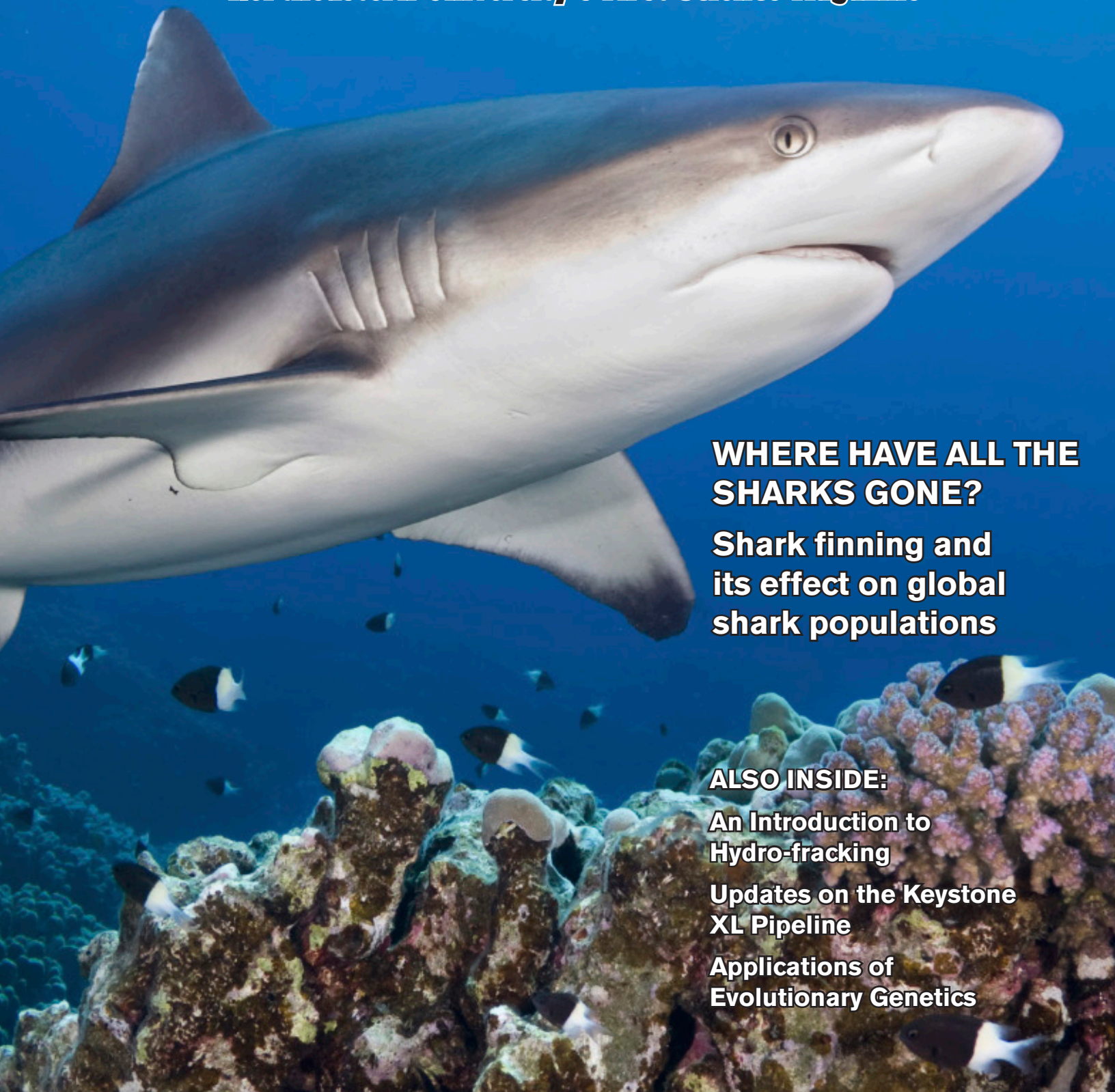
Issue 9

NUScience

Northeastern University's First Science Magazine



WHERE HAVE ALL THE SHARKS GONE?

Shark finning and its effect on global shark populations

ALSO INSIDE:

An Introduction to Hydro-fracking

Updates on the Keystone XL Pipeline

Applications of Evolutionary Genetics

LETTER FROM THE EDITOR

Dear Readers,

The events of the past few months have clearly demonstrated the level of frustration citizens have with current governmental and societal problems in the United States and abroad. From the proliferation of Occupy events across the country, to the fierce protests in Egypt, 2011 quickly became the year to have your voice heard and to demand change.

In the midst of this complex, turbulent, and thought-provoking atmosphere, Issue 9 focused on environmental activism and some of the problems plaguing the earth and its species. We have a primer on the fracking issue for your perusal, as well as updates on the Keystone debacle, and a feature on the horrific practice of shark finning. While each of these topics have alarming aspects, in their research the authors discovered the change that civilian voices can cause. When we met to discuss articles in early fall, the Keystone pipeline was still little debated. Since that point thousands of people have marched on Washington demanding it be halted, and the vote determining its fate has been pushed back until after the next election, ensuring it a spot among the campaign trail talking points. Furthermore, shark and fishery legislation has been slowly but surely advancing, with a recent approval by the ICCAT meeting in November to protect the Silky shark in Atlantic waters.

We hope that you enjoy this issue and will find something to interest you among its pages. We welcome you to join us for Issues 10 and 11 in the spring, or to submit any ideas or suggestions you might have. Whether you're an avid writer, graphic designer, web guru, or photographer, we would love to collaborate with you and showcase your work on campus. If you're looking for a place to get creative, innovative, and maybe just a bit intellectual, become a part of NU Science Magazine!

Kristina Deak
Biochemistry, 2012
Editor-in-Chief, Founder
NU Science Magazine

EAST COAST DIVERS

With over 34 years of experience, East Coast Divers has become a staple of the New England dive community. Located just off the green line in Brookline, the local shop can help you with all of your diving needs, regardless of skill level. They offer several open water certification courses throughout the year, as well as a multitude of specialty classes to build on your credentials. Most recently, they've added a new class on the fundamentals of freediving, which teaches you the practice of static apnea and can bring you to depths of up to 20m on a single breath. In addition, they provide a great networking resource for dive enthusiasts, by hosting both local shore dives every weekend (weather and season permitting), seal dives throughout the summer, and further travel opportunities to exotic locations, such as the ever-popular trip to Bonaire. Above all, the staff are extremely knowledgeable equipment specialists, and are always available for any questions you may have, or for equipment purchase, rental, or maintenance. You can find out more on their website, at www.ecdivers.com, or join their facebook group, facebook.com/ECDivers for continual updates.

NU Science Magazine thanks Nick Fazah, an instructor at East Coast Divers, for his generous donation of the image on page 9 of this issue. The photo is from a recent dive in the Maldives.

MOTE MARINE LABORATORY AND AQUARIUM

Mote Marine Laboratory and Aquarium in Sarasota, Florida has been a leader in marine research, education, and public outreach, since it's beginning in 1955. Founded by the legendary "shark lady," Dr. Eugene Clark and her mentor Dr. Charles Breder, Mote's primary research was focused on shark biology. Today, the lab has become a hub for research across a variety of disciplines, including ecotoxicology, coastal ecology, coral reef restoration, aquaculture, and marine mammal and sea turtle studies. In addition, they have expanded into a beautiful aquarium, which features more than 100 different marine species and hosts several educational lectures, special exhibits, and family-friendly events each year. Mote also has a very active internship program, with allows over 125 college students from around the country to further their research skills in a stimulating research setting each year.

Mote Marine Laboratory remains one of the top facilities for shark research in the United States, with present studies focused on the biochemistry, immunology, sensory biology, behavior, and population dynamics of a large variety of shark species. You can find out more information on the web at http://www.mote.org.

NU Science Magazine thanks Mote for their generous donation of two images in the magazine, the image of the whale shark on the back cover, as well as the sandbar within the shark fining article.

GET INVOLVED!

Are you looking for a creative way to showcase your work on campus? Do you want to boost your resume in a way that's creative, intellectual and fun? Become a part of NU Science! We publish two issues per semester on a variety of themes in science and technology and welcome our writers to explore any appropriate topic they find interesting.

You can always email us at **nusciencemag@gmail.com**, check out past issues on our website at **http://www.nusci.weebly.com**, or follow us on **Facebook** (Facebook.com/NUScienceMagazine).

We meet every **Monday** at **7:30pm** in room **245 Ryder Hall**. Come collaborate with us!

EVENT CALENDAR OF SCIENTIFIC HAPPENINGS

at Northeastern and in the Boston Area

December/January

2011

Dec 01

Affective Science Institute Meet and Greet
1:30-4:00pm

Profiles in Innovation: President Aoun hosts conversation with airspace sculptor Janet Echelman
5:00-6:00pm

Global Climate Change Meets Ecophobia Lecture
Presented by David Sobel, PhD
New England Aquarium

Dec 08

Whale Poop and the Meaning of Life Lecture
Presented by Dr. Kathleen Hunt
New England Aquarium

Book Club for the Curious: Museum of Science Book Club
This Book Club will be discussing the book "Beyond Boundaries: The New Neuroscience of Connecting Brains with Machines - and How It Will Change Our Lives" by Miguel Nicolelis
5:30pm at the Museum of Science

Dec 13

Science Ink: Tattoos of the Science Obsessed
Carl Zimmer discusses his book, "Science Ink"
6:00pm at the Harvard Natural History Museum

Dec 15

Cosmic Train Wrecks
Discussion of colliding galaxies
7:30pm at Harvard-Smithsonian Center for Astrophysics

Nursing: The Evolution of Patient Care
Discussion presented by Massachusetts General Hospital
12:15-1:00pm at the Old South Meeting House, Boston

2012

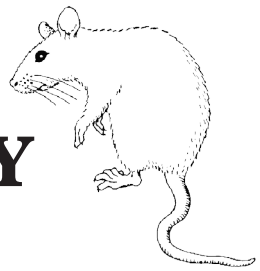
Jan 15

Northeastern Marine Science Center Monthly Lecture Series
7:00-8:30pm at Murphy Bunker at the Marine Science Center in Nahant, MA

Jan 22

Geckos: Tails to Toepads Exhibit opens at the Museum of Science
Temporary Exhibit

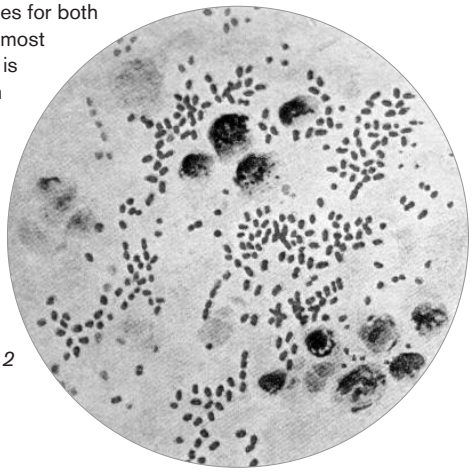
BLACK DEATH DISCOVERY

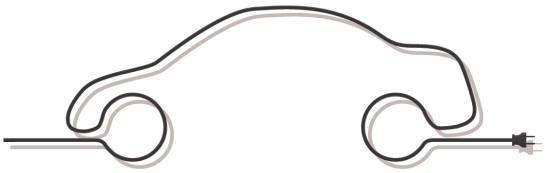


During the dark ages the Black Death swept through Europe, killing up to 50% of the population in some areas. This notorious plague had a major impact on art and inspired the development of some of the first health clinics. A little bacterium, *Yersinia pestis* is a prime suspect for the massive epidemic. Scientists recently isolated this bacterium from 700-year-old plague victims in an attempt to sequence its genome and discover its relation to other plague-causing bacteria. This technique can provide insight into the evolutionary patterns of bacteria and has the potential for elucidating health implications for today's diseases.

How do you obtain700-year-old DNA without contaminating the sample? Scientists extracted DNA from the teeth of the victims of the plague found in a cemetery created in 1348. Using a molecular capture assay, they were able to isolate the ancient DNA from contaminants and sequence it, compensating for DNA damage. From the bacteria's DNA sequence, scientists could attest that it did in fact cause the Black Death and is genetically related to the bacteria that caused widespread disease in Asia. DNA from causal bacteria has also been isolated from victims of a plague that swept through the Roman Empire in AD 541-542 and even from a plague in Athens that occurred in 430 BC. However, the technique to isolate the DNA from these victims has not been as successful and the causes for both are still said to be unknown. The most amazing aspect of this discovery is not the genomic information from the bacteria itself, but of the vast steps scientific technology has taken. The fact that we can isolate, sequence and interpret the modern brothers of ancient DNA is a great advance in creating a historical timeline of pathogens that effect humans.

-Tara Dhingra, Biochemistry, 2012





NU SCIENCE EXPLAINS...

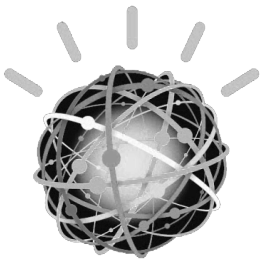
Alternative Vehicles

Knowing what we do today about how combustion engines work, it is understandable as to why someone would want an alternative to the traditional car. Not only are greenhouse gas emissions harmful to our atmosphere, the gasoline required to power engines is becoming more and more costly. One alternative type of vehicle is a hybrid. It has two engines, one gas powered and one electrically powered. These engines can power the vehicle while consuming less gasoline than conventional vehicles. This saves the owner money and results in the emission of less greenhouse gasses.

Three different mechanisms built into the car help to achieve this feat. The first is called regenerative breaking. Normally when the car brakes with a combustion engine, the excess energy is lost as heat through friction. This means that the energy is simply wasted, whereas hybrid vehicle can conserve this energy. When it brakes, the energy from the wheels is used to turn the electric motor, converting energy that is normally wasted into electricity, which can be stored in the battery until needed by the motor. The second thing that a hybrid car can do to limit fuel consumption is operate the electric motor and combustion motor at the same time. The electric engine assists in acceleration, passing and hill climbing. Since combustion engines are extremely inefficient at low speeds, in certain hybrid models the electric motor will take over at these speeds. The final thing that sets hybrids apart from traditional cars is that the combustion engine automatically shuts off when the car comes to a stop and is at rest. When pressure is applied to the accelerator, causing the engine to turn over again, the electric motor takes over and powers the vehicle. This allows the gasoline that would have been wasted during idling to be conserved.

These cars are a great option for anyone who needs to tighten their belt, or just cares about the environment. They are a more sustainable mode of transportation, and hopefully enough people will take advantage of this option to preserve our natural resources and the environment.

-Bill Fleming, Chemical Enginering, 2016



Watson:
Computer Genius

You might think computers are pretty smart.

It's probably because they can spit out a million possible answers after a quick internet search. But you do the research to find an answer, and search engines simply match keywords to bring you to sources. Computers don't solve problems or understand language, we do. But that's most computers. It's not IBM's Watson.

IBM created a trivia mastermind that easily defeated Ken Jennings in a live Jeopardy show in February.

Watson is a computer network made up of 2,800 computer processors, the equivalent to about 6,000 computers. It is about the size of 10 refrigerators and no, it doesn't have access to Google.

Rather preparing for Jeopardy like normal contestants, Watson has about 10 million documents downloaded and stored in its memory. We're talking about countless books, encyclopedias, thesauruses, and the New York Times archive, you know, the basics. IBM developers also gave him extra sources of information like Wikipedia, the Internet Movie Database (IMDB.com), and religious documents like the Bible.

It's more than just the information though. Machine learning is a new strategy that computer designers used in Watson.

It would be almost impossible to teach a computer to understand handwriting by showing it every possible way of writing a letter. If you take the letter "A," for instance, there are infinite font variations. But if you gave it hundreds of examples, Watson will recognize patterns, so that when faced with a version it doesn't already know, it can identify the letter. If it gets the letter wrong, Watson will remember that mistake and learn from it.

When given a question, Watson breaks it down and takes out keywords. Then it compiles a list of information related to those keywords.

Here's an example, with the keywords Watson would highlight in italics:

Keanu Reeves had a *Nokia* phone, but it took a *landline* to slip in and out of this, the title of a *1999 sci-fi flick*.

Watson recognizes that the question is asking for the name of a movie. So he looks for a *1999 science fiction flick* starring *Keanu Reeves* but recognizes that the details about the phone aren't relevant.

Once it breaks down the question into keywords, Watson searches through its database and comes up with a list of thousands of possible answers that relate to the keywords. That might include any movie Reeves has ever been in, other popular science fiction movies, and a list of all movies released in 1999.

Next, Watson checks to see what information overlaps and how often, and ranks each option to see what would be the most likely. Then Watson analyses how much confidence it has in each answer. If it has less than 50 percent confidence in its answer Watson will not respond.

In less than 3 seconds, it knows the answer: "The Matrix."

-Alli Knothe, Journalism, 2014

PICTURE THIS:
The Emerging Science of Mind-Reading

Everyone loves the idea of mind reading. From the proliferation of New Age psychics to appearances in pop culture - there is even machine on House that can read a girl's thoughts to diagnose her illnesses – it's clear that people find telepathy fascinating. Skeptics deride it, while the gullible happily fork over money to Madam Cleo. But what if science could actually find a way to see inside your head?

That's exactly what the Gallant lab at UC Berkeley is trying to do. Using a combination of functional magnetic resonance imaging (fMRI) and computational models, scientists have managed to recreate the mental pictures of several subjects who are watching video clips. The accuracy is striking. It's not like you can watch *Gone with the Wind* through another person's eyes, but seeing the recreated image and the clip side by side is certainly impressive. (To see the comparisons, look up "Reconstruction from brain activity" from the YouTube user gallantlabucb).

The media, as usual, has taken the press release from the Gallant lab at its word and then added its own hyperbole. Articles with titles like "Someday, you might watch your own dreams on YouTube" proliferated soon after the paper's publication, and spread across the web like wildfire. Soon, the inboxes of academics even tangentially involved with neuroscience (lowly undergraduates included) were flooded with questions like, "So can I look at my baby's thoughts now?"

While this technological advance is incredible, it doesn't come out of the blue. For years, fMRIs and PET scans have been used to map the neural patterns during various stimuli. In 2007, NeuroImage successfully predicted brain states using fMRIs. In 2008, the Gallant lab published a paper showing that, by using a vast database of brain responses to selected images, it was possible for the researcher to determine which of a given set of photographs the subject was looking at. The paper concluded that soon, instead of comparing information to decide which one of a few pictures the subject was viewing, any visualization could be recreated from brain scans alone,

This research is an exciting advance, one that hopefully will provide scientists with answers about the brain's functioning. Further delving into this line of work might even provide clues about the Big Questions – consciousness, differences in visual experience, how babies feel when they watch those insane Baby Einstein videos. Still, it would be wise to exercise caution when discussing the implications of current research – no matter how thrilling "Scientists in California can now read your mind" sounds as a lede.

-Cat Ferguson, Behavioral Neuroscience, 2013

Photos courtesy of gizmodo.com

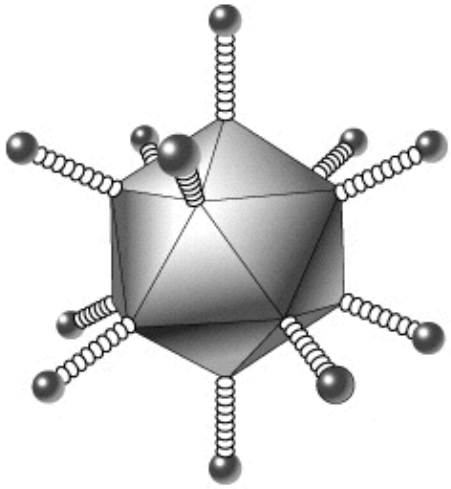
Viruses:

Murderers or Lifesavers?

Your computer crashes and you lose all 8 pages of your psychology paper due in 3 hours. What happened? Virus. Your throat kills, you cough and wheeze like your grandma, and your new best friend is a box of tissues. What happened? Virus. Your friend's mom undergoes treatment for the metastatic melanoma wreaking havoc on her body and against all odds rebounds to near full health. What happened? Virus.

The notion of a virus fighting cancer certainly is one that is hard to fathom. Yet even more conflicting to the research of "cancer curing" viruses is the fact that some cancers are caused by viruses. The World Health Organization International Agency for Research on Cancer estimated that 17.8% of human cancers were caused by viruses in 2002. These viruses are referred to as "oncoviruses". This discovery caused researchers set forth a frenzy of oncovirus research and study. In fact, Harold zur Hausen was given the 2008 Nobel Prize for his discovery that human papillomaviruses cause a majority of cervical cancers. So if viruses are the cause of cancers, how could they also be the solution? The answer is genetic engineering.

Researchers have shown that a single intravenous infusion can kill tumor cells in patients, while sparing healthy tissue. This therapy uses revolutionary technology in the fight on cancer: genetically engineered viruses. The age of the "oncolytic virus" has come. A collaboration between the University of Ottawa and the biotech company Jennerex Biotherapeutics, Inc recently released the results of an early-stage trial of experimental viral therapy for cancer. The researchers consistently showed that the engineered virus successfully infected tumors and had a very low toxicity. Dr. John Bell, chief scientific officer at Jennerex, commented on the great upside of this therapy. "With chemotherapy you get drastic side effects. Patients on this treatment only had 24-hour flu symptoms and nothing after that." Not only did the tumors



show signs of viral replication, but in six of the eight patients given the highest doses of the treatment, the tumors stabilized or shrunk. This is an efficacy rate unparalleled in other forms of cancer treatment.

Instead of just infecting all human cells a virus can get its protein shell on, a modified virus will only infect cancerous cells. This selectivity is truly its genius. Genetic engineering is transforming our feared viruses into more selective murderers. Primarily, this is done in two approaches: transductional targeting and non-transductional targeting. Transductional targeting is the process of engineering the makeup of viral binding proteins in order to increase their entry inside of the target cancer cells and decrease their entry into healthy human cells. Non-transductional targeting involves modifying the DNA makeup of a virus so that it is only capable of replicating in cancer cells. One approach to this is modifying genes essential for viral replication to be controlled by promoters, which are only found in tumor cells. This is called transcription targeting. Another type of non-transductional targeting used in oncolytic viruses involves deleting parts of the viral genome that are necessary in human cells but dispensable in cancer cells. This is called attenuation.

A majority of the oncolytic virus research involves adenoviruses. This is because adenoviruses contain a double-stranded linear DNA genome which allows for greater durability during storage and the least risk of dangerous mutations. An example of current transductional targeting techniques carried out on adenoviruses involves modifying the protein coat of the virus, which makes the virus apt to interact with integrins. Integrins are a specific set of proteins that span through a cell's membrane and into the Extracellular Matrix that allow it to make exchanges with the world around it. The engineered viruses will interact and bind with available integrins inducing endocytosis: the process by which most molecules gain entry into cells. This modification is useful as integrins are over expressed in Oesophageal Adenocarcinoma, a malignant cancer of the esophagus. As a result, the engineered viruses will enter and infect cancer cells with their excess of integrins substantially more than healthy cells of the esophagus.

Although there is currently only one "oncolytic virus" approved by a regulatory agency, a GM adenovirus H101 by the Chinese company Shanghai Sunway Biotech, a rush of experimental trials are underway. In fact, groundbreaking oncolytic virus research is occurring right next door in Cambridge and Woburn by a company called BioVox. By the end of the year, the company will release preliminary data from a Phase III trial of OncoVex, an oncolytic virus therapy, in patients with advanced melanoma. The future looks bright.

-Alex Colville, Chemical Engineering, 2016

Keystone XL

A Pipeline Plagued with Environmental and Political Problems

The project to expand the Keystone Pipeline from Alberta to the refineries near the Gulf of Mexico has been plague on the Obama administration, so much so that a conclusive answer to its construction has been pushed back until after the 2012 election. The plan, which would add approximately 1,600 miles of piping onto the already existing line, boasts the creation of over twenty thousand jobs. The appeal of the proposal is therefore the economic benefits it provides and TransCanada the company trying to build it hopes that these benefits will be enough to cause the president and his administration to approve the pipeline. They estimate that over the 100-year life of the pipeline it would pump 20 billion dollars into the economy. However this is not the only thing that should be considered when deciding whether or not this pipeline is a good idea. We should also take a look at the potential environmental impacts of this project, since they at least as much weight as the economic if not more.

There are many reasons that people say this project is a poor idea. The first problem with this system is the type of oil that would be coming down from Canada. This pipeline carries oil sands not crude oil. Oil sands produce five to thirty percent more greenhouse gas emissions than the crude oil. This is mainly due to the amount of energy required to refine the oil sands since they are more viscous. Another thing that many people fear is that the pipe could rupture. This is because of the material they are using and where they are building. The type of pipe is unfortunately susceptible to rupture and the proposed path would involve the pipeline passing directly over the Ogallala Aquifer. This aquifer provides irrigation water and drinking water to eight states, and if the pipeline leaked into the aquifer it would be a major problem since it would impact our supply of potable water. According to Alan Moore of Friends of Earth "The pipeline would pump some of the dirtiest oil on earth down from Alberta, Canada and put our farms at risk of oil spills, and it will increase pollution in communities surrounding refineries, it has much higher levels of heavy metals like lead, and when it's refined those metals end up in the air – and that means more kids with asthma, and it means more elderly people with respiratory diseases."

According to Brian Johnson of energytomorrow.org what we should be doing is a combination of offshore drilling and constructing the pipeline. Not only is he convinced that this would be environmentally safe, Johnson believes it will create jobs and stimulate the economy. He feels that it is the solution to us being dependent on regions like Venezuela and the Middle East for oil. Johnson also feels that it would be much better for us to produce from our own resources and the oil sands from Canada and believes that this is all the justification that we need in order to get behind the keystone pipeline project.

The potential environmental consequences are easily seen. However, what is not so easily seen is how the situation should be handled. The president and his administration have a serious job ahead of them deciding whether or not they should permit the pipeline's construction, they need to decide what is more important, to heed the admonition of the environmentalists and shut the project down, or to indulge their own desires and allow its construction so that jobs can be created, and the economy can be stimulated. The problem for the environmentalists is that their predictions are not a sure thing, they are in fact hypothetical, and the government is more likely to support the pipeline's construction since they are dealing with tangible benefits and hypothetical drawbacks.

Obama received a letter from many major environmental groups warning him that if he approved the pipeline it would be detrimental for his chances of reelection in 2012. In the letter they wrote, "If you block it, you will trigger a surge of enthusiasm from the green base that supported you so strongly in the last election". These groups included, Natural Resources Defense Council, the Sierra Club, the Environmental Defense Fund, the National Wildlife Federation, Greenpeace, Friends of the Earth and the Rainforest Action Network, and many more. Obama needs to weigh his options and decide which is more important fixing the economy or protecting the environment (and thereby protecting his own support base of the environmentalists for the next election).

Obama has recently decided to send the bill back for revision. He specifically stated that he wanted the environmental impacts to be reviewed and he also did this so that there is more time for information to be collected. This strategic move by President Obama has excited many people who are opposed to the pipeline. They feel that the bill will die in revision. Obama did this because he does not want this to be an issue which will influence the election. By sending this off to review, Obama hopes the issue will be on the back burner until he no longer needs to worry about re-election. Although many people are happy with this decision there are many other opponents to the pipeline who feel that Obama is beating around the bush and on Sunday November 6, thousands of protestors encircled the Whitehouse demanding that the president kill the project.

-Bill Fleming, Chemical Engineering, 2016

Global Shark Genocide

How shark finning is contributing to the population collapse of sharks

Few creatures are as mysterious, as powerful, and as biologically fascinating as sharks. Shaped by 450 million years of evolutionary success, they have survived four mass extinction events, maintaining their role as an apex predator and a keystone in the marine ecosystem. They possess both incredibly rich species diversity and tremendous physiological complexity, and their unusually robust disease resistance capabilities may hold the key to current human health problems.

We used to revere them as gods. From Fiji to Panama, ancient cultures around the globe were drawn to the unquestionable supremacy of sharks in the waters they fished. From a mix of fear and respect grew a desire to honor the species, and sharks became figureheads to explain both the darker themes of death and communication with parted souls, as well as the virtues of strength and a close tie to the simultaneous ferocity and beauty of the natural world.

That was the past. Now, we slaughter more than 100 million sharks a year, worldwide. Three sharks a second are pulled from the seas and destroyed, which has resulted in over 90% of the global shark population being eliminated over the past few decades. Some of this is due to recreational fishing, some due to bycatch, and some were caught in nets and were strangled as they thrashed to escape. But the large majority of the casualties fell to the shark genocide in "traditional values" clothing. Shark finning.

FINS ARE FOR SWIMMING, NOT EATING

Shark finning is the horrific practice of catching a shark, cutting off its fins, and tossing it back in the water, many times while the animal is still alive. It is no secret that sharks are resilient and can be aggressive and dangerous when stressed. Therefore, it is simply more efficient to brutally tear the fins from the living shark and toss it back into the water to sink to its death rather than kill it first.

Why would this practice be so widely followed? Shark fins are the critical ingredient to shark fin soup, a cultural symbol of prestige in China. Once available only to the wealthiest citizens, the rapid economic growth of the middle class in China has allowed millions more access to the delicacy. Served at everything from business meetings to weddings, many consider it the ultimate status symbol.

That must be some damn good soup. If it's good enough to bring a species close to the brink of collapse after 450 million years of success, it should be really and truly out of this world, right? Wrong. The fins themselves contain little to no flavor, and instead only add a stringy texture. Furthermore, due to their role as an apex predator, shark meat contains a great deal of toxins due to bioaccumulation throughout the food chain. A 2001 study by the Thailand Institute of Scientific and Technological Research found shark meat on sale in Bangkok contained mercury concentrations 42 times the limit safe for human consumption.

Of course, every culture has their quirks, and if turkeys were suddenly threatened with extinction and plagued with PCBs, our Thanksgivings would seem just as atrocious as this practice. As heinous and illogical as the ingredient seems, it probably wouldn't be as bad for sharks as a whole if it had remained limited to a small clientele. But the reality is, the addition of so many eager buyers has pumped a great deal of money into the trade, making it a lucrative venture for fishermen and businessmen alike. Fins can sell for as much as $700 per kilogram and a bowl of soup can go for more than $100 in a typical restaurant. As sharks become increasingly rare due to over-fishing, these price tags will just go up, making a catch even more valuable and alluring for fishermen and ensuring they will exhaust all means to land that big fish. This vicious cycle is a conservationist's nightmare and both the population numbers and logic suggest that business-as-usual needs to be halted, or we face losing these incredible organisms at a time when we are still learning about their basic biological and physical properties.

PREDATORS HELPING PREDATORS

How do we make sure this doesn't happen? The first step is public acknowledgement of the problem, and over the past few years opposition to the practice has grown overwhelmingly. Through the work of major environmental groups, such as WildAid and the Sea Shepherd Conservation Society, celebrities speaking out, (including basketball star Yao Ming and chef Gordon Ramsey) and the work of concerned individuals, such as those who made the powerful documentary, *Sharkwater*, people are beginning to take notice. In China, it's becoming popular among more progressive couples to either ban shark fin soup from their weddings, or to at least

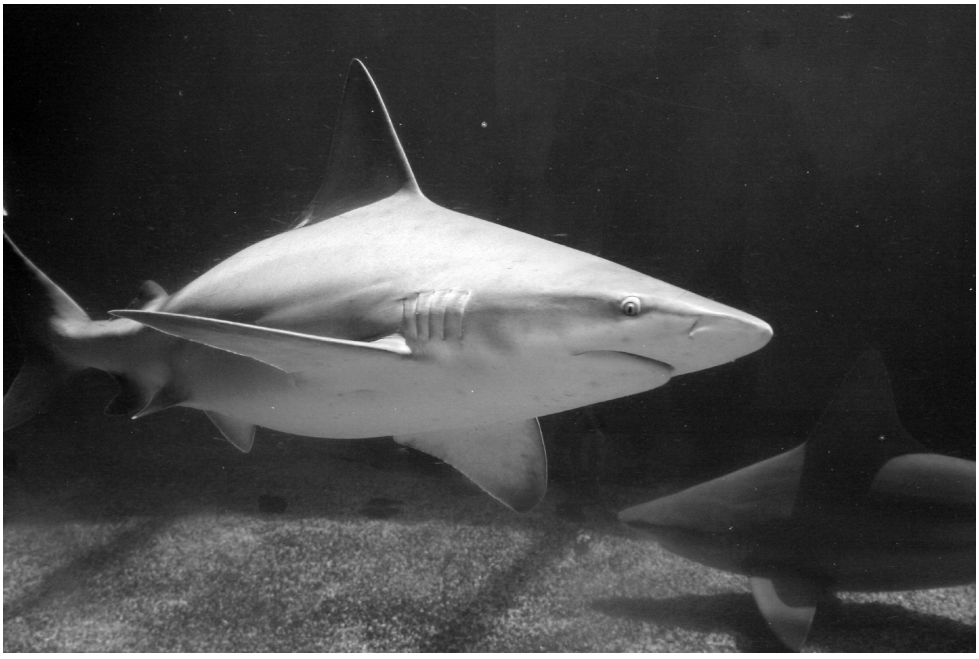


Photo courtesy of Mote Marine Laboratory

Photo courtesy of Nick Fazah, East Coast Divers

have a few '"green," shark-free tables. Even capitalist giant, Disney, has taken note. When Walt Disneyland opened in Hong Kong in 2005, it had intended to serve shark fin soup at its inaugural dinner. After some pressure from Sea Shepard, they decided it would be best for their public image if they removed it from the menu.

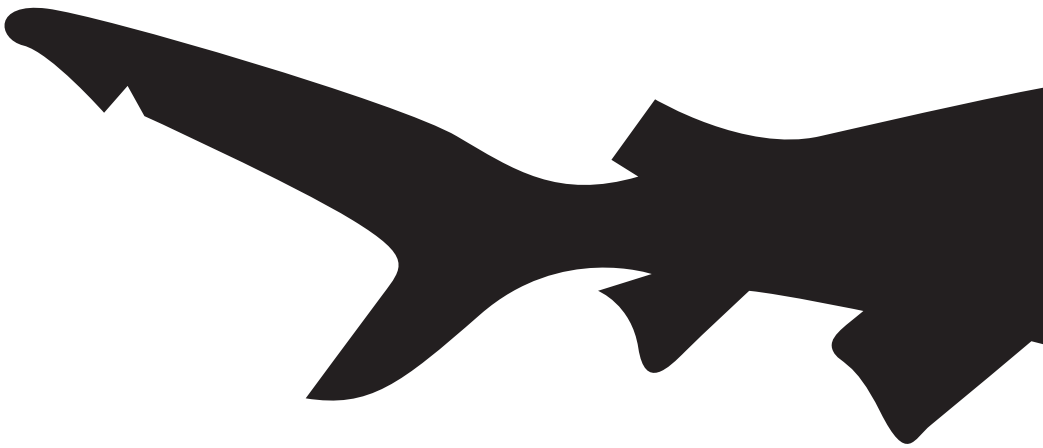
Once the enormity of the situation is realized, it is time to enact policy to promote fishery restrictions. Typically, this change comes in a few forms, either in the limits on the number or mass of sharks that can be caught, the provision that sharks must arrive at the docks with fins intact (thereby limiting the number of fish that can be killed per boat), or by setting up marine sanctuaries where any fishing is illegal.

This year has been particularly active in seeing these policy changes come to fruition. Most notably, in October, the Marshalls Islands opened the world's largest shark sanctuary in their waters. They set aside nearly 800,000 square miles of ocean, where shark fishing is now illegal. Closer to home, earlier this year California passed landmark legislation banning the sale, trade, and possession of shark fins in the state, and shark finning has also been banned in Mexico waters. Perhaps most promising, Taiwan has committed to slow finning, by enacting a law that only whole sharks may be brought to the dock. While not perfect, it is a huge steppingstone for an Asian market, and sends an important cautionary message to other like economies.

Of course, fishing laws are notoriously difficult to enforce, and there is a constant disconnect between the laws put forth by governments and what actually happens on the open sea. But one simple economic principle could resolve what policy alone cannot; sharks will only be hunted for their fins so long as it makes financial sense to do so. Once the market dries up, there will be no incentive to haul your boat and gear to sea to catch an elusive creature. The most important thing we can do then is to continue to spread the message of the crime going on in our waters and to enlighten the buyers and consumers of fins to the ecological dangers of the practice.

WHY SHOULD SCIENTISTS PAY ATTENTION?

We, as a global community, have lost sight of the value of living sharks in our waters. When we hear about them from the media, it's usually because someone has been attacked while surfing, or during Shark Week attack shows, which only enriches the evil and fearsome stigma that sharks have associated with them.



But they are worth so much more than these diminishing outlets would have us believe.

We are still at the very beginning of our study of these organisms, and much remains to be explored, including the basic life history of many species, their swimming behavior throughout the water column, and essential facets of their biochemistry.

For scientists, sharks present an organism of stunning physiological significance, which has evolved in novel ways among vertebrate species.

For example, they are one of only two of the 25,000 species of fish to evolve endothermy. While most sharks are ectothermic, those of the Lamnidae family (including Great Whites, and Mako) have a special series of blood vessels which assist in raising body temperature above that of the surroundings. Called the *rete mirabile*, the venous system allows key organ systems, (such as the eye, brains and viscera) to elevate in temperature, thereby increasing the sharks geographic range and capabilities as a predator. In addition, the Shortfin Mako has evolved the muscle capacity and nearly perfect aerodynamic shape to swim up to 50 mph by some estimates. This is believed to be a result of their behavior of heavy bluefin tuna predation, a rapidly swimming fish which contributes to 78% of their early diet. Finally, they have a remarkably low frequency of diseases, including cancer, though the examination of the molecular and physiological properties that govern this trait require further exploration.

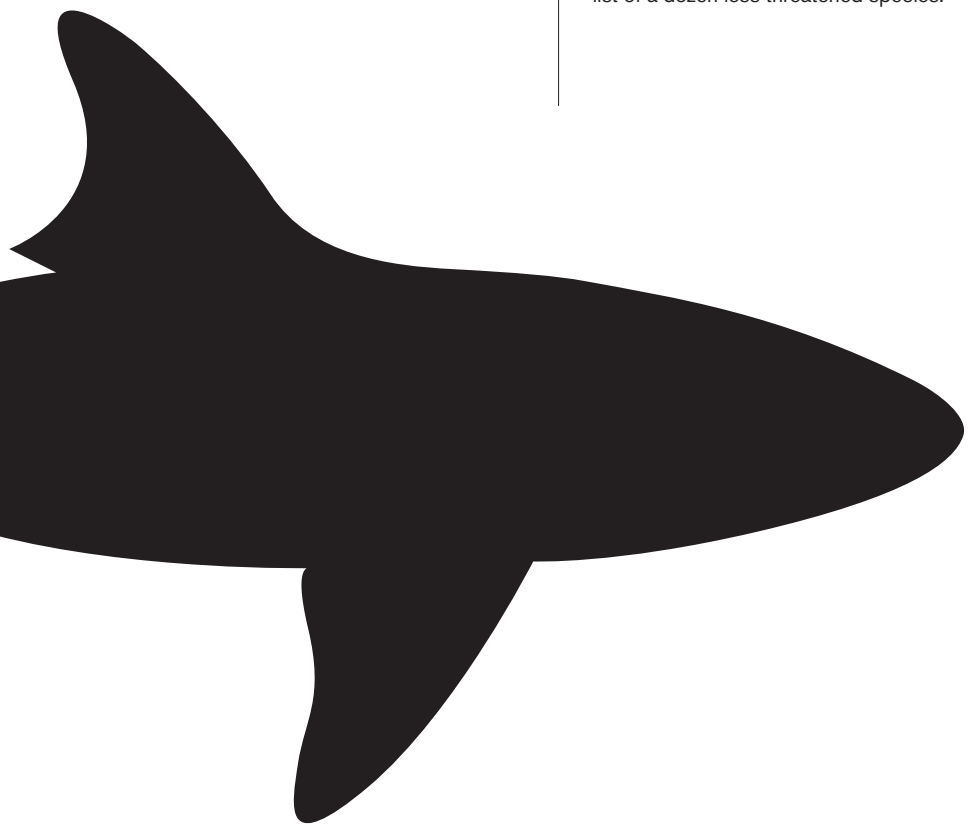
The applicability of the things we can learn from the study of sharks are endless, from expanding our knowledge of basic biological principles, to gaining insight into evolutionary biology at its finest and learning what it takes to survive on our planet where so many others have failed. And for the staunch capitalist, recent studies in *Current Issues in Tourism* determined that a shark is worth approximately $200,000 over a 15 year life-span due to ecotourism, as opposed to a one-time $100 bowl of soup.

Ultimately, the fate of the shark is in our hands. We have a responsibility as conscientious and informed people to make sure this species is protected from further exploitation.

- Kristina Deak, Biochemistry, 2012

Ways you can help!

- Sign up for alerts from Facebook groups such as the Global Shark Initiative and Save Our Sharks. It can help you keep abreast of policy changes and give you great ways to take action.
- Write to politicians. There are a lot of problems facing our country and the world right now, and it is imperative the issue of shark finning stay on the political radar.
- Talk to friends and family. The more people who understand the problem and are informed, the better!
- Donate to shark research labs. Research for marine organisms is always scarce and studying organisms in the open water is incredibly expensive. Any contribution to a reliable research organization would help in gaining knowledge about these creatures.



Conservation in Action!

The Guy Harvey Ultimate Shark Challenge

Fishing tournaments are a lucrative venture, capitalizing on the intrigue of the beasts of the deep, the masculine pride of catching the largest fish, and in terms of shark tournaments, conquering the one universally feared creature on earth. However, despite monetary and sporting gains, the tournaments obviously have a high cost, in the needless mortalities of increasingly threatened species.

In 2009, Sean and Brooks Paxton, founders of Think Out Loud Productions and renowned specialists in live-animal documentation, collaborated with Mote Marine Laboratory and Dr. Guy Harvey to create the first spectator-friendly tag-release shark fishing tournament. In an effort to, "combine the goals of sport, science, and conservation," the team was able to devise a tournament that would serve as a model for responsible fishing.

Wildly successful in its first two years, the competition is held annually in Sarasota, Fl. It begins with a qualifying round, after which fifteen two-man teams compete to catch, tag, and release as many qualifying five-feet long sharks as possible, from a list of a dozen less threatened species.

While the participants are motivated by the $15,000 in prizes, the competition is also a lucrative venture for scientists. The tags placed on the animals upon capture give important information about migratory patterns and stock identification. In addition, every qualifying shark that is caught contributes to documentation of local shark distribution and life history data. The spectators also benefit as the action on the water is captured on video and transferred live to stadium-size screens at the festival venue.

This innovative and timely approach to the problem of blending exciting sports and traditions with the real problems of sustainability and conservation deserves the acclaim it has received.

-Kristina Deak, Biochemistry, 2012

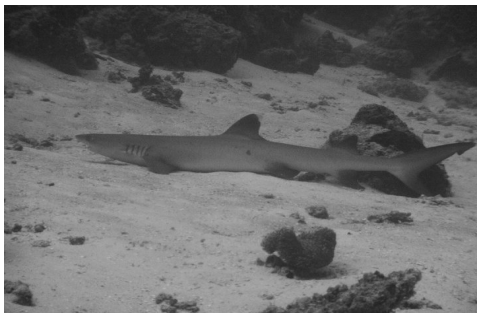


Photo courtesy of Nick Fazah, East Coast Divers

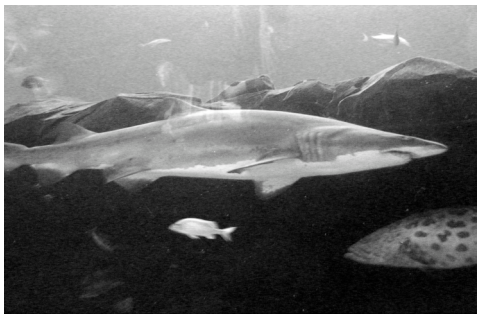


Photo courtesy of Kristina Deak

FRACK IT

Hydro-fracking, or hydraulic fracturing, recently became a big issue ("has recently become a hot news topic, "with the release of the movie Gasland (italics for movie title?) and New York's consideration of allowing the Marcellus Shale to be hydro-fracked. The controversy has led to protests, door- to- door petition campaigns, debate(what kind of debate… public, political, much publicized, etc), and general outrage. So what's the big deal?

To hydro-frack, a drilling company drills a gas well down vertically, then drills horizontally away from the well "head". Large quantities of chemically treated water and sand are then injected into the well. The pressurized force of the water, chemicals and sand fractures the shale, and the natural gas it contains is released. This gas is then brought back up the well, along with the compounds that were previously injected to release it. There are many concerns about the safety of the process, the effect on the environment, and the effect on nearby inhabitants.

Those against the process have spoken out in New York, citing the examples of Pennsylvannia, Texas and Wyoming's dramatically increased pollutant levels following hydro-fracking. The amount of product(word choice, substitute with something else since "product to be produced" is awkward) that will be produced as the well is drilled is estimated to be eight thousand trailer-truck loads worth of material. Where will this material go, and how will this sudden increase in traffic be handled? In addition, the chemicals in the water to be pressurized and blasted into the well cause concern – it is now known that while the compound is mostly water and sand, friction-reducers, bacteria-killing compounds, and lubricants are added. Some of the additives, such as butoxyethanol, formaldehyde, ethylene glycol, glycol ethers, hydrocholoric acid, sodium hydroxide and benzene, are dangerous carcinogens. While it has been stated that the drilling is too deep to ever get into ground water and effect watersheds, drinking water, and inhabitants, the fact that other areas that were near drilling locations had a problem with polluted groundwater and environments, and that water has a tendency to diffuse, worries some people. After the water has been brought back up the well, it also is carrying chemicals and radioactive isotopes that were released down below, and it is five or six times as salty as ocean water. Called frack fluid, the toxic sludge is potent in it's potential for harm. There are no plants to treat this water in New York, and it cannot be released into lakes or it will pollute the water supply. So where will it go? Opponents are afraid it will run off into lakes and pollute New York's water supply further. Even though the proposed bill plans to ban drilling in the watersheds and aquifers that supply about 57 percent of New York's water, it does not ban drilling in any other watersheds or aquifers. In addition, those against hydro-fracking cite the destruction covered in the documentary Gasland, which included exploding faucets due to buildup of gasses, dying animals and people, and streams and ponds with high toxicity levels.

Proponents of hydro-fracking say that the drilling of the planned 1,600 to 2,500 wells in the next 30 years will create many jobs, energy that does not stem from a foreign source and prosperity for the communities surrounding the sites. They claim that the industry will be highly regulated by the government, cement and metal will line the wells to prevent diffusion of water, and no ground water contamination has ever officially been proved by a government agency. In addition, the shale is estimated to hold fifty trillion cubic feet of gas, enough to power all of New York for the next forty years. This new abundance of gas would decrease fuel prices, and would benefit upstate landowners who would be able to sell their land to companies for large sums of money. The process is even purported as good for the environment, because the burning of natural gasses produces less carbon dioxide than the burning of coal.

In New York, it seems that many residents are opposed, but just as many have no idea what is happening. The governor, Andrew Cuomo, is of the opinion that hydro-fracking should be allowed. However, the bill is lacking in explanation on how to regulate the drilling companies once they have licenses to drill and where exactly the drilling may occur. While activists continue to campaign against the bill passing at all, education and revision of the bill should continue to be considered.

-Shannon Jones, Marine Biology, 2017

Tracing Human Migration

Taxonomists have struggled to perfect the classification of evolutionary relationships between organisms for thousands of years. Originally, they classified them based on similar physical, physiological and embryonic traits. From such clues, Carl Linneaus created a detailed and brilliant tree of life, and created orders, genres and other categories. Though his work was not completely accurate, it began centuries of scientific investigation and debate on the relationship between living organisms. These disagreements were unsolvable before genetics were used to elucidate the mysterious relationships between living entities.

If two people trace back their maternal line, eventually their lineages will converge on a single woman. The difference is how long ago that woman lived. How can scientists use DNA to show lineages between people or any organism? Genes change over time, and scientists can compare the similar and different nucleotide bases to construct a timeline for the separation of organisms, using an average number of mutations over time. Think of a woman with a necklace consisting of blue and green beads. The woman that owned the necklace switched a random blue bead into a green bead (or a green bead into a blue bead) each year. When she had two daughters, she gave each daughter exact copies of the necklace. Her daughters continued to change a random bead each year. When they had children, each sister passed on their copy of the necklace to their progeny, who continued to change one bead each year. From this model, it would be possible to look at necklaces of two distantly related individuals and calculate how long it has been since they have had a common ancestor based on the different pattern of the colored beads.

DNA in the nucleus has numerous checkpoints to reduce or fix mutations in the nuclear DNA. Scientists have concluded that there is about 1 nucleotide base change in one thousand million years and we can use this rate to trace back lineages. For example, the rate could be utilized to trace lineages based on the discrepancies at specific base pairs. Nuclear DNA is not the best candidate for tracing back evolutionary relationships. During meiosis, the chromosomes from the two gamete cells touch, so it is indefinte that any one chunk of DNA is from the paternal or maternal line. DNA found in the nucleus also

doesn't mutate nearly as often as genetic material that isn't as vital. Luckily the DNA found in the mitochondria of cells is suitable for the job.

Mitochondrial DNA consists of a small circular chromosome of genetic material housed in the mitochondria of cells- not the nucleus where the majority of the genetic material is housed. Scientists speculate that mitochondria were once separate organisms that fused with cells billions of years ago and now enjoy a benefical relationship within eukaryotic cells, providing the cells with energy. Mitochondrial DNA is exclusively passed down through the maternal line in the cytoplasm. Because it is only inherited from the maternal line, there is no mixing of DNA during meiosis. Haplotypes, which are chunks of genome impervious to being broken up by sexual recombination, are perfect for tracing back evolutionary lineages. Y-chromosomal DNA and mitochondrial DNA are both haplotypes. Also, mitochondrial DNA doesn't code for much. Actually some of the most important jobs done by mitochondrial DNA have traveled to nuclear DNA sometime as the mitochondria became permanent parts of eukaryotic cells. Because of this, mutations occur and remain unchecked more rapidly in mtDNA than in nuclear DNA.

There is a short segment, about 500 bases, that has a particularly high mutation rate. Called the control region, it doesn't carry codes for anything in particular, so mutations in this region don't affect mitochondrial enzymes. The mutation rate is high; if the most recent common maternal ancestor between two people lived twenty thousand years ago there would be only one difference in their control regions.

Mitochondrial Eve is a term given to the most recent common ancestor of all humans, from which everyone is descended from through their maternal line. This is a misleading statement because most common ancestor does not mean first female human, because besides the fact the speciation is a slow a subtle change, Mitochondrial Eve certainly had a human mother, and at least two daughters. We can tell that Mitochondrial Eve had at least two daughters, because if she had just one then her daughter would be the most recent common ancestor, or MRCA, of all humans. Mitochondrial Eve definitely had other female contemporaries, whose descendants for some reason have all died out in the last 200,000 years.

By using the information deduced from the DNA, scientists deduced that Mitochondrial Eve lived about 200,000 years ago near East Africa. This information solidly confirms the Out of Africa hypothesis and disproves the Multiregional hypothesis. Both are theories that describe the evolution of humans. Both theories place Africa as the original birthplace of the human race, but they differ in where *Homo sapiens* evolved. The Multiregional hypothesis states that once *Homo erectus* spread from Africa into other continents, the human species has evolved into continuously changing species, like *Homo neanderthalensis* and eventually *Homo sapiens sapiens*, all while maintaining the ability to interbreed with genetic flow.

If the Multiregionalist's theory is correct, we would expect to modern gene distribution to show that lineages between humans native to separate countries are anciently divided. If the recently Out of Africa theory is true, then we would expect the genes of modern people to show a relatively recent African centered bottleneck. Genetics favor the Out of Africa theory. Besides the timeline derived for Mitochondrial Eve, geneticist Alan Templeton looked at several chunks of DNA to generate inferences. He found that there were three major migrations out of Africa. There was one about 1.7 million years ago by *Homo erectus*, a middle emigration between 840,000 and 420,000 years ago, and the most recent emigration supported by mitochondrial and Y-chromosomal evidence between 150,000 and 80,000 years ago. Other 'signals' (the study looked at 13 haplotypes) showed that there was major back-migration from Asia to Africa 50,000 years ago. Other genetic signals show the migrations from southern to northern Europe, from southern to northern Asia, to Australia and across the Pacific Ocean, and from northeast Asia to North America. The genetic signals showed continual gene flow between Africa, southern Europe and Southern Asia.

The mutation rate of one base change per twenty thousand years has been checked against known lineage separations. We could not possibly know the last common ancestor you and I shared, but we know when *Homo sapiens* arrived on the North American continent. From geological evidence that the Bering Strait was exposed, we know that they arrived into the Americas about twelve thousand years ago. We can also compare human DNA with that of chimpanzees, who shared a common ancestor between four and six million years ago. These separations have been checked against the calculated rate and confirm that the rate is correct.

Anthropologists have debated over the origins of the inhabited Polynesian islands since Europeans first sailed there over 200 years ago. Polynesian tradition speaks obscurely about an ancestral homeland, and it was unclear if the aboriginals were originally from southeast Asia or the Americas. If Polynesians sailed from Asia, they would be battling considerable forces. Winds and the ocean current move East to West across the Pacific Ocean, so this circulation would have aided people traveling from the Americas to the Islands.

Evidence of archeology, language and domesticated plants and animals all point to Southeast Asia as the original homeland of Polynesians. The most compelling evidence for American origins is the widespread cultivation of sweet potato in the islands, which is certainly native to the Andes in South America. There are some connections to language, mythology and stone carvings that strikingly resemble Incan style.

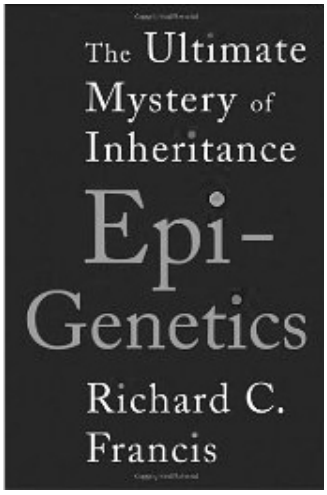
By comparing the control sequence in Mitochondrial DNA, Dr. Bryan Sykes was able to follow the "trail" of sequence mutations into the islands. His research found that the ancestors of Polynesians began their trip from either China or Taiwan. The same sequence of mutations was by far the most common in the DNA that was looked at from the islands, and not seen at all from any mtDNA looked at from South Americans. However, there was another rare sequence very different from the Asian one, that scientists hypothesized that it would show evidence that people had traveled from South America as well. Unfortunately, the scientists could not find anything like the rare Polynesian sequence anywhere in South or North America. Researchers did, however, find the same sequence in the DNA from people in the mountainous interior of New Guinea. This showed evidence that indigenous people that had been living on New Guinea forty thousand years ago (at the same time when Australia was colonized) must have joined a canoe heading for unknown lands that eventually reached the Pacific Islands.

The revolutionary field of genetics is able to lend hard proof to the previously enigmatic classification of organisms. Before genetics was used to synthesize phylogenetic trees of life, scientists were unable to know or understand how certain life forms were related. By understanding the molecular relationships between different species, we are able to construct a clearer idea of how life has evolved and even how it started. We are able to say for sure that Neanderthals did interbreed with our ancestors, because we have found echoes of Neanderthal DNA in modern humans. DNA is able to give a truth to the tree of life that humans have been curious about for thousands of years.

-Jackie Gladstein, Biology, 2014

Review of The Ultimate Mystery of Inheritance:

Epigenetics



In *The Ultimate Mystery of Inheritance: Epigenetics*, Richard Francis describes the major advances in this emerging scientific field to a non-specialized audience. He succeeds in highlighting key concepts with as little technical jargon as possible while incorporating helpful diagrams along the way. Epigenetics consists of the way genes are expressed without actually changing the genetic code. The most common example of this is methylation and demethylaton. When DNA is methylated, gene expression is silenced, i.e. the genes are turned off. Cancer can be caused when the normally methylated (or "off") genes are demethylated and turned "on." This increase in gene expression can lead to uncontrollable cell growth characteristic of tumors. Besides cancer, epigenetic alterations can factor into physical conditions like obesity, diabetes, and heart disease as well as psychological disorders like depression, anxiety and schizophrenia.

An epidemiological study featured in the first chapter shows the importance of the fetal environment on epigenetic arrangement and its impact over generations. During World War II, a food embargo coinciding with a harsh winter led to a famine in part of Holland. The daily caloric intake dropped to as little as 580 calories in some areas. The children of mothers who were pregnant during the famine are part of the Dutch Famine Cohort Study that documents the effects of malnutrition in the womb and its impact throughout a lifetime. They found that those with prenatal exposure to the famine had double the rate of obesity and an increase in schizophrenia and depression. These effects also depended greatly on timing of exposure, i.e. if their mothers were in the first, second or third trimester during the course of the famine. The study also found that all participants had the same epigenetic altered genes including a growth hormone associated with fetal development. How did these children end up with an epigenetic alteration that was present in their famine-exposed mothers? This phenomenon is called epigenetic inheritance and it is just one of many marvels Francis unravels for a general audience not versed in the confusing technical jargon of the scientific world.

Francis breaks down complex animal studies to explain generalized themes such as the long-term impact of epigenetic regulation. An example of this is the development of the stress response in rats. Rat mothers, for example, lick their babies constantly – at least good mothers do. Rat babies with "good-licker" mothers grew up to be good-lickers and had less stress. On the other hand, rats born to "bad-lickers" tended to grow up to also be bad-lickers and had hyperactive stress responses. This "good licker/bad licker" trait is not housed in the traditional genome but comes from epigenetic changes that take place during early development. By taking babies born from good-lickers and placing them with bad-licker mothers, they demonstrated this concept. The rats subsequently became bad-lickers and had high anxiety.

Epigenetics explains why genetically identical twins often differ. For example, there was a case study of two male twins - one a healthy twenty year old, the other with a disease called Kallmann Syndrome. In Kallmann syndrome, sexual development and a sense of smell are impaired. One brother had improperly formed genitals that prevented him from developing sexually as well as an impaired sense of smell. Additionally, the twin without Kallmann syndrome was not 100% healthy. He also had a very poor sense of smell. Kallmann syndrome is caused by a defect during fetal brain development. Why would two twins with the same genome and fetal environment show such severe discrepancies in disease presentation? The answer lies in the chemical attachments that coat their DNA, upregulating the genes for Kallmann syndrome in one twin and preventing severe symptoms from hitting the other. These alterations to gene expression can be long-lasting as seen in this case where an epigenetic alteration went unnoticed until the onset of puberty.

Epigenetics is changing the way we think about gene regulation and inheritance as a whole. Overall, his book is an eye opening account into this new area of research for those who are not versed in the scientific world.

-Tara Dhingra, Biochemistry, 2012

VITAMINS AND depression

Being in college is quite a difficult task. The pressure from parental demands, living alone, and the arduous task of creating a path for your future can all be very overwhelming and can often lead to depression. But is there more to depression than a stressful environment, genetic inheritance or illness? Well, according to various studies, yes; there seems to be a definite correlation between vitamin deficiency and depression, especially vitamin D and Niacin B3.

The purpose of vitamin D is not completely understood, yet what intrigues researchers is that most tissues and cells in the body have vitamin D receptors, accompanied by the enzyme machinery that transforms inactive vitamin D into the active form. Their presence shows the importance of vitamin D to our body. Moreover, various studies have shown a correlation between vitamin D deficiency and depression. One study found that people who suffered from depression had a 14% vitamin D deficiency. In addition, a number of scientists removed the vitamin D receptors from various mice and found that these mice were less active, more anxious and had poor swimming abilities compared to the wild type. Moreover, in studies of seasonal depression- a condition that is diagnosed by the tendency of patients to become depressed in relation to the season of the year–it has been proven that the number of people who are depressed increases during the wintertime, due to an obvious decrease in the presence of sunlight in the environment. The sun is an important source of vitamin D; our body produces vitamin D when our skin is exposed to the sunlight.

Moreover, Niacin B3 has been associated with increased levels of HDL cholesterol in the blood. However, studies have proven that there also is a correlation between Niacin B3 deficiency and depression. Professor Andrew W Saul discussed this link in the documentary *Food Matters*. He explains that he worked with a young woman who was depressed, suicidal and uncommunicative. She was under the supervision of a psychiatrist and took prescribed medications. Despite these efforts to improve her livelihood, her condition remained stagnant. Out of hopelessness for their loved one, the woman's family contacted Professor Saul for advice; he recommended that they consider Dr. Hoffman's depression treatment, which suggested that the depress patient take an amount of 3000mlg Niacin B3. The young lady followed Dr. Hoffman's treatment for several weeks and soon after her condition improved. Her family, exhilarated by the recovery of their loved one, shared Dr. Hoffman's treatment with the young lady's psychiatrist. He discredited this method and insisted that the Niacin B3 might in fact be harmful to the woman's health. In response to the psychiatrist's warnings, the family halted the Niacin B3 treatment and soon after the woman sank back into depression. Based on these various findings and studies, many believe that vitamin deficiency and depression are correlated.

However, although certain vitamins seem to be beneficial in the treatment of depression, there are some findings that left scientist puzzled, especially in relation to vitamin D. For instance, vitamin D is incompliant with women in post –menopause periods. In one experiment, researchers supplied a daily dose of vitamin D to post-menopausal women with depression. In contrast to the examples provided in the previous paragraphs, the status of their mental health remained the same. These results were intriguing and brought new insights of the effectiveness of vitamin D, in relation to depression, to the surface.

Nonetheless, vitamins remain a proficient treatment to and prevention of depression. Thus, everyone should be aware that the recommendations from the Institute of Medicine for adequate daily intake of vitamin D are 200 IU for children and adults up to 50 years of age, 400 IU for adults 51 to 70 years of age, and 600 IU for adults 71 years of age or older. However, most experts agree that without adequate sun exposure, children and adults require approximately 800 to1000 IU per day. And the recommended daily allowance of niacin is 2–12 mg/day for children, 14 mg/day for women, 16 mg/day for men, and 18 mg/day for pregnant or breast-feeding women.

Furthermore, it is true that certain circumstances, such as stress, surroundings, illnesses, and genetics are significant contributors to depression and this article does not advocate the use of only vitamins as the only way to treat depression. Nonetheless, if next time you feel unnaturally down, consider a walk to soak up some sunrays, and if that seems a bit out of reach, make sure to load up on your daily dose of vitamins.

-Wilize Maleombho, Behavioral Neuroscience, 2013

NU Professor and Author

Laurie Edwards shares her views on writing in the health field

NU Science had the opportunity to sit down with Laurie Edwards, a professor in the English department of Northeastern University, to discuss her writing in the health field. Her first book, *Life Disrupted: Getting Real About Chronic Illness in Your Twenties and Thirties*, explains the challenges faced by young adults who have chronic disease.

Edwards, who earned a B.A. in English from Georgetown University and a M.F.A. in Nonfiction from Emerson College, developed the concept for this book as part of her master's thesis. The work is comprised of a blend of patient narratives and research about people's experiences with chronic illness. As a writer with an interest in health science and a person who has directly dealt with chronic illness, Edwards was able to speak to a specific audience about this issue that affects a significant number of Americans.

The author is currently working on a second book that will have a heavier focus in research. This work, tentatively titled *The Night-Side of Life: The Uneasy Emergence of Chronic Illness in America* explores the changing role of sickness in today's world. As a result of the development of vaccinations, infectious disease is not as much of a threat in modern society as it was in the past. Edwards explained that due to these scientific advancements, "people are living long enough to develop chronic disease and lifestyle-related illnesses such as cardiovascular disease."

This second book discusses the role of patient advocacy in health care. Edwards specifically cited HIV/AIDS advocacy in the 1980s; she explained that this pivotal example was groundbreaking in its encouragement and support for "breakthroughs and treatments… their push for the triple drug cocktail ushered in what we know as modern day patient advocacy." According to Edwards, the book details how, "Science, technology and culture have all worked to shape the experience of being a patient."

Edwards stated that this second book is targeted towards a more mainstream audience, as opposed to her first book, which she wrote for a specific population of people affected by chronic disease. The author discussed the challenge of writing for a mainstream audience about a technical topic, stating, "The hardest part is making a lot of the research accessible."

Edwards utilized the increasingly important role of technology in the health and science journalistic field by creating a blog about chronic disease, achronicdose.com. This blog served as a way of establishing a foundation for her first book on coping with chronic illness. The author elaborated on how she has been able to experience the benefits of networking online. "I've followed a lot of people on Twitter and on their blogs and it has landed me in these beneficial situations; I got a phone call out of the blue a couple of years ago to go to New York and sit at a round table with Former President Clinton to talk about health care reform, and I suspect this was because a tweet of mine ended up in a New York Times column."

-Elizabeth Gilbert, Health Science and International Affairs, 2013

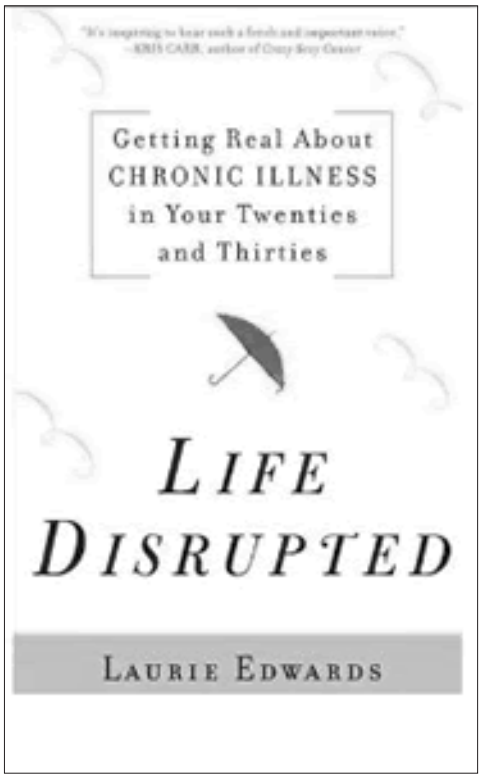


Photo courtesy of amazon.com and Laurie Edwards

When asked if she had any advice for NU students interested in pursuing a career in scientific journalism, Edwards offered the following tips:

KNOW THE SCIENCE

"There's a lot of potential for science writing with the way digital technology is going, there are a lot more avenues beyond straight print. Be willing to go beyond press releases, look at the journal articles. Don't be afraid to actually call up the study authors and say that you are writing an article and would love to get a quote. People love to talk about their work, use that to your advantage. As long as you are polite, don't be afraid to ask for interviews."

DO YOUR HOMEWORK AHEAD OF TIME

"When you are going to interview people and write articles, try to be as much of an expert as you can be, because it is really obvious to the people you are interviewing if you have done your job or not. It will help you go far if you show up with well-prepared questions and you are knowledgeable about the data. Don't be afraid to dig deep and know the science. Northeastern grants you access to thousands of journal articles so use all those tools. And read- the New York Times Health Section, Time Magazine, your local newspaper, they all have health and science sections that will help you keep your finger on what is going on in the field."

GET CLIPS AND BUILD YOUR PORTFOLIO

"When I first started out, I wrote dozens and dozens of health articles for health companies and related Web sites. The pay wasn't the best, but it was great experience and helped me build my portfolio. Eventually, I parlayed that experience into writing about health for national outlets, like the Boston Globe, The Boston Globe Magazine, Glamour, etc. Those bylines helped round out my body of work, and helped me land my first book deal. These days, with so many Web-based publications and social media avenues, there are even more ways to get bylines and clips."

KNOW ALL THE OPTIONS OUT THERE ONCE YOU GRADUATE

"For instance, there are Master's programs in health communications, Master of Science in journalism degrees where you can specialize in fields (like health/science), etc. What's more, many biotech, Pharma, and other consumer health care and life sciences companies regularly seek people with Master's degrees and PhDs in the sciences (MD, MPH, etc) to serve as full-time writers."

BE WILLING TO ASK QUESTIONS YOU GENUINELY DON'T KNOW THE ANSWERS TO!

"This is how I started on the path to my second book, *A Social History of Modern Chronic Disease*. I asked questions like: the definition of chronic disease hasn't changed but the scope of conditions that are now considered chronic has; what are the consequences of that for patients? Will patients with chronic illness ever mobilize over universal goals the way disability rights, civil rights, and other disease-specific rights groups did?"

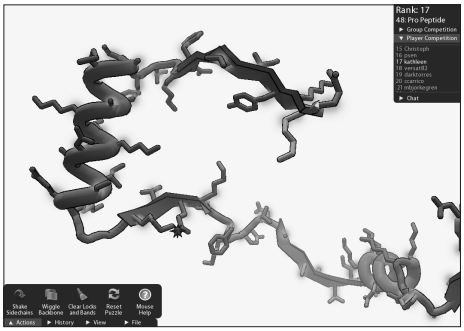
foldit

The internet has long been a powerful force for connecting people and ideas, a fact that has become more significant in recent years. In one amazing story, researchers at the University of Washington were able to utilize online-gaming in order to develop a major breakthrough in the fight against HIV. Utilizing the web game "Foldit," players without scientific training were able to discern the structure of retroviral protease, a protein vital to the multiplication of the virus. The scientists involved were able to crowdsource elements of their research that would have been impractical to do either personally or through computer simulations. This isn't a singular instance, either; researchers in a wide variety of disciplines are turning to the online community for help.

The game Foldit's greatest benefit lies in that it provides scientists with an accurate way to garner predictions about protein structure. Proteins consist of long chains of amino acids that fold in upon each other to create a shape consistent in every example of that protein. This shape will be the most stable form possible. However, although the same set of amino acids will fold identically every time for a given protein, there is no practical way to predict what that result (what shape/configuration?) will be. Computers currently lack the requisite spatial reasoning and problem solving skills, and so a programmatic solution has yet to find a solid place in protein research. Human participants, who excel in those areas where computers fail, are tapped for their creative potential. These people compete in the game to find out which shape (out of a huge number of possibilities) seems most likely.

Why is the structure of a protein significant? The form determines which amino acids will be folded into the interior of the protein and which will be exposed for interaction with other molecules. The exposed amino acids will decide how the protein works: what it will bind to and how it will react with other molecules. If players are able to create a sufficiently accurate model, scientists gain an infinitely better understanding of how the protein functions. This knowledge means that they can much more easily design a molecule to neutralize some disease-causing protein in the body.

Foldit has been discussed several times in scholarly papers, as well as in many news articles. Its applications to specific proteins related to diseases such as AIDS, cancer, and Alzheimer's,

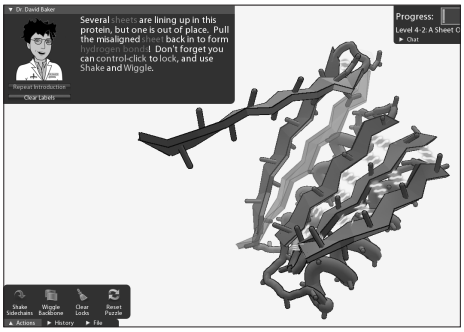


all of which are caused in some part by various proteins, have the potential to be extremely helpful to scientists. Cancer is often accompanied by damage to the p53 tumor suppressor protein, which checks cell growth, while accumulation of protein fragments in the brain might be a possible cause of Alzheimer's. A better understanding of proteins, fueled by Foldit, could help researchers develop treatments for these illnesses. In addition to this, by studying *how* players solve specific puzzles, Foldit contributes data that can be used to improve computational methods of predicting protein structure. The site reached its greatest visibility this past September with the publication of the paper by the University of Washington detailing the site's contribution to finding the structure of retroviral protease.

The scientists turned to Foldit after various other failures to determine the protein's form, and even then, they didn't find immediate success. Their original challenge on the site was poorly defined, causing all teams' submissions to look largely similar. Each group initially went for the "easy" model, focusing on the most efficient solution, the one with the lowest energy cost. In the next stage of the competition, however, a greater degree of experimentation was encouraged. (how was experimentation encouraged? Was there a new parameter introdued?) This new focus, which better engaged participants, led to more diverse, accurate models.

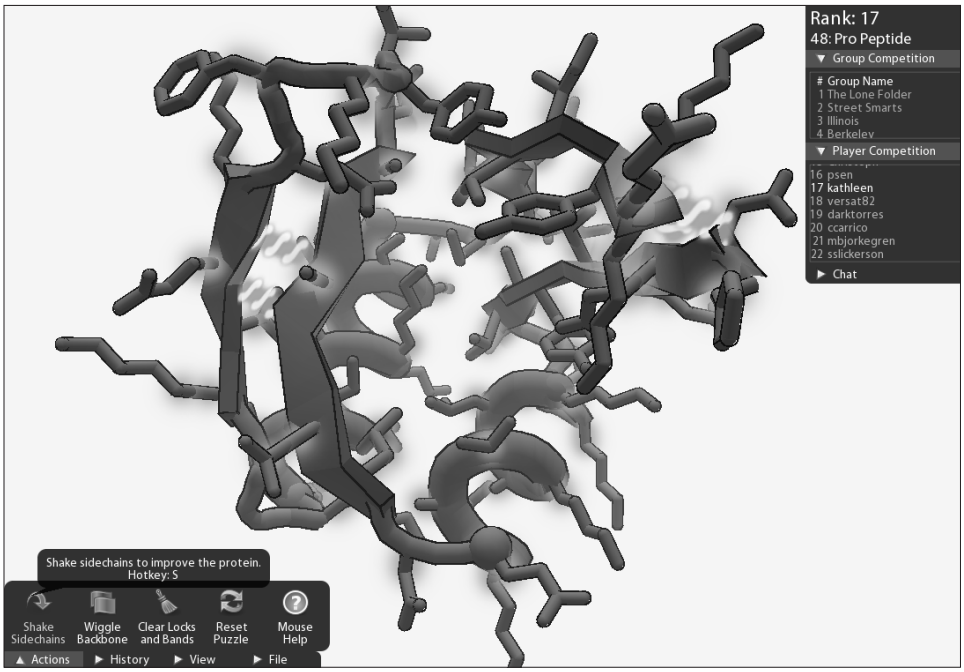
Three weeks after it began, the competition ended and the researchers took the results back to their lab. In a wonderful turn of events, the gamers' models were so precise that the team had a scientific model of the protein after just a few days of work, something scientists had been seeking for the past decade by traditional means. From this model, they could discern possible sites where drugs could attach and deactivate retroviral protease, potentially stopping the virus from multiplying. Such a treatment would be a powerful weapon in the fight against HIV/AIDS.

Although any actual treatment from this breakthrough is still years away, its impact on how research is being conducted can already be seen.



Discovering the structure of retroviral protease is one of the first major victories for what is being called "citizen science." This growing force allows those who do not necessarily have a scientific background or professional involvement with the study, to offer critical assistance with research. Much like the way that citizen journalism spreads many aspects of the field out to individuals through the Internet, citizen science relies on the web to

Photos courtesy of fold.it



connect people who want to help out. These amateur scientists offer a number of benefits over traditional research assistants. Instead of overloading one person with tedium, simple or repetitive tasks can be spread out to a much greater number of people, each of whom only has to do a small share of the work. Also, researchers can take advantage of citizen scientists around the planet in order to efficiently gather data on large-scale phenomenon in a way impossible for small teams. These perks allow even those projects with a modest budget to work with the resources and precision of more prominent ones.

One website used to coordinate citizen science is SciStarter.com. The site allows researchers to post descriptions of simple tasks that everyday people can do to assist their experiments. A user's simple search can turn up a whole host of projects in any field of interest. The vast majority of projects require no expense by the individual and are simple, often enjoyable activities. A participant might do things such as documenting specific wildlife while on a nature hike or, like Foldit, solve molecule configurations while playing a game. Other listings might request individuals to go over photographs of the night sky looking for celestial bodies such as comets. Everyday people working for one such project, SOHO Comet Hunting, have discovered almost two thousand new comets since initiating the program thirteen years ago. Many of these finds were first identified by people without formal scientific credentials. Another way to participate, perhaps the most passive, is through distributed computing. One simply gives researchers access to their computer's processing power when they aren't using it, allowing a computationally expensive task to be completed more efficiently. There are enough ways to help out research that anyone could find something they're interested in.

Another such site, CitizenScienceAlliance.org, emphasizes the wonderful educational perks of citizen science. When ordinary people get involved, it increases both their awareness for the scientific process and their enthusiasm for research. Children, in particular, stand to be profoundly impacted by early exposure and inclusion in real science. At a time when many believe America's children to be underperforming in science, these activities provide a great opportunity to interest them in actual research and provide them with enthusiasm to take back to the classroom. Both groups hope that, potentially, their involvement could lead them to pursue and scientific education and more formal research.

Groups such as these, as well as the Foldit community, are beginning to receive recognition for their work. The University of Washington paper noted that "this is the first instance that we are aware of in which online gamers solved a longstanding scientific problem." Undoubtedly, it won't be the last. Science for Citizens, the group behind SciStarter.org, was recently praised for their participation in the 2011 Maker Faire, a weekend science and inventing event in New York City. There, they provided a number of experiments designed to peak children's interest in science, such as analyzing the impression of a mastodon fossil. The event was well received for its focus on involving young people in the scientific process.

It seems clear that everyday people will continue to have an impact on scientific advances. Games such as Foldit and organizations such as Citizens for Science are phenomenal developments in ways to simultaneously conduct active research and interest people in various projects. Hopefully, an interconnected human population can drive scientific progress forward.

To learn more about Foldit, visit www.Fold.it To get involved in citizen science, visit www.SciStarter.com or www.CitizensScienceAlliance.org

-Michael Murray, English and Computer Science, 2014

TEDxWoodsHole: XPlorations!

When I got off the bus in Woods Hole on October 15th, the wind was whipping at a blustery 30 miles an hour and there were white caps proliferating in the harbor. Salty spray littered the sidewalks around the docks along the path to the Lillie Auditorium at the Marine Biological Library (MBL), and the sounds of the waves crashing and wind whistling seemed to increase the permeability of my sweater to the chill in the air. But the tangible swirling of the elements would hardly be able to top the incredible wheeling and churning and diffusion of lofty ideas and goals that was about to envelop me.

I was about to take part in TEDxWoodsHole 2011. TED is a non-profit group that is committed to giving a platform to "ideas worth spreading." The TEDx division refers to the independently organized events held throughout the country to locally support the group's goals and to bring developments of innovation in technology, entertainment, and design to as many people as possible. This conference was developed around the theme of explorations, particularly concerning marine and environmental topics. It was skillfully assembled by individuals at both the MBL and at the nearby Woods Hole Oceanographic Institution (WHOI) and featured a wide variety of lectures, art, and musical selections, not to mention a fair amount of intellectual conversation and idea exchange between performances and at the reception.

The day opened with a lecture by Dr. Max Holmes, a senior scientist at WHOI, who studies feedback loops in response to climate change and the hydrologic cycle in the Arctic, as well as global carbon flux and river biogeochemistry. He was speaking about one somewhat eccentric but theoretically sound idea about how the reintroduction of mega-fauna to regions in the Artic could help reduce the amount of carbon dioxide that enters the atmosphere each year. An

amount of CO_2 is trapped in the soil and can be released as the ground is warmed by the sun. During Artic winters, the regular amount of snow tends to insulate the ground, allowing it to remain warm and for CO_2 to leach out. Millions of years ago, however, when there were a significantly higher amount of large mammals in the region, large portions of the snow would be packed by their hooves as they herded across the region. By packing the snow they increased the propagation of the cold temperatures to the permafrost and slowed the release of CO_2 stores from the soil. It is thought that by reintroducing mega-fauna, such as bison, to the region, scientists may be able to recreate this natural phenomena.

From here, legendary oceanographer and marine conservationist, Dr. Sylvia Earle, took the stage, cautioning all present on the dangers facing our oceans. She urged the scientists present to make use of every tool at their disposal to educate the public on the plights of trawling, over fishing, pollution, and unprotected areas. In her inspiring talk she alluded to the fact that we know more now than we ever have about the devastation we are unleashing and the detriment it has to natural ecosystems and it is our essential duty to make the necessary changes to preserve our waters, which are our world's lifeblood. Both brilliant and savvy, Dr. Earle hinted at the intellectual black out in Washington and the ignorance policy holders currently have regarding environmental affairs.

A fitting follow up to this was a lecture by Dr. Diane Cowan, later in the day, founder of The Lobster Conservancy in Maine. Dr. Cowan spoke of how she accomplished the seemingly impossible, by fostering a mutually beneficial relationship between local lobstermen and scientists to create a healthy lobster fishery in the Gulf of Maine. The group is now thriving in its ability to educate both fisherman and the local communities on the benefits of studying the life habits of eggers (female lobsters capable of reproducing) and why it's important to have certain take regulations.

There were also some incredible art and music presentations throughout the day, including a preview of a new piece by composer Gregory Brown and performed by New York Polyphony entitled, "Missa Charles Darwin: Evolution in

Music." He explained how he created the piece, transposing a fragment of the DNA from Darwin's finch into notes and using the common genetic principles of insertions, deletions, and mutations in the chord progressions and different voices in his piece. It was a beautiful arrangement, carefully juxtaposing texts from the *Origin of Species* with classical hymns, to create a dialogue between the beliefs of the church and theories of science.

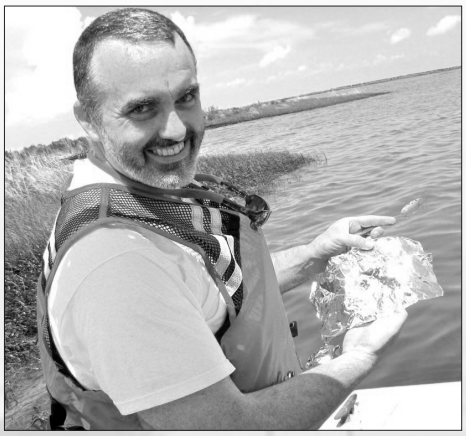
Perhaps the most hilarious presentation of the day came from Dr. Chris Reddy, also a researcher at WHOI. Dr. Reddy is a chemical oceanographer who has been studying the contamination resulting from the Deepwater Horizon spill. He

spoke on the importance of being passionate about your research while being dispassionate in your delivery of the results to the public by using clips from Star Trek and the professionalism of Spock. In one memorable quote, advice is given to, "Be like Spock, stop thinking with your glands." What timely and intelligent advice, when scientists need to educate the public on the facts alone free from bias, even when the results can trigger important emotions concerning policy and inaction. Our duty is to collect the data as accurately as possible and to present it as precisely and with as much clarity as the medium allows.

There were also talks by Ben Thayer, creator of the BioBus, a converted 1970's transportation bus, equipped with solar panels, a wind turbine, and a roof garden, that drives around inner city New York and other areas educating children about science and the natural world. Artist Colleen Flanigan presented about her immense and beautiful metal sculptures, particularly a double helix model that will be set in the ocean to provide a platform for coral growth. There were talks on using oysters to alleviate nitrogen concentrations in Cape Cod, about the mechanisms octopuses use in their impressive ability to camouflage themselves, and about an art collaborative that seeks to create a global, virtual ocean.

So what did I learn at this conference? First and foremost, while there are a lot of problems out there, there are also a lot of inspired people who know how to make a change. It is our job and responsibility as scientists to methodically explore the world and to learn as much as possible about the systems around us, but there is also much we can do to employ creativity and innovation to convey these results and act upon them. It was important and inviting to see such dynamic,

Photos courtesy of TEDxWoodsHole



intellectual leaders in their respective fields engage one another and collaborate across the boundaries of research and art. It was inspiring and fulfilling to hear of their individual successes and to be encouraged by such a diverse group of speakers to seize on what you are passionate about and work from there. There is no cookie-cutter way to make a difference, but by being educated in the problems and attacking them creatively and ambitiously, you are sure to have an impact.

-Kristina Deak, Biochemistry, 2012

COLD CASE:

Review of Museum of Science Lecture on Curing the Common Cold

The Gordon Current Science and Technology Center, located inside the Museum of Science in downtown Boston, is home to daily 20-minute lectures about new advances in science. Every three weeks, the lecture changes to showcase a new topic. This month's topic: Curing the Common Cold.

Every fall and winter, we throw on our winter coats and prepare for snow, ice and of course… cold and flu season. This inconvenient time of year manages to find its way around every preventative treatment out there. One would think that with the advances in this day and age, that we would be able to find the ultimate treatment to the common cold. And finally, we have.

The reason that a discovery like this has taken so long is because we've been dealing with viruses that copy their RNA so fast that their mutations allow them to get around the body's self defenses and multiply themselves. Viruses are so difficult to fight because they get inside our cells, whereas bacteria hang outside. So it's difficult to wipe out a virus without wiping out the entire cell. Julia, the speaker of this lecture, took us through what antiviral medicines entail. A normal flu vaccine covers an average 5 to 6 strains of the flu, though there are more out there, and their job is to bind and block a specific part of the virus, and then boost the immune system by putting it on high alert. But viruses are smart, and able to mutate in order to get around these defenses and continue multiplying and infecting.

At the MIT Lincoln library, virologists have been hard at work trying to create an effective and long-lasting antiviral medication that would serve as a broad-spectrum treatment. Their hours of dedication lead to the birth of DRACO, or Double Stranded RNA Activated Caspase Oligomerizer. DRACO's job, once in the body, is to get into the cell and bind to double-stranded RNA. Double stranded RNA is not made in healthy human cells, but by viruses. DRACO goes into all cells in the body to check for double stranded RNA. If DRACO locates these cells, it binds to them and then activates a pathway so that they can self-destruct. DRACO not only works against viruses bound to double-stranded RNA, but to DNA based viruses as well.

DRACO was first tested in 11 different types of human cells. Scientists got as far as they could with those cells and then switched to testing on mice. They tested toxicity levels as well as what organs DRACO reached. It turns out that when injected with DRACO, it reached all organs of the mice, and lasted for 2 days. The mice were then injected with a virus, such as H1N1, to see if DRACO would work to effectively remove the virus from their system. All of the mice survived, and did not look visibly sick at any point during the treatment.

The pathways that DRACO initiates are different than what viruses are used to, which is why it has been tested and proven to work in 15 different viruses. DRACO effectively killed viruses of the common cold, the flu, fevers, and stomach viruses to name a few. It is anticipated that with more work on DRACO, it can be used to kill deadly viruses as well as any new viruses that may come along.

DRACO is still being tested on mice, and is not likely to be seen on shelves for a while. Many more tests need to be run on mice as well as other animals. The FDA wants to see multiple models, and proof that DRACO works. Several years will be needed to test humans as well. The virologists at MIT are hoping to get picked up by a large pharmaceutical company, in order to carry out the rest of these tests and studies at a larger scale. But once proven, DRACO will be able to be used as both a preventative method as well as a treatment. It can be taken up to two weeks ahead of time, in order to prevent contact with a virus. In a work setting such as an emergency room, health care workers would be able to take DRACO to prevent exposure. DRACO could also be taken therapeutically, on a daily basis.

So the answer is here. It's only a matter of time before DRACO will be a member of every household's medicine cabinet, and cold and flu season will be a thing of the past!

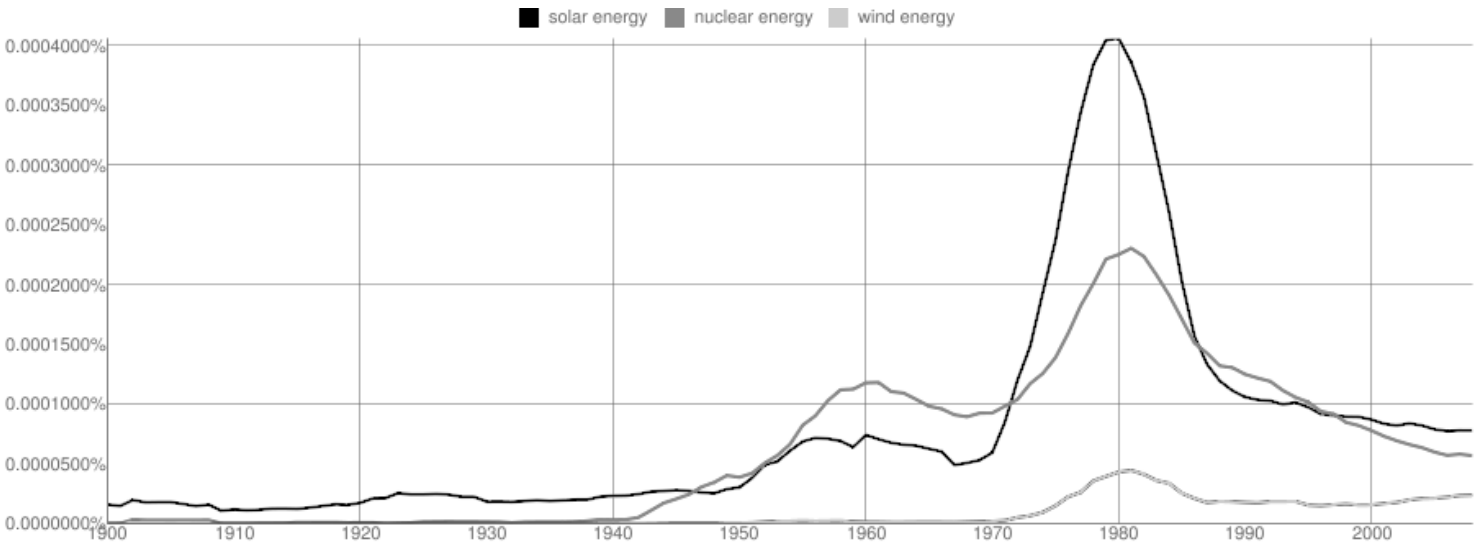
-Taarika George, Health Science, 2013

Google Ngram

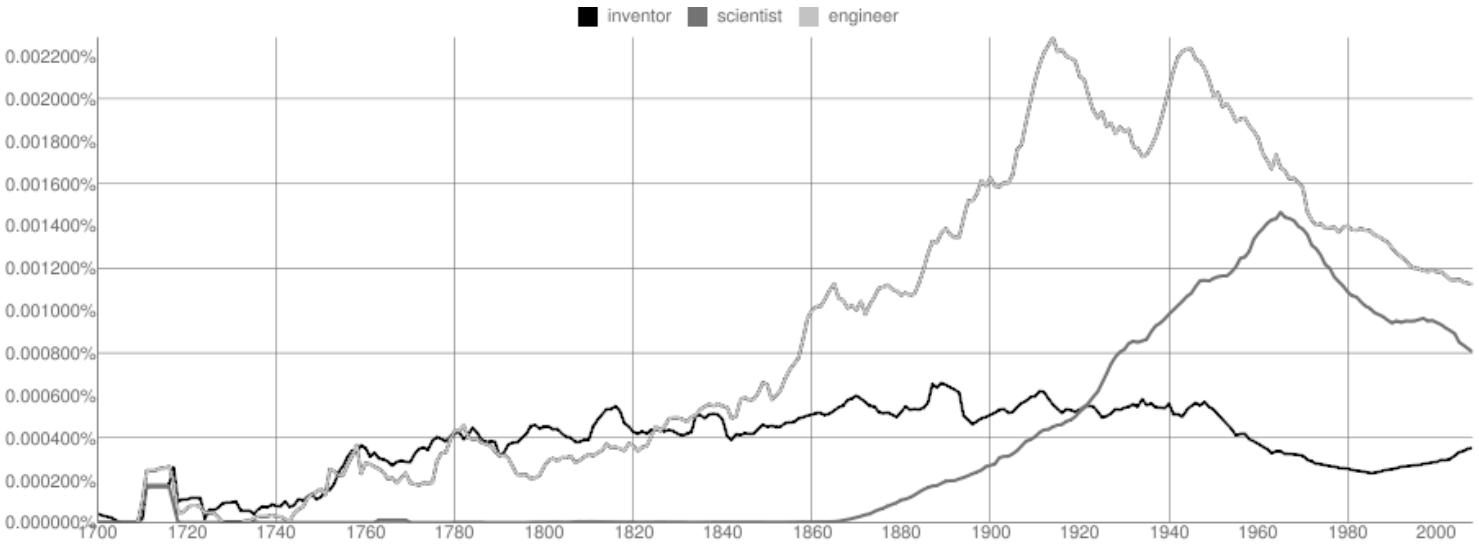
Tracking trends and ideas throughout history

Google Ngram is a new search feature developed by google. It searches over 12 million books in the google books library and plots the frequency of the word used over time. It is a new and innovative way to track changes in trends and ideas.

-Brad West, Chemical Engineering, 2013



The energy crisis in the 1970s led to an increased interest in renewable energy during the 1980s.



Much innovation that in recent years is due to the work of groups of scientists and engineers, sole inventors are not as prominent as they once were.

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