appear to be at particular risk for these internalizing problems. Resources for studying adolescent neurodevelopment disease are rarely equal between the sexes, as seen with research into ADHD and Autism symptomatology. These emerging trends that show female students are at-risk necessitate an increased focus on how to support female students with developmental dyslexia better.

While quantitative measures like surveys can help numerically assess the effects of developmental dyslexia and anxiety, it is valuable to hear the day-to-day perspective of someone living with dyslexia and anxiety. We will refer to her as Iz to protect the patient’s privacy. Iz is a 21-year-old woman who was diagnosed with dyslexia after her mother discovered she was not reading the stories but rather memorizing what her mother said. Iz’s diagnosis came almost a year and a half after her class had begun learning to read. Iz recalls, “I felt alone and ashamed that I was not progressing like those around me and began to think I was not smart enough”. However, it was not only her attitude toward reading that changed but soon enough, her behavior. “Because of my dyslexia, I struggled to read words and spell them, so this often caused me not to want to participate in activities revolving around those things.”

Furthermore, Iz affirms much of what researchers like Eissa and Piechurska found: “I believe because of my confidence issues in my education, I often would get very anxious and not focus on what I was learning.” Today, Iz is a successful college student finishing her undergraduate degree in sociology before getting her master’s in social work. Iz describes herself as incredibly fortunate; she received a diagnosis early enough and received endless support through tutors and private school teachers. However, Iz recognizes that this is a privilege and that not every child with developmental dyslexia can be given the tools to succeed before they internalize the outside noise and risk developing classroom anxiety.

Students with developmental dyslexia do not develop anxiety in a vacuum; instead, they are absent from the scary support systems to affirm them, and they are intelligible. At the present moment, most children all across the globe, from Indonesia to Germany, are without the tools to equip them with the confidence to know they will learn and the strategy to help them get there. The reality is that most resources for students with learning differences are challenging to acquire as they are typically connected to private education. However, several proposed approaches have come out of interview surveys with students who have learning differences and are in the public school system. For example, in learning a second language – something particularly difficult for adolescents with dyslexia – several interviewed students said motivational teaching strategies made all the difference. We may not have all the answers, but asking those affected by it is a fantastic place to start.

There is a need for increased awareness about youth with dyslexia. Early identification and initiation of appropriate education interventions could make a profound difference. The comorbidity rates of anxiety and dyslexia are not a done deal but a wake-up call for researchers, psychologists, and educators to think of better ways to serve these students.
Imagine yourself in middle school again. During lunch, you sit with your friends, some of whom complain about the math test they had just taken. You begin thinking about your recent pre-algebra exam and how inapplicable its material was to your immediate self-interests. It leads you to ponder a particular question about the value of math in your education and long-term career goals. You may have heard many of your peers ask this question multiple times before coming to college: "Why do I need to study math if I am never going to use it in my career?"

The answer to this question lies in the social and behavioral mechanisms underlying our intelligence and cognition. However, before foraying into the psychological literature, one must understand the historical context of mathematics's fundamental human thought process and how it became an essential component of the universal school system.

According to the mathematician Gert Schubring and researcher Alexander P. Karp, the roots of the math curriculum are extensive. It began with professional training in ancient Mesopotamia. During this time, math became part of the general school curriculum in ancient Greece. It rose to popularity over the following centuries to the point it was taught as basic knowledge in every primary school. Educators later reinforced the emphasis on math worldwide in the 1960s with the New Math Movement, which continued to influence mathematical education.

During the early years of mathematical psychology, Edward L. Thorndike (1874-1949), a famous educational psychologist of the early 20th century, published a 1922 journal article capturing how humans interpret and interact with mathematical equations, aptly titled "The Psychology of the Equation." In the article, Thorndike assesses how students view equations, explaining how they are often given an equation and told to solve it with no context. However, Thorndike later indicates that equations are crucial forms of information organization and can be beneficial to one's life, given that the meaning of their variables and unknowns are understood.

As transferable to understanding the relationships between real-life variables as learning equations may seem, this easy transition from paper to practice may not apply to all mathematical topics. According to a report from University of Georgia mathematics educator Jeremy Kilpatrick (1935-2022),

1. Compute 10!, 100!, and 500!. (Note how quickly this is accomplished.)
2. Expand the binomial \((a + b)^{10}\). Simplify the expression to check that Mathematica did it correctly.
3. Calculate and simplify the derivative of \(f(x) = \frac{e^{x^2} + \sin^2 x}{e^x + \cos^2 x}\). Take care to use the proper syntax (i.e., capitalization, parentheses, brackets, etc.) when entering the function. You might find the various palettes (which can be accessed from the Palettes menu) helpful in entering your expression.
4. Calculate and simplify the first and second derivatives of \(f(x) = \frac{x^3 + 7x^2 - 12}{2x^3 + 3x^2 + 1}\).
5. (a) Find the (indefinite) integral of \(g(x) = e^{3x} \sin 4x\). Find the definite integral between \(x = 0\) and \(x = \pi/6\).
6. Without computing either integral, say what you can about the method(s) you would use to do so.
7. Use implicit differentiation to find \(dy/dx = 4xy + x^3\) where \(2x = 0\).
8. Plot the function \(f(x)\) of one of your classmates and the derivative of that function on the same set of axes. You will probably want to explore the use of the ContourPlot command to get output that shows both graphs.

Written by Haddy Dardir
Illustrated by Natalie Covin
Thorndike published additional research revealing that after being asked to judge the size of a rectangle, students participating in his study did not show significant improvement in evaluating the size of a triangle. The study indicated that the specific cognitive skill of judging the size of one shape does not transfer to one's ability to judge the size of other shapes.

Acknowledging the transfer of cognitive skills was much more limited than teachers initially assumed. Thorndike continued to promote connectionism — the theory that states learning is achieved when a learner establishes a connection between a stimulus and response. In a typical math classroom, this theory would most likely appear as the awarding of higher grades to those who solve problems correctly. Connectionism and behaviorism continued to strongly influence math education for many years during the 20th century. However, several psychologists brought Thorndike’s work into question.

One of these psychologists was Charles H. Judd (1873-1946), another prominent educational psychologist who lived during the first half of the 20th century. Thorndike was the main target of criticism for Judd, who believed connectionism inaccurately reduced higher mental processes to simply the sum of simple cognitive processes. Judd believed that Thorndike’s work led educators to view math as a collection of specific items to be drilled rather than a gateway into abstract, systematic forms of learning. Judd also believed that while Thorndike posited the transfer of mathematical thinking arose from widely applicable generalizations, transfer instead occurs from higher levels of generalization, in which identical elements connect different situations.

Before foraying into the psychological literature, one must understand the historical context of the fundamental human thought process of mathematics and how it became an essential component of the universal school system.

Another psychologist who questioned Thorndike’s theory was William A. Brownell (1895-1977). Brownell viewed the behaviorist model of learning as an empty approach to learning math, inhibiting the ability of students to apply math to novel situations. In his 1944 article “The Progressive Nature of Learning in Mathematics,” he equated four educational weaknesses in math education with the connectionist view of learning. These included: attention being directed away from the process of learning and too much attention being given to the "product," the pace of instruction being too rapid for students to soak in the material, educators providing the wrong kind of practice to promote learning, and the assessment of error being superficial rather than beneficial to the progress of students.

Although Thorndike’s work may have shown that judging the size of a rectangle does not directly translate to judging the size of a triangle, his findings likely missed a key point regarding the cognitive skills facilitated by learning math: applications can be broad, and the links between certain mindsets and experiences may not always be immediately apparent.

For example, heuristics is another psychological construct that can be utilized to solve problems in math. Humans use heuristics, or mental shortcuts, all the time, from ignoring unimportant emails to memorizing exam question formats. However, late 20th-century studies from the mathematician Edward Begle and mathematics educator Alan Schoenfeld found that using heuristics in math does little to improve general problem-solving skills — much like heuristics in everyday life. Therefore, not only can math encourage students to avoid the overuse of heuristics in math problems but in real-life situations as well.

Regarding math in education today, the subject can be assigned practical, disciplinary, and cultural values, according to Philipp Legner, founder of mathigon.com. First and foremost, Legner acknowledges that after completing the primary school math curriculum — addition, subtraction, multiplication, division, and so on — students can have difficulty understanding the significance of learning secondary school concepts such as solving quadratic equations, sketching graphs, and trigonometry. However, these concepts can transfer to many domains in practical, everyday life, such as personal finance and news statistics. Proficiency in understanding linear relationships and interpreting percentages can give people the upper edge in these domains. While computers can perform these calculations much faster than most humans, they cannot analyze real-life situations in terms of math and interpret results with as much nuance as humans.

Second, as a result of the problems students are often met with in math, taking their time to solve each question sets students on the path to truly understanding the relationship between variables, disciplining them in the process. Moreover, IQ tests always include mathematical and logical puzzles, indicating the ability of math to test the limits of the human mind.

Lastly, the cultural impact of learning math cannot be understated. In the natural sciences, the laws of the universe are written in the language of mathematics as equations governing every natural process. Computers that are apparent in our smartphones, buildings, and transportation also would not exist without math.

While it is true that certain careers require math much more than others, the value of a mathematics education is high for every student — even for those working in jobs that require little to no calculations. Teachers must give children a reason to learn complex topics early in their academic careers to understand the brain growth and cultural competence associated with a math education. According to educational psychology, studying math can enable students to develop problem-solving skills that can allow them to better detect relationships between variables and patterns in the systems around them. As a result, the ability to do math is an essential part of the human psyche that can lead us to a better world. • • •
Demands had been made, the Batterans had asked for planets, a few solar systems in total. On opposite ends of human existence, five men held control of weapons that could deal devastating damage to anyone they were aimed at. Two men controlled one side, debating whether they wanted to give up their planets or not. But really, they were more focused on what they wanted for dinner. Three men controlled the other with a threat to fulfill, but hardly the nerve to do so.

As both sides settled into a waiting game and the clock spun steadily towards its stopping point, families across the galaxy settled in for breakfasts and dinners, work, and sleep. Children played and adults lived, all unaware that they were potential casualties in a war for continued human existence.

“Hey Chuck, do you remember when we were kids?”

“Of course, Rin, I remember.”

“Do you remember soldiers?”

“Yeah, I always wanted to be one.”

“Me too, I thought they were cool. Do you ever wonder what they would think about what we do, and our decisions?”

“I haven’t before, I guess they might have something to say,” said Rin.

“I mean things have changed so much since then though, maybe they wouldn’t even understand it.”

“That’s true Rin, they wouldn’t understand our wars.”

“No, no they wouldn’t. Do you remember 40 years ago when the Batterans revealed their long-range targeting systems? The Quan sector didn’t stand a chance. Their soldiers were dead before they even stepped onto the field.”

“I remember the Quan soldiers just kept charging; they didn’t stand a chance. It’s not like we can protect ourselves from modern lasers anyways, armor’s worthless against current firepower.”

“They should’ve given up. There was no way to fight back.”

“Are you saying we should give up? We have the same systems as them these days, not to mention that both of us have far surpassed the technology of that era.”

“But so are theirs. And now they want our planets. Would it be so bad if we gave up?”

They’d probably kill us all anyway or enslave us.”

“Is it worse than death, Rin?”

“Our people could ever be free again.”

“But life, our lives, theirs. We could all die. Us. Them.”

At the head of the table, a screen shined down the demands of the enemy onto the faces of the two men. Rin and Chuck sank low in their chairs with the weight of civilization’s future pushing them down. If anybody fires they will know, and if they fire so will the enemy. Across the galaxy, three more men hold the same fate. The heads of the Batterans may have changed in the past 40 years, but they were just as brutal as when they had killed the Quan army.

“We already won, aren’t they calling for peace?” said Henderson, arsenal coordinator for the Batteran Autarchy.

“They’re trying to bait us into withdrawing, they can’t seriously be considering firing.” posited Hoffman, chief political strategist.

“It doesn’t matter, they will call. And if they fire, so will we. They know that.”

Sovereign Monell stared out his window, the moon of his planet glowing faint pink down onto him. He knew they wouldn’t launch; he was counting on them believing that he would. But in case they did, Monell kept a communicator in his pocket. At the press of one button, this galaxy would die with him.

“Chuck, we need to concede. If we had a few months we’d have our new defense system, but we don’t have months. We have hours, a day at most,” begged Rin.

“We can’t just give in, Rin; they’d just take and take once they knew they could. I’d rather end this violently than give up.”

“We can’t; they’d know we shot as soon as we do.”

“I’m not saying that we should fire. I’m just saying that if it comes to it, we can’t give in — we would be trampled.” Chuck shook his head in determination.

“If we fight, we die. That’s how it was for soldiers when we were kids. That’s how it is for us now. Congratulations, we got our dream.”

“We’re at home, nestled in our office and yet we stand in the forefront of a great battle. We are home and we still won’t survive.”

Written by Timo Nurmi
Illustrated by Rishi Chiratanagandla
The two men stared at each other. Chuck turned his head solemnly and stared at the screen containing all his fears spelled out. His failures looked both himself and Rin in the face. On the other side of the galaxy, a man fiddled with a pen, staring down the most horrible fate he could imagine for anyone.

"Shit!" Hoffman cursed at the ink he had spilled on his shirt. His nervousness was beginning to show as the deadline for their demands drew nearer. He couldn’t help but wonder if he could dissuade Monell and Henderson, they were men of war. Monell was a battlefield commander in his youth and a dictator in his old age. He knew what war looked like, having witnessed firsthand the devastation of the Quan, helpless to fight back against the technology of that time. Hoffman thought to himself, we are two glass ships carrying glass cannons.

Henderson spoke up, “Sir, we’ve got the weapons armed and ready if they fail to give in within the hour.”

“Good, on my command, but for now we will wait for them to seal their own fates.”

Far off from Monell, Hoffman, and Henderson, a man panicked.

Call, call, call. I cannot call. We must not be weak. But surely, it’s better to be weak than to die. I have to give in. I cannot call. Chuck won’t call. Chuck might not let me call. Failure, we are failures as leaders. We will fall in vain — a sacrifice for nothing. The soldiers of old would sacrifice themselves for their beliefs, they would live and die for their countries and hearts and their god. Dulce et decorum est pro patria mori they used to say it was the motto of earth, taken to the stars. We are all soldiers now, all at risk of death. If one of us dies, so do the rest. This was not always the nature of war, the past doesn’t matter, this is how we fight. We cannot fight, there cannot be a struggle, we will live or die. I have to call. Chuck won’t let me call. The pressure was cracking Rin as his thoughts raced.

Henderson looked blankly at the window. He couldn’t process what he was about to do. Failure, we are failures as leaders. We will fall in vain — a sacrifice for nothing. The soldiers of old would sacrifice themselves for their beliefs, they would live and die for their countries and hearts and their god. Dulce et decorum est pro patria mori they used to say it was the motto of earth, taken to the stars. We are all soldiers now, all at risk of death. If one of us dies, so do the rest. This was not always the nature of war, the past doesn’t matter, this is how we fight. We cannot fight, there cannot be a struggle, we will live or die. I have to call. Chuck won’t let me call. The pressure was cracking Rin as his thoughts raced.

Henderson checked the time: 30 minutes left. Eventually he spoke.

“Sir we can’t do this. They’ll kill us too.”

“No, they won’t. They won’t fire, they’re too afraid.” replied Monell quickly.

“They’ll fire if we do.”

Hoffman sat silently, staring dejectedly at the two men speaking. Monell spoke again. “We won’t, but they don’t know that.”

“Sir?” questioned Henderson.

“I won’t doom us all over a handful of planets.”

Hoffman interjected, “Sir, why didn’t you tell us that before?”

“You wouldn’t have had your killer instinct if I had, for them to believe me, you had to believe me.”

“Sir, if this gambit fails, what do we do?”

“We double down and ask for more.”

Chuck watched Rin from across the table. He was taking apart his watch and reassembling it quickly, a pointless action to keep his hands busy. Rin was calming down, settling into the idea of doing nothing. If they did anything they would retaliate, but there was no reason why they should go first. Rin broke the silence. “If they do anything, our early warning systems will know, right?”

“Yes, if they take action we will know immediately.”

“And we are prepared to retaliate?”

“Of course.”

“Good, let’s be ready for anything, but we can wait for them.”

Chuck nodded silently, he knew how hard this was for his friend. He was never as strong as Chuck was when lives were on the line. Rin was out of his area of expertise; he was far better with his own people.

All living with the realities of war, war where it turned out the greatest weapon was nothing made by man but rather a volume of dark matter, flung from the far reaches of space. Slipping silently across the skies of a system on the outskirts, and in a single moment destroying a colonized planet, a planet long fought over by the greatest powers in the history of humanity.
Implanting the Future at your Fingertips

The Epitome of Advancements in Bio Wearables

Written by Jungsuk Lee
Illustrated by Leah Potoff

One of the beauties of the Taylor Series, a series expansion of a function, is that it lets us transform almost all abstract functions into polynomial functions. However, one of the unique features of the Taylor Series is that it cannot estimate the absolute value function. This is because the derivative of the point that changes its slope does not exist; in other words, it’s unpredictable. The field of technology is like the absolute value function. Every time it seems like humanity has reached its peak technological advancement, it seems to find a way around it to impress the world with a new invention that changes our lives at a fundamental level. For example, the iPhone changed our lives, but as the iPhone series advanced the designs started to be more, and every upgraded version was more or less the same. Then, right when we started to doubt the future advancements of technology, artificial intelligence began to disrupt society and force change, adaptation, and integration into our lives. One such intriguing development in a relatively small, niche community is the emergence of individuals who call themselves “cyborgs.”

These “cyborgs” are people who have voluntarily implanted small microchips or magnets into their bodies for various purposes. One of the most common implants is an Radio Frequency Identification (RFID) chip injected into the skin between the thumb and index finger. One of the most significant advantages of RFID chip implantation is its convenience. By having these chips embedded in their bodies, cyborgs can easily access their personal data, and even exchange contact information with others through a simple hand gesture. RFID chips can also be utilized for medical purposes, improving medical applications. For instance, they can store vital medical information, such as allergies, blood type, and emergency contact details, which healthcare professionals can easily access in an emergency. This capability can significantly improve the speed and accuracy of medical treatment in critical situations. Although the cyborg community is tiny, the implantation of the chip is as easy as a simple injection. It can be even done with premade Do-It-Yourself packages at home.

However, there are also concerns surrounding RFID chip implantation, with one of the primary issues being the potential invasion of privacy. As these chips can store and transmit personal data, there is a risk of unauthorized access or misuse. Furthermore, the potential for tracking and surveillance raises ethical concerns regarding individual autonomy and privacy rights. The long-term health risks associated with RFID chip implantation are not yet fully understood, including the prolonged exposure to electromagnetic radiation, which has stirred controversy for quite some time. Although the chips are typically encased in biocompatible materials, there is still a possibility of infection, rejection, or even migration of the chip within the body. This fatal flaw is especially important when one considers that the implantation process of the chip is much easier than removing the chip, which requires surgical procedures.

Implantations are one of many ways people could become cyborgs. A new method that tattoos digital imprints on the skin is also gaining traction in the scientific community. Additionally, digital tattoos, which embed electronic components and sensors directly onto the skin, have emerged as a promising alternative to implantations for individuals seeking to enhance their capabilities and become cyborgs. These tattoos are typically created using conductive ink and flexible electronic materials, enabling them to integrate with the wearer’s body seamlessly. There have been numerous research demonstrations for digital tattoos, such as monitoring vital signs, tracking physical activity, and enabling seamless communication with electronic devices. Digital tattoos are an accessible, less invasive tool in the cyborg community.

The concept of merging humans and technology raises several ethical and social questions. Some argue that the voluntary modification of one’s body with technology may lead to the stratification of society, with “enhanced” individuals gaining unfair advantages over others. Furthermore, there is the potential for discrimination or stigmatization of those who choose not to become cyborgs. The trend of RFID chip implantation raises several questions about the future of human-technology integration. As technological advancements continue, these chips’ capabilities will likely expand, offering even more profound enhancements to those who choose to adopt them.

By having these chips embedded in their bodies, cyborgs can easily access their homes, cars, or workplaces without the need for keys or access cards.

Implanting RFID chips can enhance personal security by replacing traditional access methods, such as keys or cards, which can be easily lost or stolen. Since these chips are embedded within the body, unauthorized access becomes exceedingly difficult.

Additionally, chips can be programmed to require biometric authentication, such as a fingerprint or retinal scan, adding another layer of security. The chips can make payments, store personal data, and even exchange contact information with others through a simple hand gesture. RFID chips can also be utilized for medical purposes, improving medical applications. For instance, they can store vital medical information, such as allergies, blood type, and emergency contact details, which healthcare professionals can easily access in an emergency. This capability can significantly improve the speed and accuracy of medical treatment in critical situations. Although the cyborg community
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/syn′. apse/ noun: the point at which a nervous impulse passes from one neuron to another.

The Synapse is an undergraduate science magazine that serves as a relay point for science-related information with a threefold objective. First, we aim to stimulate interest in the sciences by exposing students to its global relevance and contributions. Second, we work to bridge the gap between the scientific and artistic disciplines by offering students a medium through which to share their passions, creativity, and ideas. Third, we strive to facilitate collaboration between undergraduate institutions across the country, especially within the natural science departments.