Jade Ormond

Mr. Tynes

AP Computer Science Principles 6B

20 February 2018

# How Biomimicry Is Used In Medicine

Biomimetics or biomimicry is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems.[1] Hence by imitating nature's forms, scientists have been creating new devices to help keep humans healthy. For example porcupine quills are special due to their ease of entry, yet difficult extraction. Scientists believe the quills could be the key to less painful needles for injections and also better internal adhesives. Researchers are already creating adhesive patches with barbed quills on one side that provide good adhesion as well as easy removal by imitating the regular needle for injections the porcupine quill is creating a more effect way to go along with injections.[2] Replicating the overlapping scales in sharkskin known as dermal denticles (Shark skin is covered by tiny flat V-shaped scales known as dermal denticles). The "denticle" technique is being used at many hospital to help fight bacteria growth in patients.[2] Elephant trunks contains 40,000 muscles, making it incredibly strong, even though it has no bones. Scientists used this discovery to develop a new bionic arm that can help the handicapped or assist with heavy lifting in the agriculture business.[2] Muscles have the unique ability to attach to wet, solid surfaces like rocks, fish, and boats and muscles also are able to withstand strong wind and waves. The medical industry has made mussel-inspired adhesives made of soy to help in surgery.[2] The sandcastle

worm lives in a mineral shell that it creates by secreting a glue-like substance that sticks to bits of sand. The substance doesn't dissolve in water, and is able to replace water, and solidifies itself immediately. These properties appealed to medical professionals by creating a new ways to repair broken bones. Doctors have been treating shattered bones with screws and pins which aren't always proven to effective, but with the sandcastle worm fixing broken bones will become more effective.[2] The skull of a woodpecker endures a lot of force, but fortunately the bird has a curved body and tail to brace the impact and a strong, oversized beak to protect the brain. These findings could potentially lead to better shock-absorbing helmets, earthquake resistant buildings, and more focused and efficient jackhammers for construction workers.[2] Researchers discovered that the veined wings of a Clanger cicada are the first known example of a natural biomaterial that destroys bacteria on contact. The wings use their own physical structure, not helped by biological or chemical agents to tear bacteria apart. Researchers are trying to mimic these properties to create a new antibacterial material.[2] Hydrophobic surfaces are used when a product needs to allow air to flow through an opening but can't let liquids such as blood or water into it. By putting in a single piece of hydrophobic membrane on an opening it does exactly that.[3] However if the liquid has low surface level like oil or soap the hydrophobic surface will have little to no effect on the opening to keep out liquids. However there has been a discovery that can block out the oils from entering an open wound. The substance is called oleophobic membrane and oleophobic membrane is what has the ability to keep out lower level surfaces oils would be repealed from the surface just as water is when using a Hydrophobic surface.[3] Termites are infamous for creating some of the most elaborate ventilation systems for cooling and producing higher oxygen counts when using a medical on the planet.[4] Even in some of the

hottest places, these termite mounds, remain exceptionally cool inside and transmet a constant flow of oxygen out of the many holes. Mosquitoes have a particularly unique mouth in comparison to the porcupine.[4] The mosquito nedal is composed of several moving parts that work into skin and provides the minimum amount of pain. Medical developers at Kansai university created a similar mouth on a nanometer scale. A needle that pretrates like a mosquitoes mouth, but still using pressure to painlessly glide through skin.[5] The shark skin ability to completely avoid and parasite or bacteria Sharklet Technologies a biotech company, has figured out a way to utilize the shark skin specifically on the way parasites and bacteria can't stick to sharks. Which is caused by the denticles a v-shaped pattern of the skin's surface.[6] Scientists have figured out how to print the pattern onto adhesive film, and fight off bacteria. This product is ideal for usage in places like schools and hospitals where germs easily spread. Popular Science reported "The film which is covered with microscopic diamond-shaped bumps, is the first "surface topography" proven to keep the bugs at bay. [6] In tests in a California hospital, for three weeks the plastic sheeting surface prevented dangerous microorganisms, such as E. coli and Staphylococcus A, from establishing colonies large enough to infect humans."[6] With the concern of the spread of H1N1 as well as general concern about staph infection and other bacterial diseases that seem to spread rapidly in hospitals and in the general population, this material could offer an incredible solution to stopping wild spreads. CEO Joe Bagan states, "We think they come across this surface and make an energy-based decision that this is not the right place to form a colony." [6] And PopSci points out that because it doesn't kill the bacteria, the risk of microbes evolving resistance is slim to none. Sharks are one of the oldest creatures on the planet and they've evolved to be essentially perfect in many ways.[6] Their skin has also been

used to create other biomimicry solutions to problems such as aerodynamic cars and also famously for swimsuits worn by Olympic swimmers. And with biomimicry playing a role in the medical field the research on bone superglue inspired by the sandcastle worm being just one example  provides the shark skin more significance to use. [6] Finding a way to replace antibiotics so bacteria is susceptible to die seemed to finally come around. Bacteria has evolved into many different diseases and infections that affects the body in different ways and humans way to combat the bacteria has seem to be diminished. Antibiotic resistance is a major threat to global health and researchers have struggled to identify new antimicrobial compounds to stop and defeat bacteria.[7] By the late 1990s the bacterial reservoirs that's proven to be clinically useful antibiotics had sprung appeared to run dry and lose its effectiveness towards killing the bacteria. As bacterial genome sequencing became more widespread in the last decade researchers discovered many potential sources of new drugs hidden in these genomes (the haploid set of chromosomes in a gamete or microorganism, or in each cell of a multicellular organism). However, finding a way to take them and use them in the medical field is what hinders the process.[7] (View exhibit 1 for the following reference) The bacterium Streptomyces coelicolor produces a variety of novel compounds when grown in combination with other bacterial species that already found the throat ( the most common place Streptomyces coelicolor is found)  and these interspecies interactions result in differences in colony development and pigment production when viewed under a microscope.[7] To help counteract the epidemic research has found a new way to create an antibiotic with several different kinds of animals and plant life to assist in the medical field. The Komodo Dragon is a toxic filled lizard that may be one of the many results in research to help provided a new "Super antibiotic" that will be more useful than

any other previous methods used by professionals. “Natural antimicrobial peptides are found pervasively in life on this planet,” Bishop says. “It’s one of the most primitive immune systems; even bacteria use antimicrobial peptides against other bacteria.” Animals that live in microbially challenged areas are more likely be fight off or not succumb to any infections.[7] The lizard could be expected to harbor numerous and varied antimicrobial peptides because of their habitat is microbially challenged. Alligators for example live in swamps infested with microbes and regularly sustain injuries from other gators and seem to never die due to any sort of infection which is related to the lizard. Komodo dragon has been thought to harbor dozens of species of potentially harmful bacteria in its saliva.[7] The giant lizards damage their gums as they attack prey, eat carrion, or fight each other, and those oral bacteria make their way into the animals’ bloodstreams with intent to kill by a slow death. Despite regular exposure to pathogens, these reptiles rarely succumb to infection because of there immunity to the bacterias they secrete through the gums. “This year alone the influenza vaccine has been 36 percent effective against the flu, according to a report released Thursday (February 15) by the US Centers for Disease Control and Prevention (CDC)”[8] The 2017-2018 flu season has been particularly server especially when dealing with young children. Already 63 children have died three-quarters of the children were not vaccinated. Building a new vaccine that won’t cause death when using it and will only cause slight sickness as the predecessor did with Komodo Dragon gum substances is the new challenge researchers face. “It has been an especially challenging season, with high rates of hospitalization for both influenza and its complications. . . . Many schools have closed in an attempt to control the spread of the illness and doctors’ offices are packed with patients seeking diagnosis and antiviral treatment.”[8]

[1] Parker, Laura. “Inspired by nature: the thrilling new science that could transform medicine | Laura Parker.” *The Guardian*, Guardian News and Media, 25 Oct. 2016, <www.theguardian.com/science/2016/oct/25/bioinspiration-thrilling-new-science-could-transform-medicine.>

[2] Page, Amanda. “8 Healthy Biomimicry Breakthroughs.” *Health Tech With Strange Inspirations | HealthCentral*, Healthcentral, 15 Mar. 2013, <www.healthcentral.com/slideshow/7-healthy-biomimicry-breakthroughs#slide=9.>

[3] Ximedica. “Living Innovation Blog.” *Ximedica*, <www.ximedica.com/index.php/about/entry/medical-device-biomimicry-the-benefits-of-being-oleophobic.>

[4] Adams, Dallon. “The best of biomimicry: Here's 7 brilliant examples of nature-Inspired design.” *Digital Trends*, 29 Jan. 2017, <www.digitaltrends.com/cool-tech/biomimicry-examples/.>

[5] “The Biomimicry Institute - Examples of nature-Inspired sustainable design.” *Biomimicry Institute*, biomimicry.org/biomimicry-examples/.

[6] Heimbuch, Jaymi. “Biomimicry in Medicine: Sharkskin-Inspired Material Stops Bacterial Breakouts.” *TreeHugger*, Treehugger, 5 Feb. 2018, ,www.treehugger.com/clean-technology/biomimicry-in-medicine-sharkskin-inspired-material-stops-bacterial-breakouts.html.>

[7] Gaia. “Environment and Ecology.” *What is Biomimicry?*, environment-ecology.com/biomimicry-bioneers/367-what-is-biomimicry.html.

[8] Hennighausen, Amelia, and Eric Roston. “14 Smart Inventions Inspired by Nature: Biomimicry.” *Bloomberg.com*, Bloomberg, 23 Feb. 2015, <www.bloomberg.com/news/photo-essays/2015-02-23/14-smart-inventions-inspired-by-nature-biomimicry.>

Exhibit 1: