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Imagine a future where Navy divers can dive deeper than ever before, managing the cold and the pressure without bulky equipment. They can see and hear through the dark and murky waters using bionic enhancements, trick the enemy by disguising themselves as fishes, swim faster through the use of exoskeletons, and heal themselves at these depths. It's not too far-fetched after I watched the video of the inspiring Dr. Sarah Chapman, the program officer of the undersea medicine program in the Office of Naval Research. In the video, Dr. Chapman discussed her goals in the field of underwater medicine and how she hoped to turn us, mortals, into a superhero, who can endure being underwater for a long duration. While people may bring up the counterargument that we do possess this ability via artificial equipment, Dr. Chapman discussed her vision which involves a way for humans to seamlessly transition from land to sea, without the use of artificial equipment, allowing us humans to be agile and independent underwater. Dr. Chapman also discussed many interesting and insightful research ideas such as an augmented reality heads-up display, which solves the problem of visibility underwater, caused by the darkness and murkiness of underwater environments. This newfound visibility will allow divers and other people to traverse the underwater regions with ease. Furthermore, it's interesting that Dr. Chapman wanted to expand on the applicability of the technology by increasing its utility. For example, being able to make the augmented reality device display the diver's health conditions in addition to providing more visibility. This creativeness and versatility of Dr. Chapman are what inspire me to choose biology in general and undersea medicine in particular as my STEM area of research.

In addition, I really enjoyed Dr. Chapman's unique thinking with the idea to utilize oxygen already present in the water rather than carrying oxygen in tanks. Previous attempts have turned out unsuccessful as people were trying to mimic gills that extract the free molecular oxygen in the water. This doesn't work for humans as gills are designed for fish! Fish are much smaller in nature, which is why gills provide them with a sufficient amount of oxygen. However, humans are much larger in size so the amount of oxygen that gills generate does not scale up to what is needed for our metabolic processes. To solve this problem, Chapman utilized electrolysis to separate oxygen from water. This fixes the issue of not having enough oxygen when diving. This unique and innovative solution created by Dr. Chapman inspires me to think outside of the box and reminds me that science is not one straight path, rather it is a path with lots of twists and turns, failures and successes, that eventually result in an idea coming to fruition. This is proven by the fact that Dr. Chapman's revolutionary idea still has some problems that need to be tackled. For example, Dr. Chapman highlighted that researchers still have to tackle the limited usability of electrolysis as this is commonly done using ultrapure water, it needs to be improved to deal with murky water.

Dr. Chapman studied and observed marine mammals. She looked at how they breathe underwater. This is because marine mammals share similar metabolic demands as humans (this field is known as comparative physiology). She is looking for ways how humans can use similar techniques that marine mammals use. This field of study is still under development, however, the idea seems very promising and it will be interesting to see how it plays out in the future.

Dr. Chapman discussed a unique and revolutionary idea involving organisms already present in our bodies, called microbiomes. The human body's mass is 60% bacteria which forms a symbiotic relationship with our skin. These organisms can be genetically engineered to respond to changes in the environment, essentially forming a microbiome with the capability to adapt to changes in temperature. Dr. Chapman discussed that this bacteria could potentially be used by divers and navy personnel in cold wet environments which can trigger a reaction that causes these bacteria to generate heat. This idea is extremely promising and its utility would serve to save lives. This is because navy divers are often in deep areas where temperatures are extremely cold. On top of this, the environment can also be quite dangerous which can often lead these divers to experience tears in their drysuits. This is extremely dangerous as the diver is subject to extreme temperatures and, if not counteracted immediately, can be fatal.

This idea revolving around microbiomes in undersea medicine was the one I personally found most interesting and revolutionary, hence it is the topic that I decided to pursue on my own and do more research on. By exploring scholarly articles and sources online, I was able to find numerous other applications and unique ways other people were using microbiomes to help provide humans with benefits and advantages in certain environments. One such way can be seen in the research done by the Defense Advanced Research Projects Agency (DARPA) ReVector program. This is a program that was formed to help preserve the health of military personnel who serve in areas dominated by the mosquito-borne disease. Recently, a team was awarded 15 million dollars for their research in creating a mosquito repellent based on the skin microbiome. The team plans to utilize the human skin's own microbiome to create a Live Biotherapeutic Product (LBP). This product will serve to prevent human chemicals from being emitted from the body that typically attracts mosquitoes. This will simultaneously repel the insects away from the warfighters in the area. Typically, the microbiome on our skin serves to protect us from skin-related diseases, however, the microbiome also emits a unique odor that attracts mosquitoes. The team is studying our skin's microbiome in hopes of engineering a "sunscreen" like a product that can be applied to one's skin and instantly provide protection against mosquito bites. The application of this technology is immensely beneficial as mosquito-borne diseases are some of the most deadly (such as malaria and the zika virus) so being able to utilize microbiomes to repel the vectors of the disease itself is revolutionary and amazing! This technology will save countless lives of men and women who sacrifice their lives to serve and protect us abroad. The technology can also be extended to civilians in order to improve public health. Further research of the technology can also be used to protect humans from non-mosquito-based diseases like Lyme disease (caused by ticks) and sleeping sickness (caused by the Tsetse fly).

However, the applications of microbiome-based technology do not stop there. Microbiomes are actually being used to serve as an early warning to nerve gas exposure. The genetically engineered microbiomes can act as a sentinel due to their highly responsive nature, enabling it to diagnose warfighters who have been exposed to nerve gas early on, before the damage becomes too severe. Furthermore, microbiomes can be used to identify stress in warfighters. This is due to the fact that prolonged exposure to physiological stress has been shown by research to cause changes in one's personal microbiome composition. Recent research has been done where the microbiome has been modified by having

warfighters utilize a fiber-rich diet to increase resilience to common military stressors such as lack of sleep, prolonged physical activity, etc.

From these advances in microbiome-based research, we can see how Dr. Chapman's work in microbiomes to create temperature adaptations in harsh underwater environments is being used in different applications by scientists all over the world. This really inspires me to one day use my passion for biology to conduct research that contributes to the safety of our warfighters. I plan to use modern technologies like computational biology, synthetic biology, genetic circuits, and gene editing using CRISPR to create biosensors out of the microbiome and interface them with devices like the Augmented Reality Helmets so that the warfighters and their command and control centers have a real-time view of their health statuses. In addition, these genetically modified microbiomes can be used to generate appropriate responses (generating heat, creating antibodies, etc.) to ensure the safety of our warfighters.

In the future, I hope to pursue a career where I can study the body's microbiomes and apply the concepts I have learned from Dr. Chapman's video and my own personal research to solve various issues faced by our warfighters and the general public. I would like to thank the Naval Horizons for this opportunity and for Dr. Chapman's enlightening video which has inspired me to one day follow in her footsteps as a researcher for the U.S. Navy and our Armed Forces.